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4–11 April 2014

Copenhagen, Denmark

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1 Executive summary

WGDEEP met at ICES Headquarters in Copenhagen, Denmark on 4–11 April 2014. The group was chaired by Pascal Lorance from France and Gudmundur Thordarson from Iceland. Terms of Reference of the Working Group are given in Section 2.

2014 was the first year WGDEEP gives advice according to a new advice schedule. In short it means that for half of the stocks advice is given in year *y* and the other half has advice in year *y+1*. The exception from this schedule is stocks from Va (Iceland) that will have advice annually. Available time-series for international landings and discards, fishing effort, survey indices and biological information were updated and for all stocks and are presented in Sections 4 to 14 of the report.

For some fisheries, significant discrepancies were found between official landings data supplied to ICES and scientific estimates of landings. In order to maintain the consistency of time-series (which previously used only scientific estimates), some landings have been included in the data tables as "unallocated landing" (see Section 2.2).

The EG provided generic commentary on the application of the HCR to deep-water stocks in the ICES area and specific comments on the application of the HCR in the 2012 advisory process with respect to specific stocks assessed by WGDEEP. In particular, it was found that, when catches decrease year on year it may not be sensible to use a three year average as the basis in the 3.2 rule or other DLS rules that use catches. This may result in higher advice, even with the 20% buffer and the additional 20% cap, than the catches in the terminal year. To further develop methods to provide quantitative advice consistent with the MSY framework, WGDEEP has applied a new approach to Productivity Susceptibility Analysis (PSA) using orange roughy stocks to the west of the British Isles as a case study (Chapter 15). Following WKDEEP 2014, a particular HCR was also adopted for black scabbardfish; assessed for the first time as a unique stock widespread in the NE Atlantic, which spatially and technically distinct fisheries exploit in Faroese waters, Celtic Seas, West Iberia and Azores.

Significant progress in the reliability of several assessments was achieved. The benchmark from WKDEEP 2014 applied to three stocks, ling in Va, blue ling in Vb, VI and VII and black scabbardfish in Vb, VI, VII, VIII and IX.

The assessment of ling in VA using GADGET, developed as exploratory assessment in recent years, is now benchmark as a fully analytical model. The spawning stock of ling in Va is estimated to have reached in 2013 a highest observed level in 30 years, three times above the 1982–2002 average. The state of other ling stocks is diverse and overall less favourable.

Blue ling stocks also showed different status amongst stock units with strong variations in catch, recruitment and biomass in Va, a sustained increased in biomass in relation to a decrease fishing mortality in Vb, VI and VII, and a persistent low level in other areas.

Assessment of tusk was carried out as described in the stock annex, the main progress being made is the standardization of cpue series for many of the stock units and a new estimate of F_{MSY} for tusk in Va. Estimates of biomass for tusk in Va from the GADGET model were revised downward the main reason being a significant drop in the tuning series in 2014 (Icelandic March survey).

Currently ICES advices on two stock units of greater silver smelt, in Va and other areas. WGDEEP-2014 proposes to split the other areas GSS into three advisory units; Area I and II, Vb and VIa and finally other areas. Exploratory assessments were presented for GSS in Va (GADGET) and Vb (XSA).

A new approach for orange roughy where a Productivity Susceptibility Analysis (PSA) was used to appraise the likely impact of existing fisheries on stocks of this species. Previous perceptions that orange roughy stocks were depleted in the north-east Atlantic are not changed but the PSA suggests that the bycatch of orange roughy in current fisheries is sustainable for orange roughy stocks.

The status of the roundnose grenadier stocks are varied. Roundnose grenadier in Vb, VI, VII and XIIb is assessed using a Bayesian surplus production model since 2010. The fishing pressure in 2013 is estimated low, the biomass is slowly rebuilding after two decades of over-exploitation. Roundnose grenadier in the Skagerrak was overexploited in the first half on the 2000s, the limited data available suggest it's now at low level and may be rebuilding under a no catch regulation. The state of roundnose grenadier stocks on the Mid-Atlantic Ridge is unclear owing to very limited data. In this area there was significant fisheries in the past, past to the 1970s, the declined since the 1990s, but increased slightly if the last three years. In other areas, roundnose grenadier occurs at low level.

The assessment of black scabbardfish was benchmarked at WKDEEP 2014. This species was formerly assessed in three units in the ICES area. Although no final conclusion is reached all available evidence suggest that a single stock does a large clockwise migrations in the Northeast Atlantic and further south in the CECAF areas where spawning occurs. Whether fish in Azorean waters and on the Mid-Atlantic Ridge (ICES Subareas X and XII) belongs to the same widely distributed stock is uncertain and the picture in Subarea X is further blurred by the mixing with the closely related intermediate scabbardfish (*Aphanopus intermedius*).

Greater forkbeard is caught mostly as a bycatch. Adults are a landed bycatch in slope fisheries for hake, monkfish, megrims and deep-water species and juveniles are a discarded bycatch in numerous fisheries. The assessment is based upon indices from four surveys, which suggest increasing biomass in all areas.

Alfonsinos are a mixture of two species (*Beryx splendens* and *Beryx decadactylus*. These species are oceanic demersal species occurring at the top of seamounts and along slopes, where they form local aggregations. They are widespread in the Northeast Atlantic from Iceland to the Azores and along the continental slope, in particular to the west of Iberia and Bay of Biscay. The stock structure is uncertain and data very limited. Although a longline survey is carried out in the Azores, where most of the catch occur, the reliably of survey indices is uncertain for these species owing to their large and patchy spatial distributions. As a consequence, the perception of the status of these stocks relies primarily on catch trends.

A reliable estimate of the fishing effort of the Spanish artisanal fleet in the Strait of Gibraltar was used to calculate cpues and the results trend over the last five years confirmed the previous expert judgement that this stock was severely overexploited by artisanal fisheries. The use of the new fishery-dependent biomass index may need being scrutinized by the ICES benchmark process. The stock of the same species in the Azores (ICES Subarea X) also showed signs of overexploitation, while the third blackspot seabream stock in ICES Subareas VI, VII and VIII remains at a low level, since its collapse in the 1980s.

In response to a request from the NEAFC, the working group update descriptions of deep-water fisheries in the NEAFC and ICES areas by compiling data on catch/landings, fishing effort and known spawning areas and areas of local depletion at the finest spatial resolution possible by ICES subarea and division (Chapter 15).

2 Introduction

The **Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources** (WGDEEP), chaired by Pascal Lorance*, France, and Gudmundur Thordarson*, Iceland, met at ICES Headquarters, 4–11 April 2014.

Sixteen participants from nine countries and one ICES secretariat staff contributed to the report. The full participants list is in Annex 1.

2.1 Terms of Reference

The Terms of Reference are given below:

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

b) Evaluate the harvest control rule for data-limited stocks developed by WKLIFE and further develop methods to provide quantitative advice consistent with the MSY framework for stocks assessed by WGDEEP.

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

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

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

f) Assess the progress made on the benchmark WKDEEP 2014, including blue ling in Vb, VI and VII, black scabbardfish in Vb, VI, and VII, black scabbardfish in IXa, and ling in Va.

g) Evaluate the stock status of Icelandic stocks for the provision of annual advice in 2014.

h) Evaluate the stock status of all EU stocks for the provision of biennial advice in 2014.

i) Prepare for an evaluation of the stock status for the rest of stocks for the provision of a rollover advice on 2014 and a biennial advice in 2015.

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 for the meeting must be available to the group no later than 14 days prior to the starting date.

WGDEEP will report by 25April 2014 for the attention of ACOM.

This was coordinated as indicated in the table below.

Fish Stock	Stock name	Stock Coord.	Assess. Coord.	Advice year	Advice frequency
alf-comb	Alfonsinos/Golden eye perch (*Beryx* spp.) in the Northeast Atlantic	Mário Rui Rilho de Pinho	Mário Rui Rilho de Pinho	2014	Biennial
arg-icel	Greater silver smelt (*Argentina Silus*) in Division Va	Bjarki T. Elvarsson	Bjarki T. Elvarsson	2014	Annual
arg-oth	Greater silver smelt (*Argentina Silus*) in Subareas I, II, IV, VI, VII, VIII, IX, X, XII, and XIV, and Divisions IIIa and Vb (other areas)	Hege Overboe Hansen	Elvar Halldor	2015	Biennial
bli-5a14	Blue ling (*Molva dypterygia*) in Division Va and Subarea XIV (Iceland and Reykjanes ridge)	Gudmundur Thordarson	Gudmundur Thordarson	2014	Annual
bli-5b67	Blue ling (*Molva dypterygia*) in Subdivision Vb, and Subareas VI and VII	Pascal Lorance	Pascal Lorance	2014	Biennial
bli-oth	Blue ling (*Molva dypterygia*) in Divisions IIIa, and IVa and Subareas I, II, VIII, IX, and XII	Hege Overboe Hansen	Hege Overboe Hansen	2015	Biennial
bsf-89(1)	Black scabbardfish (*Aphanopus carbo*) in Subareas VIII and IX	Ivone Figueiredo	Ivone Figueiredo	2014	Biennial
bsf-nort(1)	Black scabbardfish (*Aphanopus carbo*) in in Subareas VI, VII, and Divisions Vb, XIIb	Ivone Figueiredo	Ivone Figueiredo	2014	Biennial
bsf-oth(1)	Black scabbardfish (*Aphanopus carbo*) in other areas (Subareas I, II, IV, X, XIV and Divisions IIIa, Va)	Ivone Figueiredo	Ivone Figueiredo	2014	Biennial
gfb-comb	Greater forkbeard (*Phycis blennoides*) in the Northeast Atlantic	Guzmán Diez	Guzmán Diez	2014	Biennial
lin-arct	Ling (*Molva molva*) in Subareas I and II	Kristin Hell	Kristin Hell	2015	Biennial
lin-icel	Ling (*Molva molva*) in Division Va	Bjarki T. Elvarsson	Bjarki T. Elvarsson	2014	Annual
lin-faro	Ling (*Molva molva*) in Division Vb	Lise	Lise	2015	Biennial
lin-oth	Ling in (*Molva molva*) Divisions IIIa and IVa, and in Subareas VI, VII, VIII, IX, XII, and XIV (other areas)	Kristin Hell	Kristin Hell	2015	Biennial
ory-comb (ory-scrk; ory-vii; ory-rest)	Orange roughy (*Hoplostethus atlanticus*) in the Notheast Atlantic	Leonie Dransfeld	Leonie Dransfeld	2014	Biennial
rng-1012;	Roundnose grenadier (*Coryphaenoides rupenstris*) in in Mid-Atlantic Ridge (Xb, XIIc, Va1, XIIa1, XIVb1)	Vladimir T. Vinnichenko	Vladimir T. Vinnichenko	2015	Biennial

Fish Stock	Stock name	Stock Coord.	Assess. Coord.	Advice year	Advice frequency
rng-kask	Roundnose grenadier (*Coryphaenoides rupenstris*) in Division IIIa	Hege Overboe Hansen	Hege Overboe Hansen	2014	Biennial
rng-675b	Roundnose grenadier (*Coryphaenoides rupenstris*) in Subareas VI and VII, and Divisions Vb and XIIb	Lionel Pawlowski	Lionel Pawlowski	2014	Biennial
rng-oth	Roundnose grenadier (*Coryphaenoides rupenstris*) in all other areas (I, II, IV, Va2, VIII, IX, XIVa, and XIVb2)	Vladimir T. Vinnichenko	Vladimir T. Vinnichenko	2015	Biennial
sbr678	Red (=blackspot) seabream (*Pagellus bogaraveo*) in Subareas VI, VII and VIII	Guzmán Diez	Guzmán Diez	2014	Biennial
sbr-ix	Red (=blackspot) seabream (*Pagellus bogaraveo*) in Subarea IX	Juan Gil	Juan Gil	2014	Biennial
sbr-x	Red (=blackspot) seabream (*Pagellus bogaraveo*) in Subarea X (Azores region)	Mário Rui Rilho de Pinho	Mário Rui Rilho de Pinho	2014	Biennial
usk-arct	Tusk in Subareas I and II (Arctic)	Kristin Helle	Kristin Helle	2015	Biennial
usk-icel	Tusk in Division Va and Subarea XIV	Gudmundur Thordarson	Gudmundur Thordarson	2014	Annual
usk-mar	Tusk in Division Subarea XII, excluding XIIb (Mid Atlantic Ridge)	Kristin Helle	Kristin Helle	2015	Biennial
usk-oth	Tusk in Divisions IIIa, Vb, VIa, and XIIb, and Subareas IV, VII, VIII, and IX (other areas)	Kristin Helle	Kristin Helle	2015	Biennial
usk-rock	Tusk in Division VIb (Rockall)	Kristin Helle	Kristin Helle	2014	Biennial
oth-comb	Other deep-sea species combined	Tom Blasdale	Tom Blasdale	2015	Collated data

Due to the number of tasks that is put on WGs (Generic ToRs and bookkeeping) together with the reduced number of days allocated for the meeting the WGDEEP had to prioritise the tasks at the meeting. The main focus was on the adoption of assessments that were the basis for stock status and the premise for the forecasts. This was done to ensure that the basis for the advice was agreed upon. Below is a brief discussion on how WGDEEP addressed its ToRs.

ToR a) Address the general ToRs

The ToR where not addressed systematically for all the stocks. See discussion on Intercatch in 2.2.

ToR b) Evaluate the DLS framework by WKLIFE.

WGDEEP evaluated thoroughly the DLS framework and the main points identified were:

- When catches decrease year on year it may not be sensible to use a three year average as the basis in the 3.2 rule or other DLS rules that use catches. This may result in higher advice, even with the 20% buffer and the additional 20% cap, than the catches in the terminal year.
- For many of the stocks assessed by WGDEEP more than one survey series is available for the stock. However each of these surveys may only cover part of the spatial distribution of the stock. This is not really addressed in the DLS framework. One possible advisory rule might be to take the average of the 3.2 factors from all the survey or another advisory rule might be the one that was proposed in the WKDEEP benchmark for black scabbard fish in the table below:

INDEX 1	INDEX 2	CATCH ADVICE
Increasing	Increasing	Increase
Increasing	stable	stable
decreasing	stable	decrease
stable	stable	stable
decreasing	decreasing	decrease

ToR c) Complete the development of Stock Annexes for all the stocks assessed by WGDEEP

Due to time constraints little work was done on this ToR. However following the benchmark meeting on deep-water species in February 2014, three annexes have been updated: ling in Va, blue ling in Vb, VI and VII and finally for black scabbard fish.

ToR d) Update the description of deep-water fisheries in both the NEAFC and ICES area(s)

A supgroup addressed this ToR and the work is presented in Chapter 15.

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

At the meeting exploratory assessments were presented for the following stocks:

- Red seabream in IX using Gadget. The model work is in very early stages and further development is expected in the future.
- Greater Silver Smelt in Va using Gadget. The model was initially presented to the group in 2012 but has been further developed. The main problem at present is the fit to the tuning series. However that is not a modelling issue but rather a result of the high variances in the time-series.
- Greater Silver Smelt in Vb using XSA. The model has been presented to the group before and the main update is that the level of biomass appears more stable than in the past. However the model only uses landings and data from Vb but not from other fisheries nearby such as VIa the model cannot be considered a realistic assessment tool, specially taking into account the poor diagnostic from the XSA.
- Ling in Vb using XSA. The model was presented to the group six years ago. The main issues are that the catch-at-age matrix is not complete for the terminal years and age–length keys were used. The retrospective analysis indicate a strong bias. The model is tuned with a commercial cpue

and it was suggested rather to use the Faroe summer survey as it is a standardized survey and additionally may have some information on recruitment of ling in Vb.

The exploratory assessments are further discussed in the relevant sections of the report and a full description of them can be found in working documents attached to the report.

ToR f) Evaluate the results of WKDEEP 2014

WGDEEP-2014 considered the results of WKDEEP 2014 to be an improvement and updated relevant stock section accordingly. Similarly assessment was carried out as described in the revised stock annexes.

ToRs g, h and i) Evaluate stock status and draft advice

Addressing these ToRs was the bulk of the work by WGDEEP, all assessments and draft advice sheets were presented in plenary and agreed on by the group.

2.2 WGDEEP data call

On the 28th of February 2014 a data call on deep-sea species in the NE-Atlantic was released by ICES for the stocks assessed by WGDEEP. This was the first data call for these stocks and it is expected that this will become an annual thing. The data call was released late and that may have had some effect on the amount of response it got.

As for many stocks assessed by the group landings are small and taken by few nations it is hard to distinguish whether a 'non-reply' was because nations did not have any catches relevant to the data call or if they failed to reply. In many cases, especially for non-EU nations there is no designated 'data submitter' so the data call had to be answered by the members of the EG adding additional workload on them. The opposite to the aim of the data call.

Many nations uploaded data to InterCatch but in some cases there were problems as expertise on InterCatch was lacking. InterCatch is designed for raising catch in numbers so its use for WGDEEP is limited as the overwhelming majority of the stocks assessed by the group only has landings. Therefore there is little to no benefit of InterCatch to the group compared to the preliminary landings table issued by ICES before the EG takes place. No stock coordinator used InterCatch to get their final landings estimate.

Data provided to the EG via the data call

NATION	NATION CODE	CONFIRMED RECIEVING	REPLIED BUT NO CATCHES	LOADED TO IC	SENT DATA NO UPLOAD to IC	RECTANGLE DATA	BLACK SCABBARD FISH DATA
Belgium	BE						
Canada	CA						
Denmark	DK	x		x			
Estonia	EE	x	x				
Fance	FR			x(1)		x	x
Faroe Islandt	FO	x				y	
Finland	FI						
Germany	DE	x		x			
Greenland	GL	x					
Iceland	IS			x		x	x
Ireland	IE	x		x			
Italy	IT						
Latvia	LV	x	x				
Lithunia	LT	x					
Netherlands	NL				x	x	
Norway	NO				x	x	
Poland	PL	x					
Portugal	PT			x		x	x
Russia	RU			x			
Spain	ES	x		x			
Sweden	SE	x		x			
UK England	UKE			x			
UK Northern Ireland	UKN						
UK Scotland	UKS			x			
UK-C. I. Gurnsey	GG						
UK-C. I. Jersey	JE						
UK-Isle of Man	IM						
United Kingdom	UK	x		x		x	
United States	US						

(1) **On 10.04.2014 (one day before the end of the meeting).**

The group discussed the content of the data call next year. Confidence was expressed that the collation of data through data call will improve quickly as some countries and institutes are setting teams and data plate-forms to address these. One reason for the late provision of some data was the somewhat late release of this first data call. It is worth noting that most necessary assessment data were available to the EG via alternative sources, primarily collation by members themselves.

2.3 Unallocated landings data

Since 2012, The Spanish Authority for Fisheries (Secretaría General de Pesca, SGP), which is also the National authority for the Data Collection Framework, established a new policy and general approach for the provision of official data on catches and fishing effort. This new plan, including the control of fishing activity, has been developed in agreement with the corresponding European Commission authorities. Before 2012, the SGP has had an agreement with the Spanish research institutions IEO and AZTI for the provision of all the catch, effort and biological data in ICES area.

As a result, all Spanish landings data provided in 2013 are official catches which for some stocks may not match the scientific estimates. This may cause a problem where there are significant discrepancies between official data and scientific estimates differences which could affect the coherence of stock historical series. Official statistics are based on logbooks and Auction sheets. It is expected that over time the differences found for some stocks will diminish and official data converge with scientific estimates. To get the best possible assessment of the stock status, the WG considers useful to use unallocated catches as adjustments (positive or negative) to the official catches made for any special knowledge about the fishery for which there is firm external evidence.

2.4 Change of WGDEEP chairs

This year was the first time Gudmundur Thordarson (Iceland) and Pascal Lorance (France) chaired the group. Members of WGDEEP would like to express their gratitude to Tom Blasdale the former chair of WGDEEP for the last six years. First as the only chair and then as a co-chair with Phil Large. Last but not least the group would like to thank Phil Large for his devotion to WGDEEP from 1996, first as a regular member, then as a stock assessment coordinator and finally as a co-chair of the group. He leaves a big void that will be hard to fill.

3 Area overviews

3.1 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. 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 extend on the information presented in the NWWG and WGRED reports.

3.1.1 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 for 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 gear. 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 time of the year.

Demersal fisheries take place all around Iceland including 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 flat fish like plaice, dab, lemon sole and witch.

The total catch in Icelandic waters in 2011 amounted to 1151 thousand tonnes where pelagic fish amounted to 773 thousand tonnes, and deep-sea species amounted to around 343 thousand tonnes (Figure 3.1.1; Table 3.1.1).

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. There were no catches reported by Greenland or other countries (EU, Norway) in 2011.

Fisheries targeting marine resources off Greenland can be divided into inshore and offshore fleets. The Greenland fleet has been built up through the 1960s and is today comprised of 450 ships with an inside motor and a large fleet of small boats. It is estimated that around 1700 small boats are dissipating in some sort of artisanal fishery mainly for private use or in the poundnet fishery.

There is a large difference between the fleet in the northern and southern part of Greenland. In south, where the cod fishery was a major resource the average vessel age is 22 years, in north only nine years.

Inshore fleet

The fleet is constituted by a variety of different platforms from dog sledges used for ice fishing, to small multipurpose boats engaged in whaling or deploying mainly passive gears like gillnets, poundnets, traps, dredges and longlines. West Greenland water is ice free all years up to Sisimiut at 67°N.

In the northern areas from the Disko Bay at 72°N and north to Upernavik at 74°30N, dog sledge are the platforms in winter and small open vessels the units in summer, both fishing with longlines to target Greenland halibut in the icefjords. The main bycatch from this fishery is redfish, Greenland shark, roughhead grenadier and in recent years cod in Disko Bay.

The inshore shrimp fisheries are departed along most of the West coast from 61–72°N. The main bycatch with the inshore shrimp trawlers is juvenile redfish, cod and Greenland halibut. An inshore shrimp fishery is conducted mainly in Disko Bay but also occasional in fjords at southwest Greenland. Most of the small inshore shrimp trawlers have dispensation for using sorting grid, which is mandatory in the shrimp fishery.

Cod is targeted all year, but with a peak time in June–July, and poundnet and gillnet are main gear types. Bycatches are mainly the Greenland cod (*Gadus ogac*) and wolffish.

In the recent years there has been an increasing exploitation rate for lumpfish. Fishing season is rather short, around April and along most of the West coast the roe is landed. Bycatch is mainly comprised of seabirds (eiders). The scallop fishery is conducted with dredges at the West coast from 64–72°N, with the main landings (<3000 t) at 66°N. Bycatch in this fishery is considered insignificant. Fishery for snow crab is presently the fourth largest fishery in Greenland waters measured by economic value. The snow crabs are caught in traps in areas 62–70°N. Problems with bycatch are at present unknown. A small salmon fishery with driftnets and gillnets are conducted in August to October, regulated by a TAC.

Offshore fleets

Apart from the Greenland fleet resources are exploited by several nations mainly EU, Iceland, Norway and Russia. Recently, Greenland halibut and redfish were targeted using demersal otter-board trawls with a minimum mesh size of 140 mm since 1985.

Cod fishing has ceased since 1992 in the West Greenland offshore waters, but started again in the 2000s. In 2010 the fishery was closed off West Greenland. In East Greenland the fishery has been closed north of 62°N since 2008 in order to protect cod spawning grounds. The Greenland offshore shrimp fleet consists of 15 freezer trawlers. They exclusively target shrimp stocks off West and East Greenland, landing in 2011 around 128 000 and 1084 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.

At the east coast an offshore pelagic fleet targets redfish, a rather clean fishery without any significant bycatches, in the Irminger Sea and extending south of Greenland into NAFO area. There used to be a capelin fishery but it ceased in 2009.

3.1.2 Trends in fisheries

Iceland

Tusk, ling and blue ling remains the most important "deep-sea species" in Icelandic waters). In recent years, about 120 vessels were engaged in these fisheries with registered annual catches from less than 100 kg to nearly 1000 tonnes. In 2011 about 13 000 tonnes of deep-water species were caught in bottom-trawl, plus 11 000 t of greater silver smelt. There has been an increase in the landings of ling, tusk and blue ling in the period 2006–2010, with a slight drop in 2011(Figure 3.1.1). The increase in the two former stocks was a consequence of increase in quota (a TAC is not set for blue ling). Since 2008 the longline fishery for blue ling seems to have changed from almost a pure bycatch fishery to a more targeted fishery (Figure 3.1.3). 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 3.1.1 gives the catches of the Icelandic fleet of the most important deep-sea species taken by different gears in 2007 to 2010 and Table 3.1.2 gives the total landings of deep-sea species from Subdivision Va since 2000.

Greenland

In the last century the main target species of the various fisheries in Greenland waters have changed. A large international fleet landed in the 1950s and 1960s, large catches of cod reaching historic high in 1962 with about 450 000 t. The offshore stock collapsed in the late 1960s early 1970s due to heavy exploitation and changes in environmental conditions. Since then the stock remained depended on occasional Icelandic larval cod transported. From 1992 to 2004 the biomass of offshore cod at West Greenland has been negligible, but increased in the late 2000s due to incoming cod from Iceland (2003 YC). Since 2010 the cod biomass has been concentrated in the spawning grounds off East Greenland. In 1969 the offshore shrimp fishery started and has been increasing ever since reaching a historic high of 157 000 t in 2006. Recent catches however indicate a decline in the shrimp fishery.

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

3.1.3 Technical interactions

Iceland

The ling, blue ling and tusk in Icelandic waters constitute only a minor portion of the total demersal removal from the Icelandic Ecosystem (Figure 3.1.2). These three species are to some extent bycatch in fisheries targeting other species; both in the longline (Figure 3.1.3) and the bottom-trawl (Figure 3.1.4) 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 3.1.4).

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 3.1.5).

However some limited targeted longline fishery of 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 3.1.6).

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 targeting cod off the east coast.

3.1.4 Ecosystem considerations

Iceland

Iceland is located at the junction of the Mid-Atlantic Ridge and the Greenland-Scotland Ridge, just south of the Arctic Circle. 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 brake. In the Denmark Strait it divides into a branch that flows northeastward and eastward 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 out 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/m^2-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 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 at 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 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).

Iceland is a partner in the European project CoralFISH, started in 2008 to investigate the interaction between cold-water corals, fish and fisheries and develop monitoring and predictive modelling tools for ecosystem based management. Most coral areas investigated have been damaged by fishing activity to different extents (Anon., 2009; Ólafsdóttir and Burgos, unpublished).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 (*Brosme brosme*), ling (*Molva molva*), herring, capelin and blue whiting. Most fish species spawn in the warm Atlantic water off the south and southwest coasts. Fish larvae and 0-group 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 1996/1997 to about 1000 Kt in 2006/2007 (NWWG, 2007). Herring were very abundant in the early 1960s, collapsed and then have increased since 1970 to a historical high level in the last decade. 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 are collected in extensive bottom-trawl surveys conducted in early spring and autumn, but information on their 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 on the order of 1.5 million tonnes.

At least twelve species of cetaceans occur regularly in Icelandic waters, and 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 seal, 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. These are notorious changes for Atlantic water in this area. Off central N-Iceland similar changes have been observed although with higher interannual variability. This period has been characterized with an increase of temperature and salinity in the winter north of Iceland in the last ten years is on average 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 nursing 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 in 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.

There is one demersal stock, which apparently has not taken advantage, or not been able to take advantage, of the milder marine climate of Icelandic waters. This is the Icelandic cod, which flourished during the last warm epoch, which began around 1920 and lasted until 1965. By the early 1980s the cod had been fished down to a very low level as compared to previous decades and has remained relatively low since. During the last 20 years the Icelandic cod stock has not produced a large year class and the average number of age 3 recruits in the last 20 years is about 150 million fish per annum, as compared to 205–210 recruits in almost any period prior to that, even the ice years of 1965–1971.

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 mix 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 on 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 exist and with a historic large shrimp biomass in West Greenland water in present time feeding conditions would be optimal for fish predators such as cod (Hvingel and Kingsley, 2006).

In recent years more southerly distributed species such as monkfish, lemon sole, saithe and whiting has been observed on surveys in offshore West and East Greenland and inshore West Greenland.

3.1.5 Management measures

Iceland

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.

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 total allowable catch (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 "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 certain percentage. If, in a given area, there are several consecutive quick closures the Minister of Fisheries can with regulations close the area for 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 3.1.5). 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 at protect juveniles. Figure 3.1.7 shows a 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, TAC, mesh size, grids, minimum landing size and closed areas for the Atlantic cod, snow crab, scallops, salmon and shrimp. Fishery for Greenland cod and lumpfish are unregulated.

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

Table 3.1.1. Overview of the Icelandic deep-sea landings (in tonnes) in Icelandic waters (Va) in 2007 to 2011 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	10 825	16 429
	Pelagic trawl	108	4	4	185
	Total	4226	8778	10 829	16 428

Table 3.1.2. 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	

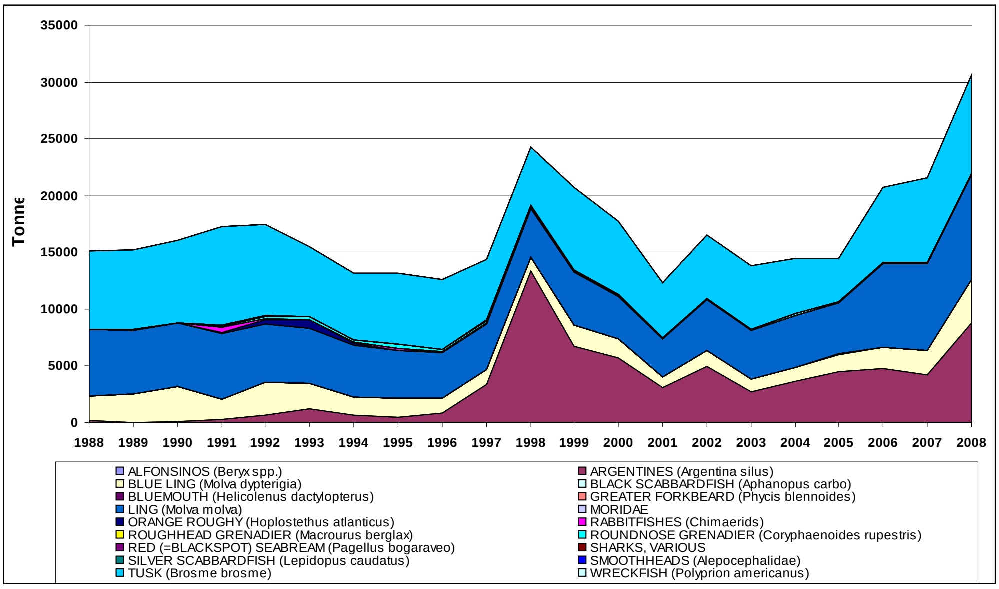

Figure 3.1.1. Fishery of deep-sea species in Subdivision Va 1988–2008, by species.

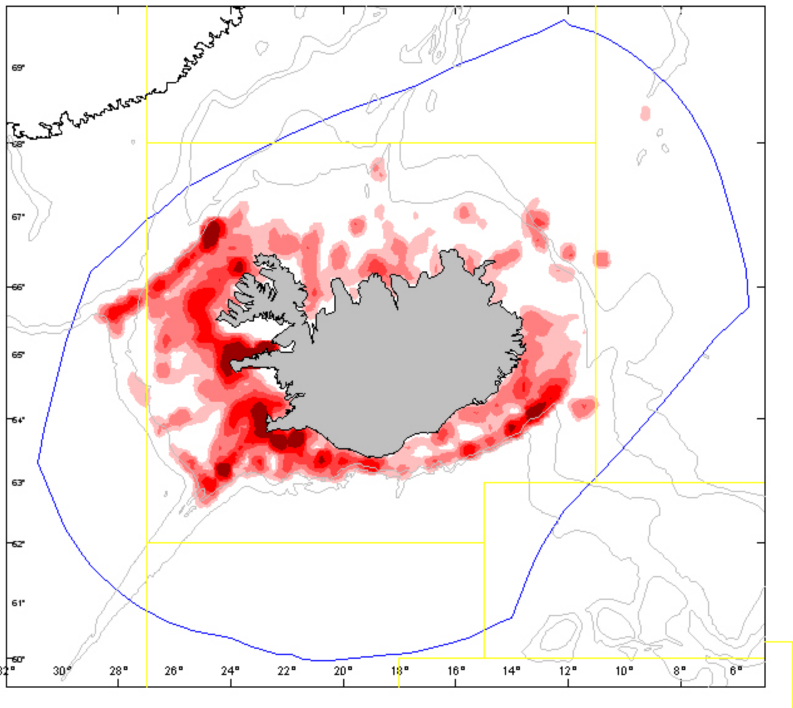

Figure 3.1.2. The spatial distribution of the total removal of all species by the Icelandic demersal fishing fleet in the Icelandic EEZ in 2007. The EEZ is shown as a blue line, regular thin lines show major ICES areas and contour lines indicate 500 and 1000 m depth.

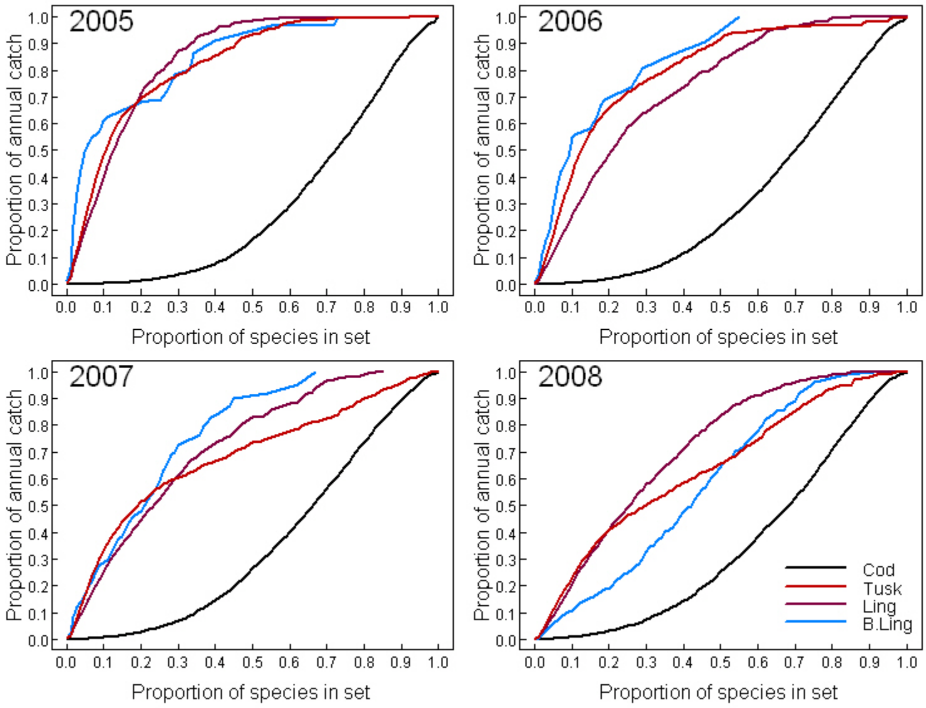

Figure 3.1.3. Cumulative plot for longline in 2005–2008. An example describes this probably best. Looking at the figure for 2005 above it can be seen from the solid line that 50% of the catch of ling comes from sets where tusk is less than 15% of the total catch whereas only insignificant % of the catch 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.

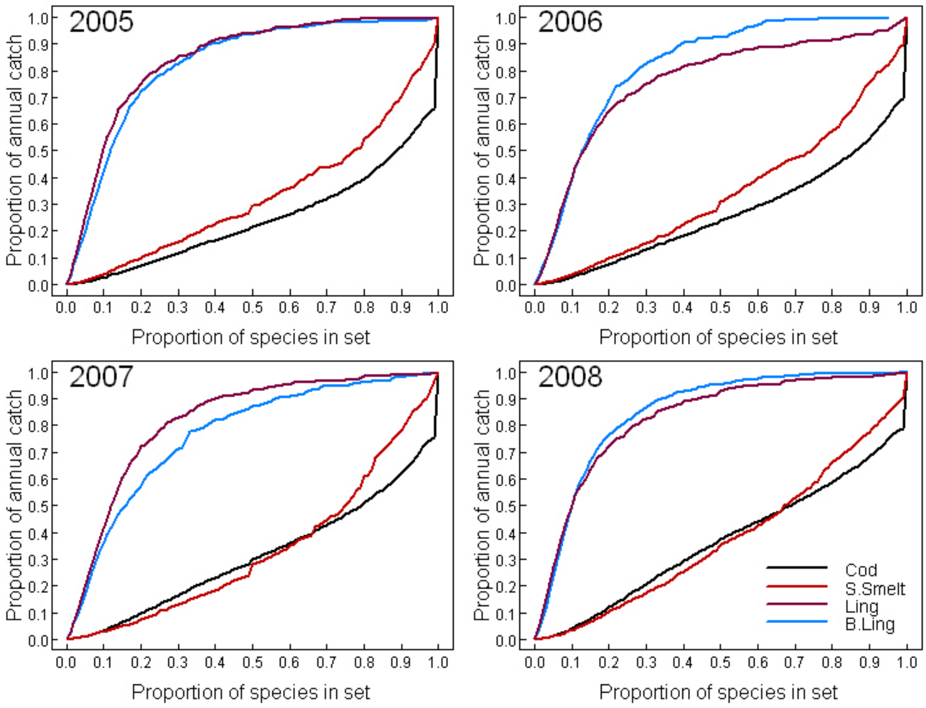

Figure 3.1.4. Cumulative plot for bottom trawl in 2005–2008. See Figure 3.1.3 for details.

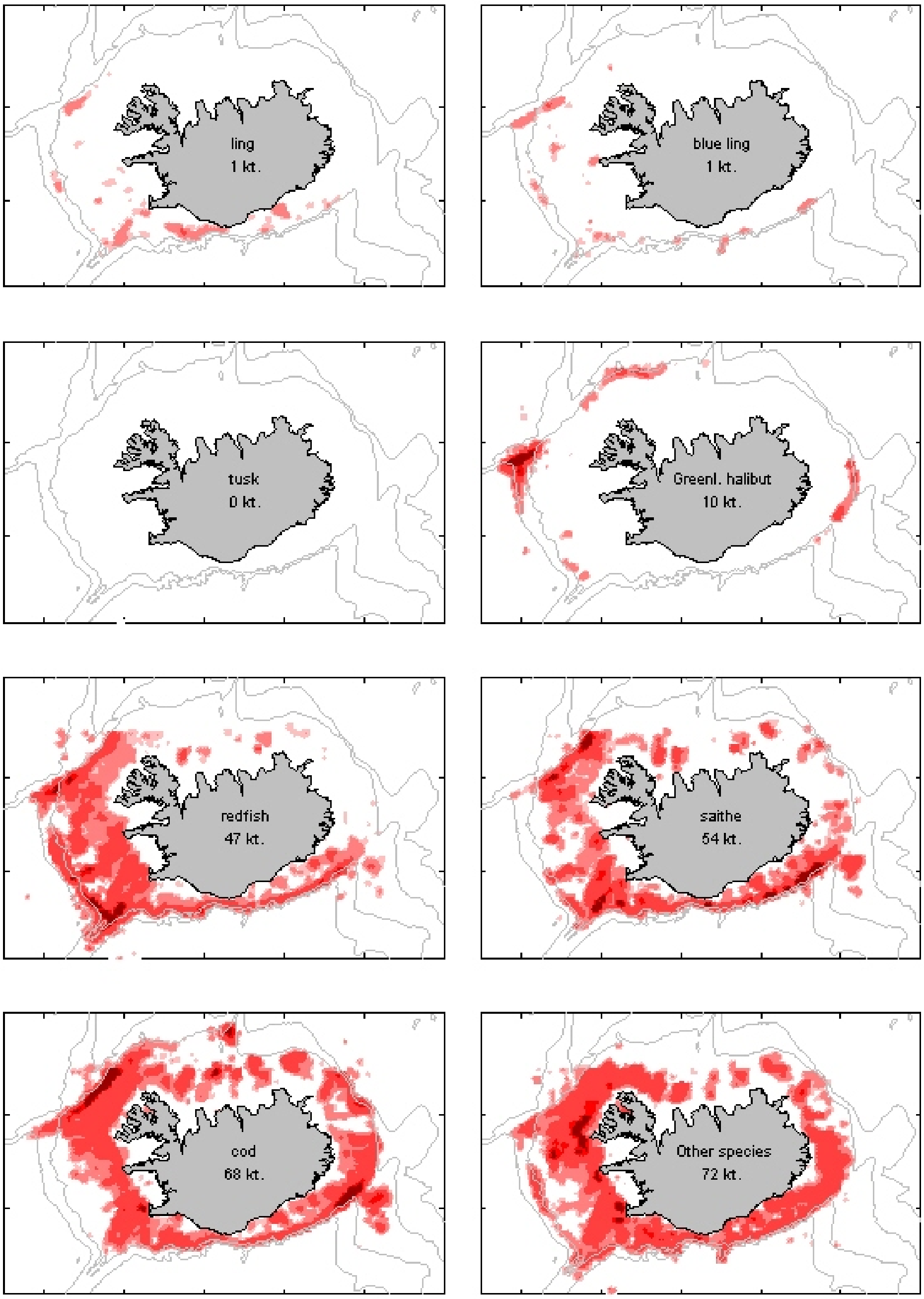

Figure 3.1.5. Spatial distribution of the removal of various species by the bottom trawling in 2007. The densities scale is comparable among the figures. The total catch by species is shown in units of thousand tonnes (kilotonnes). The grey lines correspond to 500 and 1000 meter depth contours.

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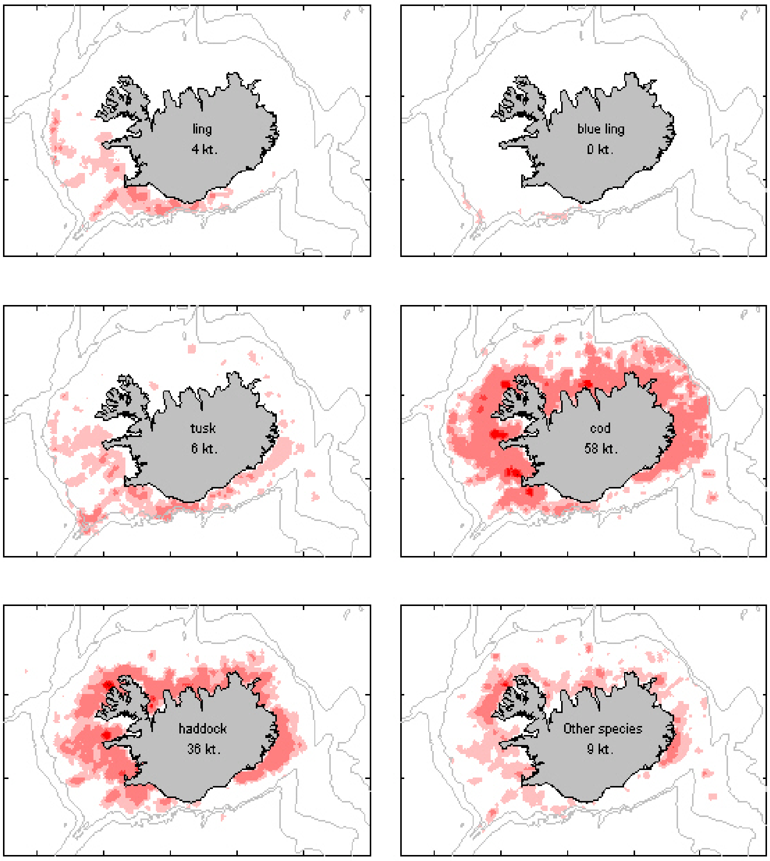


Figure 3.1.6. Spatial distribution of the removal of various species by the long lining in 2007. The densities scale is comparable among the figures. The total catch by species is shown in units of thousand tonnes (kilotonnes). The grey lines correspond to 500 and 1000 meter depth contours.

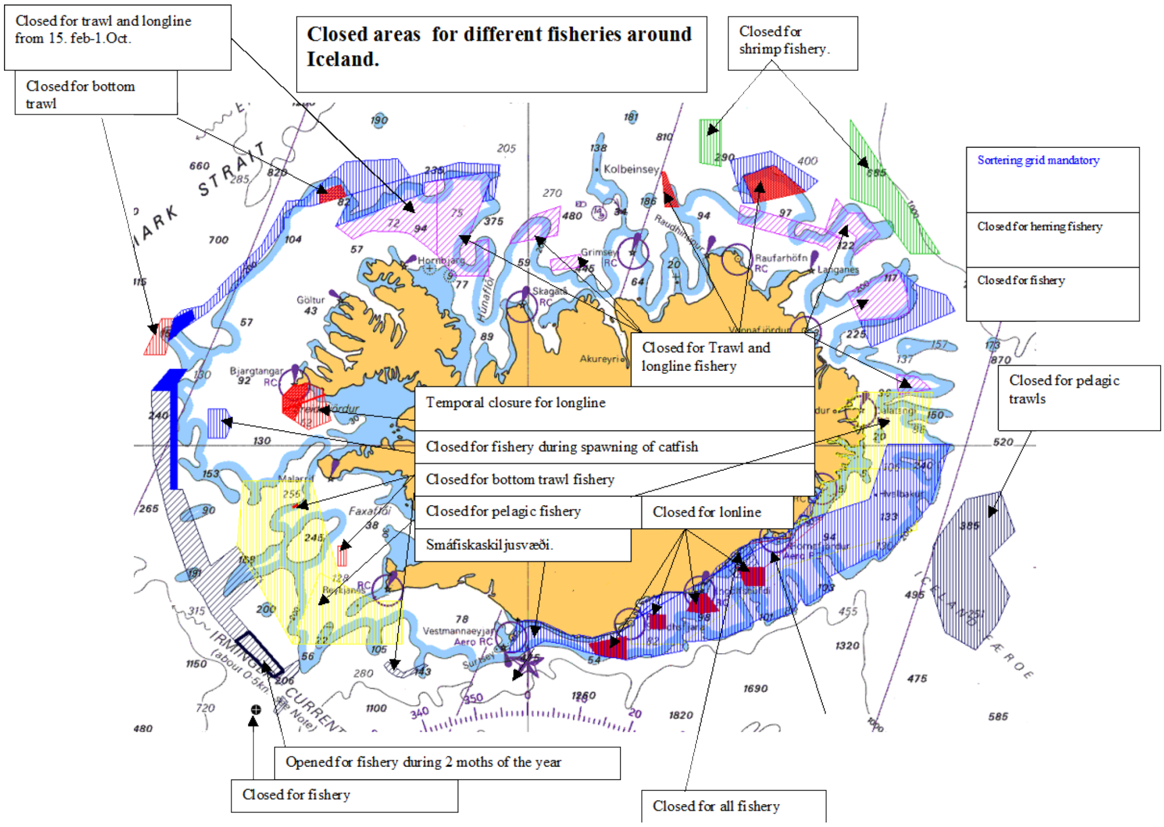


Figure 3.1.7. Overview of closed areas around Iceland. The boxes are of different nature and can be closed for different time period and gear type.

3.2 Stocks and fisheries of the Barents Sea and Norwegian Sea

3.2.1 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 3.2.1 and Figure 3.2.1). Tusk is mainly caught by longliners and a small proportion is caught in gillnets, while ling is caught almost equally by longliners and gillnetters. 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 dypterigia*). 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 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 33 in 2013 (Table 3.2.2). 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, then especially in the southern southeast area off the coast of Norway. The fishery has changed to be dominated by semi-pelagic trawlers operating further north but still off the coast of Norway at deeper areas and along the continental slope. This fishery effort directed at *A. silus* varied and was 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 1990s. During the period 2004–2006 there was a large increase in landings resulting in a Norwegian TAC set to 12 000 tons from 2007 and onwards. Landings have since then reflected the TAC.

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.

3.2.2 Trends in fisheries

Landing statistics for Subareas I and II for the period 1988–2013 are given in Table 3.2.1.

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 eighties to about 7000 tons in 2005. During the last years the reported catches has increased compared to the level in 2005. Preliminary landings for 2013 is about 8637 tonnes. Landings of ling have remained stable at 10 000 tons. Preliminary landings in 2013 are 8825 tons. Blue ling landings declined markedly from 1988 through 1993, and the catches have been at a low level until 2013 (Figure 3.2.2).

Greater silver smelt

During the period 1988–2000 there was a slight downwards trend in the landed catches. From 2000 through 2006 there was an increase in the landed catches to about 22 000 tons. Since 2007 the catches have declined to a level around the TAC set for this area and preliminary data for present year are consistent with that trend (Figures 3.2.1 and 3.2.2).

3.2.3 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 meters containing two deep basins of 3000–4000 meters. 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 saltwater from the north. This creates distinct fronts which are closely related to bottom topography. The topography and large variations in depth gives a varied 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 caused 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 200–400m depths. Fosså *et al*., 2000 estimated that between 1500–2000 km² of the Norwegian EEZ is covered by this habitat. 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 seamounts 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.

No new information was provided to the working group.

3.2.4 Management measures

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 2013 set to 7250 t. There is no minimum landing size in the Norwegian EEZ. There is no directed fishery for blue ling and a 10% bycatch is allowed from other fisheries in Norwegian waters for this species.

The Norwegian greater silver smelt fishery has since 2007 been regulated by a Norwegian TAC. Norwegian vessels need specified licence and get individual quotas. The total TAC for greater silver smelt in Subarea I and II in 2013 was 12 000 t. In addition EU sets TACs and quotas applicable to EC vessels fishing in community waters and international waters of Subarea I and II. The EU TAC has been 90 t in later years.

Table 3.2.1. 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) SEABREAM (*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 3.2.1. Overview of landings in Subareas I and II, continued.

Species	2006	2007	2008	2009	2010	2011	2012	2013
ALFONSINOS (*Beryx* spp.)								
ARGENTINES (*Argentina silus*)	21 685	13 273	11 876	11 929	11 854	11 476	12 134	11 979
BLUE LING (*Molva dypterigia*)	202	262	333	285	426	437	337	159
BLACK SCABBARDFISH (*Aphanopus carbo*)								
BLUEMOUTH (*Helicolenus dactylopterus*)								
GREATER FORKBEARD (*Phycis blennoides*)	49	47	117	82	132	113	98	83
LING (*Molva molva*)	8845	10 338	11 346	8564	10 580	10 099	8425	8825
MORIDAE								
ORANGE ROUGHY (*Hoplostethus atlanticus*)								
RABBITFISH (*Chimaerids*)	28	63	80	88	197	150	TOM?	
ROUGHHEAD GRENADIER (*Macrourus berglax*)	78	50	55	53	45	29	54	
ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*)	8	12	10	8	23	16	5	17
RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*)								
SHARKS, VARIOUS			1					
SILVER SCABBARDFISH (*Lepidopus caudatus*)								
SMOOTHHEADS (*Alepocephalidae*)								
TUSK (*Brosme brosme*)	9988	10 744	11 883	9657	12 658	11 646	10 394	8637
WRECKFISH (*Polyprion americanus*)								

Table 3.2.2. Number of vessels exceeding 21 m in the Norwegian longliner fleet during the period 1995–2012.

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
2011	37
2012*	36
2013	33

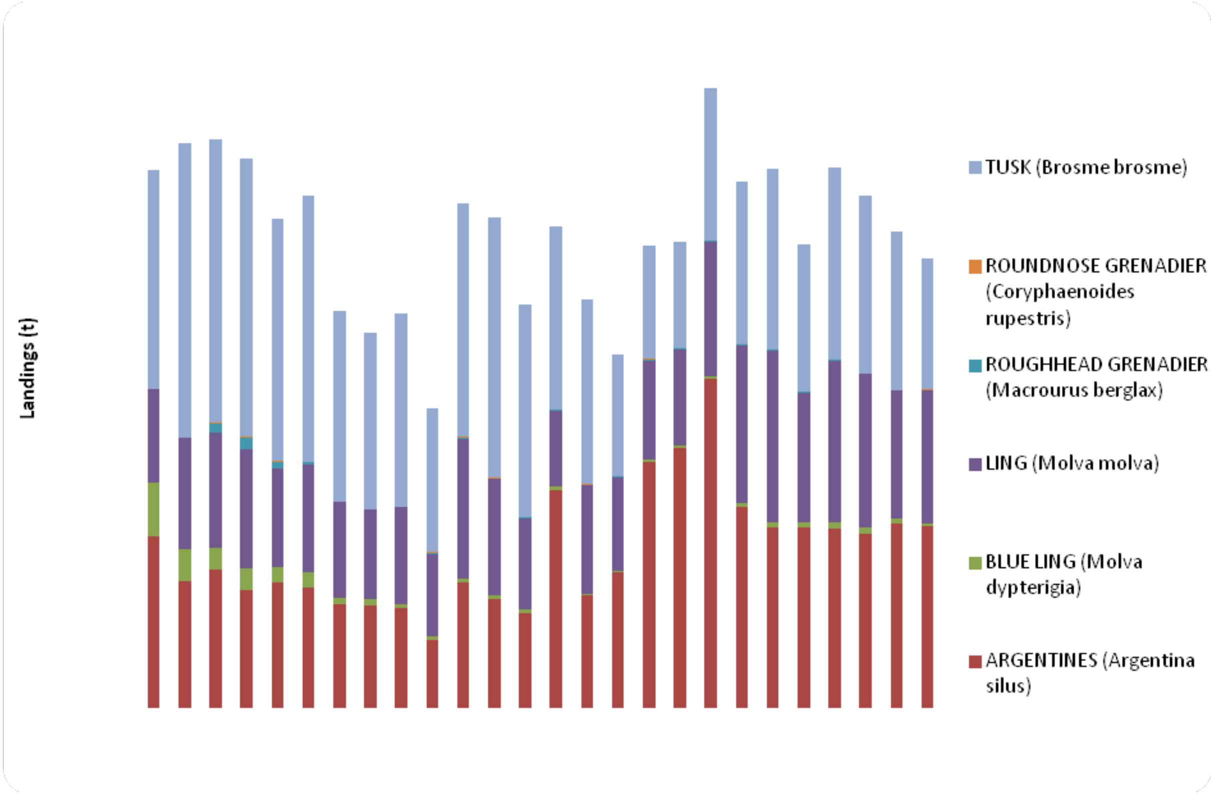


Figure 3.2.1. Trends in the landings in Subareas I and II. Landings of roundnose and roughhead grenadier are insignificant in Subareas I and II. Preliminary data for 2013.

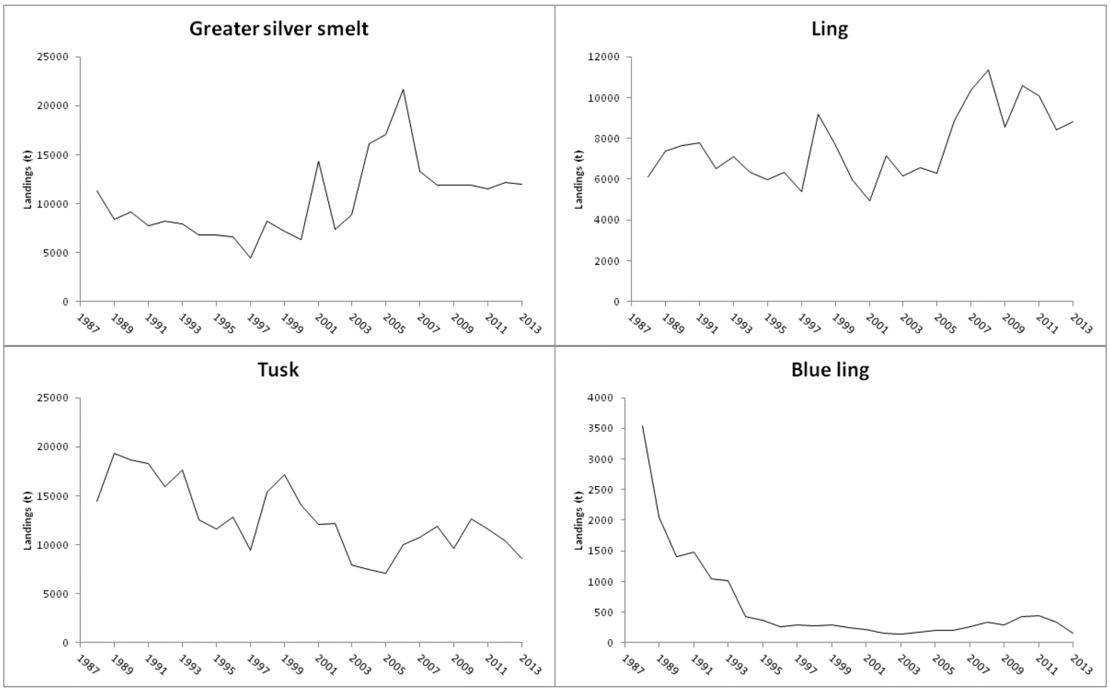


Figure 3.2.2. Trends in the landings of argentines, tusk, ling and blue ling in Subareas I and II. Landings are in different scales. * Preliminary data for 2013.

3.3 Stocks and fisheries of the Faroes

3.3.1 Fisheries overview

Fisheries in Faroese waters (Division Vb)

The fishery around the Faroe Islands has for centuries been an almost free international fishery involving several countries. Up to 1959, all vessels were allowed to fish around the Faroes outside the 3 nm zone. During the 1960s, the fisheries zone was gradually expanded, and in 1977 an EEZ of 200 nm was introduced in the Faroe area. The demersal fishery by foreign nations has since decreased and Faroese vessels now take most of the catches. The main fisheries in Faroese waters are mixed-species, demersal fisheries and single-species, pelagic fisheries. The demersal fisheries are mainly conducted by Faroese vessels, but vessels from other nations are still participating like Norwegian longliners and EU trawlers licensed through bilateral and multilateral agreements. Due to a dispute on mackerel regulations, no such bilateral agreement has been in force between the Faroes and Norway and EU for 2011 onwards. The major part of the pelagic fisheries is conducted by foreign vessels through similar agreements.

3.3.2 Trends in fisheries

Except for the traditional longline fisheries for tusk and ling, which have been well established for decades, the Faroese deep-water fisheries started in the late 1970s following the expansion of the national EEZs to 200 nm and a wish to reallocate fishing effort from traditional shelf fisheries. In the first years all fishing was within the Faroese EEZ. Later, the fishery gradually expanded to more distant areas and to include more and more species/stocks.

The main deep-water fleet consists of about 13 otter board trawlers with engines larger than 2000 Hp. They have traditionally targeted saithe, redfish *(Sebastes* spp.), Greenland halibut, blue ling and to a lesser degree black scabbardfish *(Aphanopus carbo)* and roundnose grenadier *(Coryphaenoides rupestris)*. There has been an increased effort in Faroese waters as the deep-water fleet has reduced its effort in other areas. This has resulted in increased effort on black scabbardfish, roundnose grenadier and blue ling in Vb with a corresponding increase in the landings of these species. However, due to poor economic conditions especially the very high fuel prices, the number of vessels has declined in the most recent years and the effort towards deep-water species has declined further due to a switch to pair-trawling targeting mainly saithe.

The traditional longline fleet fishing ling, tusk and blue ling consist of 24 longliners larger than 110 GRT; they are mainly targeting cod and haddock and in years where the availability of these species is high and market conditions satisfactory, they spend very little effort in deep water. There has been a more directed fishery of ling and tusk in 2011 and 2012 because of lower availability of cod and haddock.

In the 1990s, a gillnet fishery directed at monkfish *(Lophius piscatorius)* and Greenland halibut *(Reinhardtius hippoglossoides)* developed in Vb and is now well established; bycatches in this fishery are among others deep-sea redcrab and blue ling. Exploratory trap fishery for deep-sea crab are performed.

A trawl fishery for greater silver smelt (*Argentina silus*) has been expanding rapidly in recent years. Three pairs of pair trawlers (six boats), which otherwise mainly target saithe (*Pollachius virens*), hold licences to this fishery that mainly takes place in late spring and summer. Small quantities of greater silver smelt are also taken as bycatch in the blue whiting fishery and in the deep-water fishery for e.g. red fish and blue ling.

Updated total international landings of deep-sea species in Division Vb are given in Table 4.2.1 and Figure 4.2.1.

3.3.3 Technical interaction

As explained above, several fleets are fishing deep-sea species in Vb, either regularly targeting these species or now and then participate in such fisheries depending on availability of other targets. While greater silver smelt is taken only by three pair trawlers with special licences for this fishery, grenadiers and black scabbard fish are targeted by the larger otter-board trawlers (>2000 HP).

The text table below shows the 2007–2013 shares by Faroese fleet categories in % of ling, blue ling and tusk, respectively.

	Year	Longliners <110 GRT	Longliners >110 GRT	OB trawlers <1000 HP	OB trawlers >1000 HP	Pair-trawlers <1000 HP	Pair-trawlers >1000 HP	Others
Ling	2007	9	48	2	19	5	15	2
	2008	8	65	1	8	3	10	5
	2009	3	56	1	3	5	30	2
	2010	3	68	1	2	4	21	1
	2011	7	58	1	1	3	27	3
	2012	4	61	0	2	5	25	3
	2013	15	47	0	1	6	26	4
Blue ling	2007	0	16	0	83	+	+	1
	2008	0	24	0	69	0	1	5
	2009	0	29	0	64	1	2	4
	2010	0	21	0	73	1	4	1
	2011	3	42	3	34	4	14	0
	2012	4	66	0	12	1	14	3
	2013	5	27	1	48	2	4	3
Tusk	2007	9	74	1	10	1	3	2
	2008	9	81	0	6	1	2	1
	2009	4	80	0	5	1	8	1
	2010	3	88	0	3	1	5	0
	2011	7	85	1	2	1	4	0
	2012	4	90	0	1	1	5	0
	2013	18	71	0	3	1	5	2

Although the proportions by fleet of these three species do vary annually, ling is on average over many years a 60% line fishery and 40% trawl fishery; blue ling is mainly a trawl fishery whereas longlines mainly take tusk. If Norwegian vessels are included, most of the ling is taken by longline.

3.3.4 Ecosystem considerations

The waters around the Faroe Islands are in the upper 500 m dominated by the North Atlantic current, which to the north of the islands meets the East Icelandic current. Clockwise current systems create retention areas on the Faroe Plateau (Faroe shelf) and on the Faroe Bank. In deeper waters to the north and east is deep Norwegian Sea water, and to the south and west is Atlantic water. From the late 1980s the intensity of the North Atlantic current passing the Faroe area decreased, but it has increased again since. The productivity of the Faroese waters was very low in the late 1980s and early 1990s. This applies also to the recruitment of many fish stocks, and the growth of the fish was poor as well. From 1992 onwards the conditions have returned to more normal values, which also are reflected in the fish landings. There has been observed a very clear relationship, from primary production to the higher trophic levels (including fish and seabirds), in the Faroe shelf ecosystem, and all trophic levels seem to respond quickly to variability in primary production in the ecosystem (Gaard *et al*., 2001).

Existing and former areas of *Lophelia* coral have been mapped around the Faroes through questionnaires to fishermen (Frederiksen *et al*., 1992; Jákupsstova *et al*., 2002).

An estimated 11 000 km^2 of living coral are found in Faroese waters, although this is estimated to be a significant reduction from earlier times (ICES, 2005). Some of these coral areas have in recent years been closed to fishing and mapping of these areas is ongoing with the purpose of a further expansion of closed areas.

No new information was presented to the working group.

3.3.5 Management measures

Since 1 June 1996, a management system based on a combination of area closures and individual transferable effort quotas in days within fleet categories have been in force. The individual transferable effort quotas apply to 1) the longliners less than 110 GRT, the jiggers, and the single trawlers less than 400 HP, 2) the pair trawlers and 3) the longliners greater than 110 GRT. One fishing day by longliners less than 100 GRT is considered equivalent to two fishing days for jiggers in the same gear category. Longliners less than 110 GRT could therefore double their allocation by converting to jigging. The allocation of number of fishing days is based on areas shallower than about 200 m. Holders of individual transferable effort quotas who fish in deeper waters can fish for three days for each day allocated. The single trawlers greater than 400 HP are not regulated through number of fishing days, but the numbers of fishing licences have been settled for this fleet as well as for the gillnetters and they are regulated by depth of fishing as well. Trawlers are not allowed to fish within the 12 nautical mile limit and large areas on the shelf are closed to them. Inside the 6 nautical miles limit only longliners less than 110 GRT and jiggers less than 110 GRT are allowed to fish. The Faroe Bank shallower than 200 m is closed to all trawl and gillnet fisheries. From 2011 onwards, the otter-board trawler fleet larger than 400 HP has been included in the day effort system and most of them have now been included into category 2), the pair trawlers, since they have switched to pair trawling.

Technical measures such as area closures during the spawning periods, to protect juveniles and young fish and mesh size regulations are a natural part of the fisheries regulations.

As mentioned above, vessels from other nations are licensed to fish in Faroese waters through bilateral and multilateral agreements. Only Norway and EU have permission to fish deep-water species. From 2011 onwards, no such agreement has been in force due to a dispute on mackerel regulations. As no agreement was reached between the Faroe Islands and European Union, no fishing quota was attributed to EU vessels in 2011. This seems to remain the same in 2012. This has significant impact on deep-water catch in Division Vb where EU vessels allowed a quota of 2700 t of ling and blue ling (against which a bycatch of roundnose grenadier and black scabbardfish of 952 tonnes could be counted). The main impact of the absence of the EU-Faroe Islands agreement in 2011 was on French catches of blue ling in Divisions Vb.

Table 3.3.1. Deep-sea landings in Division Vb.

Species	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ALFONSINOS (*Beryx* spp.)			5		4			1					
ARGENTINES (*Argentina silus*)	287	227	2888	60	1443	1063	960	12286	9498	8433	17570	8214	5209
BLUE LING (*Molva dypterigia*)	9526	5264	4799	2962	4702	2836	1644	2440	1602	2798	2584	2932	2524
BLACK SCABBARDFISH (*Aphanopus carbo*)		166	419	152	33	287	160	424	186	68	180	172	311
BLUEMOUTH (*Helicolenus dactylopterus*)												64	16
DEEP WATER CARDINAL FISH (*Epigonus telescopus*)							4	3	8	8		8	2
GREATER FORKBEARD (*Phycis blennoides*)	2	1	38	53	49	27	4	9	7	7	8	34	32
LING (*Molva molva*)	4488	4652	3857	4512	3614	2856	3622	4070	4896	5657	5359	5238	4109
MORIDAE				5								1	3
ORANGE ROUGHY (*Hoplostethus atlanticus*)			22	48	13	37	170	420	79	18	3	5	155
RABBITFISHES (Chimaerids)								1				3	54
ROUGHHEAD GRENADIER (*Macrourus berglax*)										6	9	99	1
ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*)	1	258	1549	2311	3817	1681	668	1223	1078	1112	1667	1996	1791
RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*)													
SHARKS, VARIOUS			140	78	164	478	192	262	380	308	433	470	409
SILVER SCABBARDFISH (*Lepidopus caudatus*)													
SMOOTHHEADS (Alepocephalidae)													
TUSK (*Brosme brosme*)	5665	5122	6181	6266	5391	3439	4316	3978	3310	3319	2710	3964	2700
WRECKFISH (*Polyprion americanus*)													

Table 3.3.1. Continued. Deep-sea landings in Division Vb.

SPECIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ALFONSINOS (*Beryx* spp.)					2		0	0	0	0			
ARGENTINES (*Argentina silus*)	10 081	7471	6558	5310	7013	12 559	14 126	14 592	14 228	15 609	15 071	9854	10 951
BLUE LING (*Molva dypterigia*)	2116	2024	3815	2700	2516	2850	3296	2060	1136	1684	1115	1010	609
BLACK SCABBARDFISH (*Aphanopus carbo*)	879	1744	1635	869	553	783	789	1868	1067	840	395	416	363
BLUEMOUTH (*Helicolenus dactylopterus*)				3	0		0	1					
DEEP WATER CARDINAL FISH (*Epigonus telescopus*)	7		2	1	0		0	0					
GREATER FORKBEARD (*Phycis blennoides*)	102	149	73	50	46	39	56	45	22	60		0	
LING (*Molva molva*)	4609	4139	5453	6039	5849	5213	4731	4747	4630	6101	4784	6003	4075
MORIDAE	100	19	8	1	1	5	8	4	1	11	5	5	0
ORANGE ROUGHY (*Hoplostethus atlanticus*)	5	1	5	7	13	0	1	0	2	0			1
RABBITFISHES (Chimaerids)	96	64	61	100	63	62	78	49	6	5			
ROUGHHEAD GRENADIER (*Macrourus berglax*)	4	3	12	10	6	10	5	3		1			
ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*)	2016	1031	1532	1575	1837	1775	1700	1112	446	369	56	16	17
RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*)													
SHARKS, VARIOUS	543					303	663	509	462	173	87	300	211
SILVER SCABBARDFISH (*Lepidopus caudatus*)													
SMOOTHHEADS (Alepocephalidae)				6	1		0	4					
TUSK (*Brosme brosme*)	3993	3003	3292	3643	3632	3876	3775	3750	3265	4981	3282	3793	1460
WRECKFISH (*Polyprion americanus*)							0	0					

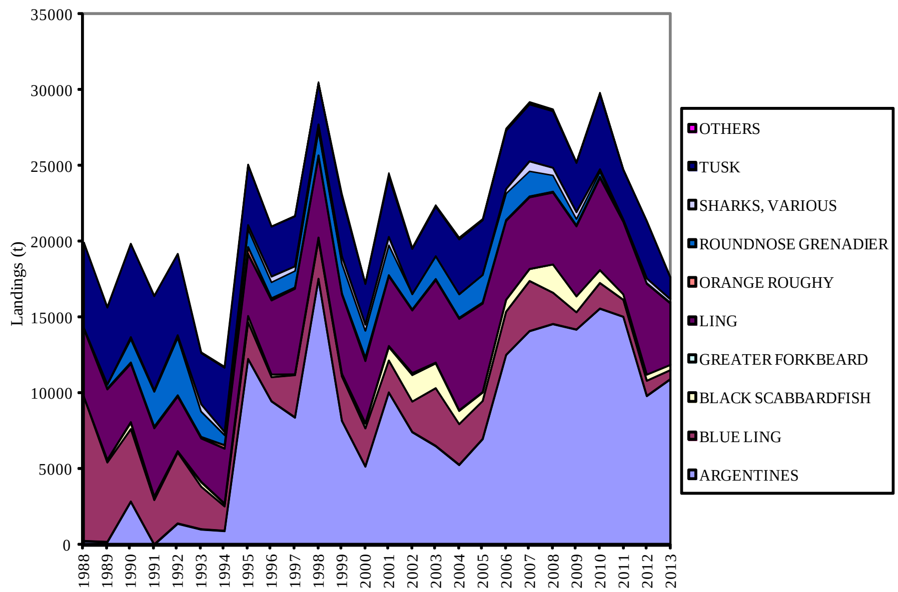


Figure 3.3.1. Annual landings of major deep-water species in Faroese waters (Vb) (1988–2013).

3.4 Stocks and fisheries of the Celtic Seas

3.4.1 Fisheries overview

Deep-water trawl fisheries are conducted in ICES Subareas VI and VII, principally by French, Irish, Spanish and Scottish vessels. Until 2012, 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 Subarea 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 ten vessels in 2011. The reduction by three vessels in 2011 is partly due the wreck of one vessel and the absence of agreement between the Faroe Island and the EU in 2011. 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.

The Irish deep-water fisheries included a mixed fishery based on the flat grounds for black scabbard, roundnose grenadier and siki sharks and a targeted orange roughy fishery on aggregations and mounds. Both fisheries have now ceased.

A number of Scottish vessels target monkfish (*Lophius* spp) on the upper continental slope and down to 1000 m 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 and black scabbardfish.

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 fork-beard and blackbelly rosefish.

A fleet of 29 Spanish bottom freezer trawlers have fished in the international waters of the Hatton Bank (ICES XIIb and VIb1) over the past years, but their presence is discontinuous. A total of ten trawlers fished at Hatton in 2011 from January to October, but their number varied among months, ranging from one to nine ships and peaking in summer. Vessels conduct fishing trips of variable duration. According to scientific observer data, fishing is mostly conducted from 1000 to 1400 m. Roundnose grenadier and Baird's smoothhead (3–12 000 t per year in 1997–2011) are the most important species in the catches. Black scabbardfish (peaked at 5100 t in 2006 and has decreased since to 150 t in 2011, preliminary estimate) and blue ling (peaked at 1500 t in 2002, has decreased since to 60 t in 2011, preliminary estimate) are also caught in significant amounts. Historical data on the catch and effort of this fleet have been problematic, and the EG 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 ICES 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 operated in deep-water of Subareas VI and VII targeting hake, monkfish and deep-water sharks, this fishery was stopped or seriously reduced from 2006 as a result of regulation of deep-water gillnetting at depth below 600 m (see below, management measures).

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

There has been a UK trap fishery for deep-water red crab *Chaceon affinis* in *S*ubarea VI and VII, but this is now ceased.

3.4.2 Trends in fisheries

Total landings with time of deep-water species from Subareas VI and VII are given in Table 3.4.1. 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 slow.

Landings in 2012 should be considered preliminary.

3.4.3 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, hake, 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 blackbelly rosefish, which is discarded in large quantities by vessels fishing on the continental shelf in Division VIa and on the Rockall Bank in Subarea VII, and to greater forkbeard in Subarea VII. Before the collapse of the stock, blackspot seabream also occurred on the shelf and juveniles were coastal in the summer (Lorance, 2011).

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.

3.4.4 Ecosystem considerations

3.4.4.1 Aspects of the ecoregion description relevant to the deep water

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 latter feature 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 and b; Gordon, 1986; Gordon and Bergstad, 1992). At any depth 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.

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 species vs. 22 occurring on the shelf). In contrast, ray species are more numerous on the shelf. Rays are caught is small numbers by deep-waters fisheries. As rather rare species they may be severely impacted by fishing but this is difficult to assess because they would require high sampling intensity. Lastly, chimaeras (five species) form a third group of *Chondrichthyans*, whose life-history and population dynamics are poorly known and which occur only in deep water.

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.

Cold-water corals (CWCs), large sponges and the associated communities are termed Vulnerable Marine Ecosystems (VMEs). Information on known locations and the impact of fishing on VMEs, primarily CWCs, is compiled and updated by WGDEC. No exhaustive description of the distribution of VMEs exists. *Lophelia pertusa* is found on the continental slopes off Norway, Iceland, Faroes, the UK, France, Spain and Portugal as well as the Mid-Atlantic Ridge (e.g. Rogers, 1999). To the west of Scotland, *L. Pertusa* occurs from depths as shallow as 130 m down to 2000 m (Grehan *et al*., 2005; Duineveld *et al*., 2012). 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.

3.4.4.2 Activity and pressure

Fishing has a stronger impact on species with low population productivity (Jennings *et al*., 1998; Jennings *et al*., 1999), making them particularly vulnerable to over-exploitation. This applies to both the target and non-target species. A large proportion of deep-water trawl catches can consist of unpalatable species and numerous small species, including juveniles of the target species, which are usually discarded. Based upon 55 hauls, Allain *et al*. (2003) estimated that discards represented 25 to 68% of the total catch in weight of the French mixed trawl fishery for deep-water species, depending on depth. In recent year, discards were estimated at 20–25% of the total catch, based on the larger DCF sampling. The two reasons for the difference are the reduced fishing depth in recent years that imply a smaller proportion of smoothheads (*Alepocephalus* spp.) in the catch and the distribution of the fishery now more restricted to the West of Scotland while data from Allain *et al*. (2003) came from 47°N (west of France) or 59°N (North of Scotland).

The Baird's smoothhead (*Alepocephalus bairdii*) and the greater argentine (*Argentina silus*) made together more than 50% of the discards in weight in 2011 in the French trawl fishery (Dubé *et al*., 2012). However; a large number of other non-marketable benthopelagic 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 reduce the biomass and abundance of the whole fish community biomass.

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. 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 (CWC), 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.

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; Durán-Muñoz *et al*., 2011). The degree of this damage depends on fishing effort (ICES, 2007b). The recovery rates for damaged coral are extremely slow (Risk *et al*., 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). A number of areas on Rockall and Hatton Banks have been closed to fishing with gears in contact with the seafloor (Figure 4.7.3).

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 large 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 from 1990 and the early 2000s. 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 fishing effort 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).

3.4.4.3 State

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.

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 scabbard-fish). 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 (Howell *et al*., 2009; Heymans *et al*., 2011).

In the Porcupine Seabight (Subarea VII) recent studies of the changes of the deep-water fish community suggested that the abundance in number in the early 2000s was reduced to 50% of pre-exploitation period (1977–1989) abundance and that the abundance decrease extended deeper that the depth range of fishing activities (Bailey *et al*., 2009). This latter observation reported as an "unexpected phenomenon" was further explained by the spreading of the decrease number of exploited populations to the whole depth and area of distribution of these populations (Priede *et al*., 2010). This latter phenomenon is indeed an expected effect, it is the "sink" effect of fishing in a particular area and the contrary of the "spillover effect" expected from MPAs (e.g. Forcada *et al*., 2009). In a further paper, the decline in the fish community biomass, at fished depth in the same area, between the pre- and post-exploitation period was estimated to 36% (Godbold *et al*., 2012). This level of change is actually lower that the roughly 50% of virgin biomass that can be expected for communities exploited at MSY level, in an ideal situation of a balanced exploitation where all population would be affected proportionally to their resilience/vulnerability (Garcia *et al*., 2012).

3.4.5 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 seabream (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.

EU-TACs for ling since 2005 and for blue ling and greater silver smelt since 2009 in Subareas, II, IV, V, VI and VII are set within the annual TAC regulation because the TAC level depends upon annual negotiations between The Faroe Islands, 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.

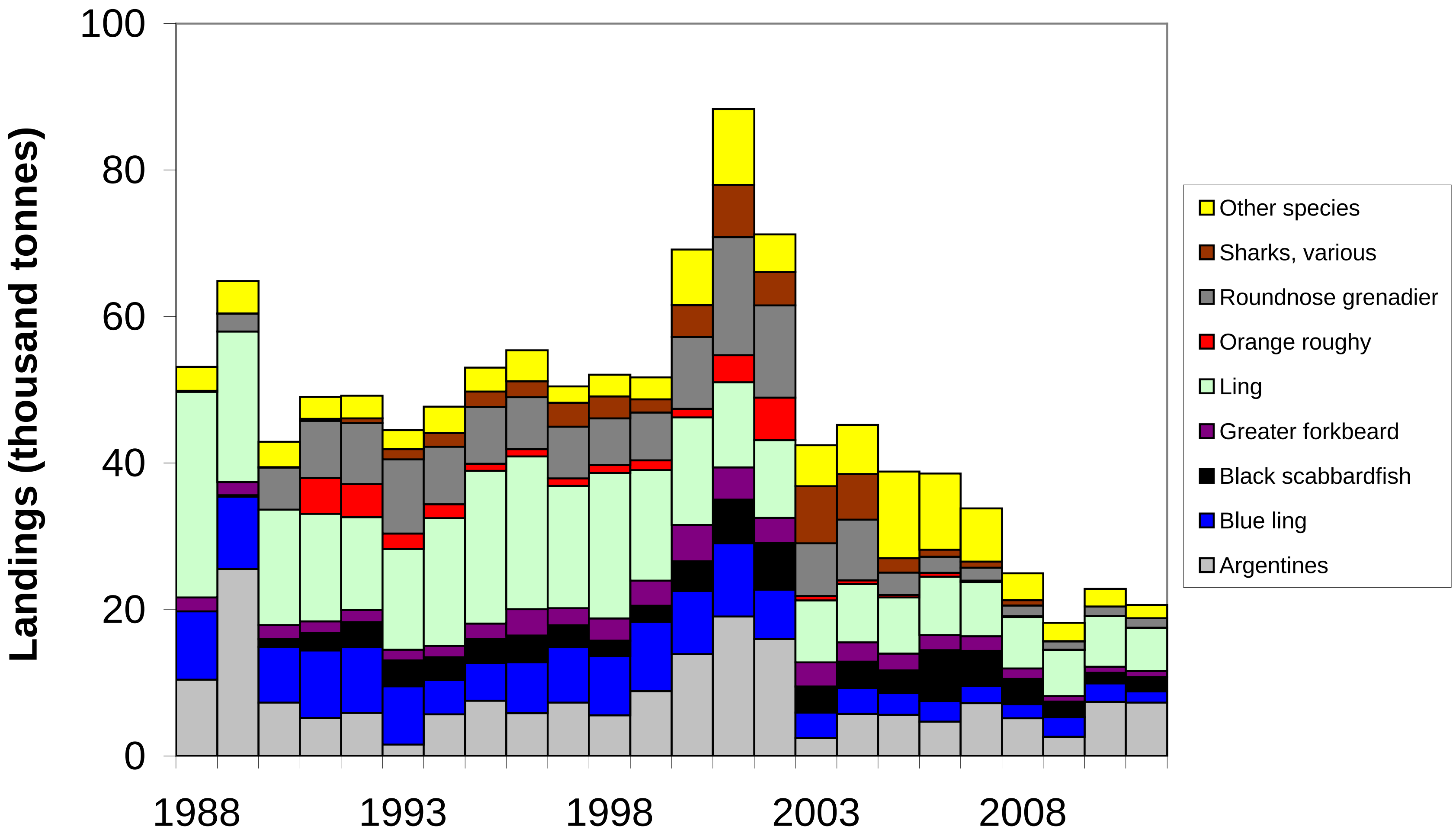


Figure 3.4.1. Landings of deep-water species from Subareas VI and VII.

Table 3.4.1. Deep-water species landings (tonnes) 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	2011
Alfonsinos		12	8		3	1	5	3	178	25	81	75	133	186	95	84	64	70	78	65	50	7	13	
Argentines	10 438	25 559	7294	5197	5906	1577	5707	7546	5863	7301	5555	8856	13919	19049	15975	2476	5761	5619	4683	7233	5171	2627	7405	7279
Blue ling	9316	9850	7628	9223	8957	7953	4673	5130	6929	7569	8098	9475	8636	10013	6729	3460	3522	2965	2800	2352	1880	2660	2515	1550
Black scabbardfish	0	184	1034	2401	3436	3530	3098	3275	3678	2996	2100	2178	4038	5932	6407	3571	3623	3112	6971	4761	3476	2128	1435	1948
Bluemouth		127	100	128	159	152	117	71	87	88	145	354	332	279	196	397	433	307	219	320	257	108	75	
Deep water cardinal fish						30	217	91	45	49	115	258	302	393	985	1078	873	687	413	224	24	10	10	
Greater forkbeard	1898	1815	1921	1574	1640	1462	1571	2138	3590	2335	3040	3430	4967	4405	3417	3287	2606	2290	2081	1995	1418	796	824	843
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	14 685	11 631	10 613	8445	7959	7683	7964	7419	7034	6280	6941	5915
Moridae				1	25							20	159	194	159	327	71	63	111	64	57		1	
Orange roughy		8	17	4908	4523	2097	1901	947	995	1039	1071	1337	1158	3692	5788	622	523	302	522	184	123	18	0	0
Rabbitfish							2					236	404	797	570	469	444	571	325	391	370	47	31	
Roughhead grenadier						18	5	4	13	12	10	34	11	45	12	11	33	1488	2003	1180	128	210	11	
Roundnose grenadier	32	2440	5730	7793	8338	10121	7860	7767	7095	7070	6364	6538	9815	16127	12596	7185	8297	3088	2179	1759	1460	1149	1312	1278
Blackspot seabream	252	189	134	123	40	22	10	11	29	56	17	23	20	52	25	40	55	41	63	130	63	61	62	22
Sharks, various	85	40	43	254	639	1392	1864	2099	2176	3240	3023	1791	4347	7144	4573	7781	6231	1973	966	837	732	15	0	0
Silver scabbardfish						2						18	17	6	1			57	377	88	40	44	32	
Smoothheads				31	17								978	5305	260	393	2657	5978	4966	2565	896	295	511	
Tusk	3002	4086	3216	2719	2817	2378	3233	3085	2417	1832	2240	1647	4532	2725	1817	1713	1375	1736	1639	1398	1643	1715	1638	1792
Wreckfish	7		2	10	15				83		12	14	14	17	9	2	2			2	3	8	3	
Deep-water red crab								10	1365	187	347	335	688	355	993	1083	661	810	204	836	125			

3.5 Stocks and fisheries of the North Sea (IIIa and IV)

3.5.1 Fisheries overview

The main fisheries currently catching deep-sea species in the IIIa and IV are:

- Bycatches of ling and tusk 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 bycatch. 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 U.K. 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.
- 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.

3.5.2 Trends in fisheries

An overview of total landings is shown in Figure 3.5.1 and Table 3.5.1.

Table 3.5.2 gives an overview of the 2011 landings by country and subareas.

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 meters. The geographical area of exploitation was very small, constituting of 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 are 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.

3.5.3 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 meshed fishery and the bycatch landings are restricted by the general 10% (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.

3.5.4 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*.

No new information was provided to the working group.

3.5.5 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 is expire 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 the management in the EU zone are managed according to EU regulation, while the fisheries in the Norwegian zone IV are managed according to Norwegian regulations following the EU-Norway negotiations.

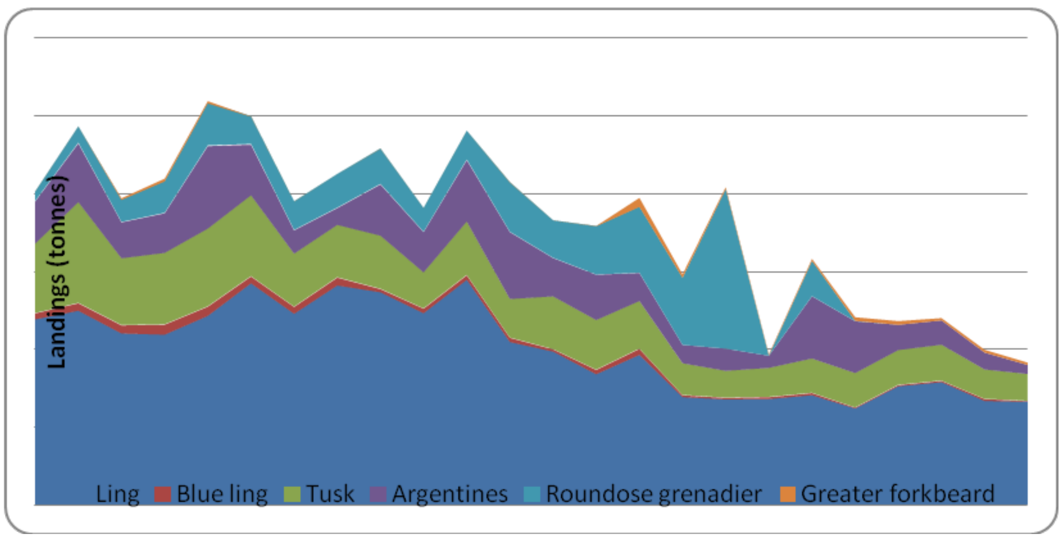


Figure 3.5.1. Overview of deep-sea species landings, over 1988–2011 (tonnes).

Table 3.5.1. Landings of Deep-sea species in Division III and IV, 1997–2011.

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
RABBITFISHES (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) SEABREAM (*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 3.5.1. Continued.

Species	2010	2011
ALFONSINOS (*Beryx* spp.)		
ARGENTINES (*Argentina silus*)	1081	585
BLUE LING (*Molva dypterigia*)	124	50
BLACK SCABBARDFISH (*Aphanopus carbo*)		
BLUEMOUTH (*Helicolenus dactylopterus*)		
GREATER FORKBEARD (*Phycis blennoides*)	182	159
LING (*Molva molva*)	6609	5998
MORIDAE		
ORANGE ROUGHY (*Hoplostethus atlanticus*)		
RABBITFISHES (Chimaerids)	22	6
ROUGHHEAD GRENADIER (*Macrourus berglax*)		
ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*)	8	2
RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*)		
SHARKS, VARIOUS	1	
SILVER SCABBARDFISH (*Lepidopus caudatus*)		
SMOOTHHEADS (*Alepocephalidae*)		
TUSK (*Brosme brosme*)	2282	1666
WRECKFISH (*Polyprion americanus*)		

Table 3.5.2 Landings (t) by country, division and species in 2011 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											
	IV a											
	IV b											
	IV c											
UK-E+W												
	IVa			28		6						
	IVb											
	IVc											
UK-Scot												
	IVa		1	1976	2	72						
	IVb			10								
	IVc											
FRO												
	IVa											
	IVb											
	IVc											
NOR												
	IIIa			52		13			2			
	IVa	585	35	3757		1469			2		145	
	IVb		11	83		95			2		14	
	IVc											
FRA												
	IVa		1	43	6	3			0		3	
	IVb				0	1			0		1	
	IVc			0								
		585	50	5998	2	1666			6		159	

3.6 Stocks and fisheries of the South European Atlantic Shelf

3.6.1 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 on conger, greater forkbeard, deep-water sharks and ling.

The **French trawler fishery** mainly target 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 pollock (*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 zero quota.

In ICES Subarea IX on the contrary there is a main directed **Portuguese longline fishery** for black scabbard fish (*Aphanopus carbo*) with a bycatch (now discarded since the introduction of zero EU TAC in 2010) of the deep-water sharks, and also and **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* with some bycatch of deep-water species.

Unlike former years, the official Spanish landings in 2012 have been estimated from the logbooks rather than from the sale sheets. This means that landings of artisanal fleets (mainly small gillnetters and liners) are not included in the official Spanish landings reported this year to the WG. This change in reporting procedure has resulted in significant apparent changes in the landings of theses subareas compared to the historical series in former years, especially for several species (p.e. *Helicolenus dactylopterus, Epigonus telescopus, Lepidopus caudatus, Polyprion americanus* and *Pagellus bogaraveo*).

3.6.2 Trends in fisheries

Although since 1988 from six to 17 deep species are usually landed in Areas VIII and IX, the catches of *Aphanopus carbo* (49.3%) *Lepidopus caudatus* (12.8%) *Pagellus bogaraveo* (9.7%), *Molva molva* (5.2%), *Phycis blennoides* (4.3%), *Polyprion americanus* (4.1%), *Beryx* spp (1.8%), *Helicolenus dactylopterus* (5.6%) and *Argentina sphiraena* (2.7%) represent on average the 95.4% of total subareas' landings.

Since 1988 on average 7011 t of these species are landed from these subareas. The most important peak was observed in 1995 (12 678 t) due to an increase of *L. caudatus* landings in Subarea IX (Table 3.6.1).

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 it is worthy of remark that 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 higher value (4524 t). Since this year the trend indicates a decrease until 2000, and after this year the average landings have been 3112 t/year.

The trend of silver scabbard fish landings is very variable along the period 1988–2006. Landings of this species have been always lower than black scabbardfish ones, except in 1995 in which 5672 t were reached. In 2000 only 16 t were reported but the landings of this species were increased to 902 t in 2011 and decreased again strongly in 2012 to 36 t (Figure 3.6.1).

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. In European Atlantic Shelf from 1988 to 1998 the landings rank between 666 and 1175 t (on average 958 t), and from 2000 to 2012 the total landings average 596 t. However landings since 2009 decreased to a 59%.

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, and in 1998 the peak of the series (1799 t) is raised. However, since the peak in 1998 landings of this species have been decreased strongly reaching only 54 t in 2011 and 203 in 2012 (Figure 3.6.1).

Geater forkbeard (*Phycis blennoides*), wreckfish (*Polyprion americanus*) and alfonsinos (*Beryx* spp.)

Since 1998 the 97% of greater forkbeard landings in Southern European Atlantic shelf belongs to Subarea VIII. The landings in the combined areas show a clear increase from 1988 to 1998 and, after the peak in 1998, the landings in 2012 have been decreased until 41 t.

The wreckfish landings do not show a clear trend, in 1994 shows a peak of 440 t but since this year the trend in landings is negative until 2004. Since this year the wreckfish shows an important increase in the landings, reaching the peak of the series with 504 ton in 2007. But in 2010 and 2011 decreased until 110 t and 112 t respectively and in 2012 increased until 256 t.

The most important landings of alfonsinos in Subareas VIII and IX ware recorded in since 1995. From 1995 to 2004 increase of landing trends is observed but since 2008 landings maintained below 100 t/year (Table 3.6.1).

3.6.3 Technical interactions

An update of information of gear interaction of Spanish fleets fishing deep-water species during the period 2005–2012 is shown in Table 3.6.2.

3.6.4 Ecosystem considerations

There is a need to evaluate the scale of impacts of lost and abandoned gillnets and trammelnets in Subareas VIII and IX.

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

No new information is available to the WG.

3.6.5 Management measures

In 2011 and 2012 TACs for the most of deep-water species were the same or set at lower levels than previous years. TACs 0 adopted in 2010 for some species 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, is still maintained for 2011 and 2012 (Council Regulation (EU) No 1225/2010). 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 3.6.1. 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

Table 3.6.1 Continued. Overview of landings in Subareas VIII and IX.

Species	2005	2006	2007	2008	2009	2010	2011	2012*
ALFONSINOS (*Beryx* spp.)	191	94	71	101	65	40	60	79
ARGENTINES (*Argentina silus*)	202		1	11	1	0	1	7
BLUE LING (*Molva dypterigia*)	61	351	36	56	16	7	234	281
BLACK SCABBARDFISH (*Aphanopus carbo*)	2770	2726	3480	3644	3612	3454	2797	2738
BLUEMOUTH (*Helicolenus dactylopterus*)	206	279	356	345	240	120	309	1332
DEEP WATER CARDINAL FISH (*Epigonus telescopus*)	9	11	6	320	134	1	128	2
GREATER FORKBEARD (*Phycis blennoides*)	337	316	166	562	206	69	61	41
LING (*Molva molva*)	487	355	321	296	328	169	54	203
MORIDAE	15	9	18	9	6	4	18	6
ORANGE ROUGHY (*Hoplostethus atlanticus*)	27	43	1	9	17	8	1	29
RABBITFISHES (Chimaerids)	5	10	3	3	1	0	0	1
ROUGHHEAD GRENADIER (*Macrourus berglax*)		3	0	0	0	0	0	0
ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*)	7	28	11	5	2	1	1	0
RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*)	584	656	718	751	809	548	475	336
SILVER SCABBARDFISH (*Lepidopus caudatus*)	526	620	654	846	931	829	902	36
SMOOTHHEADS (*Alepocephalidae*)				0	0	0	0	0
TUSK (*Brosme brosme*)		1	0	0	0	4	0	0
WRECKFISH (*Polyprion americanus*)	196	333	504	317	313	110	115	256
DEEP WATER RED CRAB (*Chaceon* spp)		305	83	0	0	0	0	0
LESSER SILVER SMELT (*Argentina sphiraena*)	223	264	180	244	153	103	137	23

*** preliminary**

Table 3.6.2. Quantitative description of fishing gears and landings (t) interaction of Spanish fleets in Subareas VIII and IX.

landings (ton)		2005		2006		2007		2008		2009		2010		2011		2012	
Species	Gear	VIII	IX	VIII	IX	VIII	IX	VIII	VIII	IX	IX	VIII	IX	VIII	IX	VIII	IX
Argentina sphyraena	LLS	0												0	0		
	GNS			0		0			0								
	OTB	32	0	261	3	184	1	237	1	2		103		115	1	22	
	Others	0	4	0										20			0
Beryx spp.	LLS	21		26	3	47	1	4		4	5		0	20	3	30	
	GNS	35		13		9	1	1		1	5		0	13	4	28	6
	OTB	19		7	2	3	4	5	1	3			0	1	1	2	0
	Others	62	6	1	2	0											
Lepidopus caudatus	LLS		449		563		645		842		894			813	0		7
	GNS											785		1		1	
	OTB		0		0		3				4			0	13	0	0
	Others	0	59		51		0		0			44		0	0	0	
Molva molva	LLS	47		48		32		34		0			0	34		149	
	GNS	16		8		7		1		0			16	3		42	
	OTB	12		17	0	8	1	8		1			4	9		9	
	Others	66	0	0										1		1	
Pagellus bogaraveo	LLS	44	334	28	369	83	404	20	439	16	594		0	39	258	80	6
	GNS	6		7		17	2	4	1	7		379	0	62	0	3	6
	OTB	16	2	21	4	47	1	15	3	1	0		0	16	0	18	20
	Others	24	29	1	66	2		2		0			2	5	1	1	3
Phycis spp.	LLS	148	0	80	1	294	3	20	14	20	5	2	1	173	7	2	0
	GNS	8	0	21	1	41	4	3	29	1	4	1	8	18	5	0	0
	OTB	97	39	84	28	113	55	56	0	58	53	0	15	38	34	13	6
	Others	0	18	0	42	0	0	0			0	20		6	14	0	0
Polyprion americanus	LLS	15	0	2	1	42	6	2	3	1	5		0	3	3	75	1
	GNS	0		0		2	6	0	0	0	4	1	0	0	1	20	0
	OTB	0	1	0	3	0	5	1	0	0	1				1	3	0
	Others	0	5	0	10							3			2	0	

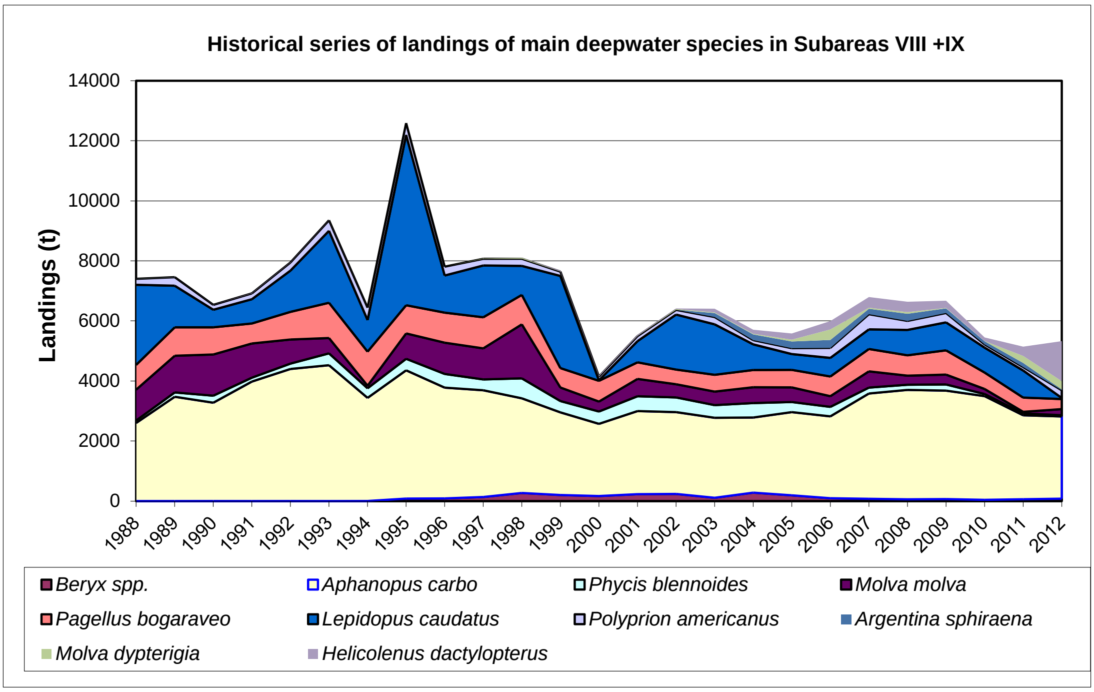


Figure 3.6.1. Historical series of the ten main species landed in combined Subareas VIII and IX since 1988.

3.7 Stocks and fisheries of the Oceanic Northeast Atlantic

3.7.1 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 two 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 and an artisanal fishery inside the Azorean EZZ and this are 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, others commercially important species are also caught and the target species change seasonally according abundance, species vulnerability and market.

The fishery is clearly a typical small scale one, where the 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 dypterigia)* were found. Trawl and longline fisheries were conducted in Subareas X, XII, XIV and V (Figure 4.7.1) by Russian, Icelandic, Faroese, Polish, Latvian and Spanish vessels.

3.7.2 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. An expansion on the fishing area has been observed for this fleet class during the last decade.

Also in one other fleet component, the medium size boats, ranging from 12 to 16 meters, a change from bottom longline to handlines has been observed during the last five or six 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 are not available). A new Spanish fishery has developed in Division XIVb since 2010. Total catch of roundnose grenadier in this fishery in 2011 was 3366 t. Grenadier has also been taken as bycatch in the Faroese orange roughy fishery and Spanish blue ling fishery. During the entire fishing period to 2011, the catch of roundnose grenadier from the northern MAR amounted to more than 236 000 t, mostly from ICES Subarea XII. Catches from Areas VIb, XII and XIVb and for the year 2012 were reported from the Spanish trawl fishery. Spanish catches of roundnose grenadier reported from Subarea XIVs amounted to 1876 tonnes; however there were also significant unallocated catches from this area (7326 t from XIV and 5472 t from 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 more 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 areas along of the MAR, where it can be abundant on the tops and the slopes of narrow underwater peaks. 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 Sub area 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, 2004–2011. The black scabbard fish was the main bycatch species and in recent years it amounted bulk of catches (45–313 t for both Subareas in 2009–2011).

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 scabbard-fish and silver roughy (*Hoplostethus mediterrraneus)*. A joint Norwegian-Russian 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 the species in the area.

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 (Figure 4.7.3). Spain reported landings from area XIVb1, and XIIa for the year 2012 and 2013. The main species caught was Roundnose greanadier, *Macrourus berglax and berBaird's slickhead*. Landings from Va were also reported being the main species caught the Roundnose greanadier, *Macrourus berglax, Lepidopus caudatus* and *Baird's slickhead.* Detailed catch information was presented for area XIIb for 2012 and 2013.

3.7.3 Technical interactions

Azores EEZ`s

The fishery is multispecies 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 from 2004 to 2010 shows that for some species, like deep-water sharks, the discards may be important. Actually, commercial value species like red blackspot seabream and wreck fish, 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 not known that whether the industrial fleets fishing on the MAR fish 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 some aggregating seamount species (orange roughy, alfonsinos) and target mainly roundnose grenadier and smoothhead. Therefore it is unlikely to interact with fisheries in the southern MAR and other fisheries for roundnose grenadier landings of which on the northern ridge have been small over recent years.

3.7.4 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, do not have a coastal platform and are 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 heights 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 roundnose grenadier, orange roughy, alfonsinos, etc. and a number of seamounts have been targeted by commercial fleets. Such habitats are however highly susceptible to damage by 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 amongst benthic species, may be high and therefore particularly vulnerable.

3.7.5 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 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). 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.

Current NEAFC measures include VME regulations of bottom fisheries (which includes closures and other area restrictions, encounter protocols etc.) and a general effort restriction in deep-sea species fisheries as well as a gillnet ban deeper than 200m.

Specific measures were introduced for roundnose grenadier, orange roughy, blue ling and deepwater sharks. (http://neafc.org/managing_fisheries/measures/current)

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 XIVb2.

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ALFONSINOS (*Beryx* spp.)	631	550	983	229	175	229	199	243	172	139	157	192	211	250	312	245	232	222	168
ARGENTINES (*Argentina silus*)		1			2					4									
BLUE LING (*Molva dypterigia*)	602	814	438	451	1363	607	675	1270	1069	644	35	65	1			72	0	16	9
BLACK SCABBARDFISH (*Aphanopus carbo*)	304	455	203	253	224	357	134	1062	502	384	198	73		80	162	240	163	16	206
BLUEMOUTH (*Helicolenus dactylopterus*)	589	483	410	381	340	452	301	280	338	282	190	209	275	281	267	213	231	190	235
DEEP WATER CARDINAL FISH (*Epigonus telescopus*)						3		14	16	21	4	10	7	7	7	5	5	4	4
GREATER FORKBEARD (*Phycis blennoides*)	75	47	32	39	41	100	91	63	56	46	22	134	201	18	26	14	11	6	8
LING (*Molva molva*)	50	2	9	2	2	7	59	8	19		2				1			0	0
MORIDAE						1	88	113	140	91	69	127	86	53	68	54	55		
ORANGE ROUGHY (*Hoplostethus atlanticus*)	676	1289	814	806	441	447	839	28	201	711	324	104	20	108	26	74	112	139	
RABBITFISHES (*Chimaerids*)			32	42	115	48	79	98	81	128	193				22	0		2	6
ROUGHHEAD GRENADIER (*Macrourus berglax*)					3	7	10	7	2	28	8	8			6	0	0	2726	868
ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*)	644	1739	8622	11979	9696	8602	7926	11 468	10 805	10 748	513	86	2	13	5	1691	3366	2724	1907
RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*)	1115	1052	1012	1119	1222	947	1034	1193	1068	1075	1383	958	1070	1089	1042	687	624	613	692
SHARKS, VARIOUS	1385	1264	891	1051	50	1069	1208	35	25	6	14	104	63	12	1	7	5	31	70
SILVER SCABBARDFISH (*Lepidopus caudatus*)	789	826	1115	1187	86	28	14	10	25	29	31	35	55	63	64	68	148	282	0
SMOOTHHEADS (*Alepocephalidae*)		230	3692	4643	6549	4146	3592	12538	6883	4368	6872							160	17
Trachipterus sp																		54	
TUSK (*Brosme brosme*)	18	158	30	1	1	5	52	27	83	16	66	64	19		2	107	0	29	
WRECKFISH (*Polyprion americanus*)	244	243	177	140	133	268	232	283	270	189	279	497	664	513	382	238	266	226	209
TOTAL	7122	9153	18460	22323	20443	17323	16533	17272	10950	8161	10360	2666	2674	2487	2393	3715	5218	7441	4398

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

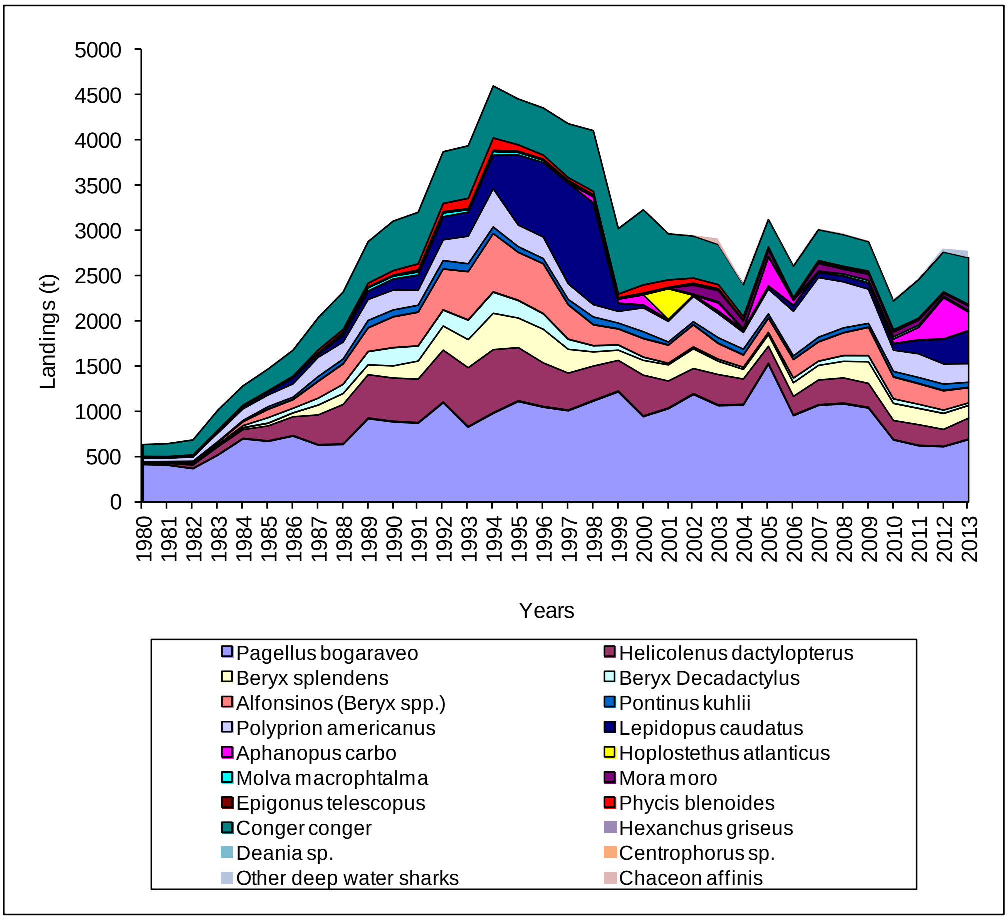
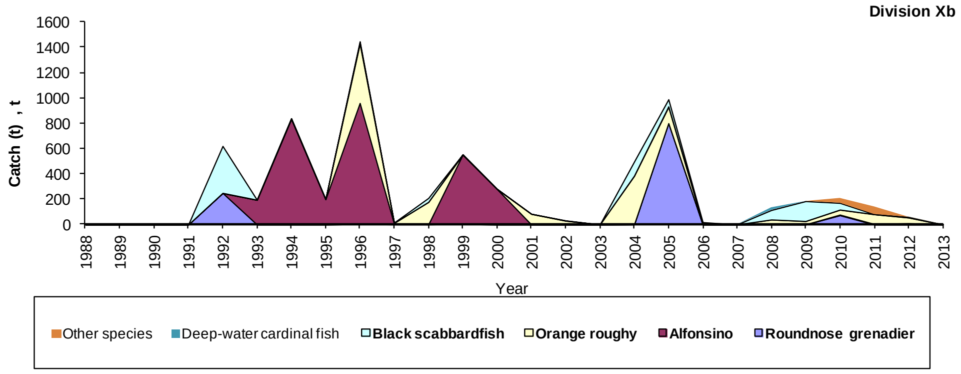
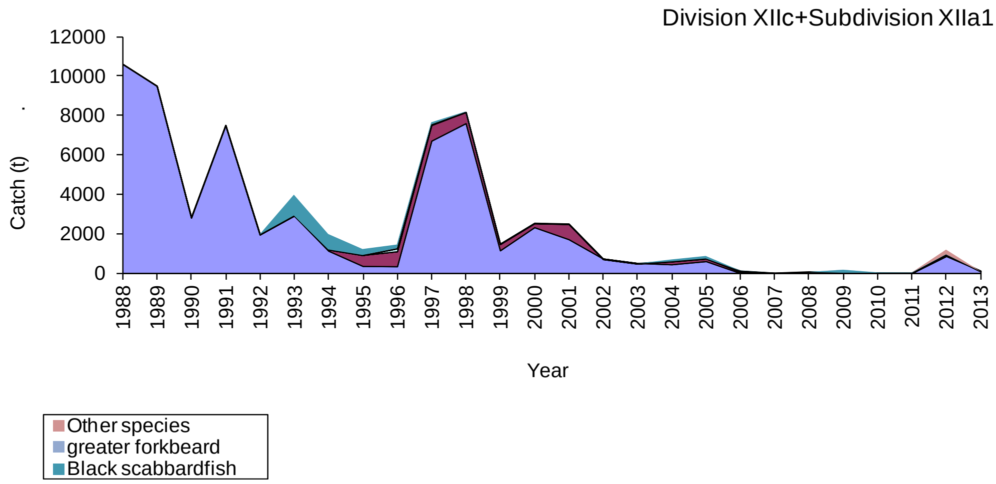


Figure 4.7.2. Annual landings of major deep-water species in Azores from hook and line fishery (1980–2011).





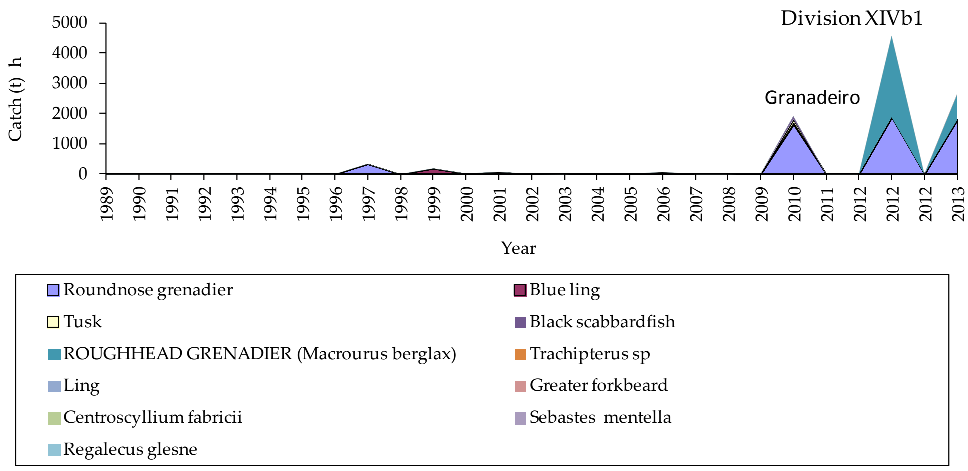


Figure 4.7.1. Annual catch of major deep-water species on MAR in 1988–2011.

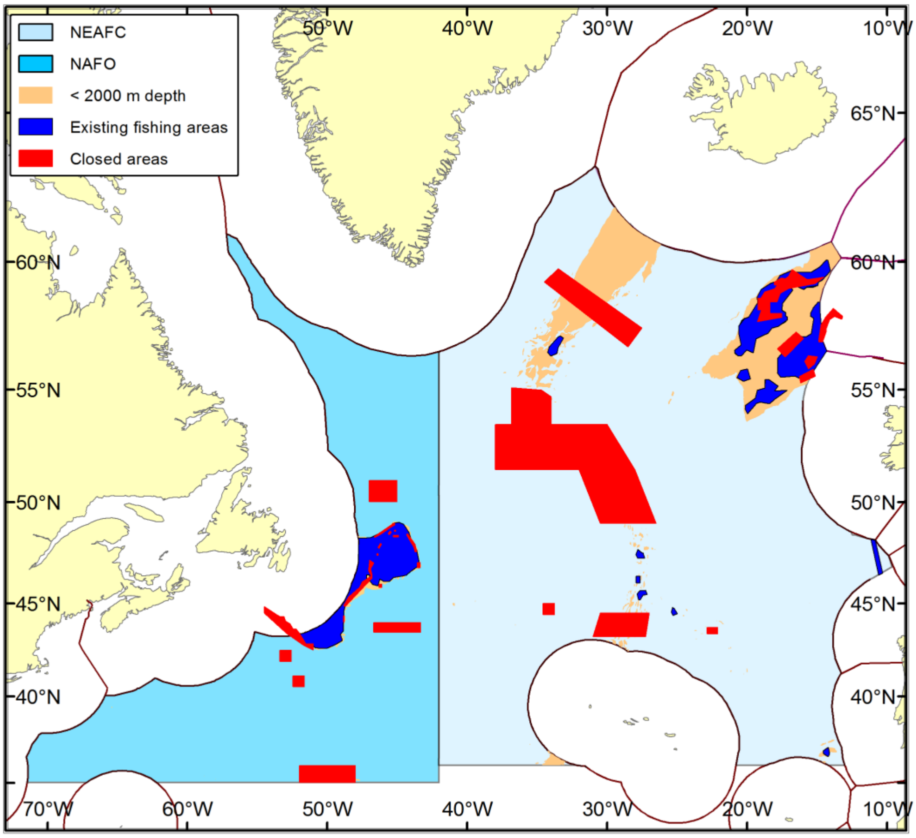


Figure 4.7.3. RFMO regulatory areas of Mid Atlantic Ridge, and closures introduced by NEAFC and NAFO (red) (from WD Bergstad and Høines, 2011).

4 Ling (*Molva molva*) in the Northeast Atlantic

4.1 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 the 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.

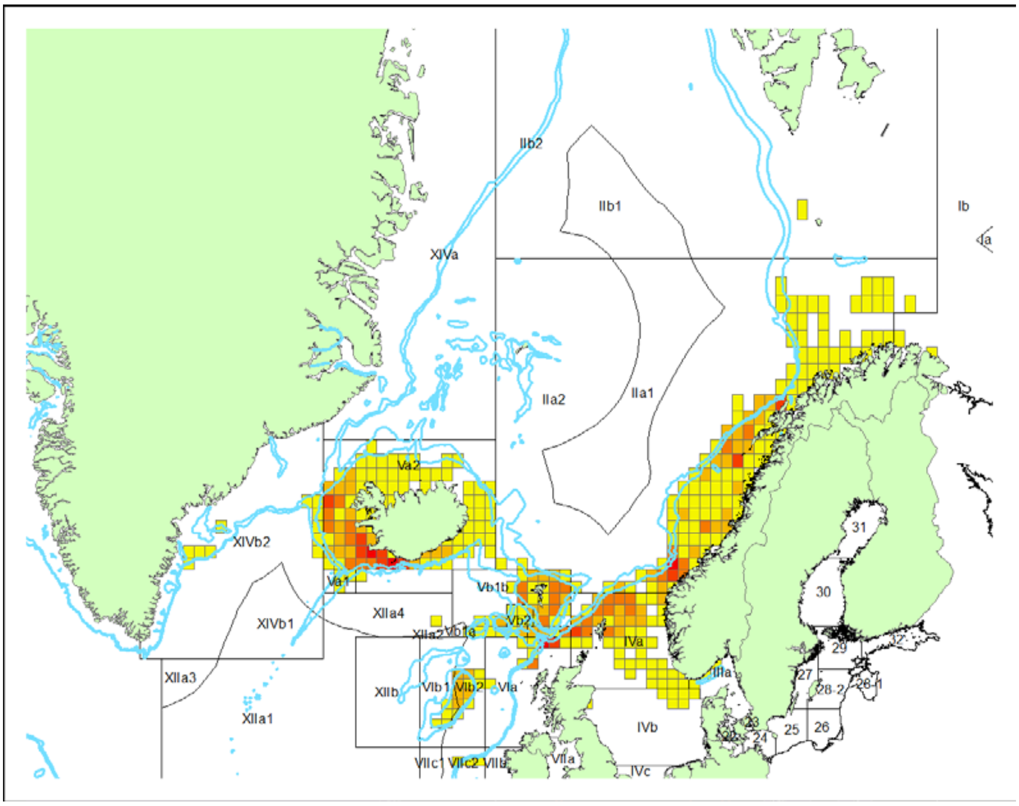


Figure x. Map of fishery distribution (Data from Iceland, Faroes and Norway).

In a working document presented at WGDEEP-2014, the first study of population genetic structure of ling by genotyping six geographically distinct samples with eleven microsatellite DNA markers. The results rejected the hypothesis of a single ling stock in the Northeast Atlantic, and rather suggest the existence of two or more groups, with the main grouping represented by a western (Rockall and Iceland) and an eastern group (Faroe Bank, Norway). Significant genetic differences coincide with an expanse of deep water that probably limits connectivity facilitated by migration.

Retention in gyres and directional oceanic circulation may also prevent drift and admixture during planktonic life stages. On the other hand, the apparent absence of genetic differentiation within the eastern part of the distribution range indicates gene flow, perhaps by larval drift and migration, over considerable distances.

A small-scale exchange of 50 ling otolith images was done in 2013 (WKAMDEEP, 2013). The results of this exchange showed that the mean CV of all the 9 age readers of ling was 10.3% and the conclusion was that the precision is probably high enough to support age-structured analytical assessments (WGDEEP, 2013). The results from the annotations of this exchange highlighted that the problem (in most cases) was to do with edge growth. It is necessary to train an age reader and inform them when to count the first translucent zone (first year) (WKAMDEEP, 2013). Also earlier ling otolith exchanges concluded that there was some inconsistencies between age readers but the differences were not very substantial and could easily be adjusted (Bergstad *et al.*, 1998; Øverbø Hansen, 2012). An analysis of edge growth of ling otoliths is recommended to help on this problem with edge growth.

4.2 Ling (*Molva Molva*) in Division Vb

4.2.1 The fishery

A general description of the fisheries in Faroese waters is provided in the Faroe overview section. The fishery for ling in Vb has changed in 2011–2013 as the Norwegian longliners are not allowed to fish in Faroese waters due to the mackerel allocation. The Faroese are landing almost all the catches and do also utilize the fishing areas that the Norwegian longliners used to fish. Around 60–70% of the ling in Vb was caught by Faroese longliners in 2010–2013 and the rest mainly by trawlers (30–40%). The longline fisheries are mainly on the slope on the Faroe Plateau and some of it is on the bank area and Wyville-Thomson Ridge (Figure 4.2.1). Ling is also caught as bycatch by trawlers mainly fishing saithe on the Faroe Plateau (Figure 4.2.2).

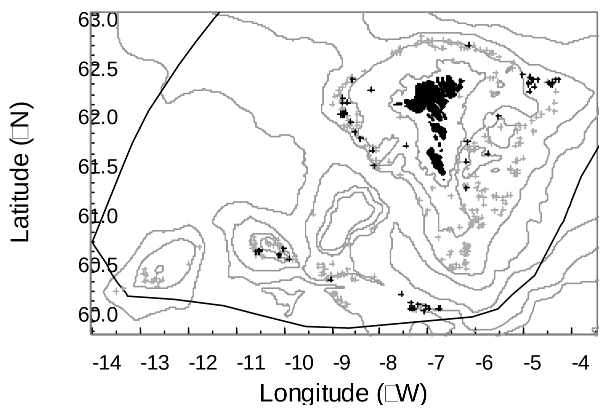


Figure 4.2.1. Ling in Vb. Longline positions in 2013 for five selected longliners (black) and all longliners (grey) where ling is in catch and tusk+ling >50% of the total catch.

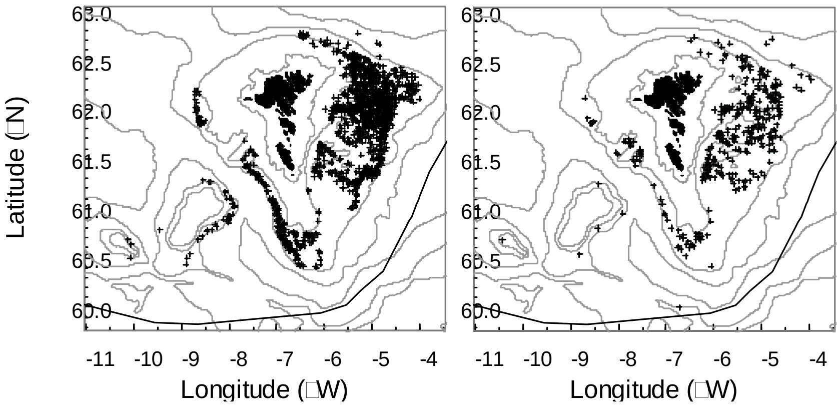


Figure 4.2.2. Ling in Vb. Distribution of pair trawler hauls in 2013 with a) ling in catch and >60% saithe of the total catch and b) more than 20% ling of the total catch.

4.2.2 Landings trends

Landings data for this stock are available from 1904 onwards; landing statistics for ling by nation for the period 1988–2013 are given in Tables 4.2.1–4.2.3 and total landings data from 1950 onwards are shown in Figure 4.2.3. Total landings in Division Vb have in general been very stable since the 1970s varying between around 4000 and 7000 tonnes. In the period from 1990–2005 around 20% of the catch were fished in area Vb2, and in the period 2006–2013 this has decreased to around 10%. The preliminary landings of ling in 2013 are 4086 tonnes, of which the Faroes caught 99%. The reason for the low foreign catches is the fact that due to a dispute on mackerel allocation, no bilateral agreement on fishing rights between the Faroes and Norway and EU could be made for 2011–2013.

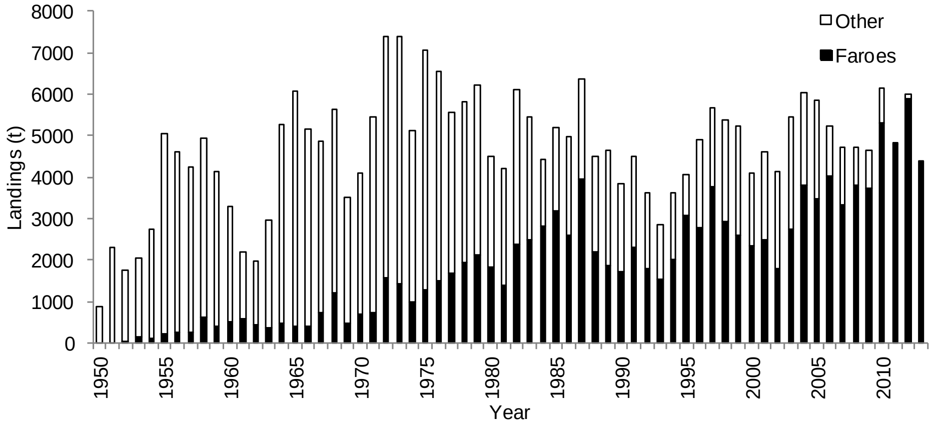


Figure 4.2.3. Ling in Vb. Total international landings since 1950.

4.2.3 ICES Advice

The 2012 advice for this stock is biennial and valid for 2013 and 2014 (see ICES, 2012): Based on the ICES approach for data-limited stocks, ICES advises that there should be a 20% reduction in effort.

4.2.4 Management

For the Faroese fleets, there is no species-specific management of ling in Vb, although licences are needed in order to fish. The main fleets targeting ling are each year allocated a total allowable number of fishing days to be used in the demersal fishery in the area. The recommended minimum landing size is 60 cm, but that is not enforced because of the discard ban. Mostly 25% of the ling catch (per settings/hauls) can be juveniles e.g. smaller than 75 cm. Other nations are regulated by TACs. Details on management measures in Faroese waters are given in the Faroe overview section.

4.2.5 Data available

Data on length, gutted weights and age are available for ling from the Faroese landings and Table 4.2.4 gives an overview of the levels of sampling since 1996.

Due to limited resources at Faroe Marine Research Institute (FaMRI), the sampling intensity of ling otoliths has been low from year 2007. Hence, in order to perform an age-based assessment, it has been necessary to combine age samples from all fleets/seasons and even between years to make an age–length key.

There are also catch and effort data from logbooks for the Faroese longliners and trawlers.

From the two annual Faroese groundfish surveys on the Faroe Plateau, especially designed for cod, haddock and saithe, biological data (length and round weight) as well as catch and effort data are available. Data of ling larvae from the annual 0-group survey on the Faroe Plateau was also used.

In addition, there are also data available on catch, effort and mean length from Norwegian longliners fishing in Faroese waters.

A three year project on ling and tusk started in January 2013 at FaMRI, which hopefully can give some additional information to the WG next year.

4.2.5.1 Landings and discards

Landings were available for all relevant fleets. No estimates of discards of ling are available. But since the Faroese fleets are not regulated by TACs and in addition there is a ban on discarding in Vb, incentives for illegal discarding are believed to be low. The landings statistics are therefore regarded as being adequate for assessment purposes.

4.2.5.2 Length compositions

Length composition data are available from the Faroese commercial longlliners, the trawler fleet that captures ling as bycatch and two groundfish surveys (Figures 4.2.4–4.2.7).

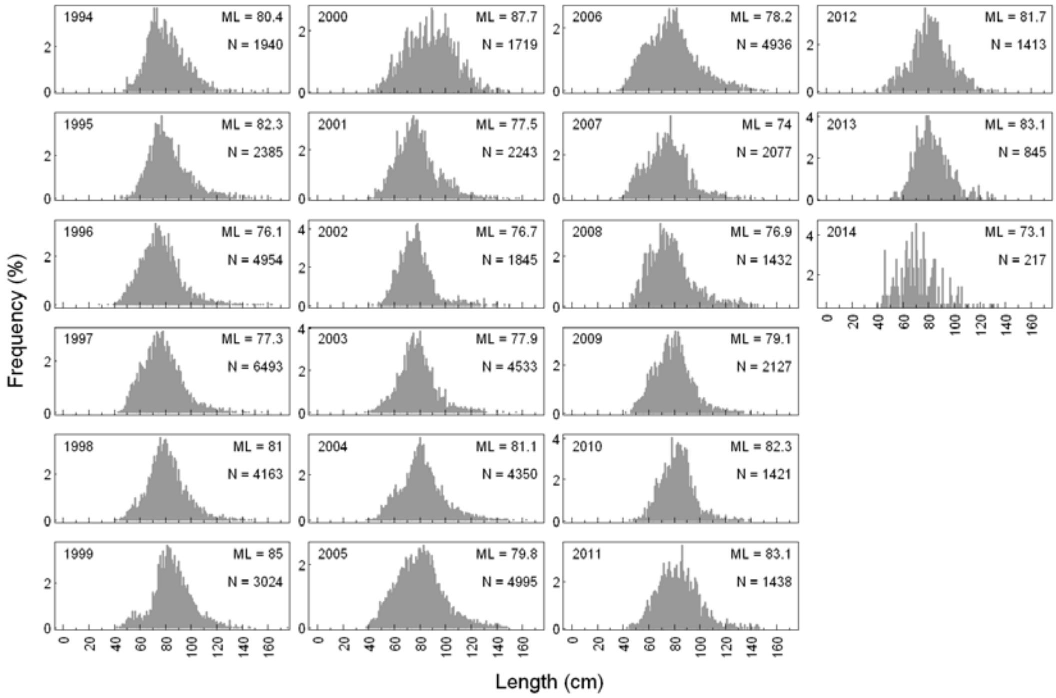


Figure 4.2.4. Ling in Vb. Length distribution in the sampling of the landings from Faroese long-liners (>110 GRT). ML- mean length, N- number sampled.

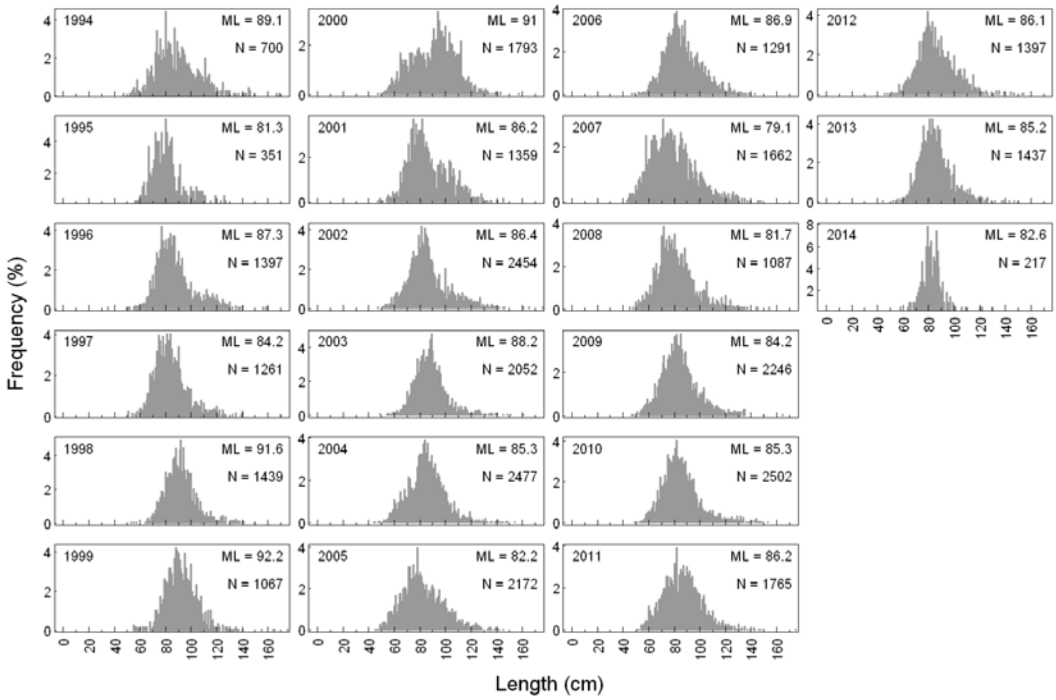


Figure 4.2.5. Ling in Vb. Length distribution in the sampling of the landings from Faroese trawl-ers (>1000 HP). ML- mean length, N- number sampled.

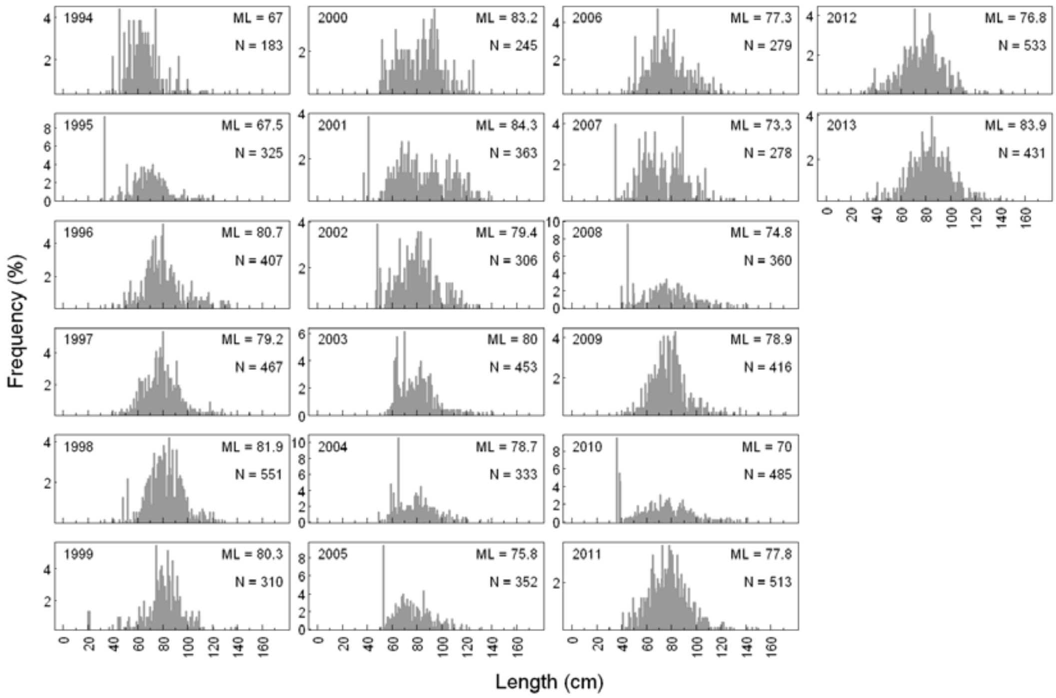


Figure 4.2.6. Ling in Vb. Length distribution from the spring groundfish survey ML- mean length, N- number of calculated length measures. The small ling are often sampled from a subsample of the total catch, so the values are multiplied to total catch.

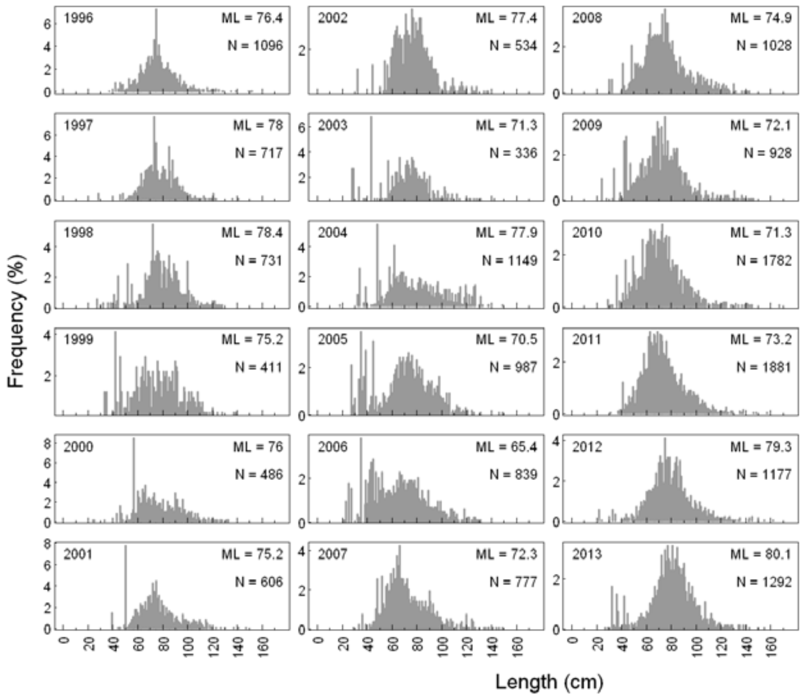


Figure 4.2.7. Ling in Vb. Length distribution from the summer groundfish survey. ML- mean length, N- number of calculated length measures. The small ling are often sampled from a sub-sample of the total catch, so the values are multiplied to total catch.

4.2.5.3 Catch-at-age

Catch-at-age data were provided for Faroese landings in Vb 1996–2006 and raised with other nations' landings. Due to few age data in the period from 2007–2013 were all ages from this period combined (the same age–length key for all these years). Thereafter were the age–length data distributed on the lengths for the distinct years and fleets (longliners and trawlers) (Table 4.2.5, Figure 4.2.8). The common ages in the landings are from five to nine years and the mean age is around 7–8 years. The age distribution (raw data) in the sampling of commercial landings from longliners and trawlers are presented in Figures 4.2.9–4.2.10.

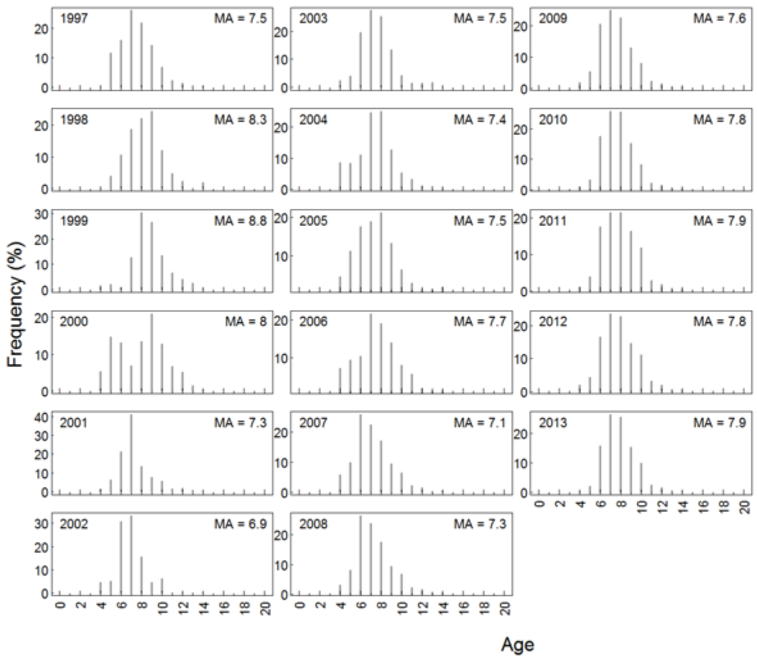


Figure 4.2.8. Ling Vb. Catch-at-age composition used in the exploratory assessment. MA- mean age, N- catch in number.

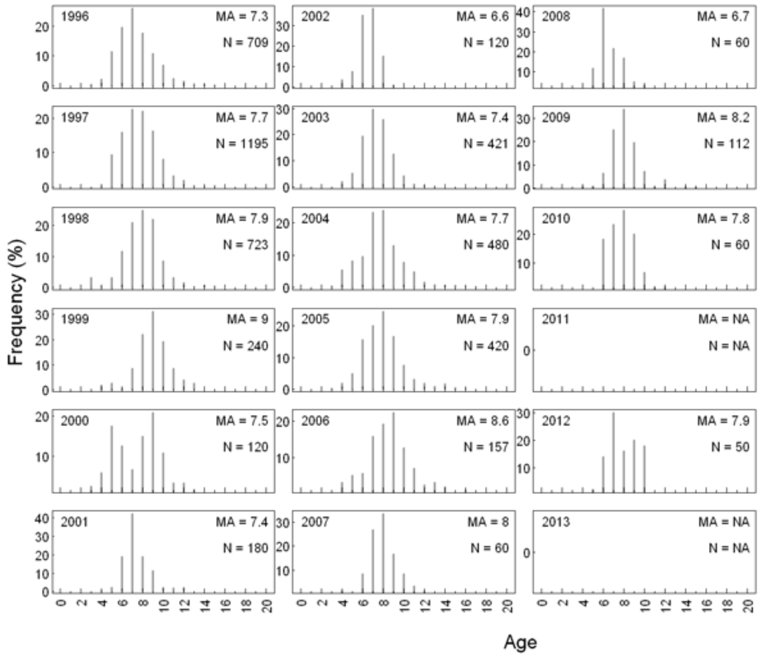


Figure 4.2.9. Ling in Vb. Age distribution (raw data) in the landings from Faroese longliners (>110 GRT). MA- mean age, N- number sampled.

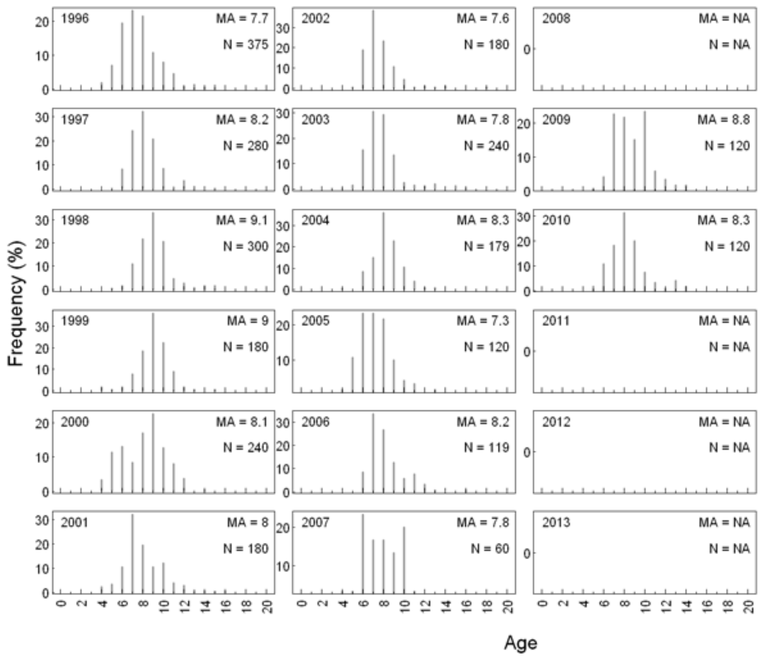


Figure 4.2.10. Ling in Vb. Age distribution (raw data) in the landings from Faroese trawlers (>1000 HP). MA- mean age, N- number sampled.

An attempt was done on counting daily growth in the otoliths of eleven ling larvae from the Faroese annual 0-group survey in 2013. The results showed that larvae between 12 and 22 mm were from 48 to 84 days old (Bjørn Gunnarsson, Hafro, Iceland) (Figure 4.2.11). These results indicate that ling spawn at least in April–May in Faroese waters.

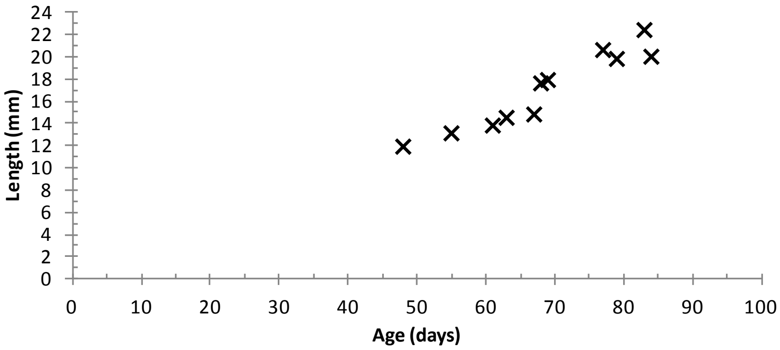


Figure 4.2.11. Ling in Vb. Daily growth of ling larvae.

4.2.5.4 Weight-at-age

Mean weight-at-age data are provided for the Faroese fishery in Vb from 1996–2013 (Table 4.2.6). There is no particular decreasing trend in the mean weights over the period. The mean weight-at-age is modelled for the years 2007–2013 due to few age samples.

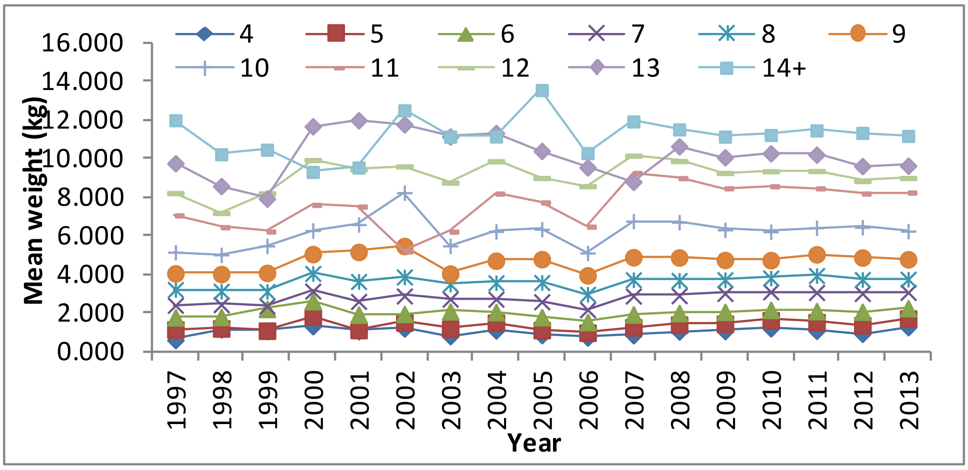


Figure 4.2.12. Ling in Vb. Catch weight-at-age. NB. 2007–2013 data are modelled.

4.2.5.5 Maturity and natural mortality

Data from the groundfish surveys in 2013 of 432 ling (lengths from 25–150 cm) indicated a L_{50} at around 70–74 cm, and ages from 364 ling (2–16 years old) indicated an A_{50} around six years. This fit well with the statement that ling become mature at ages 5–7 (60–75 cm lengths) in most areas, with males maturing at a slightly lower age than females (Magnusson *et al.*, 1997).

No annual measurements of maturity-at-age were available and knife-edge maturity for age 7 and older has been assumed in the assessment.

4.2.5.6 A natural mortality of 0.2 was assumed for all ages in the exploratory assessment. Catch, effort and research vessel data

Commercial cpue series

There are catch per unit of effort (cpue) data available for three commercial series, the Faroese longliners, the Faroese pair trawlers and Norwegian longliners fishing in Vb.

The Faroese cpue data for the period 1986–2013, are from five longliners (GRT>110) and 6–10 pair trawlers (HP>1000). The effort obtained from the logbooks is estimated as 1000 hooks from the longliners, number of fishing (trawling) hours from the trawlers and the catch as kg stated in the logbooks.

The Faroese longliner series were from sets where they catch ling and the catch of ling and tusk combined represented more than 50% of the total catch and depth was >150 m. The bycatch series for ling from the Faroese pair trawlers >1000 HP was limited to hauls where they catch ling and the catch of saithe is more than 60% of the total catch in the haul.

A general linear model (GLM) was used to standardize all the cpue series (kg/h or kg/1000 hooks) for the commercial fleet where the independent variables were the following: vessel (actually the pair ID for the pair trawlers, otter board trawlers or longliners), month (January–April, May–August, September–December), fishing area (Vb1, Vb2) and year. The dependent variable was the log-transformed kg per hour or kg/1000 hooks measure for each trawl haul or longline setting, which was back-transformed prior to use. The reason for this selection of hauls/settings was to try to get a series that represents changes in stock abundance.

The cpue data from Norwegian longliners fishing in Vb are described in the stock annex for ling in IIa and were standardized (Section ling in I and II; Helle and Pennington, WD WGDEEP 2013). The Norwegian and Faroese longliners are comparable and both have ling (and tusk) as target species.

Both the Faroese longline series (directed effort measured as number of 1000 hooks) and the trawl bycatch series (effort measured as hours) was used as tuning series in the exploratory assessments.

Fisheries independent cpue series

Cpue estimates (kg/hour) for ling are available from two annual groundfish surveys on the Faroe Plateau designed for cod, haddock and saithe. Both surveys are restricted to the area on the Faroe Plateau (Vb1) and do as such not cover the whole distribution area for ling since the Faroe Bank (Vb2) is not included. These series have so far not been used for tuning because no age data are available, but in 2013 has a total of 364 otoliths been sampled and the agenda is to sample more ling otoliths in 2014 and hopefully get enough otoliths to do an age–length key from the survey.

The abundance indices from the groundfish surveys are standardized according to number of stations in each stratum and weighted with strata area for all the different strata. The distribution of ling in the groundfis surveys is shown in Figure 4.2.13. A potential recruitment index was calculated from ling less than 40 cm from the survey.

The spring survey has been carried out in February–March since 1982 (100 fixed stations), and the summer survey in August–September since 1996 (200 fixed stations). For the spring survey, however, data are only available for the period 1994–2008 due to problems with extraction of older data from the database. Only mean cpue (kg/hour) was extracted from the data for the period 1983–1993 for level comparisons.

In addition, an index was calculated from the annual 0-group survey in June/July on the Faroe Plateau and the distribution shows that ling larvae is caught mostly on the Plateau, not so much on the Bank (Figure 4.2.14).

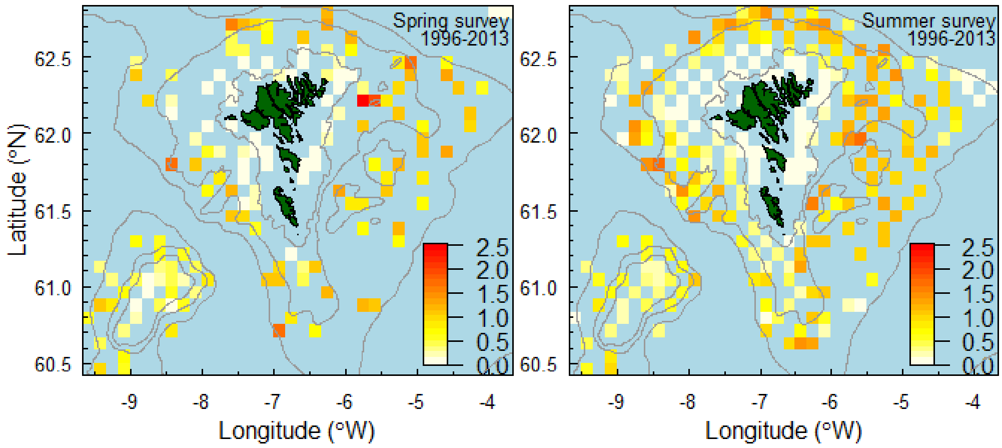


Figure 4.2.13. Ling in Vb. Distribution of ling in the annual spring and summer groundfish surveys as average log(kg/hour+1). Depth contour line for 100, 200 and 500 m.

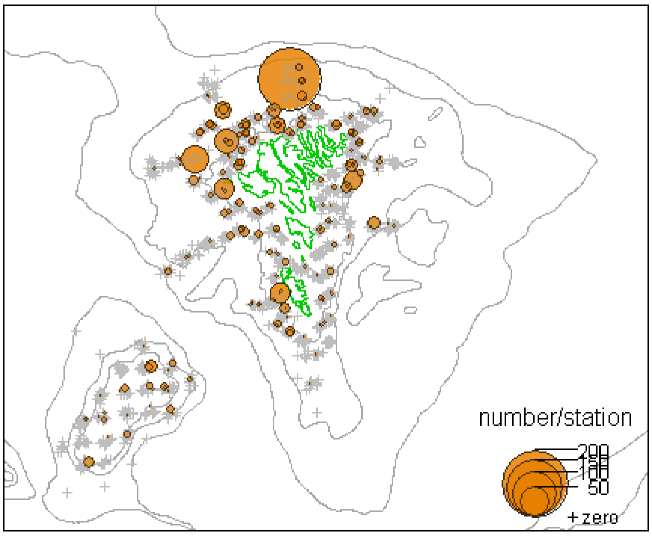


Figure 4.2.14. Ling in Vb. Distribution of larvae (number/station) from the annual 0-group survey in June/July for the years 1996-2013.

4.2.6 Data analyses

Mean length in the length distribution from commercial catches from Faroese longliners and trawlers showed an increase in mean length from 2007–2013 (Figure 4.2.4–4.2.5). The mean length in length distributions for the Norwegian longliners fishing in Faroese waters, in the period 2003–2009 were about 87 cm. The Faroese trawlers have a slightly higher mean length in the catches as the Faroese longliners.

Length distributions from the two groundfish surveys in Division Vb showed high interanual variation in mean length, from 65 to 85 cm, which may partly be explained by occasional high abundance of individuals smaller than 60 cm (Figures 4.2.6–4.2.7).

Fluctuations in cpue

Information on abundance trends can be derived from the cpue data from the Faroese longliners (Figure 4.2.15), Norwegian longliners fishing in Vb (Figure 4.2.16), from the Faroese pair trawlers (bycatch; Figure 4.2.15) and from the Faroese groundfish surveys (Figure 4.2.17). The data from these series are presented in Table 4.2.7.

The Faroese longline cpue series, the Faroese trawl bycatch cpue series and the Norwegian longline series show a positive trend since around 2001. There are very few data from Norwegian longliners in 2009–2013.

The two survey cpue series indicate a stable situation since the late 1990s and an increase in recent years.

A potential recruitment index was calculated from the two surveys as the number of ling smaller than 40 cm (Figures 4.2.18–4.2.19). This shows indications of increasing recruitment in recent years. In addition, a potential recruitment index was calculated from the annual 0-group survey on the Faroe Plateau 1983–2013 (Figure 4.2.20). This figure also supports an indication of increasing recruitment in some years.

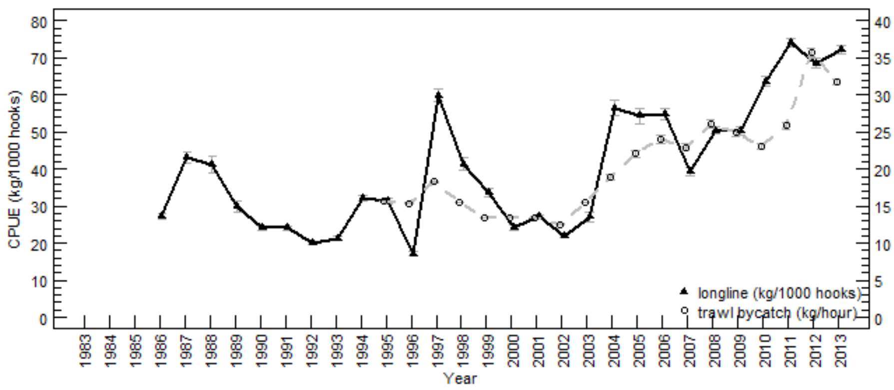


Figure 4.2.15. Ling in Vb. Standardized cpue from Faroese longliners (black line) and pair trawlers (bycatch, stippled line) fishing in Faroese waters. Data from longliners (>110 GRT) are from settings where ling was caught, ling+tusk>60% of the total catch and the depth was deeper than 150 m. Data from trawlers are from hauls where ling was caught and saithe >60% of the total catch. The error bars are SE.

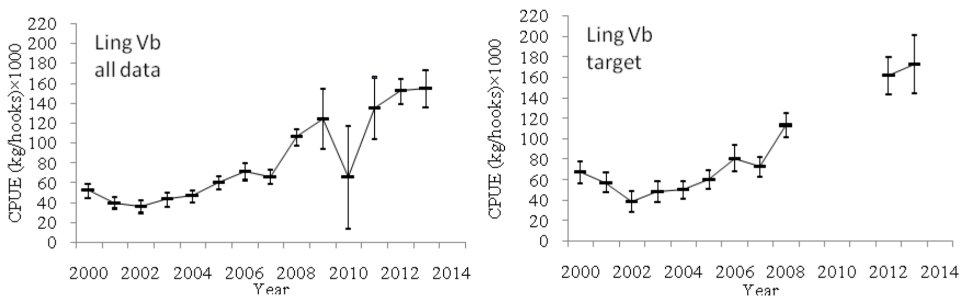


Figure 4.2.16. Ling in Vb. The standardized cpue ((kg/hook)x1000) for ling from Norwegian longliners fishing in Vb for the period 2000 through 2013. The bars denote the 95% confidence intervals. Note that there are very few data since 2009 (WD Helle and Pennington, WGDEEP 2014).

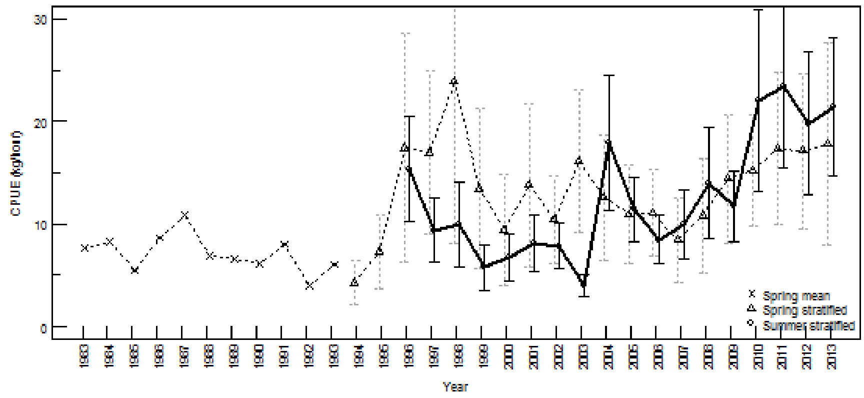


Figure 4.2.17. Ling in Vb. Standardized cpue (kg/h) in the two annual Faroese groundfish surveys on the Faroe Plateau. The error bars are SE.

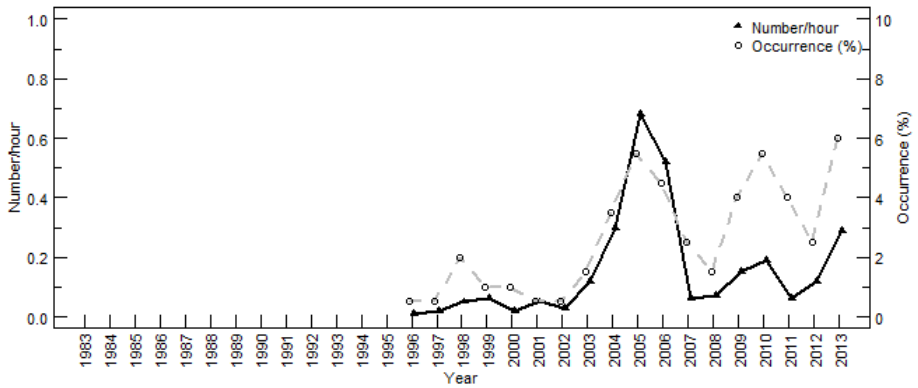


Figure 4.2.18. Ling in Vb. Number/hour and occurrence (%) per year of ling smaller than 40 cm in the summer survey.

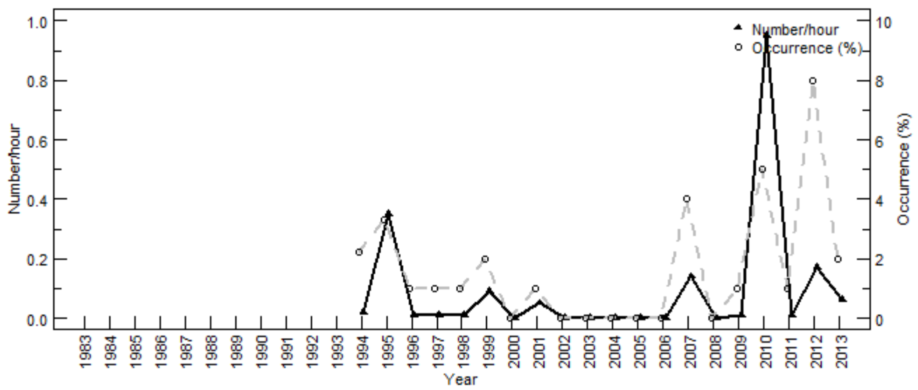


Figure 4.2.19. Ling in Vb. Number/hour and occurrence (%) per year of ling smaller than 40 cm in the spring survey.

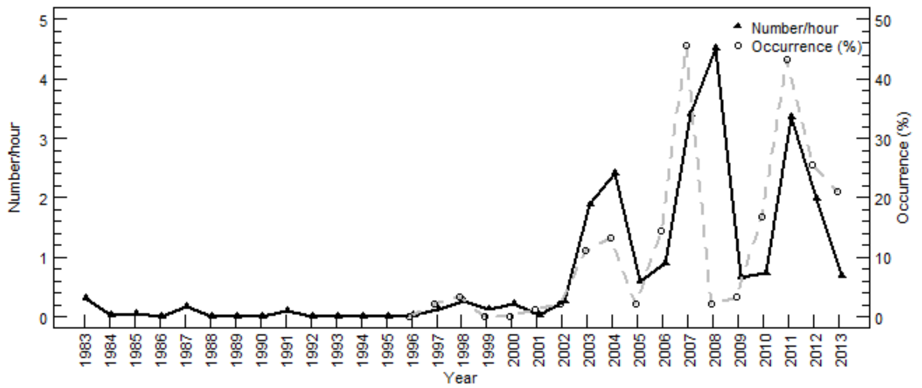


Figure 4.2.20. Ling in Vb. Number/hour and occurrence (%) of larvae on the Faroe Plateau from the annul 0-group survey.

Analytical assessment

An exploratory assessment of ling in Vb was done by using an age-based extended survivor analysis model (XSA) (Ofstad, WD WGDEEP 2014). The results were presented at the WGDEEP 2014 meeting. Due to few otolith samples in the period from 2007–2013 the otolith samples for these years were combined in the age–length key before they were multiplied to the actual years length distributions per fleet. For the period 1997–2006 the actual age–length key were used for the actual year, so these years are not combined.

Outputs from the XSA model showed seasonal problems in the log q residuals. The longliner series and the trawler bycatch series, used as tuning series, had approximately same weight in the model.

The results from the XSA model showed that ling in Faroese waters is at a high level as both the total biomass and SSB were above long-term mean in the latest five years (Table 4.2.8). The recruitment since 1997 was between 1.7 and 5 million. The total biomass ranged between 21 and 36 thousand tons with an increase in the last five years and the total SSB varied between 11 and 22 thousand tons. The fishing mortality varied between 0.22 and 0.53 and the natural mortality was set to 0.2 for all ages. The retrospective pattern showed that recruitment and fishing mortality tended to be underestimated, whereas the biomass and SSB tended to be overestimated.

A modified yield per recruit analysis was used to calculate F_{MAX} and $F_{0.1}$. The selection patterns, as well as the weights, were calculated as the average for the whole assessment period (1997–2013). In this case the F_{MAX} was well-defined (F-factor of 0.8 giving an absolute F of 0.31) and could be used as the target F. Fishing of F_{MAX} gave a catch of around 5500 tons and a biomass of 31 000 tons. The estimate of $F_{0.1}$ (F-factor of 0.4 giving an absolute F of 0.16) gave a catch of around 5100 tons and biomass of around 41 000 tons (Figure 4.2.21).

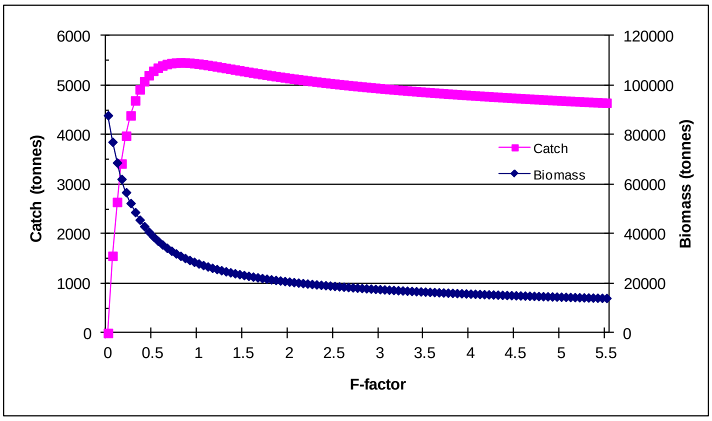


Figure 4.2.21. Ling in Vb. A modified yield-per-recruit plot. The YPR estimates indicated F_{MAX} to be around 0.31 (catch around 5500 t) and $F_{0.1}$ to be around 0.16 (catch around 5100 t).

Fproxy

Changes in relative fishing mortality (F_{proxy} = yield / abundance (kg/hour) from the summer survey) are presented in Figure 4.2.22. The abundance from the groundfish summer survey on the Faroe Plateau was chosen for F_{proxy} calculation because the survey covers both the distribution area and the fishing area. In addition, the summer survey covers the Plateau best as it has twice as many stations than the spring survey. Compared with the first years of the series, F_{proxy} in 2009–2013 was relatively stable but at lowest values of the series. Average of the five last years was used to calculate the target F_{proxy}. The target F_{proxy} was calculated to be 21 = 4075 (yield in 2013)/ 190 (abundance in the summer survey in 2013). This gives a target catch of around 6000 tons = 275 (average abundance for 2009–2013) *21 (target F_{proxy}).

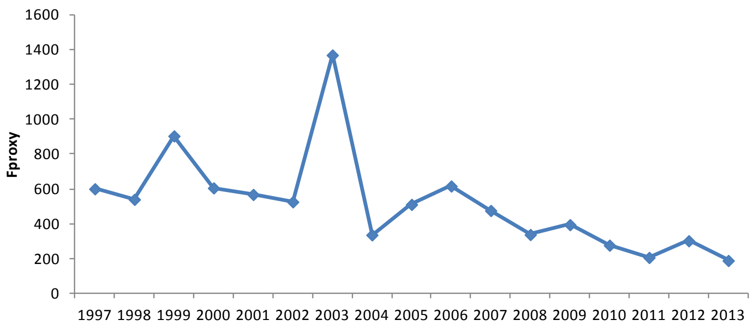


Figure 4.2.22. Ling in Vb. Changes in relative fishing mortality (F_{proxy}). Summer groundfish survey abundance (kg/h) for the Faroe Plateau is used in the calculations.

4.2.6.1 Reference points

No reference points have been proposed for this stock. However, as adult abundance as measured by surveys is above the average of the time-series, expert judgement considered it likely that SSB is above any candidate values for MSY $B_{trigger}$.

4.2.7 Comments on assessment

All signs from commercial catch and surveys indicate that ling in Vb is at present in a good state. This is confirmed in the exploratory assessment. The cpues from longline and trawl fishery were used as tuning series in the assessment and they represent around 95% of the total fishery of ling.

There is a clear seasonal pattern in log q residuals and there need to be a closer look at the diagnostic to find the best settings. It is a need to look closer at the ALK for the whole period to try to solve the strong log q residual patterns. Still, the assessment shows that there is an increase both in stock biomass and spawning–stock biomass during the last five years period. The recruitment since 1998 is stable between 3.0 and 5.0 million.

It will be further working on the assessment for ling in Vb during a Faroese project that ends in 2015. There is an ongoing work to get enough otoliths from small ling in the survey for use in a tuning series from the summer groundfish survey to get better data on younger ages. Suggestions from a reviewer some years ago was to try models that do not relay so much on age data such as statistical catch-at-age models and length-based models including the information available on age and recruitment.

Ling in Vb is a category 3 stock according to the ICES DLS approach proposed by the ADG in 2012. There are possibilities to increase ling in Vb to a category 1 stock with some more work.

4.2.8 Management consideration

Stability in landings and trends in abundance indices suggest that ling in Division Vb has been stable since the middle of the 1980s, with an increasing trend in the last years. The available dataseries do not cover the entire period of the fishery (back to the early 1900s; see Figure 4.2.3 for landings since 1950) and no information is available on stock levels prior to 1986. There is evidence of increased recruitment from 2004 compared to earlier levels.

The only species-specific management for Faroese fisheries of ling in Division Vb is the recommended minimum landing size (60 cm), but this does not appear to be enforced because of the discard ban. Mostly 25% of the ling catch (per settings/hauls) can be juveniles e.g. smaller than 75 cm.

The exploitation is influenced by regulations aimed at other groundfish species, e.g. cod, haddock, and saithe. The fisheries by other nations are regulated by TACs.

Table 4.2.1. Ling in Vb1. Nominal landings (1988–2013).

Year	Denmark (2)	Faroes	France	Germany	Norway	E&W (1)	Scotland (1)	Russia	Total
1988	42	1383	53	4	884	1	5		2372
1989		1498	44	2	1415		3		2962
1990		1575	36	1	1441		9		3062
1991		1828	37	2	1594		4		3465
1992		1218	3		1153	15	11		2400
1993		1242	5	1	921	62	11		2242
1994		1541	6	13	1047	30	20		2657
1995		2789	4	13	446	2	32		3286
1996		2672			1284	12	28		3996
1997		3224	7		1428	34	40		4733
1998		2422	6		1452	4	145		4029
1999		2446	17	3	2034	0	71		4571
2000		2103	7	1	1305	2	61		3479
2001		2069	14	3	1496	5	99		3686
2002		1638	6	2	1640	3	239		3528
2003		2139	12	2	1526	3	215		3897
2004		2733	15	1	1799	3	178	2	4731
2005		2886	3		1553	3	175		4620
2006	3	3563	6		850		136		4558
2007	2	3004	9		1071		6		4092
2008		3354	4		740	32	25	11	4166
2009	13	3471	2		419		270		4174
2010	28	4906	2		442		121		5500
2011	49	4270	2		0		0		4321
2012	117	5452	7		0		0		5576
2013*	3	3820	7		0		0		3830

***Preliminary.**

(1) Includes Vb2.

(2) Greenland 2006–2013.

Table 4.2.2. Ling in Vb2. Nominal landings (1988–201).

Year	Faroes	France	Norway	Total
1988	832		1284	2116
1989	362		1328	1690
1990	162		633	795
1991	492		555	1047
1992	577		637	1214
1993	282		332	614
1994	479		486	965
1995	281		503	784
1996	102		798	900
1997	526		398	924
1998	511		819	1330
1999	164	4	498	666
2000	229	1	399	629
2001	420	6	497	923
2002	150	4	457	611
2003	624	4	927	1555
2004	1058	3	247	1308
2005	575	7	647	1229
2006	472	6	177	655
2007	327	4	309	640
2008	458	3	120	580
2009	270	1	198	469
2010	393	1	236	630
2011	522	0	0	522
2012	434	1	0	435
2013*	255	1	0	256

***Preliminary.**

Table 4.2.3. Ling in Vb. Nominal landings (1988–2013).

Year	Vb1	Vb2	Vb
1988	2372	2116	4488
1989	2962	1690	4652
1990	3062	795	3857
1991	3465	1047	4512
1992	2400	1214	3614
1993	2242	614	2856
1994	2657	965	3622
1995	3286	784	4070
1996	3996	900	4896
1997	4733	924	5657
1998	4029	1330	5359
1999	4571	666	5238
2000	3479	629	4109
2001	3686	923	4609
2002	3528	611	4139
2003	3897	1555	5453
2004	4731	1308	6039
2005	4620	1229	5849
2006	4558	655	5213
2007	4092	640	4731
2008	4166	580	4747
2009	4174	469	4643
2010	5500	630	6129
2011	4321	522	4843
2012	5576	435	6011
2013*	3830	256	4086

***Preliminary.**

Table 4.2.4. Ling in Vb. Overview of the sampling from commercial landings since 1996.

Year	Length	Weight	Age
1996	6399	410	1084
1997	7900	541	1526
1998	5912	538	1081
1999	4536	360	480
2000	3512	360	360
2001	3805	420	420
2002	4299	180	300
2003	6585	360	661
2004	6827	1169	659
2005	7167	3217	540
2006	6503	4038	276
2007	4031	1713	120
2008	2521	1945	60
2009	4373	4348	232
2010	4345	4279	180
2011	3405	2828	0
2012	2810	2447	50
2013	2477	2076	0

Table 4.2.5. Ling in Vb. Catch number-at-age (thousands) from the commercial fleet.

YEAR\AGE	4	5	6	7	8	9	10	11	12	13	14+
1997	1	219	298	490	411	266	126	41	27	8	6
1998	1	59	159	284	335	369	180	70	33	1	27
1999	18	25	9	167	399	349	176	84	53	33	1
2000	49	134	120	62	123	192	116	61	46	13	2
2001	20	88	311	597	195	111	80	23	27	10	1
2002	61	67	415	447	210	62	81	2	2	2	2
2003	39	65	331	465	428	226	68	22	25	28	0
2004	152	147	196	440	447	224	91	54	18	16	5
2005	76	189	295	316	356	221	108	47	22	23	31
2006	116	153	169	354	310	228	131	93	32	28	22
2007	83	143	375	326	247	135	92	31	20	3	7
2008	41	110	360	326	240	128	93	31	23	11	8
2009	23	67	259	316	285	163	102	28	17	8	5
2010	11	49	276	406	402	241	130	34	21	10	7
2011	14	46	208	254	254	193	140	34	22	9	6
2012	28	65	254	365	350	226	169	47	28	9	4
2013	4	23	174	293	283	171	110	27	17	6	3

Table 4.2.6. Ling in Vb. Catch weight-(kg) at-age from the commercial landings.

YEAR/AGE	4	5	6	7	8	9	10	11	12	13	14+
1997	0.603	1.147	1.782	2.404	3.221	4.058	5.156	7.062	8.216	9.764	11.993
1998	1.157	1.203	1.799	2.437	3.132	4.024	5.018	6.451	7.186	8.582	10.229
1999	1.067	1.088	2.216	2.366	3.118	4.083	5.480	6.227	8.203	7.930	10.466
2000	1.321	1.826	2.617	3.139	4.055	5.056	6.281	7.604	9.931	11.678	9.314
2001	1.061	1.122	1.921	2.604	3.638	5.168	6.587	7.521	9.443	11.990	9.542
2002	1.202	1.512	1.959	2.887	3.872	5.474	8.242	5.198	9.600	11.777	12.506
2003	0.806	1.190	2.088	2.724	3.502	4.044	5.482	6.219	8.761	11.145	11.145
2004	1.104	1.501	2.054	2.721	3.570	4.714	6.232	8.193	9.865	11.329	11.148
2005	0.861	1.118	1.791	2.586	3.586	4.793	6.345	7.731	9.000	10.400	13.558
2006	0.733	0.982	1.537	2.176	2.978	3.955	5.116	6.479	8.573	9.549	10.289
2007	0.854	1.264	1.930	2.883	3.728	4.894	6.765	9.262	10.155	8.799	11.929
2008	1.047	1.399	2.003	2.901	3.692	4.880	6.707	8.992	9.877	10.640	11.518
2009	1.069	1.447	2.066	3.017	3.731	4.750	6.313	8.467	9.259	10.072	11.144
2010	1.210	1.625	2.168	3.102	3.815	4.743	6.215	8.571	9.349	10.277	11.229
2011	1.085	1.524	2.102	3.067	3.943	5.043	6.424	8.461	9.359	10.208	11.465
2012	0.931	1.370	2.074	3.015	3.740	4.876	6.444	8.194	8.841	9.617	11.338
2013	1.274	1.719	2.255	3.074	3.754	4.787	6.247	8.245	9.000	9.636	11.178

Table 4.2.7. Ling in Vb. Data on the cpue series from Faroese commercial fleets and groundfish surveys. St- standardized and org- orginal data, not standardized data.

	Longline		Trawl (bycatch)		Spring survey			Summer survey	
year	st_mean	st_se	st_mean	st_se	org_mean	st_mean	st_se	st_mean	st_se
1983					7.7				
1984					8.3				
1985					5.5				
1986	27.3	0.7			8.6				
1987	43.2	1.6			10.9				
1988	41.2	2.4			6.9				
1989	30.0	1.5			6.6				
1990	24.1	0.6			6.2				
1991	24.1	0.6			8.0				
1992	20.0	0.5			4.0				
1993	21.3	0.5			6.1				
1994	32.2	0.7			4.4	4.3	2.1		
1995	31.3	0.8	15.7	0.1	8.0	7.3	3.6		
1996	17.2	0.6	15.4	0.1	14.2	17.4	11.2	15.3	5.1
1997	59.9	1.7	18.3	0.0	16.0	17.0	7.9	9.4	3.2
1998	41.4	1.8	15.5	0.0	21.3	23.9	15.8	9.9	4.1
1999	33.6	1.1	13.5	0.0	11.1	13.4	7.8	5.8	2.2
2000	24.3	0.7	13.4	0.0	10.1	9.4	5.5	6.8	2.3
2001	27.3	0.4	13.4	0.0	17.7	13.8	8.0	8.1	2.7
2002	22.0	0.4	12.6	0.0	10.8	10.4	4.2	7.9	2.2
2003	27.0	1.2	15.5	0.0	15.3	16.1	6.9	4.0	1.1
2004	56.5	2.2	19.0	0.3	11.0	12.5	6.1	17.9	6.5
2005	54.4	2.0	22.1	0.5	10.6	11.0	4.8	11.4	3.1
2006	54.7	1.5	24.0	0.6	9.0	11.1	4.3	8.4	2.4
2007	39.5	1.1	23.0	0.5	8.3	8.4	4.2	9.9	3.4
2008	50.4	1.0	26.1	0.6	11.3	10.8	5.6	14.0	5.5
2009	50.2	1.1	24.9	0.5	14.2	14.4	6.2	11.7	3.4
2010	63.7	1.2	23.1	0.4	13.6	15.2	5.4	22.1	8.8
2011	74.0	1.1	25.8	0.5	17.1	17.4	7.5	23.3	7.9
2012	68.6	1.4	35.7	0.5	16.7	17.1	7.6	19.8	7.0
2013	72.2	1.1	31.8	0.4	17.7	17.8	9.9	21.4	6.7

Table 4.2.8. Ling in Vb. Summary table from XSA.

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	F_{BAR} 6-11
	Age 4					
1997	1784	24 133	16 946	5657	0.334	0.335
1998	3406	24 245	16 120	5359	0.333	0.419
1999	4465	23 154	12 827	5238	0.408	0.505
2000	4456	30 199	11 753	4109	0.350	0.398
2001	3853	25 906	12 282	4609	0.375	0.352
2002	3050	29 135	15 102	4139	0.274	0.241
2003	3270	26 455	15 679	5453	0.348	0.351
2004	3421	28 002	16 275	6039	0.371	0.413
2005	4164	25 398	15 200	5849	0.385	0.429
2006	4333	21 031	11 486	5216	0.454	0.532
2007	4046	25 751	12 933	4733	0.366	0.380
2008	4148	28 710	14 451	4736	0.328	0.350
2009	4649	31 109	16 008	4643	0.290	0.331
2010	4832	35 577	17 748	6129	0.345	0.397
2011	3996	35 080	18 309	4843	0.265	0.306
2012	3231	34 430	20 343	6003	0.295	0.358
2013	3086	36 247	21 928	4376	0.200	0.222
Arith.						
Mean	3776	28 504	15 611	5125	0.336	0.372
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

4.3 Ling (*Molva Molva*) in Subareas I and II

4.3.1 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. Figure 4.3.1 shows the spatial distributions of total effort and total catch for the Norwegian longline fishery in 2013.

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 2013 there were only 33 vessels above 21 m in the fishery.

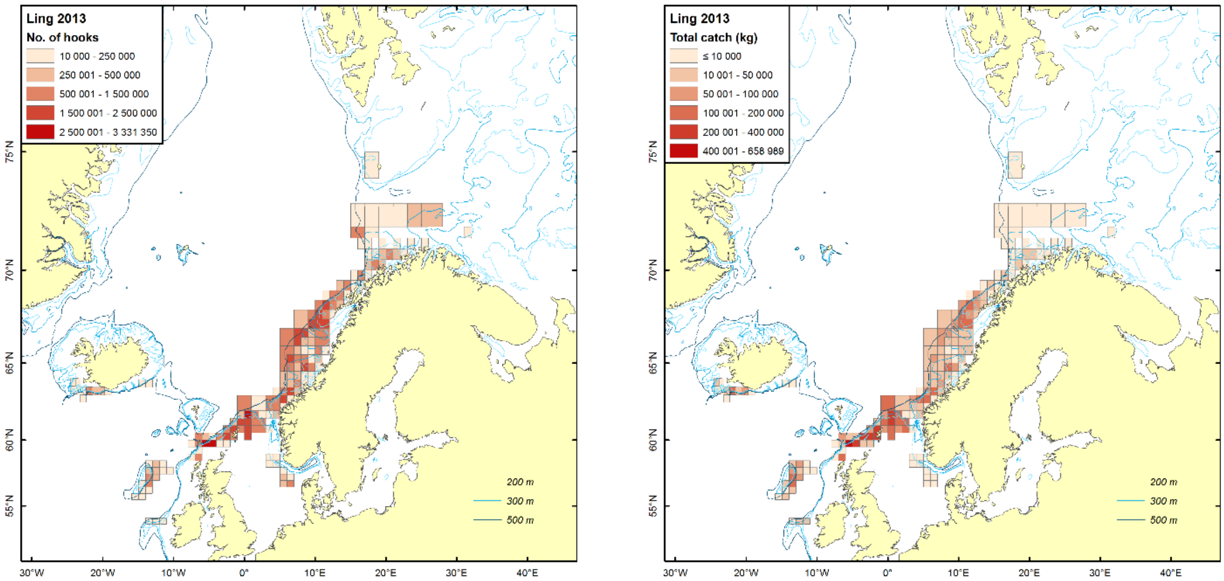


Figure 4.3.1. Distribution of effort and catch for the Norwegian longline fishery in 2013.

4.3.2 Landings trends

Landing statistics by nation in the period 1988–2013 are in Tables 4.3.1a–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, 2008 and 2010 the landings increased to over 10 000 t. Preliminary landings for 2013 are 8825 t. Total international landings in Areas I and II are given in Figure 4.3.2.

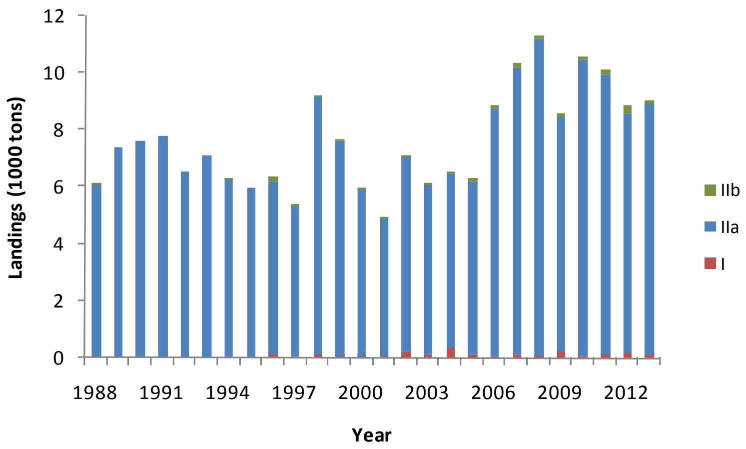


Figure4.3.2. Total international landingsof ling in Subareas I and II.

4.3.3 ICES Advice

Advice for 2013 and 2014: Based on the ICES approach for data-limited stocks, ICES advises that there should be a 20% reduction in effort.

4.3.4 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 2013 set to 7250 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 2013.

4.3.5 Data available

4.3.5.1 Landings and discards

Amounts landed were available for all relevant fleets. No estimates of amount of ling discards are available. But since the Norwegian fleets are not regulated by TACs, and additionally there is a ban on discarding, while incentives for illegal discarding are believed to be low. The landings statistics are therefore regarded as being adequate for assessment purposes.

4.3.5.2 Length compositions

Length composition data are available for the longliners and gillnetters in the Norwegian Reference fleet Figure 4.3.3 shows plots of the length distribution in Areas I and II for the period 2001 to 2013. This shows that the median length in Area I has varied slightly, while the length in Area IIa has been very stable. Length compositions from the Russian fisheries investigations are also given in Aleksandrov and Vinnichenko, WD, 2014.

The relation between weight and length is shown in Figure 4.3.4, and the length distribution based on data from the Norwegian Reference fleet is shown in Figure 4.3.5.

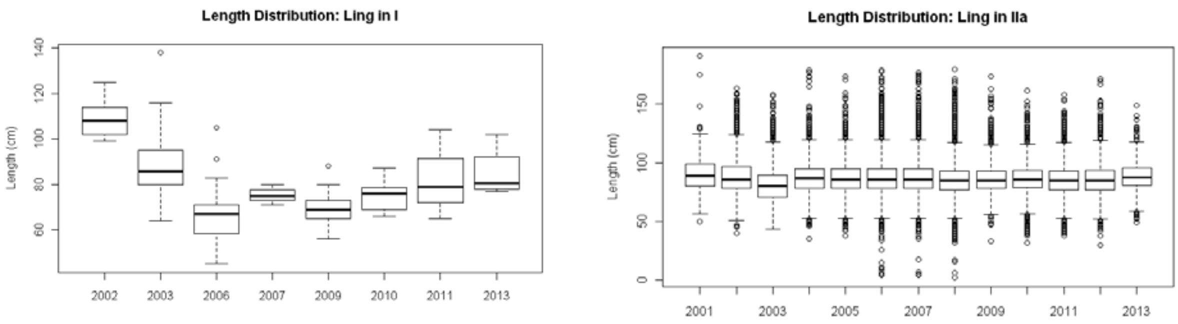


Figure 4.3.3. Plots of the length distribution in Areas I and II for the period 2001 to 2013.

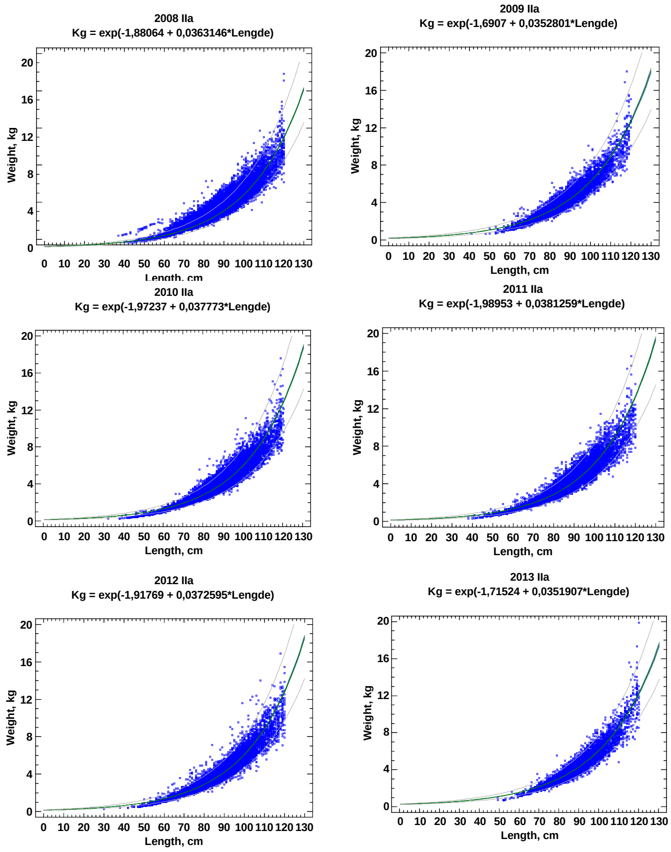


Figure 4.3.4. Weight–length relationship from the period 2008–2013. Data is collected by the Norwegian Reference Fleet.

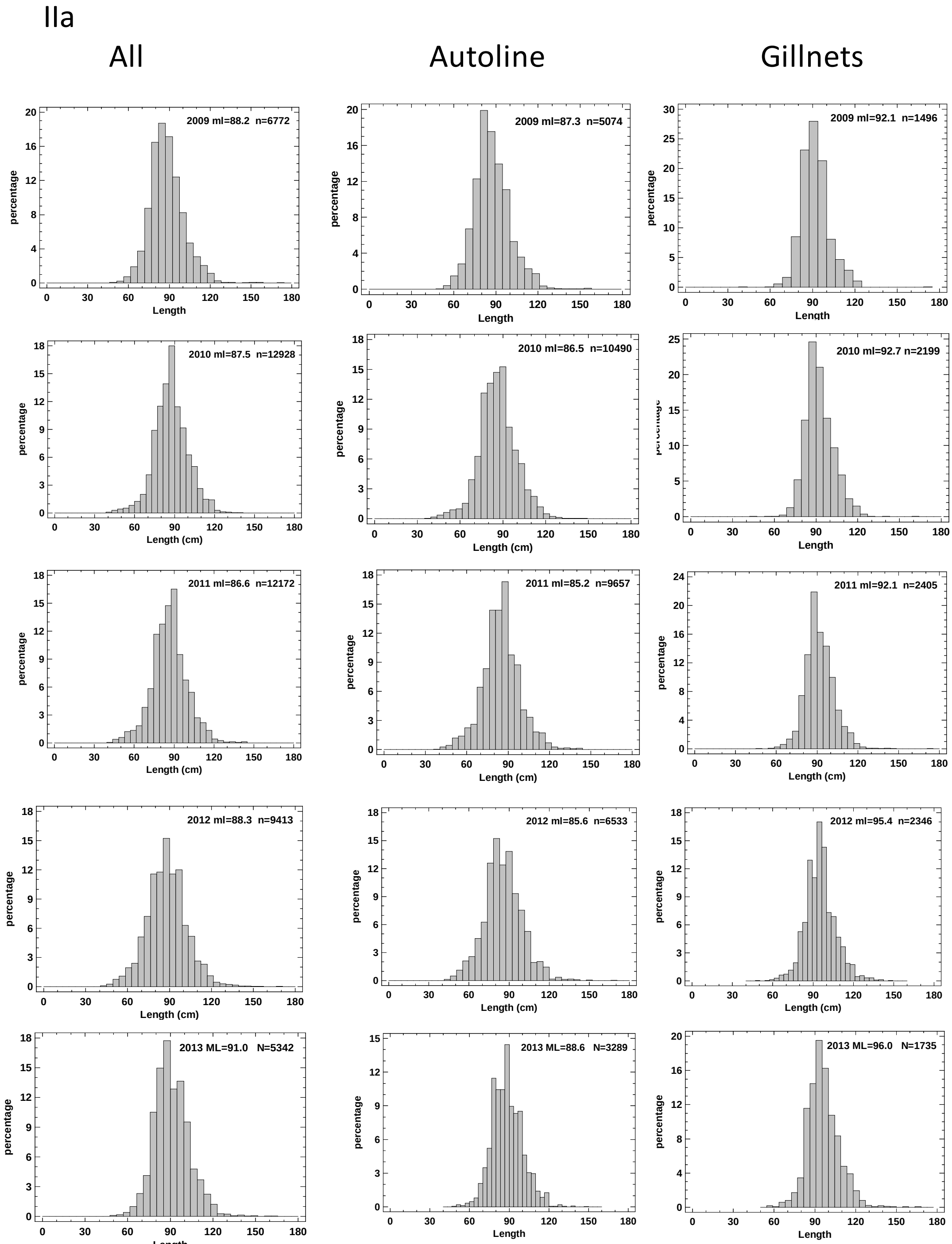


Figure. 4.3.5. Length composition in all catches, taken by longliners and gillnetters during the period 2009–2013.

4.3.5.3 Age compositions

The estimated age distribution of the catch in the ling caught in the longline and in the gillnet fishery for the time period 2009–2013 in shown in Figure 4.3.6.

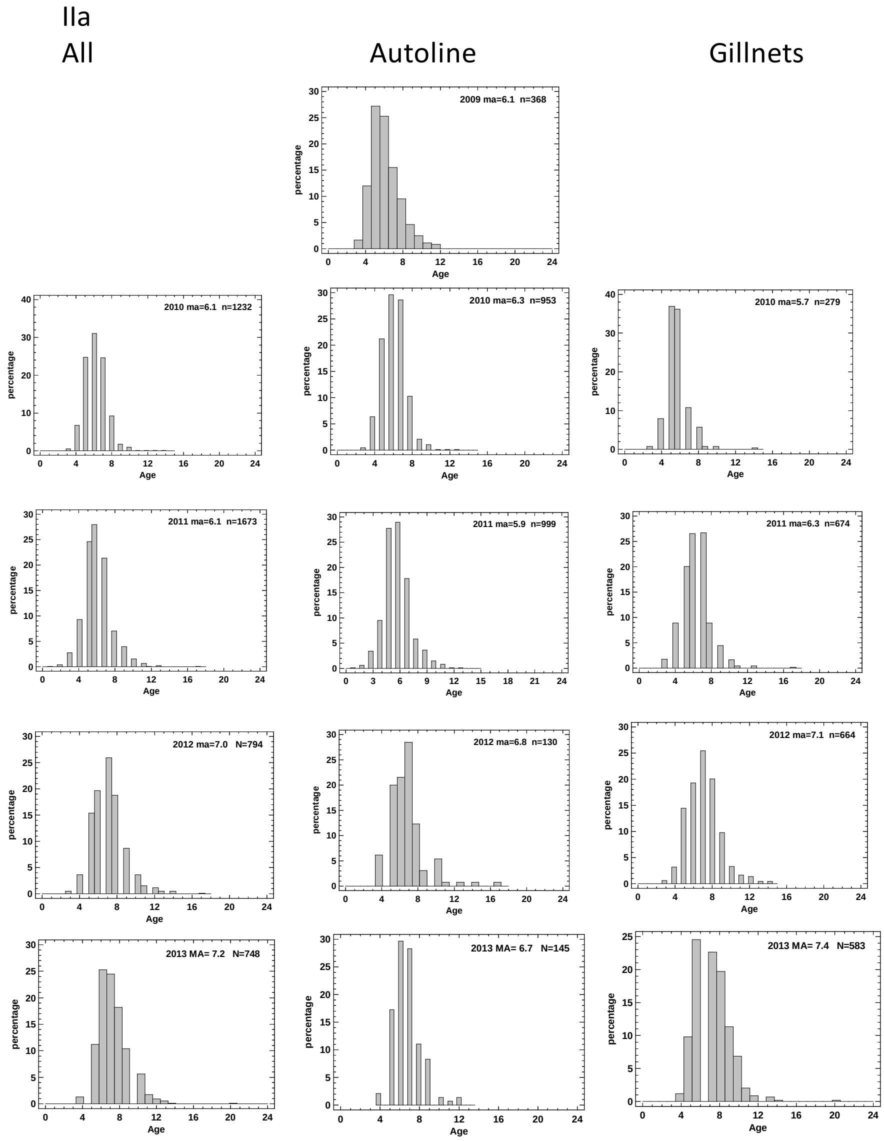


Figure 4.3.6. Age composition of the fish, taken by longliners and gillnetters during the period 2009–2013.

4.3.5.4 Length and Weight-at-age

Age data from 2009 to 2013 were analysed and Figure 4.3.7 gives the average mean length and mean weight-at-age.

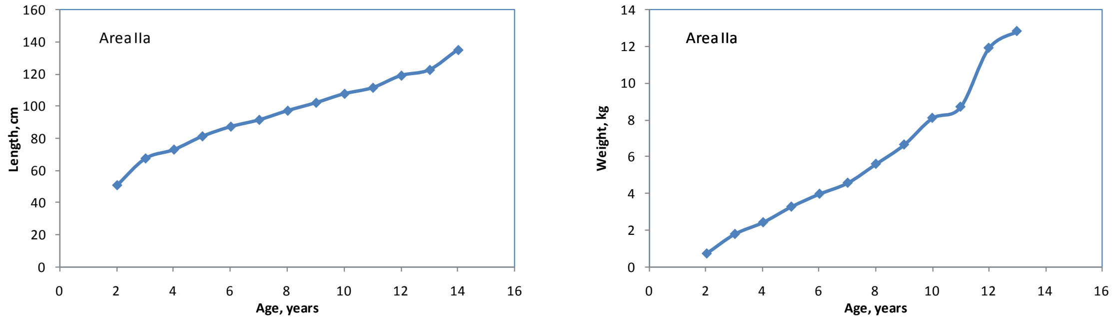


Figure. 4.3.7. Average mean length and mean weight-at-age for the period 2009–2013.

4.3.5.5 Maturity and natural mortality

No new data were presented.

4.3.5.6 Catch, effort and research vessel data

A standardized cpue series for 2000–2013 for Norwegian longliners is presented in Figure 4.3.8. The series was based on all data available and a subset of data for the days when ling was targeted (made up more than 30% of the total catch weight). No research vessel data are available.

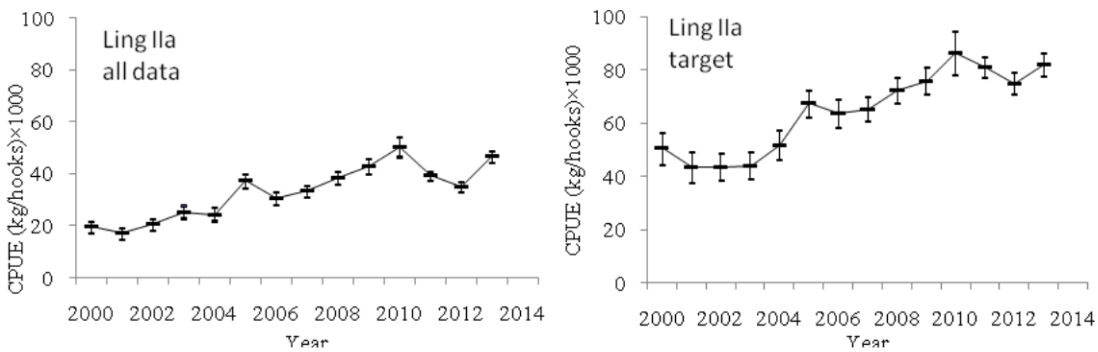


Figure4.3.8. Ling in IIa. Estimates of cpue (kg/1000 hooks) based on skipper's logbooks based on all available data and on catches when ling was considered the target species 2000–2013. The bars denote the 95% confidence interval.

4.3.6 Data analyses

Length distribution

Figures 4.3.3 and 4.3.5 show plots of the length distributions in Areas I and II for the period 2001 to 2013. It appears that the mean length in Area I have varied slightly, while the mean length in Area IIa have been very stable. The average length is slightly higher in the gillnet fishery compared to the longline fishery.

Development of the Norwegian fishery

The number of longliners has declined in recent years (Figure 4.3.9), from 72 to 33 in the period 2000–2013. The numbers of fishing days per vessel in Area IIa have decreased from 73 days in 2011 to 44 days in 2013 (Table 4.3.2).

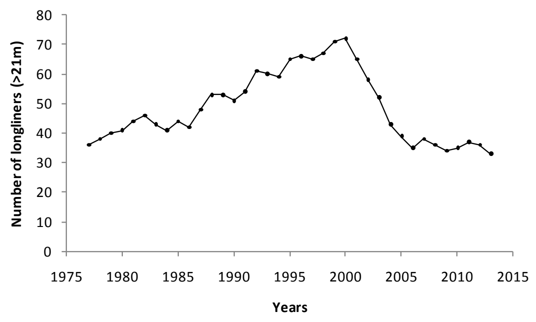


Figure 4.3.9. Change in number of vessels in the Norwegian longliner fleet during the period 1977–2013 (vessels exceeding 21 m that landed 8 t or more of ling, blue ling and tusk in a given year).

Table 4.3.2. Average number of fishing days per longline vessel in Subarea IIa for the period 2000–2013.

Ling	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
IIa	23	40	50	40	37	51	54	65	52	65	70	73	59	44

During the period 2000 to 2013 the main technological change in Subareas I and II was that the number of hooks per day increased from 31 000 hooks to 37 000 hooks (Figure 4.3.10).

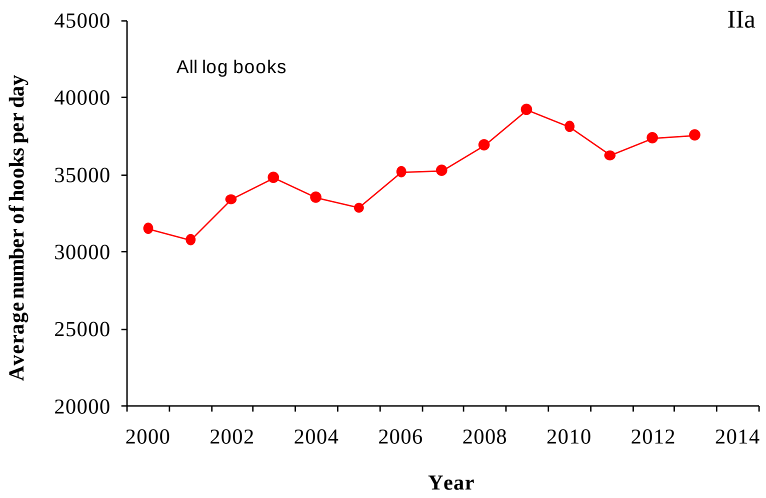


Figure 4.3.10. Average number of hooks the Norwegian longliner fleet used per day in ICES Subarea IIa for the years 2000–2013 in the fishery for tusk, ling and blue ling.

The number of hooks set by each vessel when ling were caught varied considerably from vessel to vessel, but it does not appear that average catch of ling per 1000 hooks varied significantly with the number of hooks set. In particular the catch rate increased more or less linearly with increasing numbers of hooks. Therefore, it was decided that no nonlinear adjustment is needed for the number of hooks set for estimating a cpue series for ling. No other changes or variability in the longline fishery over the years appeared to affect noticeably the catchability of the fleet.

It was also estimated that the total number of hooks set per year has gone down 60% since 2002 and the total number of weeks the fleet is fishing for ling has gone down from 1200 weeks in 2001 to 500 weeks in 2013.

In conclusion all these changes have resulted in a reduction of the fishing effort targeting ling in Areas I and II.

4.3.6.1 Calculating a cpue series based on all data or when ling was targeted

All catch data and a subset of the catch data when ling was assumed to be the target species were used to calculate a standardized cpue series. The two cpue series for ling were estimated using a generalized linear model. In particular, the following model was most likely the appropriate estimator according to Helle and Pennington (WD 2014).

$$y_{i,j,k,l} = c + \mu_i + \alpha_j + \beta_k + e_{i,j,k,l} \quad (1)$$

was found to be appropriate where: $y_{i,j,k,l}$ is the catch (kg) per hook in year i, month *j* for set *l* by vessel *k*; *c* is a constant; μ_i, *i* = 2000-2013, is the year effect; α_j, *j* = 1-12, is the month effect; β_k is the vessel effect, *k* depends on the dataset; and $e_{i,j,k,l}$ is the error term.

4.3.6.2 Biological reference points

Estimates of LMAX and AFC were identified and made available to WKLIFE.

4.3.6.3 Comments on the assessment

The cpue series show a positive development of the ling population.

4.3.7 Management considerations

Increased catches since 2006 do not appear to have had a detrimental effect on the stock given that cpue has remained stable over the period.

Table 4.3.1a. Ling Ia and b. 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	57				57
2011	129				129
2012	158				158
2013*	126				126

***Preliminary.**

Table 4.3.1a. Ling Ia. WG estimates of landings.

Year	Norway	Iceland	Scotland	Faroes	Total
2012	1				1
2013	41				41

Table 4.3.1b. Ling IIa. WG estimates of landings.

Year	Faroes	France	Germany	Norway	E & W	Scotland	Russia	Ireland	Iceland	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	18	10 318	0	2	47			10 395
2011	4	6	6	9764			19			9799
2012	21	6	9	8334		7	45		3	8421
2013*	7	15	7	8677		1	114		4	8825

***Preliminary.**

Table 4.3.1c. Ling IIb. WG estimates of landings.

Year	Norway	E & W	Faroes	France	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		162
2009	84				84
2010	128				128
2011	164			7	171
2012	266				266
2013*	76				76

***Preliminary.**

Table 4.3.1d. 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	11 346
2009	236	8244	84	8564
2010	57	10 395	128	10 580
2011	128	9799	171	10 099
2012	158	8425	266	8425
2013*	126	8825	76	8825

***Preliminary.**

4.4 Ling (*Molva Molva*) in Division Va

4.4.1 The fishery

The fishery for ling in Va has not changed substantially in recent years. Around 150 longliners annually report catches of ling, around 50 gillnetters around 60 trawlers and ten *Nephrops* boats. Most of ling in Va is caught on longlines and the proportion caught by that gear has increased since 2000 to around 65% in 2009–2011. At the same time the proportion caught by gillnets has decreased from 20–30% in 2000–2001 to 3–8% in 2008–2011. Catches in trawls have varied less and have been at around 20% of Icelandic catches of ling in Va (Table 4.4.1).

Table 4.4.1. Ling in Va. Number of Icelandic boats and catches participating in the ling fishery in Va.

Year	Number of boats			Catches in tonnes				Sum
	Longliners	Gillnetters	Trawlers	Longline	Gillnet	Trawl	Others	
2000	165	88	68	1537	703	729	236	3526
2001	146	114	57	1086	1056	492	223	3174
2002	128	92	56	1277	649	661	248	3111
2003	137	73	54	2207	453	580	336	3840
2004	144	67	68	2011	548	656	506	4000
2005	152	60	72	1948	517	1081	766	4596
2006	167	51	81	3733	634	1242	669	6577
2007	155	59	76	4044	667	1396	492	6889
2008	138	43	78	5002	509	1509	714	7993
2009	141	46	67	6230	747	1540	1096	9867
2010	156	50	68	6531	390	1537	1411	10 143
2011	151	58	59	5595	241	1677	1279	9060
2012	156	48	58	7477	264	1398	1551	10 952
2013	163	45	57	6781	354	2805	254	10 194

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 by trawlers, less than 500 m (Figure 4.4.1). The main fishing grounds for ling in Va as observed from logbooks are in the south, southwestern and western part of the Icelandic shelf (Figure 4.4.2). 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 4.4.3).

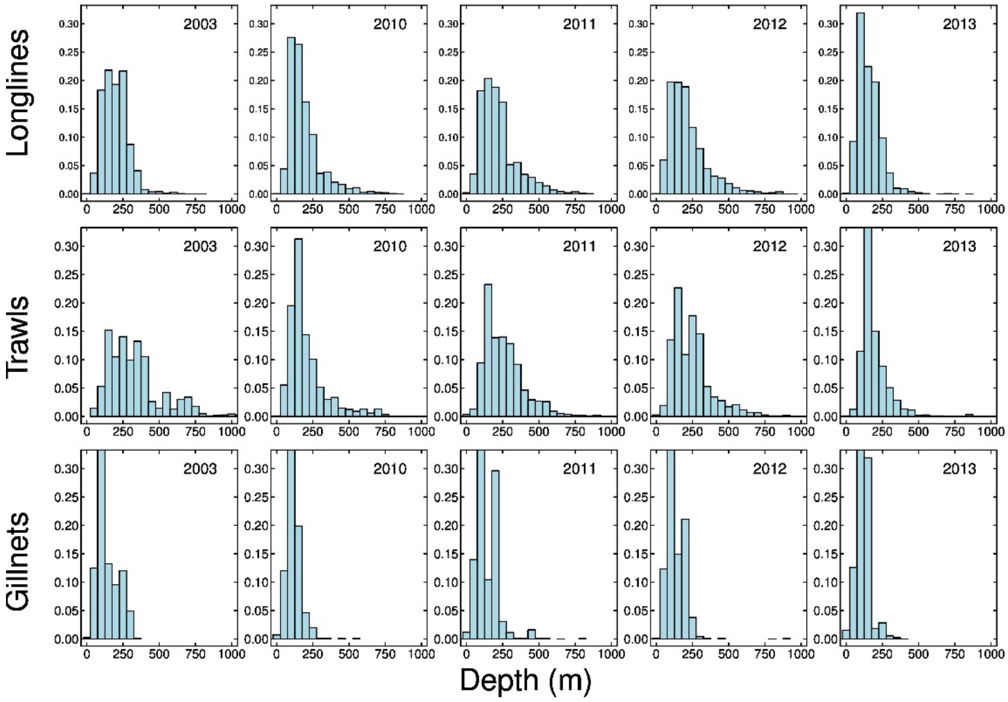


Figure 4.4.1. Ling in Va. Depth distribution of ling catches from longlines, trawls and gillnets from Icelandic logbooks.

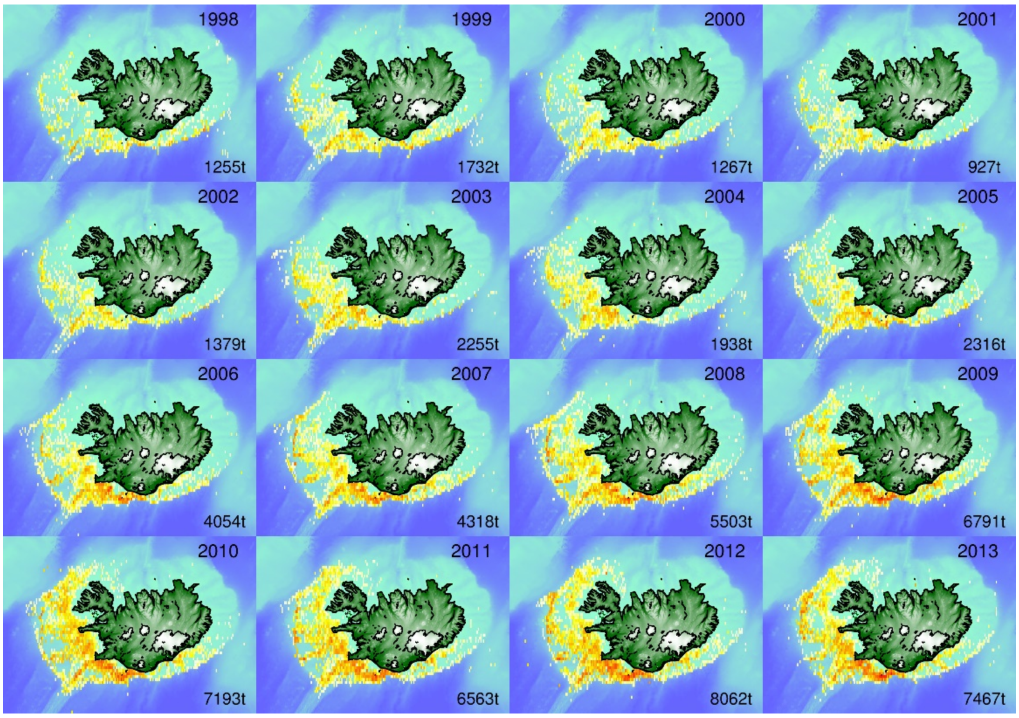


Figure 4.4.2. Ling in Va. Geographical distribution (tonnes/square mile) of the Icelandic ling fishery since 1998 as reported in logbooks by the Icelandic fleet. All gears combined.

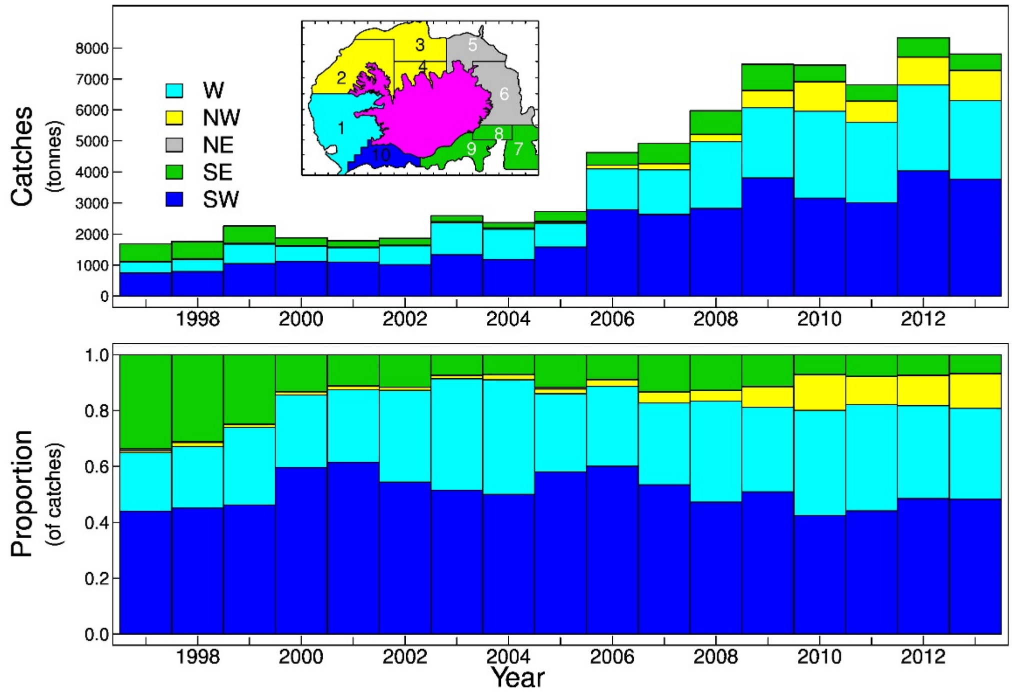


Figure 4.4.3. Ling in Va. Changes in spatial distribution of ling catches as recorded in Icelandic logbooks.

4.4.2 Landings trends

In 1950 to 1971 landings of ling in Va ranged between 7 kt to 15 kt. Landings decreased between 1972 and 2005 to between 3 kt to 7 kt as a result of foreign vessels being excluded from the Icelandic EEZ. In 2001 to 2010 catches increased substantially year on year and reached 11 thousand tonnes in 2010. In 2011 catches decreased somewhat to around 9600 tonnes but reached 12 thousand tonnes in 2012 and 2013. This has not been reached since the early seventies. (Table 4.4.6 and Figure 4.4.4).

4.4.3 ICES Advice

The ICES advice for 2013 and 2014 states: Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 12 000 tonnes.

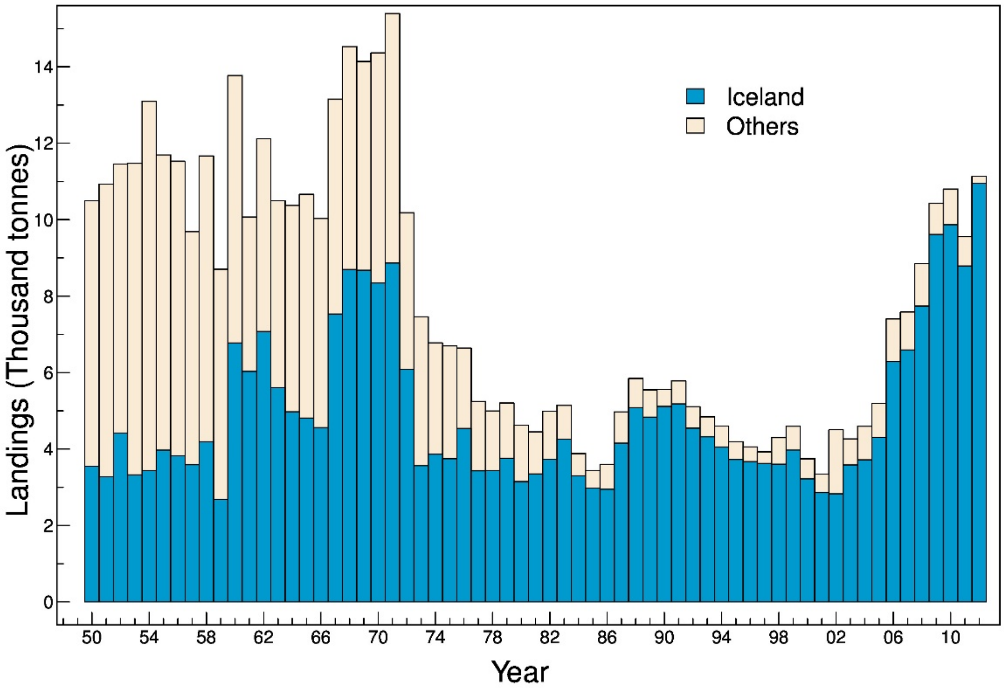


Figure 4.4.4. Ling in Va. Nominal landings.

4.4.4 Management

The Icelandic Ministry of Industries and Innovation (MII) 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 2001/2002 fishing year.

Landings have exceeded both the advice given by MRI and the set TAC in all fishing years except 2001/2002 (Table 4.4.2). Overshoot in landings in relation to advice/TAC was less in the 2010/2011 (35%) and 2011/2012 (24%) fishing years than in the 2009/2010 fishing year (53%). 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 has until recently not been taken into consideration by the Ministry when allocating TAC to Icelandic vessels. There is no minimum landing size for ling in Va.

Table 4.4.3 gives an overview of the composition of the total landings by Icelandic vessels in Va of Ling. In general there is always something left of last year's quota (column 3 in Table 4.4.3). This indicates that the holders of 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 Table 4.4.3). This fishing in excess of the 'available' TAC is then met with converting TAC from other species to ling quota. This is a reversal of the trend at the beginning of the table when considerable proportion of the TAC was either converted to other species or moved to the next Quota year. In the 2011/2012 slightly less was transferred of other species quota for fishing ling (column 8) relative to the few preceding quota years.

In the 2010/2011 and 2011/2012 fishing years the TAC allocated to Icelandic vessels (column 1 in Table 4.4.3) is lower than the total TAC set by the MII (National TAC column in Table 4.4.2). This is a response by the managers to constrain total catches close to set TAC, i.e. taking into account catches by foreign fleets (see below).

There are 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 maximum 1200 tonnes 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.

Table 4.4.2. Advice given by MRI, set national TAC by the Ministry of Fisheries and Agriculture and landings by fishing year (1st of September o 31st of August). Landings for 2011/2012 are preliminary.

Fishing year	MRI-advice	National-TAC	Landings
1999/2000			3961
2000/2001			3451
2001/2002	3000	3000	2968
2002/2003	3000	3000	3715
2003/2004	3000	3000	4608
2004/2005	4000	4000	5238
2005/2006	4500	5000	6961
2006/2007	5000	5000	7617
2007/2008	6000	7000	8560
2008/2009	6000	7000	10 489
2009/2010	6000	7000	10 713
2010/2011	7500	7500	10 095
2011/2012	8800	9000	11 133
2012/2013	12 000	11 500	12 445
2013/2014	14 000		

Table 4.4.3. Ling in Va.

QUOTA	SET	OTHER	P.Y.	VESSEL	EFF.	LAND.	TAC	SPECIES	TAC	TAC	CONF.	U.TAC
Year	TAC	TAC	TAC	Tr.	TAC		- Land	Tr	left	moved		n.-tr.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2001/2002	3.0	0.007	0.000	0	3.007	2.546	0.460	-0.145	0.315	0.220	0.006	0.101
2002/2003	3.0	0.008	0.220	0	3.228	3.134	0.094	0.188	0.282	0.208	0.004	0.078
2003/2004	3.0	0.008	0.208	0	3.216	3.796	- 0.580	0.838	0.258	0.210	0.002	0.050
2004/2005	4.0	0.007	0.210	0	4.216	4.461	- 0.245	0.576	0.331	0.281	0.005	0.054
2005/2006	5.0	0.010	0.281	0	5.292	5.853	- 0.561	0.902	0.341	0.310	0.007	0.038
2006/2007	5.0	0.012	0.310	0	5.321	6.609	- 1.288	1.961	0.674	0.638	0.005	0.041
2007/2008	7.0	0.021	0.638	0	7.659	6.733	0.925	0.255	1.180	1.044	0.000	0.137
2008/2009	7.0	0.030	1.044	0	8.074	9.178	- 1.104	1.459	0.355	0.359	0.010	0.006
2009/2010	7.0	0.017	0.359	0	7.375	9.616	- 2.241	2.351	0.110	0.105	0.008	0.012
2010/2011	6.0	0.017	0.084	0	6.101	7.355	- 1.254	1.548	0.294	0.296	0.009	0.007
2011/2012	7.2	0.021	0.296	0	7.517	7.981	- 0.464	0.615	0.151	0.142	0.002	0.011
2012/2013	9.2	0.023	0.142	0	9.365	8.793	0.572	0.376	0.196	0.187	0.001	0.01

(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 three 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.

4.4.5 Data available

In general sampling is considered good from commercial catches from the main gears (longlines and trawls). The sampling does seem to cover the spatial distribution of catches for longlines and trawls but less so for gillnets. Similarly sampling does seem to follow the temporal distribution of catches (see WGDEEP 2012).

4.4.5.1 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) (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 extent and this is thought to discourage discarding in mixed fisheries. A description of the management system is given in the area overview.

4.4.5.2 Length compositions

An overview of available length measurements is given in Table 4.4.4. 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 and trawling fleet are presented in Figure 4.4.5.

Table 4.4.4. Ling in Va. Number of available length measurements from Icelandic commercial catches.

Year	Longlines	Gillnets	D. Seine	Trawls	Sum
2000	1624	566	0	383	2573
2001	1661	493	0	37	2191
2002	1504	366	0	221	2091
2003	2404	300	0	280	2984
2004	2640	348	46	141	3175
2005	2323	31	101	499	2954
2006	3354	645	0	1558	5557
2007	3661	0	76	400	4137
2008	5847	357	15	969	7188
2009	9014	410	0	966	10 390
2010	7322	57	0	2345	9724
2011	7248	0	150	1995	9393
2012	12 770	85	150	2748	15 753
2013	10 771	267	122	2337	13 497

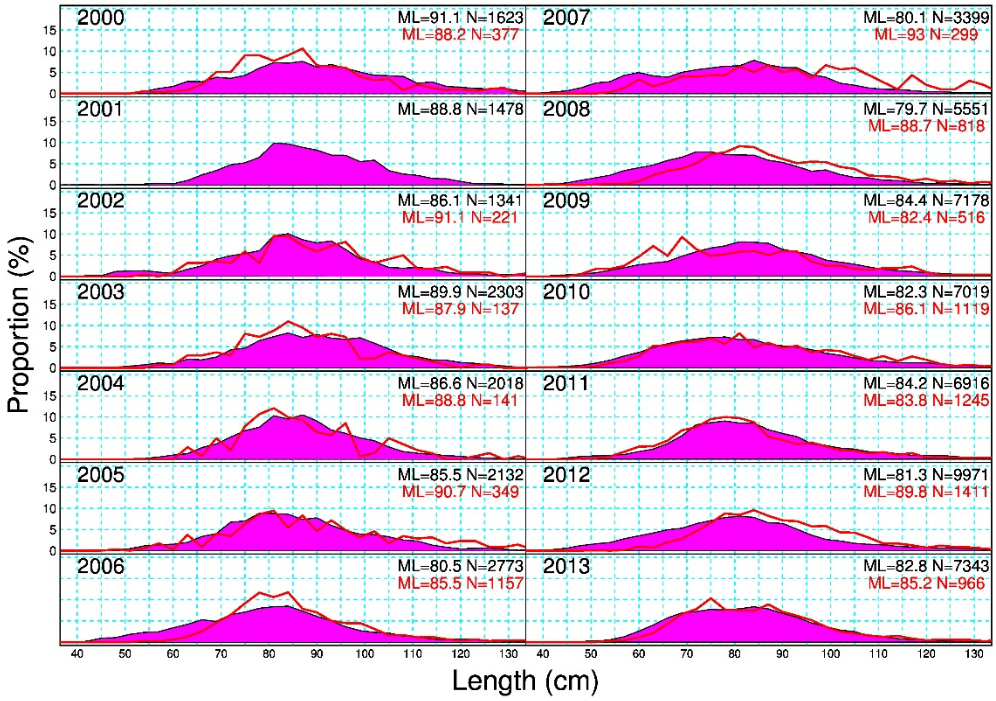


Figure 4.4.5. Ling in Va. Length distributions from the Icelandic longline fleet (pink area) and trawls (red lines).

4.4.5.3 Age compositions

A limited number of otoliths collected in 2010 were aged and a considerable difference in growth rates was observed between the older data and the 2010 data (WGDEEP, 2011:WD07). Limited progress has been made since 2010. Now aged otoliths are available from the 2005, 2010 to 2012 spring surveys and from 2012 from commercial catches (Table 4.4.5). Most of the ling caught in the Icelandic spring survey is between age 5 and 8 but from longlines the age is between 6 to 9 (Figure 4.4.6).

Table. 4.4.5. Ling in Va. Number of available aged otoliths from the Icelandic spring survey and commercial catches.

Year	Spring survey	Longlines	Trawls
2005	122		
2007	224		
2010	245	46	
2011	538		
2012	553	440	149
2013	320		

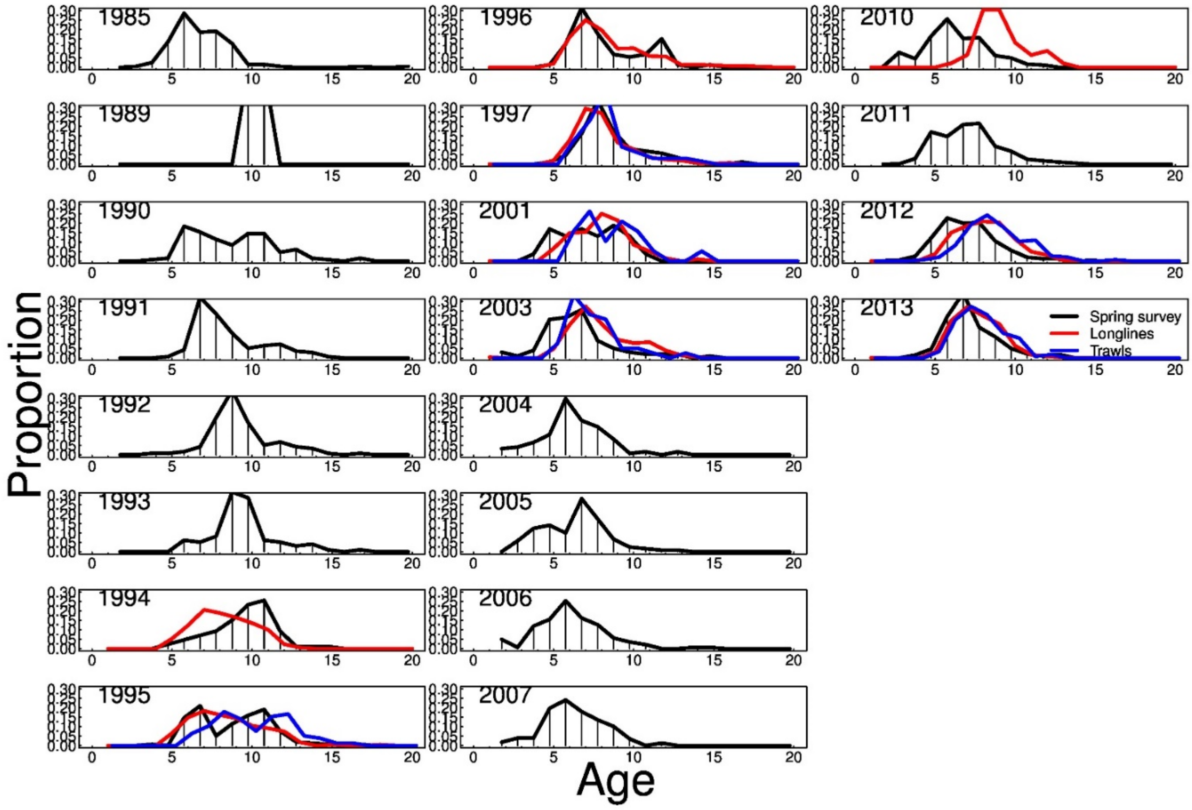


Figure 4.4.6. Ling in Va. Age distribution of ling in the Icelandic spring survey and commercial catches (raw data).

4.4.5.4 Weight-at-age

No data available.

4.4.5.5 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, set to 0.15 in the analytical assessment.

4.4.5.6 Catch, effort and research vessel data

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

Figure 4.4.7 shows nominal catch per unit of effort (cpue) and effort in the Icelandic longline fishery. Cpue is calculated using all logbook 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.

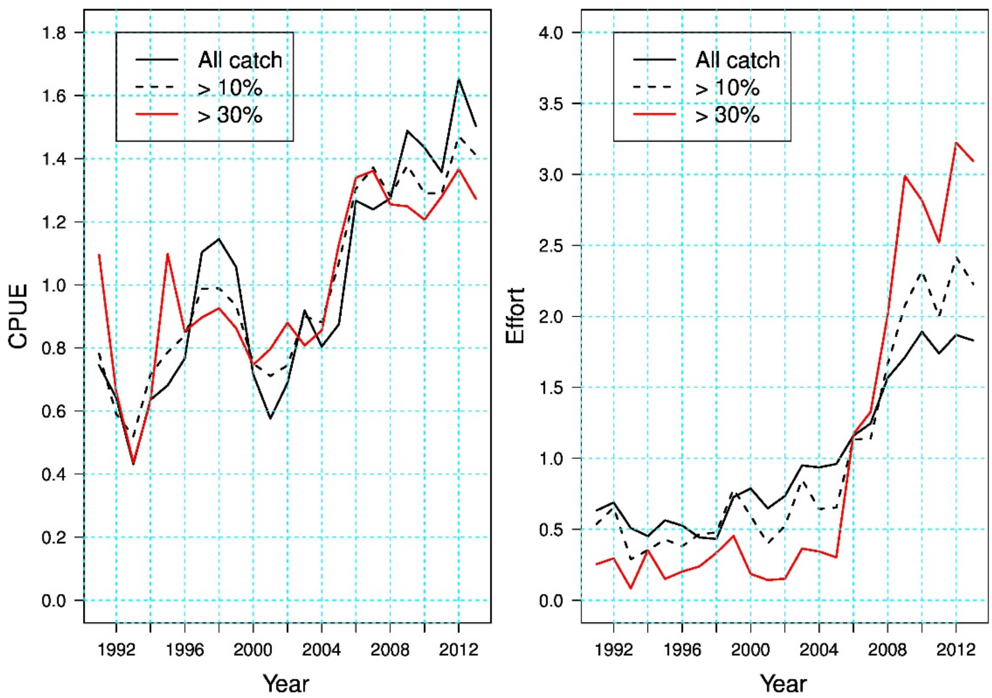


Figure 4.4.7. Ling in Va. Index of raw cpue (sum(yield)/sum(effort)) and effort (number of hooks) of ling from the Icelandic longline fishery based on logbooks 1991–2013. The criteria for the calculations were all sets where ling was reported in the logbooks and where ling composed at least 10% and 30% of the total catch in each set.

Icelandic survey data

Indices: The Icelandic spring groundfish survey, which has been conducted annually in March since 1985, covers the most important distribution area of the ling fishery. In addition, the autumn survey was commenced in 1996 and expanded in 2000 however a full autumn survey was not conducted in 2011 and therefore the results for 2011 are not presented. A detailed description of the Icelandic spring and autumn ground-fish surveys is given in the stock annex.

Figure 4.4.8 shows both a recruitment index and the trends in biomass from both surveys. Length distributions from the spring survey are shown in Figure 4.4.9 (abundance) and changes in spatial distribution the spring survey are presented in Figure 4.4.10.

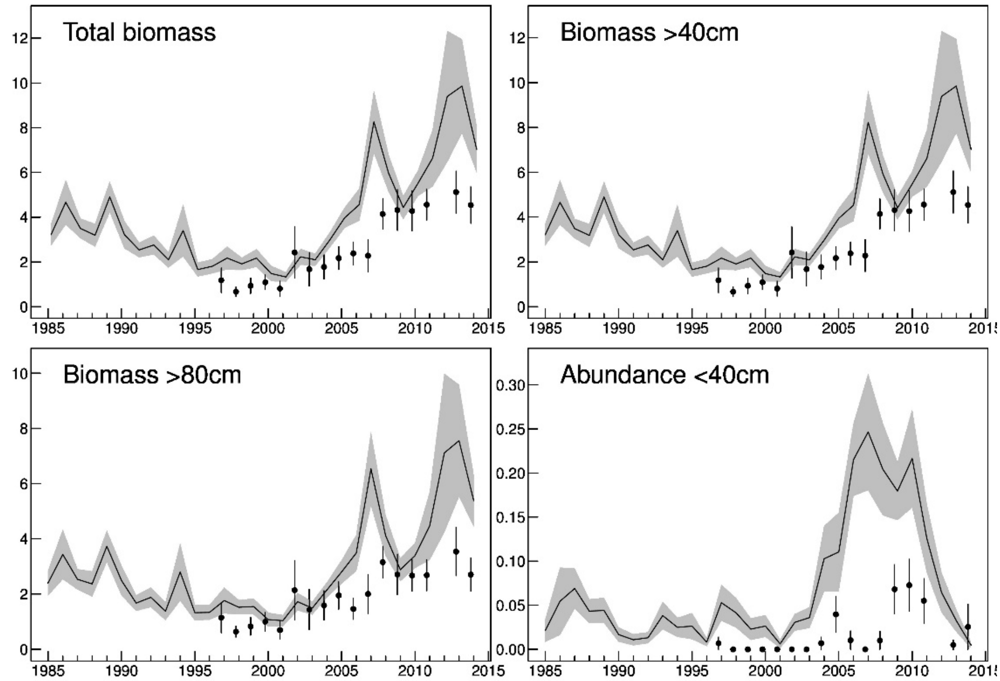


Figure 4.4.8. Ling in Va. Shown are a) Total biomass indices, b) biomass indices larger than 40 cm, c) biomass indices larger than 80 cm and d) abundance indices smaller than 40 cm. The lines with shades show the spring survey index from 1985 and the points with the vertical lines show the autumn survey from 1997. The shades and vertical lines indicate +/- standard error.

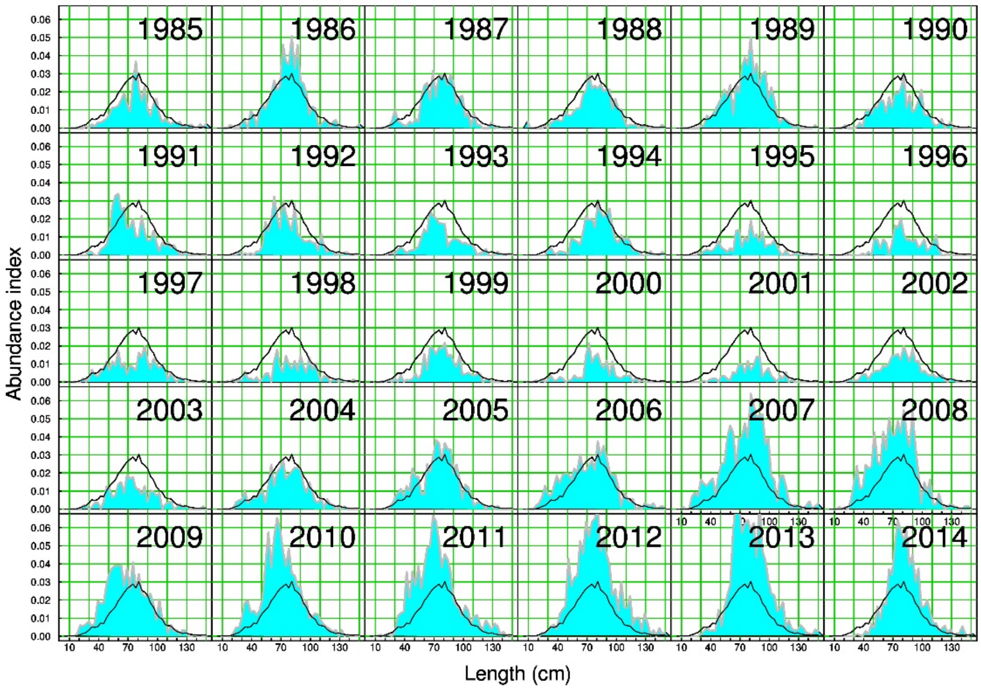


Figure 4.4.9. Ling in Va. Abundance indices by length (3 cm grouping) from the spring survey since 1985. Black line is the average over the whole period.

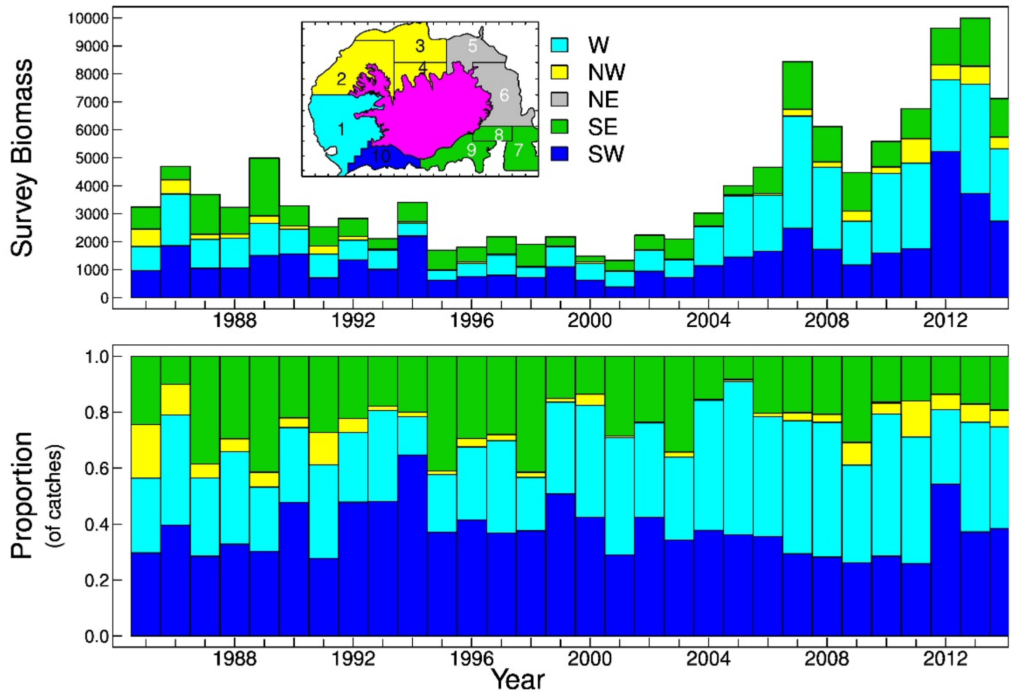


Figure 4.4.10. Ling in Va. Estimated survey biomass in the spring survey by year from different parts of the continental shelf (upper figure) and as proportions of the total (lower figure).

4.4.6 Data analyses

There have been no marked changes in the number of boats participating in the ling fishery in Va. Catches have increased by around 2 kt between 2011 and 2012 mainly because of an increase in the Icelandic catches. Most of ling catches are taken at depths less than 250 meters however in recent years there has been an increase in the proportion in deeper waters by longliners (Figure 4.4.1). This is most likely the result of increased targeting of blue ling in deeper waters by the longline fleet. Spatial distribution of catches has been similar since 2000 with around 80% of catches caught on the western and southwestern part of the shelf (Figures 4.4.2 and 4.4.3).

Sampling from commercial catches of ling is considered good; both in terms of spatial and temporal distribution of samples in relation to landings (WGDEEP 2012). Mean length as observed in length samples from longliners decreased from 2000 to 2008 from around 91 cm to 80 cm (Figure 4.4.5). This may be the result of increased recruitment in recent years rather than increased fishing effort. However mean length increased slightly in 2009 to 2011 to around 83–84 cm but has again reached around 80 cm in 2012. It is premature to draw conclusions from the limited age-structured data. It can only be stated that most of the ling caught in the Icelandic spring survey is between age 5 and 8; but from longlines the age is between the ages of 6 to 9 (Figure 4.4.6).

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 2006 (Figure 4.4.6).

Ling in both in 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 gradually decreased until 1995 (Figure 4.4.8). 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 then highest observed value in 2007 or about two times higher than that observed in the late 1980s. The indices then fell sharply again in 2008 and 2009 to a similar level as in the late 1980s. In 2010 to 2013 the indices increased again to similar levels in 2012 as observed in 2007 but decreased sharply again in 2014. The index of the large ling (90 cm and larger) shows similar trend as the total biomass index (Figure 4.4.8). The recruitment index of ling, defined here as ling smaller than 40 cm, also showed a similar increase in 2003 to 2007 and but then decreased by around 25% and remained at that level until 2010. For the last two years the index has fallen by a factor of three from its level in 2010 and is currently below the level observed before 2004 (Figure 4.4.8). In the WGDEEP-2010 report it was suggested that the consistently high indices (overall length groups) in the spring survey in 2007 might have been an outlier because of unexplained changes in catchability rather than actual change in stock size. However given another high value in the biomass index it is possible that there may be considerable interannual changes in the catchability rather than in the biomass of the stock. However it is noted that recruitment has been high in recent years and these year classes may contribute to the increase in biomass indices.

The shorter autumn survey shows that biomass indices were low from 1996 to 2000, but have increased since then (Figures 4.4.8). There is a consistency between the two survey series; the autumn survey biomass indices is however derived from substantially ling caught. Also there is an inconsistency in the recruitment indices (<40 cm), where the autumn survey show much lower recruitment, in absolute terms compared with the spring survey (Figure 4.4.8). 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. No marked changes are observed between the 2010 and 2012 autumn survey in terms of total biomass. Length distributions from the spring survey show that the ling caught in the spring survey in 2012 is on average larger than usually observed in the survey (Figure 4.4.9).

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, but an increase can be seen in most areas (Figure 4.4.10). However most of the index in terms of biomass comes from the southwestern area or around 50% compared to around 30% between 2003 and 2011. A similar pattern is observed in the autumn survey.

Analytical assessment on Ling using Gadget

In 2014 a model of Ling in Va developed in the Gadget framework (see http://www.hafro.is/gadget for further details) was benchmarked for the use in assessment. The relevant reference points were developed using a specialised bootstrap.

Data used and model settings

Data used for tuning are given in the stock annex.

Model settings used in the Gadget model for ling in Va are described in more detail in the stock annex.

Diagnostics

Likelihood components and their respective weights

In a typical Gadget model parameters are estimated using a weighted negative log-likelihood. The weights are assigned using an iterative reweighting procedure, described in detail in the stock annex. In the procedure each likelihood component is emphasized in turn in order to achieve the "best" fit to a particular dataset. The weights assigned to each component are based on this best fit for each of the components. Table 4.4.6 shows the various likelihood component scores in relation to the final score and, when a likelihood score is emphasized, to other components. This table should give an indication of potential data conflicts. There is little indication of major conflicts however some differences are noteworthy. The recruitment likelihood component (si2049) appears to be downweighted, indicating that other data sources, such as age data, adjust the recruitment. Data arising from longline fleets appear to have some conflicts when other data sources are emphasized however this appears not to have an effect in the final estimate.

Table 4.4.6. Ling in Va. Likelihood component scores from the Gadget model of ling in Va. The rows indicate the likelihood component groups emphasized while the columns the scores from a particular component. The bottom line gives the scores of each component in the final optimisation run.

Component	alkeys gillnet	alkeys longline	alkeys survey	alkeys trawl	ldist gillnet	ldist longline	ldist survey	ldist trawl	si2049	si5069	si70180
Survey indices	1.685	15.000	11.530	2.370	18.260	191.700	31.660	28.430	2578	6784	14 720
Survey data	1.718	10.550	7.790	1.718	17.380	311.400	12.800	44.930	9742	21 140	55 190
longline data	1.699	10.020	8.570	1.699	20.550	42.650	12.840	41.550	9901	26 100	45 780
Other commercial data	1.191	10.260	8.738	1.639	10.560	104.700	13.280	14.680	13 750	28 670	54 950
Final run	1.707	10.190	8.250	1.707	8.049	41.930	12.580	14.630	9528	14 300	17 260

Observed and predicted proportions by fleet

Overall fit to the predicted proportional length– and age–length distributions is close to the observed distributions. (Figures 4.4.11 to 4.4.18). In the initial years of the spring the observed length proportions appear have greater noise in, however as the number of samples caught the noise level decreases. Similarly for gears where only a small portion of the ling catch is caught, such as the gillnets, the overall noise is greater than for those gears with greater number of samples.

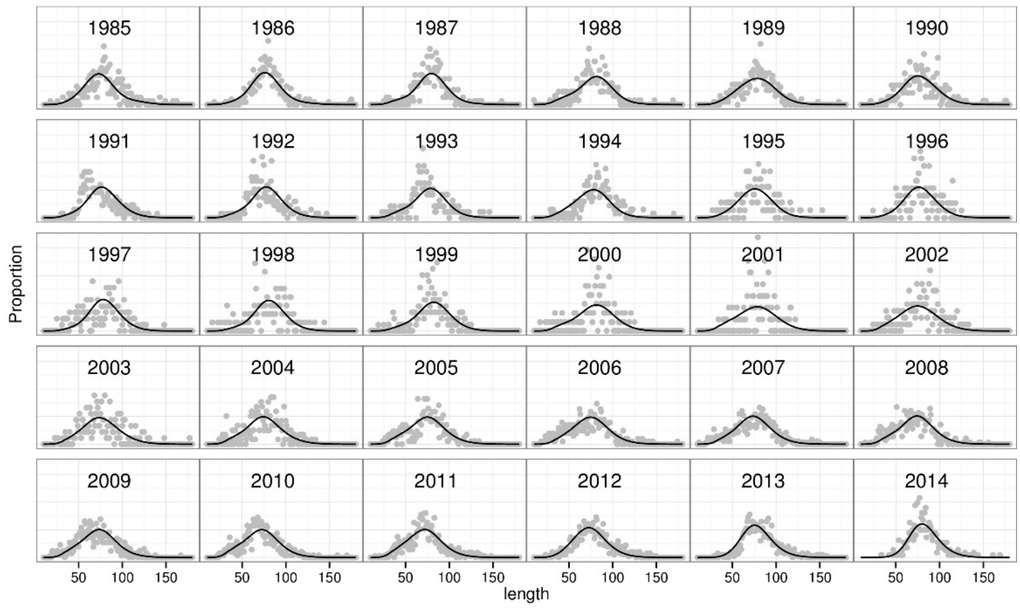


Figure 4.4.11. Ling in Va. Fitted proportions-at-length from the Gadget model (solid lines) compared to observed proportions in the spring survey (grey dots).

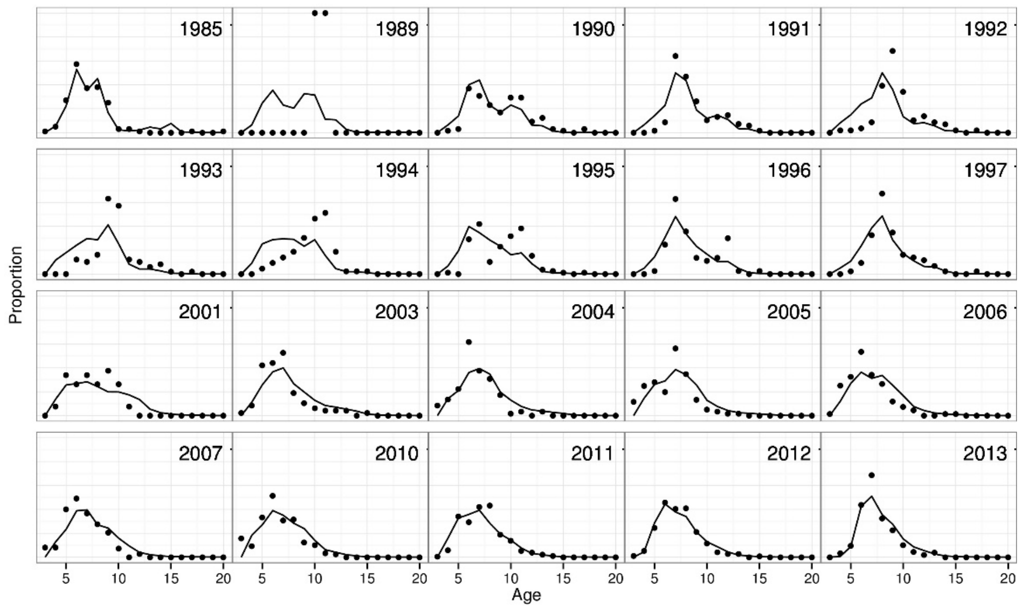


Figure 4.4.12. Ling in Va. Fitted proportions-at-age from the Gadget model (solid lines) compared to observed proportions in the spring survey catches (black points).

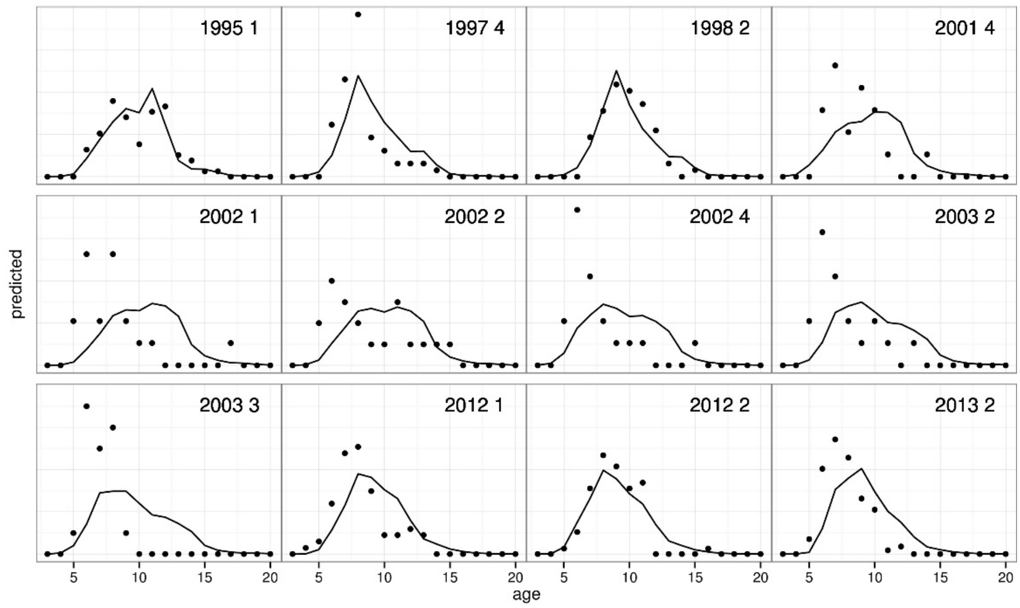


Figure 4.4.13. Ling in Va. Fitted proportions-at-age from the Gadget model (solid lines) compared to observed proportions in gillnet catches (black dots).

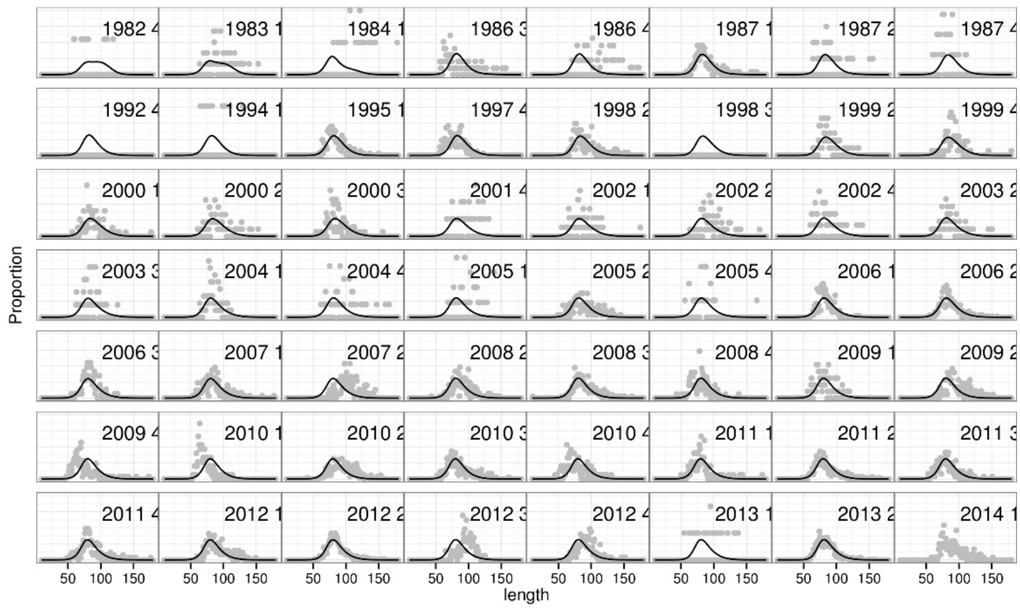


Figure 4.4.14. Ling in Va. Fitted proportions-at-length from the Gadget model (solid lines) compared to observed proportions from gillnet catches (grey dots).

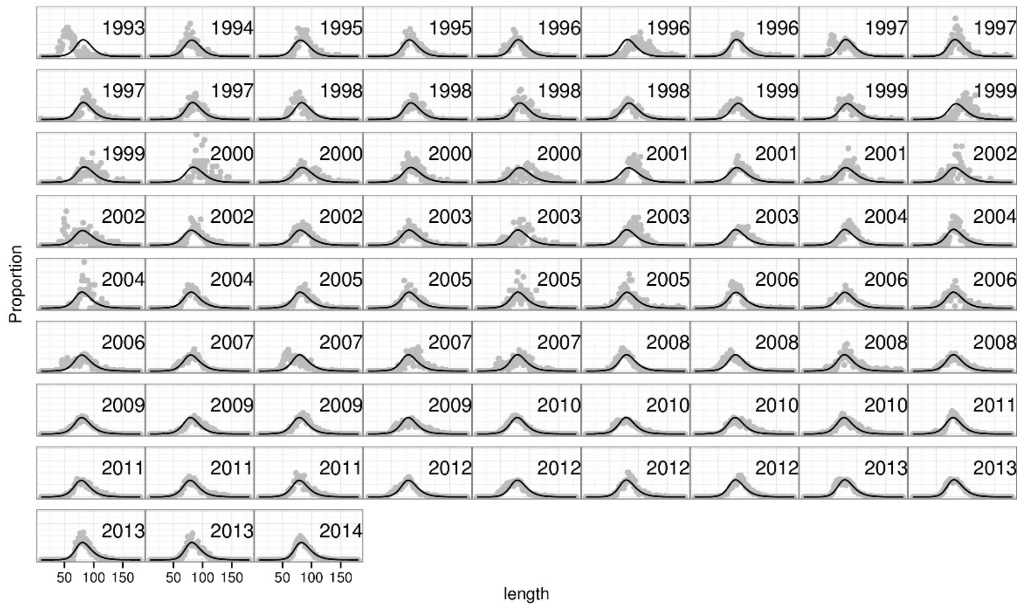


Figure 4.4.15. Ling in Va. Fitted proportions-at-length from the Gadget model (solid lines) compared to observed proportions from longline catches (grey dots).

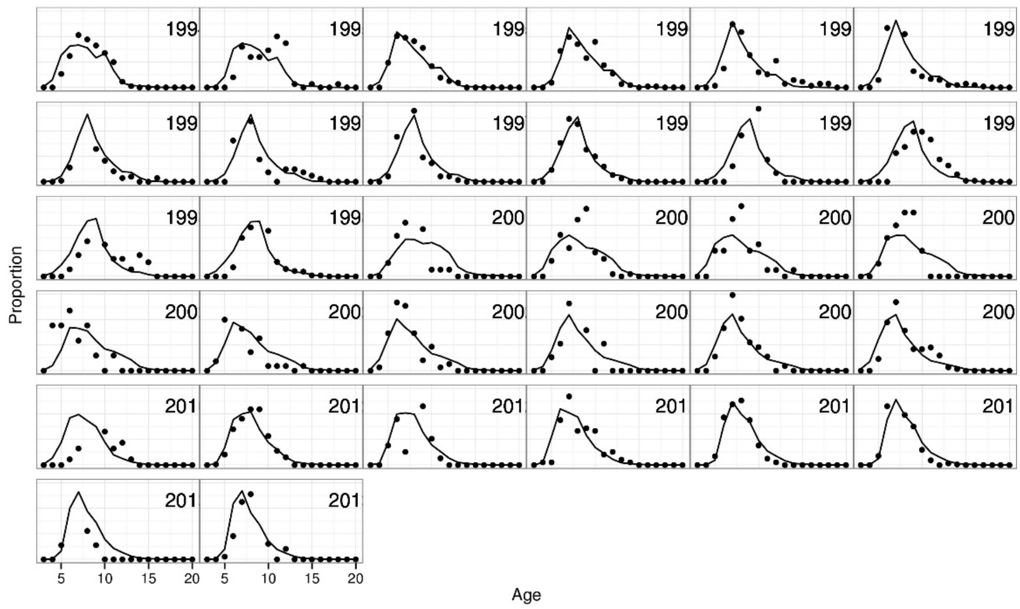


Figure 4.4.16. Ling in Va. Fitted proportions-at-age from the Gadget model (solid lines) compared to observed proportions from longline catches (grey dots).

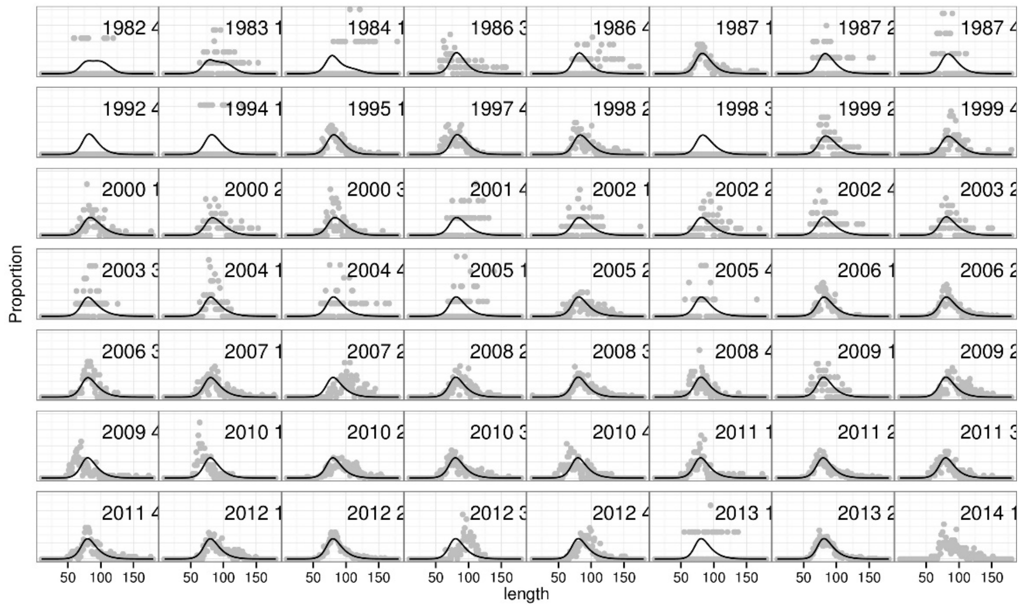


Figure 4.4.17. Ling in Va. Fitted proportions-at-length from the Gadget model (solid lines) compared to observed proportions from trawl catches (grey dots).

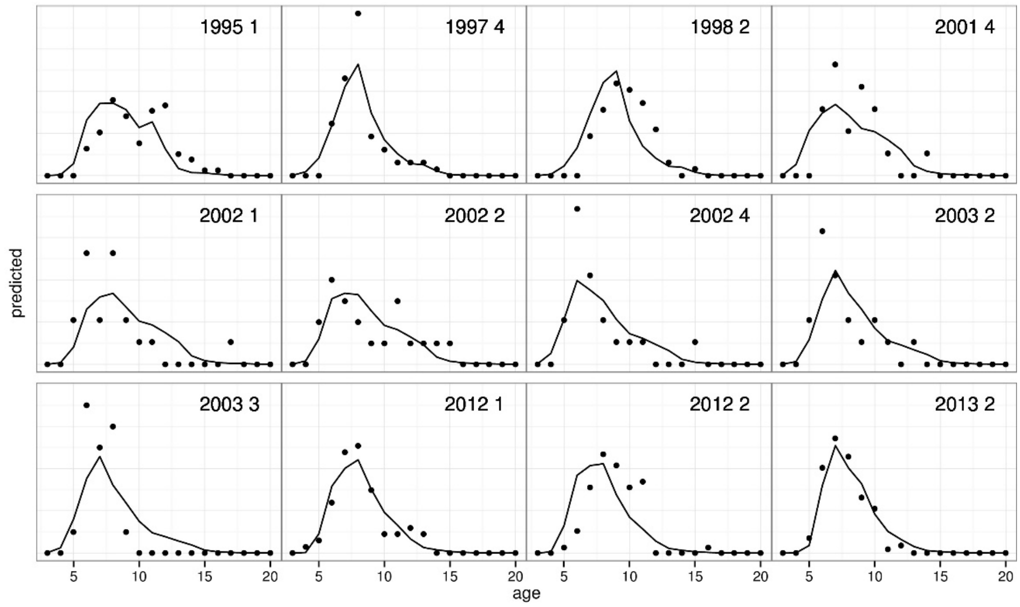


Figure 4.4.18. Ling in Va. Fitted proportions-at-age from the Gadget model (solid lines) compared to observed proportions from trawl catches (black dots).

Model fit

Figure 4.4.19 shows the overall fit to the survey indices described in the stock annex. In general the model appears to follow the stock trends historically. However the terminal estimate is substantially higher than the observed value. In general the number of ling caught in the survey was lower for all length groups in 2014. Looking at the first three length groups (20–50, 50–60, 60–70) the model appears to discount the recruitment peak observed between 2005 and 2010 as the increase is not observed in the bigger length classes to the same degree.

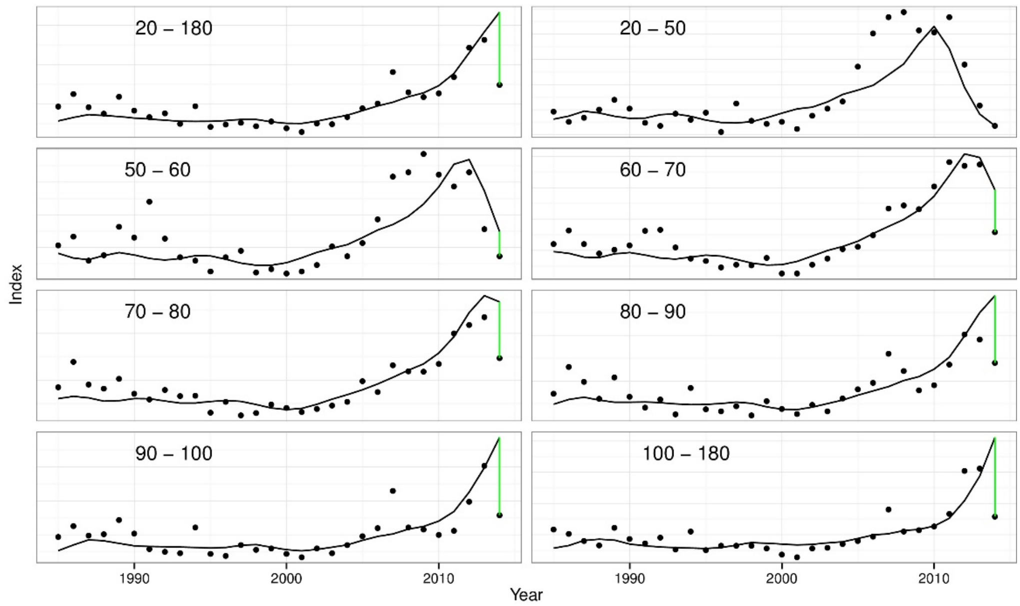


Figure 4.4.19. Fitted spring survey index by length group from the Gadget model (black solid lines) and the observed number of ling caught in the survey. The top left panel indicates the overall biomass fit. The green line indicates the difference between the terminal fit and the observations.

Results

The results are presented in Table 4.4.7 and Figures 4.4.20 and 4.4.21. Recruitment peaked in 2009 to 2010 but has decreased and is estimated in 2013 to have been the lowest observed. Spawning–stock biomass has increased since 2000 and is now estimated close to the highest SSB estimate in the time-series. Similarly harvestable biomass is estimated at its highest level in the time-series. Fishing mortality for fully selected ling (age 14-19) has decreased from 0.62 in 2008 to 0.25 in 2013. Estimates of the selection curve indicate a similar selection between trawler and longliners while the gillnetters catch substantially larger ling. Spring survey selection appears to have a similar l50 as longlines and trawls but a more gradual slope. The yield per recruit gives an estimate of F_{MAX} equal to 0.24, which is in line with the F_{MSY} of 0.24 estimated for the 2014 benchmark. The stock–recruitment relationship indicates a response to changes in the environment and/or stock composition however, as noted during the 2014 benchmark, it is uncertain what are the main drivers behind these changes.

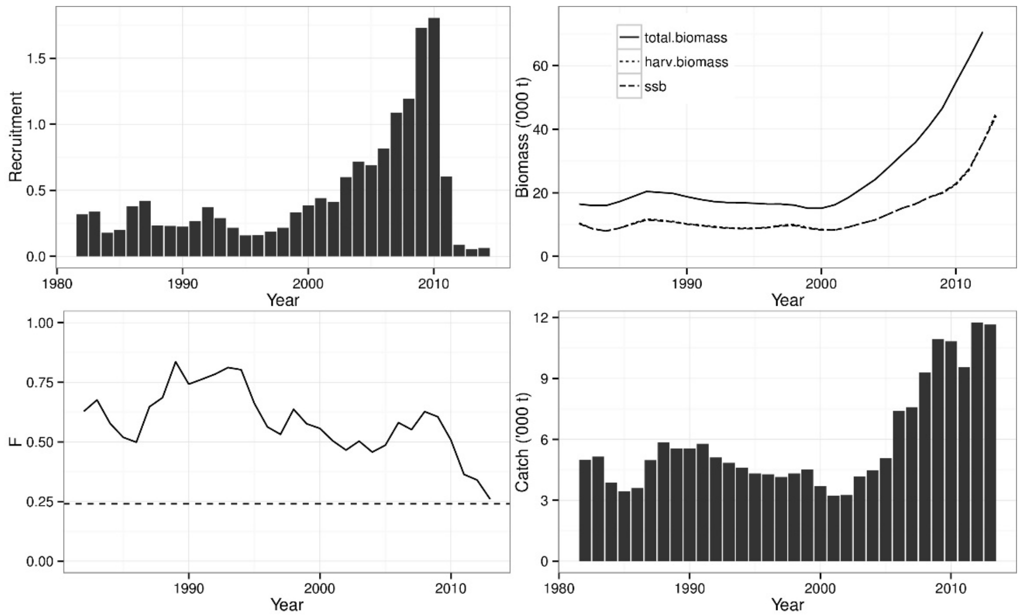


Figure 4.4.20. Ling in Va. Estimated recruitment, biomass, fishing mortality and total catches.

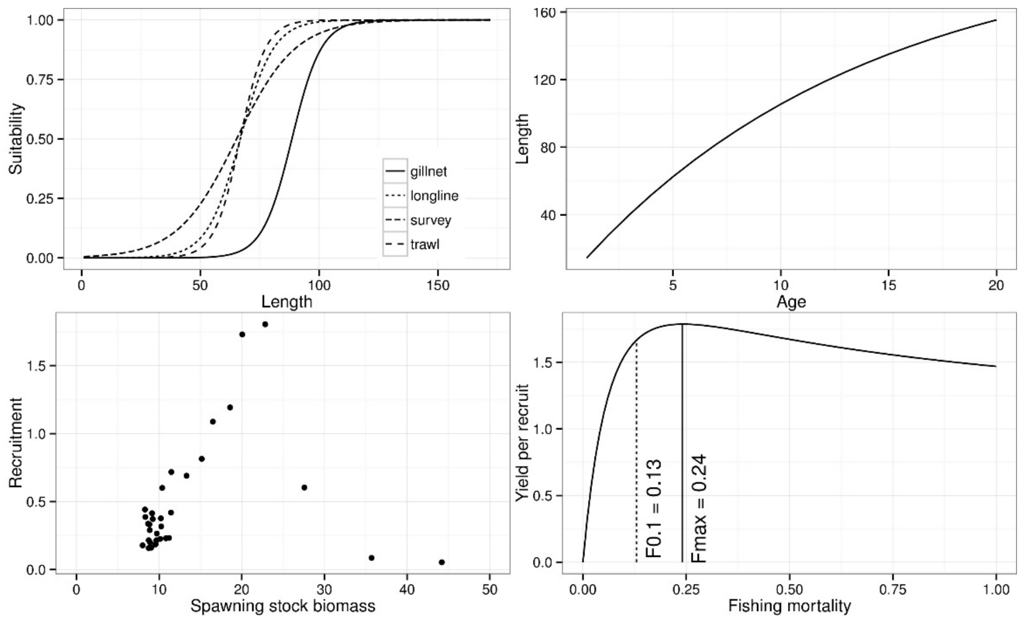


Figure 4.4.21. Ling in Va. Estimated fleet selection, growth, Stock recruitment relationship and yield per recruit.

Table 4.4.7. Ling in Va. Estimates of recruitment, biomass, harvestable biomass and fishing mortality for ling as fully recruited into the fishery i.e. selection is 1 on a logistic selection curve along with reported catches.

Year	Fishing mortality	Total biomass	Harvestable biomass	Spawning-stock biomass	Recruitment (num. Individuals)	Catch
1982	0,63	16.462.049	10.485.333	10.239.731	3.184.472	4.985.121
1983	0,68	15.980.053	8.704.943	8.675.909	3.383.370	5.142.871
1984	0,58	15.991.431	7.954.796	8.008.798	1.787.202	3.877.855
1985	0,52	17.240.048	8.912.029	8.889.748	2.000.719	3.441.243
1986	0,50	18.812.126	10.388.271	10.209.477	3.775.352	3.597.204
1987	0,65	20.414.938	11.756.300	11.457.044	4.206.329	4.975.496
1988	0,69	20.128.534	11.427.215	11.190.623	2.327.824	5.846.628
1989	0,84	19.779.947	10.987.098	10.836.273	2.305.237	5.548.443
1990	0,74	18.768.450	10.247.780	10.121.319	2.254.886	5.556.928
1991	0,76	17.910.307	9.879.909	9.718.317	2.659.255	5.782.985
1992	0,78	17.258.858	9.398.938	9.221.967	3.721.616	5.106.549
1993	0,81	16.940.148	9.004.092	8.854.380	2.895.562	4.840.626
1994	0,80	16.913.668	8.838.946	8.733.149	2.165.650	4.604.939
1995	0,66	16.701.689	8.839.423	8.743.381	1.582.940	4.318.615
1996	0,56	16.450.149	9.166.764	9.014.140	1.608.467	4.277.724
1997	0,53	16.457.846	9.814.747	9.564.117	1.854.544	4.147.276
1998	0,64	16.108.097	10.001.323	9.704.647	2.169.208	4.317.435
1999	0,58	15.129.738	9.082.775	8.844.252	3.333.761	4.510.324
2000	0,56	15.127.610	8.478.176	8.324.015	3.862.868	3.696.742
2001	0,50	16.216.607	8.364.250	8.298.586	4.411.542	3.223.114
2002	0,47	18.468.037	9.195.101	9.173.681	4.136.053	3.256.532
2003	0,50	21.308.916	10.400.276	10.390.683	6.001.217	4.162.838
2004	0,46	24.174.035	11.474.529	11.473.227	7.187.143	4.463.425
2005	0,49	28.006.949	13.308.715	13.303.241	6.896.189	5.066.633
2006	0,58	31.988.848	15.124.542	15.140.694	8.159.669	7.407.000
2007	0,55	35.862.439	16.457.647	16.509.232	10.878.581	7.585.000
2008	0,63	40.975.353	18.527.571	18.592.825	11.929.221	9.289.000
2009	0,61	46.611.818	19.886.269	20.069.997	17.309.402	10.943.000
2010	0,51	54.656.479	22.520.881	22.834.182	18.052.450	10.832.000
2011	0,36	62.426.733	27.187.792	27.563.212	6.042.867	9.561.000
2012	0,34	70.610.691	35.686.450	35.684.473	865.539	11.750.000
2013	0,26	75.404.909	45.094.818	44.188.714	541.365	11.657.362

Projections

Forward projections were conducted using Gadget. The main assumptions were:

Recruitment (age 3) set as equal to mean recruitment in 2000 to 2003, in order to reduce the effects of the recruitment spike in the years post-2003. This should however not affect the projected catch level in 2014 to 2015.

Catches in the remainder of the 2013/2014 fishing year were set based on F_{MSY} of 0.24 which is roughly the current F.

The projections were run to 2020 for F_{MSY} = 0.24 (Table 4.4.8 and Figure 4.4.22). According to the projections SSB and harvestable biomass will peak in 2016, however total biomass will peak a year earlier. Catch levels will peak at 14.3 kt in 2016 but decrease after 2016 from to 10.7 kt in 2020.

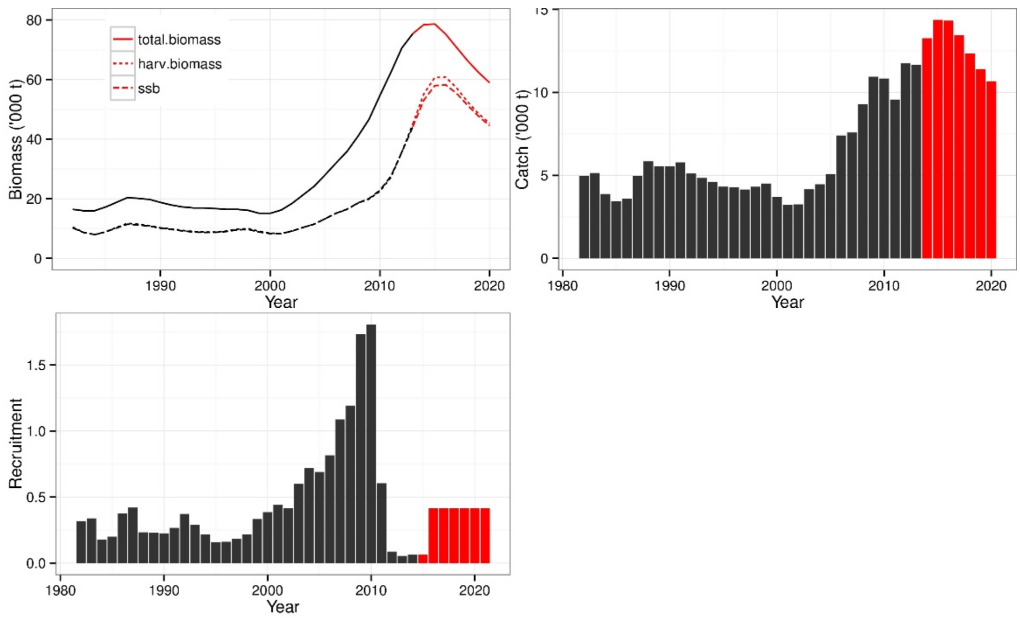


Figure 4.4.22. Ling in Va. Projected biomass, recruitment and catches according to F_{MSY}.

Table 4.4.8 Ling in Va. Projected biomass and catch.

Year	Catch	Total biomass	Spawning-stock biomass	Harvestable biomass
2014	13.259.113	78.418.213	53.079.007	55.170.898
2015	14.362.556	78.619.952	57.952.687	60.704.758
2016	14.317.819	75.192.246	58.206.285	60.784.179
2017	13.436.350	70.695.333	55.308.410	57.138.125
2018	12.346.496	66.268.137	51.347.310	52.494.666
2019	11.407.897	62.339.159	47.633.174	48.471.345
2020	10.666.641	58.931.475	44.516.016	45.301.065

4.4.7 Comments on the assessment

4.4.7.1 Management considerations

All the signs from commercial catch data and surveys indicate that ling in Va is at present in a good state. This is confirmed in the Gadget assessment. However the drop in recruitment since 2010 will result in decrease in sustainable catches from those proposed for the fishing year 2014/2015 of 14 000 tonnes to catches being considerably lower than 10 000 tonnes by 2020.

Currently the longline and trawl fishery represent 95% of the total fishery, while the remainder is assigned to gillnets. Should those proportions change dramatically, so will the total catches as the selectivity of the gillnet is substantially different.

Table 4.4.6. Ling in Va.

Year	Belgium	Faroe	France	Germany	Iceland	Norway	UK	Total
1950					3551			10 497
1951					3278			10 929
1952					4420			11 454
1953					3325			11 470
1954					3442			13 095
1955					3972			11 693
1956					3823			11 525
1957					3591			9687
1958					4195			11 663
1959					2681			8700
1960					6774			13 770
1961					6032			10 066
1962					7073			12 117
1963					5607			10 492
1964					4976			10 374
1965					4811			10 658
1966					4559			10 032
1967					7531			13 152
1968					8697			14 526
1969					8677			14 138
1970					8345			14 362
1971					8867			15 391
1972					6085			10 177
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

Year	Belgium	Faroe	France	Germany	Iceland	Norway	UK	Total
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
2011	0	519	0	0	8789	249	0	9557
2012	0	811	0	0	10 952	248	0	12 011
2013	0	955	0	0	10 196	294	0	11 445

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

4.5.1 The 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 2012 landings in III and IV, 79% were taken by longlines, 11% 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 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 1988–2013, 42% of the total landings were in Area IV, 31% 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.

4.5.2 Landings trends

Landing statistics by nation in the period 1988–2013 are in Tables 4.5.1 and 4.5.2 and Figures 4.5.1 and 4.5.2.

There was a decline in landings from 1988 to 2003, since when the landings have been stable. When Areas 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 2003–2011. In 2012 and 2013 the landingr increased in all areas, and the total catch in 2013 was almost 19 000 tons.

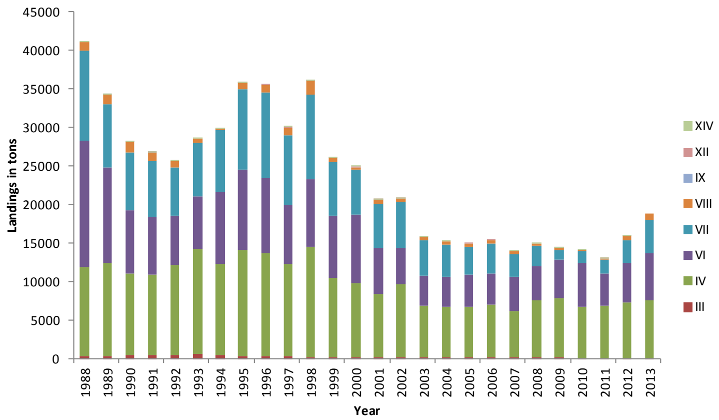


Figure 4.5.1. International landings. Ling in other areas.

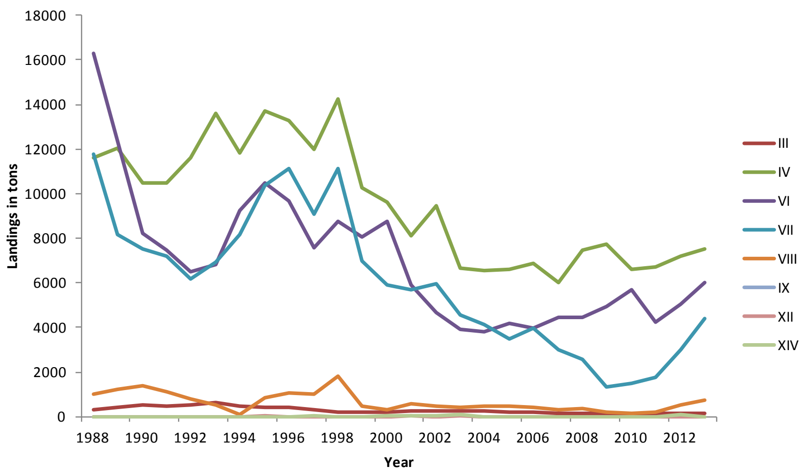


Figure 4.5.2. International landings. Ling in other areas.

4.5.3 ICES Advice

Advice for 2013 and 2014: Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 10 800 tonnes.

4.5.4 Management

Norway has a licensing scheme in EU waters, and in 2014 the Norwegian quota in the EC zone was 5500 t. The quota for the EU in the Norwegian zone (Area IV) is set at 950 t.

EU TACs for areas partially covered in this section are in 2014:

Subarea III:	87 t;
Subarea IV:	1942 t;
Subarea VI, VII (EU and international waters):	7300 t.

In addition, there is a temporal EU area closure for tusk,ling and blue ling fisheries (EU No 40/2013) where it is prohibited to fish or retain on board tusk, blue ling and ling in the Porcupine Bank during the period from 1 May to 31 May 2013. Spatial positions of the closure are given in the regulation.

4.5.5 Data available

4.5.5.1 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 has been reported from some fleets by Spain, who in 2012 discarded 46 tons ,and in 2013, discarded 70 tons of ling.

An estimated 27 tonnes of ling was discarded by the fleet OTB_MC. This fleet produces 2/3 of the French ling landings, the discards might mainly be small ling There are additional minor discards bythe fleet OTD_DEF_WS (Bottom trawlers for demersal species to the west of Scotland).

Table 4.5.2. Discards by the French fleet.

Species	OT_CRU	OTB_DEF_WS	OTB_DWS	OTB_GG	OTB_MC	Total
Molva spp	0	1.3	0	0	27.3	28.6

4.5.5.2 Length compositions

Average fish length, weight–length relationships and the length distribution from the Norwegian longline and gillnet fishery in Areas IVa, VIa, VIb are shown in Figures 4.5.3–4-5.7. Data are from the Norwegian longline reference fleet.

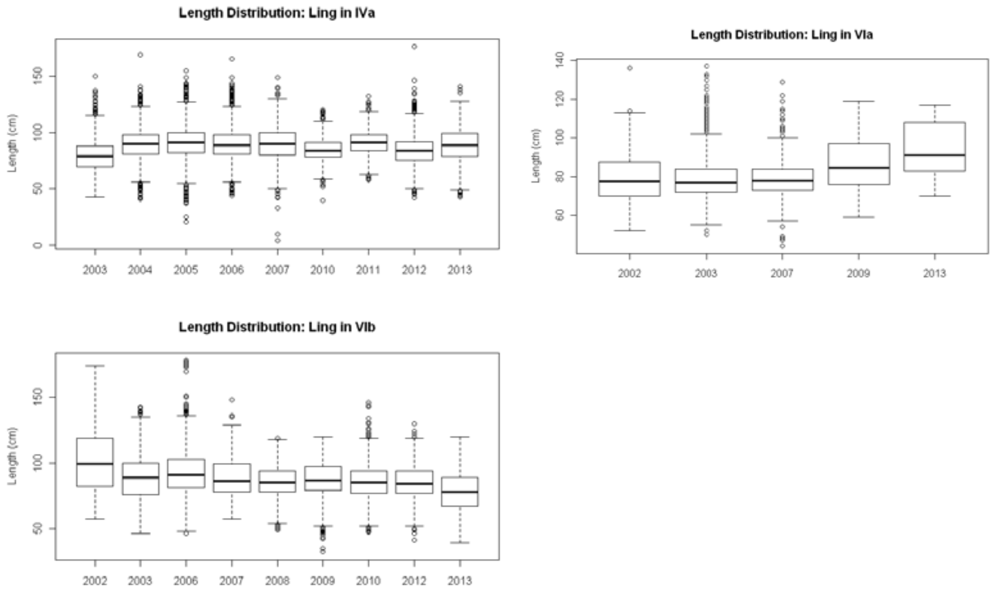


Figure 4.5.3. Box and whisker plots of length distribution of the Norwegian longline reference fleet in IVa, VIa and VIb.

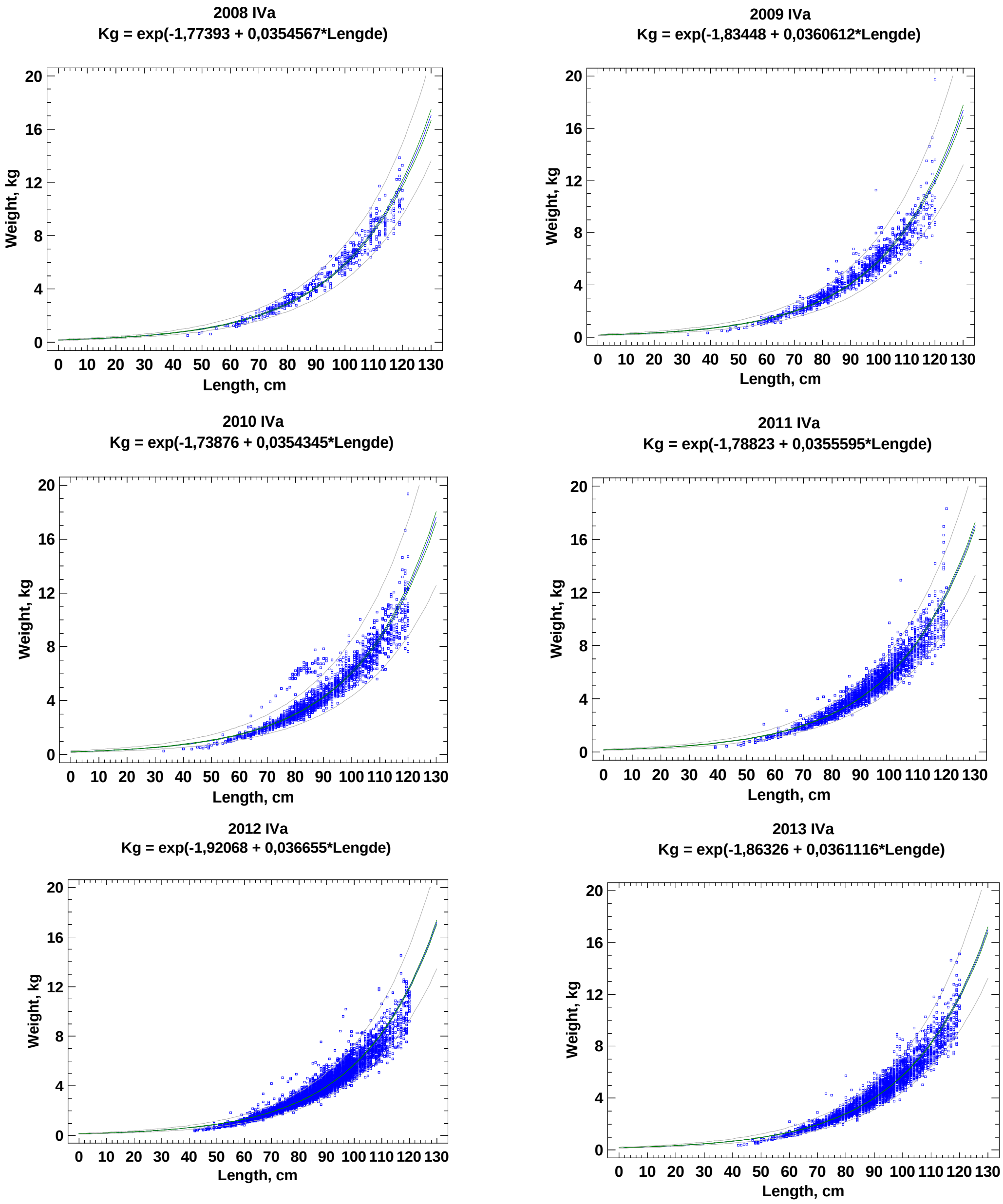


Figure 4.5.4. Weight versus length for ling in area IVa based on all available Norwegian data.

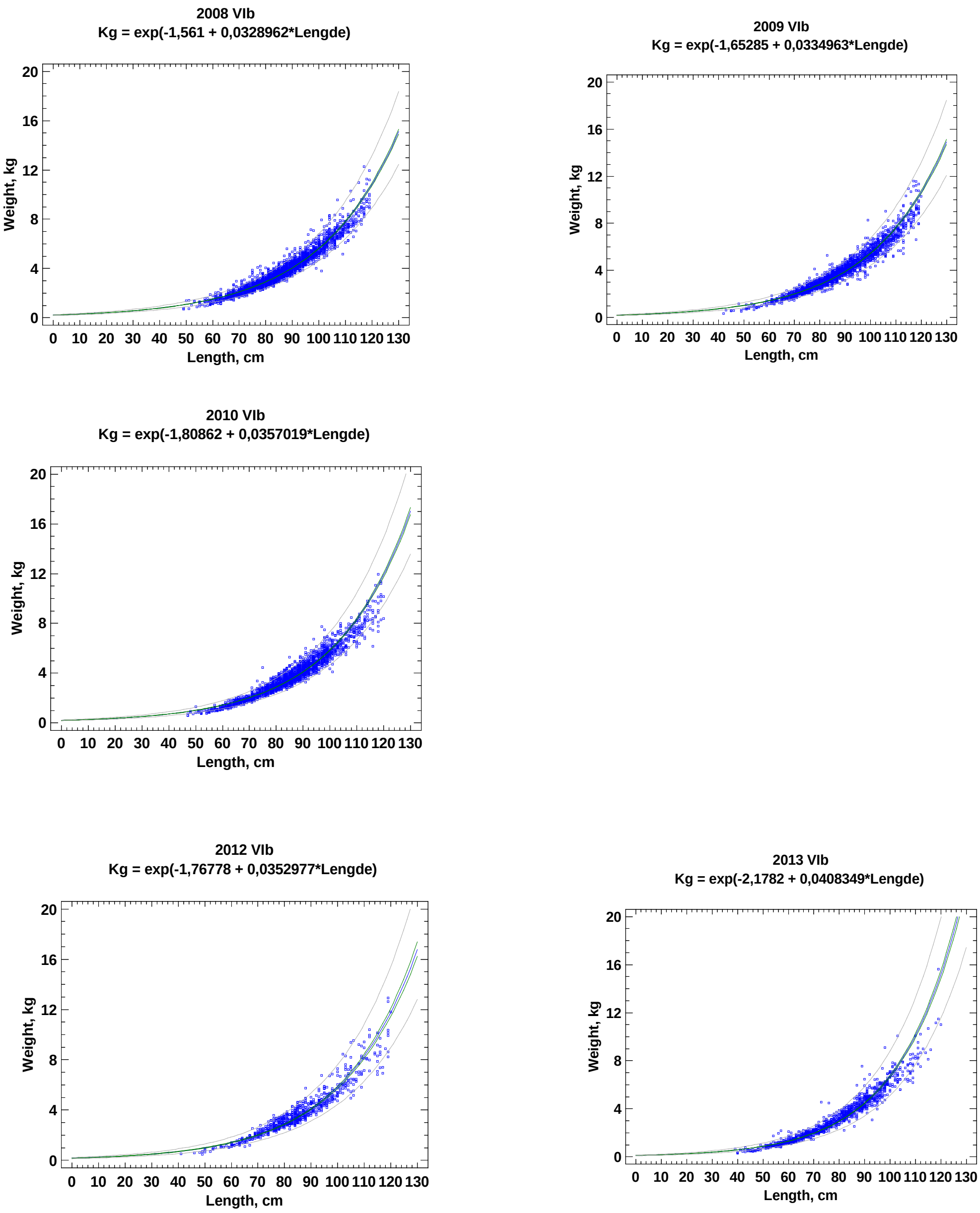


Figure 4.5.4. Weight as a function of length for ling in area IVb based on all available Norwegian data.

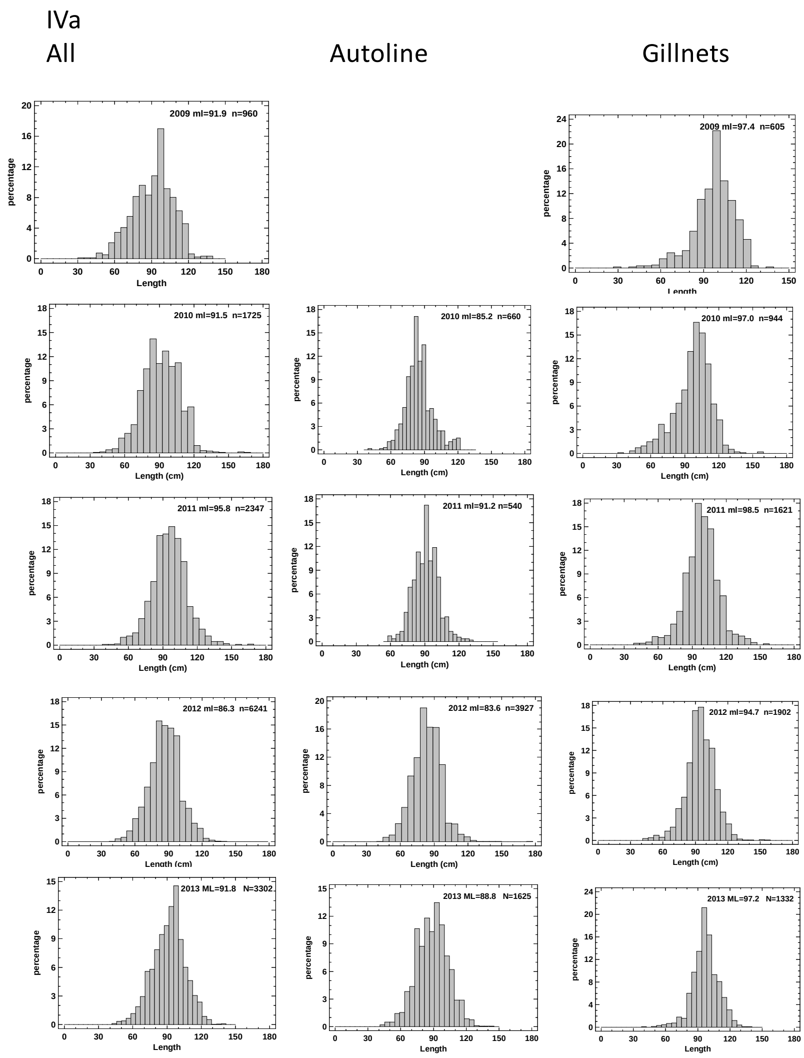


Figure 4.5.6. Length distributions in Area IVa for all, autoline vessels and gillnets fished ling.

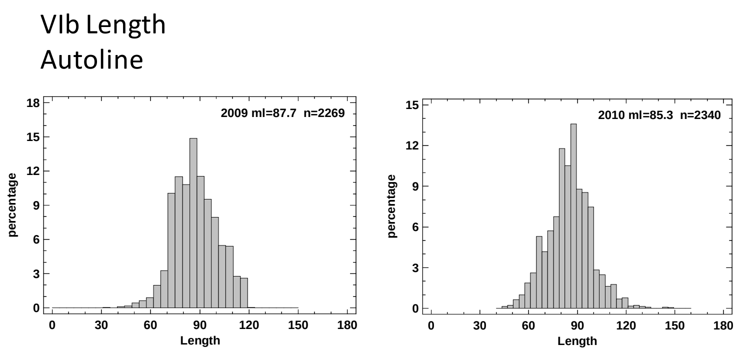


Figure 4.5.7. Length distribution in Area IVa for all, autoline vessels and gillnets.

4.5.5.3 Age compositions

Age distributions for Areas IVa and VIb for the years 2009–2013 are shown in Figures **4.5.8** and **4.5.9.** The average age is about 6.5 in Area IVa and 6.1 in Area VIb.

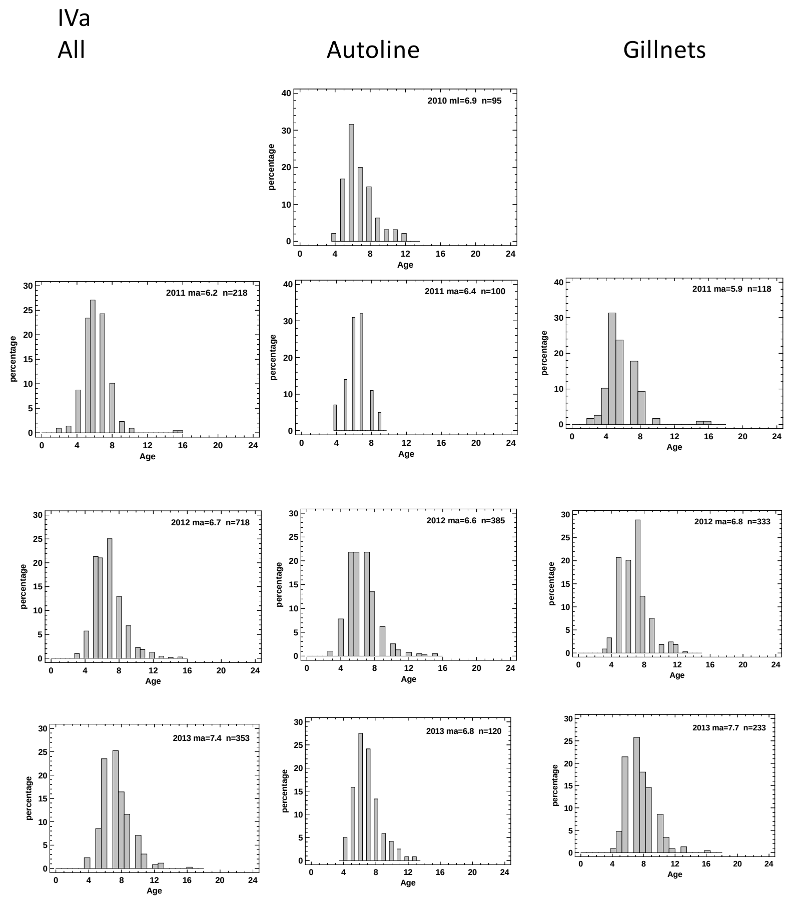


Figure 4.5.8. Length distributions in Area IVa for all catches, and catches taken by longliners and gillnetters during the period 2010–2013.

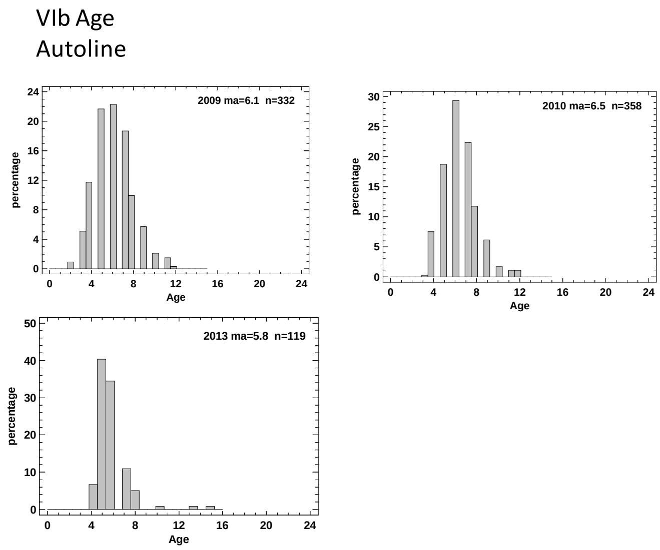


Figure 4.5.9. Age distributions in Area VIb for all catches taken by longliners during the years 2009, 2010 and 2013.

4.5.5.4 Weight-at-age

Average weight and length-at-age for 2009 to 2013 was available for Areas IVa and IVa Figure 4.5.10.

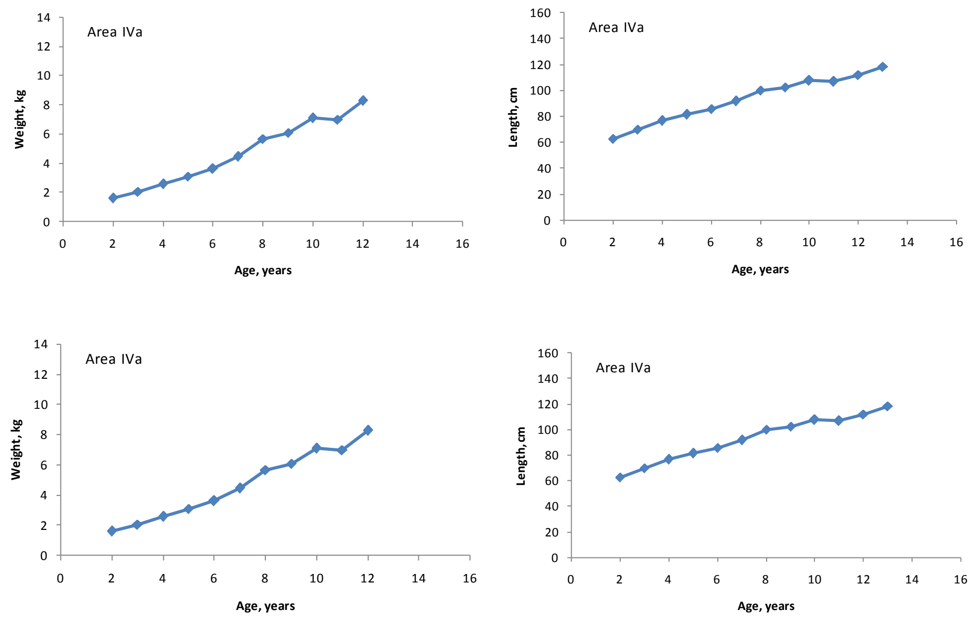


Figure 4.5.10. Average weight and length-at-age for 2009 to 2013 for Areas IVa and IVa.

4.5.5.5 Maturity and natural mortality

No new data were presented.

Catch, effort and research vessel data

French IBTS survey

Ling is caught in small numbers in the French western-IBTS area, also referred to as EVHOE. Population indices (swept area raised abundance and biomass as well as mean length) for the Bay and Biscay and Celtic Sea (ICES Divisions VIIg,hjk and VIIIa,b,d) combined were provided for years 1997–2012 (Figure 4.5.11). The survey covers depths from 30 to 600 m and is stratified by depth and latitude.

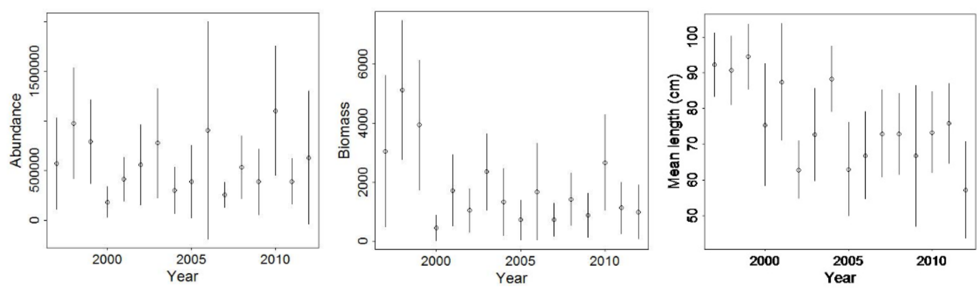


Figure 4.5.11. Population indices (swept area raised abundance and biomass as well as mean length) for the Bay and Biscay and Celtic Sea (ICES Divisions VIIg,hjk and VIIIa,b,d) for the years 1997–2012.

Commercial cpues

A standardised commercial cpue by the Norwegian longline reference fleet was presented to WGDEEP 2013:

Catch and effort data for Norwegian longliners for IV, VIa and VIb were updated for the period 2000 up to 2013 (Figure 4.5.12). For the standardised Norwegian cpue series, data was available from official logbooks from 2000 onwards. All catch data, and a subset where ling appeared to have been targeted, were used to estimate a standardized cpue. Details on the methodology can be found in the Ling I&II chapter and the working document Helle and Pennigton, 2014.

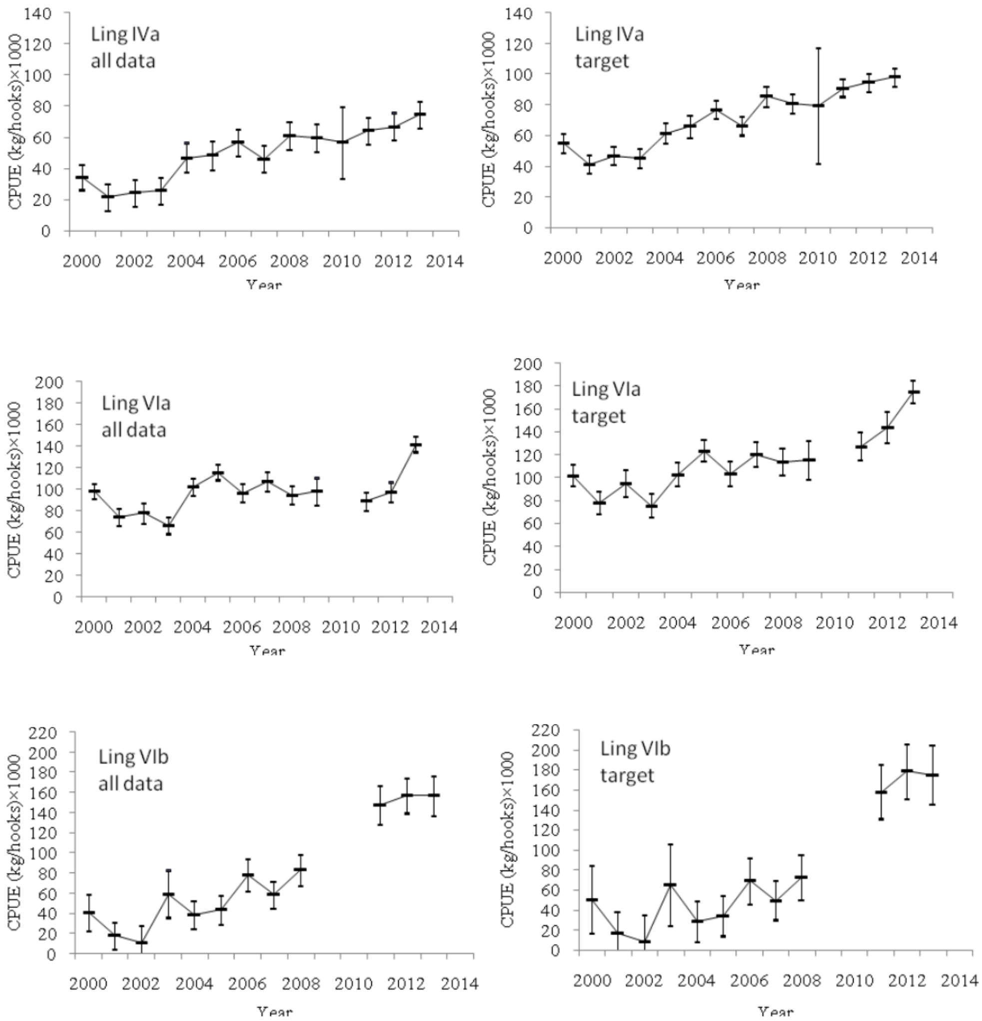


Figure 4.5.12. Cpue series for ling for the period 2000–2013 based on all available data and when ling appeared to have been targeted. The bars denote the 95% confidence intervals.

4.5.6 Data analyses

Length data analysis

Mean lengths from commercial catches by the Norwegian longlining refernce fleet fluctuate are around 90 cm for IV and VIb and around 80 cm for VIa. Data do not indicate apparent time trends.

The French IBTS survey (EVHOE)

Total abundance varies with no apparent trends, biomass may have been higher in the early years of the time-series, and the mean length may also be decreasing. However, numbers of ling caught in the survey are low so that confidence intervals of indicators are wide.

Data from the Norwegian Reference Fleet and the longline fleet

For the Norwegian longline fleet, for which a standardised cpue was presented, the following obervations were made and summarised in WD Helle and Pennington, 2014a and 2014b:

- The overall number of longliners declined ca. twofold from the late nineties to 2013, while the catch per vessel increased (Figure 4.5.4.);
- The average number of days that each Norwegian longliner operated in an ICES division was highly variable for IVa, stable for VIb and declining for VIa (Table 4.5.3);
- The average number of hooks has remained relatively stable in IVa and VIa (Figure 4.5.5);
- There was a linear relationship between the number of hooks and the average catch of ling (see WD and/or Ling I&II);
- No other changes or variability in the longline fishery over the years appeared to affect noticeably the catchability of the fleet.

Table 4.5.3. Average number of fishing days per longline vessel in Areas IIa for the period 2000–2013.

Ling	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
IIIa	+			1					1	1				
IVa	19	22	29	20	22	25	38	27	25	49	3	21	26	22
IVb	1	+		1				3				3	1	1
VIa	13	13	11	12	14	23	13	10	9	7		8	5	11
VIb	4	5	7	4	5	8	7	6	2	2	7	4	5	4
VIIc	3	1			1	+		1					1	

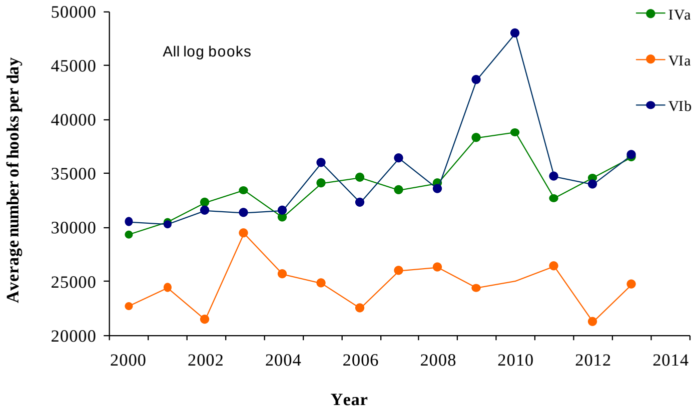


Figure 4.5.13. Average number of hooks the Norwegian longliner fleet used per day in IVa, VIa and VIb for the years 2000–2013 for the fishery for tusk, ling and blue ling.

4.5.7 Comments on the assessment

The standardised cpue time-series of the Norwegian longliners shows similar trends as the superpopulation model presented in 2012 and the the unstandardised time-series as presented in 2011. The trend is either stable (IVa and VIa) or increasing (VIb) in the last decade (Figure 4.5.5). The confidence intervals are wider due the way the uncertainty was calculated based on the super-population model and the GLM based cpue. Both methods for calculating cpue series indicated that the cpue values were statistically significantly higher at the end of the period than at the beginning.

4.5.8 Management considerations

The cpues from the commercial vessels either indicate a stable or an increasing trend in the last years.

Table 4.5.1. 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	20		142
2011		65		57	18		**140**
2012		66	<1	61	17		**144**
2013*		56	1	62	11		**130**

***Preliminary.**

Table 4.5.1. (continued).

LING IVa

Year	Belgium	Denmark	Faroes	France	Germany	Neth.	Norway	Sweden[1)]	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	-	62	40		3914		28		1921	6398
2011		541		90	62		3790	8	18		1999	**6508**
2012		419		86	47		4591	6	28		1822	**6999**
2013		548		208	83		4273	5	39		2169	**7325**

***Preliminary.**

[(1)] Includes IVb 1988–1993.

Table 4.5.1. (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	23	55	1	13	56	26	10	17		201
2011	15	59	0		85	24	11	17		**211**
2012	12	45	0	10	83	25	7	8		**190**
2013	15	47	1	5	71	13	21	12	4	**189**

***Preliminary.**

Table 4.5.1. (continued).

LING VIa update for Spain.

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

Year	Belgium	Denmark	Faroes	France (1)	Germany	Ireland	Norway	Spain(2)	E&W	IOM	N.I.	Scot.	Total
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
2011			102	428		95	683	8				1683	2999
2012			30	585		47	542	862				1589	3655
2013*			50	1294		54	1429	899	10			1500	5236

***Preliminary. (1) Includes VIb until 1996 (2) Includes minor landings from VIb.**

Table 4.5.1. (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
2011	12	5		16	957		1		268		**1259**
2012	60	13		13	1089	3			218		**1396**
2013*		21		8	532	6			229	1	**797**

***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 4.5.1. (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
2011	1	2	23	1			1	**28**
2012	2		11	1			0	**14**
2013	1		6				23	**30**

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

Table 4.5.1. (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
2011	29		58			28		93	**208**
2012	48	1	39	230	370	1		246	**934**
2013*	386	2	46		379	101		180	**1094**

***Preliminary. (1) See Ling VII. (2) Included with UK (EW). (3) Included with VIIg–k until 2011.**

Table 4.5.1. (continued).

LING VIId, e

Year	Belgium	Denmark	France (1)	Ireland	E & W	Scotland	Ch. Islands	Netherlands	Spain	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	4		144		138				8	294
2011	5		238		176				6	**425**
2012	7		230	1	164	2			7	**411**
2013	5		509		179					**693**

***Preliminary.**

Table 4.5.1. (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	10	42	0	17	0	69
2011	20	39	2	94		**155**
2012	28	79	<1	59	<1	**166**
2013	22	147	5	39	40	**252**

***Preliminary. (1) See Ling VII.**

Table 4.5.1. (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	10		108	1	279		301	135			14	848
2011	15		260		465		16	157			23	**936**
2012	23		549	2.4	516		201	138			56	**1498**
2013	24		1204		505		190	190			203	**2316**

***Preliminary. (1) See Ling VII. (2) Includes VIIb, c until 2011. (3) Included in UK (EW).**

Table 4.5.1. (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		31	11		134
2011		148		47	6		**201**
2012		338		201	2		**541**
2013*		624			3	4	**631**

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 4.5.1. (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
2011		1						1
2012	3						1	**4**
2013								**0**

Table 4.5.1. (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		3						3
2011	2			1				3
2012	1		105					**106**
2013								**0**

***Preliminary.**

Table 4.5.2 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	142	6398	201	3256	2691		16	326	294	69	848	134		0	3	14 093
2011	140	6508	211	2999	1259		28	208	425	155	936	201		1	3	13 074
2012	145	6999	191	3655	1396		14	934	411	166	1498	541	1	4	106	16 061
2013*	130	7325	189	5236	797		30	1094	693	252	2316	770		0	0	18 832

***Preliminary.**

Table 4.5.3. Average number of fishing days per longline vessel in Areas IIa for the period 2000–2012.

Ling	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
IIIa	+			1					1	1				
IVa	19	22	29	20	22	25	38	27	25	49	3	21	26	22
IVb	1	+		1				3				3	1	1
VIa	13	13	11	12	14	23	13	10	9	7		8	5	11
VIb	4	5	7	4	5	8	7	6	2	2	7	4	5	4
VIIc	3	1			1	+		1					1	

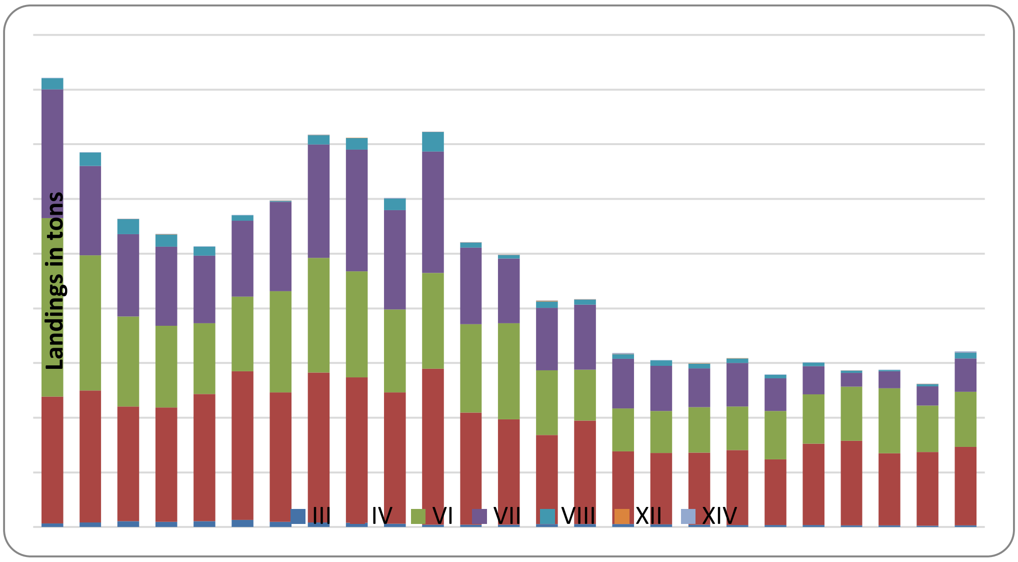


Figure 4.5.1. International landings. Ling in other areas.

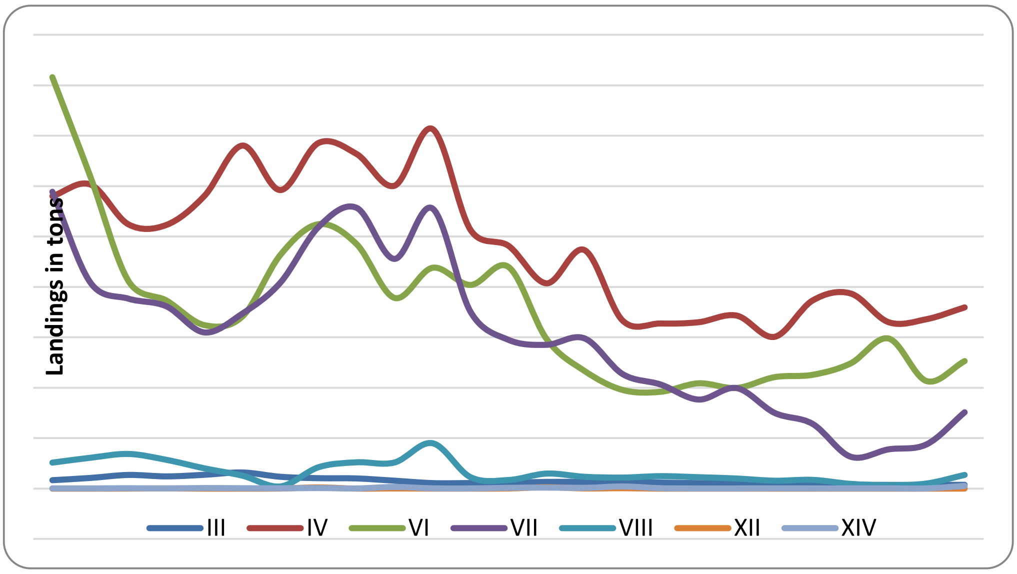


Figure 4.5.2. International landings. Ling in other areas.

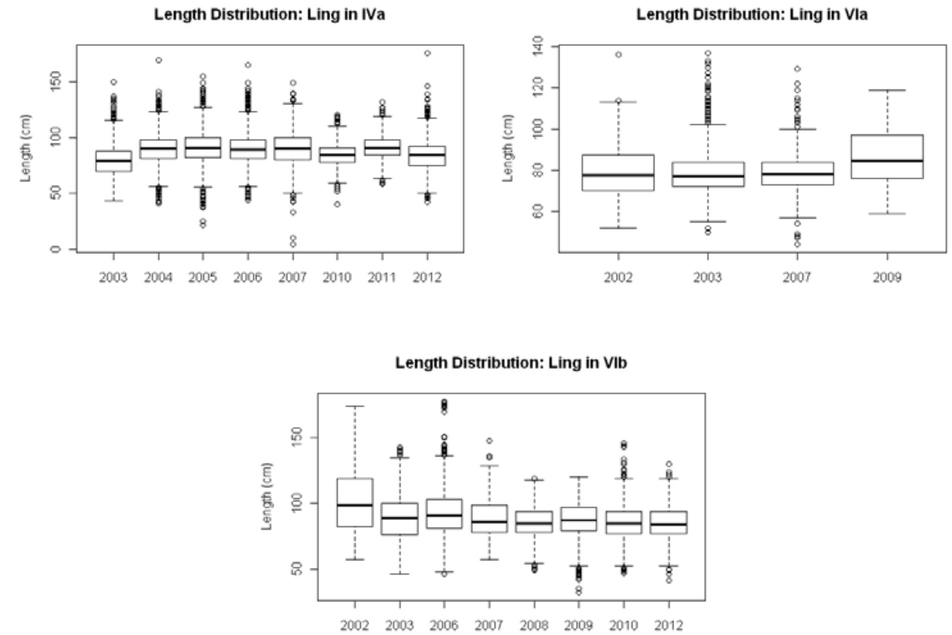


Figure 4.5.3. Box and whisker plots of length distribution of the Norwegian longline reference fleet in IVa, VIa and VIb.

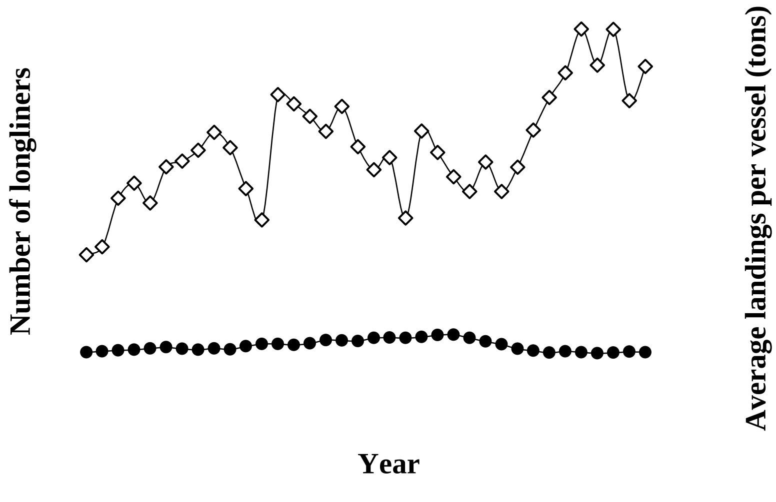


Figure 4.5.4. The number of longliners (filled circles) and average landings per vessel of ling and tusk (open diamonds) in the period 1977–2012.

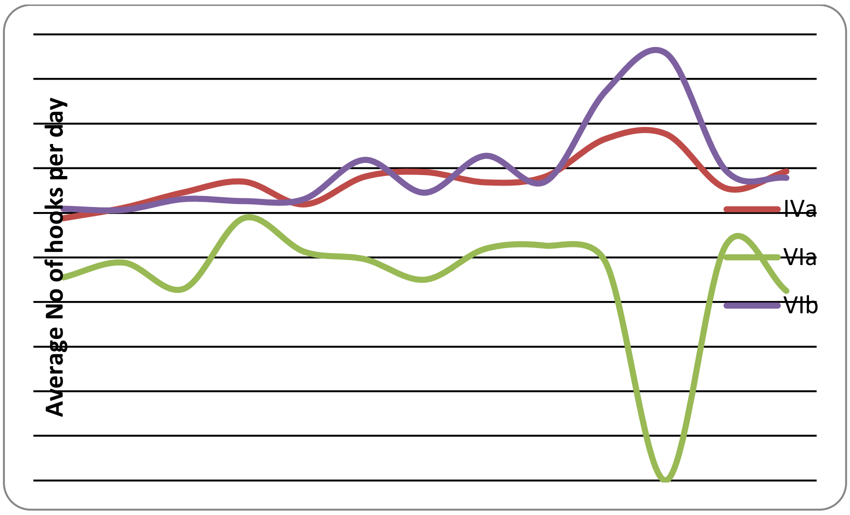


Figure 4.5.5.Average number of hooks the Norwegian longliner fleet used per day in IVa, VIa and VIb for the years 2000–2012 for the fishery for tusk, ling and blue ling.

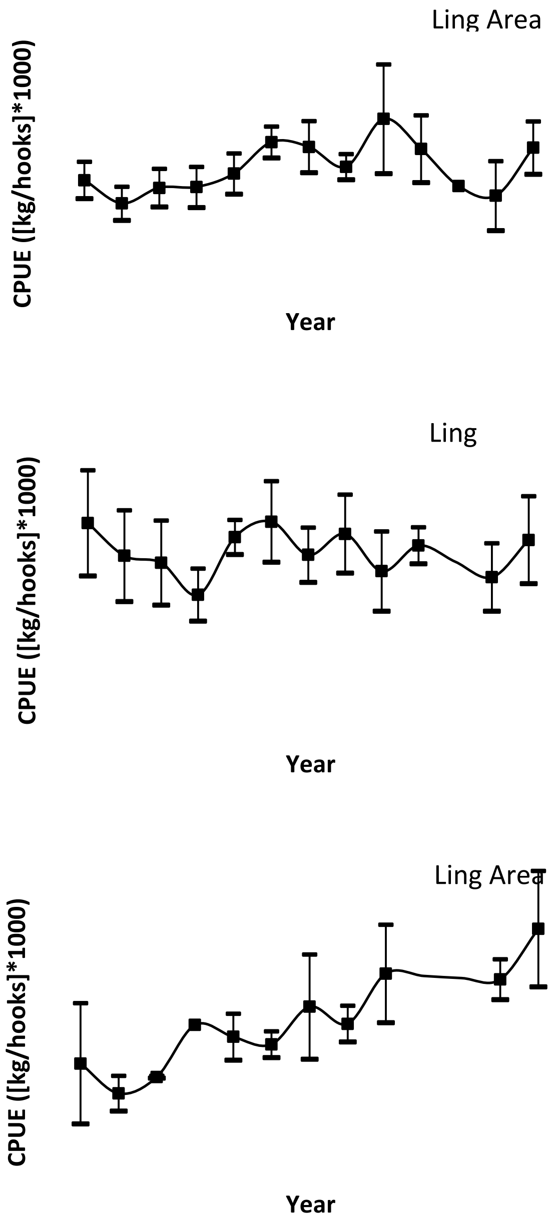


Figure 4.5.6.Cpue series for ling for the period 2000–2012 based only on vessels that caught ling on 100 or more days. The bars denote the estimated two standard errors.

5 Blue Ling (*Molva dypterygia*) in the Northeast Atlantic

5.1 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. 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 in each of areas of the northern and southern stocks and elsewhere suggest further stock separation. However, in most areas small blue ling below 60 cm do not occur and fish appear in survey and commercial catch at 60–80 cm suggesting scale large spatial migrations and therefore limited population structuring. The conclusion is that stock structure is uncertain within the areas under consideration.

As in previous years, in addition to one stock in Division Vb and Subareas VI and VII and one in Division Va and XIV. All remaining areas are grouped together as "other areas". This latter unit includes Subareas I and II and Division IVa and IIIa were historical landing have been significant and southern areas, VIII, IX and X were the species do not occur. Landings reported in VIII, IX and X can be ascribed to the related Spanish ling (*Molva macrophtalma*). The situation in XII is different as this Subarea includes part of the Mid-Atlantic Ridge (XIIa1, XIIa2, XIIa4 and XIIc) and the western slope of the Hatton Bank (XIIc). None of these have represented major landings in the 2000s. However, based upon the continuity of bathymetric features and lesser abundance, blue ling from the western Hatton Bank is likely to be similar to those from the northern Hatton Bank (VIb). Therefore, including ICES Division XIIb in the assessment unit Vb, VI and VII could be considered. Because of the much lesser abundance of blue ling on the Hatton Bank, this should not have a major impact on stock modelling.

Historical total international landings show that blue ling have been exploited for long (Figure 5.1.1). 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 aggregations. 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 5.1.2. 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.

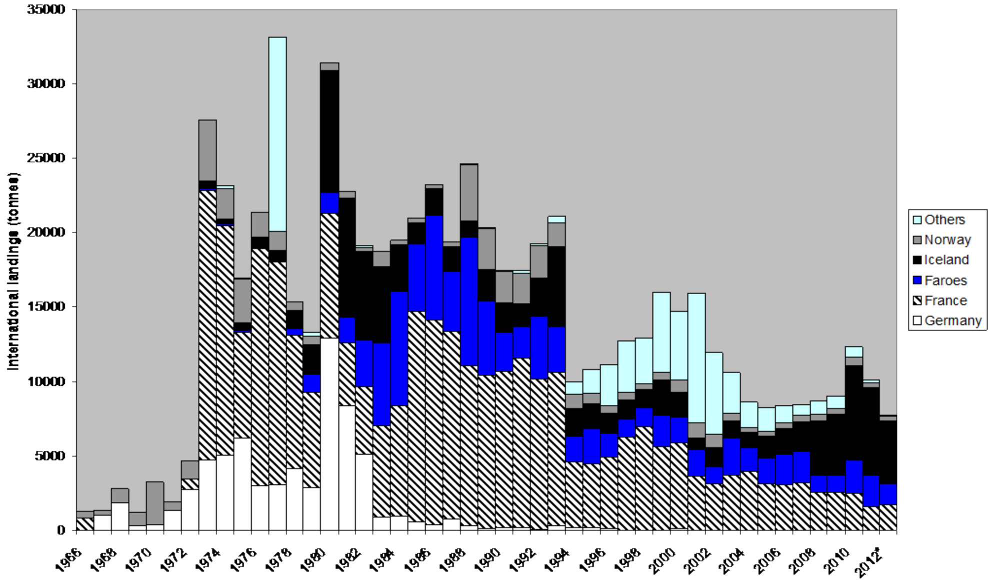


Figure 5.1.1. Total international landings of blue ling in the Northeast Atlantic 1966–2012.

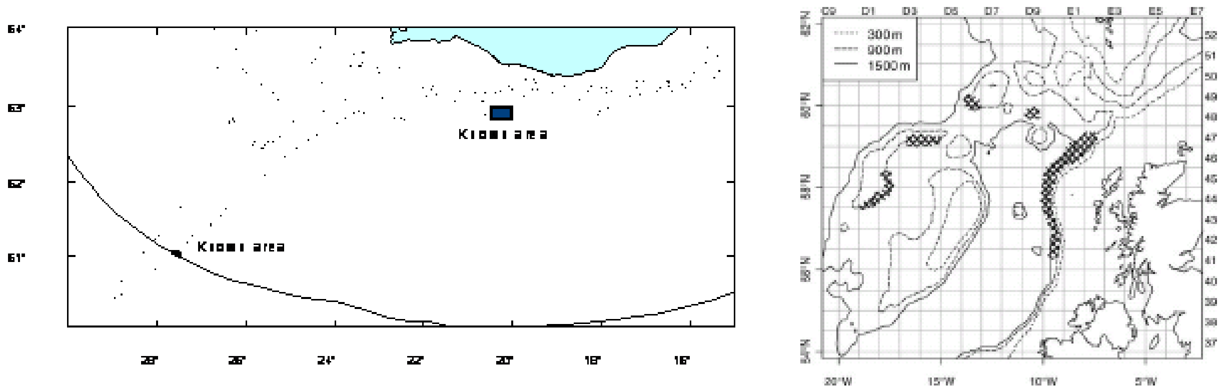


Figure 5.1.2. Known spawning areas of blue ling in Icelandic water (a) and to the West of Scotland (b, from Large *et al.*, 2010).

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

5.2.1 The fishery

The change in geographical distribution of the Icelandic blue ling fisheries from 1999, to 2013 (Figure 5.2.1 and 5.2.2) indicates that there has been an expansion of the fishery of blue ling to northwestern waters. This increase may partly be the result of increased availability of blue ling in the north-western area, but more likely because of an increase in effort or reporting.

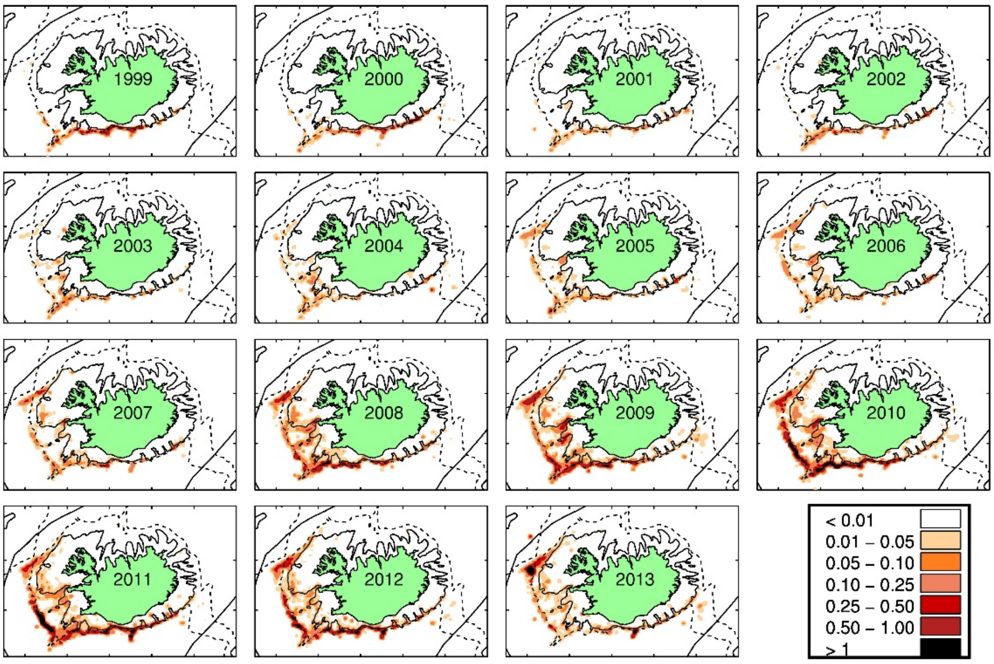


Figure 5.2.1. Blue ling in Va and XIV. Geographical distribution (tonnes/square mile) of the Icelandic blue line fishery since 1998 as reported in logbooks. All gear types combined.

Before 2008 the majority of the catches of blue ling in Va were by trawlers, as bycatch in fisheries targeting Greenland halibut, redfish, cod and other demersal species (Table 5.2.3). Most of the catches by trawlers are taken in waters shallower than 700 m and by longliners until 2008 mostly at depths shallower than 600 m.

After 2007 there was a substantial change in the fishery for blue ling in Va (Table 5.2.3). The proportion of catches taken by longliners increased from 7–20% in 2001–2007 to around 70% in 2011 as longliners started targeting blue ling. The trend has reversed and in 2013 the proportion of longline catches decreased to 51%. At the same time longliners have started fishing in deeper waters than before 2008 but since then the bulk of the longline catches have been taken at depths greater than 500 m (Figure 5.2.3).

Historically the fisheries in Subarea XIV have been relatively small but highly variable.

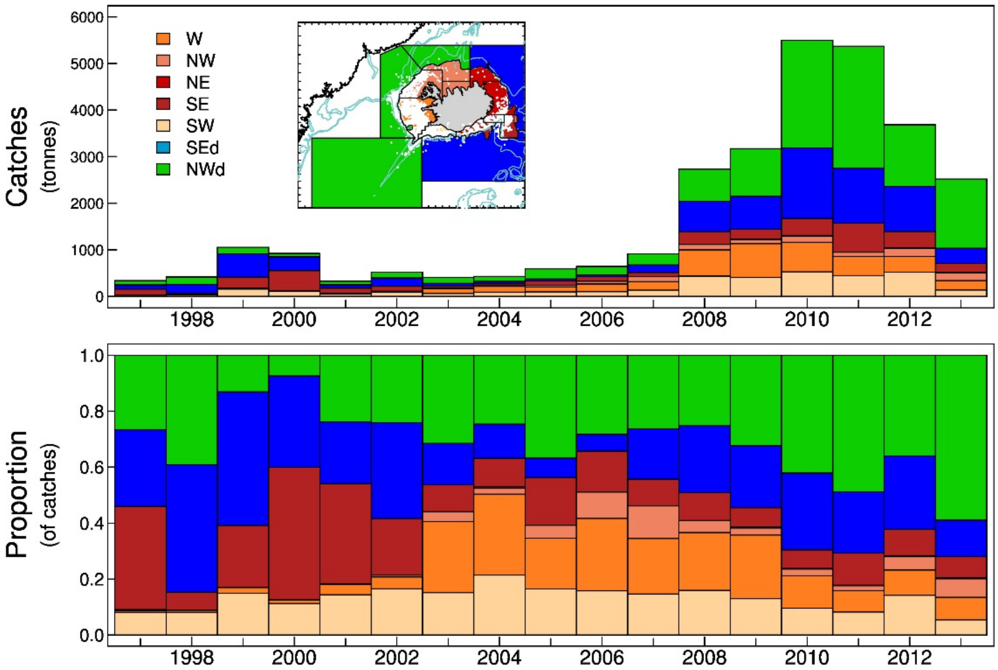


Figure 5.2.2. Blue ling in Va and XIV. Spatial distribution of reported catches in Va in tonnes (upper) and as annual proportions (lower). The inserted map shows the area division and location of operations in 2013 (hauls and lines) as white points.

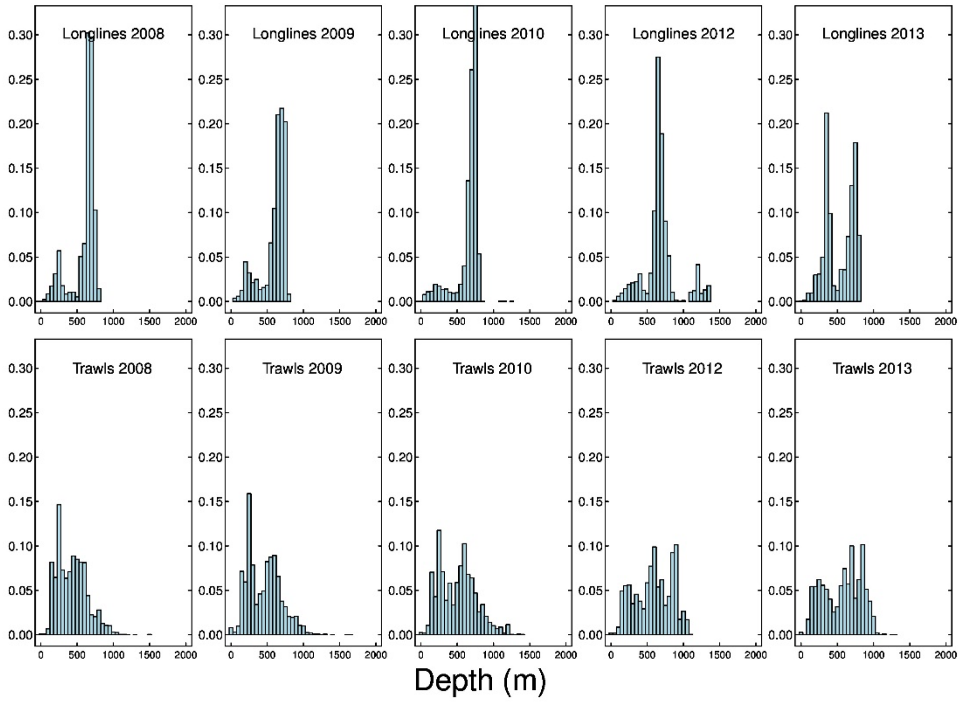


Figure 5.2.3. Blue ling in Va and XIV. Depth distribution of longlines (upper row) and trawls (lower row) catches in Va according to logbook entries.

5.2.2 Landings trends

The preliminary total landings in Va 2013 were 3082 t of which the Icelandic fleet caught 2768 t. (Table 5.2.2 and Figure 5.2.4). Catches of blue ling in Va increased by more than 370% between 2006 and 2010, the main part of this increases can be attributed to increased targeting of blue ling by the longline fleet. Since then catches in Va decreased compared to 2010 or by around 3600 tonnes (Table 5.2.3).

Total international landings from XIV (Table 5.2.2) 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 2013 were 15 t.

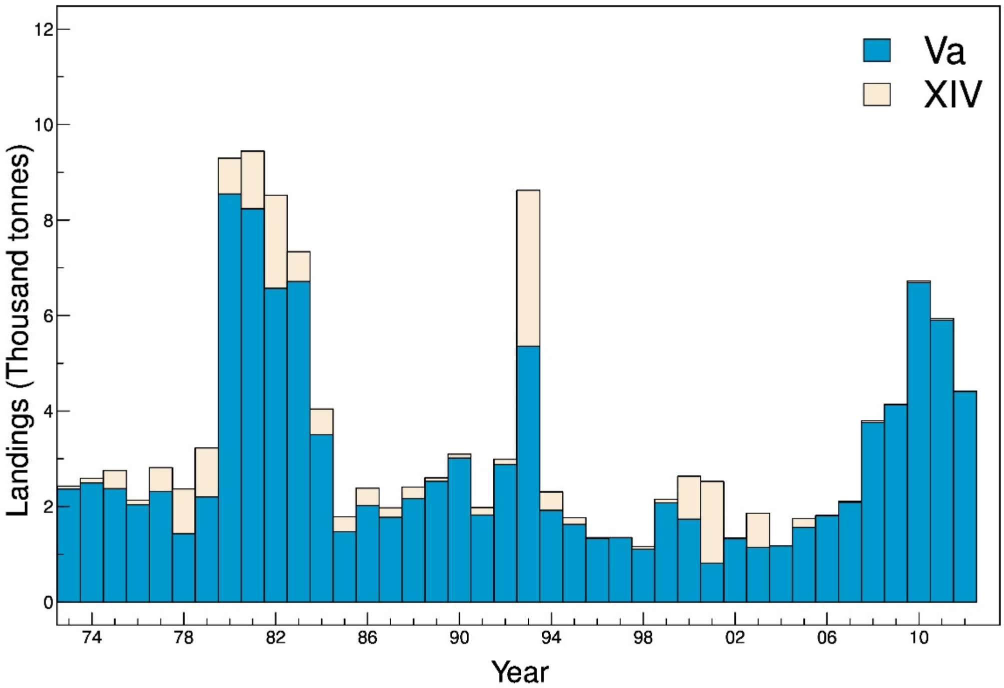


Figure 5.2.4. Blue ling in Va and XIV. Nominal landings.

5.2.3 ICES Advice

The ICES advice for 2013 and 2014 is: Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 3100 tonnes. Area closures to protect spawning aggregations should be maintained and expanded as appropriate.

The basis for the advice was the following: For data-limited stocks with reliable abundance information from fisheries-independent data and a target F_{proxy}, where abundance is considered above MSY $B_{trigger}$, ICES uses a harvest control rule that calculates catches based on the F_{proxy} target multiplied by the most recent survey biomass estimates.

For this stock the F_{proxy} of 1.7 is applied as a factor to the 2010 biomass estimate of 1824 t, resulting in catch advice of no more than 3100 t. ICES does not implement the uncertainty cap of 20% used for other data-limited stocks because recently the fishing mortality increased far above what is considered the F_{MSY} proxy.

The 20% precautionary buffer is therefore not applied because the stock is above possible reference points and an F_{MSY} proxy is used.

5.2.4 Management

Before the 2013/2014 fishing year the Icelandic fishery was not regulated by a national TAC or ITQs. The only restrictions on the Icelandic fleet regarding the blue ling fishery were the introduction of closed areas in 2003 to protect known spawning locations of blue ling, which are in effect. As of the 2013/2014 fishing year, blue ling is regulated by the ITQ system (regulation 662/2013) used for many other Icelandic stocks such as cod, haddock, tusk and ling. The TAC for the 2013/2014 fishing year was set at 2400 based on the recommendations of MRI using the same advisory procedure as in 5.2.3.

5.2.5 Data available

In general sampling is considered adequate from commercial catches from the main gears (longlines and trawls). The sampling does seem to cover the spatial distribution of catches for longlines and trawls. Similarly sampling does seem to follow the temporal distribution of catches (WGDEEP 2012).

5.2.5.1 Landings and discards

Landings data are given in Tables 5.2.1 and 5.2.2. 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 being subjected to TAC constraints before 2013/2014 fishing year nor minimum landing size there should be little incentive to discard blue ling in Va.

5.2.5.2 Length compositions

Length distributions from the Icelandic trawl and longline catches for the period 1999–2013 are shown in Figure 5.2.5. Mean length from trawls has varied from about 75 cm to 86 cm in the period without any obvious trend. On average mean length from longlines is higher than from trawls.

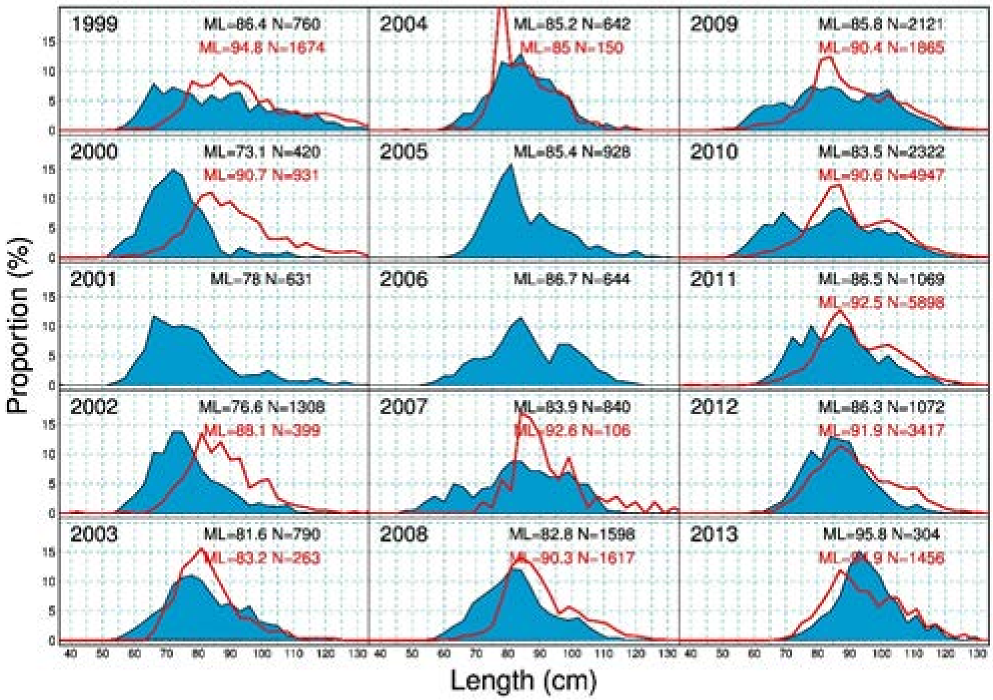


Figure 5.2.5. Blue ling in Va and XIV. Length distribution of blue ling from trawls (blue area) and longlines (red lines) of the Icelandic fleet in Va since 1999. The number of measured fish (N) and mean length (ML) is also given.

5.2.5.3 Age compositions

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

5.2.5.4 Weight-at-age

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

5.2.5.5 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*).

5.2.5.6 Catch, effort and survey data

Effort and nominal cpue data from the Icelandic trawl and longline fleet are given in Figure 5.2.6. Due to changes in the fishery (expansion into new areas, fleet behaviour, etc) 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. However looking at fluctuations in cpue and effort may be informative in regards to the development of the fishery. Cpue from longlines has remained high since 2008. No marked changes are observed from trawls since 2000.

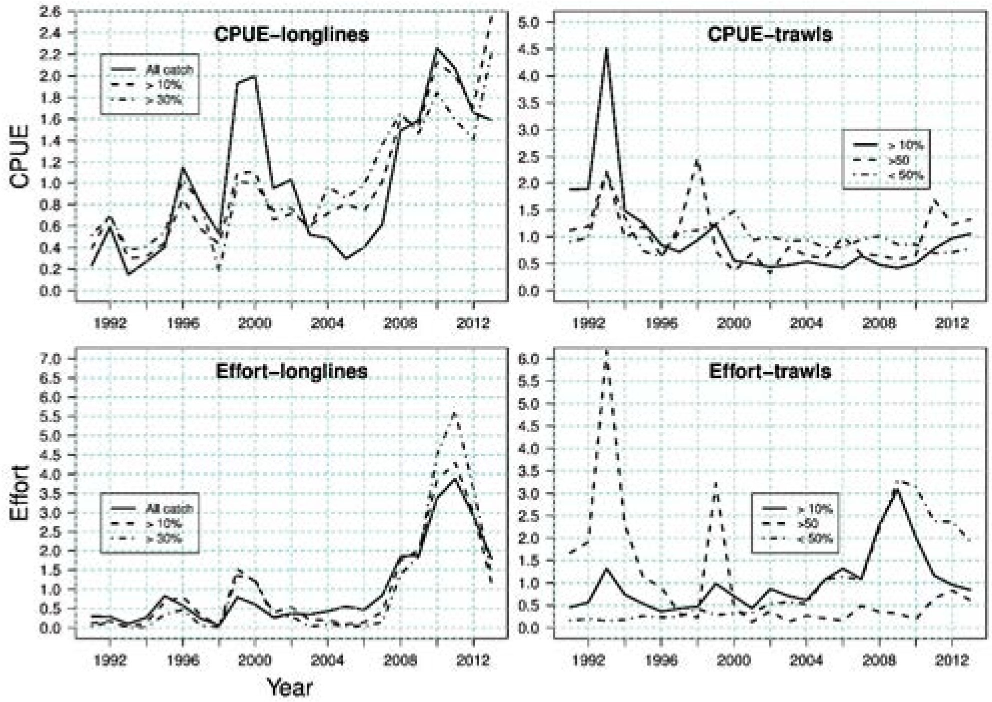


Figure 5.2.6. Blue ling in Va and XIV. Nominal cpue and effort from longlines and trawls in Va based on logbook data where blue ling was either recorded in catches or above certain level.

Time-series stratified abundance and biomass indices from the spring and autumn trawl surveys are shown in Figure 5.2.7 and length distributions from the autumn survey and its spatial distribution in Figures 5.2.8 and 5.2.9. Due to industrial action in 2011 the autumn survey was cancelled after about one week of survey time. Therefore no estimates are presented for 2011.

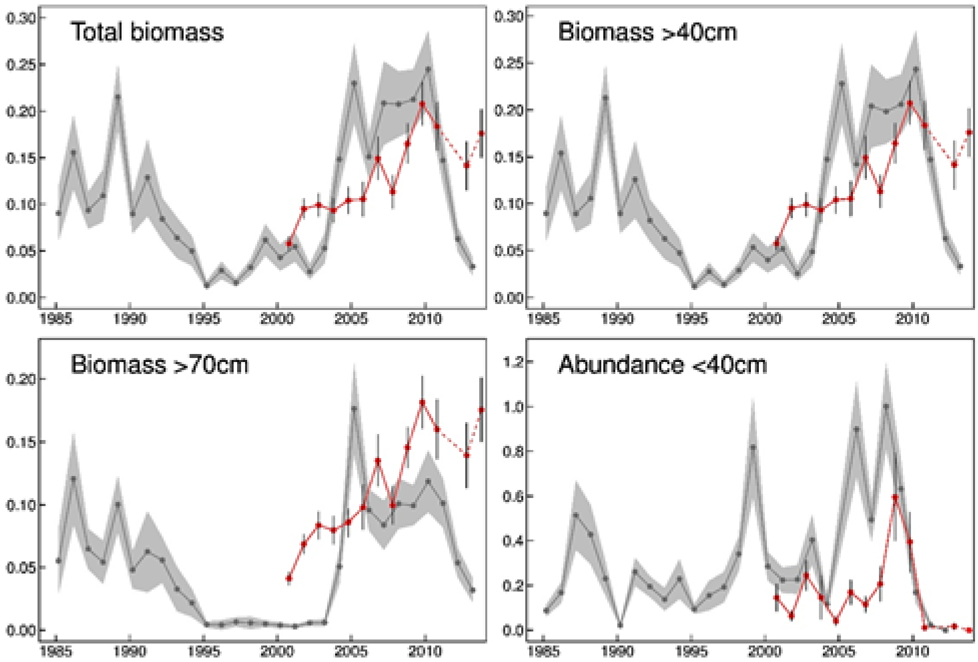


Figure 5.2.7. Blue ling in Va and XIV. Abundance indices for blue ling in the Icelandic spring survey since 1985 (line and shaded area) and the autumn survey since 2000 (red points and vertical lines). A) total biomass index, b) biomass of 40 cm and larger c) biomass of 70 cm and larger, d) abundance index of <40 cm. The shaded area and the vertical bar show +/- standard error of the estimate.

5.2.6 Data analyses

Landings and sampling

Catches from the Icelandic longline fleet increased rapidly from 2007 to 2010 resulting in a rapid expansion of the fishing area and change in the selectivity of the fishery even though there are now strong indications in 2012 and 2013 that this may have reversed. This can be seen when looking at Table 5.2.3. In 2005 longliners caught 102 tonnes of blue ling when trawlers caught 1260 tonnes or 84% of the total catches (1505 tonnes). In 2011 trawlers caught 1618 tonnes, out of 5900 tonnes caught or 27%, but longliners 4138 tonnes or 70%. In 2013 the proportions caught by each gear were close to 1:1.

As longliners take on average larger blue ling (Figure 5.2.5) this will have resulted in an overall change in the selection pattern since 2007. Total catches by the Icelandic fleet decreased between 2010 and 2013 and this decrease is mainly the result of decrease in trawls in 2011 but in longlines in 2012 and 2013. The expansion of the longline fleet to deeper waters (Figure 5.2.3) may be the result of decreased catch rates in shallower areas. However it may also be the result or wrong recording of depth by captains (metres vs. fathoms).

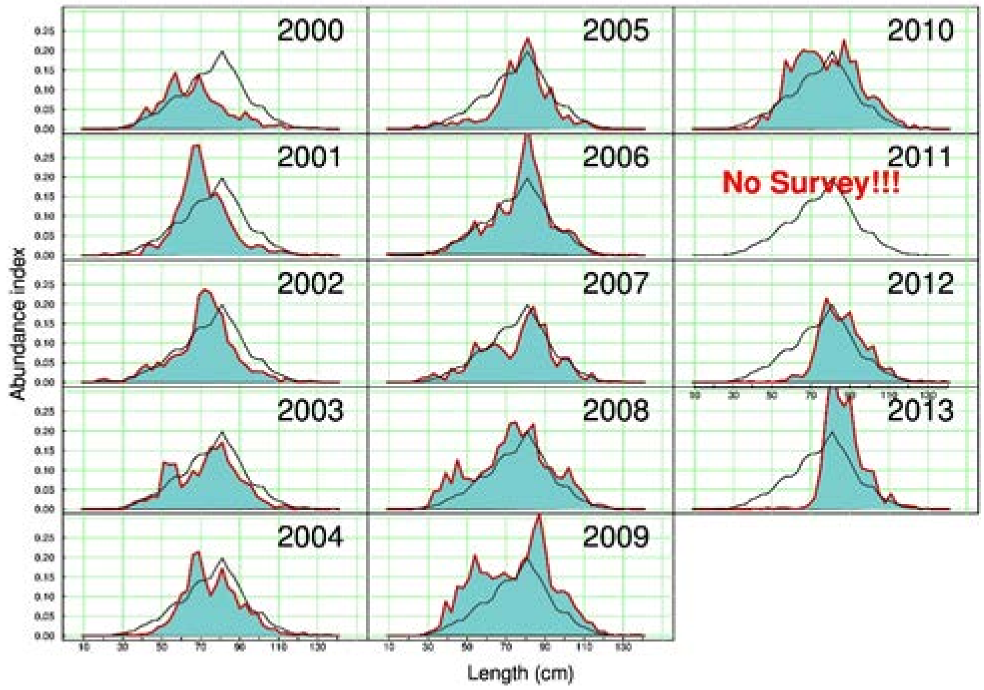


Figure 5.2.8. Blue ling in Va and XIV. Length distributions from the Icelandic autumn survey since 2000. Black line is the average by length over the whole survey period.

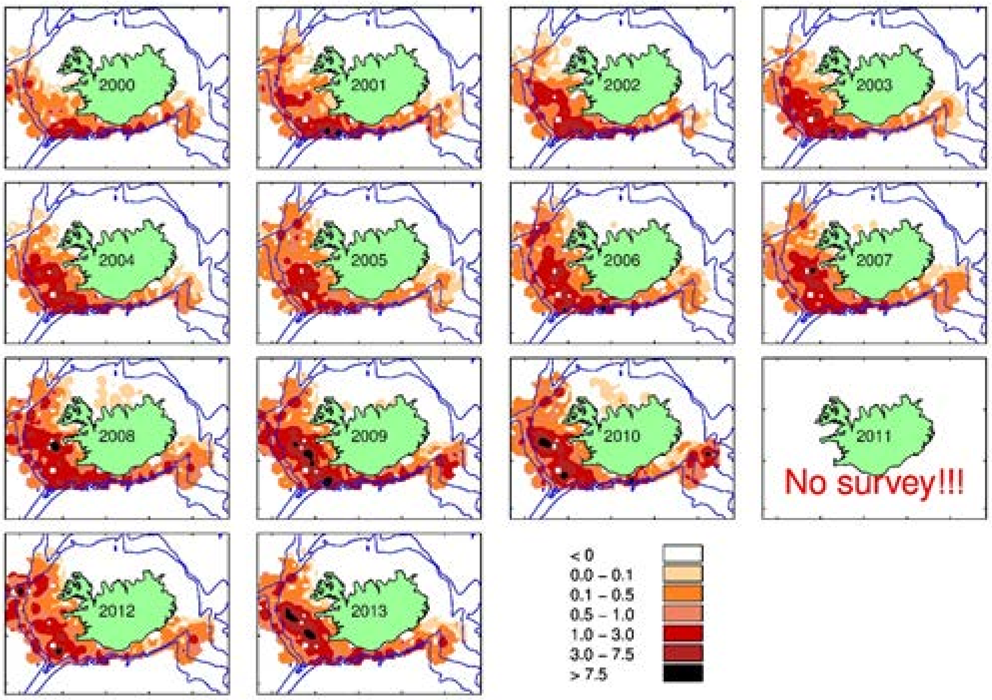


Figure 5.2.9. Blue ling in Va and XIV. Spatial distribution from the Icelandic autumn survey.

Cpue and effort

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 5.2.6). In

2011 to 2012 there was a slight decrease in cpue from longline but the cpue increased again in 2013 to its highest value in the time-series. Cpue from trawling has remained at low levels while effort has been increasing.

Surveys

The spring survey covers only the shallower part of the depth distributional range of blue ling and shows high interannual variance (Figure 5.2.7). It is thus unknown to what extent the spring indices reflect actual changes in total blue 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.

The shorter autumn survey, which goes to greater depths and is therefore more likely to reflect the true biomass dynamics than the spring survey does indicate that there was an increase in blue ling biomass since 2007 (Figure 5.2.7). In 2010 to 2012 the index has decreased slightly. However the index again increased in 2013 and is close to the high values of 2009 and 2010. A large increase of more than 200% in the recruitment index was observed in 2008 but in the 2010 to 2013 autumn survey it had decreased again to its lowest observed value (Figures 5.2.7 and 5.2.8). Due to industrial action only part of the autumn survey was conducted in 2011.

F_{proxy}

Relative fishing mortality (F_{proxy} = Yield/Survey biomass) derived from the autumn survey (+40 cm) and the combined catches from Va and XIV indicates that fishing mortality may have increased by more than 150% between 2007–2010 (Figure 5.2.10 and Table 5.2.4). Since then there are indications that it may have decreased by similar percentage between 2012 and 2013, to the same levels as observed in 2002 and 2009. The reason for the decrease is because of proportionally greater decrease in landings than in the survey index.

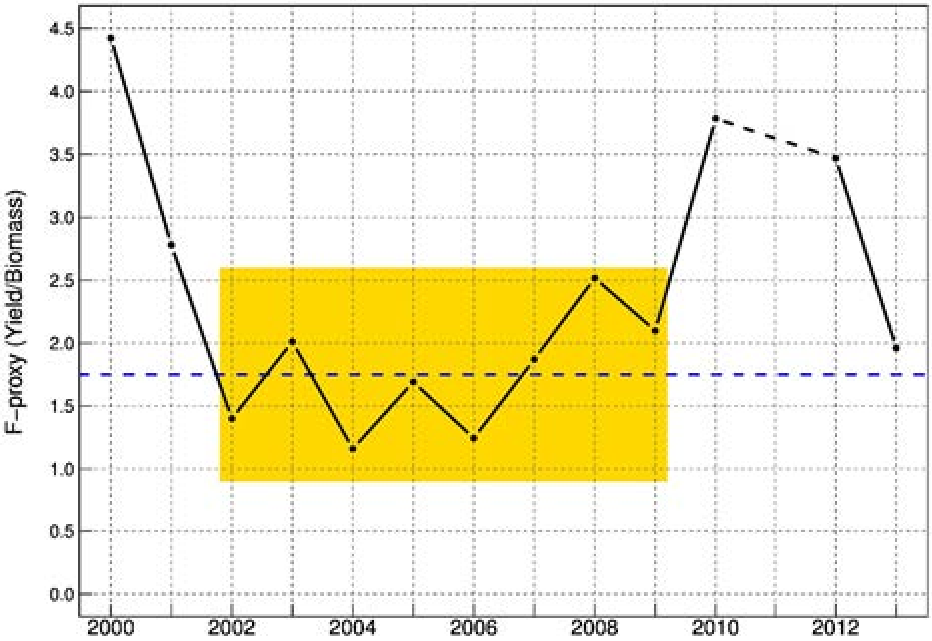


Figure 5.2.10. Blue ling in Va and XIV. Changes in relative fishing mortality (Yield/Survey biomass >39 cm). The yellow box highlights the reference period used by ICES as basis for the 2012 advice and the blue dotted line is the target F_{proxy} of 1.75 (Mean of 2002 to 2009).

Analytical assessment

Exploratory stock assessment on Blue ling in Va and XIVb using Gadget

An exploratory stock assessment of blue ling in Va using the Gadget model was presented at WGDEEP 2012. The EG agreed that the exploratory Gadget assessment presented at the meeting was promising and the estimates from the model could possibly become part of the assessment of blue ling in Va and XIVb or even the basis for advice in the future. However there are several issues with the model that need closer examination and these are tied to the assumptions of growth and selectivity of the fleets in the model. The temporal trends of the estimates of the model (biomass, recruitment and fishing mortality) were relatively stable but the levels of these estimates vary given different model specifications. Updated results of the model were not presented at WGDEEP 2014.

5.2.7 Comments on the assessment

The assessment presented above is based on the ICES DLS approach for category 3 stocks and was proposed by the ADG in 2012. In the 2012 advice the target F_{proxy} was set at 1.7 or the average F_{proxy} in 2002 to 2009, however the landings from XIV were not correct and using the revised landings the target should be 1.75. Using the same approach to advice on catch levels the landings should not exceed 3080 tonnes (1762.3*1.75), using 1.7 as the target would result in a TAC of 3000 t.

5.2.8 Management considerations

Landings have decreased considerably in the last year and as blue ling in Va is now part of the ITQ system such a rapid increase in landings is unlikely. Blue ling is caught in mixed fisheries by the trawler fleet, mainly targeting redfish and Greenland halibut but in a directed fishery by the longliners. Because of the restrictions of the TAC the implications of low blue ling TAC for the trawlers can be considerable, even though the species is a low percentage in their catches.

Closure of known spawning areas in should be maintained and expanded where appropriate.

5.2.9 Response to technical minutes

The comments by the RG in 2012 were constructive and justified in most ways. The will prove valuable in coming years.

Table 5.2.1. 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	515	0	6377	8	0	6900
2011	594	0	5903	2	0	6499
2012	201	0	4207	2	0	4410
2013[1)]	*312*	0	2768	2	0	3082

[1)] **Provisional figures.**

Table 5.2.2. Blue ling: Landing in ICES Division XIV. Source: STATLANT database.

Year	Faroe	Germany	Greenland	Iceland	Norway	Russia	Spain	UK	Denmark	Total
1973	0	50	0	10	0	0	0	0	0	60
1974	0	90	0	6	0	0	0	0	0	96
1975	0	285	0	90	3	0	0	0	0	378
1976	0	65	0	21	0	0	0	13	0	99
1977	0	491	0	0	0	0	0	6	0	497
1978	0	933	0	0	4	0	0	0	0	937
1979	0	1026	0	0	0	0	0	0	0	1026
1980	0	746	0	0	0	0	0	0	0	746
1981	0	1206	0	0	0	0	0	0	0	1206
1982	0	1946	0	0	0	0	0	0	0	1946
1983	0	621	0	0	0	0	0	0	0	621
1984	0	537	0	0	0	0	0	0	0	537
1985	0	315	0	0	0	0	0	0	0	315
1986	214	149	0	0	0	0	0	0	0	363
1987	0	199	0	0	0	0	0	0	0	199
1988	21	218	3	0	0	0	0	0	0	242
1989	13	58	0	0	0	0	0	0	0	71
1990	0	64	5	0	0	0	0	10	0	79
1991	0	105	5	0	0	0	0	45	0	155
1992	0	27	2	0	50	0	0	32	0	111
1993	0	16	0	3124	103	0	0	22	0	3265
1994	1	15	0	300	11	0	0	57	0	384
1995	0	5	0	117	0	0	0	19	0	141
1996	0	12	0	0	0	0	0	2	0	14
1997	1	1	0	0	0	0	0	2	0	4
1998	48	1	0	0	1	0	0	6	0	56
1999	0	0	0	0	1	0	66	7	0	74
2000	0	1	0	4	0	0	889	2	0	896
2001	1	0	0	11	61	0	1631	6	0	1710
2002	0	0	0	11	1	0	0	0	0	12
2003	0	0	0	0	36	0	670	5	0	711
2004	0	0	0	0	1	0	0	7	0	8
2005	2	0	0	0	1	0	176	8	0	187
2006	0	0	0	0	3	1	0	0	0	4
2007	19	0	0	0	1	0	0	0	0	20
2008	1	0	0	0	2	0	381	0	0	384
2009	1	0	0	0	3	0	111	4	0	119
2010	1	0	0	0	9	0	34	0	0	44
2011	0	0	0	0	2	0	0	1	0	3
2012	0	0	0	367	9	0	0	0	0	376
2013[1]	0	0	4	0	0	0	0	3	8	15

[1]) Provisional figures.

Table 5.2.3. 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	Longliners		Trawlers	
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	No boats	Hooks (mill.)	No. boats	Hrs (thous)
2000	804	797	25	1626	15	5.6	23	2.1
2001	129	576	51	756	15	2.3	26	1.6
2002	255	980	22	1257	12	2.8	30	3.1
2003	197	879	22	1098	9	1.4	37	2.7
2004	145	891	44	1080	10	2.1	39	2.8
2005	102	1260	143	1505	8	0.9	52	4.3
2006	151	1461	121	1733	12	1.5	53	4.9
2007	373	1537	81	1991	12	2.8	51	4.2
2008	1453	2111	88	3652	23	10.2	67	9.6
2009	1678	2245	208	4131	25	10.6	64	13.1
2010	3977	2184	213	6374	37	20.0	61	10.0
2011	4138	1618	144	5900	35	21.2	57	5.9
2012	2425	1306	476	4207	24	15.1	53	5.2
2013	1421	1293	54	2768	28	6.6	49	4.0

Table 5.2.4. Blue ling in Va and XIV. Catches in Va and XIV along with survey biomass index (larger than 40 cm) from the Icelandic Autumn survey and the calculated F_{proxy} ($(C_{Va} + C_{XIV})/I$).

Year	Va	XIV	Index	F_{proxy}
2000	1645	896	574.5	4.42
2001	931	1710	950.2	2.78
2002	1372	12	988.3	1.40
2003	1160	711	930.1	2.01
2004	1199	8	1039.7	1.16
2005	1592	187	1051.4	1.69
2006	1855	4	1492.9	1.25
2007	2091	20	1128.1	1.87
2008	3758	384	1645.2	2.52
2009	4233	119	2073.8	2.10
2010	6905	44	1836.8	3.78
2011	6702	3	*No survey*	
2012	4521	376	1411.5	3.47
2013	3082	15	1762.3	1.76

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

5.3.1 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 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 round the year together with roundnose grenadier, black scabbardfish and deep-water sharks.

5.3.2 Landings trends

Total international landings from Division Vb (Table 5.3.1a–f and Figure 5.3.1) 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 to around 1500 t in 2011–2013, mainly due to the absence of agreement between the Faroe Islands and the EU. In 2013, Faroese catch were mostly from one single vessel.

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 less than 1500 t or in 2011–2013. In recent year reducing EU TACs have been the main driver of the catch level.

Landings from Subarea VII are comparatively small, mostly less than 500 t per annum in the whole time-series and have declined in recent years to <50 t.

5.3.3 ICES Advice

The ICES advices for 2013 and 2014 is based on the ICES approach for DLS stocks and states that (1) catches should be no higher than 3900 t in 2013; (2) existing management measures should be continued and (3) spatial management to prevent targeted fishing on spawning aggregations should be expanded to cover spawning areas in Division VIb.

Although it is phrased for 2013 only, the advice is entitled "advice for 2013 and 2014" and the table of catch corresponding to the advice includes the 3900 t for both 2013 and 2014.

5.3.4 Management

Prior to 2009, EU deep-water TACs were 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 Islands set a quota for some EU countries, including a significant ling and blue ling quota, from which a bycatch of roundnose grenadier was allowed, for French vessels. There was no such agreement between the Faroe Island and the EU in 2011 and 2012.

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
Year	Area	ICES advice	EU TAC	EU	Norway	Faroe	
2006	VI, VII	Biennial		3037	200	400	3065
2007	VI, VII	No direct fisheries		2510	160	200	3065
2008	VI, VII	Biennial		2009	150	200	3065
2009	Vb, VI, VII	No direct fisheries	2309	2009	150	150	3065
2010	Vb, VI, VII	Biennial	2032	1732	150	150	2700
2011	Vb, VI, VII	No direct fishery. Limit bycatch. Reduction in catches	2032	1717	150	0	0
2012	Vb, VI, VII	Same as 2011	2031	1882	150	0	0
2013	Vb, VI, VII	3900	2540	23905	150	0	0
2014	Vb, VI, VII	3900	2540	2210(2)			

(1) TAC for ling and blue ling, against which a maximum bycatch of 1080 and 952 tonnes in 2009 and 2010 respectively of roundnose grenadier and black scabbard fish can be counted. (2) provisional, see Council regulation (EU) No 43/2014 of 20 January 2014.

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.

In Faroese waters, Faroese vessels are encouraged to land all fish, which is thought to be done for blue ling. Faroese vessels are regulated by licences and fishing days. Data availability.

5.3.5 Data availability

In Faroese waters, Faroese vessels are encouraged to land all fish, which is thought to be done for blue ling. Faroese vessels are regulated by licences and fishing days.

5.3.5.1 Landings and discards

Landings data were updated.

The proportion of blue ling discarded in the French deep-water trawl fishery in 2012 based upon French on-board observations carried out under the DCF was estimated to 0.06%, confirming that discards of this species are insignificant in this fishery. However, the French industry reported low levels of discarding towards the end of 2009 when quotas were exhausted.

Spanish observer on board trawlers fishing in VIb reported that discards for this species are negligible, in the range of 0–0.5% of the catch.

Discards are presumed non-existent in Faroese waters.

Some blue ling discards were recorded in 2012 in the French bottom trawl fishery for demersal fish in the Celtic Sea and West of Ireland. An estimated raised discards of 55 tonnes (95% confidence limit 18–117 t) was calculated for this fishery. Owing to the relatively southern distribution of this fishery, this discard is likely to comprise a high proportion of the Spanish ling (*Molva macrophthalma*) which, which is more abundant than blue ling at latitude south of 50–52°N and can be misidentified. Small Spanish ling are caught on the Celtic Sea outer shelf and upper slope.

Although discards may occur in other fleets fishing along the upper slope for demersal species, discards are considered minor compared to landings of deep-water fishing fishing fleets.

5.3.5.2 Length compositions

Length composition of blue ling from Faroese trawlers in Division Vb are presented in Figure 5.3.2.

Length distribution of blue in Faroese spring and summer groundfish surveys are shown in Figures 5.3.3 and 5.3.4. In both surveys higher numbers of small blue ling 40–80 cm were caught in 2008–2012, possibly suggesting higher recruitment in these years (Figures 5.3.5).

Time-series (1984–2013, excluding 1985 and 1986) of the length composition of French trawl landings of blue ling are given in Figure 5.3.6. The trends in annual and quarterly mean length are shown in Figure 5.3.7.

5.3.5.3 Age compositions

French quarterly age–length keys from DCF sampling in 2009–2013 were used to estimate age composition of the catch in these years. Age estimates from otoliths readings for all years 2009–2013 were revised in 2013 in order to obtain consistent estimates, not affected by reader effect or improvement of the expertise over time as age reading of blue ling were resumed in 2009, using image analysis. Age estimation was carried out according to the reading protocol recommended by WKAMDEEP (ICES, 2013). Nevertheless, age estimates of blue ling are not validated.

5.3.5.4 Weight-at-age

Blue ling is landed gutted in France, the only EU country were landings of this species are sampled. Weight-at-age is calculated using the length-at-age and length–weight relationship. Weight and length data were provided by Faroe Island and the parameter estimates of the length–weight relationship from new data were similar to the previous estimates.

5.3.5.5 Maturity and natural mortality

No new data.

5.3.5.6 Catch, effort and RV data

The standardised cpue time-series from the Faroese trawler fleet was updated (Ofstad, 2014 WD) however, this time-series was not used in assessment.

The standardized cpue from haul-by-haul data provided by the French industry skipper tallybooks (see stock annex) was updated (Figures 5.3.9–5.3.11). This index is based upon five small areas (Figure 5.3.9). In 2011–2012, there was no fishing in Areas new6 and new5 and little in ref5 from vessels providing tallybook data. As a consequence the index was calculated for two out of the five areas used in previous years.

The time-series from the Scottish deep-water research survey was updated with 2013 indices. (Figure 5.3.12).

No deep-water Irish survey was carried out since 2009.

Standardized time-series from the Faroese spring and summer surveys were provided (Figure 5.3.13).

5.3.6 Data analyses

Length distribution of catches of Faroese fleets show that fish caught are mostly in the length range 70–120 cm (Figures 5.3.3–5.3.4). Recruitment inputs are visible in some years, e.g. 2007–2009.

Mean length in French trawl landings (Figure 5.3.7) shows a strong decline until the mid-1990s followed by an increasing trend over 1995–2013, with some low levels in some years reflecting recruitment pulses, in particular in 2007.

In recent years, the index of biomass from French haul-by-haul data has been that based on the two small areas edge 6 and other6 (see Figure 5.3.9). The same was done in 2014, however, and additional index based upon four small areas was calculated (Figure 5.3.11). This index suggests that the overall increasing trend may be higher than that what is reflected by the index used. This might arise from local biomass rebuilding in areas no longer fished but not accounted in the cpue index used.

Biomass indices from French logbooks

The Biomass index from logbooks presented in 2012 and 2013 was not updated.

Surveys

The Faroese surveys show varying biomass since 1994 with high values in 2004, 2005 and since 2009. The depth range (<500 m) does not extend down to the core depth distribution of blue ling. The provided indices used all hauls from 200 to 500 m and are stratified indices.

Multiyear catch curve (MYCC) model

The Multiyear catch curve (MYCC, Trenkel *et al.*, 2012, see stock annex) was applied to age distribution in 2009–2013 and total international landings from 1995 to 2013. Runs were done with fixed M from M=0.10 to M=0.19, a range based upon possible estimates from life-history characteristics.

The results at different M value showed similar trends with an increasing total mortality estimate from 1995 to 2001, then decreasing. As Z is well estimated in the last years from age composition data, M values on the higher end of the range, forced the model to estimate a larger stock number, which allows accommodating the catch with a small Z. At higher M, the stock varied less over time in relation to its larger overall size. Therefore the recent estimates of M derived from revised age readings result in estimates of F consistent with previous perception of the overexploitation of the stock in the 1990s and early 2000s. At *M*=0.13, F is estimated to have increased to 0.2 or more in the early 2000 and to have decreased to less than 0.05 after 2010.

Stock Reduction Analysis (SRA) using FL_{aspm}.

Like for the MYCC, a series of SRA runs were made with various input values of *M*. as required in the stock annex. At *M*=0.19, the model estimated the initial biomass in 1966 at about 190 000 t, with peak harvest rate of about 0.5 in some years (not shown). At *M*=0.1, the initial biomass was estimated to about 300 000 t, temporal variations of the harvest rate, *H*, showed the same pattern at all *M* assumptions but the overall level was lower at low *M*, as a low *M* implies a higher biomass. The temporal pattern of the biomass and harvest rate is given in Figure 5.3.15 for *M*=0.11. The estimated exploitable biomass and harvest rate for *M*=0.11 are given in Table 5.5.

As in the MYCC model, the stock size increases with M while in SRA, it decreases with increasing M, it is likely that the M value for which the stock size estimates of the two model are similar is closer to the actual natural mortality. The biomass of age groups 9 and over in the two model in the year range 1995–2013, common to the two models was compared, these biomass were most similar at M=0.11 (Figure 5.3.16).

The change in the initial and current biomass and current harvest rate with the input M in SRA are shown in the table below.

Natural mortality assumed in SRA runs and corresponding outputs for the initial (B_0) and current ($B_{CURRENT}$) biomasses (thousand tonnes) and Harvest rate (H) in the last year.

M	B_0	$B_{current}$	H
0.1	294	98	0.03
0.11	276	91	0.03
0.13	250	88	0.04
0.15	223	78	0.05
0.17	202	73	0.05
0.19	187	72	0.05

SRA estimated harvest rate were low for all the range of natural mortality. The estimated H in the past was 5 to 10 times above the current level for 20 years from 1984 to 2003.

The results of both models are shown for M=0.11. An F reference point calculated for this level of M was chosen as $F_{50\%SPR}$=0.07 from YPR with the stock dynamics used in SRA.

Some more reference points were calculated. $F_{0.1}$, F_{MSY} and F_{MAX} were all above the M value assumed in their calculation. This comes from the age at selectivity and the age at maturity being set at the same level in the model, which is meant to represent properly the true stock, where individual recruit to the fishery at an age of 8 years and are almost all mature.

Projection

The stock was projected in 2014 starting from number-at-ages at 01/01/2014 estimated by the MYCC model. The catch in 2014 was assumed to correspond to the ICES advice: 3900 t. For 2015, F=0.07 result in a catch of 4662 t.

Nevertheless the current biomass calculated by SRA is only 33% of the biomass in 1966, considered corresponding to an unexploited level. Based on this, the current biomass could be considered close to or below MSY $B_{trigger}$, although this reference point in undefined for this stock.

Space–time modelling

Blue ling is considered sensitive to local depletion (Large *et al.*, 2010). Only one such case, in Icelandic waters, was clearly reported by Magnússon and Magnússon (1995) who described the depletion of a spawning aggregation within a few years.

Possible local depletion effects in the fishing area for blue ling to the West of Scotland where investigated by Augustin *et al.* (2012). This analysis used the French tallybook data and applied a novel three dimensional tensor product of a soap film smooth of space with a penalized regression spline of time allowing to account for the complex boundary of blue ling habitat, driven primarily by bottom depth.

The model was a generalised additive mixed model (GAMM) as followed:

Log(μi)=f1(durationi)+f2(depthi,yeari)+f3(depthi)+f4(monthi)
+f5(depthi,monthi)+f6(northi,easti,yeari)+f7(powerk(i))

where μi = E(y_i) and y_i is catch in haul *i* from a Tweedie distribution with variance $\phi\mu_i^p$. *k(i)* indexes the vessel that made the i^{th} haul and $f_{1\text{-}6}$ are smooth functions of the covariate associated with each haul. The geographic coordinates northing and easting are longitude and latitude projected onto a square grid using the universal transverse mercator projection. f_7 is a linear function of vessel engine power (see Augustin *et al.*, 2012, for a complete description of the model).

The model showed a spatial distribution with a generally higher blue ling density in northern areas and some localised areas of higher density (Figure 6.3.18). The smooth used allows for accurate estimation of the spatial distribution (compare bottom right panel with a standard spline in Figure 6.3.18 to all other panel with the three-dimensional tensor).

This space–time model did not show evidence of recent local depletion of blue ling to the West of Scotland over the period 2000–2010. This does not imply that no such effect occurred in the past when the fishing mortality was much higher, but applies to the current fishery. Prediction made for the same small areas as the standardised lpues showed and increasing time-trend in particular in Areas new6, new5 and ref5 that have not been fished in recent years. Prediction were also made for the spawning areas that have been regulated since 2009 and also showed an increase abundance (Figure 5.3.19).

5.3.7 Comments on assessment

The assessment of blue ling in ICES Areas V, VI and VII is based on three steps. A multiyear catch curve model (MYCC) is used to estimate the total annual mortality taking into account annual variations in recruitment, a stock reduction analysis (SRA) is used to predict the biomass dynamics of the stock, and a yield-per-recruit model is used to estimate reference points. The approach was deemed appropriate for assessing this stock.

The WKDEEP 2014 benchmark suggested that future work should be directed at combining all available information within one assessment method, such as XSA or Stock Synthesis, rather than the current approach which pieces together the information using three assessments.

5.3.8 Management considerations

Blue ling is susceptible to sequential depletion of spawning aggregations. Maintaining the current closed areas will provide protection for the spawning aggregations. This may not be needed if the current TAC management regime is effective in limiting fishing mortalities as intended and if highly aggregated fisheries in these areas do not cause local depletion.

Table 5.3.1a. Landings of blue ling in Subdivision Vb1.

Blue ling Vb1

YEAR	FAROES	FRANCE(1)	GERMANY(1)	NORWAY(2)	E & W(1)	IRELAND	RUSSIA(1)	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		12 500	**21 232**
1978	423	3369	744	237	35			**4808**
1979	1072	2683	691	331				**4777**
1980	1187	2427	5905	304				**9823**
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	1193	430	4	130	11	2		**1770**
2002	685	578		274	8			**1545**
2003	1079	1133		12	1			**2225**
2004	751	1132		20			13	**1916**
2005	1028	781		15	1			**1825**
2006	1276	839		21	1		16	**2153**

YEAR	FAROES	FRANCE(1)	GERMANY(1)	NORWAY(2)	E & W(1)	IRELAND	RUSSIA(1)	TOTAL
2007	1220	1166		212	8		36	**2642**
2008	642	865		35			110	**1652**
2009	523	325					0	**848**
2010	840	464		49		0	0	**1353**
2011	838	312		0		0	0	**1150**
2012	799	424		8		0	5	**1236**
2013	526	556		0		0	3	**1085**

***Preliminary. (1) Includes Vb2; (2) includes Vb2 up to 1974.**

Table 5.3.1b. Landings of Blue ling in Subdivision Vb2.

Year	Faroes	Norway	Scotland	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	1	196
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	212	69	63	344
2002	318	21	140	479
2003	1386	84	120	1590
2004	710	6	68	784
2005	609	14	68	691
2006	647	34	16	697
2007	632	6	16	654
2008	317	0	91	408

Year	Faroes	Norway	Scotland	Total
2009	444	8	161	613
2010	656	10	225	891
2011	319	0	0	319
2012	211	0		211
2013	83	0	2	85

***Preliminary. (1) Includes Vb1.**

Table 5.3.1c. Landings of blue ling in Division VIa.

Year	Faroes	France	Germany	Ireland	Norway	Spain[1]	E & W	Scotland	Lithuania[2]	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		362		164			16 777
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	179	117	797	116	2136	16	6244
2002		2172		125	61	285	16	2027	28	4714
2003	7	2010		2	106	3	3	428	29	2588
2004	10	2264		1	24	4	1	482	38	2824
2005	17	2019		2	33	88		390	1	2550
2006	13	1794		1	49	87	3	433	2	2382
2007	13	1814			31	47		113	1	2019
2008	14	1579			73	10		112	2	1790
2009	11	2202			74	165		178		2630

YEAR	FAROES	FRANCE	GERMANY	IRELAND	NORWAY	SPAIN(1)	E & W	SCOTLAND	LITHUANIA(2)	TOTAL
2010	43	1937			86	223		134		2423
2011	10	1136			93	10		74		1323
2012	5	1178			86	6		47		1322
2013*	2	1097			132	11		203		1445

***Preliminary. (1) Includes VIb; (2) Includes VIb for all countries up to (and including) 1974.**

Table 5.3.1d. Landings of blue ling in DivisionVIb.

Year	Poland	Russia	Faroes	France	Germany	Norway	E & W	Scotland	Iceland	Ireland	Estonia	Spain	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

Year	Poland	Russia	Faroes	France	Germany	Norway	E & W	Scotland	Iceland	Ireland	Estonia	Spain	Total
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	112		4	7	30					**169**
2008		12	2	29		2	2	9		0			**56**
2009		1		10		1		7		0			**19**
2010		0	0	39		15		1		0			**55**
2011		0	0	9		11		0					**20**
2012				3		3						1	**217**
2013				4				0				3	**38**

[1] **included in VIa.**

Table 5.3.1e. Landings of blue ling in Subarea VII.

Year	France	Germany	Spain	Norway	E & W	Scotland	Ireland	Total
1988	21	1	0	0	0	0	0	22
1989	292	0	0	2	0	0	0	294
1990	223	0	0	0	0	0	0	223
1991	211	0	0	0	0	1	0	212
1992	398	0	0	3	0	6	0	407
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	3	22	1	283	30	10	601
1999	115	2	59	1	168	18	27	390
2000	91	2	65	5	31	17	73	284
2001	84	2	64	5	29	17	634	835
2002	45	4	42	0	77	55	453	676
2003	27	1	42	0	8	16	28	122
2004	23	1	15	0	4	1	19	63
2005	37	0	25	0	1	0	11	74
2006	30	0	31	0	2	0	4	67
2007	121	0	38	0	2	1	2	164
2008	28	0	6	0	0	0	0	34
2009	10	0	1	0	0	0	0	11
2010	13	0	24	0	0	0	0	37
2011	23	0	26	0	0	0	0	49
2012	19	0	21	5	0	0	0	45
2013	32	0	0	0	0	0	0	32

*** Preliminary.**

Table 5.3.1f. 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	16 777		20 575
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	294	15 116
1990	4799	7405	223	12 427
1991	2962	9011	212	12 185
1992	4702	8550	407	13 659
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	601	10 682
1999	2931	9085	390	12 406
2000	2524	8352	284	11 160
2001	2114	9178	835	12 127
2002	2024	6053	676	8753
2003	3815	3338	122	7275
2004	2700	3459	63	6222
2005	2516	2891	74	5481
2006	2850	2733	67	5650
2007	3296	2188	164	5648
2008	2060	1846	34	3940

2009	1461	2649	11	4121
2010	2244	2478	37	4759
2011	1469	1343	49	2861
2012	1447	1539	45	3031
2013*	1170	1483	32	2685

*** Preliminary.**

Table 5.4. Total and fishing mortality, stock number and recruitment estimates from the MYCC model under the assumption M=0.1.

Year	Z	Z standard dev.	Recruitment number (millions)	Recruit. Standard dev.	Total Numbers ages 9+ (millions)	Number age 9+ Sd	F
1995	0.23	0.01	3.35	0.32	16.04	1.74	0.12
1996	0.24	0.01	3.36	0.33	16.12	1.52	0.13
1997	0.28	0.02	3.39	0.33	16.13	1.33	0.17
1998	0.28	0.01	3.35	0.32	15.56	1.20	0.17
1999	0.33	0.02	3.42	0.34	15.17	1.10	0.22
2000	0.33	0.02	3.40	0.32	14.32	1.06	0.22
2001	0.35	0.02	3.37	0.30	13.63	1.04	0.24
2002	0.29	0.02	3.19	0.36	12.76	1.06	0.18
2003	0.27	0.02	3.23	0.33	12.75	1.12	0.16
2004	0.23	0.01	3.30	0.31	13.05	1.18	0.12
2005	0.22	0.01	3.46	0.32	13.82	1.20	0.11
2006	0.22	0.01	3.54	0.36	14.64	1.26	0.11
2007	0.21	0.01	3.46	0.32	15.17	1.34	0.10
2008	0.18	0.01	3.53	0.35	15.79	1.44	0.07
2009	0.18	0.01	3.21	0.33	16.36	1.50	0.07
2010	0.19	0.01	3.25	0.33	16.90	1.56	0.08
2011	0.16	0.00	3.13	0.39	17.12	1.65	0.05
2012	0.16	0.00	3.20	0.36	17.84	1.74	0.05
2013	0.15	0.00	3.42	0.34	18.68	1.78	0.04
2014			3.32	0.34	19.39	1.82	

Table 5.5. Time-series 1966–2013 of exploitable biomass and Harvest rate (H) from the stock reduction analysis (SRA), with M=0.11.

Year	Exploitable biomass	H	Year	Exploitable biomass	H
1966	276	0	1990	73	0.2
1967	275	0.01	1991	70	0.2
1968	273	0.01	1992	68	0.24
1969	271	0	1993	64	0.19
1970	270	0.01	1994	63	0.11
1971	267	0.01	1995	67	0.13
1972	265	0.02	1996	69	0.14
1973	261	0.11	1997	69	0.17
1974	237	0.1	1998	68	0.18
1975	218	0.07	1999	66	0.22
1976	207	0.1	2000	61	0.21
1977	191	0.18	2001	59	0.25
1978	165	0.09	2002	55	0.18
1979	158	0.07	2003	55	0.15
1980	155	0.16	2004	57	0.12
1981	139	0.11	2005	60	0.1
1982	134	0.09	2006	64	0.1
1983	131	0.1	2007	67	0.09
1984	127	0.14	2008	70	0.06
1985	120	0.18	2009	74	0.06
1986	109	0.23	2010	78	0.07
1987	97	0.21	2011	81	0.04
1988	88	0.26	2012	87	0.04
1989	78	0.23	2013	92	0.03

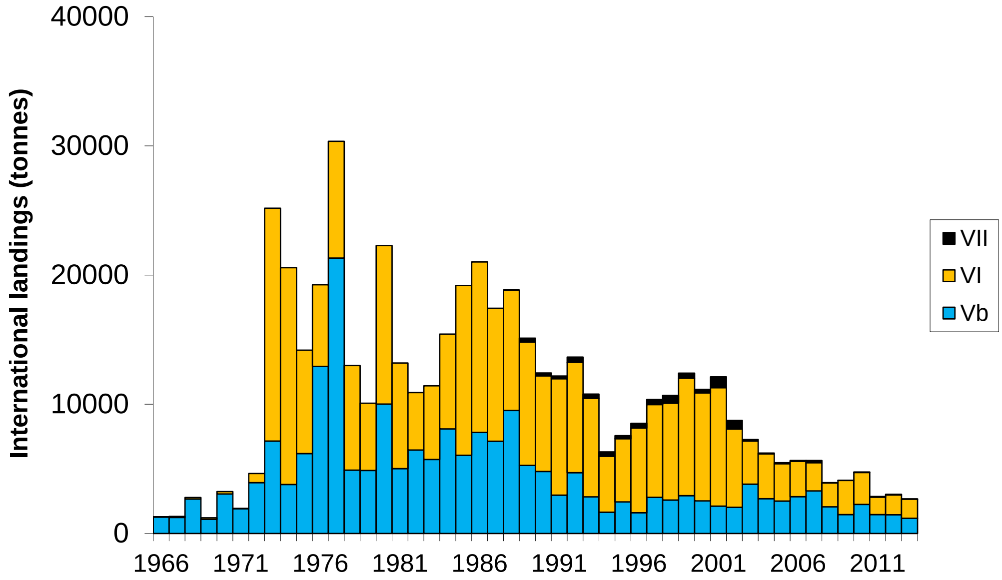


Figure 5.3.1. Trends in total international landings for southern blue ling (Vb, VI, VII).

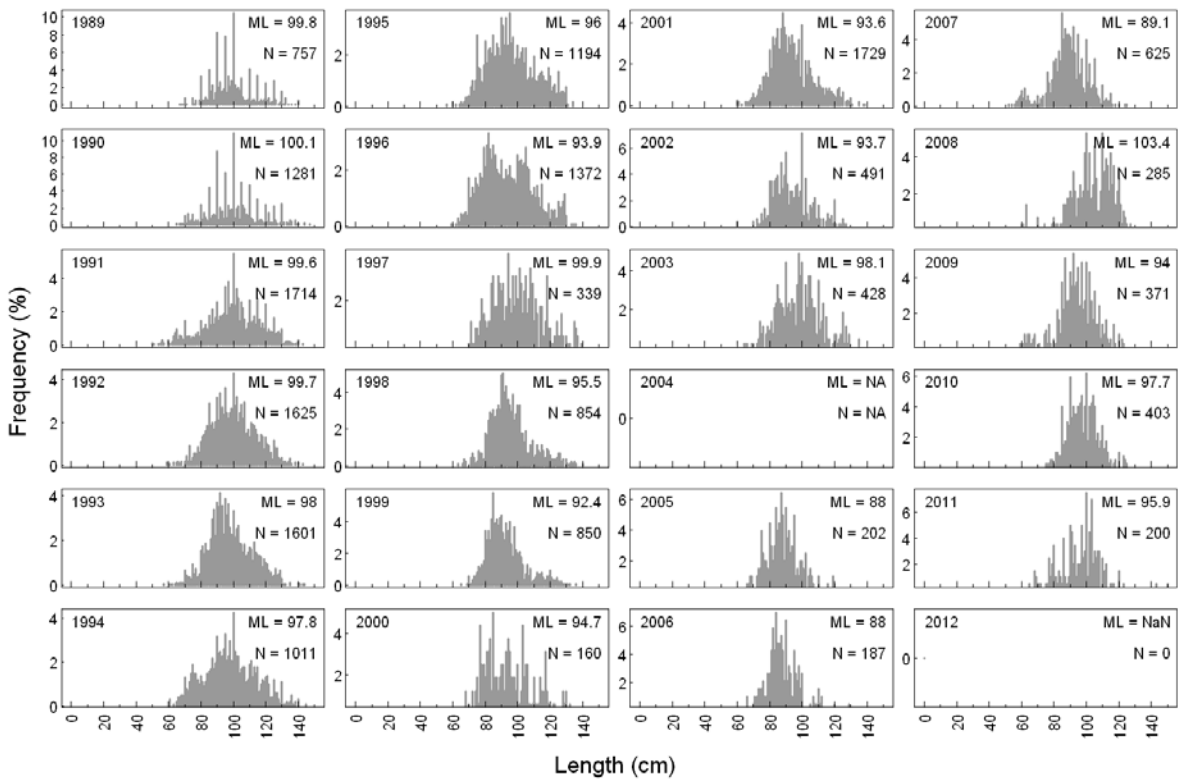


Figure 5.3.2. Blue ling in Vb (Faroes). Length distribution in the landings from Faroese otter-board trawlers >1000 HP.

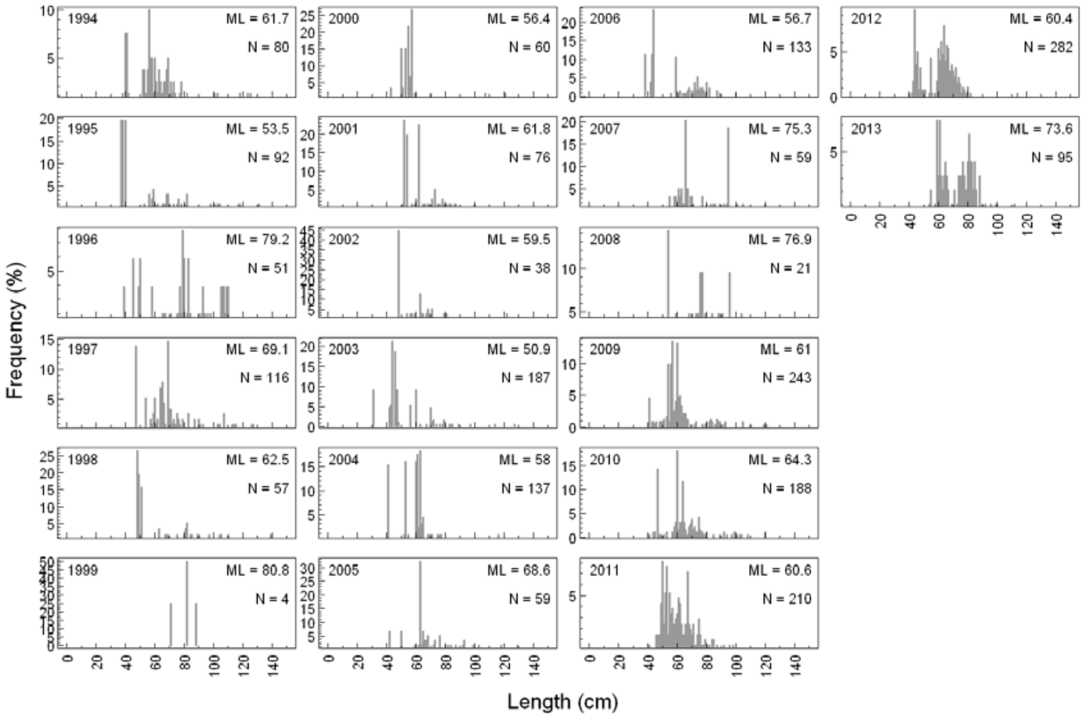


Figure 5.3.3. Length distribution of blue ling in the spring groundfish Faroese survey.

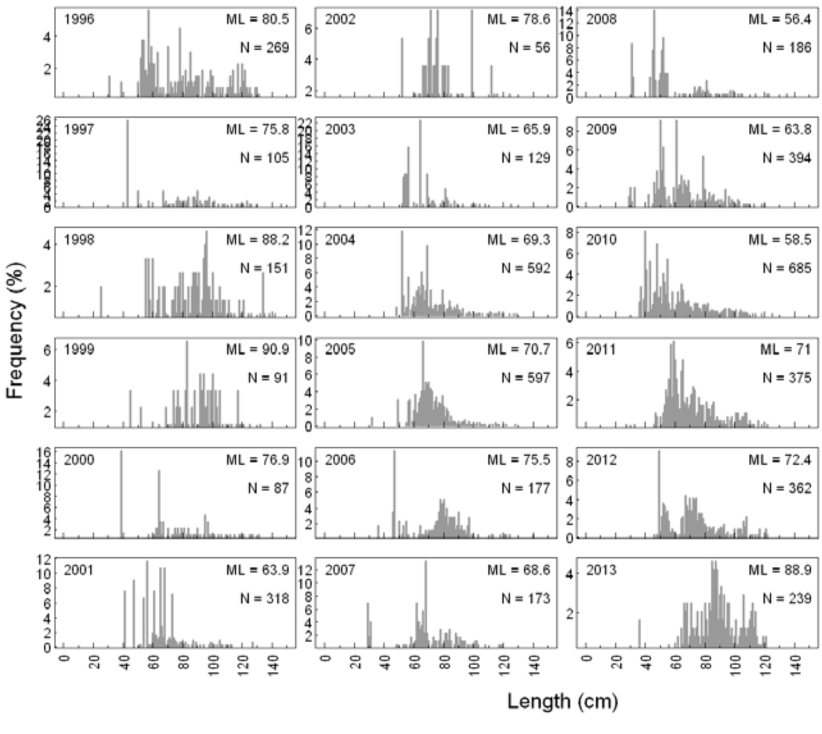


Figure 5.3.4. Length distribution of blue ling in the summer groundfish Faroese survey.

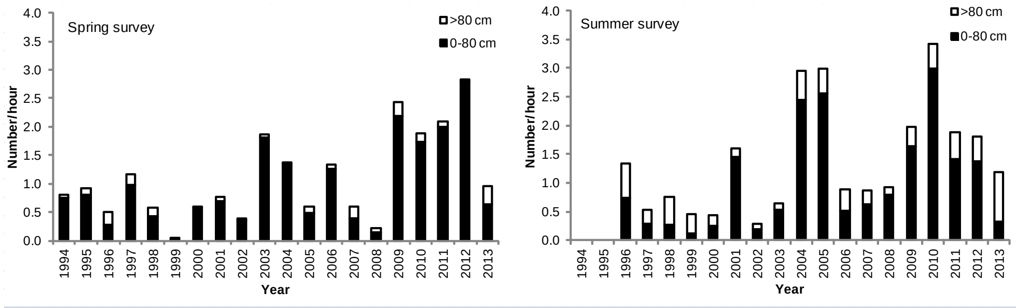


Figure 5.3.5. Number of juvenile (<80 cm) and adult (>80 cm) blue ling caught in the Faroese groundfish survey on the Plateau from spring (left panel) and summer (right panel).

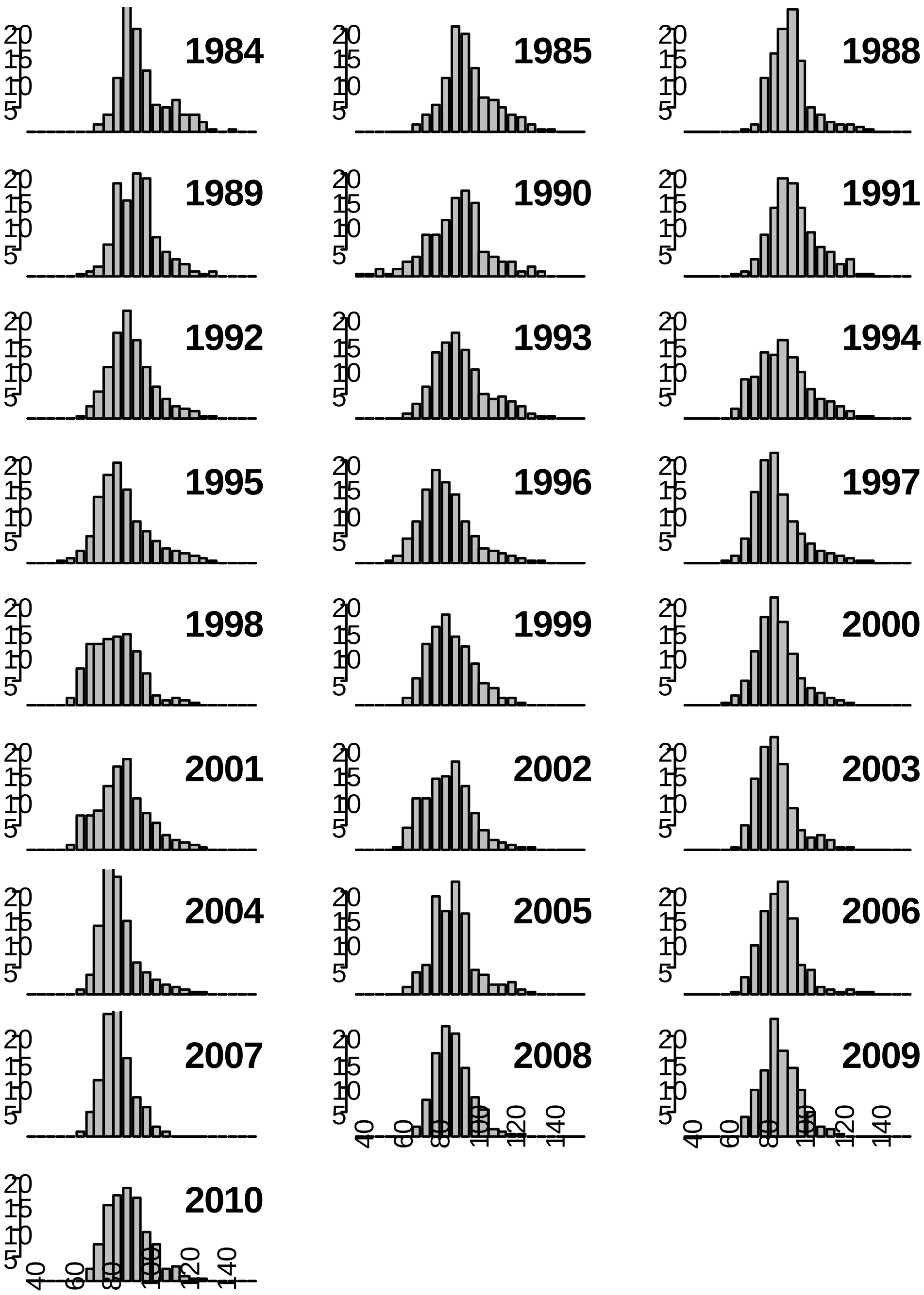


Figure 5.3.6. Length distribution1984–2011 of the landings of blue ling from the French trawl fishery (for legibility, small numbers below 60 cm, occurring in a few years only, were cut off).

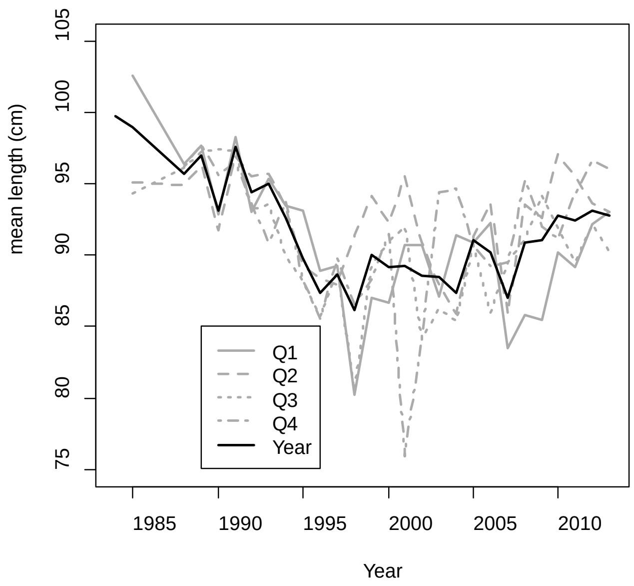


Figure 5.3.7. Quarterly mean length in French trawl landings, 1984–2013.

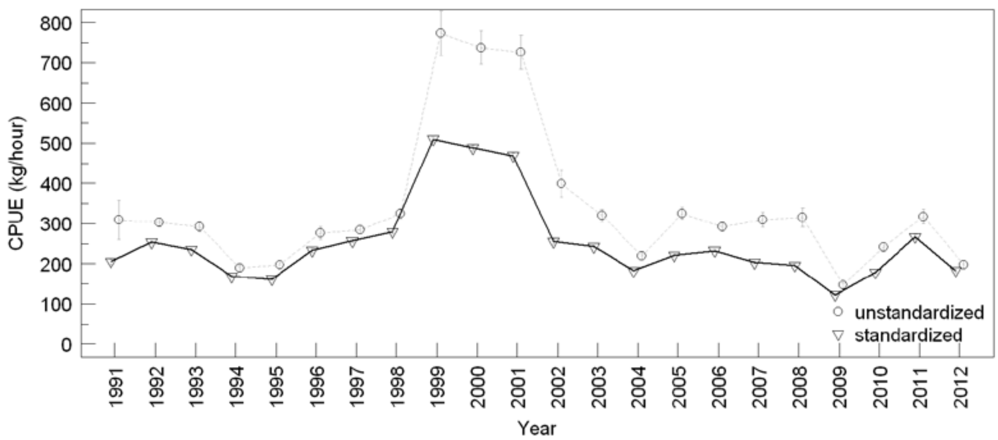


Figure 5.3.8. Blue ling in Vb, Standardised cpue from Faroese trawlers in the bank area west of the Faroes (DB–DG, 9–14.)

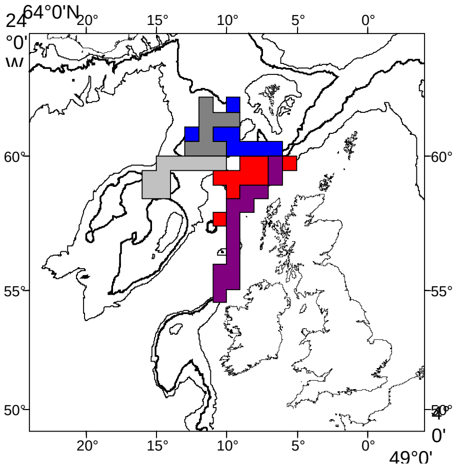


Figure 5.3.9. Areas used to calculate French lpues for blue ling: .dark grey: new grounds in Vb (new5); light grey: new grounds in VI (new6); red: others in VI (other6); purple: edge in VI (edge6); blue: reference grounds in Vb (ref5). Depth contours are 200, 1000 and 2000 m.

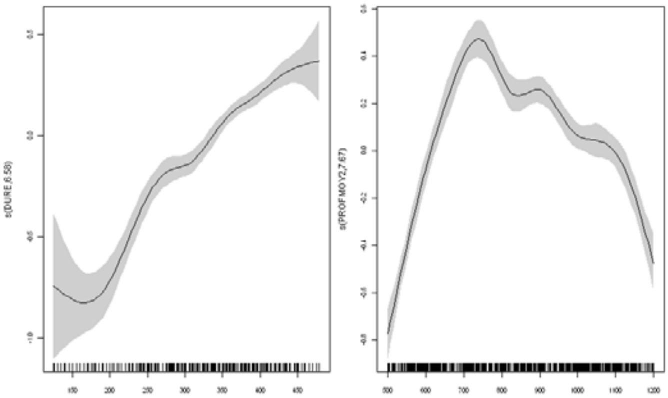


Figure 5.3.10. Haul duration and depth effect, GAM model for the tallybook index.

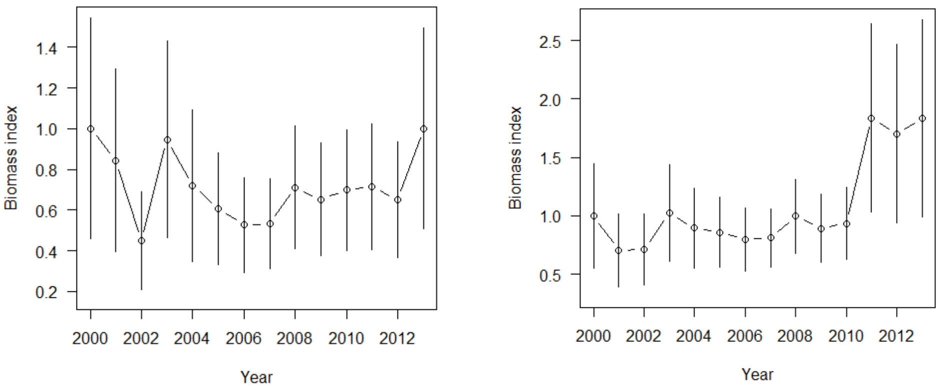


Figure 6. 3.11. Trends in annual mean lpue of blue ling, from French trawl tallybook data. Left index combining small areas "edge6" and "other6" only where most of the fishing occurred in recent years. Right index combining small areas "edge6", "other6", "new5" and "ref5".

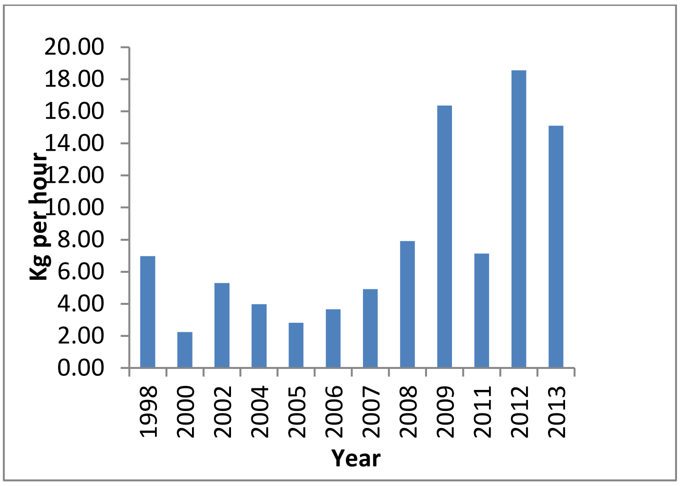


Figure 6. 3.12.1. Biomass index in the Scottish deep-water survey, based on haul carried out from 400 to 1600 m.

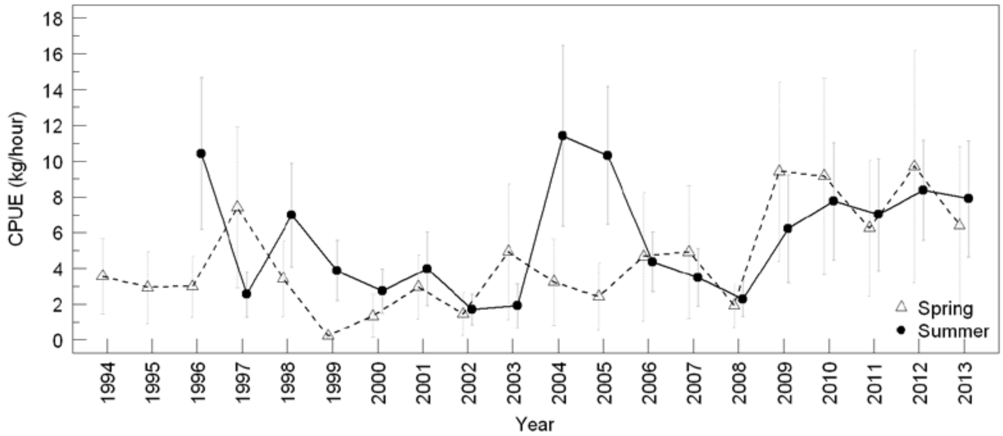


Figure 5.3.12. Biomass indices in the spring and summer Faroese surveys for haul deeper than 200 m.

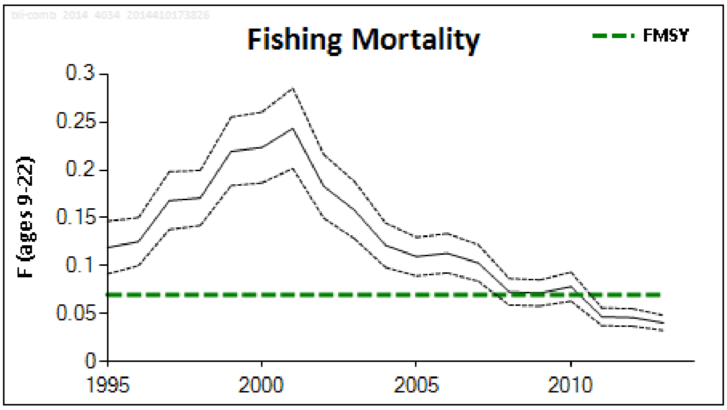


Figure 5.3.13. Estimated fishing mortality from the MYCC.

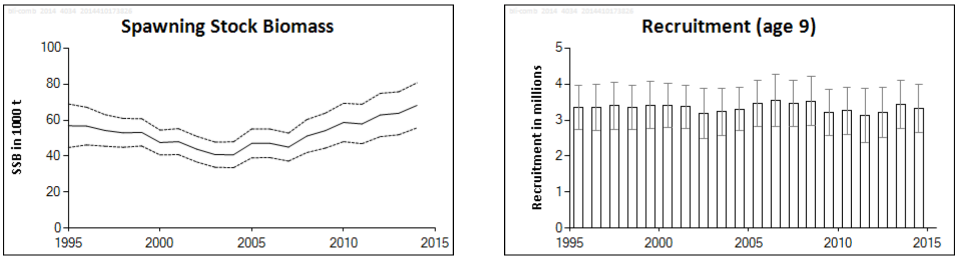


Figure 5.3.14. Estimated biomass of age 9+ and recruitment numbers (at age 9) from the MYCC.

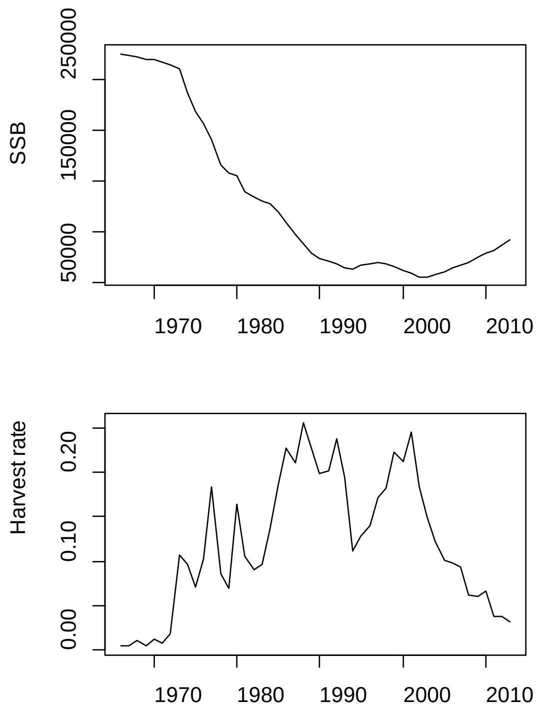


Figure 5.3.15. Spawning–stock biomass (SSB, tonnes) and harvest rate from 1966 (onset of the fishery) to 2013 estimated by SRA.

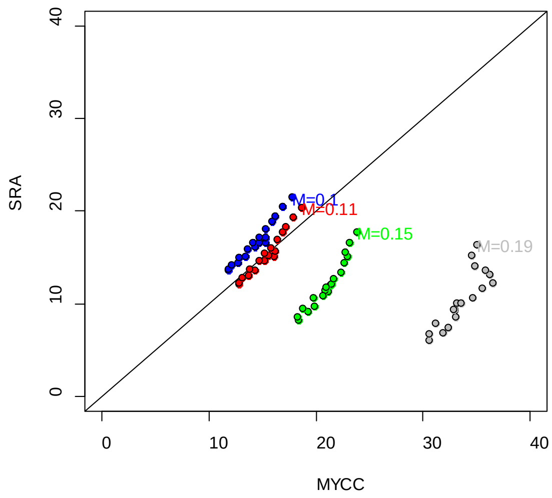


Figure 5.3.16. Comparison of stock numbers of age groups 9+ estimated by SRA and MYCC for M=0.1, 0.11, 0.15 and 0.15

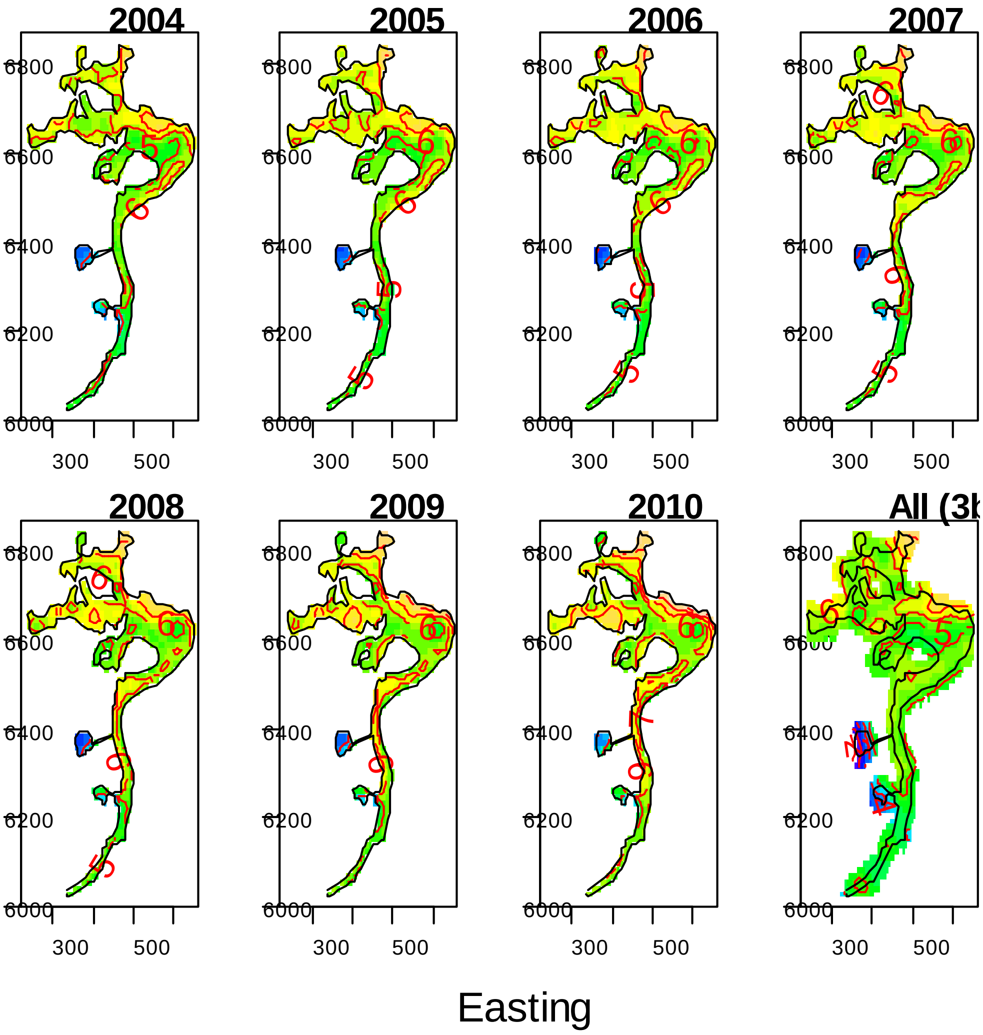


Figure 6.3.18. Spatial distribution of the blue ling biomass estimated by the space–time model per year 2004–2010. The bottom right panel shows the estimated spatial distribution for all years combined with a model using a standard thin plate regression spline smooth, which does some averaging across the natural boundary of blue ling distribution.

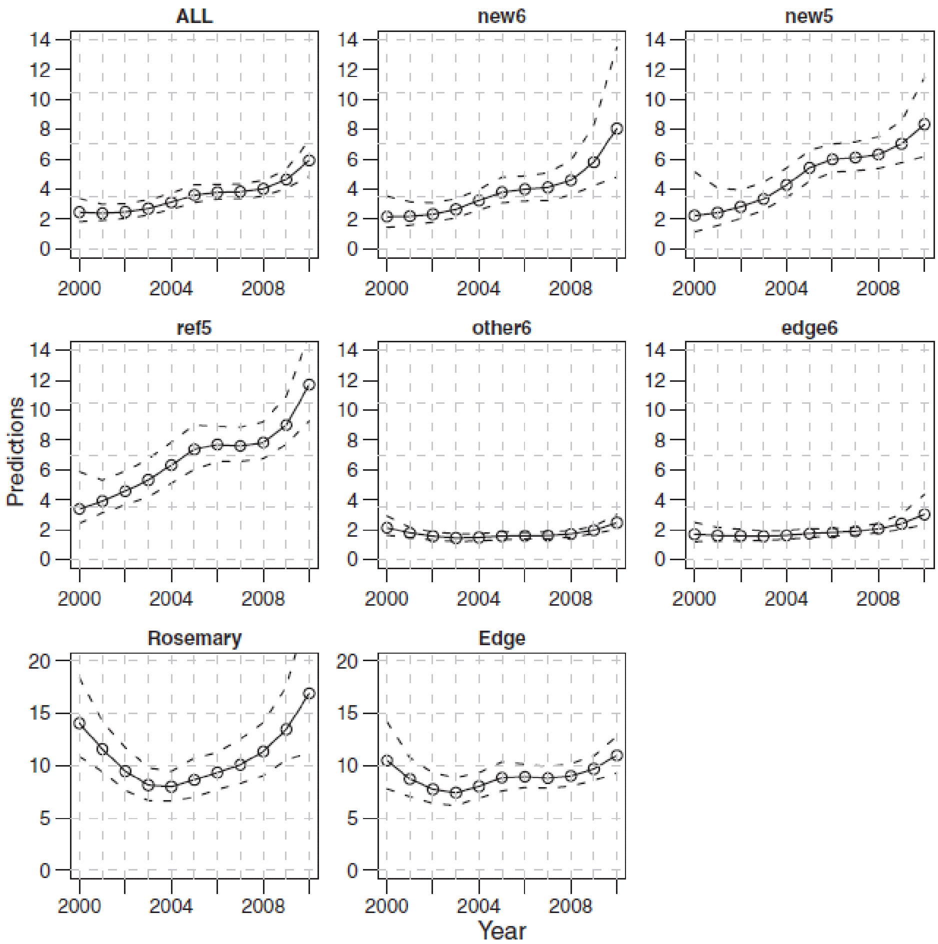


Figure 5.3.19. Time trends of median haul landings in 100 kg by area (ALL areas, new6, new5, ref5, other6 and edge6) and for two spawning areas. Time trends were predicted by fishing area for January in each year for haul duration of 6 h, a depth of 850 m and a vessel power of 1850 kWatt. For spawning areas, predictions were made for the peak of the spawning period (April) and otherwise with the same fixed values as the other predictions. The dashed lines are 95% Bayesian credible intervals.

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

5.4.1 The fishery

The directed fishery on spawning aggregations for blue ling on Hatton Bank (Division XIIb) and Division IIa is no longer conducted and blue ling is now taken as bycatch only in other fisheries in these areas. Blue ling has been an important bycatch in trawl fisheries for mixed deep-water species on Hatton Bank (Division XIIb). There has also been a small bycatch in the longline fisheries in Division IIa. Recently, Faroese and Norwegian vessels have caught blue ling in this area with longlines and nets. 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.

5.4.2 Landings trends

Landings data are presented in Table 5.4.0a–f and Figures 5.4.1–3. Landings of blue ling from other areas are presently at a low level. During the whole time-series, around 90% or more of the total landings were taken in Subareas II, IV and XII combined. Recently, most of the landings come from Subarea IIa. For all areas a decline has been seen since 1993 and for each area the landings have been below 500 tonnes in recent years.

5.4.3 ICES Advice

The ICES advice for 2011 and 2012 is:

"No directed fisheries for blue ling, and a reduction in catches should be considered until such time there is sufficient scientific information to prove the fishery is sustainable:

- Measures should be implemented to minimize the bycatch;
- Closed areas to protect spawning aggregations should be maintained and expanded where appropriate."

5.4.4 Management

A 2012 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 1882 tonnes; of this a quota for Norwegian vessels was set to 150 tonnes to be fished in IIa, Vb, VI and VII.

5.4.5 Data availability

5.4.5.1 Landings and discards

Landings data are demonstrated in Table 5.4.1. No discard data are available.

5.4.5.2 Length compositions

No length data are available.

5.4.5.3 Age compositions

No age data are available.

5.4.5.4 Weight-at-age

No weight-at-age data are available.

5.4.5.5 Maturity and natural mortality

No data were available.

5.4.5.6 Catch, effort and research vessel data

No data are available.

5.4.6 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 25% of the mean landings from the years 1988–1993 (the period with stable landings). Since 2004 the landings have been stable at a low level (Figures 5.4.1–5.4.3).

There is an increase in landings from Area II as a result of a 36% increase in Faroese landings from this area. However, the overall landings are decreasing for this stock.

The increase in Division IIIa in 2004 (2.5 times increase from 2004–2005) comes from increased Danish landings from the roundnose grenadier fishery. This fishery stopped in 2006 and the landings of blue ling have since been insignificant.

5.4.6.1 Biological reference points

WKLIFE has not yet suggested methods to estimate biological reference points for stocks which have only landings data or are bycatch species in other fisheries. Therefore, no attempt was made to propose reference points for this stock.

5.4.7 Comments on assessment

Not applicable.

5.4.8 Management considerations

Trends in landings suggest serious depletion in Subarea II. Landings have also declined strongly in Subarea XII from 2002 onwards. Landings in others are minor but there is some evidence of a persistent decline in Subarea IV.

Advice given in 2012 remains appropriate.

No directed fisheries for blue ling, and a reduction in catches should be considered until such time there is sufficient scientific information to prove the fishery is sustainable.

Measures should be implemented to minimize the bycatch.

Closed areas to protect spawning aggregations should be maintained and expanded where appropriate.

Fisheries in Subarea XIIb probably belong to the same stock that is exploited in Subarea VI. Management in this area should be consistent with the Advice for Vb, VI and VII.

Table 5.4.0a. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Sub-area I. (* preliminary).

Year	Iceland	Norway	FRANCE	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
2011			3	3
2012			1	1
2013*				0

Table 5.4.0b. 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	1			234		4			422
2011	312	7			167					434
2012*	188	7			142		1			338
2013	36	16			107					159

Table 5.4.0c. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Sub-area 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
2011				0
2012				0
2013*		1		1

Table 5.4.0d. 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		24		109		21		155
2011			129		47		1		177
2012*			96		70				166
2013			8		38				46

Table 5.4.0e. 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	unallocated	Total
1988		263											263
1989		70											70
1990		5											5
1991		1147											1147
1992		971											971
1993	654	2591	90			unallocated							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

Year	Faroes	France	Germany	Spain	E & W	Scotland	Norway	Iceland	Poland	Lithuania	Russia	unallocated	Total
2009		+		312							+		312
2010				50									50
2011				55									55
2012				205								427	633
2013*				178								76	254

Table 5.4.0f. 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	422	0	155	92	670
2011	0	434	0	50	50	534
2012	1	336	0	166	633	1136
2013*	0	159	1	46	254	460

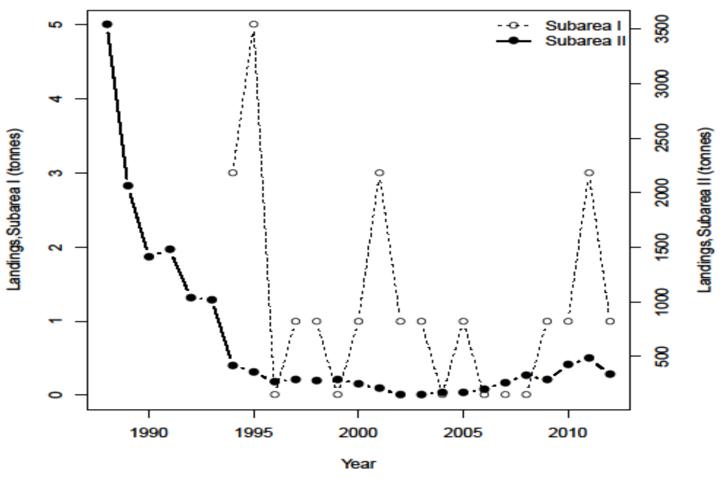


Figure 5.4.1. Landings of blue ling in Subareas I and II.

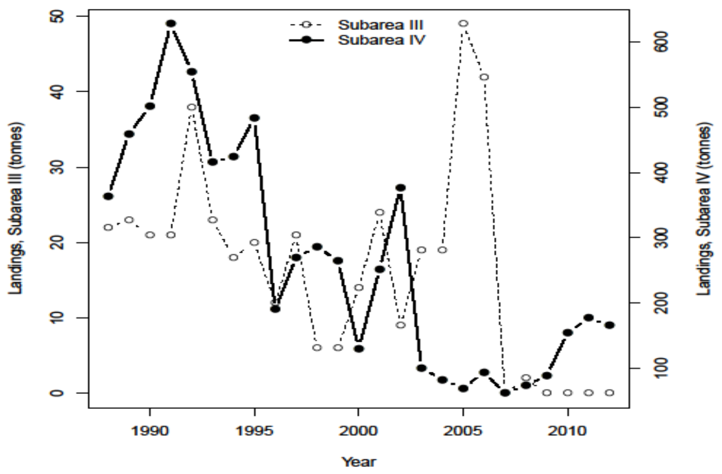


Figure 5.4.2. Landings of blue ling in Subareas III and IV.

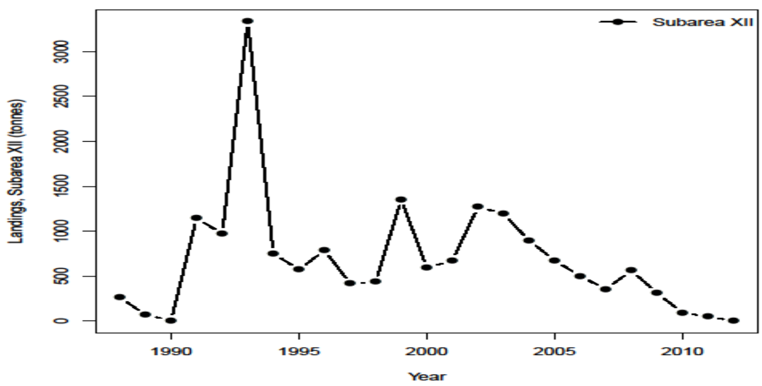


Figure 5.4.3. Landings of blue ling in Subarea XII.

6 Tusk

6.1 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.

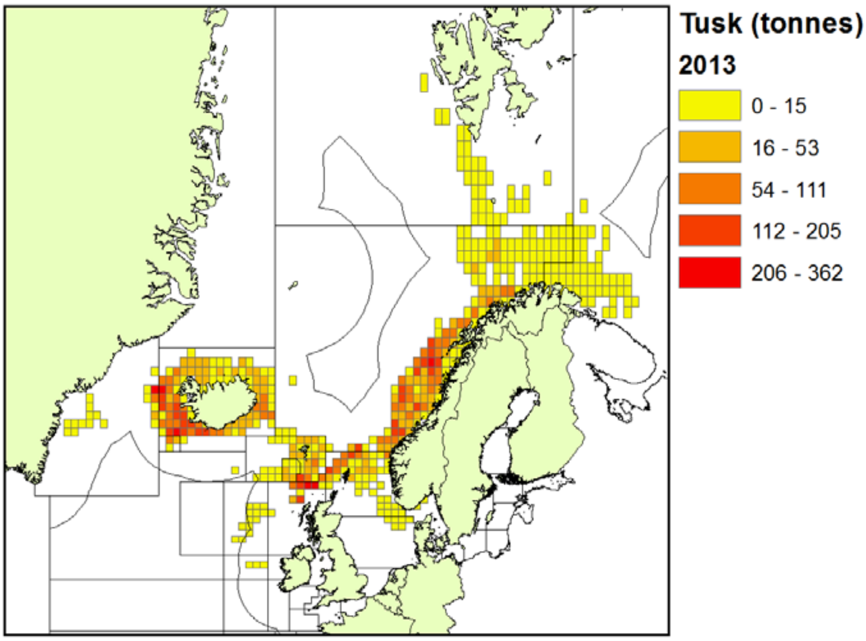


Figure 6.1. Reported landings of tusk in the ICES area by statistical rectangle, 2013. Data from Norway, Faroes, Iceland, France, UK (England and Wales) and Spain. Landings shown in this figure account for 99% of all reported landings in the ICES area.

6.2 Tusk (*Brosme Brosme*) in Division Va and Subarea XIV

6.2.1 The fishery

Tusk in Va is caught in a mixed longline fishery, conducted in order of importance by Icelandic, Faroese and Norwegian boats. Between 150-240 Icelandic longliners report catches of tusk, but much fewer gillnetters and trawlers (Table 6.2.1). Most of tusk in Va is caught on longlines or around 97% of catches in tonnes and this has been relatively stable proportion since 1992 (Table 6.2.1).

Table 6.2.1. Tusk in Va. Number of boats reporting catches and their landings.

Year	Number of boats			Catches (Tonnes)			
	Longliners	**Gillnetters**	**Trawlers**	**Longline**	**Trawl**	**Other**	**Sum**
2000	244	20	13	4536	91	80	4707
2001	230	36	7	3210	72	98	3380
2002	194	18	11	3703	75	126	3904
2003	202	8	9	3902	55	60	4017
2004	192	6	10	2996	84	44	3124
2005	231	7	17	3324	164	46	3534
2006	228	11	12	4908	92	54	5054
2007	205	8	17	5834	95	57	5986
2008	170	16	30	6756	113	60	6929
2009	158	20	38	6754	107	91	6952
2010	165	25	34	6760	93	66	6919
2011	165	18	36	5744	67	34	5845
2012	173	22	37	6255	59	27	6341
2013	169	16	36	4873	73	27	4973

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 meters (Figure 6.2.1). The main fishing grounds for tusk in Va as observed from logbooks are on the south, southwestern and western part of the Icelandic shelf (Figures 6.2.2 and 6.2.3).

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 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 6.2.3).

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.

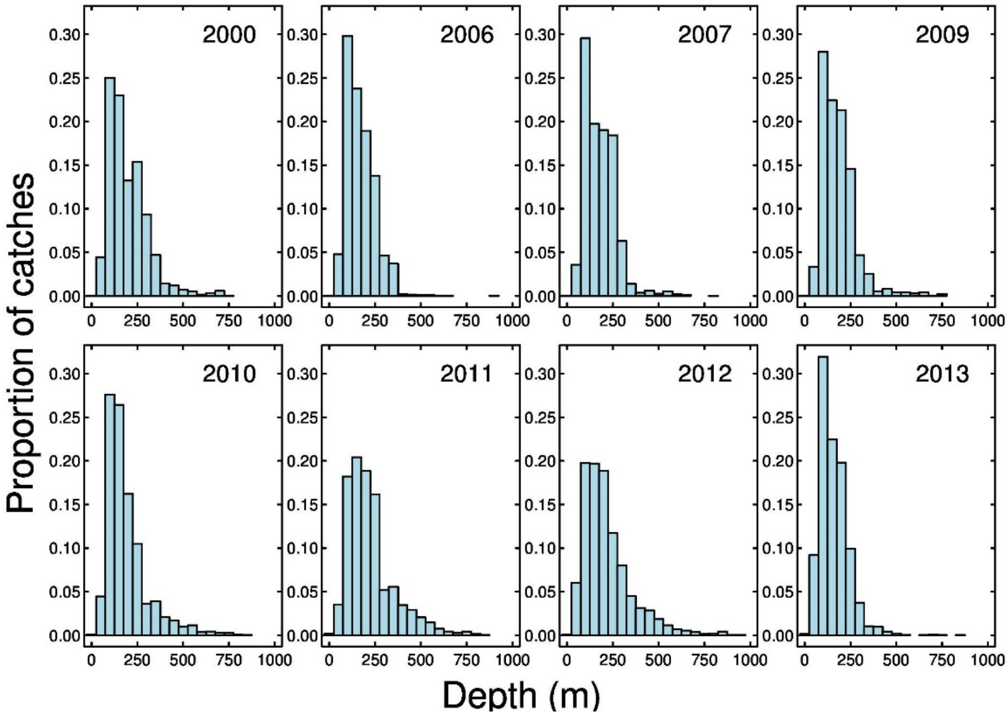


Figure 6.2.1. Tusk in Va and XIV. Depth distribution of longline catches in Va according to logbooks.

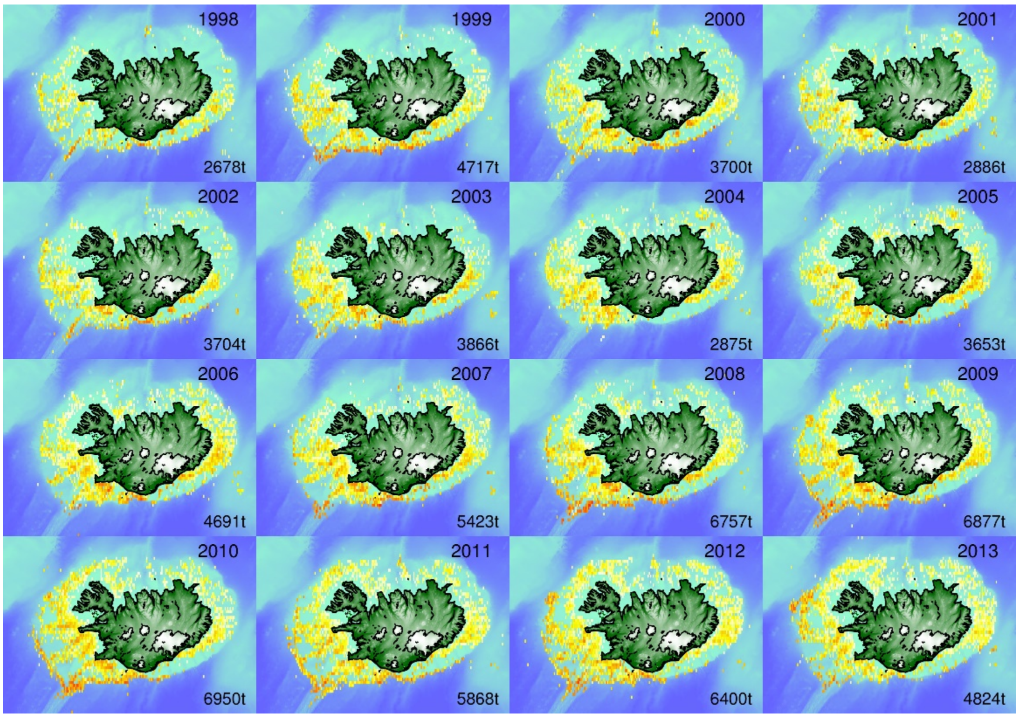


Figure 6.2.2. Tusk in Va and XIV. Geographical distribution of the Icelandic fishery since 1998 as reported in logbooks. All gears combined.

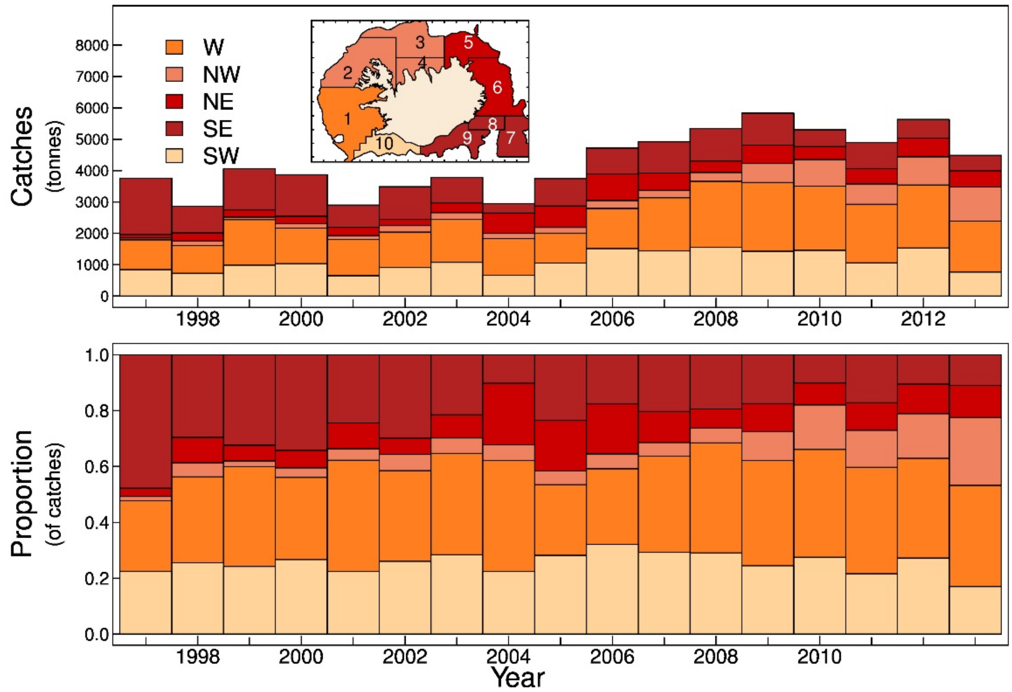


Figure 6.2.3. Tusk in Va and XIV. Changes in spatial distribution of the Icelandic fishery in 1996–2012 as reported in logbooks. All gears combined.

6.2.1.1 Landings trends

The total annual landings from ICES Division Va were around 6300 tonnes in 2013 (Table 6.2.7). This is contrary to the trend in landings from 2000 in which the annual landings gradually increased in Va to around 9000 tonnes in 2010 (Figure 6.2.4).

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 (Table 6.2.7).

Landings in XIV have always been low compared to Va, rarely exceeding 100 t. (Table 6.2.8).

6.2.1.2 ICES Advice

The latest Advice from ICES in May 2012 states: ICES advises that, based on the MSY approach, catches should be no more than 6700 t.

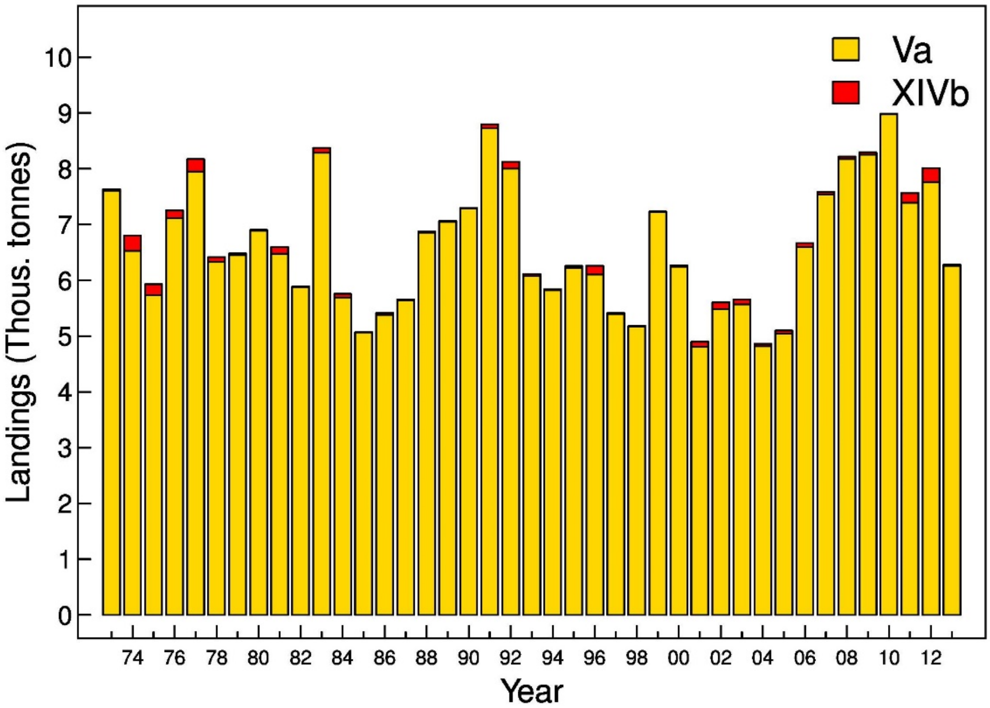


Figure 6.2.4. Tusk in Va and XIV. Landings in Va and XIV (source STATLANT).

6.2.1.3 Management

The Icelandic Ministry of Industries and Innovation (MII) 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 but the overshot in landings has decreased from 30–40% to less than 10% in the last fishing year (Table 6.2.2).

Table 6.2.2. Tusk in Va and XIV. TAC recommended for tusk in Va by the Marine Research Institute, national TAC and total landings from the quota year 2001/2002.

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	7777
2011/12	6900	7000	7401
2012/13	6700	6400	6833
2013/14	6200	5900	

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. However for the last two fishing years, managers have to some extend taken into account the foreign catches (see below). The tusk advice given by MRI and ICES for each quota year is, however, for all catches, including foreign catches.

Table 6.2.3 gives an overview of the composition of the total landings by Icelandic vessels in Va of tusk. In general there is always something left of last year's quota (column 3 in Table 6.2.3). This indicates that the holders of tusk 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 except in 2011/2012 (columns 6 and 7 in Table 6.2.3). This fishing in excess of the 'available' TAC is then met with converting TAC from other species to tusk quota. This was a reversal of the trend at the beginning of the table when considerable proportion of the TAC was either converted to other species or moved to the next Quota year. In the 2011/2012 and 2012/2013 between 800–900 tonnes of tusk were converted to other species (column 8).

In the 2010/2011 to 2012/2013 fishing years the TAC allocated to Icelandic vessels (column 1 in Table 6.2.3) is lower than the total TAC set by the MII (National TAC column in Table 6.2.2). This is a response by the managers to constrain total catches close to set TAC, i.e. taking into account catches by foreign fleets (see below).

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 maximum 1200 tonnes 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.

Table 6.2.3. Tusk in Va and XIV. Overview of TAC composition of landings in Va (Thous. tonnes)

QUOTA year	SET TAC	OTHER TAC	P.Y. TAC	VESSEL Tr.	EFF. TAC	LAND.	TAC - Land	SPECIES Tr	TAC left	TAC moved	CONF.	U.TAC n.-tr.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2001/2002	4.5	0.001	0	0	4.501	3.483	1.018	-0.623	0.394	0.296	0.003	0.101
2002/2003	3.5	0.001	0.296	0	3.797	3.735	0.063	0.168	0.231	0.188	0.001	0.045
2003/2004	3.5	0.001	0.188	0	3.689	3.37	0.319	0.223	0.542	0.496	0.002	0.048
2004/2005	3.5	0.001	0.496	0	3.997	3.516	0.48	-0.136	0.344	0.289	0.001	0.057
2005/2006	3.5	0.001	0.289	0	3.789	4.664	-0.875	1.017	0.142	0.114	0.005	0.033
2006/2007	5	0.001	0.114	0	5.115	6.306	-1.19	1.645	0.454	0.445	0.003	0.012
2007/2008	5.5	0.001	0.445	0	5.947	6.097	-0.15	0.74	0.59	0.538	0	0.052
2008/2009	5.5	0.001	0.538	0	6.039	7.059	-1.02	1.228	0.207	0.205	0.002	0.005
2009/2010	5.5	0.003	0.205	0	5.709	6.965	-1.257	1.332	0.076	0.056	0.002	0.021
2010/2011	5.4	0.001	0.051	0	5.452	5.545	-0.093	0.235	0.142	0.131	0.001	0.013
2011/2012	6.3	0.001	0.131	0	6.432	5.347	1.085	-0.914	0.171	0.149	0.002	0.025
2012/2013	5,76	0,001	0,149	0	5,910	4,971	0,939	-0,840	0,099	0,069	0,000	0,031

(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.

6.2.2 Data available

In general sampling is considered good from commercial catches from the main gear (longlines). The sampling does seem to cover the spatial distribution of catches for longlines and trawls but less so for gillnets. Similarly sampling does seem to follow the temporal distribution of catches (WGDEEP, 2012).

6.2.2.1 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) (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 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.

6.2.2.2 Length compositions

An overview of available length measurements from Va is given in Table 6.2.4. Most of the measurements are from longlines, number of available length measurements increased in 2007 from around 2500 to around 4000 and have been close to that since.

Length distributions from the longline fishery are shown in Figures 6.2.5 (abundance) and 6.2.6 (biomass). In the figures the length distributions are multiplied with a maturity ogive to get estimates of the proportion of catches mature.

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

Table 6.2.4. Tusk in Va and XIV. Number of available length measurements from Icelandic (Va) commercial catches.

Year	Longline		Gillnets		Trawls	
	Samples	**Measured**	**Samples**	**Measured**	**Samples**	**Measured**
2000	17	2532	0	0	0	0
2001	17	2513	0	0	1	151
2002	17	2453	0	0	0	0
2003	18	2661	0	0	0	0
2004	10	1472	0	0	1	150
2005	12	1775	0	0	0	0
2006	15	2225	0	0	3	450
2007	22	3154	2	167	1	150
2008	32	4722	0	0	0	0
2009	27	3945	0	0	0	0
2010	29	4354	0	0	0	0
2011	28	4141	0	0	0	0
2012	35	5105	0	0	1	150
2013	22	3278	0	0	0	0

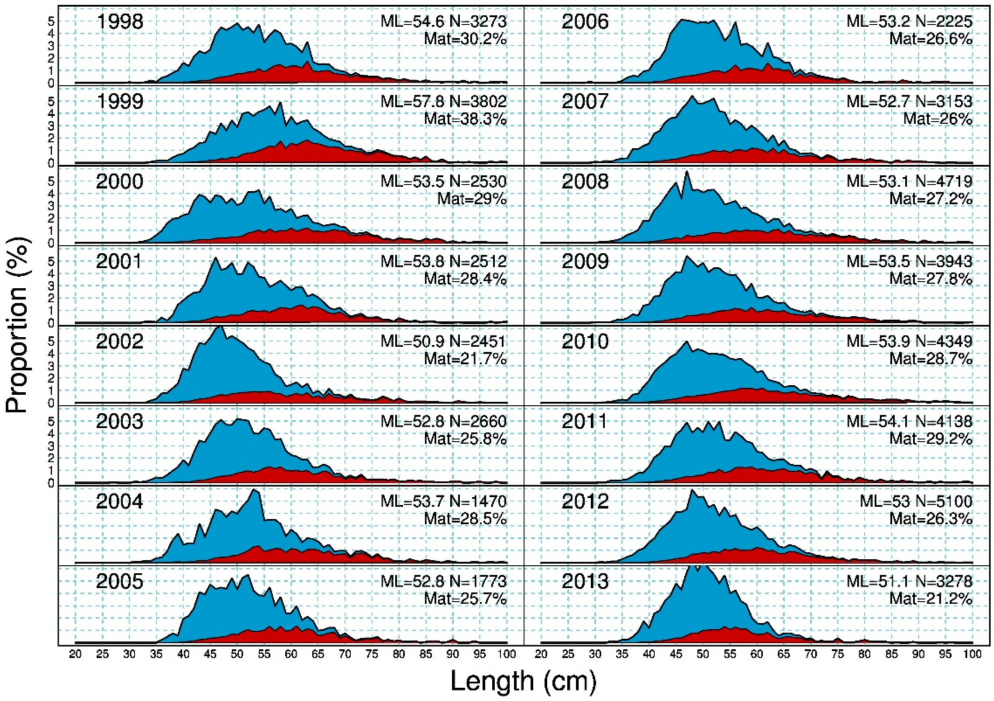


Figure 6.2.5. Tusk in Va and XIV. Length distributions from Icelandic commercial longline catches in abundance. Blue areas are immature tusk and red represent mature tusk. Small numbers to the right refer to mean length (ML), number of samples (N) and percentage of mature individuals (Mat).

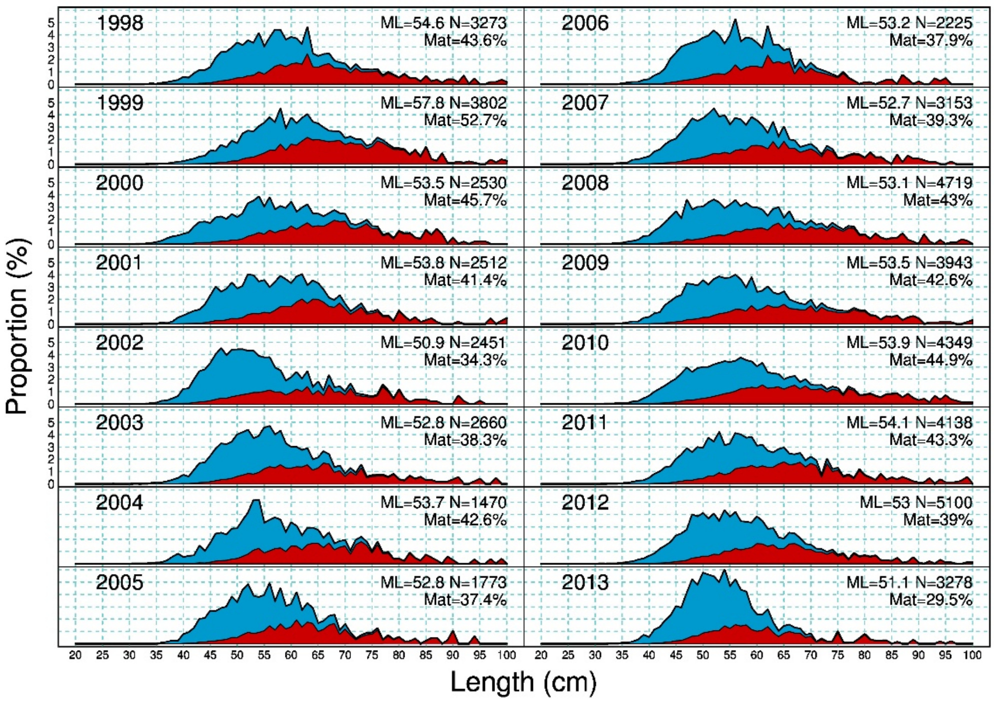


Figure 6.2.6. Tusk in Va and XIV. Length distributions from Icelandic commercial longline catches in biomass. Blue areas are immature tusk and red represent mature tusk. Small numbers to the right refer to mean length (ML), number of samples (N) and percentage of mature individuals (Mat).

6.2.2.3 Age compositions

Table 6.2.5 gives an overview of otolith sampling intensity by gear types from 2000 to 2013 in Va. Since 2010 considerable effort has been put into ageing tusk otoliths, so now aged otoliths are available from 1984, 1995, 2004–2013. The ageing are used as input data for the Gadget assessment (Figure 6.2.7). It is expected that the effort in ageing of tusk will continue.

No data are available from XIV.

Table 6.2.5. Tusk in Va and XIV. Number of available otoliths from Icelandic (Va) commercial catches and the Icelandic Spring survey and the number of aged otoliths.

YEAR	LONGLINE			SURVEY		
	Samples	**Otoliths**	**Aged**	**Samples**	**Otoliths**	**Aged**
2000	17	849	0	229	321	0
2001	17	849	0	208	282	0
2002	17	851	0	207	303	0
2003	18	900	0	229	343	0
2004	10	500	0	225	422	399
2005	12	600	0	263	488	148
2006	15	750	0	281	499	457
2007	22	1100	0	290	483	381
2008	32	1600	600	282	489	475
2009	27	1350	1090	277	453	434
2010	29	1449	1373	241	378	363
2011	28	1400	1306	270	738	728
2012	34	1700	1160	285	771	750
2013	23	1150	510	275	744	517

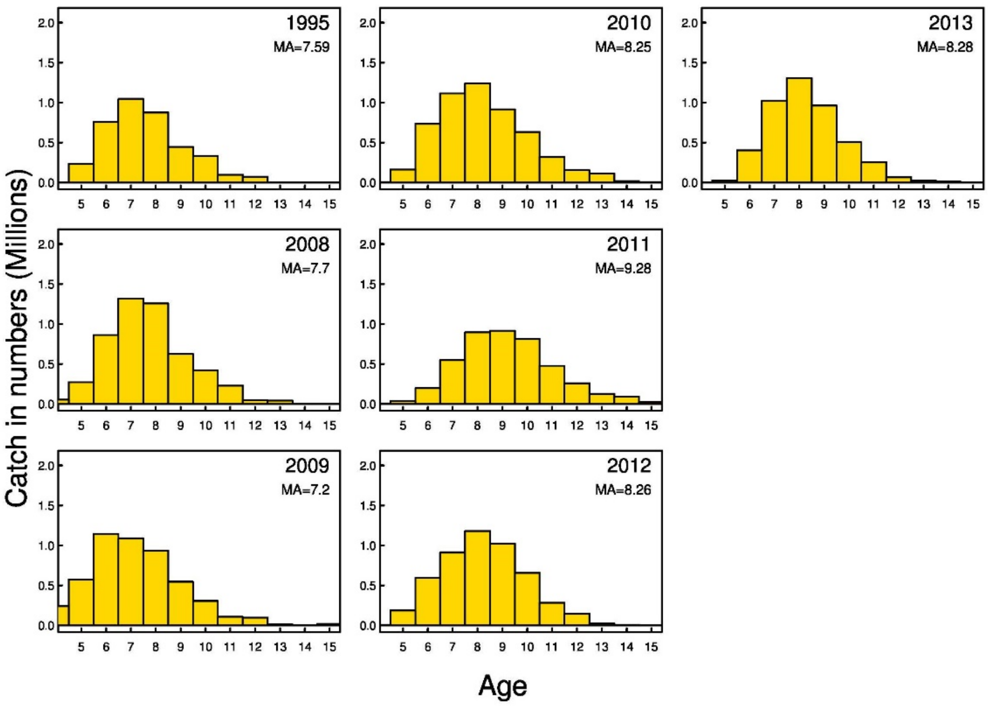


Figure 6.2.7. Tusk in Va and XIV. Catch in numbers in Va (From longlines)

6.2.2.4 Weight-at-age

Weight-at-age data from Va are limited to 2008–2013 (Figure 6.2.8).

No data are available from XIV.

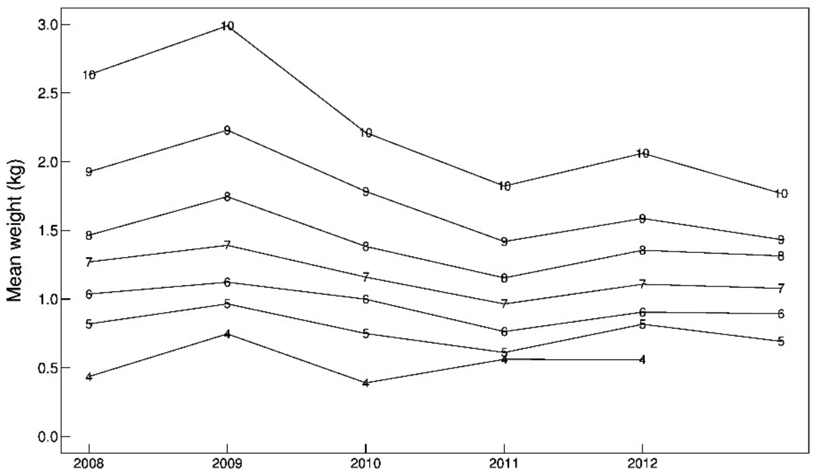


Figure 6.2.8. Tusk in Va and XIV. Changes in mean weight-at-age from commercial catches in Va.

6.2.2.5 Maturity and natural mortality

At 54 cm around 25% of tusk in Va is mature, at 62 cm 50% of tusk is mature and at 70 cm 75% of tusk is mature based on the spring survey data.

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

No data are available for XIV.

6.2.2.6 Catch, effort and research vessel data

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

Figure 6.2.9 shows nominal 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.

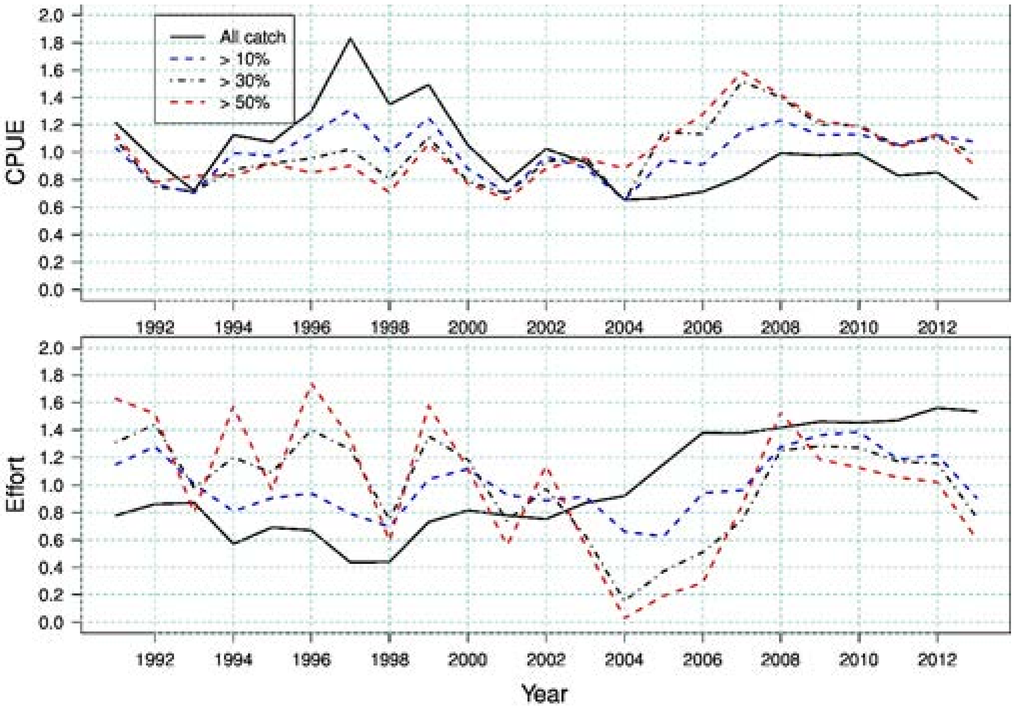


Figure 6.2.9. Nominal cpue and effort from the Icelandic longline fishery for catches where tusk composed different percentages of the total catch in each set.

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.

In 2011 the 'Faroe Ridge' survey area was included into the estimation of survey indices. This topic was mentioned at the WKDEEP 2010 meeting but not acted upon (see: WD 01 to the 2010 ICES WKDEEP). One of the problems 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 nine of the stations were included again in the survey and all of the 24 stations in 2005. Inclusion of the Iceland-Faroe Ridge has some impact on the total survey index for the years when this area was surveyed.

In addition, the autumn survey was commenced in 1996 and expanded in 2000 however a full autumn survey was not conducted in 2011 and therefore the results for

2011 are not presented. A detailed description of the Icelandic spring and autumn ground-fish surveys is given in the Stock Annex. Figure 6.2.10 shows both a recruitment index and the trends in various biomass indices. Survey length distributions are shown in Figure 6.2.11 (abundance) and changes in spatial distribution in Figures 6.2.12 and 6.2.13.

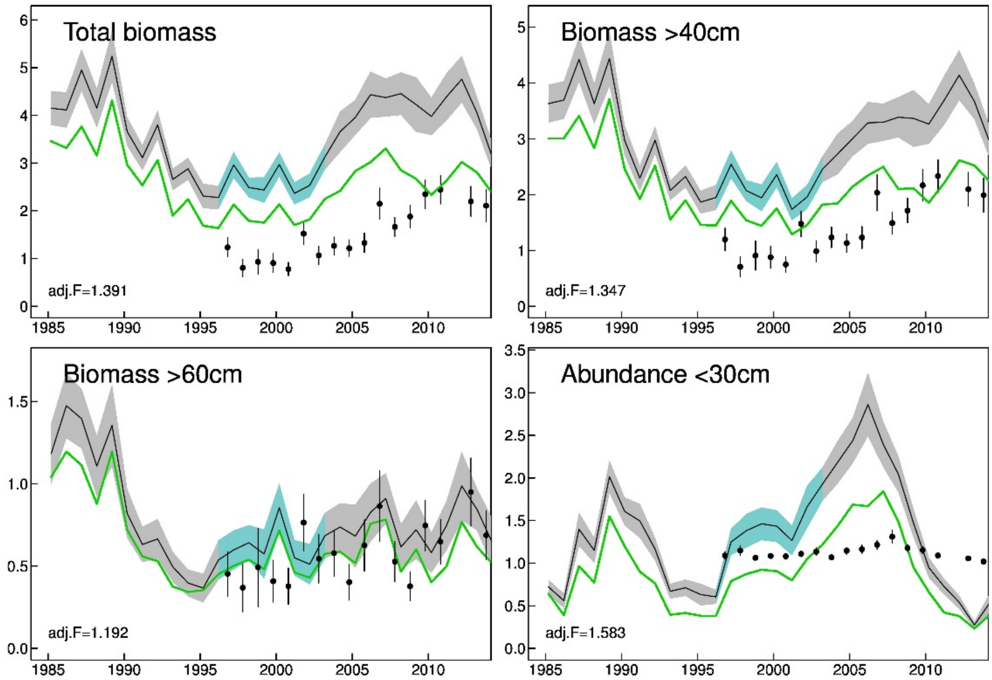


Figure 6.2.10. Tusk in Va and XIV. Indices in the Spring Survey (March) 1985 and onwards (line shaded area) and the autumn survey (October) 1996 and onwards (No autumn survey in 2011). Green line is the index excluding the Faroe-Iceland Ridge.

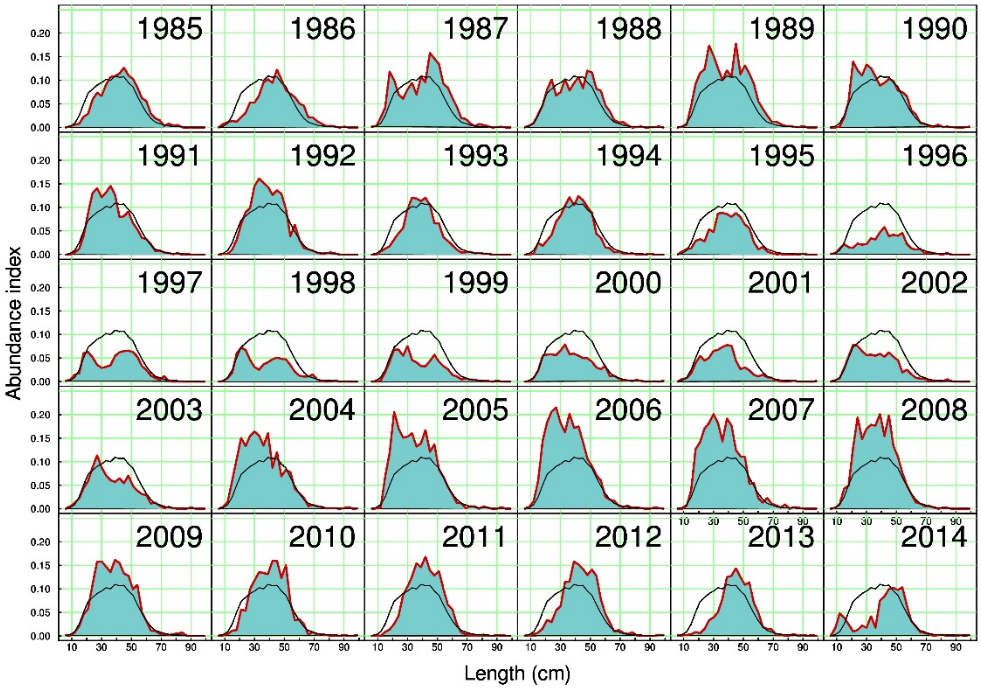


Figure 6.2.11. Tusk in Va and XIV. Length disaggregated abundance indices from the spring survey (March) 1985 and onwards. Black line is the average over the whole period.

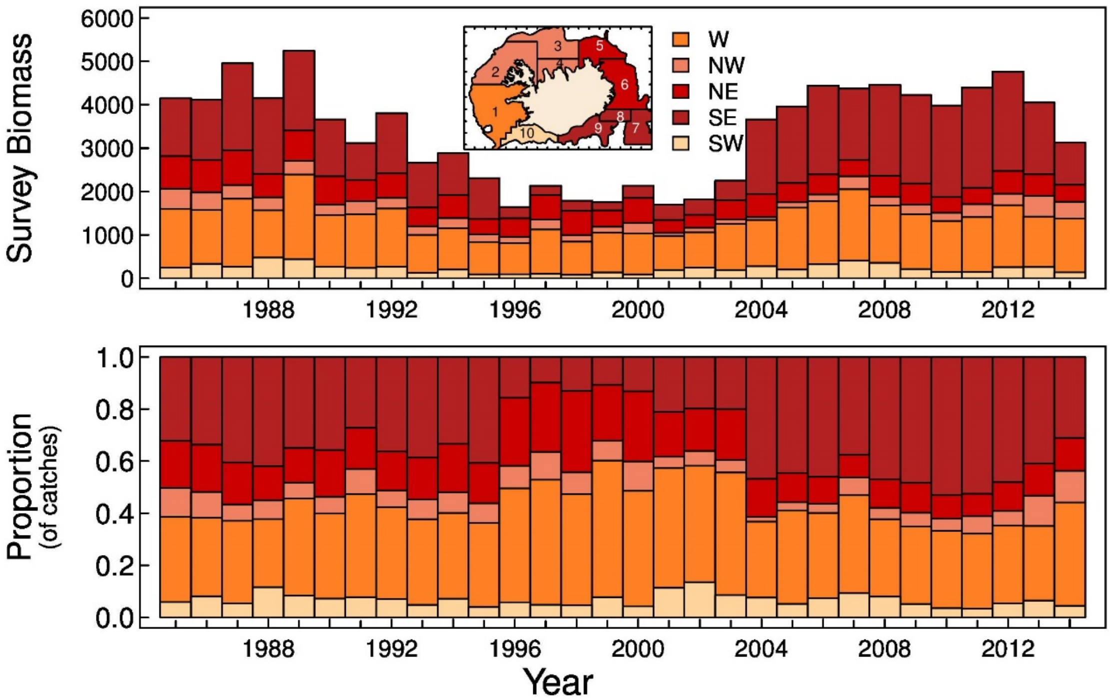


Figure 6.2.12. Tusk in Va and XIV. Estimated survey biomass in the spring survey (March) by year from different parts of the continental shelf (upper panel) and as a proportion of the total (lower panel).

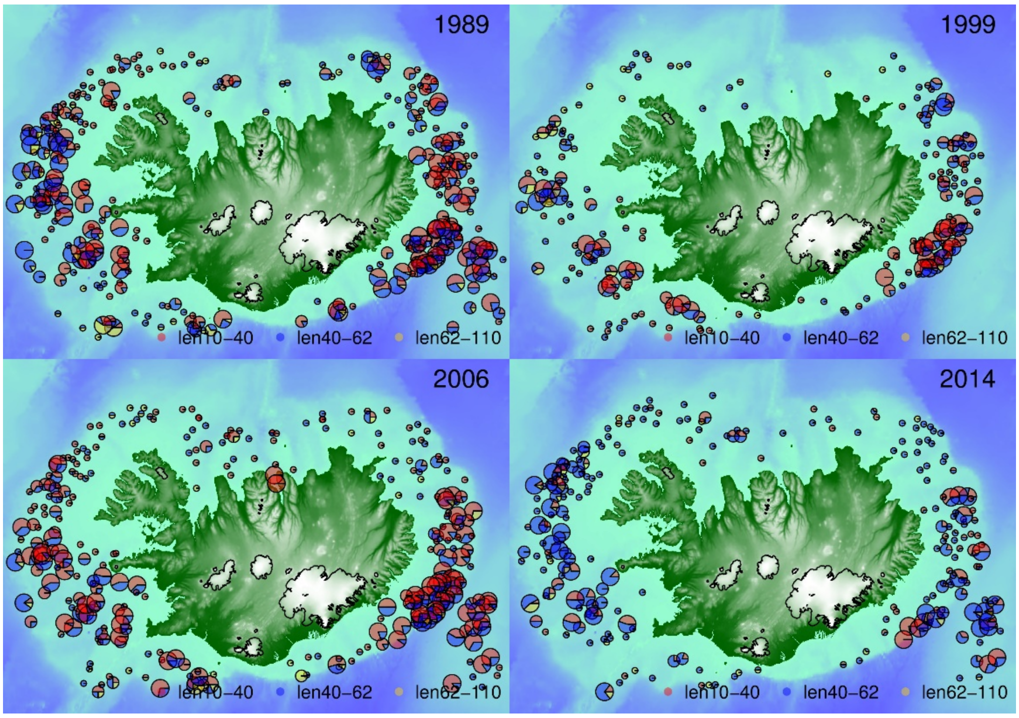


Figure 6.2.13. Tusk in Va and XIV. Changes in spatial distribution divided by size. Size of pie is indicative of numbers of specimens caught at the tow-station.

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, 1999).

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

6.2.3 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.

There have been no marked changes in the number of boats nor the composition of the fleet participating in the tusk fishery in Va (Table 6.2.1). Catches decreased from around 9000 tonnes in 2010 to 6300 tonnes in 2013. This decrease is mainly because of reductions in landings by the Icelandic longline fleet and to a lesser extend Faroese and Norwegian landings (Table 6.2.7). This has resulted in less overshoot of landings relative to set TAC (Tables 6.2.2 and 6.2.3) and species conversions in the ITQ system in the last two fishing years are different than in previous years in that tusk was converted to other species compared to other species being converted to tusk in previous fishing years.

There are no marked changes in the length compositions since 2004, mean length in the catches ranges between 52.7 and 54.1 (Figure 6.2.5). According to the available length distributions and information on maturity only around 29% of catches in abundance and 44% in biomass are mature (Figures 6.2.5 and 6.2.6). There does seem to be a shift in the age distribution from commercial catches between 2010 and 2011 where ages are higher. However the age distributions from 2012 and 2013 appear similar as observed in 2010 (Figure 6.2.6). The reason for this is unknown, but given they lack of distinctive cohort structure in the data the first explanation might be a lack of consistency in ageing. Reasons such as difference in sampling, temporal or spatial are highly unlikely.

Cpue is not considered a reliable stock indicator but may nevertheless be indicative of changes in fleet dynamics. Cpue and effort have remained more or less stable since 2008 (Figure 6.2.9).

At WGDEEP 2011 the Faroe-Iceland ridge was included in the survey index when presenting the results from the Icelandic spring survey for tusk in Va. That index is also used for tuning the Gadget model. Total biomass index and the biomass index for tusk larger than 40 cm (harvestable part of the stock) have decreased since a high in 2011 (Figure 6.2.10). The same holds for the index of tusk larger than 60 cm (spawning–stock biomass index) but that index didn't increase by similar factors as the other two biomass indices. The index of juvenile abundance (<30 cm) has decreased by a factor of 6 since 2005 when it peaked, the juvenile index increased slightly between the 2013 and 2014 survey. The index excluding the Faroe-Iceland Ridge shows similar trends as described above. The result from the shorter autumn survey are by and large similar to those observed from the spring survey except for the juvenile abundance index that is more or less at a constant level compared to the spring survey juvenile index. Due to industrial action the autumn survey did not take place in 2011.

When looking at the spatial distribution from the spring survey around half of the index is from the SE area (Figure 6.2.12). However only around 20 to 25% of the catches are caught in this area (Figures 6.2.2 and 6.2.3). The change in juvenile abundance between 2006 and 2014 can be clearly seen in Figure 6.2.13 where in 2006 juveniles (<40 cm) were all over the southern part of the shelf but can hardly be seen in 2014.

Stock assessment on Tusk in Va using Gadget

Since 2010 the Gadget model (**G**lobally applicable **A**rea **D**isaggregated **G**eneral **E**cosystem **T**oolbox, see www.hafro.is/gadget) has been used for the assessment of tusk in Va (See stock annex for details). In 2012 the EG decided to lower the value of natural mortality used in the assessment from 0.2 to 0.15 (See discussion in WGDEEP-2012 report) and this was subsequently adopted by the RG, ADG and ACOM.

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.

Diagnostics

Weights of likelihood components

Weights were assigned to likelihood components using the re-iterative procedure outlined in the Stock Annex. As in previous assessments the survey indices (si2039, si4069, si70110) were grouped together and similarly the length and age distributions from the survey (ldist.survey, alkeys.suvey) and from commercial catches (ldist.comm, alkeys.comm). The weights were similar to those assigned in 2012 except for si2039 component which is the juvenile index in the Gadget model. The overall likelihood score was 7223 of which the survey index components accounted for 3,72%, the age and length data from the survey for around 32,13% and the data from commercial catches for 64.15% (Table 6.2.6). It can therefore be stated that the model follows the survey data considerably better than the commercial catch data.

Table 6.2.6. Tusk in Va and XIV. Weights of likelihood components in the 2013 assessment and their individual likelihood score. For comparisons the weights of the 2012 assessments are also presented.

COMPONENT	*WEIGHT*	WEIGHT	LIKELIHOOD	% OF LIK.
	2013	**2014**	**score**	**score**
bounds	10.00	10.00	0	0
understocking	1.00	1.00	0	0
si2039	48.11	37.24	90.91	1.26
si4069	21.29	21.88	114.09	1.58
si70110	3.18	3.34	63.58	0.88
ldist.catch	0.11	0.11	2599.78	35,99
ldist.survey	0.06	0.06	1067.19	14,78
alkeys.catch	0.34	0.24	2034.56	38,17
alkeys.survey	0.22	0.22	1252,81	17,35
Sum			7222.90	

Observed and predicted proportions by fleets: Overall the fit of the predicted proportional length distributions is close to the observed distributions (Figures 6.2.14 and 6.2.15). In general for the commercial catch distributions the fit is better at the end of the time-series (Figure 6.2.14). 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.

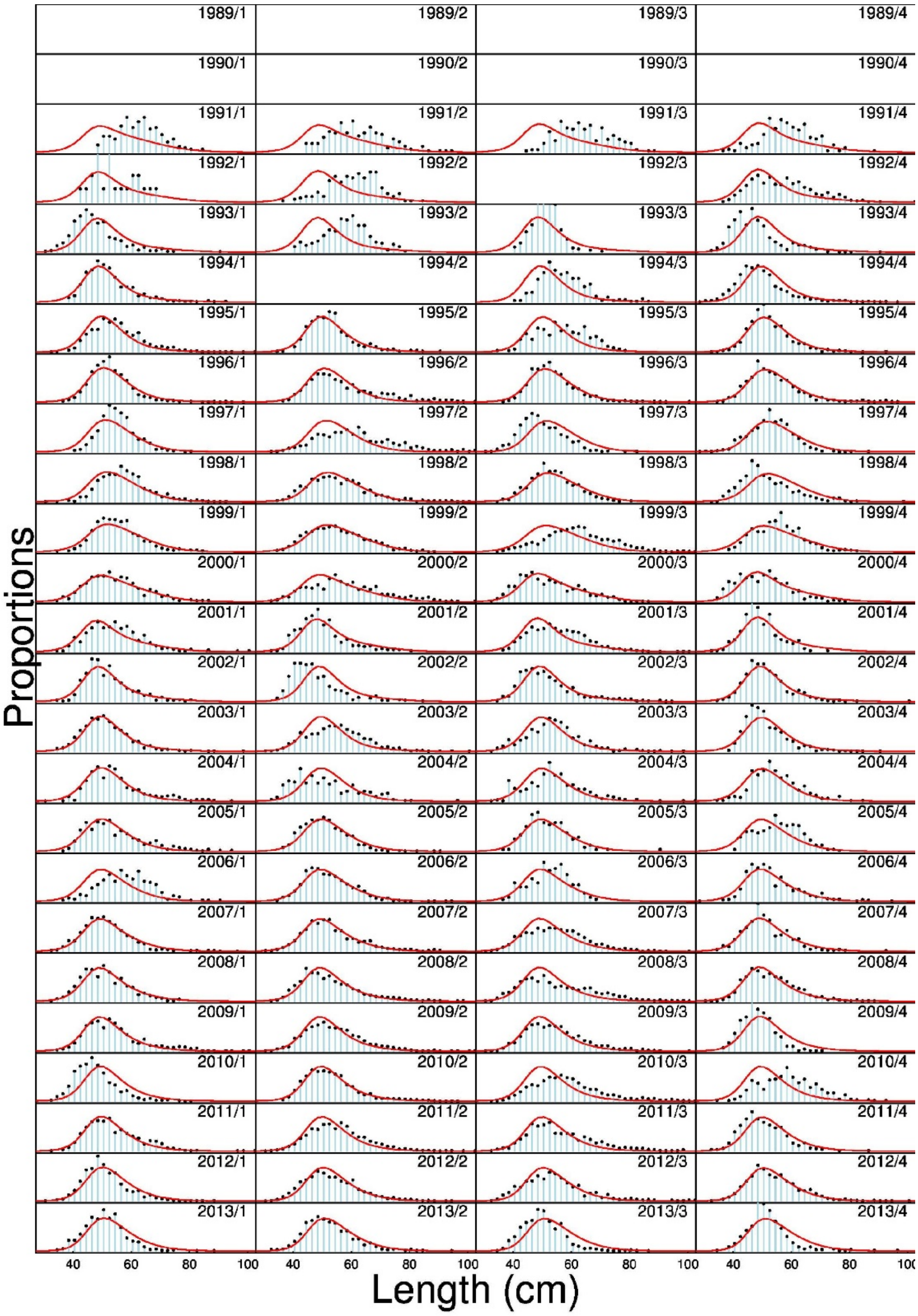


Figure 6.2.14. Tusk in Va and XIV. Proportional fit (red line) to observed length distributions (points and blue bars) from commercial catches (longlines) by year and quarter from Gadget.

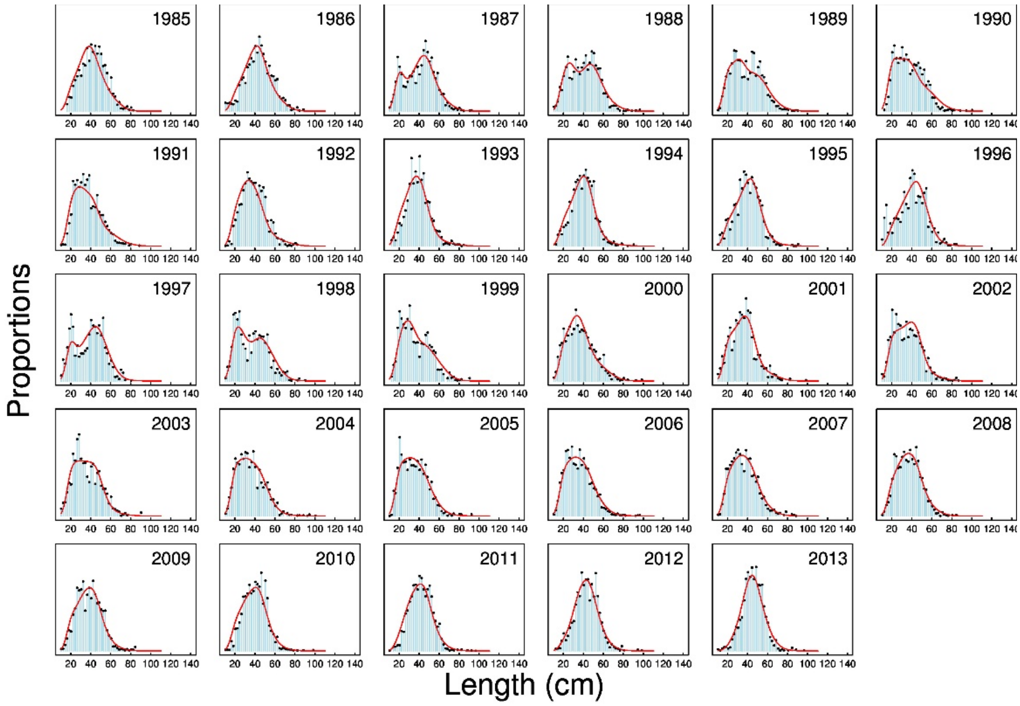


Figure 6.2.15. Tusk in Va and XIV Fit (red line) to observed length distributions (points and blue bars) from the Icelandic spring survey by year from Gadget.

Model fit: In Figure 6.2.16 the length disaggregated indices are plotted against the predicted numbers in the stock as a time-series. The correlation between observed and predicted is good for the first five length groups (20–29, 30–39, 40–49, 50–59 and 60–69) which the first three to four are the main length groups of tusk caught in the spring survey. In the two larger length groups the fit gets progressively worse. Overall fit, when the disaggregated abundance indices and predictions are converted to biomass and summed over the length intervals is good, and the model is predicting similar biomass as the survey indicates in the terminal year (Figure 6.2.16).

Retrospective analysis: Compared to last year's assessment there is a downward revision of SSB. Similarly fishing mortality was estimated at lower level in 2012 than now**.** Overall the perception of the stock does change considerably from last year (Figure 6.2.17). It should be noted that at the time of WGDEEP 2013 the results of the 2013 spring survey were not available. Results of an analytical retrospective analysis (omitting last year's data) give similar results though the bias is not as strong (Figure 6.2.18).

Retrospective analysis may be misleading for this model as data are being added each year into the time-series (ageing going back in time), not only at the end of the time-series. Therefore estimates may change considerably much farther back in time than in traditional age-based models. Additionally the steep drop in the tuning series (the spring survey) that the model is following results in lower biomass estimates and higher estimates of fishing mortality. This can be seen in the analytical retrospective fit to the survey indices in Figure 6.2.19. There is little retrospective bias in the smaller length groups but the peak in the indices in 2005 to 2011 is being down-graded, i.e. the model underestimates in that period with each additional year. For the larger length groups the model overestimated the indices (abundance) in the peak period in the first runs but in the later runs it is either in line with the indices or under them.

This is a very traditional problem when there is a large interannual change in tuning series.

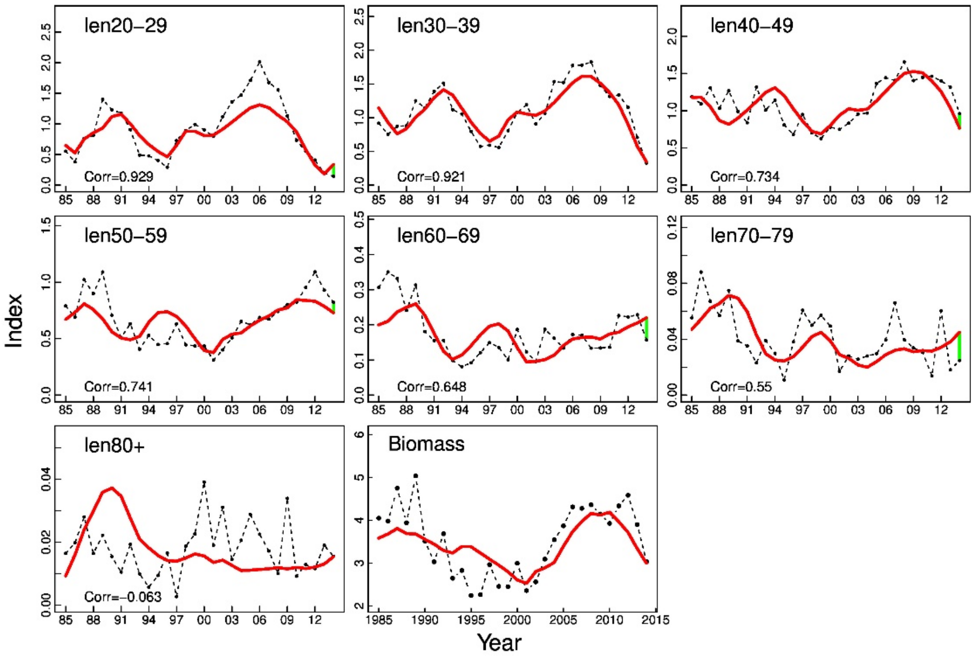


Figure 6.2.16. Tusk in Va and XIV. Gadget fit to indices from disaggregated abundance by length indices from the spring survey and to summed-up biomass.

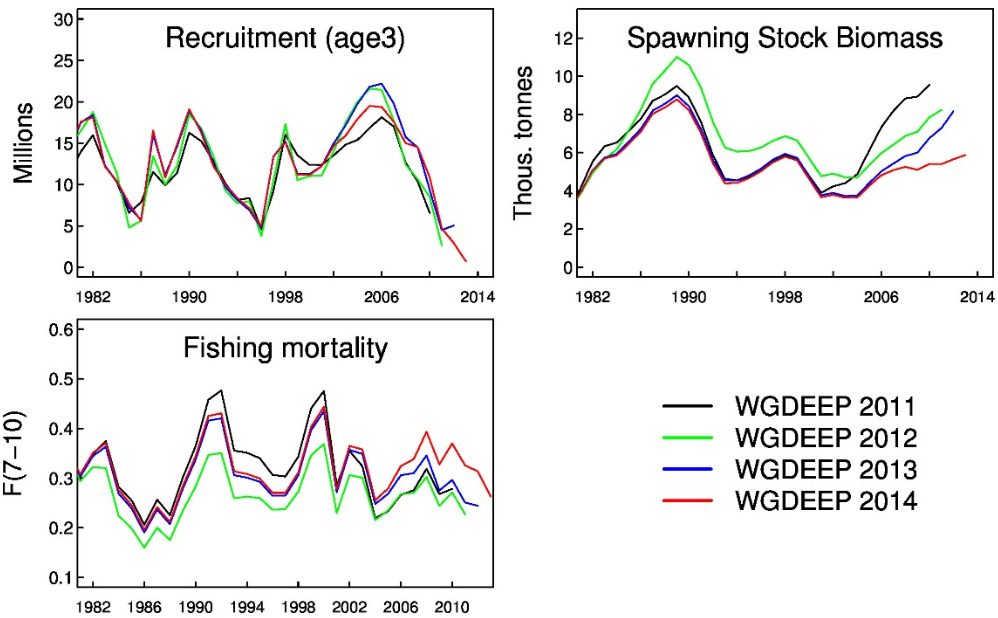


Figure 6.2.17. Tusk in Va and XIV. Historical retrospective analysis of the Gadget runs presented at WGDEEP 2011 to 2014.

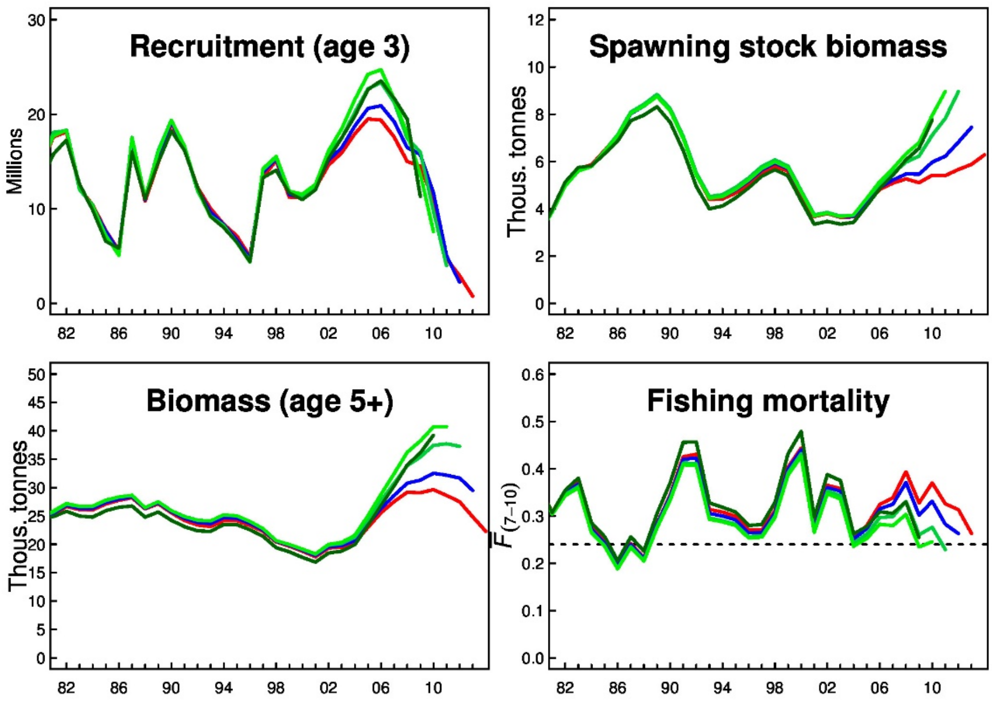


Figure 6.2.18. Tusk in Va and XIV. Analytical retrospective analysis of the Gadget runs presented.

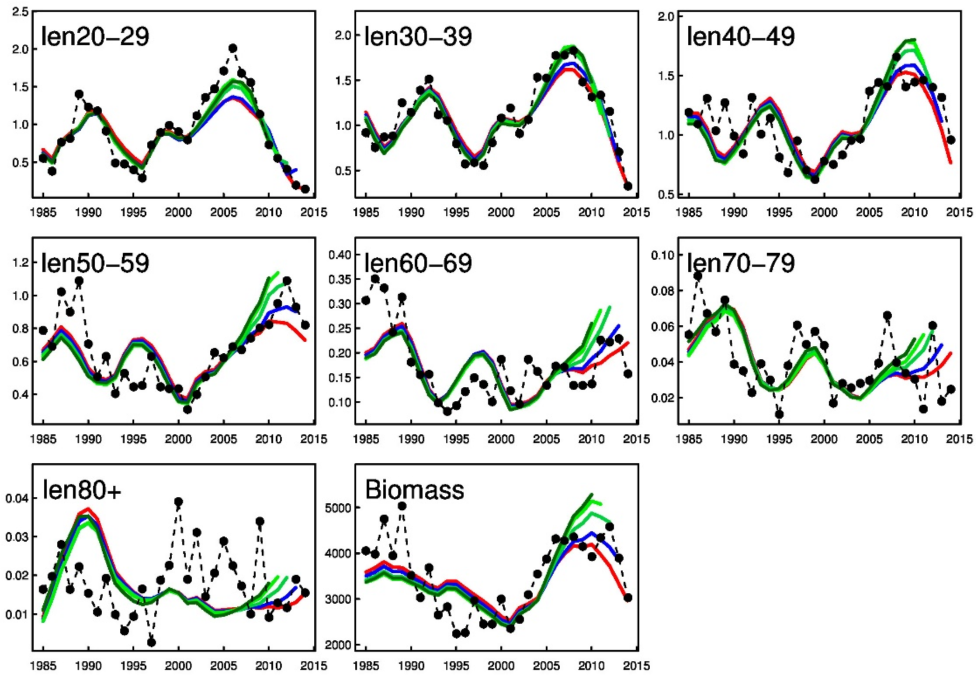


Figure 6.2.19. Tusk in Va and XIV. Analytical retrospective fit to the survey indices used for tuning the Gadget model.

Results

The results are presented in Table 6.2.9 and Figure 6.2.20. Recruitment peaked in 2005 to 2006 but has decreased and is estimated in 2013 to have been the lowest observed. Spawning–stock biomass has increased slowly since 2005. Harvestable biomass is estimated at a fairly high level compared to the rest of the time-series. Fishing mortality for the main age groups in the fishery (F_{7-10}) has decreased from 0.39 in 2008 to 0.26 in 2013. Fishing mortality for fully selected tusk (F_{13-16}) shows the same trend at a higher level. Estimates of total biomass show a decrease since 2008. Estimates of selection curves are similar to those estimated last year (Figure 6.2.21).

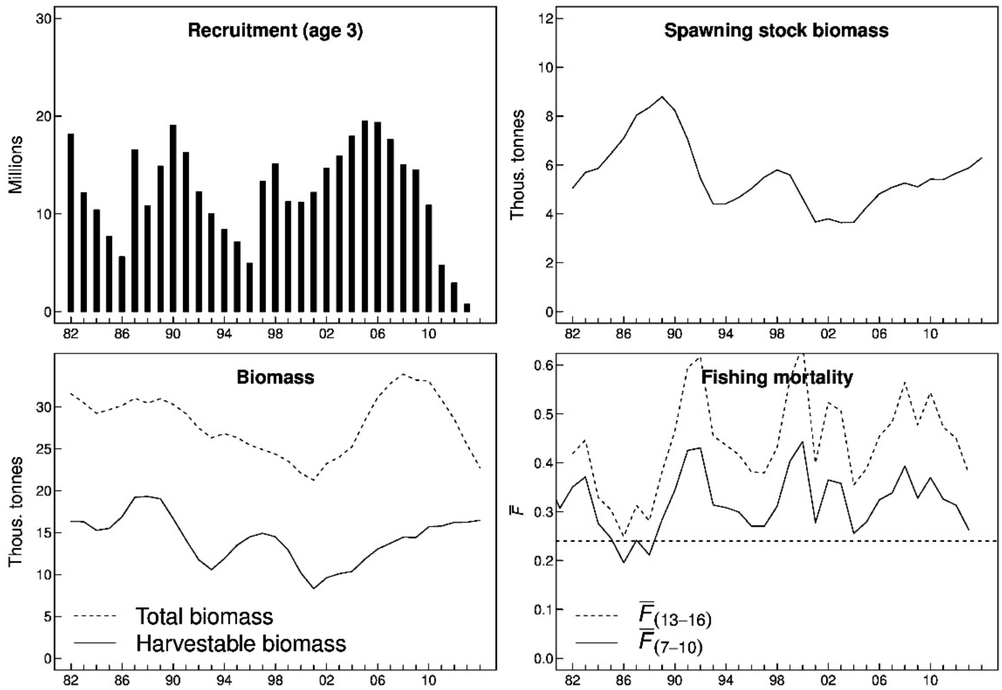


Figure 6.2.20. Tusk in Va and XIV. Estimates of recruitment, biomass, harvestable biomass and fishing mortality for tusk as fully recruited into the fishery i.e. selection is 1 on a logistic selection curve (broken line) and for the age groups most important in the fishery i.e. ages 7 to 10 (solid line).

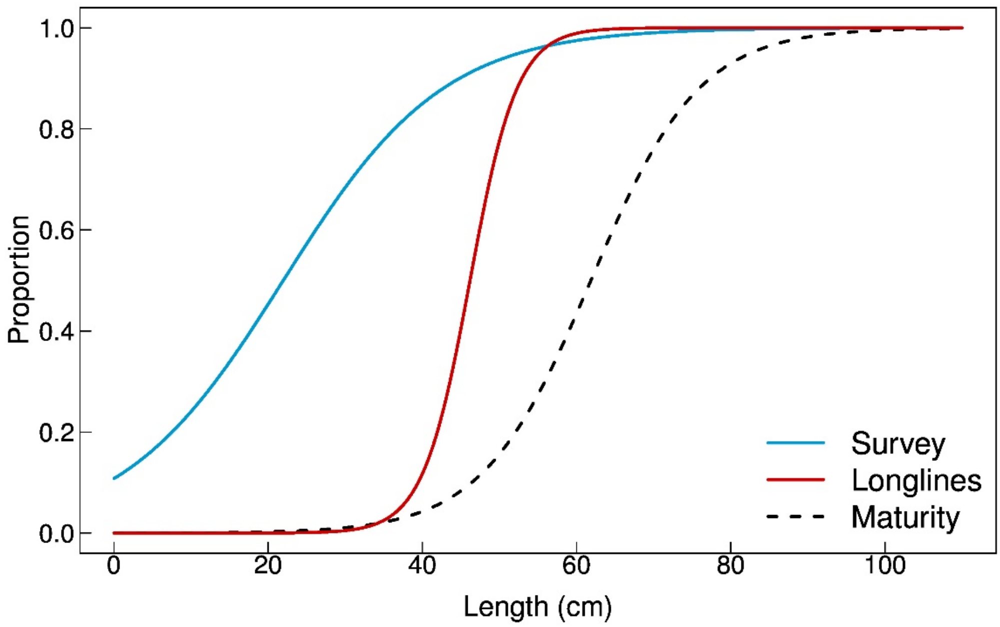


Figure 6.2.21. Tusk in Va and XIV. Estimated selection curves from Gadget and for comparison the maturity ogive (black broken line) used for estimation of SSB.

Reference points

In the past Yield per recruit based reference points estimated as described in the stock annex have been used as proxies for F_{MSY}. F_{MAX} from a Y/R analysis is 0.24 and $F_{0.1}$ is 0.15 (Figure 6.2.22). As F_{MAX} is well defined and that there are no obvious limitations in the model in terms of fit to the data WGDEEP proposed in 2012 that F_{MAX} be adopted as proxy for F_{MSY}, ACOM subsequently used F_{MAX} as an proxy MSY reference point for the advice in 2012. Running the analysis for F for the fully recruited age groups in the fishery (age 13 to 16) results in slightly higher estimates of F_{MAX}=0.3 as is to be expected (Figure 6.2.22). According to bootstrap results presented in WGDEEP 2013 the estimated CV for F_{MAX} is 3% indicating that the 95% confidence interval of F_{MAX} are between 0.226 and 0.255.

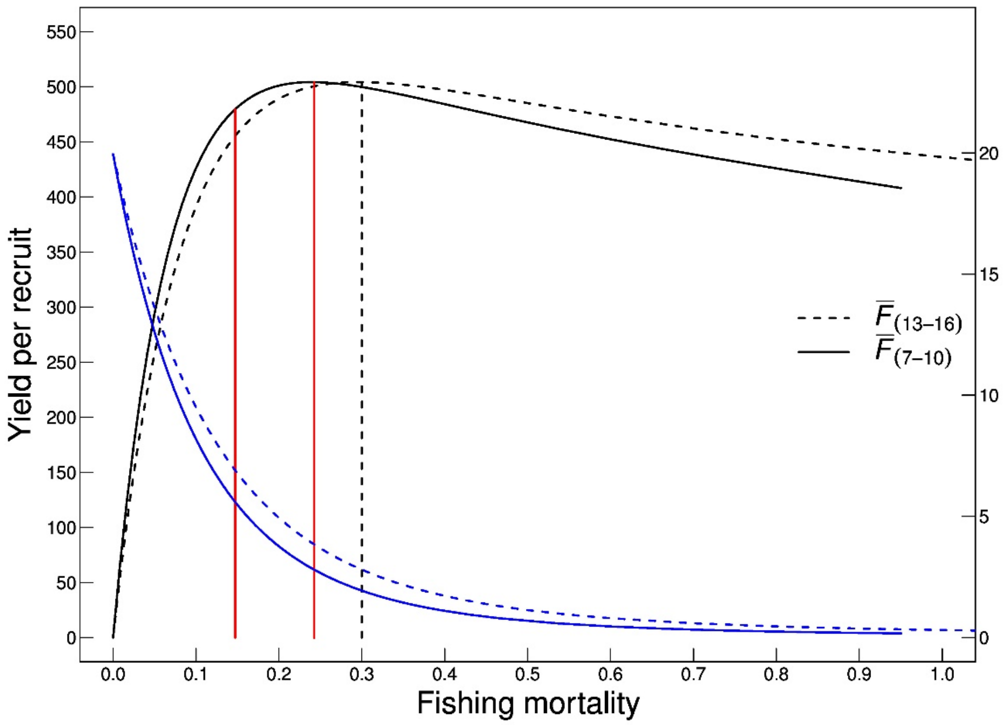


Figure 6.2.22. Tusk in Va and XIV. Estimates of yield per recruit and S/R analysis using Gadget. The results are presented for the main age groups in the fishery (7 to 10) and for historical comparison for ages 13–16 or fully recruited to the fishery.

Stochastic simulations using the auto-correlation in recruitment (AR-1 model) were run until the year 2115 under fishing mortality ranging from 0 to 0.6. From these simulations an estimate of F_{MSY} of 0.20 is obtained. The equilibrium catch curve is rather flat at F_{MSY} indicating that the value is uncertain however using the F_{MSY} estimate would result in considerably larger biomass of the stock compared to fishing at F_{MAX} (Figure 6.2.23). WGDEEP 2014 recommends using F_{MSY}=0.2 as the target fishing mortality rather than F_{MAX}.

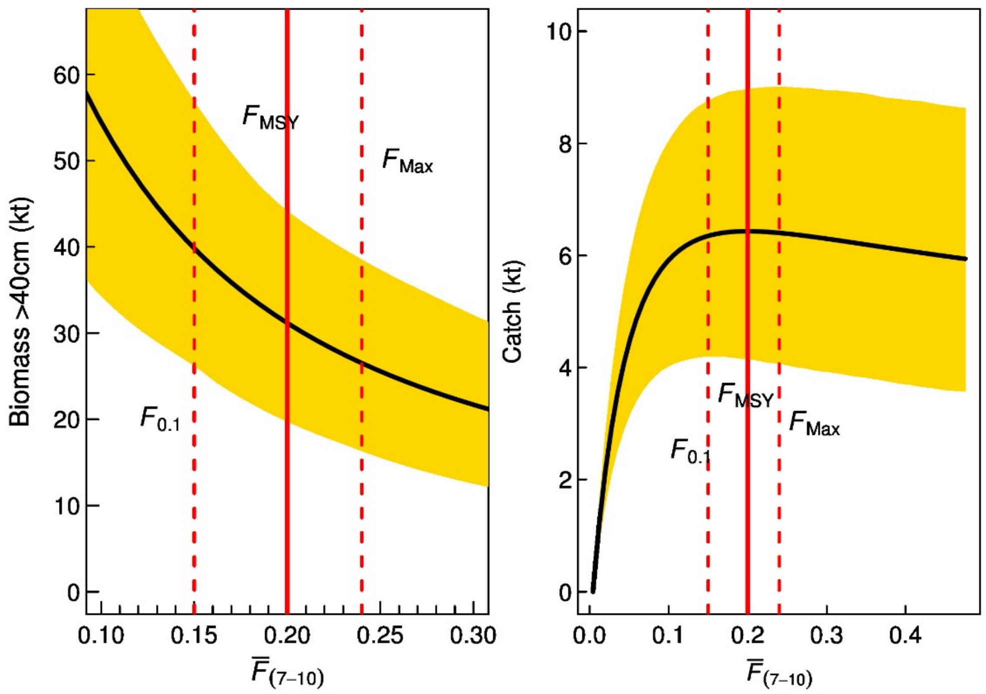


Figure 6.2.23. Tusk in Va and XIV. Equilibrium stock biomass and catch from stochastic simulations.

Projections

Forward projections were conducted using Gadget. The main assumptions were:

- Recruitment (age3) set as equal to mean recruitment in 2011 to 2013. Does not affect the projected catch level in 2014 to 2015.
- Catches in quarter 1 in 2014 are known and catches in quarters 2 and 3 are set as the reminder of the TAC for the 2013/14 fishing year.

The projections were run to 2018 for F_{MSY} = 0.2 (Table 6.2.9). According to the projections SSB will peak in 2017, however total biomass has already started to decrease and harvestable biomass peaks in 2015. Catch levels decrease after 2014 from 3.94 kt to 2.8 kt in 2018. For comparison, projections were also run, using the same assumptions for F_{MAX} and $F_{0.1}$ (Table 6.2.10).

6.2.4 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.

This assessment was conducted in the same way as last year. The relatively large change in estimates of mortality and biomass of tusk in Va in this year's assessment compared to the one used for advice in 2012 is because of large reduction in biomass estimates in the tuning series and also inclusion of more age-structured data in the time-series (not only in the terminal year)..

6.2.5 Management considerations

All the signs from commercial catch data and surveys indicate that the biomass of tusk in Va and XIV is decreasing. This is confirmed in the Gadget assessment and can be attributed to the continous decrease in recruitment for in the last 3–4 years.

Due to the selectivity of the longline fleet catching tusk in Va a large proportion of the catches is immature (60% in biomass, 70% in abundance). The spatial distribution of the fishery in relation to the spatial distribution of tusk in Va as observed in the Icelandic spring survey may result in decreased catch rates and local depletions of tusk in the main fishing areas.

The basis for the advice this year should be changed from the one used in 2012, i.e. from F_{MAX}=0.24 to the estimate of F_{MSY}=0.20 obtained from stochastic simulations.

Tusk is a slow growing late maturing species, therefore closures of known spawning areas should be maintained and expanded if needed. Similarly closed areas to longline fishing where there is high juvenile abundance should be maintained and expanded if needed.

6.2.6 Response to technical minutes

The comments were mainly complementary and the RG agreed with the changes made to the assessment method by the EG, the largest being the inclusion of the Faroe-Iceland Ridge and the change in natural mortality from 0.2 to 0.15. The technical comments are mainly on typos and are well received. The comment on the units for survey biomass is a frequent question but it has to be pointed out that it is an index and as such should not have any units as the q from the survey is unknown (but estimated in Gadget, where it varies depending on length groups).

Table 6.2.7. Tusk in Va and XIV. Nominal landings by nations in Va.

Year	Faroe	Denmark	Germany	Iceland	Norway	UK	Total
1973	3363	0	576	2366	911	391	7607
1974	3172	0	375	1857	893	230	6527
1975	2445	0	384	1673	975	254	5731
1976	2397	0	334	2935	1352	94	7112
1977	2818	0	212	3122	1796	0	7948
1978	2168	0	0	3352	812	0	6332
1979	2050	0	0	3558	845	0	6453
1980	2873	0	0	3089	928	0	6890
1981	2624	0	0	2827	1025	0	6476
1982	2410	0	0	2804	666	0	5880
1983	4046	0	0	3469	772	0	8287
1984	2008	0	0	3430	254	0	5692
1985	1885	0	0	3068	111	0	5064
1986	2811	0	0	2549	21	0	5381
1987	2638	0	0	2984	19	0	5641
1988	3757	0	0	3078	20	0	6855
1989	3908	0	0	3131	10	0	7049
1990	2475	0	0	4813	0	0	7288
1991	2286	0	0	6439	0	0	8725
1992	1567	0	0	6437	0	0	8004
1993	1329	0	0	4746	0	0	6075
1994	1212	0	0	4612	0	0	5824
1995	979	0	1	5245	0	0	6225
1996	872	0	1	5226	3	0	6102
1997	575	0	0	4819	0	0	5394
1998	1052	0	1	4118	0	0	5171
1999	1035	0	2	5794	391	2	7224
2000	1154	0	0	4714	374	2	6244
2001	1125	0	1	3392	285	5	4808
2002	1269	0	0	3840	372	2	5483
2003	1163	0	1	4028	373	2	5567
2004	1478	0	1	3126	214	2	4821
2005	1157	0	3	3539	303	41	5043
2006	1239	0	2	5054	299	2	6596
2007	1250	0	0	5984	300	1	7535
2008	959	0	0	6932	284	0	8175
2009	997	0	0	6955	300	0	8252
2010	1794	0	0	6919	263	0	8976
2011	1347	0	0	5845	198	0	7390
2012	1203	0	0	6341	217	0	7761
2013	1092	0.12	0	4973	192	0	6257

Table 6.2.8. Tusk in Va and XIV. Nominal landings by nations in XIV.

YEAR	FAROE	DENMARK	GREENLAND	GERMANY	ICELAND	NORWAY	RUSSIA	SPAIN	UK	TOTAL
1973	16	0	0	9	0	0	0	0	2	27
1974	259	0	0	2	15	0	0	0	1	277
1975	29	0	0	17	13	138	0	0	0	197
1976	0	0	0	5	89	47	0	0	1	142
1977	167	0	0	16	0	40	0	0	1	224
1978	0	0	0	47	0	38	0	0	0	85
1979	0	0	0	27	0	0	0	0	0	27
1980	0	0	0	13	0	0	0	0	0	13
1981	110	0	0	10	0	0	0	0	0	120
1982	0	0	0	10	0	0	0	0	0	10
1983	74	0	0	11	0	0	0	0	0	85
1984	0	0	0	5	0	58	0	0	0	63
1985	0	0	0	4	0	0	0	0	0	4
1986	33	0	0	2	0	0	0	0	0	35
1987	13	0	0	2	0	0	0	0	0	15
1988	19	0	0	2	0	0	0	0	0	21
1989	13	0	0	1	0	0	0	0	0	14
1990	0	0	0	2	0	7	0	0	0	9
1991	0	0	0	2	0	68	0	0	1	71
1992	0	0	0	0	3	120	0	0	0	123
1993	0	0	0	0	1	39	0	0	0	40
1994	0	0	0	0	0	16	0	0	0	16
1995	0	0	0	0	0	30	0	0	0	30
1996	0	0	0	0	0	157	0	0	0	157
1997	0	0	0	0	10	9	0	0	0	19
1998	0	0	0	0	0	12	0	0	0	12
1999	0	0	0	0	0	8	0	0	0	8
2000	0	0	0	0	11	11	0	3	0	25
2001	3	0	0	0	20	69	0	0	0	92
2002	4	0	0	0	86	30	0	0	0	120
2003	0	0	0	0	2	88	0	0	0	90
2004	0	0	0	0	0	40	0	0	0	40
2005	7	0	0	0	0	41	8	0	0	56
2006	3	0	0	0	0	19	51	0	0	73
2007	0	0	0	0	0	40	6	0	0	46
2008	0	0	33	0	0	7	0	0	0	40
2009	12	0	15	0	0	5	11	0	0	43
2010	7	0	0	0	0	5	0	0	0	12
2011	20	0	0	0	131	24	0	0	0	175
2012	33	0	0	0	174	46	0	0	0	253
2013	1.9	0.3	0	0	0	23.8	0	0	0	26

Table 6.2.9. Tusk in Va and XIV. Estimates of biomass, harvestable biomass, spawning–stock biomass (SSB) in thousands of tonnes and recruitment (millions) and fishing mortality from Gadget. Projections for 2014 to 2018 are shown in italics.

Year	Biomass	Harvestable biomass	SSB	Recruitment (age 3)	Catch	F(7–10)
1980	32.426	13.207	2.884	14.341	6.890	0.37
1981	31.595	15.439	3.912	17.591	6.476	0.31
1982	31.574	16.321	5.055	18.135	5.880	0.35
1983	30.503	16.304	5.695	12.157	8.287	0.37
1984	29.243	15.274	5.860	10.401	5.692	0.28
1985	29.669	15.505	6.465	7.688	5.065	0.25
1986	30.164	16.900	7.100	5.585	5.381	0.20
1987	31.041	19.212	8.036	16.533	5.645	0.24
1988	30.461	19.318	8.360	10.829	6.865	0.21
1989	30.988	19.037	8.794	14.864	7.077	0.28
1990	30.301	16.685	8.225	19.070	7.292	0.34
1991	29.199	14.146	7.048	16.275	8.733	0.43
1992	27.485	11.760	5.458	12.255	8.010	0.43
1993	26.312	10.572	4.398	10.013	6.059	0.31
1994	26.817	11.900	4.416	8.369	5.828	0.31
1995	26.353	13.499	4.670	7.115	6.231	0.30
1996	25.455	14.496	5.035	4.952	6.241	0.27
1997	24.911	14.926	5.501	13.352	5.759	0.27
1998	24.373	14.498	5.798	15.099	5.146	0.31
1999	23.533	12.912	5.593	11.225	7.290	0.40
2000	22.087	10.166	4.632	11.142	6.240	0.44
2001	21.269	8.308	3.670	12.196	4.526	0.28
2002	23.238	9.607	3.797	14.631	5.249	0.36
2003	24.030	10.101	3.639	15.907	5.315	0.36
2004	25.257	10.364	3.655	17.924	4.655	0.26
2005	28.383	11.826	4.272	19.500	4.820	0.28
2006	31.115	13.036	4.817	19.366	6.602	0.32
2007	32.802	13.732	5.087	17.593	7.594	0.34
2008	33.917	14.442	5.261	14.996	8.175	0.39
2009	33.221	14.430	5.104	14.515	8.253	0.33
2010	33.099	15.696	5.420	10.855	8.986	0.37
2011	30.874	15.786	5.404	4.702	7.391	0.33
2012	28.541	16.225	5.660	2.924	7.762	0.31
2013	25.481	16.242	5.877	0.742	6.258	0.26
2014	22.773	16.470	6.288	2.788	6.522	0.29
2015	19.149	15.076	6.233	2.788	3.941	0.20
2016	17.361	14.344	6.700	2.789	3.677	0.20
2017	15.527	12.730	6.810	2.789	3.280	0.20
2018	13.761	10.933	6.567	2.789	2.869	NA

Table 6.2.10. Prognosis from the Gadget model fishing at $F_{0.1}$ and F_{MAX}.

$F_{0.1}$ = 0.15

year	ssb	catch	Fbar
2013	5.877	6.258	0.26
2014	6.288	6.292	0.26
2015	6.431	3.138	0.15
2016	7.347	3.088	0.15
2017	7.917	2.898	0.15

F_{MAX} = 0.24

year	ssb	catch	Fbar
2013	5.877	6.258	0.26
2014	6.288	6.714	0.30
2015	6.070	4.565	0.24
2016	6.198	4.074	0.24
2017	5.998	3.484	0.24

6.3 Tusk (*Brosme brosme*) on the Mid-Atlantic Ridge (Subdivisions XIIa1 and XIVb1)

6.3.1 The fishery

Tusk is a bycatch species in the gillnet and longline fisheries in Subdivisions XIIa1 and XIVb1. During the period 1996–1997 Norway also had a fishery in this area.

6.3.2 Landings trends

Landing statistics by nation in the period 1988–2013 are shown in Table 6.4.1.

The reported landings are generally very low in this area. Russia reported landings of tusk in 2005–2007 and 2009 and no landings were reported for 2010 and 2011. In 2012 Norway reported 17 tonnes in Area XIVb1 and the Faroe Islands, 1 tonn. No landings have been reported in 2013.

6.3.3 ICES Advice

Advice for 2013 and 2014: ICES advises on the basis of the approach for data-limited stocks that catches should not be increased unless there is evidence that this is sustainable. Measures should be taken to limit occasional high levels of bycatch.

6.3.4 Management

NEAFC (Rec 03 2014) recommends that in 2014 the effort in areas beyond national jurisdiction shall not exceed 65 per cent of the highest level for deep-water fishing in previous years.

6.3.5 Data available

6.3.5.1 Landings and discards

Landings were available for all the relevant fleets. No discard data were available.

6.3.5.2 Length compositions

No length compositions were available.

6.3.5.3 Age compositions

No age compositions were available.

6.3.5.4 Weight-at-age

No data were available.

6.3.5.5 Maturity and natural mortality

No data were available.

6.3.5.6 Catch, effort and research vessel data

No data were available.

6.3.6 Data analyses

There are insufficient data to assess this stock.

Biological reference points

WKLIFE has not yet suggested methods to estimate biological reference points for stocks which have only landings data or are bycatch species in other fisheries. Therefore, no attempt was made to propose reference points for this stock.

6.3.7 Comments on the assessment

No assessment was carried out this year.

6.3.8 Management considerations

As this is a bycatch species in fisheries for other species, advice should take account of advice for the targeted species in those fisheries. The life-history traits do not suggest it is particularly vulnerable.

Table 6.4.1. 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
2011						0	0
2012	1						1
2013*							0

***Preliminary.**

TUSK XIVb1

YEAR	FAROES	ICELAND	NORWAY	E & W	RUSSIA	TOTAL
2012			17			**17**
2013*						**0**

Table 6.4.1. (Continued).Tusk, total landings by subareas or division.

YEAR	XII	XIVB1	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
2011			
2012	1	17	18
2013*			0

***Preliminary.**

6.4 Tusk (*Brosme brosme*) in VIb

6.4.1 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.

During the period 1988 to 2013 Norwegian vessels have report over 80 percent of the total landings, and in 2012 more than 90 percent of the landings were reported by Norwegian vessels. Small bycatches of tusk were also taken in the area by trawlers in the haddock fishery.

6.4.2 Landings trends

Landing statistics by nation in the period 1988–2013 are in Table 6.5.1.

Landings varied considerably between 1988–2000 and peaked at 2344 t in 2000, and since then have been low with a declining trend. In 2013 the catch was 57 tons an all-time low during this time period (Figure 6.5.1).

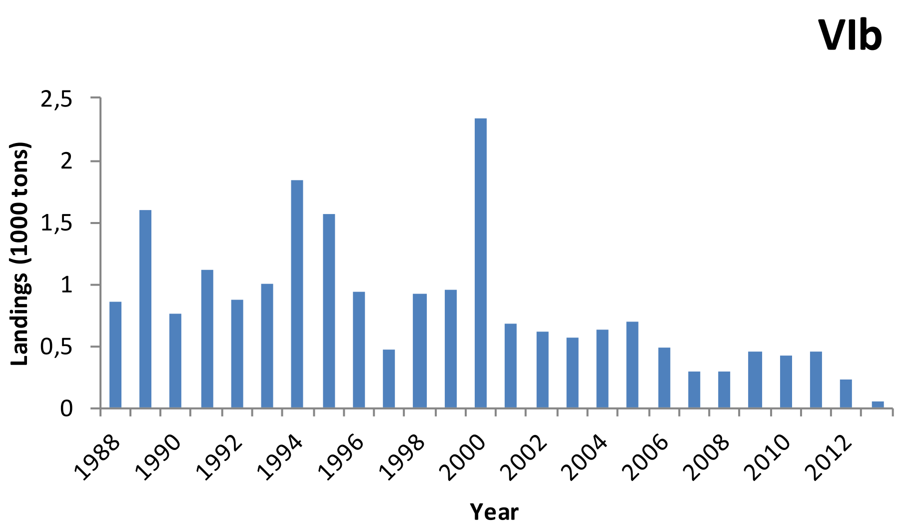


Figure 6.5.1.The international total landings of tusk from Subarea VIb.

6.4.3 ICES Advice

Advice for 2013 and 2014: Based on the ICES approach for data-limited stocks, ICES advises catches of no more than 350 t.

6.4.4 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 2014 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 2013 is set at 535 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.

6.4.5 Data available

6.4.5.1 Landings and discards

Landings were available for all relevant countries. No new discard data were available.

6.4.5.2 Length compositions

The length distribution of tusk based on data provided by the Norwegian reference fleet for the period 2003–2013 is presented in Figure 6.5.2. The average length during this period fluctuated without any obvious trend (no data were available for 2011).

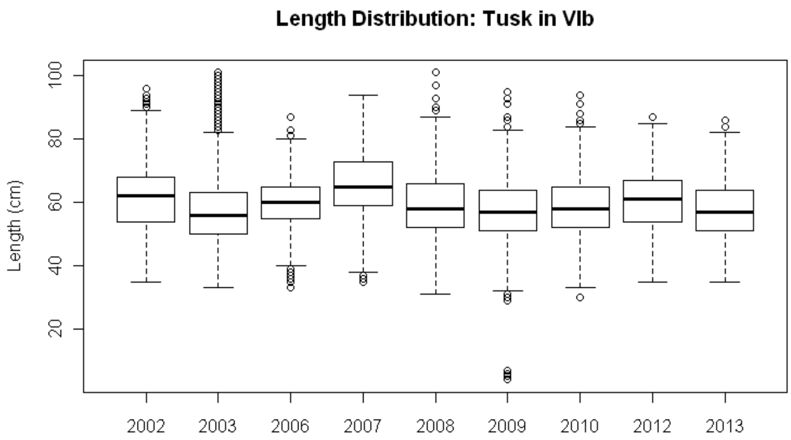


Figure 6.5.2. The length distribution of tusk based on data provided by the Norwegian reference fleet for the period 2003–2013 (no data were available for 2011).

6.4.5.3 Age compositions

No new age composition data were available.

6.4.5.4 Weight-at-age

No new data were presented.

6.4.5.5 Maturity and natural mortality

No new data were presented.

6.4.5.6 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 2000–2013. 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.

6.4.6 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, WD 2014). The number of longliners has declined from 72 to 33 during the period 2000–2013. 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 five and eight days per vessel, however in 2000 and 2013 this had declined to four (Helle and Pennington, WD 2014).

Table 6.5.2. Average number of days that each Norwegian longliner fished in an ICES subarea/division.

Tusk	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
VIb	4	6	8	5	5	8	7	6	5	2	4	4	4	3

The number of hooks set per day and the total set per year also remained stable during the period 2000–2008, however in 2009 and 2010 there was a large increase in Subarea VIb Figure 6.5. This increase in the number of hooks may be due to poor data quality as the vessels were changing from paper to electronic logbooks. From 2011, when the quality of the data was good, the number of hooks per day was at the same level as in the period (2000–2008) (Figure 6.5.3).

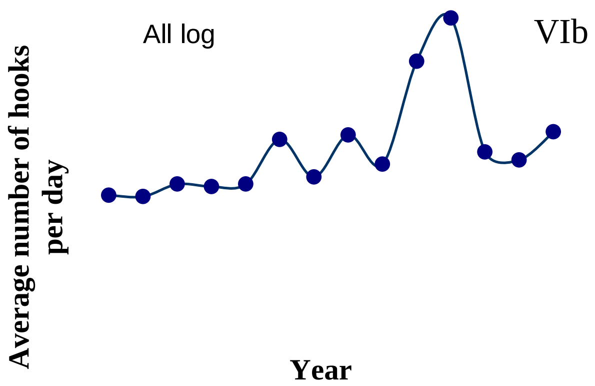


Figure 6.5.3. Average number of hooks the Norwegian longliner fleet used per day in each of the ICES Subarea VIb for the years 2000–2013 in the fishery for tusk, ling and blue ling.

The standardized cpue series shows a declining trend during the period 2000–2007, after 2007 cpue has been at a stable but low level (Figure 6.5.4).

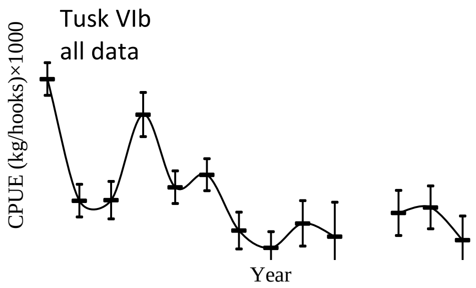


Figure 6.5.5. Estimated cpue (kg/1000 hooks) series for tusk in Subarea VIb based on skipper's logbooks (during the period 2000–2013. The bars denote the 95% confidence intervals.

Biological reference points

Estimates of L_{MAX} and AFC were identified and made available to WKLIFE.

6.4.7 Comments on the assessment

The new and standardizes cpue show the same trend as the unstandardized cpue and the cpue series based on a super-population model presented in 2012.

6.4.8 Management considerations

The landings have since 2001 been low with a decreasing trend until 2008. The last three years the landings have remained stable at around 500 tonnes. The cpue also show a decreasing trend until 2007 after this it has been at a stable low level. The main fishing grounds traditionally exploited by the Norwegian fleet in this subarea were closed to bottom contacting gears in 2007 and this may have influenced recent estimates of cpue.

Table 6.5.1. 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
2011	3					433			14		450
2012	15					209			9		233
2013		1				45			11		57

***Preliminary.**

Table 6.5.1. (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
2011	450	450
2012	233	233
2013	57	57

***Preliminary.**

Average number of hooks the Norwegian longliner fleet used per day in each of the ICES Subarea VIb for the years 2000–2012 in the fishery for tusk, ling and blue ling.

6.5 Tusk (*Brosme brosme*) in Subareas I and II

6.5.1 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. Figure 6.3.1 shows the spatial distribution of total effort and total catch for the Norwegian longline fishery in 2013.

Russian landings (68 t) from Subdivisions IIa and IIb in 2013 were mainly taken as bycatch in longline fisheries.

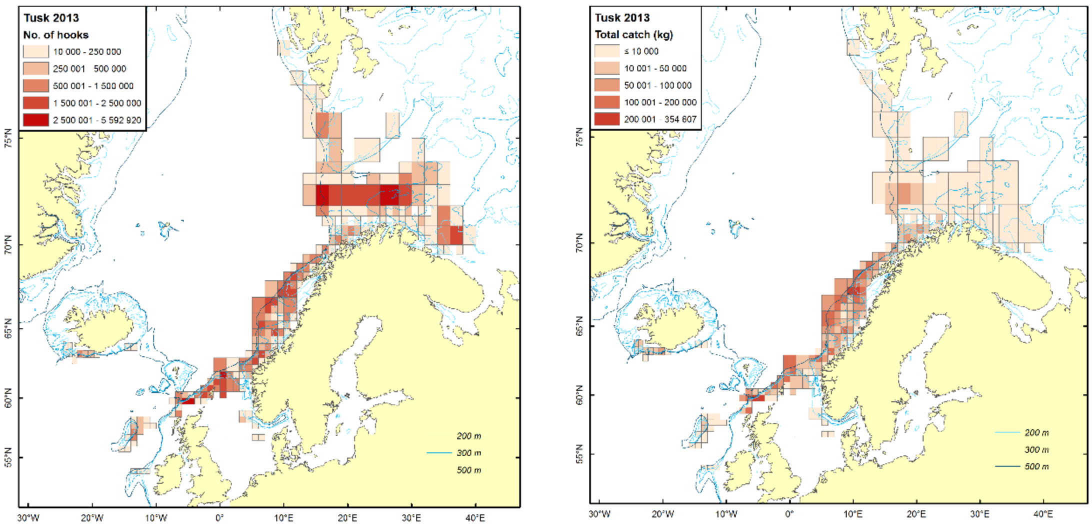


Figure 6.3.1. Distribution of total effort and total catch for the Norwegian longline fishery in 2013.

6.5.2 Landings trends

Landing statistics by nation in the period 1988–2013 are given in Table 6.3.1a–d. Landings declined from 1989 to 2005, after this the landings increased (Figures 6.3.2 and 6.3.3). The preliminary landings for 2013 are 8637, slightly lower than in previous years.

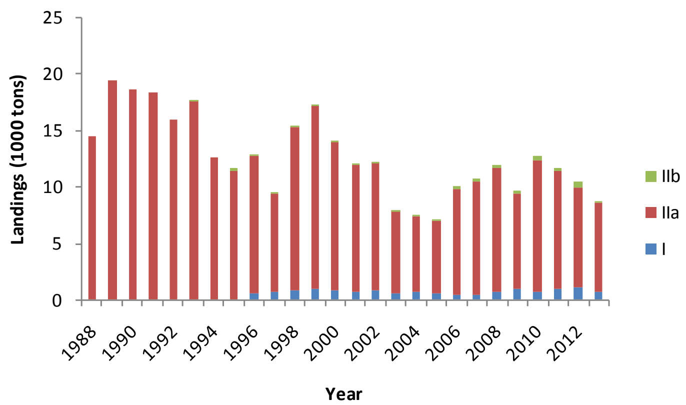


Figure 6.3.2. Total yearly landings of tusk in Areas I and II for the period 1988–2013.

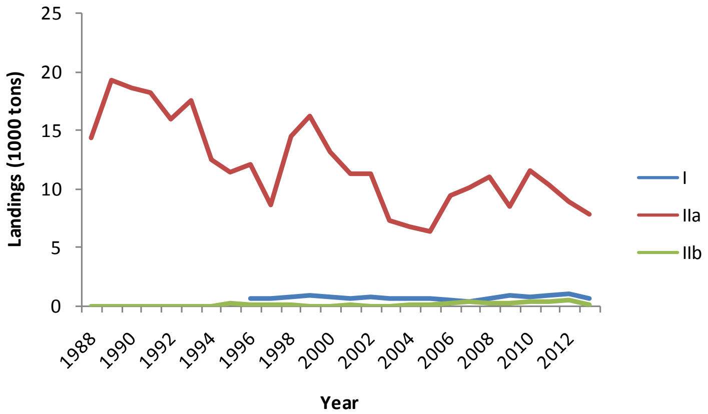


Figure 6.3.3. Total yearly landings of tusk in Areas I and II in each area for the period 1988–2013.

6.5.3 ICES Advice

Advice for 2013 and 2014: Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 9040 t.

6.5.4 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 2013 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 to 21 t in 2013.

6.5.5 Data available

6.5.5.1 Landings and discards

The amounts landed were available for all the relevant fleets. No estimates of the amount of ling discards are available. But since the Norwegian fleets are not regulated by TACs and there is a ban on discarding, the incentive for illegal discarding is believed to be low. The landings statistics are, therefore, regarded as being adequate for assessment purposes.

6.5.5.2 Length compositions

Figure 6.3.4 shows the length distribution and Figure 6.3.5 shows the length–weight relationship of tusk based on data provided by the Norwegian reference fleet for the period 2001–2013. The length fluctuated without any obvious trend.

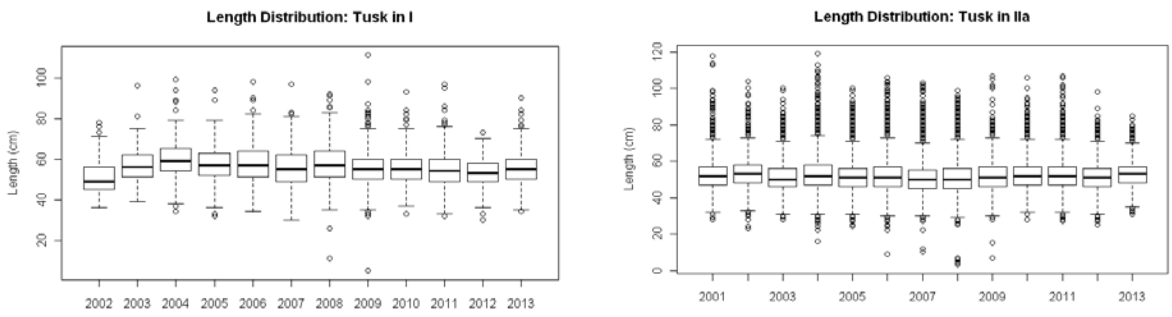


Figure 6.3.4. Box and whisker plots showing the length distribution of tusk. The data were provided by the Norwegian reference fleet for the period 2001–2013.

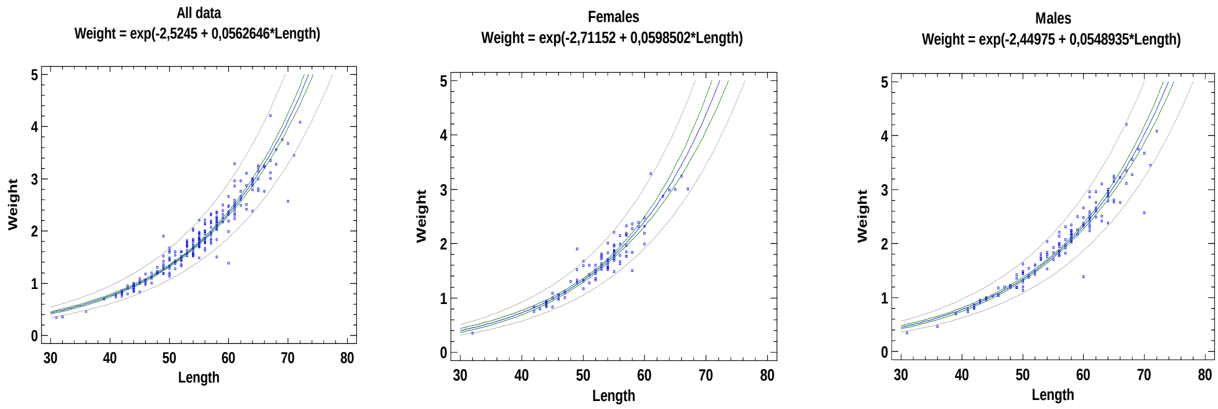


Figure 6.3.5. Length–weight relationship of tusk.

6.5.5.3 Age compositions

Age–length-weight relationship based on data from a small area off Lofoten. The data collected for the project CoralFish are shown in Figure 6.3.7. The average length-at-age and weight-at-age were slightly higher for males than for females. It should be noted that these samples may not be representative of the entire population.

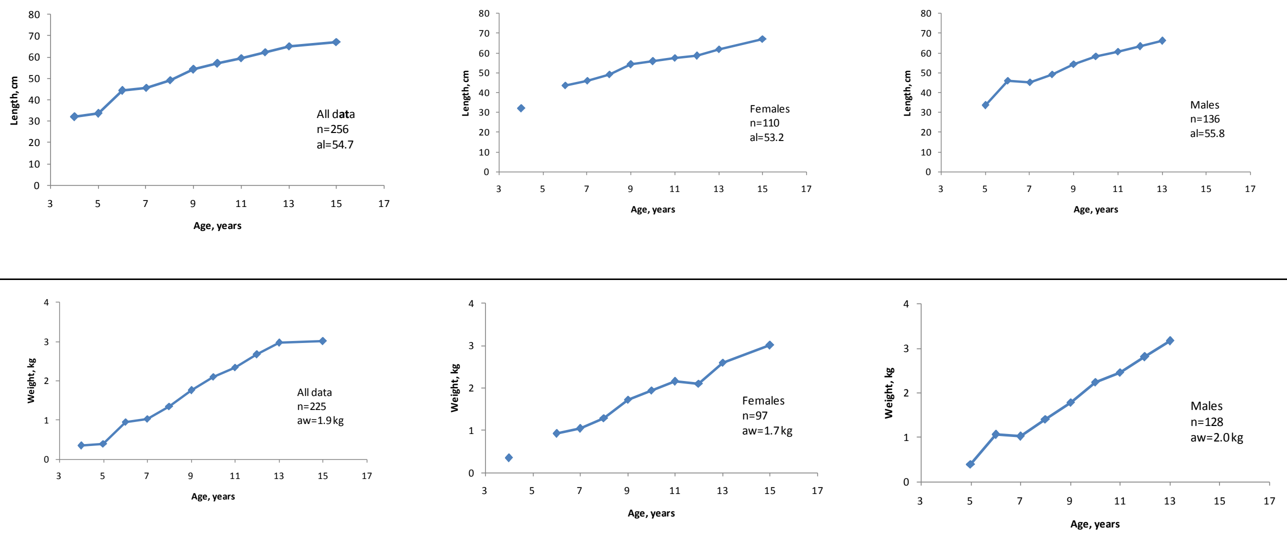


Figure 6.3.7. Weight and length-at-age using data from the females and males combined.

6.5.5.4 Maturity and natural mortality

No data were presented.

6.5.5.5 Catch, effort and research vessel data

Catch and effort data for Norwegian longliners were presented (Figure 6.3.5; Table 6.3.2). No research vessel data were available.

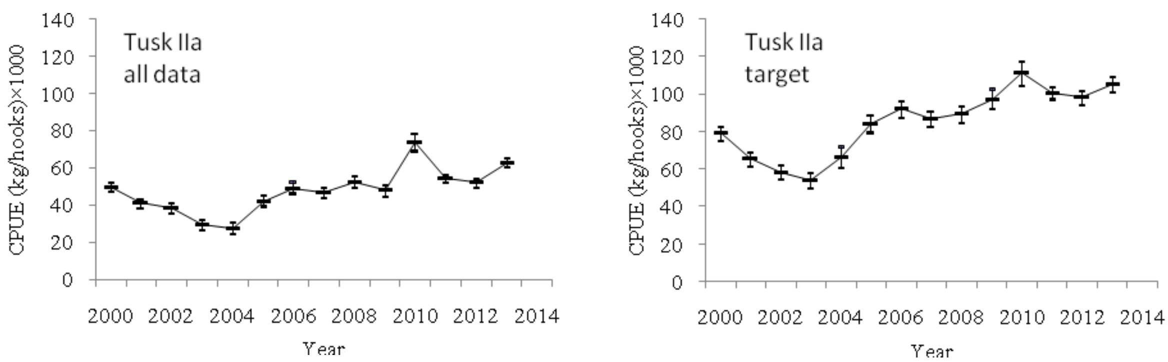


Figure 6.3.8. Estimates of cpue (kg/1000 hooks) of tusk based on skipper's logbook data for 2000–2012. The bars denote the 95% confidence interval.

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2013. 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 the WD Helle and Pennington, 2014.

6.5.6 Data analyses

No analytical assessments were possible due to lack of age-structured data and/or tuning-series.

Graphs of two standardized GLM-based cpue series estimated from all data and from a subset where tusk made up more than 30% of the catches are shown in Helle and Pennington (WD, 2014). The number of longliners has declined, from 72 to 33 in the period 2000–2013 (Figure 6.3.5). The numbers of fishing days per vessel has remained relatively stable during the last few years (Helle and Pennington, WD13 2013).The number of hooks set per day increased from 32 000–37 000 over the period 2000–2013 (Figure 6.3.6).

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 analyses were carried out.

Table 2. Average number of days that each Norwegian longliner operated in an ICES subarea/division.

TUSK	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
I	3	1	5	5	6	5	1	5	4	6	4	12	9	6
IIa	34	57	66	58	60	69	67	89	92	87	93	103	78	63
IIb	1		2		1	2	1	3	4	2	2	4	4	2

Figure 4.3.9. Trend of Norwegian longliner fleet size during the period 1977–2013 (considering vessels exceeding 21 m that landed 8 t or more of ling, blue ling and tusk in any given year).

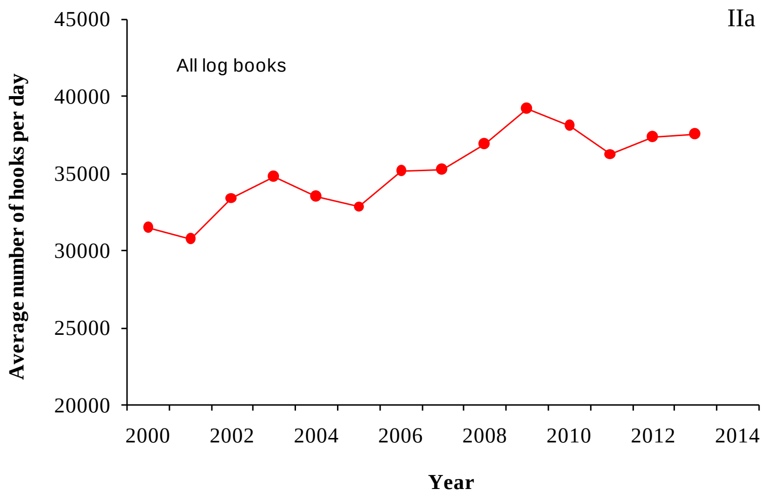


Figure 4.3.10. Average number of hooks the Norwegian longliner fleet used per day in ICES Subarea IIa during the years 2000–2013 in the fishery for tusk, ling and blue ling.

Biological reference points

Estimates of L_{MAX} and AFC were identified and made available to WKLIFE.

6.5.7 Comments on the assessment

The two new standardized cpue series based on all data and when tusk was targeted show a stable and positive trend. The trends are similar to the previous cpue series based on a super-population model presented in 2012.

6.5.8 Management considerations

Catch levels since 2004 do not appear to have had a detrimental effect on the stock given that cpue continues to increase steadily. Current catch levels are considered to be appropriate. The size of the longline fleet fishing for tusk is likely to decrease because of greater access to quotas for Arcto-Norwegian cod.

Table 6.3.1a. Tusk I. WG estimates of landings.

Year	Norway	Russia	Faroes	Iceland	Ireland	France	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				1	727
2011	941						941
2012	1024						1024
2013*	698						698

***Preliminary.**

Table 6.3.1b. Tusk IIa. WG estimates of landings.

Year	Faroes	France	Germany	Greenland	Norway	E & W	Scotland	Russia	Ireland	Iceland	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	3			8354		1	82			8499
2010	39	6			11 445		1	49			11 540
2011	59	5			10 290		1	41			10 405
2012	54	7	1		8764	2		48		1	8877
2013*	14	13	3		7720		7	52		2	7811

***Preliminary.**

(1)Includes IIb.

Table 6.3.1c. Tusk IIb. WG estimates of landings.

Year	Norway	E & W	Russia	Ireland	France	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		282
2009	249		39			288
2010	334		57			391
2011	299		20		5	324
2012	453		40			493
2013*	121		16			137

Table 6.3.1d. 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	634	10 966	282	11 882
2009	870	8499	288	9657
2010	727	11 540	391	12 658
2011	941	10 386	319	11 646
2012	1024	8862	493	10 394
2013	689	7811	137	8637

***Preliminary.**

6.6 Tusk (*Brosme brosme*) in other areas (IIIa, IVa, Vb, VIa, VII, VIII, IX and other areas of XII)

6.6.1 The fishery

A general description of the fisheries in these areas are in the overviews in Sections 3.3., 3.4, 3.5 and 3.6.

Tusk is a bycatch species in the trawl, gillnet and longline fisheries in these subareas/divisions. Norway has traditionally landed the dominant proportion of the total landings. Around 90% of the Norwegian and Faroese landings are taken by longliners.

When landings from Areas III–IV and VIa–XII are pooled over the period 1988–2013, 36% of the landings have been in Area IV, 46% in Area Vb, and 15% in Area VIa.

In Area Vb, tusk was mainly fished by longliners (about 90%), and the rest of the catch was taken by large trawlers. The main fishing ground for tusk is on the slope around the Faroes Plateau and the Faroe Bank deeper than approximately 200 m .The Norwegian longliners were not allowed to fish inside the Faroese EEZ in the period 2011–2013, the Faroese longliners fish in the area where the Norwegian longliners used to fish. In 2014 Norwegian longliners now have quotas in this area.

6.6.2 Landings trends

Landing statistics by nation during the period 1988–2012 are in Table 6.6.1 and are shown by year in Figure 6.6.1.

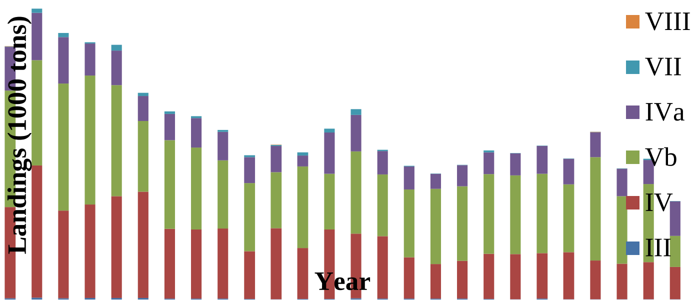


Figure 6.6.1. Landings of tusk per year for the period 1988–2013.

For all subareas/divisions, the catches have been relatively stable over the last five years except for Area Vb, which had a large increase in 2010 and a large decrease in 2013 (Figure 6.6.2).

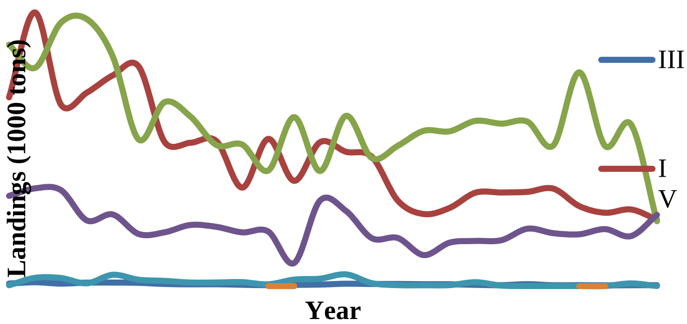


Figure 6.6.2. Landings of tusk in each area for the period 1988–2013.

6.6.3 ICES Advice

Advice for 2013 and 2014: Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 8500 tonnes.

6.6.4 Management

There is a licensing scheme and effort limitation for Vb. The minimum landing length for tusk in Division Vb is 40 cm. Norway previously had a bilaterally agreed quota with the Faeroes in Vb, and the quota for 2010 was 1774 t. There were no quota agreements for the years 2011–2013. In 2014, Norway can catch 1250 tons ling/tusk and 1025 tons tusk. Norway also has a licensing scheme in EU waters and in 2014 the Norwegian quota in the EC zone was 2923 t. 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 2014:

Subarea III:	29 t;
Subarea IV:	235t;
Subarea V, VI, VII (EU and international waters):	535 t.

NEAFC recommends that in 2009 the effort in areas beyond national jurisdictions shall not exceed 65% of the highest level of effort for deep-water fishing applied in previous years.

6.6.5 Data available

6.6.5.1 Landings and discards

The amount of landings was available for all relevant fleets. No estimates of the quantity of discards for tusk were on hand. Both for the Norwegian and Faroese fleet, there is a ban on discarding, and incentives for illegal discarding are believed to be low. The landings statistics and logbooks are therefore regarded as being adequate for assessment purposes.

Spain reported that discards were 40 tons in Area VIIc2.

6.6.5.2 Length compositions

Figure 6.6.3 show the estimated length distribution for tusk in Areas IVb, Vb and VIa based on data provided by the Norwegian reference fleet for the period 2001–2013.

Length distributions of the catches by the Faroese longliners, and those for the spring and summer groundfish surveys in Vb were presented for the period 1995–2011 (Figures 6.6.4–6.6.6).

Length information from the Russian investigations is in Aleksandrov and Vinnichenko, WD 2014.

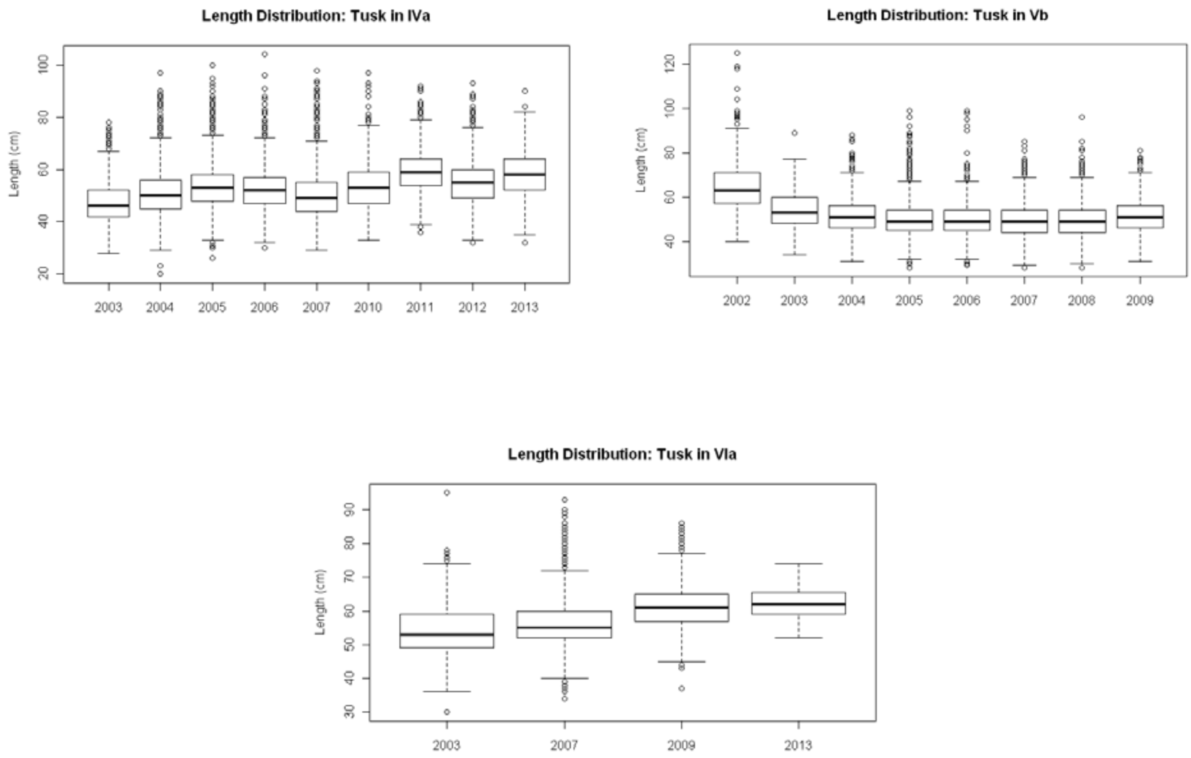


Figure 6.6.3.Plots of the length distribution in Areas IVa, Vb and VIa for the period 2001 to 2013. The graphs are based on length data from the Norwegian reference fleet.

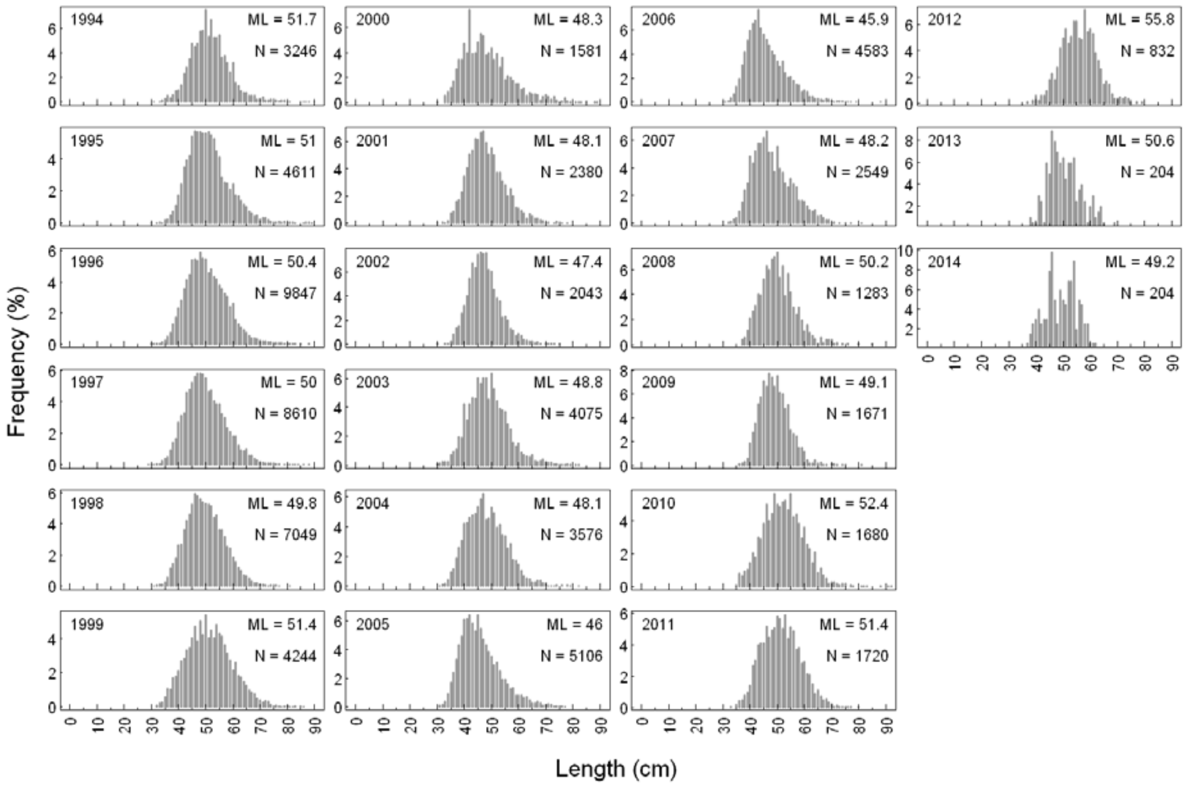


Figure 6.6.4. The estimated length distributions of the catch of tusk by longliners (>100 BRT) in Area Vb.

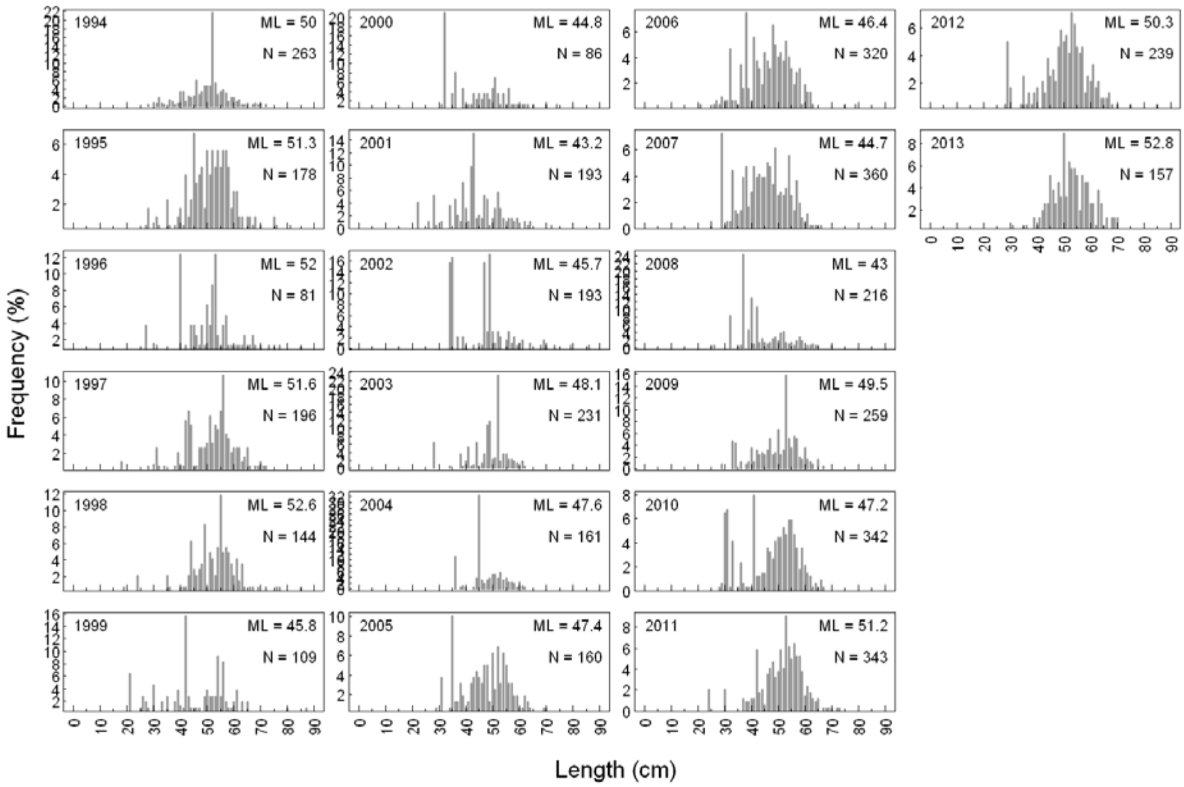


Figure 6.6.5. Estimated length distributions of tusk in Area Vb based on data from the spring groundfish surveys.

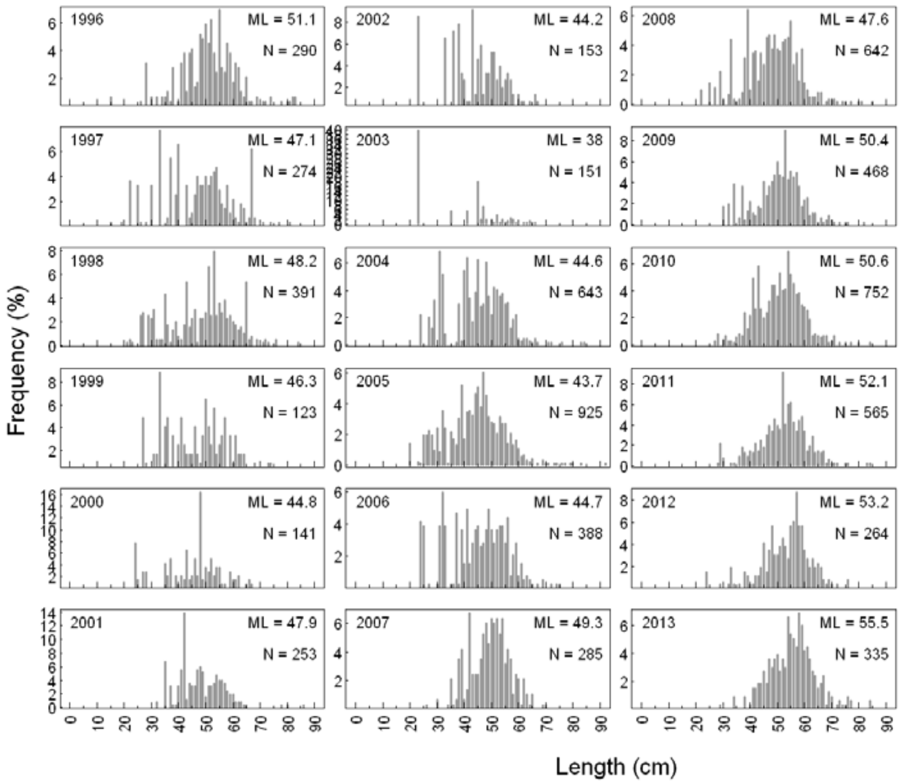


Figure 6.6.6. Estimated length distributions of tusk in Area Vb based on data from the the summer groundfish surveys.

6.6.5.3 Age compositions

A small-scale exchange of 50 tusk otolith images was conducted in 2013 (WKAMDEEP, 2013). The results of this exchange showed that the average coefficient of variation (CV) of the ten age readers of tusk was 16.9%, and the conclusion from this experiment was, because of the relatively large ageing errors, care should be taken when interpreting estimated year-class strength and population rates of growth (WGDEEP, 2013). The CV per reader ranged from 12.9–23.7%. Only a few of these age readers were trained in ageing these species, thus it may be that the CV will be improved by more training. It is therefore recommended to undertake more exchanges and between reader comparisons for this species (WKAMDEEP, 2013).

An attempt was made to count daily growth rings in the otoliths of nine tusk larvae taken during annual 0-group survey on the Faroe Plateau in 2013. The results showed that larvae between 12 and 25 mm were from 32 to 70 days old (Bjørn Gunnarsson, Hafro, Iceland; Figure 6.6.7). These results indicate that tusk spawn by at least April–May in Faroese waters.

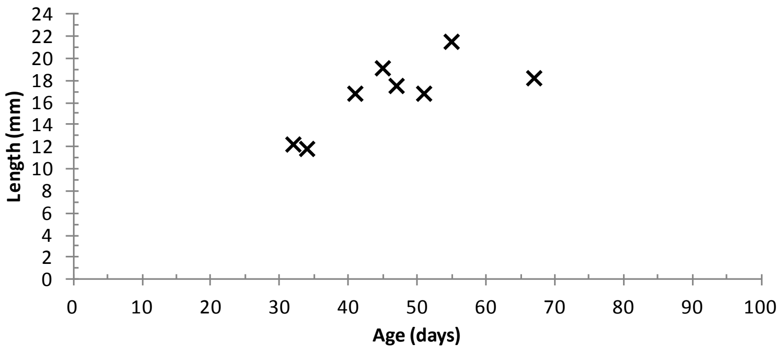


Figure 6.6.7. Daily growth of nine tusk larvae caught in Area Vb.

6.6.5.4 Weight-at-age

No data were presented.

6.6.5.5 Maturity and natural mortality

The estimated maturity ogive of tusk based on data from the Faroese surveys in 2013 indicated a L_{50} around 55–59 cm (N=320) and an A_{50} around nine years (N=305).

6.6.5.6 Catch, effort and research vessel data

Catch and effort data for Norwegian and Faroese longliners were presented. Cpue indices from the Faroese groundfish surveys were also 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 2000–2012. 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. The quality of the Norwegian logbook data is poor in 2010 due to changes from paper to electronic logbooks. Since 2011 the quality has improved considerably as data from the entire fleet were available.

A standardized cpue series for the period 2000–2013 is in 6.6.8. From the Faroese investigations a cpue series based on groundfish surveys and a standardized cpue series for the Faroese longliners (>100 GRT) for the period 1987–2013 was also available Figures 6.6.9 and 6.6.10. Number/hour and occurrence (%) of tusk larvae caught on the Faroe Plateau was also presented Figure 6.6.11.

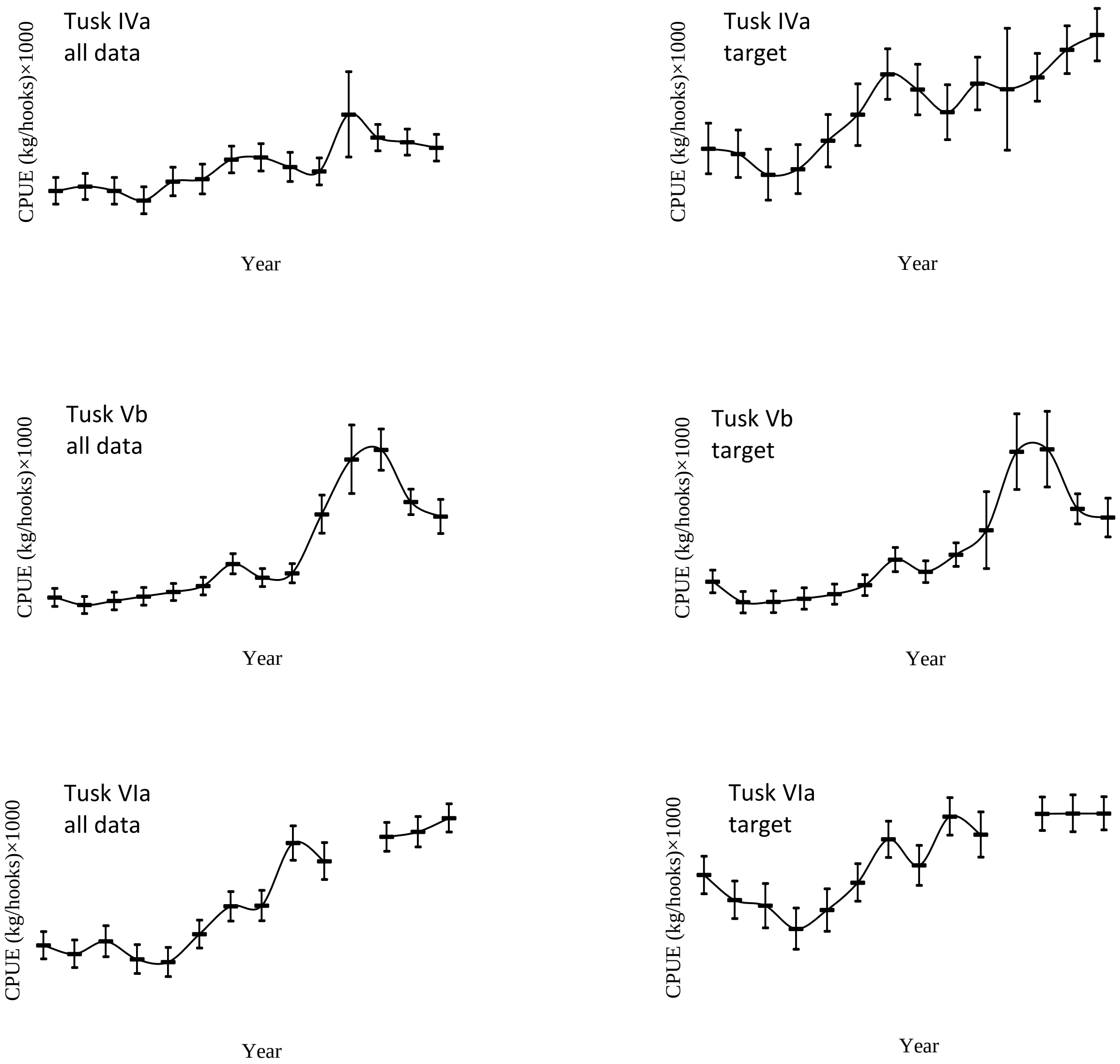


Figure 6.6.8. A cpue series for ling for the period 2000–2013 based on all available data and when ling appeared to be targeted. The bars denote the 95% confidence intervals.

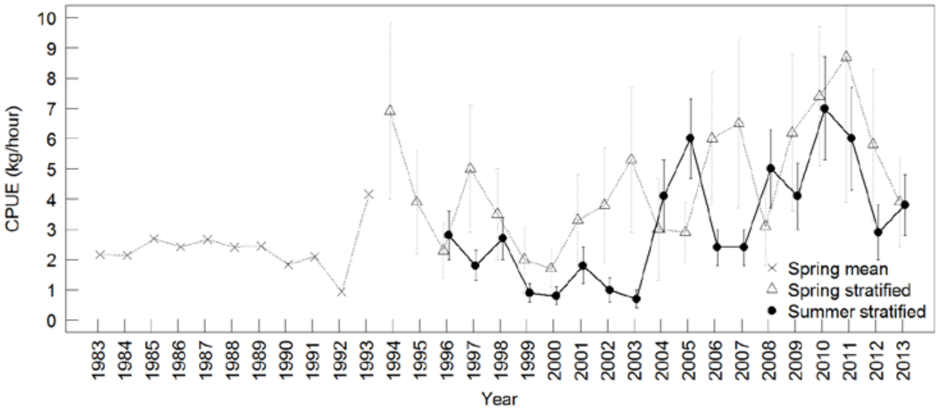


Figure 6.6.9. Estimated cpue series for tusk in Area Vb based on groundfish surveys.

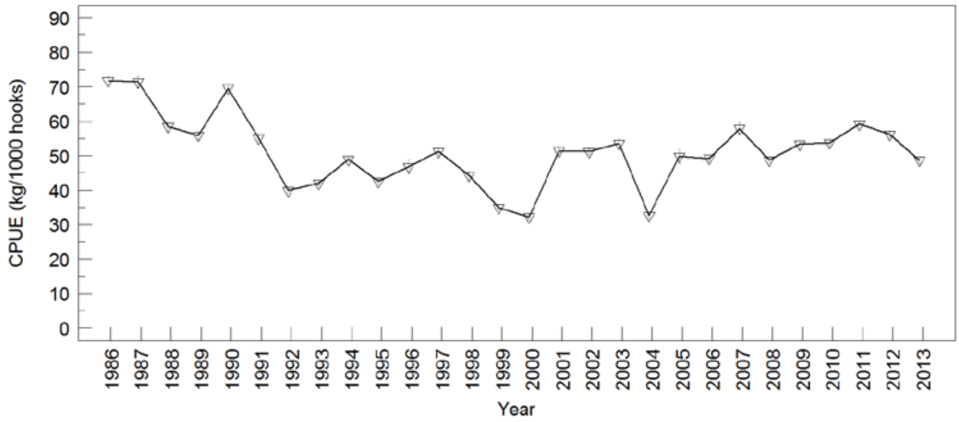


Figure 6.6.10. Standardized cpue series for tusk in Area Vb based on data from 4–5 longliners (<110 GRT) fishing in Faroese waters. Criteria: tusk was in the catch, ling+tusk>60% of total catch and the depth was >200 m.

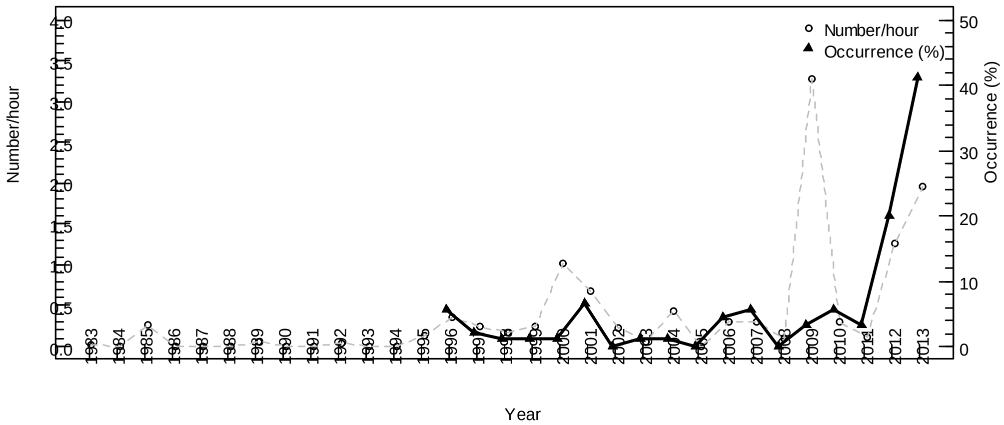


Figure 6.6.11. Number/hour and occurrence (%) of tusk larvae caught on the Faroe Plateau. (0-groupSurveyCpue.R, Yngul1983–2013cpue.csv, Tusk0groupCpue.png).

6.6.6 Data analyses

No analytical assessments were attempted this year.

Norwegian length distributions, based on data provided by the longline reference fleet from Areas IVb, Vb and VIa, has varied slightly with no obvious trend (Figure 6.6.3).

Faroese data from Area Vb show that the mean length in the spring and summer groundfish surveys varied between 43 to 53 cm (Figures 6.6.5 and 6.6.6). The length distributions from these surveys are noisy and some lengths seem to be overestimated (especially small fish). The reason behind this is probably that small tusk, below commercial landing size, are based on a subsample from the total catch and thereafter multiplied up to the total catch weight. There were few fish caught that were less than 30 cm, so there are no abundance indices (recruitment) for juvenile tusk from the spring survey.

The estimated mean lengths for the landings by longliners varied from 46 to 51 cm, and there was no apparent downward trend in mean lengths over time (Figure 6.6.4). The main catches had fish lengths that were between 40 and 60 cm.

Cpue trends

IVa

Two cpue series for tusk in Area VIa based on Norwegian longline data were presented; one based on all data, and one based on when tusk appeared to be the target species. The series based on all the data shows a stable and slightly increasing trend while the one based on the targeted fishery shows a clear and positive upward trend Figure 6.6.8.

Vb

Indices from Faroese surveys and Norwegian longliners were available for Area Vb.

The abundance indices (cpue) from the Faroese groundfish surveys do not show the same trend as the longline cpue (Figures 6.6.9 and 6.6.10). The spring cpue series indicates a rather large decrease in abundance, whiles the summer survey series indicates a smaller decrease.

The commercial cpue serie is based on five longliners, and catches were selected when; tusk was in the catch, tusk+ling was more than 60% of the total catch, and the catch was taken at a depth deeper than 200 m. The cpue series for the period 2005 to 2013 has been quite stable, around 50 kg/1000 hooks, over the last nine years though it has decreased during the last two years (Figure 10).

Abundance indices based on tusk caught in the Faroese 0-group survey on the plateau are at a very low level in the period 1983–2011, whereas the level has increased during the latest two years (Figure 6.6.11).

The cpue series based on the Norwegian longline data shows a stable trend from 2000 to 2008, afterwards it increased until 2012 and then decreased (Figure 6.6.7).

VIa

In **VIa** the cpue based on the Norwegian longline data shows a decrease in cpue from 2004 to 2008, after this it has remained on a high and stable level (Figure 6.6.7).

Biological reference points

Estimates of L_{MAX} and AFC were identified and made available to WKLIFE.

6.6.7 Comments on the assessment

The Norwegian longline cpue series based on the logbook is now standardized. However, it shows the same trend as the unstandardized cpue series and the series based on a super-population model that was presented in 2012.

6.6.8 Management considerations

Landings in all subareas have been stable since 2002. The cpue series both for the Faroes longline fishery in Vb and for the Norwegian longline fisheries show a stable or positive trend since 2003 with a decrease during the last few years. In IVa and VIb the cpue series indicate a positive development of the stocks.

Table 6.6.1. Tusk IIIa, IV, Vb, VI, VII, VIII, IX. WG estimates of amount landed.

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	3	46
2009	1	17	1	19
2010	1	17	3	21
2011	1	14	3	17
2012	1	17	2	20
2013*	1	20	1	22

***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	16	2	1975		3		85	1	2139
2009	48		8	1	2108	7	3		93		2268
2010	36		10	2	1734		8		71		1861
2011	52		24		1482	1	6		72		1636
2012	28		14	1	1635	1	3		67		1749
2013*	42		28	3	1374		3		76		1526

[1] Includes IVb 1988–1993.

***Preliminary.**

Table 6.6.1. (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						15
2011	1		95						96
2012	2		43					2	47
2013*	3		29						32

(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	3135
2010		3949	16		866		58		4889
2011		3288	3		1		1		3293
2012		3668	23		102				3793
2013*		1460	49		0				1509

1) Included in Vb_2 until 1996.

(2) Includes Vb_2.

(3) Reported as Vb.

(4) 2000–2003 Vb1 and Vb2 combined.

*** Preliminary.**

Table 6.6.1. (Continued).

TUSK Vb2

Year	Faroe	Norway	E & W	Scotland (1)	France	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		127				127
2011		0				0
2012		0				0
2013*					12	12

(1)Includes Vb1.

(2)See Vb1.

(3)Included in Vb1.

***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	183		5	939			48		1216
2011		87	173		1	1060			25		1337
2012		106	166		1	860			41		1174
2013*		46	355		1	1204			66	86	1758

Not allocated by divisions before 1993.

*** Preliminary.**

Table 6.6.1. (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				
2011				
2012*				

***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		5					5
2011		1					1
2012			63				63
2013*	3	1					4

***Preliminary.**

Table 6.6.1. (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							0
2011	0							0
2012	0					2		2
2013*	0							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
2011		0	0
2012			0
2013*			0

***Preliminary.**

Table 6.6.1. (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	3560	317	1059		90	3		7249
2007	21	2180	15	3468	344	1077		13	1		7119
2008	46	2139	71	3798	61	1347		4	0		7466
2009	19	2268	17	3135	164	1242		4	0		6849
2010	21	1861	15	4889	127	1216		3	0	4	8136
2011	17	1623	96	3287	0	1337		5	0	0	6361
2012	20	1749	47	3793	0	1174		63	2		6848
2013*	22	1526	32	1509	12	1758		4	0		4863

*Preliminary.

7 Greater silver smelt

7.1 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.

The 2013 WGDEEP communicated the following request; "In light of the 2012 advice for greater silver smelt where ACOM states that 'greater silver smelt may be sufficiently isolated at separate fishing grounds to be considered as individual assessment units'. As this may also apply to other stocks assessed by WGDEEP the group would ask ACOM to give clear guidance on what criteria has to be met for this to apply." ACOM has replied as follows; "The ICES approach to DLS recognises that it is possible to give advice in data-limited situations. A similar approach could be extended to cover the definition of advice units where data are limited and it is unlikely that conclusive evidence on stock identity will be available in the near future.

WGDEEP to provide supporting information for SIMWG in a working document. (Communicated to WGDEEP. Communicated to SIMWG.)"

Thus at WGDEEP 2014 a working document to SIMWG was prepared, and also distributed to ACOM. In this working document WGDEEP 2014 concludes that greater silver smelt meets the criteria that fishing grounds are sufficiently isolated (Figure 7.1.1), and that it is data-limited in terms of stock structure. WGDEEP suggests division into further advice units (ICES WGDEEP 2014 WD02).

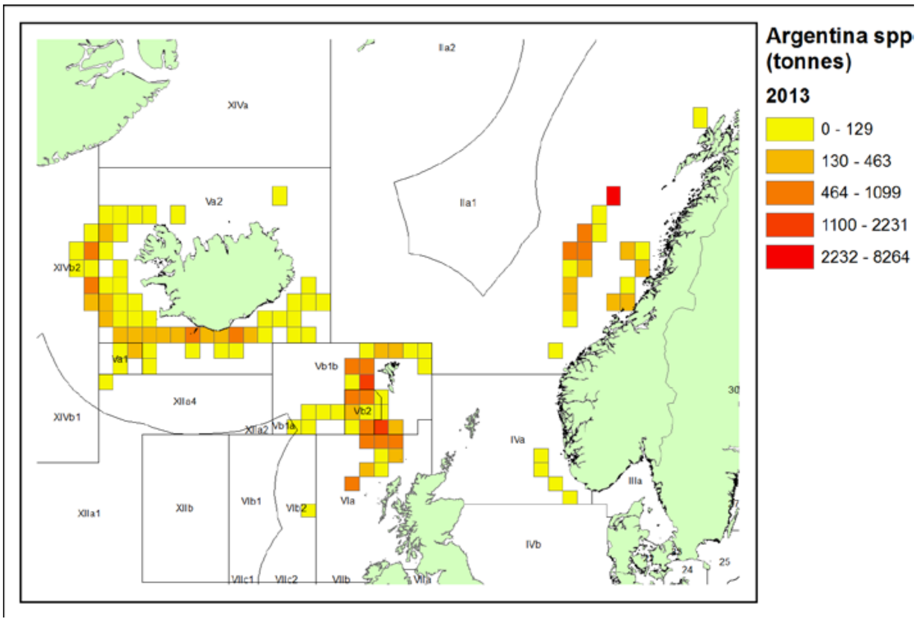


Figure 7.1.1. Catches of greater silver smelt by Iceland, Norway, Faroes and the Netherlands in 2013. Some catches of *A. Sphyraena* and *Argentina* unidentified may be included in the Norwegian and Dutch landings.

A small-scale exchange of 50 GSS otolith images was done in 2013 (WKAMDEEP, 2013). The results of this exchange showed that the mean CV of all the 12 age readers was 7.5% and GSS was considered the easiest of the species examined in the exchange to age by all age readers. The conclusion was that the precision is probably high enough to support age-structured analytical assessments (WKAMDEEP, 2013).

Landings of greater silver smelt in NE Atlantic are shown in Figure 7.1.2.

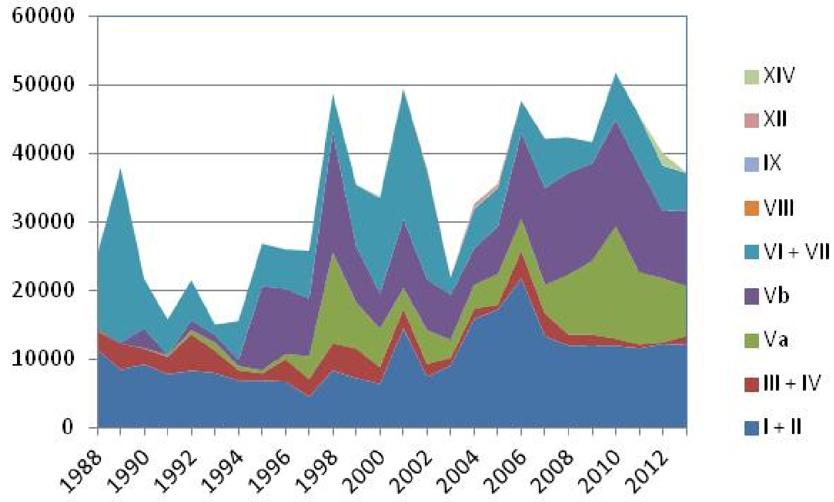


Figure 7.1.2. Landings of greater silver smelt in the NE Atlantic, by ICES areas.

7.2 Greater silver smelt (*Argentina silus*) in Division Va

7.2.1 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 red-fish fishery. Since 1997, a directed fishery for greater silver smelt has been ongoing and the landings have increased significantly (Table. 7.2.1).

7.2.1.1 Fleets

Since 1996 between 20–36 trawlers have annually reported catches of greater silver smelt in Va (Table 7.2.1). 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 the number of hauls seems to be increas-ing in recent years. Number of hauls peaked in 2010, similar number of hauls were reported in 2011 and 2012 as in 2009. 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 (Table 7.2.2).

Table 7.2.1. 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%
1997	26	854	2257	384	0,846
1998	39	2587	11132	1968	0,955
1999	24	1451	4456	824	0,865
2000	23	1263	3491	643	0,827
2001	26	767	1577	255	0,715
2002	32	1134	3127	504	0,777
2003	30	1127	1965	253	0,538
2004	27	1017	2688	340	0,705
2005	30	1368	3520	361	0,732
2006	31	1542	3725	395	0,715
2007	26	1259	3440	461	0,759
2008	31	3143	8428	863	0,663
2009	34	3434	10233	1010	0,694
2010	36	4724	16280	1836	0,740
2011	34	3244	10155	973	0,723
2012	31	3334	9732	985	0,713
2013	31	2704	7192	618	0,651

7.2.1.2 Targeting and mixed fisheries issues in the Greater Silver Smelt fishery in Va

Mixed fisheries issues: species composition in the fishery

Redfish spp. (*Sebastus marinus* and *S. mentella*) are the main species when it comes to 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 (Table 7.2.2).

Table 7.2.2. Greater silver smelt in Va. Proportional species composition where greater silver smelt was more than 50% of the total catch in a haul.

YEAR	REDFISH		GREENLAND HALIBUT	LING	BLUE LING	OTHER
	S. marinus	*S. mentella*				
1997	1,4	79	0,0	6,9	7,2	5,5
1998	5,3	77,9	0,0	3,6	6,4	6,8
1999	4	79,9	0,0	2,5	5,9	7,6
2000	4,8	71	0,2	0,3	9,7	14,1
2001	22,4	55,4	4,5	0,5	0,9	16,3
2002	16,9	74,2	0,4	1,2	4,0	3,2
2003	37,7	52	0,4	0,1	5,1	4,7
2004	25,1	68,4	0,7	0,1	0,9	4,8
2005	15,6	69,5	4,3	1,4	3,0	6,2
2006	28,8	59,8	1,4	0,9	1,0	8,1
2007	12,1	70,9	5,9	0,3	6,1	4,6
2008	26,7	60,8	2,8	1,2	5,0	3,4
2009	20,9	63,7	3,3	0,2	7,9	4,1
2010	16	63,7	2,0	0,9	6,4	11,1
2011	13,4	66,3	2,2	0,4	4,8	12,9
2012	8,9	67,5	1,3	0,2	7,5	14,5
2013	9,6	63,8	4,7	0,2	9	12,8

Spatial distribution of catches through time

Spatial distribution of catches in 1996–2013 is presented in Figures 7.2.1 and 7.2.2. 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 (Figures 7.2.1 and 7.2.2).

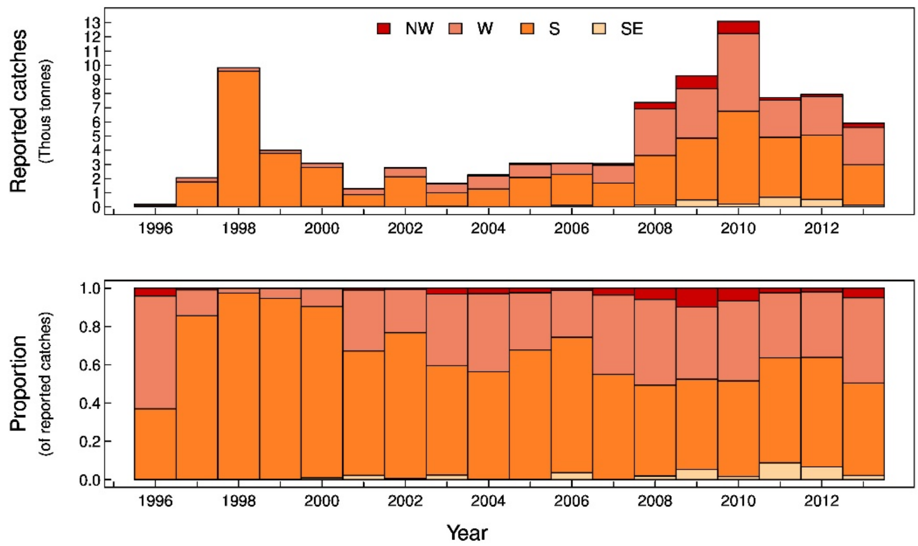


Figure 7.2.1. Greater silver smelt in Va. Catches defined by survey regions deeper than 400 m by year (See stock annex for details). Above are the catches on absolute scale and below in proportions.

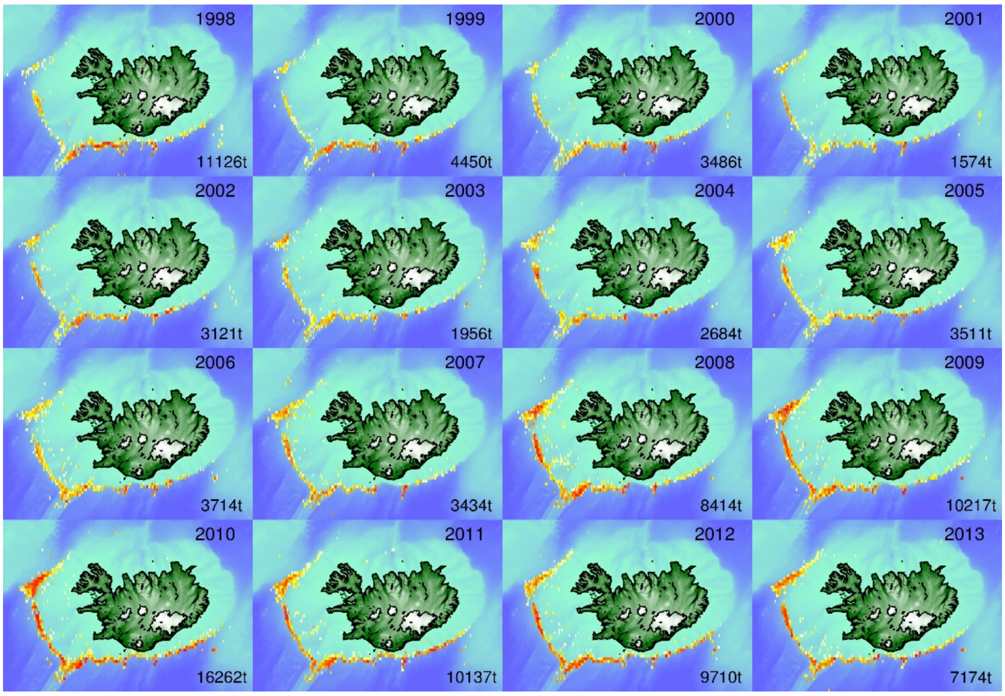


Figure 7.2.2. Greater silver smelt in Va. Spatial distribution of catches as reported in logbooks.

7.2.2 Landings trends

Landings of Greater Silver Smelt are presented in Table 7.2.1 and Figure 7.2.3. Since directed fishery started in 1997–1998, the landings 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 16 500 t in 2010. In 2011 and 2012 landings decreased due to closure of the fishery by managers and landings in 2013 amounted to approximately 7100 tonnes.

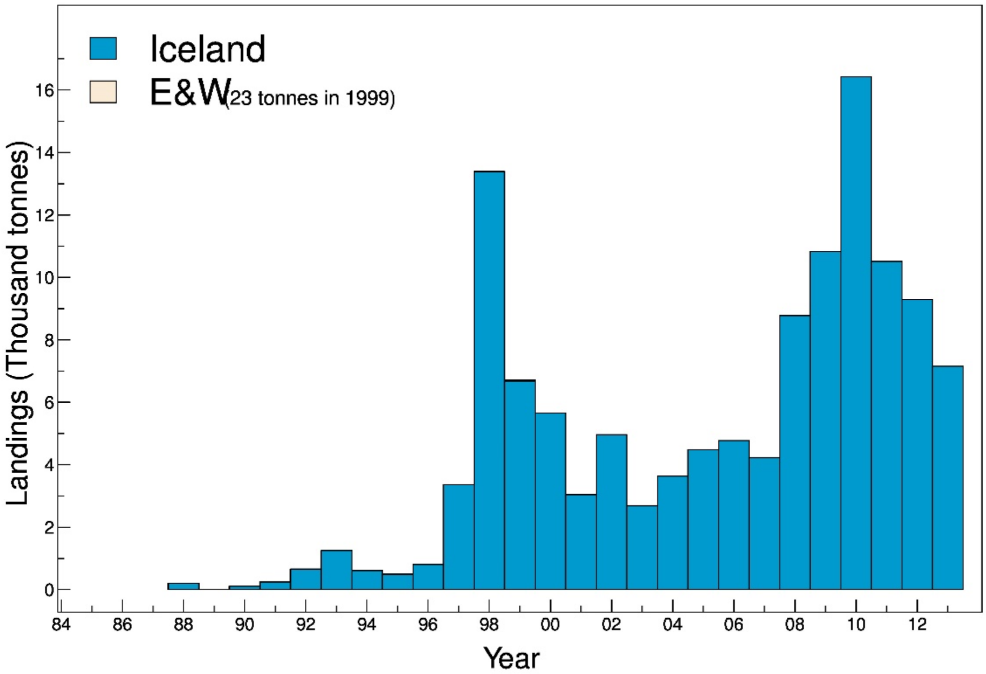


Figure 7.2.3. Greater silver smelt in Va. Nominal landings.

7.2.3 ICES Advice

The ICES advice for 2013 and 2014 is: Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 3700 tonnes.

The basis for the advice was the following: For data-limited stocks with reliable abundance information from fisheries-independent data and a target F_{proxy}, where abundance is considered above MSY $B_{trigger}$, ICES uses a harvest control rule that calculates catches based on the F_{proxy} target multiplied by the most recent survey biomass estimates.

For this stock the F_{proxy} of 0.076 is applied as a factor to the 2010 biomass estimate, resulting in catch advice of no more than 3700 t. ICES does not implement the default rule as used for other data-limited stocks because the fishing mortality has increased significantly in the last two years.

7.2.4 Management

Before the 2013/2014 fishing year the Icelandic fishery was managed 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.

On the 7th of June 2010 the Ministry of Fisheries and Agriculture redrew licences for the remaining time of that fishing year (2009/2010). Licences were similarly redrawn on the 7th of March 2011 (for 2010/2011), 2nd of December 2011 (for 2011/2012) and on the 18th of March 2013 (for (2012/2013).

As of the 2013/2014 fishing year, greater silver smelt is regulated by the ITQ system (regulation 662/2013) used for many other Icelandic stocks such as cod, haddock, tusk and ling. The TAC for the 2013/2014 fishing year was set at 8000 based on the recommendations of MRI using a preliminary Gadget model.

7.2.5 Data available

7.2.5.1 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.

7.2.5.2 Length compositions

Table 7.2.3 gives the number of samples and measurements available for calculations of catch in numbers of Greater Silver Smelt in Va. Length distributions are presented in Figure 7.2.4.

7.2.5.3 Age compositions

Table 7.2.3 gives the number of samples and measurements available for calculations of catch in numbers of greater silver smelt in Va. Estimates of catch in numbers are given in Figure 7.2.5.

Table 7.2.3. Greater silver smelt in Va. Summary of sampling intensity and overview of available data for estimation of catch in numbers.

Year	No. length samples	No. length measurements	No. otolith samples	No. otoliths	No. aged otoliths
1997	45	4863	28	1319	985
1998	141	14911	102	6018	890
1999	58	4163	44	2180	82
2000	27	2967	18	1011	113
2001	10	489	6	245	17
2002	21	2270	10	360	127
2003	63	5095	13	425	0
2004	34	996	7	225	84
2005	49	3708	14	772	0
2006	29	4186	13	616	465
2007	14	2158	8	285	272
2008	44	3726	39	1768	1387
2009	53	5701	36	1746	1387
2010	134	16351	68	3370	3120
2011	63	6866	40	1953	1774
2012	35	3891	23	1094	405
2013	47	4925	34	710	704

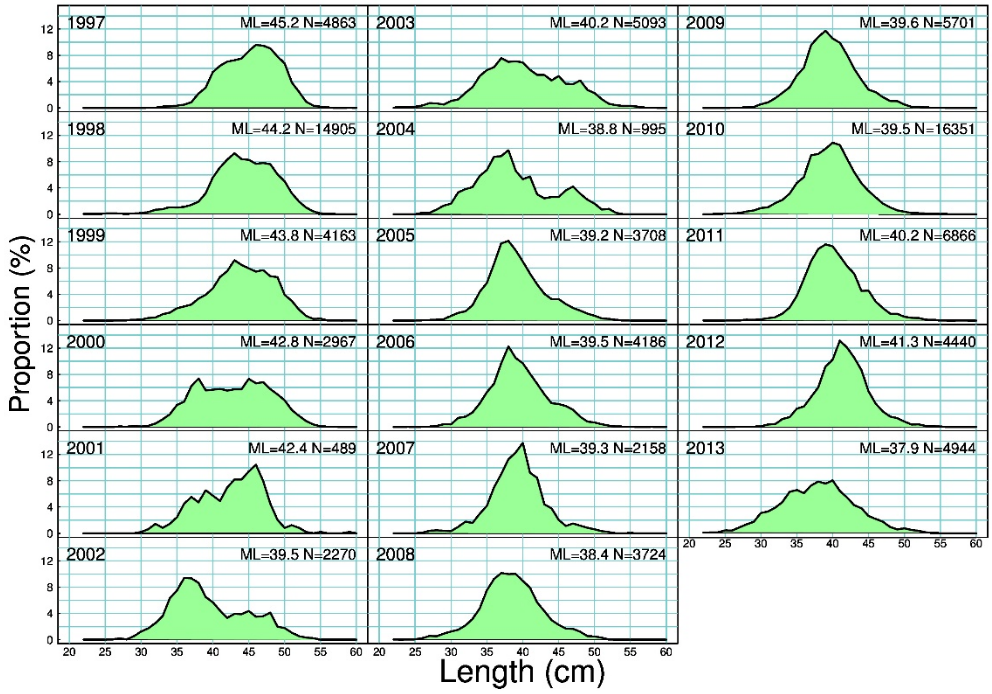


Figure 7.2.4. Greater silver smelt in Va. Length distributions from commercial catches.

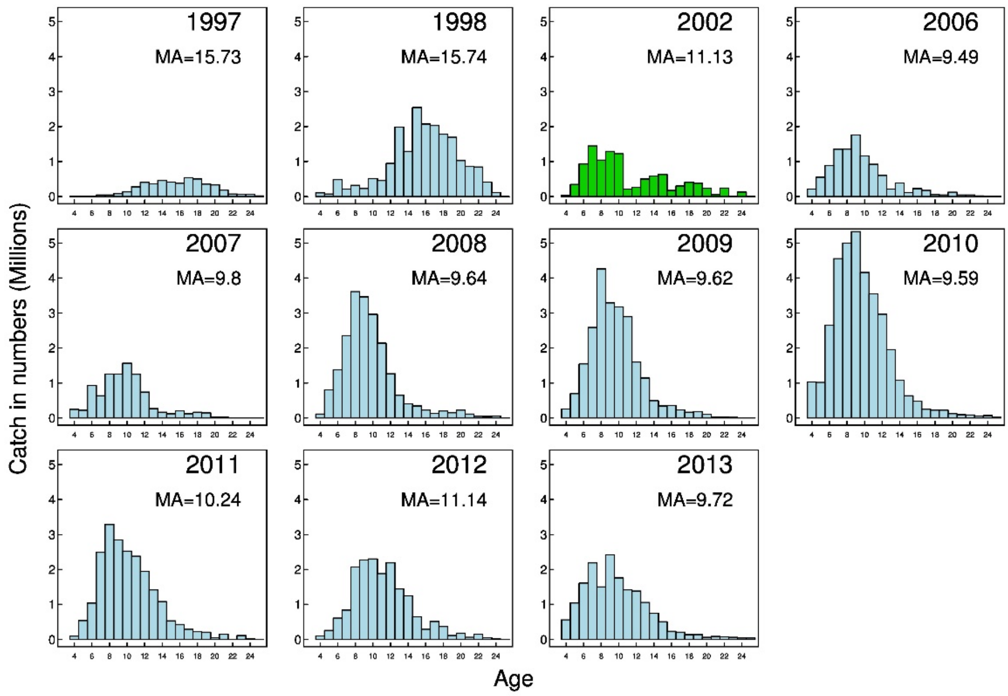


Figure. 7.2.5. Greater silver smelt in Va. Catch in numbers. Estimates for 2002 are based on limited number of aged otoliths (See Table 7.2.3).

7.2.5.4 Weight-at-age

No marked changes can be observed in mean weight-at-age from commercial catches between 1997–1998 and 2006–2013.

7.2.5.5 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 stock annex for details). Males tend on average to mature at a slightly higher age or at 6.5 compared to 5.6 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.

7.2.5.6 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. Figure 7.2.6 gives trend in biomass and juvenile abundance for the spring survey in 1985 to 2012 and for the autumn survey in 2000 to 2012. Due to industrial action in 2011 the autumn survey was cancelled after about one week of survey time. 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. At WGDEEP 2010 three versions of indices from the autumn survey were presented:

1) Index using the original stratification scheme for the spring and autumn survey (See stock annex for details).
2) A winsorized index using the same stratification scheme as in 1 (See stock annex for details).
3) Index using a revised stratification scheme, specially designed for the autumn survey.

The group considered the revised indices (3) a step forward and that the data from the Icelandic autumn survey should in the future be processed using the revised stratification scheme. The index for greater silver smelt at depths greater than

400 meters, based on the revised stratification scheme was then used by ACOM in the advisory process. The index for depth greater than 400 meters is assumed to be the best available indicator of the available biomass to the fishery (Figure 7.2.7).

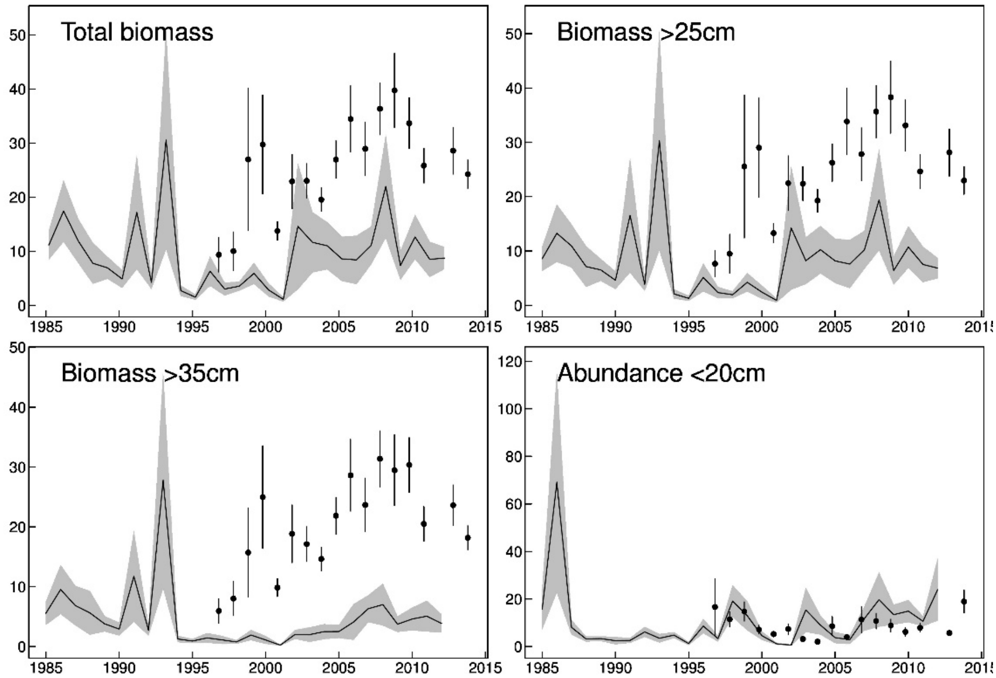


Figure 7.2.6. Greater silver smelt in Va. Indices from the Icelandic spring survey (black lines and shaded area) and from the autumn survey (dots and vertical lines). Vertical lines and shaded area represent +/- 1 standard error.

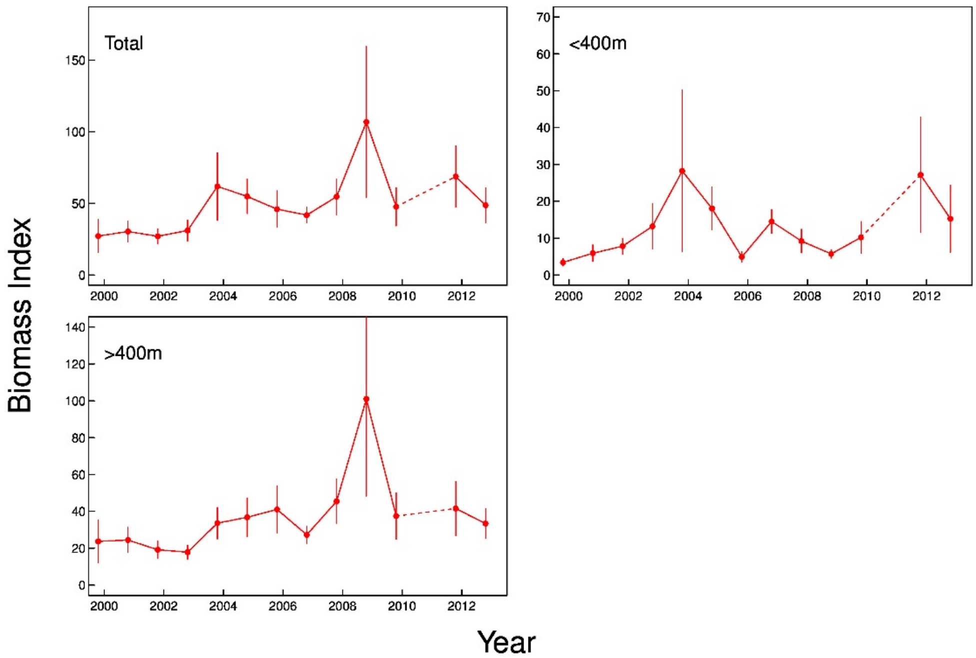


Figure 7.2.7. Greater silver smelt in Va. Index from the Icelandic autumn survey, divided by depth.

7.2.6 Data analyses

Landings and sampling

Spatial distribution of catches did not change markedly between 2012 and 2013 and fishing for greater silver smelt in the NW area seems to have stopped (Figures 7.2.1 and 7.2.2). Landings of greater silver smelt increased rapidly from 2007 to 2010 when they peaked at around 16 000 tonnes, since then they have decreased to around 7000 tonnes in 2013 (Figure 7.2.3 and Table 7.2.4). The decrease in catches is the result of increased vigilance by the managers to constrain catches to those advised. At the same time mean length in catches decreased from around 44 cm in 1998 to 38–40 in 2008 to 2011 however there is a slight increase in mean length in 2012 but that increase was not present in 2013 (Figure 7.2.4). A similar continuous downward trend in mean age in the commercial catches is also observed. Mean age in the fishery has decreased since the late nineties from around 16 to around 10 in 2006 to 2011 but as for mean length, mean age in catches in 2012 increased and is estimated at 11.5 years in 2012 compared to 10.3 in 2011 and 9.7 in 2013 (Figure 7.2.5). The reason for this change is not known as there is no marked difference in the spatial distribution of the fishery.

Surveys

As mentioned above greater silver smelt is a difficult species to survey in trawl surveys and the indices derived from the both the spring and autumn survey have high CVs. The spring survey biomass indices are characterized by occasional spikes in the indices without any clear trend. The only thing that can be derived from the spring survey is that the biomass indices (total and >25 cm), in 1985–1993 and again from 2002 to 2010 at a slightly higher level than in 1994–2001. The juvenile index has a very high peak in 1986 but then hardly any juveniles are detected in the survey in 1987 to 1995. Since 1998 there have been several small spikes in the recruitment index (Figure 7.2.6).

The observed trends in the biomass indices from the autumn survey have a considerably different trends than those observed in the spring survey (Figure 7.2.6). According to the autumn survey biomass increased more or less year on year from 2000 to 2008 but then decreased in 2009 and 2010. The total biomass index in the autumn survey shows a slight increase in 2012, compared to 2010, while that increase has levelled off in 2013. In some sense the autumn survey has similar trends in juvenile abundance as the spring survey.

There is a clear gradient in mean length of greater silver smelt with depth, larger fish being in deeper water. Also fishing for greater silver smelt in Va is banned at depths less than 400 meters the autumn survey index for depth greater than 400 meters is considered the best indicator of available biomass to the fishery. This index does not seem to have changed much between 2010 and 2013 (Figure 7.2.7).

F_{proxy}

Changes in relative fishing mortality (F_{proxy} = Yield / Survey biomass at depths greater than 400 m) are presented in Figure 7.2.8 and Table 7.2.5. According to the graph, F_{proxy} was relatively stable in 2004 to 2006 but then increased slowly from 2006 to 2008. This was mainly driven by increases in catches. The decrease in 2009 is the result of a very high value of the index in that year but the decrease between 2010 and 2012 is because of decrease in catches as the index was at similar levels between the two years (Figure 7.2.7).

The definition of the F_{proxy} is obviously sensitive to the definition of the abundance index. In 2012 the advice was given based on survey catches of length greater than 25 cm, while here the index is based on catches in depths greater than 400 m. In terms of the advice for the 2013/2014 the resulting advice would have been 5600 t (95% CI: 3000–11 000) or roughly 2000 t greater on average than the advice given by ICES.

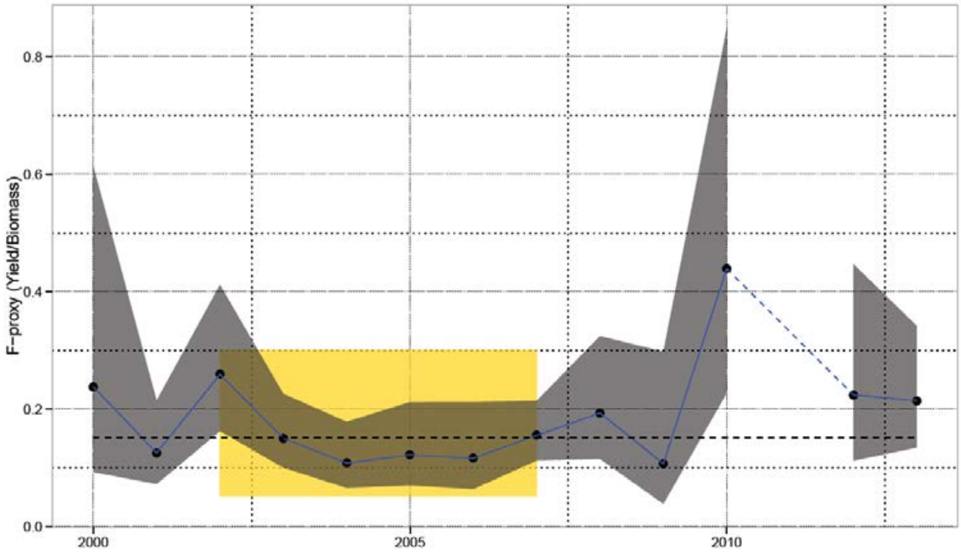


Figure 7.2.8. Greater silver smelt in Va. Changes in relative fishing mortality (F_{proxy}). The index used is the >400 m index from the Icelandic autumn survey.

Analytical assessment

An exploratory stock assessment of greater silver smelt in Va using the Gadget model was presented at the WGDEEP 2014 meeting. In general the model followed the trends observed in the autumn survey data but the model seemed to be driven mainly by the age-structured data as it captured the shifts in the age distribution observed in the commercial catches. According to the model SSB increased from 22 kt in 1982 to little below 40 kt in 1998 when it decreased to similar levels in 1999 to 2003 as in 1982. This drop coincided with the start of the targeted fishery in the late nineties. In 2008 to 2010 the SSB had reached 50 kt, a value substantially higher the initial starting values in 1982. This may seem contradictory however the initial value of the SSB is of little importance as, as noted earlier, a directed fishery started in the late 1990s. Estimates of fishing mortality for fully selected age groups (age 15 to 22) showed a rapid increase in 1997 to 1998 from virtually zero to 0.5 but then a decline to 2007 and a terminal estimate of 0.23. According to the forward projections from the model catch levels should have been set, based on $F_{0.1}$, at 9.6 kt in 2014/2015.

The Gadget model can be viewed as general framework for utilizing all available data and as such can detect inconsistencies in the data often ignored in other models which make much stronger assumptions about stock dynamics such as stock production models. In general the exploratory Gadget model did seem to capture the main trends in the data, i.e. trends in mean length and age but issues with the survey indices remain. That does not have to come as a surprise due to the high CV in the indices. The model did seem to follow the age structured data quite well.

7.2.7 Comments on the assessment

The assessment presented above is based on the ICES DLS approach for category 3 stocks and was proposed by the ADG in 2012. In the 2012 advice the target F_{proxy} was set at 0.076 or the average F_{proxy} in 2002 to 2007. Since then the biomass index from the autumn survey at depths greater than 400 m has been deemed more appropriate measure of the biomass available to the fishery with a target F_{proxy} 0.151. Using the same approach to advice on catch levels with this new biomass index the landings should not exceed 5041 tonnes (33 387*0.151).

7.2.8 Management considerations

Exploitation of greater silver smelt has been at high levels for the last five years. The evidence from the available data indicates that this high exploitation rate may be in excess of the stocks productivity but according to the available data i.e. indices, length and age distributions there are no marked changes in the last four to five years.

Table 7.2.4. Greater silver smelt in Va. Nominal landings in 1988–2012.

YEAR	CATCHES
1988	206
1989	8
1990	112
1991	247
1992	657
1993	1.255
1994	613
1995	492
1996	808
1997	3.367
1998	13.387
1999	6.704
2000	5.657
2001	3.043
2002	4.960
2003	2.686
2004	3.637
2005	4.481
2006	4.775
2007	4.226
2008	8.778
2009	10.829
2010	16.428
2011	10.515
2012	9.290
2013	7.154

Table 7.2.5. Greater silver smelt in Va. Landings and survey biomass from the Icelandic autumn survey (greater than 400 m) and F_{proxy} (Yield/Survey biomass)

Year	Landings	Index	CV Index	F_{proxy}
2000	5657	23 722	0.482	0.238
2001	3043	24 441	0.277	0.125
2002	4960	19 184	0.237	0.259
2003	2686	17 850	0.207	0.150
2004	3637	33 617	0.254	0.108
2005	4481	36 786	0.282	0.122
2006	4775	41 061	0.306	0.116
2007	4226	27 276	0.164	0.155
2008	8778	45 438	0.264	0.193
2009	10 829	101 014	0.521	0.107
2010	16 428	37 432	0.336	0.439
2011	10 515	No survey		
2012	9290	41 554	0.353	0.224
2013	7154	33 387	0.238	0.214

7.3 Greater silver smelt (*Argentina silus*) in I, II, IIIa, IV, Vb, VI, VII, VIII, IX, X, XII, XIV

As mentionet in chapter 7.1 stock structure for greater silvers smelt is under scrutiny. In an working document to SIMWG and ACOM the WGDEEP 2014 meeting recoments that this unit is split further into advicary units as fishing grounds are suffisiently isolated. It is also suggested that further division may be adequate. This change might be implimented in 2015, wich is an advisory year.

7.3.1 The fishery

Significant fisheries occur in Subareas IIa to VIa; other areas have only minor bycatch of this species. Presently the main actors in direct fisheries are Norwegian fleets in IIa2, Faroese fleets in Vb and VIa, and Dutch fleets in VIa. The Norwegian, Faroese and Dutch catches have since 2005 represented more than 90% of the total landings from this stock.

7.3.2 Landing trends

Preliminary figures for total landings in 2013 are 31 709 t (Tables 7.3.1 and 7.3.2, Figure 7.3.1). Landings in Area IIa, mainly conducted by Norway, were reduced in 2007 as a response to management to stabilise around 12 000 t and preliminary numbers for 2013 landings are at that level.

Landings in Vb increased rapidly from 2004 (5300 t) to 2006 (12 400 t) and further increased with landings in 2011 being 15 586 t. Landings in 2012 showed substantial reduction to 9854 t, while landings in 2013 are 11 065. These landings are mainly from the Faroese directed fisheries. The reason for this change is believed to result from a shift in the fishery to other target species and that the fleet fish in VIa inside the Faroese 200 EEZ boarder.

The landings in VI and VII increased and had maximum of 19 049 t in 2001; then decreased again and have been between 5000 and 7500 since 2004. Preliminary landings in 2013 are 5513 t. Landings in VI and VII mainly come from Faroese and Dutch fisheries, of which 99% are taken in VIa.

It should be noted that lesser silver smelt (*Argentina sphyraena*) may in some southerly areas have been included in the landing figures. According to research on the Spanish Porcupine survey where both species appear lesser silver smelt are smaller and occupies shallower areas than greater silver smelt (Figures 7.3.2, 7.3.3 and 7.3.4). The proportion of lesser silver smelt in the fisheries is not believed to be large but further investigations should be undertaken.

7.3.3 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."

The 2012 advice for this stock is biennial and valid for 2013 and 2014 (see ICES, 2012): Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 31 300 tonnes.

7.3.4 Management

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 tonnes TAC was introduced as a precautionary measure to reduce an increase in the fishery. This TAC has been the same since 2007. 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.

The EU introduced TAC management in 2003. For 2013 the EU TAC is set to 5434 t which is close to the 2012 level (I+II =90 t; III+IV = 1028 t; V, VI, VII = 4316 t).

For 2014 the EU TAC is set to 5434 t which the same as 2013 (I+II =90 t; III+IV = 1028 t; V, VI, VII = 4316 t).

For the Faroese fleets, there is no species-specific management of GSS in Vb, although licences are needed in order to fish. The recommended minimum landing size is 28 cm. Other nations are regulated by TACs.

The Faroese GSS fishery is at the moment managed by an agreement between the Faroese GSS fishery fleet and the Faroese authorities, guided by the stock assessment and scientific advice of FaMRI. The current agreement is that total annual landings should not exceed 18 thousand t Faroese waters.

7.3.5 Data available

7.3.5.1 Landings and discards

Landings data are presented by area and countries (Tables 7.3.1 and 7.3.2, Figure 7.3.1).

Discarding is banned in Norway and Faroese waters and there is no available information on GSS discard in these areas.

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). Information available on discards in 2009 and 2012 in Basque country and Spanish fisheries in Subareas VI–VII, and Divisions VIIIabcd and northern IXa (Table 7.3.3). These estimates have been in the range 1000–4000 t since 2003. In 2010 and 2011 they were around 2000 t. New calculation of the estimates for 2012 and 2013 reduce strongly the discards reported by Spain. Based upon on-board observations from DCF sampling, the catch composition of the French mixed trawl fisheries in Vb, VI and VII include 5.3% of greater silver smelt, based upon data for year 2011 (Dubé *et al*., 2012). This species is discarded in that fishery; it represents 25.3% of the discards. Raised to the total landings from that fishery an estimated 280 t of discarded greater silver smelt was estimated for 2011. Based upon similar level of the fishery in 2010–2012 this figure applies to recent years.

7.3.5.2 Length compositions

There are length distributions of commercial catches from the Norwegian trawl fisheries in IIa from 2009–2013 (Figure 7.3.5), Faroese commercial trawl catches in Vb (7.3.6) and from the Russian commercial bottom trawl catches in the Faroese Fishing Zone (Figure 7.3.7). In addition, there exist length measurements from the Netherlands fishery in VIa.

Also, length distributions data of GSS from different surveys in IIa, Vb and VII are presented. Data from the Norwegian slope survey in IIa in March 2012 are shown in Figures 7.3.8. Length distributions and mean length of immature and mature GSS from the Faroese spring- and groundfish survey in Vb are showed in Figures 7.3.9, 7.3.10 and 7.3.11. The size compositions of *Argentinas* spp. from Porcupine survey since 2001 is presented in Figure 7.3.12 (Velasco *et al*., WD WGDEEP 2014).

7.3.5.3 Age compositions

Age compositions from Norwegian catches in IIa and Faroese landings in Vb are presented in Figures 7.3.13 and 7.3.14. In addition, there exist age data from the Netherlands fishery in VIa.

Age distributions from the Norwegian slope survey in IIa in March 2012 are shown in Figures 7.3.15. There also exist age data of greater silver smelt from the Faroese groundfish surveys in Vb.

7.3.5.4 Weight-at-age

Weight-at-age data of GSS from the Faroese commercial trawl fisheries are presented in Figure 7.3.16.

7.3.5.5 Maturity and natural mortality

Maturity of greater silver smelt from Russian commercial bottom-trawl catches in the Faroese FZ in April–May 2013 are shown in Figure 7.3.17.

No new data on natural mortality were presented.

7.3.5.6 Catch, effort and research vessel data

One standardized cpue series from commercial trawlers targeting GSS in Faroese waters (Vb) are shown in Figure 7.3.18 (Ofstad, 2014 WD WGDEEP).

Data from different surveys in IIa, Vb and VII were also presented.

An acoustic survey was conducted in 2012 along the continental slope in Norwegian EEZ from 62–74°N (Hallfredsson and Heggebakken, WD ICES WGDEEP 2013). This survey is run biennially and 2012 was the second time the survey is carried out.

Highest densities of greater silver smelt in 2012 were found in similar areas as in 2009 on the continental slope off central Norway (Figure 7.3.19). Total acoustic biomass estimates 2009 and 2012 surveys are shown in Table 7.3.4.

Cpue indices for greater silver smelt from the annual Faroese groundfish surveys for cod, haddock and saithe in Vb are shown in Figure 7.3.20, as well as density and distribution from the same survey is shown in figure 7.3.21 (Ofstad, WD WGDEEP 2014). It has to be noted that these surveys have very few stations deeper than 500 m and are therefore only likely to cover the juveniles and are unlikely to represent the biomass of the fishable stock.

Spanish bottom-trawl surveys have been carried out in Area VII (Porcupine) since 2001. Recent investigations have revealed that survey catches from the Spanish Porcupine survey contain both *A. Silus* and *A. Sphyraena* (Figures 7.3.2, 7.3.3 and 7.3.4). Abundance and biomass indices from survey catches of mixed *A. silus* and *A. sphyraena* is presented in Figure 7.3.22. As with the Faroese surveys the Spanish survey only goes to 400 m and is unlikely to cover the depth range of greater silver smelt.

7.3.6 Data analyses

Landings have increased from the whole stock area since 1994 but have been stable at level between 30 000–35 000 tonnes since 2007 for the main fisheries in Areas IIa, Vb and VIa. Size and age in catches have decreased but seem to have been stable recently. The Norwegian landings are around the TAC set to 12 000 tonnes. Landings trends in this period may therefore not be indicative of stock abundance.

Length and age distributions

Norwegian size and age distributions from fisheries in IIa (Figures 7.3.5 and 7.3.13) are similar in different key fishing areas and showed that catches continue to consist of rather younger fish than catches in the 1980s during the initial years of the target fisheries 1990s (Bergstad, 1993; Monstad and Johannessen, 2003; Johannessen and Monstad, 2003). There are no marked changes in the size and age composition in the recent 5–6 years. However length and age distributions in the Norwegian survey in the area show higher length and age, with proportion of old fish closer to what was found in the 1980s compared to what is found in the fisheries (Figures 7.3.8 and 7.3.15) This may indicate that the fisheries are conducted on shallow waters compared to the species distribution, as size of greater silver smelt increases with depth. Faroese length and age compositions from the landings in Vb have decreased since 1994–2000 and have been stable since then (Figures 7.3.6 and 7.3.14). The reason for the decrease in mean length is thought to be directed fishery on a virgin stock (Ofstad, WD WKDEEP 2010). The variation in mean length from the latest years could be due to sampling from different depths in the various areas, as the size of GSS is increasing with depth. In WKDEEP 2010 it was suggested to divide the length composition of GSS from the surveys into juvenile and mature individuals; to check if the trend in mean length changed over time (Figure 7.3.11). No change in trends for mean length is found for juveniles, while there is a slight decrease in mean length since the start of the series for mature fish.

The size compositions from Porcupine Bank in area VII have no obvious trend towards smaller fish but these data may by disturbed by the relative species composition *A. silus* and *A. sphyreana* (Figure 7.3.12).

Commercial and survey cpue series

There is an increasing trend across the time-series in the Faroese commercial cpue (area Vb) (Figure 7.3.18). 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.

The Faroese summer survey biomass index showed no strong trend between 1996 and 2011 (Figure 7.3.20). 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 (very few stations deeper than 500 m) will likely result in poor sampling of adult fish as large individuals are generally found at greater depths.

For Subarea VII, abundances and biomass indices from the Spanish porcupine survey have been showed a decreasing trend from 2002 until 2011 but have been rising since then (Figure 7.3.22). However the survey is unlikely to cover all the exploitable biomass of the stock as it only goes down to 400 meters.

Exploratory assessment

An exploratory stock assessment of GSS in Faroese waters (Vb) using XSA was presented to the group. It is basically an update of previous exploratory assessments, with new years added to the time-series (Ofstad, WD WGDEEP 2014). There is a strong retrospective bias in the model except for the last two years. Additionally a strong residual pattern is observed and plus group is set at a relatively low age (14+) resulting in a large plus group. Catches in the XSA run only include Faroese catches in Vb and VIa but not Dutch catches in VIa.

7.3.7 Comments on the assessment

Advice is given every second year for this stock and last year's advice applies for present year.

The advice is based on trends in two surveys that are very in a limited area of this extremely widespread assessment unit. Especially the Porcupine survey is conducted where no known fisheries have been conducted, and far south from current main fishing grounds around Faroe Islands and west of Norway.

On request from ACOM the WGDEEP 2014 has sent a working document with supporting information to SIMWG and ACOM regarding stock structure. There a more comprehensive division into advisory units is advocated.

7.3.8 Management considerations

Management advice for this stock was subject to further development after the 2012 WGDEEP meeting under the WKLIFE process.

The trends from Faroese analysis are not alarming, and in Porcupine bank survey abundance indices have since 2011 gone from downward to upward trends. Population characteristics from Norwegian fisheries data are not showing negative trends in recent years. Population characteristics from Norwegian surveys show larger and older fish than samples from the fisheries in the same area. Acoustical biomass estimates in 2012 show some reduction compared to 2009, but further estimates are needed before this can be fully interpreted as trend.

FAMRI has recommended a TAC of 18 thousand tons in Faroese waters of Vb for 2014, since the current assessment may not be stable enough to provide reliable estimates.

Table 7.3.1. Greater Silver Smelt I, II, IIIa, IV, Vb, VI, VII, VIII, IX, X, XII, XIV. WG estimates of landings in tonnes. *) landings in 2012 are preliminary.

Greater silver smelt (*Argentina silus*) I and II

Year	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Iceland	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					15 796
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			11 831				23			11 854
2011			11 476							11 476
2012			12 002				0.2	114	18	12 134
2013*			11 978				0.3			11 979

Table 7.3.1. (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
2011						585	0.2			585
2012			1.4		49	224				274
2013*	55		1.9			1250		21		1327

Table 7.3.1. (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
2011	15 071	8							15 079
2012	9744	110							9854
2013*	10 951	114							11 065

Table 7.3.1. (Continued).

Greater silver smelt (*Argentina silus*) VI and VII

Year	Denmark	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			580	3724	7	3	20		11		7405
2011		3655			0.1	3729	1		2				7279
2012		2781	2	538	0.2	3248	10	5	5		1		6608
2013	388	2933		417	0.1	1757	5				13	0.2	5513

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		
2011	1	1
2012		
2013*		

Table 7.3.1. (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
2011		0.9	0.9
2012		1.9	1.9
2013*			

Table 7.3.1. (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					
2011					
2012		31			31
2013*					

Table 7.3.1. (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			
2011			
2012			
2013*		1824	1824

Table 7.3.2. 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
2011	11 476	585	15 586	7387	1	0.9			35 036
2012	12 134	274	9854	6590		1.9	31		28 885
2013*	11 979	1327	11 065	5513				1824	30 709

Table 7.3.3. GSS in VIb. Discard of greter silver smelt in Basque country (AZTI) and Spanish fisheries (IEO).

AZTI

species	ICES area/division	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Argentina silus	VI	298	89	31	57	194	68	81	127	2	*	*
	VII	16	1	17	9	13						
	VIIIabd	282	7	242	36	3						
IEO												
Species	**ICES area/division**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Argentina silus	Subareas VI-VII	2211	2978	2149	1147	1823	2988	4028	1878	2048	177	90
cv		*64*	*44*	*62*	*40*	*55*	*34*	*36*	*36*	*90*		
Argentina silus	Divisions VIIIc,	0		0	0	6	5	0	0		0	2
cv	North IXa			*100*		*88*	*64*		*100*			

***Included in IEO Discards.**

Table 7.3.4. GSS in IIa. Abundance estimates (t) for Greater silver smelt in Norwegian slope surveys Mars 2009 and 2012. For methods see Harbitz, WD ICES WKDEEP 2010.

	2009	2012
Lat < 70 deg, depth >500 m	77 272	33 468
Lat < 70 deg, depth <500 m	57 897	79 624
Lat > 70 deg, depth >500 m	1642	5310
Lat > 70 deg, depth <500 m	2447	2961
Total	139 258	121 363

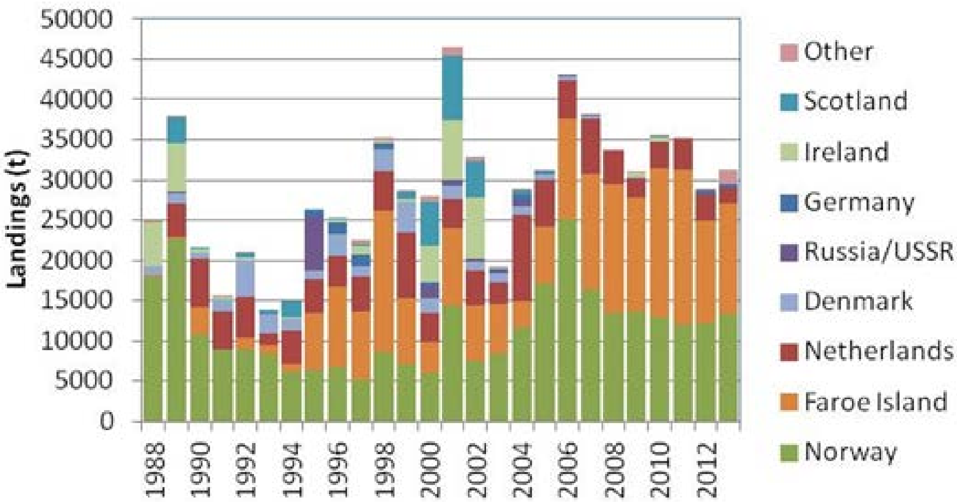


Figure 7.3.1. Total landings of greater silver smelt in I, II, IIIa, IV, Vb, VI, VII, VIII, IX, X, XII, and XIV by countries.

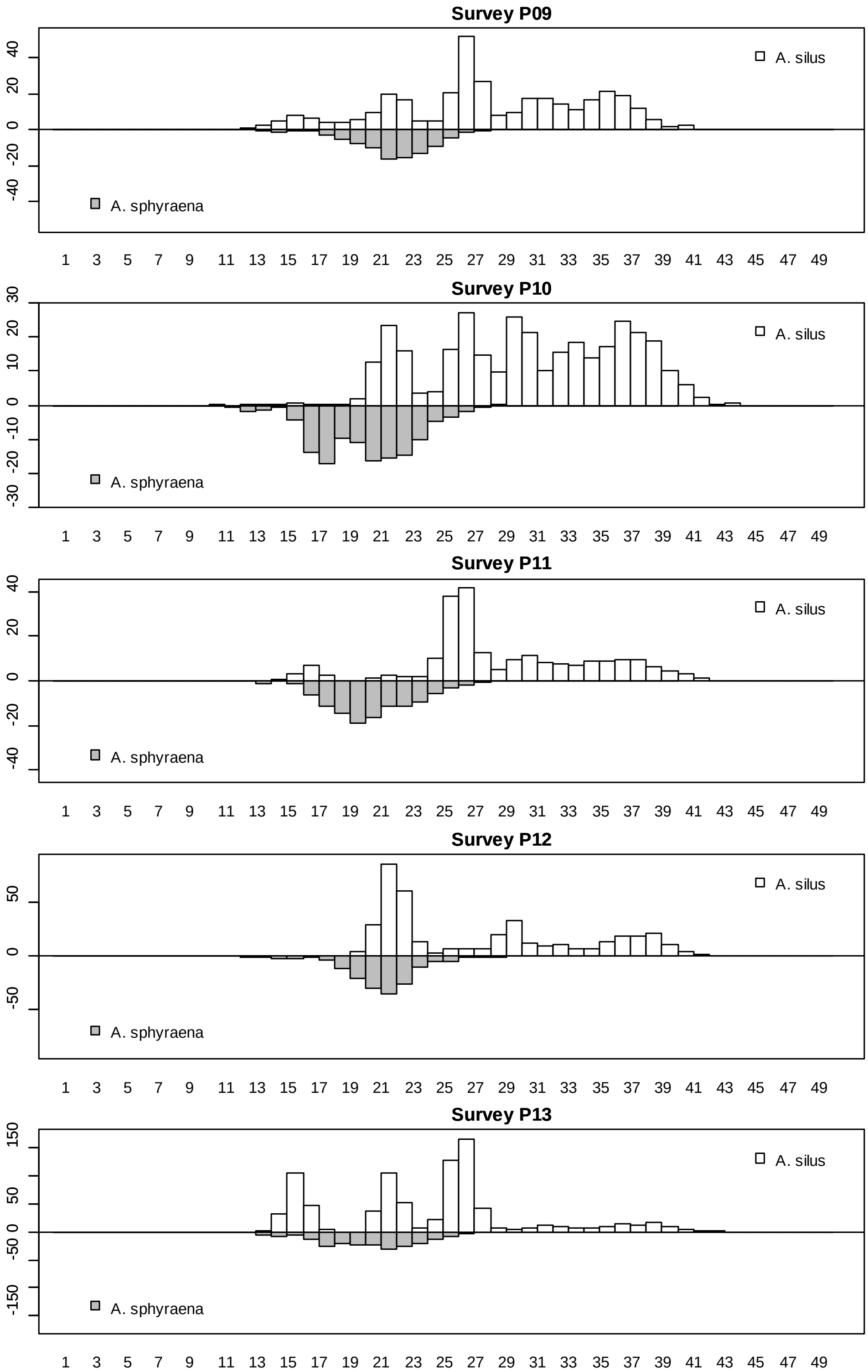


Figure 7.3.2. Greater silver smelt in VII. Mean stratified length distributions of *A. silus* and *A. sphyraena* in 2009–2012 in Spanish Porcupine surveys. (Velasco *et al*., WD WGDEEP 2013).

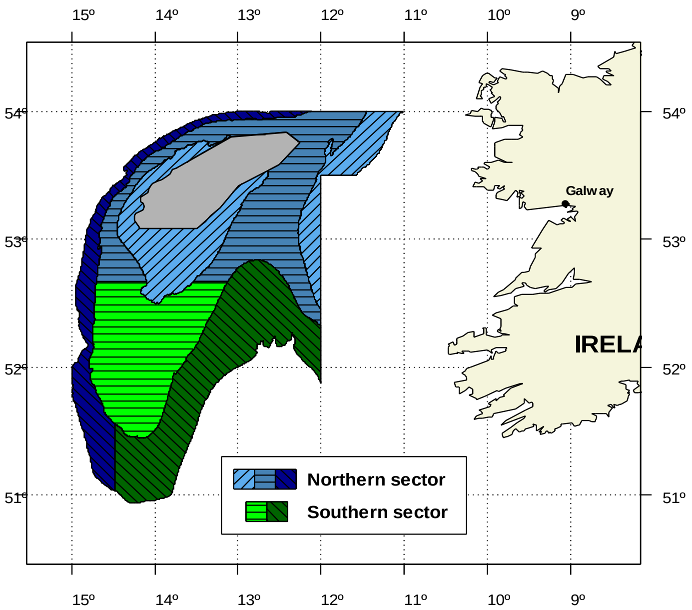


Figure 7.3.3. Greater silver smelt in VII. Stratification design used in Porcupine surveys from 2003. Depth strata are: A) shallower than 300 m, B) 301–450 m and C) 451–800 m. The grey area in the middle of Porcupine Bank corresponds to a large non-trawlable area, not considered for area measurements and stratification.

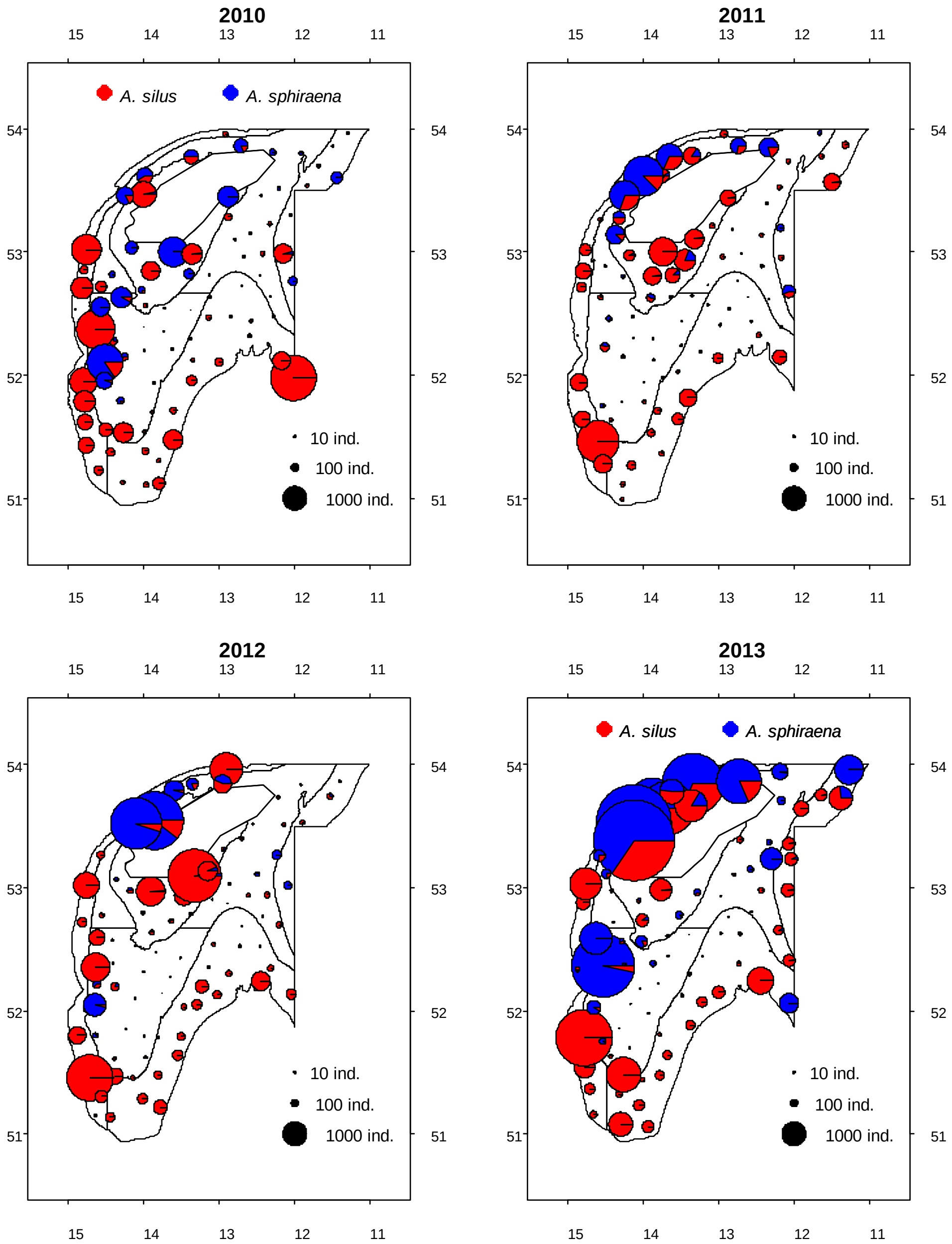


Figure 7.3.4. Greter silver smelt in VII. Distribution of *Argentina silus* and *A. sphyraena* by numbers during in 2010–2013 in the Spanish Porcupine bank survey.

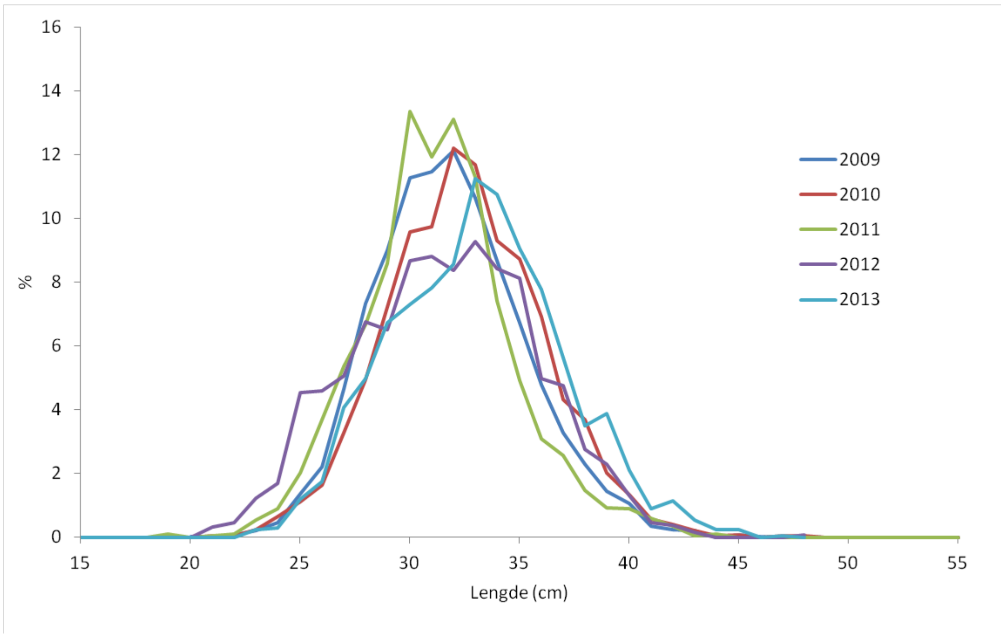


Figure 7.3.5. Greater silver smelt in IIa. Length distributions from the fisheries in 2009–2013. Samples from all fishing fields summed up within a year. (Hallfredsson and Heggebakken, 2014 WD, WGDEEP).

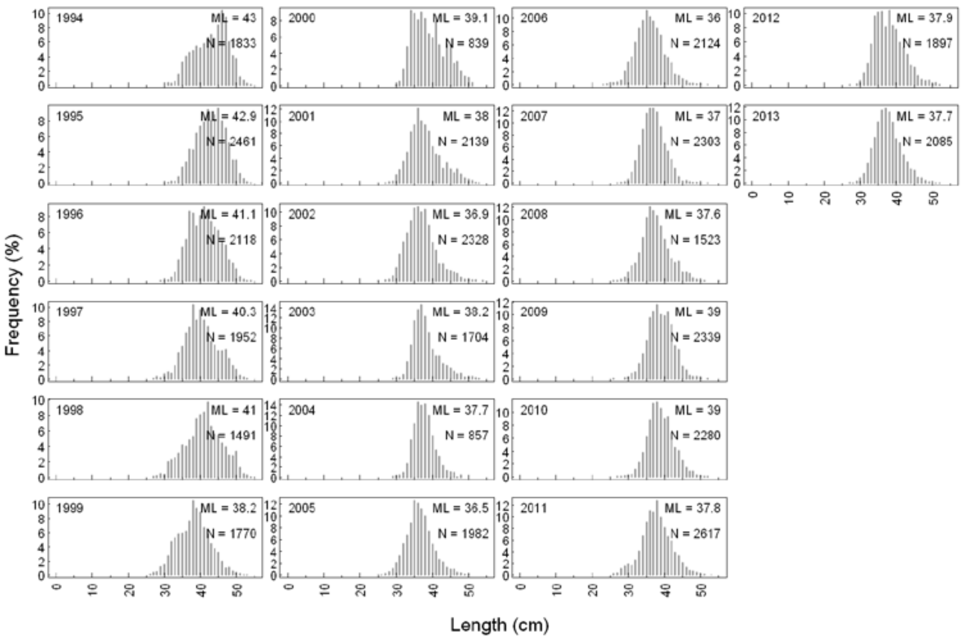


Figure 7.3.6. Grater silver smelt in Vb. Length distributions of greater silver smelt in the Faroese landings (Ofstad, WD WGEEP 2014).

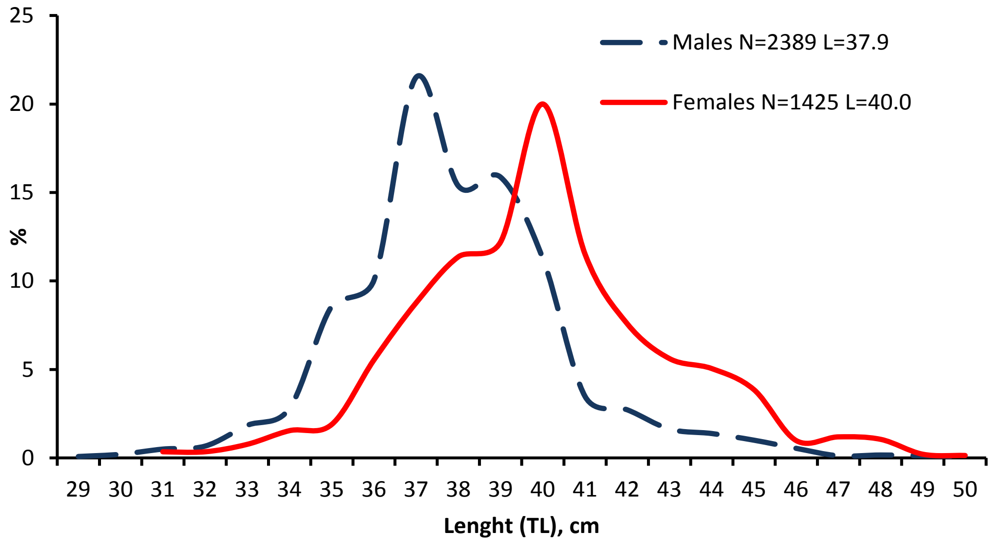


Figure 7.3.7. Greater silver smelt in IIa. Length composition of greater silver smelt from Russian commercial bottom-trawl catches in the Faroese FZ in April–May 2013 (Aleksandrov and Vinnichenko, 2014 WD WGDEEP). Also shown are arrhythmic mean lengths (Lm).

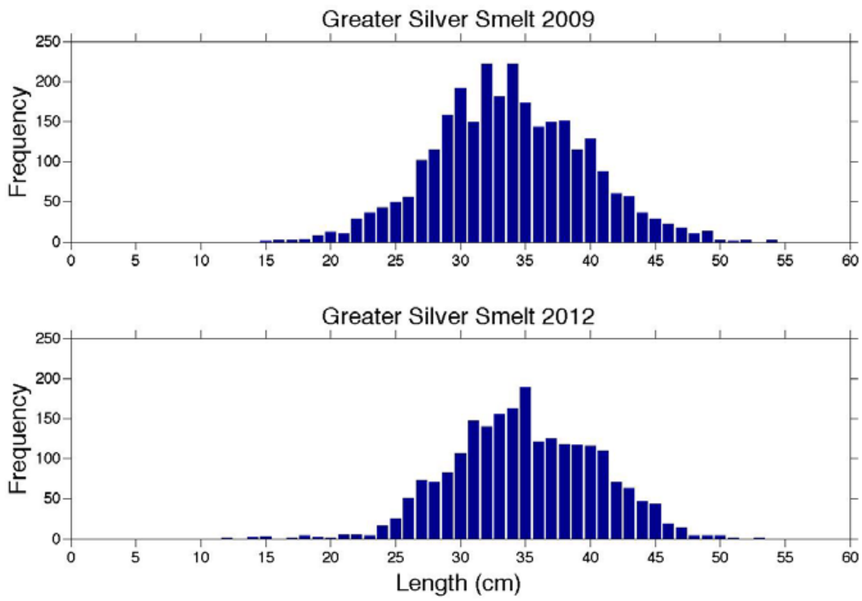


Figure 7.3.8. Greater silver smelt in IIa. Length distributions for greater silver smelt in the Norwegian slope surveys March 2009 and 2012.

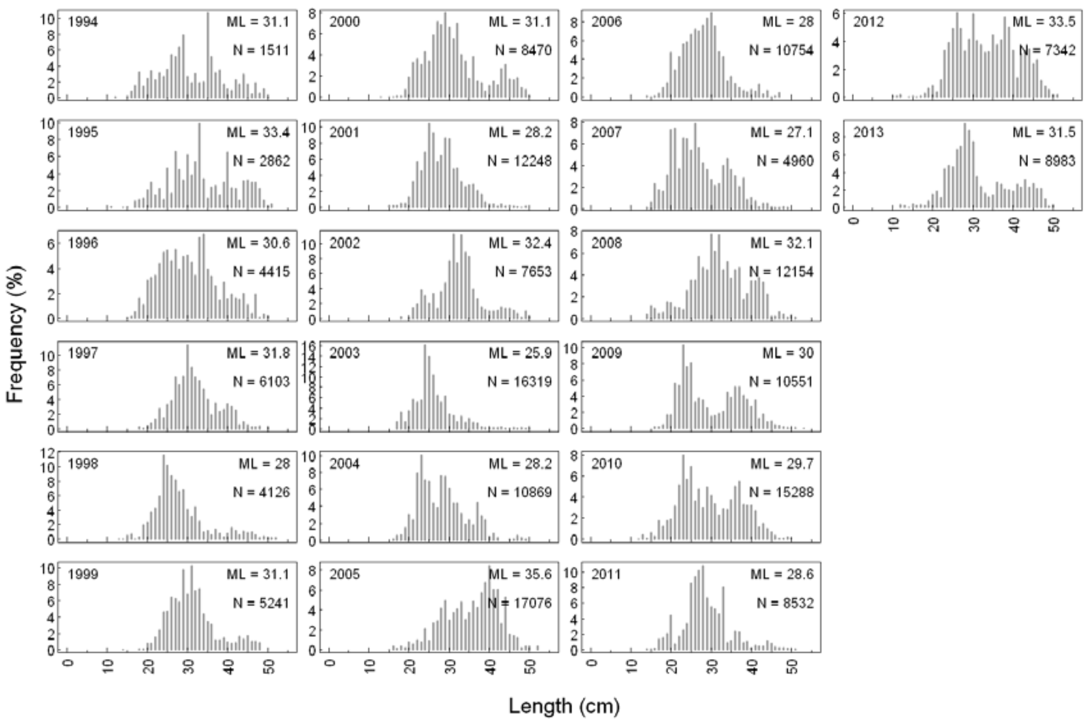


Figure 7.3.9. Greater silver smelt in Vb. Length distribution from the Faroese spring survey with mean length (ML) and number of calculated length measures (N). Greater silver smelt is sampled from a subsample of the total catch, so the values are multiplied to total catch.

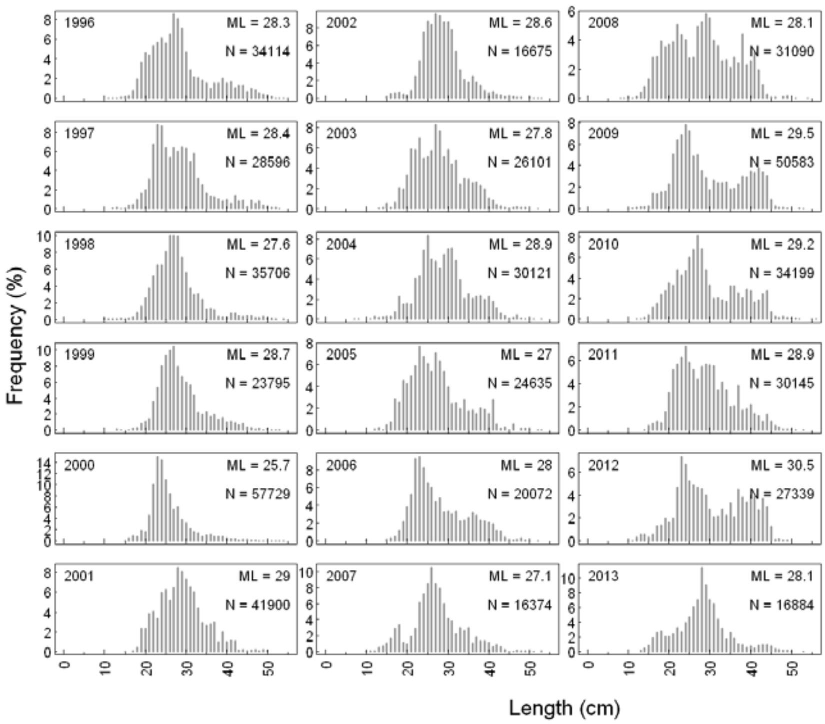


Figure 7.3.10. Greater silver smelt in Vb. Length distribution from Faroese summer survey with mean length (ML) and number of calculated length measures (N). GSS is sampled from a subsample of the total catch, so the values are multiplied to total catch.

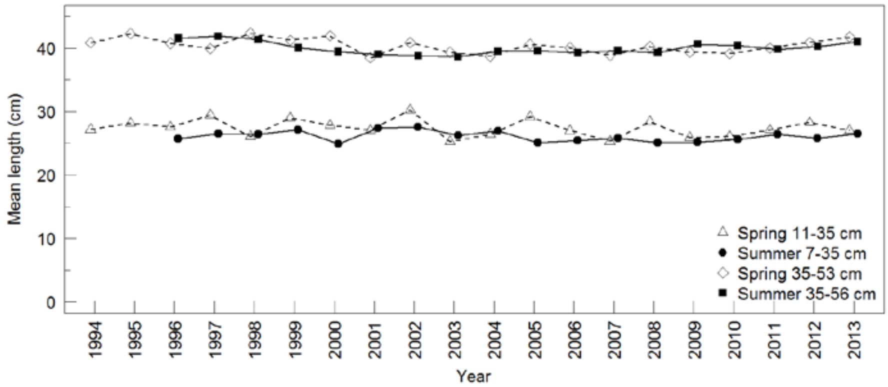


Figure 7.3.11. Greater silver smelt in Vb. Mean length for juvenile (<35 cm) (top) and mature (>34.9 cm) (bottom) GSS from the groundfish surveys (Ofstad, WD WGEEP 2014).

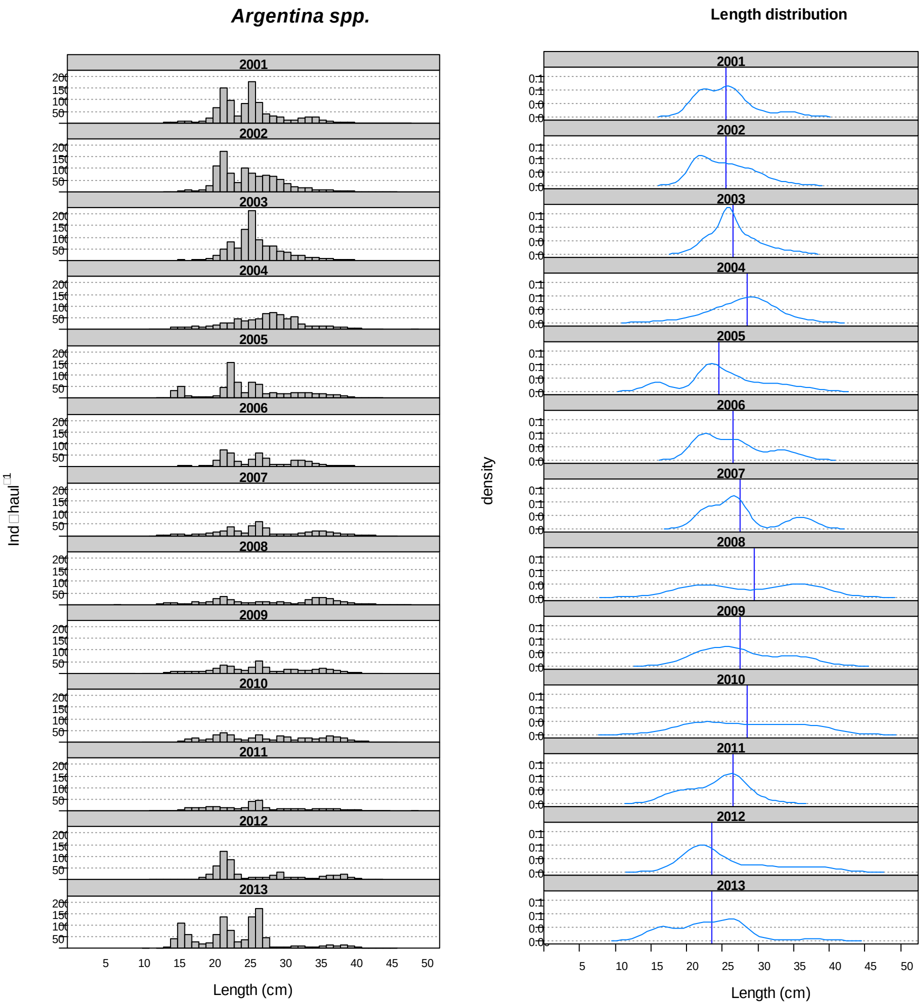


Figure 7.3.12. GSS in VII. Mean stratified length distributions of *Argentina* spp. in Spanish Porcupine surveys.

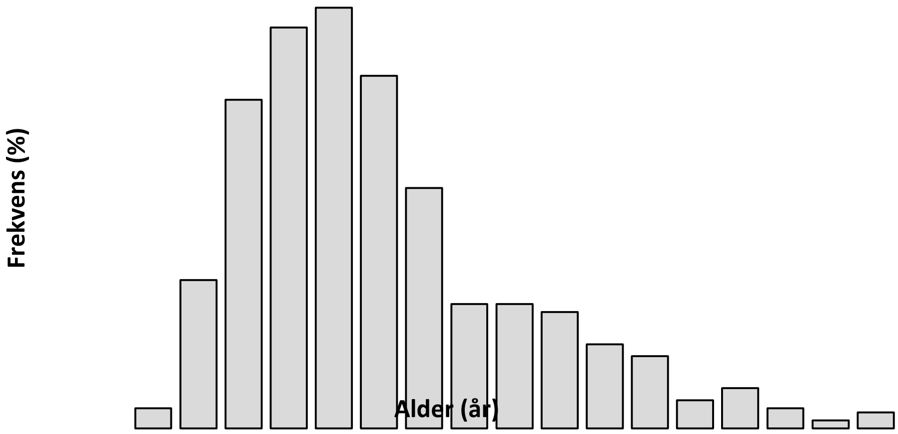


Figure 7.3.13. GSS in IIa. Age distributions of greater silver smelt from Division IIa fisheries in 2013. These are data from individual samples (denoted by IMR serial number). Fishing areas are given in brackets (Hallfredsson and Heggebakken, WD WGDEEP 2014).

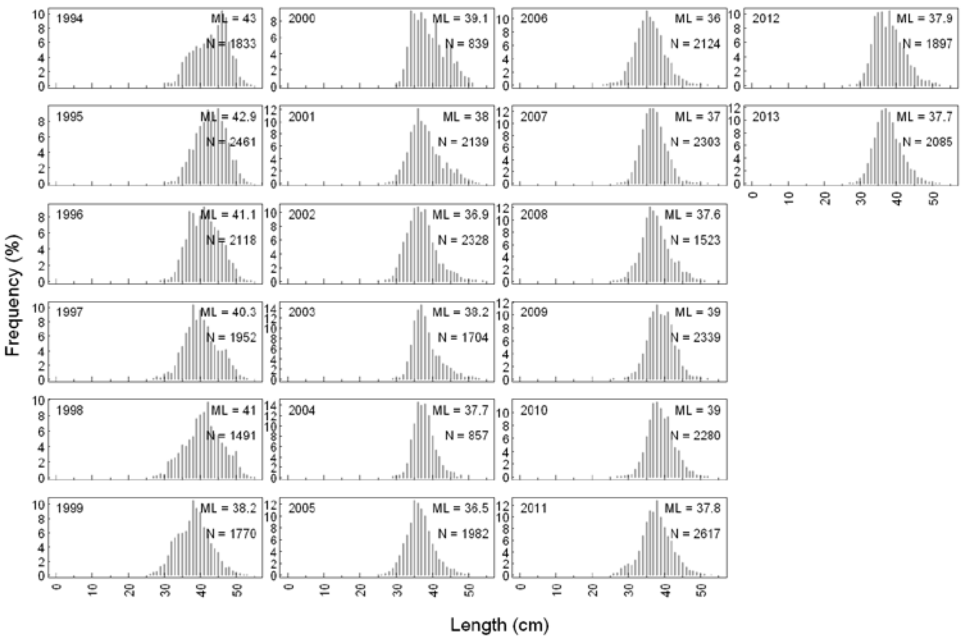


Figure 7.3.14. GSS in Vb. Age distribution (raw data) from commercial pair trawlers with mean age (MA) and number aged (N) 1994–2013 (Ofstad, 2014 WD, WGDEEP).

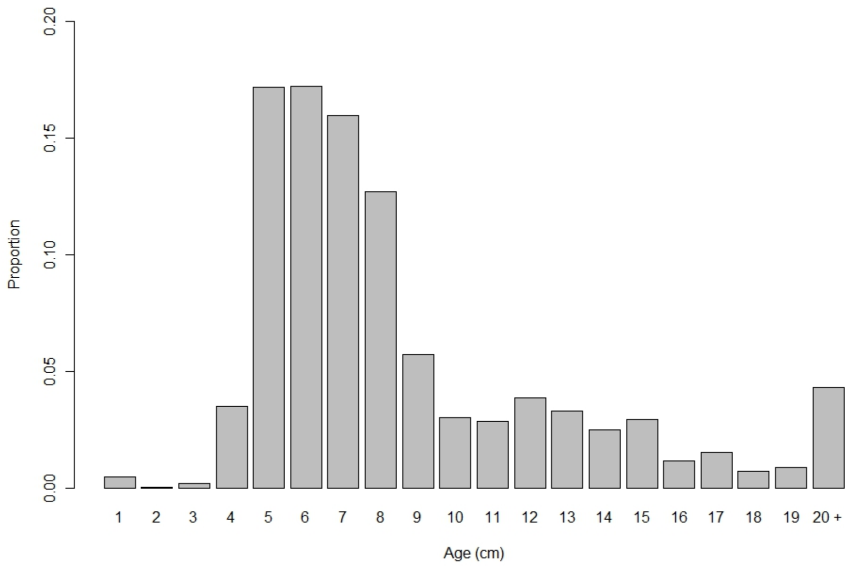


Figure 7.3.15. GSS in IIa. Age distribution for greater silver smelt in the Norwegian slope survey March 2012.

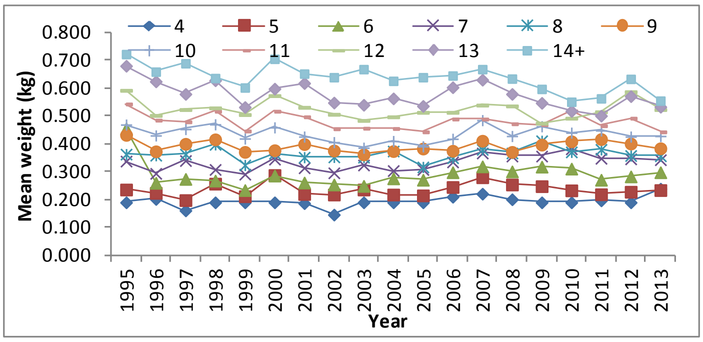


Figure 7.3.16. GSS Vb. Mean weight at ages 4-14+ of GSS in the commercial catch.

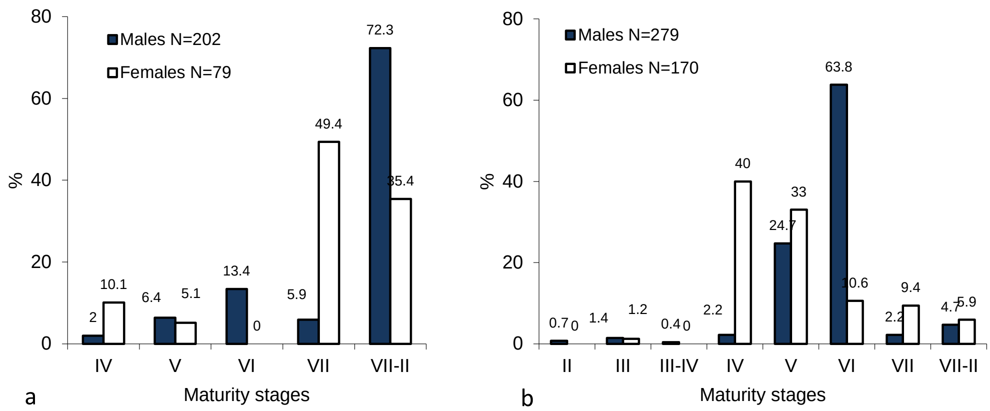


Figure 7.3.17. GSS in Vb. Maturity of Greater silver smelt from commercial bottom-trawl catches in the Faroese EEZ in April–May 2013 (a- Lousy Bank, b-Bill Baileys Bank)(Aleksandrov and Vinnichenko, 2014 WD WGDEEP).

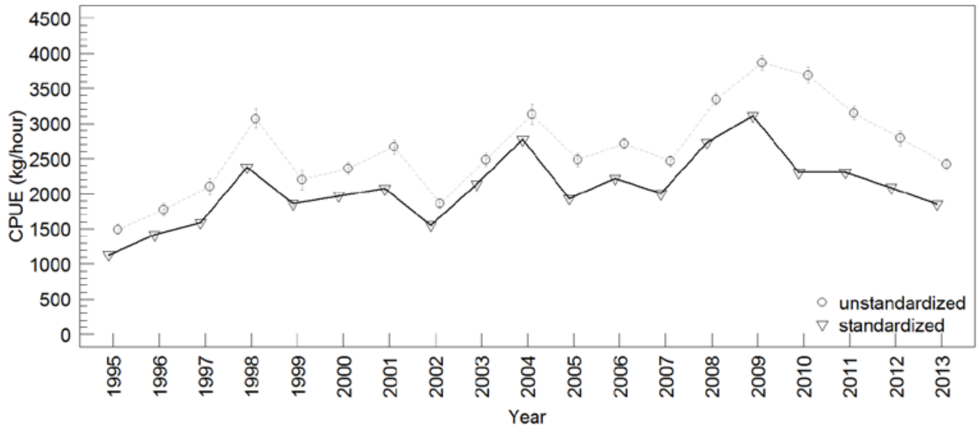


Figure 7.3.18. GSS in Vb. Standardized cpue from pair trawlers fishing greater silver smelt where catch of GSS is more than 50% of total catch in each haul (Ofstad, WD WGEEP 2014).

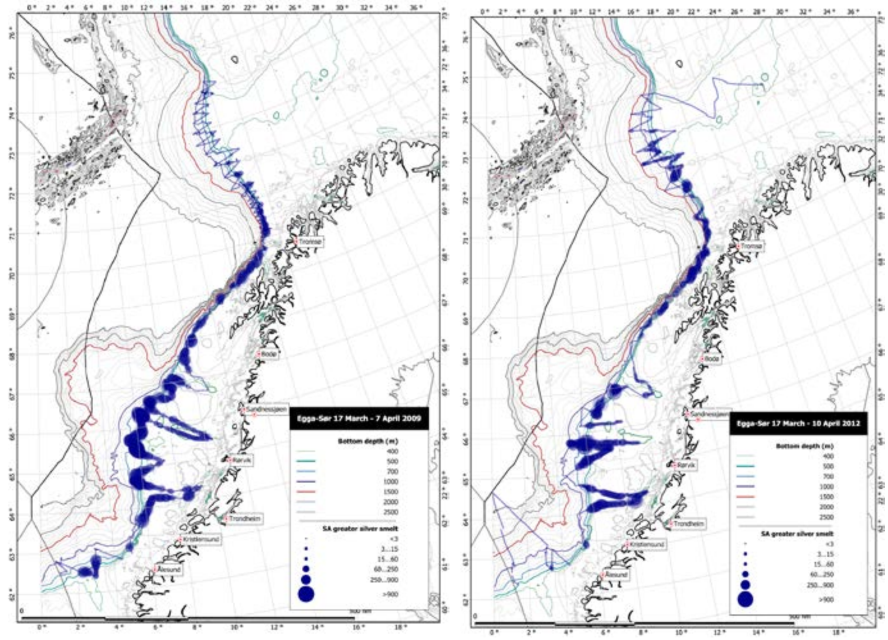


Figure 7.3.19. GSS in IIa. Acoustic estimates (SA-values) for distribution of greater silver smelt in Norwegian continental slope surveys March/April 2009 and 2012.

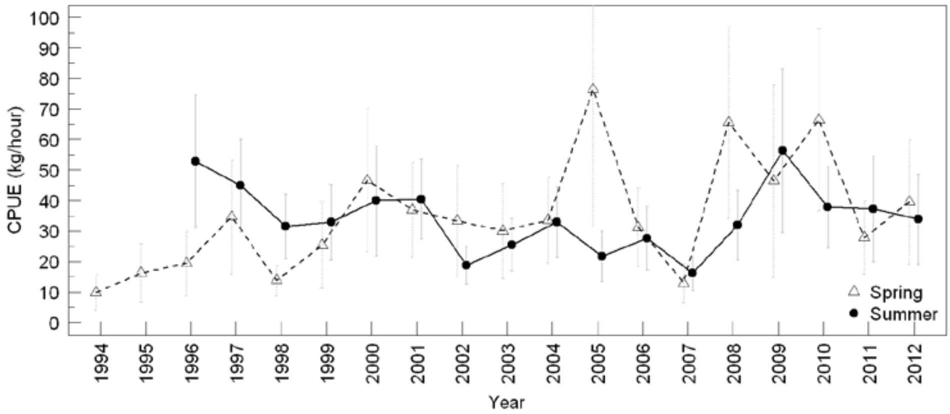


Figure 7.3.20. GSS in Vb. Standardized cpue from Faroese groundfish surveys. Arrows +- SE. (Ofstad, WD WGEEP 2014).

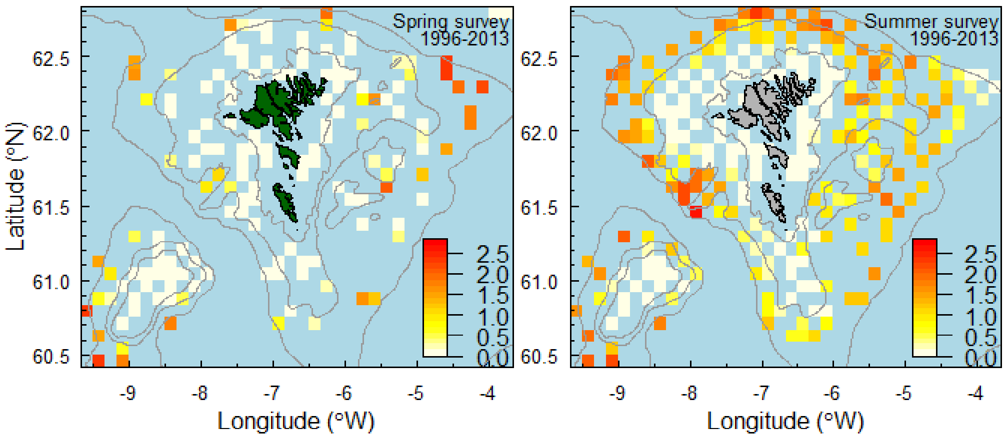


Figure 7.3.21. GSS in Vb. Density and distribution of greater silver smelt in the annual spring- and summer groundfish surveys as average log(kg/hour+1). Depth contour line is for 100, 200 and 500 m.

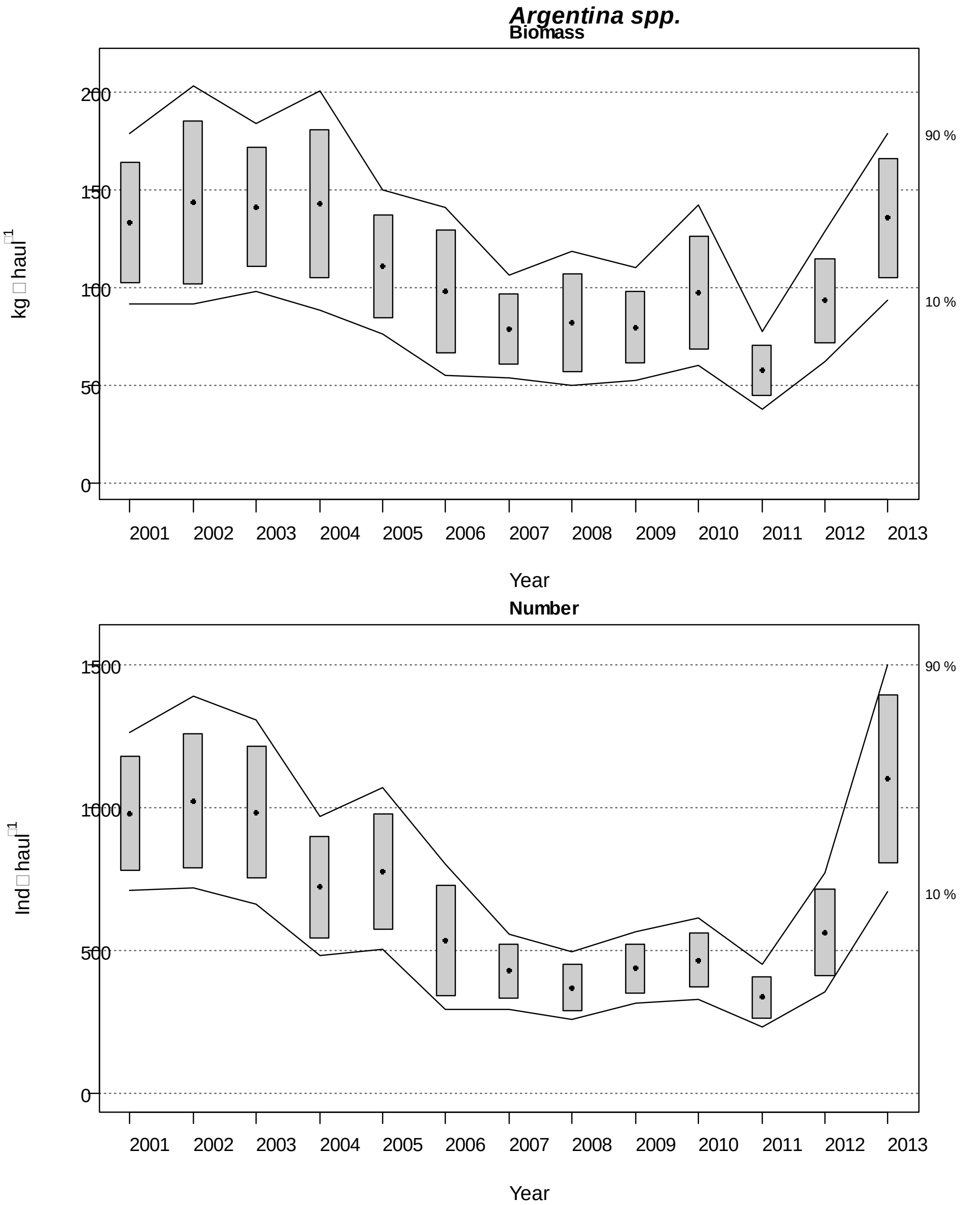


Figure 7.3.22. Greater silver smelt in VII. Changes in *Argentina* spp. (mainly *Argentina silus*) biomass and abundance indices during Porcupine Survey time-series. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

8 Orange roughy (*Hoplostethus atlanticus*) in the Northeast Atlantic

8.1 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 8.1.1 shows the accumulated catch of orange roughy in the NEA in the different ICES areas for catches from 1991 to 2013.

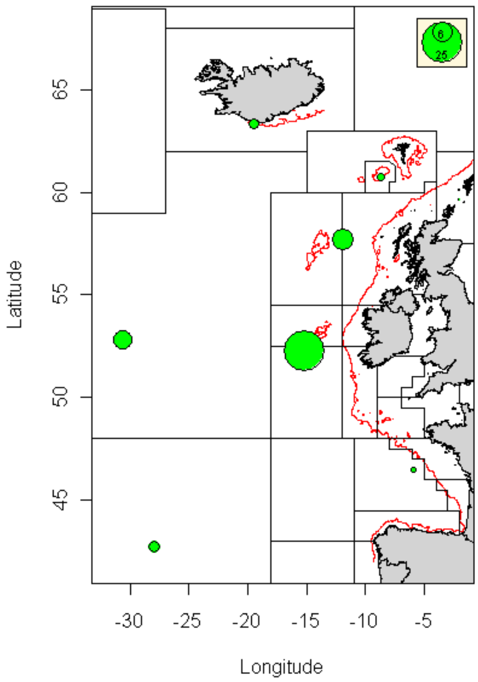


Figure 8.1.1. Fisheries for orange roughy by ICES areas in Northeast Atlantic. Size of circles reflects historic accumulated catch 1991–2013 in thousand tons.

8.2 Orange roughy (*Hoplostethus Atlanticus*) in Subarea VI

8.2.1 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.

8.2.2 Landings trends

Table 8.2.0 and Figure 8.2.1 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 landings of orange roughy in Area VI recorded in 2013. The cumulative landings in Area VI until 2013 was 7187 tons.

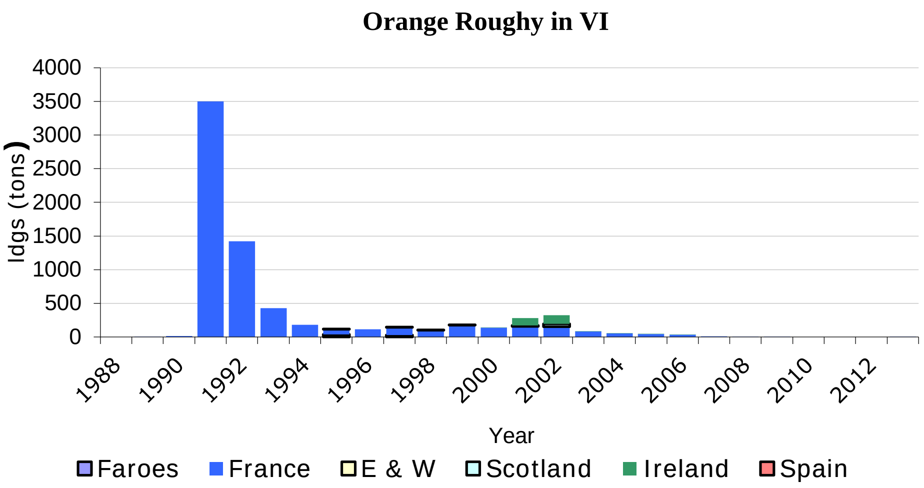


Figure 8.2.1. Time-series of orange roughy landings by country in ICES Area VI.

8.2.3 ICES Advice

The ICES advice for 2013 and 2014 is: Due to its very low productivity, orange roughy can only sustain very low rates of exploitation. Currently, it is not possible to manage a sustainable fishery for this species. ICES recommends no directed fisheries for this species. Bycatches in mixed fisheries should be as low as possible.

8.2.4 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 between 2007 and 2009. A zero TAC has been set for orange roughy in VI since 2010.

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	0	0
2012	0	0	0
2013	0	0	0
2014	0	0	0

8.2.5 Data available

8.2.5.1 Landings and discards

Landings are in Table 8.2.0.

The raising of the observed bycatch from on-board observers to the fleet level for the French deep-water trawl fishery to the West of the British Isles gave an estimated discard of 1 tonnes (confidence limits 0-1t) at the fleet level.

8.2.5.2 Length compositions

Length distributions are available from historical observer programmes and current deep-water surveys. Available information can be found in the stock annex.

8.2.5.3 Age compositions

No new information. Available information can be found in the stock annex.

8.2.5.4 Weight-at-age

No information.

8.2.5.5 Maturity and natural mortality

No new information. Available information can be found in the stock annex.

8.2.5.6 Catch, effort and research vessel data

No new information. Available information can be found in the stock annex.

8.2.6 Data analyses

See Section 8.3 for productivity susceptibility analysis.

8.2.7 Management considerations

The fisheries for orange roughy in Subareas VI and VII have now ceased and a zero TAC has been implemented since 2010. A zero TAC without allowing a bycatch can potentially lead to discarding if existing fisheries overlap with the distribution of orange roughy. Examination of French observer data suggests that bycatch and discarding of orange roughy is currently not significant (<1 tonne).

Due to the closure of the fishery in VI and VII there are limited fishery-dependant data to evaluate the status of the stocks. Also, current fisheries limited monitoring programmes are insufficient to monitor the recovery of the stocks in VI and VII.

Assessment of the susceptibility of orange roughy populations in VI and VII to recent and current deep-water trawl fisheries (see Section 8.3) has shown a strong reduction in risk over time when fisheries stopped directed targeting practices and continued with mixed deep-water trawl fisheries. Some spatial overlap between the species and current fisheries remains, such as on the ″flat″ fishing grounds in VI on the continental slope to the northwest of Ireland extending to the west of Scotland. The overlap between orange roughy distribution and current fishery seems to generate small bycatch. Owing to previous estimates of sustainable catch of a few hundred tonnes per year in VI and VII, the impact of current fisheries are considered sustainable.

Table 8.2.0. 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
2011		0					0
2012		0					0
2013		1(1)					3**

*** Preliminary. (1) discards only; including 2 tonnes unallocated**

8.3 Orange roughy (*Hoplostethus Atlanticus*) in Subarea VII

8.3.1 The fishery

After the collapse of the fishery in Subarea VI, the main fishery for orange roughy in the northern hemisphere moved to this subarea. This fishery peaked in 2002 and rapidly declined thereafter. Some targeted fishing from a few or even one single 20–24 m trawlers was carried out until 2008 while the remaining catches were a bycatch from the mixed deep-water trawl fishery operating on the slopes.

8.3.2 Landings trends

Table 8.3.1 and Figure 8.3.1 show the landings data for orange roughy as reported to ICES or as reported to the Working Group. There have been no landings of orange roughy reported in VII since 2010.

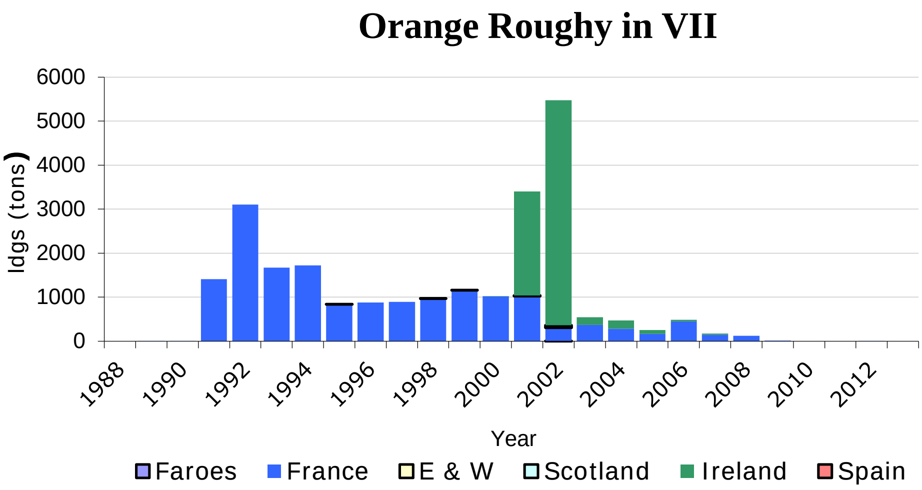


Figure 8.3.1. Time-series of orange roughy landings by country in ICES Subarea VII.

8.3.3 ICES Advice

The ICES advice for 2013 and 2014 is: Due to its very low productivity, orange roughy can only sustain very low rates of exploitation. Currently, it is not possible to manage a sustainable fishery for this species. ICES recommends no directed fisheries for this species. Bycatches in mixed fisheries should be as low as possible.

8.3.4 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	0	0
2012	0	0	0
2013	0	0	0
2014	0		

The TAC for orange roughy in VII is set to 0 t for 2013 and 2014.

8.3.5 Data available

8.3.5.1 Landings and discards

Landings are shown are in Table 8.3.0.

On-board observed catch (unraised landings and discards) by the French fleet operating in VI and VII in tonnes of roundnose grenadier, black scabbardfish, greater forkbeard, blue ling and deep-water shark (labelled deep-water species) and of orange roughy are shown in the table below:

	2004	2005	2006	2008	2009	2010	2011	2012	2013
Deep-water species	148	93	49	96	382	350	701	488	378
Orange roughy	16	1	2	0	9	0	1	0.05	0.05
Ratio	0.11	0.01	0.04	0.00	0.02	0	0.0014	>0.001	>0.001

In recent years, discards estimated at fleet level have been calculated for total discards and by species. In 2012, the estimated discard was 20% of the total and the estimated discards of orange roughy was 400 kg for a total catch (landings+discards) estimate of 5300 tonnes at fleet level.

These data suggest that the bycatch of orange roughy in the mixed deep-water trawl fishery is low.

8.3.5.2 Length compositions

No new information available. Historic information can be found in the stock annex.

8.3.5.3 Age compositions

No new information available. Historic information can be found in the stock annex.

8.3.5.4 Weight-at-age

No data.

8.3.5.5 Maturity and natural mortality

No new information available. Historic information can be found in the stock annex.

8.3.5.6 Catch, effort and research vessel data

No new information. Available information can be found in the stock annex.

8.3.6 Data analyses

Productivity susceptibility analysis (PSA) was performed to evaluate the biological vulnerability of orange roughy in relation to other deep-water species and the risk that recent and current fisheries pose to its populations in VI and VII (Irish EEZ only).

Two productivity susceptibility analyses (PSA) were carried out according to Hobday *et al*. (2007, 2011) using a modified version of the Marine Stewardship Council (MSC) assessment worksheets. The first PSA was a multispecies comparison of species that are typically caught in the mixed deep-water trawl fishery west of Ireland and Scotland (ICES subareas VI and VII) and included five teleosts and three elasmobranchs. Productivity scores were calculated for seven attributes, based on biological data derived from published literature using Northeast Atlantic estimates where available. Scoring categories were adjusted from Hobday *et al*. (2007) to account for the overall longevity of the species examined and their body sizes. Susceptibility scores were based on the four attributes availability, encounterability (vertical overlap between fish distribution and fishery), selectivity and death after capture as described by

Hobday (2007) and two additional attributes which included seasonal migration and schooling, aggregation and other behavioural responses (Patrick *et al*. 2010).

The second PSA focused on orange roughy and was used to examine the change of susceptibility over time. Availability, the spatial overlap of fishing effort distribution with the distribution of a population, was calculated by summing up the grid cells of the orange roughy distributional area which intersected with the grid cells of VMS deep-water effort for every year. Spatial catch information of orange roughy within the Irish EEZ was compiled from haul by haul information from scientific observer programmes, catch data from logbooks linked to VMS and scientific surveys: orange roughy acoustic survey programme on the Porcupine Bank from 2005, Irish deep-water trawl survey from 2006 to 2009 and Scottish Deep-water survey from 2000 to 2011 (Figure 8.3.2). Spatial and temporal distribution of the French and Irish Deep-water fisheries in the part of ICES Subareas VI and VII that is within Ireland's exclusive economic zone (EEZ), were derived from VMS data between 2006 and 2012. France and Ireland were the two main nations operating deep-water fisheries within the Irish EEZ (ICES, 2012). Seasonal migration considers the susceptibility to fisheries due to migration and was considered here in the context of fishing practices which targeted seasonal migrations on seamounts and other bathymetric features. A high susceptibility was given for the years, when directed seamount fisheries on orange roughy spawning aggregations were taking place, this score was reduced when the targeted fisheries ceased and only mixed trawl fisheries on deep-water slopes were carried out. Further details on methodology including PSA scoring tables are given in Dransfeld *et al*. (2014).

In the multispecies PSA, orange roughy scored 2 in productivity, which is the midpoint and indicates a medium biological risk to fishing (Figure 8.3.3). Most of the teleost species scored lower with North Atlantic codling (*Lepidion eques*) and greater forkbeard (*Phycis blennoides*) showing highest productivity (i.e. lowest vulnerability scores) and orange roughy and roundnose grenadier scoring highest (both with a score of 2) in vulnerability. The three elasmobranchs all display lower productivity than the teleost species. The overall species vulnerability to fishing was highest for the two squalid shark species, followed by orange roughy, *Etmopterus spinax* and roundnose grenadier. The species *Phycis blennoides* and *Lepidion eques* have low scores due to their higher productivity, while black scabbardfish has lower values due to lower susceptibility.

In the single-species multiannual PSA, availability scores were given according to the spatial overlap between the distribution of orange roughy and the distribution of deep-water fishing effort as monitored by VMS. In 2006, 71% of the cells intersected, this figure decreased to 19% by 2009 and ranged between 25 and 33% for the last three years (figure 8.3.4). The main reduction in spatial overlap over time was observed on the western and southwestern slopes of the Porcupine Bank. Highest consistent overlap through time was evident on the northern slope of the Porcupine Bank and the continental slope northwest of Ireland. Direct target fisheries with vessels fishing on spawning aggregations of orange roughy over seamounts decreased from 2007 onwards. This resulted in a change of susceptibility scores reducing the risk from high during the period of actively targeting spawning aggregations to low when only mixed fisheries on the continental slopes caught orange roughy. Aggregated PSA scores indicated a reduction in risk scores over time (Figure 8.3.5). Scores fell within the medium risk category for 2006 and decreased into the low risk category from 2007 onwards.

Time-dependant PSA, based on the spatial overlap between orange roughy distribution and recent and current deep-water fisheries demonstrated a strong reduction in risk over time when fisheries stopped directed targeting practices and continued with mixed deep-water trawl fisheries. Some spatial overlap between the species and current fisheries remains and while the method can show relative risk reduction, it cannot inform on whether the risk is low enough to allow the recovery of depleted populations.

8.3.7 Comments on the assessment

As a first step, a PSA on the deep-water fish community was presented to analyse the relative vulnerability of orange roughy in relation to other species to the mixed deep-water trawl fishery conducted to the west of Ireland and Britain. In a further application, the PSA approach was used on a single species to evaluate whether and how the risk of recent deep-water fisheries have changed over time. This stems from the necessity to develop a form of risk assessment for a population which is considered depleted. The population is data deficient with regards to fisheries-dependent and independent data due to closed fisheries and a lack of scientific monitoring programmes. Using the PSA on one species means that the productivity attributes are fixed in time and the focus of the analysis is on the relative susceptibility of the species to fisheries and their changes over time.

At the onset of this study (2006) the orange roughy TAC for VII was 1149 t and landings were 488 t which were primarily caught in a directed fishery (ICES, 2011). TACs reduced to 0 within a time frame of four years and landings decreased accordingly as deep-water fleets discontinued target fisheries for orange roughy. In addition, several spatial management measures were introduced, including, in 2007, orange roughy protection areas from which no orange roughy could be landed and offshore areas of special conservation for the protection of vulnerable marine ecosystems (VMEs) which banned fishing with bottom impacting gear from 2008 onwards (EC, 2007). The discontinuation of a directed fishery owing to management is reflected in the change of fishing positions which moved away from historic areas where directed fisheries were executed on bathymetric features such as mounds, ridges and canyons. This is particularly apparent on the western and southwestern Porcupine Bank with its high concentrations of canyons and mounds which has been identified as areas of high orange roughy abundance (O'Donnell *et al*., 2007). The change in fishing pattern resulted in a decrease of PSA scores from a high risk category to a relatively low risk category. The fishery subsequently developed into a mixed fishery on flat fishing grounds targeting roundnose grenadier and black scabbardfish. The areas where these fisheries are still executed, are the "flat" fishing grounds on the continental slope to the northwest of Ireland extending to the west of Scotland. Distribution maps of orange roughy and the deep-water fishing effort indicate that there is still some spatial overlap in this area. One geographical region worth highlighting is the northern slope of the Porcupine Bank. Fishing effort had ceased in this location in 2009 but returned in 2010 to 2012. In the same area, positive catch rates from the Irish deep-water trawl survey in 2007–2009 have confirmed the presence of orange roughy (see ICES 2012). These areas are flat fishing grounds and include juveniles and adults (O'Donnell et al. 2007, ICES 2011) which are believed to migrate to bathymetric features to spawn (Shephard *et al*., 2007). Thus although the risk has decreased over the study period, as indicated by the PSA, some risk stills remains in certain locations.

In conclusion, time-dependant PSA, based on the spatial overlap between orange roughy distribution and recent and current deep-water fisheries demonstrated a strong reduction in risk over time when fisheries stopped directed targeting practices and continued with mixed deep-water trawl fisheries. Some spatial overlap between the species and current fisheries remains and while the method can show relative risk reduction, it cannot inform on whether the risk is low enough to allow the recovery of depleted populations.

8.3.8 Management considerations

The fisheries for orange roughy in Subareas VI and VII have now ceased and a zero TAC has been implemented since 2010. A zero TAC without allowing a bycatch can potentially lead to discarding if existing fisheries overlap with the distribution of orange roughy. Examination of French observer data suggests that bycatch and discarding of orange roughy is currently not significant (<1 tonne). Due to the closure of the fishery in VI and VII there are limited fishery-dependant data to evaluate the status of the stocks. Also, current fisheries independent monitoring programmes are insufficient to monitor the recovery of the stocks in VI and VII.

Assessment of the susceptibility of orange roughy populations in VI and VII to recent and current deep-water trawl fisheries has shown a strong reduction in risk over time when fisheries stopped directed targeting practices and continued with mixed deep-water trawl fisheries. Some spatial overlap between the species and current fisheries remains, such as the northern slope of the Porcupine Bank. Fishing effort had ceased in this location in 2009 but returned from 2010 onwards. In the same area, scientific trawl surveys have confirmed the presence of orange roughy including juveniles (see ICES, 2012). The overlap between orange roughy distribution and current fishery seems to generate small bycatch. Owing to previous estimates of sustainable catch of a few hundred tonnes per year in VI and VII, the impact of current fisheries are considered sustainable.

Table 8.3.1. 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							0
2011							0
2012	2						
2013*							

***Preliminary.**

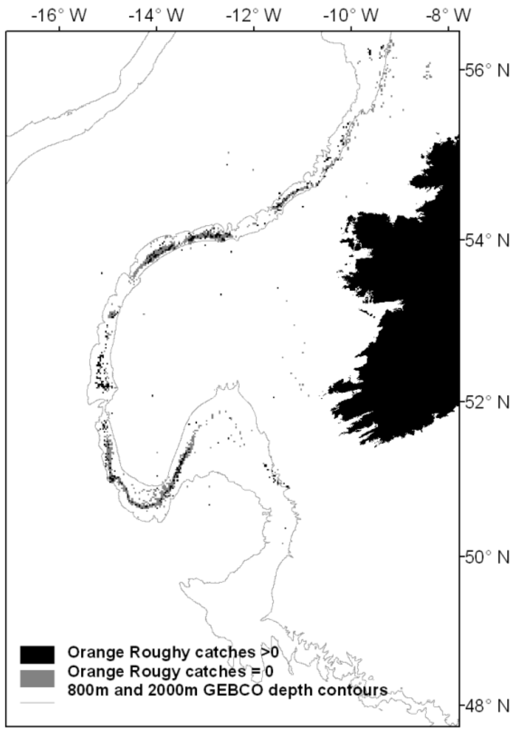


Figure 8.3.2. Spatial positions of orange roughy catches in the Irish EEZ between 2001 and 2011 derived from scientific trawl surveys, fisheries observer programmes and VMS-logbook analysis as gridded sums at a resolution of 1.8 minutes longitude by 1.2 minutes latitude. Contour lines in light grey present the 800 m and 2000 m depth bands.

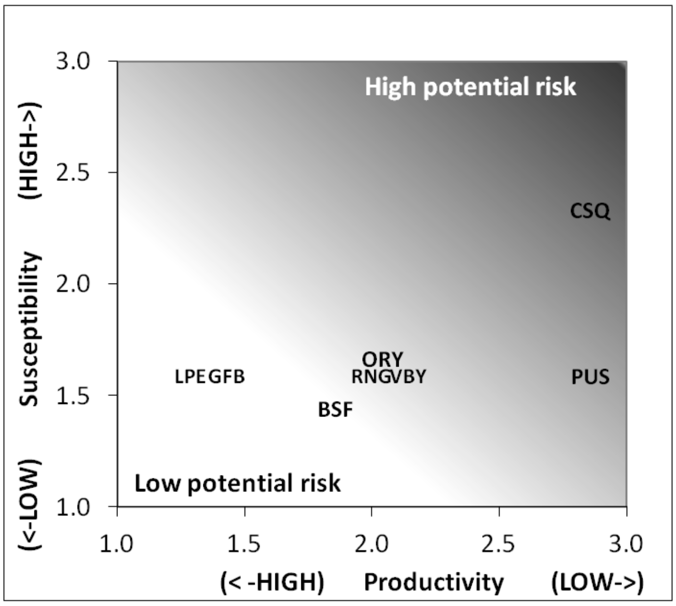


Figure 8.3.3.Multispecies PSA plot: The x axis gives average scores of the attributes that influence the productivity of eight deep-water species; the y axis gives the scaled scores of attributes that influence the susceptibility of the species to the impacts from deep-water fishing in the study area to mixed deep-water trawl fisheries. Productivity and susceptibility scores are used to calculated the euclidian distance and indicate the relative risk of the fishery to the species.

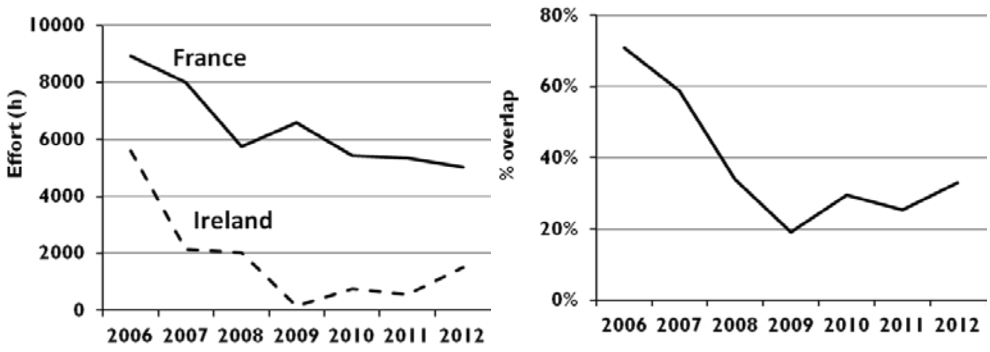


Figure 8.3.4. Hours of Irish and French deep-water effort over time in the Irish EEZ, based on VMS data analysis (left). Change in spatial overlap of orange roughy and deep-water fisheries (proportion of orange roughy distribution area which intersected with VMS deep-water effort area at a resolution of of 1.8 minutes longitude by 1.2 minutes latitude (right).

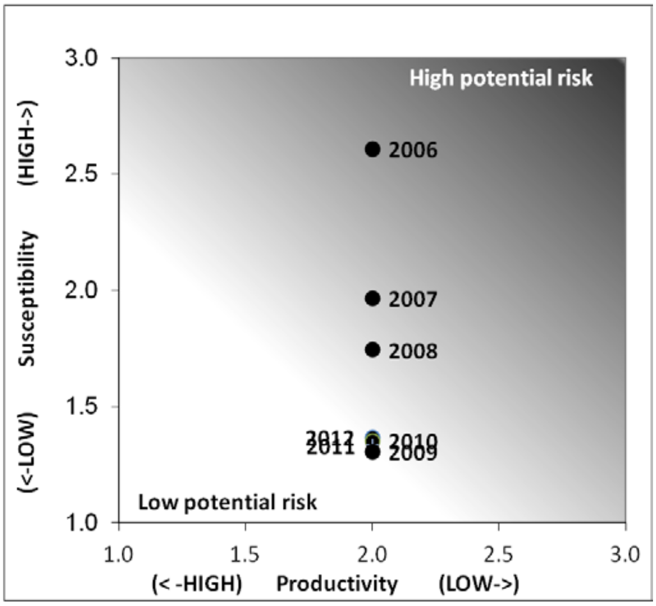


Figure 8.3.5. Time-dependant PSA plot: The x-axis gives average scores of the attributes that influence the productivity of orange roughy; the y-axis gives the scaled scores of attributes that influence the susceptibility of orange roughy to the impacts from deep-water fishing in the study area between 2006 and 2012. Productivity and susceptibility scores are used to calculated the euclidian distance and indicate the relative risk of the fishery to the species.

8.4 Orange Roughy (*Hoplostethus atlanticus*) IN I, II, IIIa, IV, V, VIII, IX, X, XII, XIV

8.4.1 The fishery

Fisheries have been conducted in Subareas Va, Vb, VIII, X, and XII. Most started in the early 1990s, the exception being Subarea X which started in 1996. In the last seven years, fisheries are mainly occurring in X and XII, with sporadic catches in Va, Vb and IX.

8.4.2 Landing trends

Table 8.4.0 and Figure 8.4.1 show the landings data for orange roughy for the ICES areas 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.

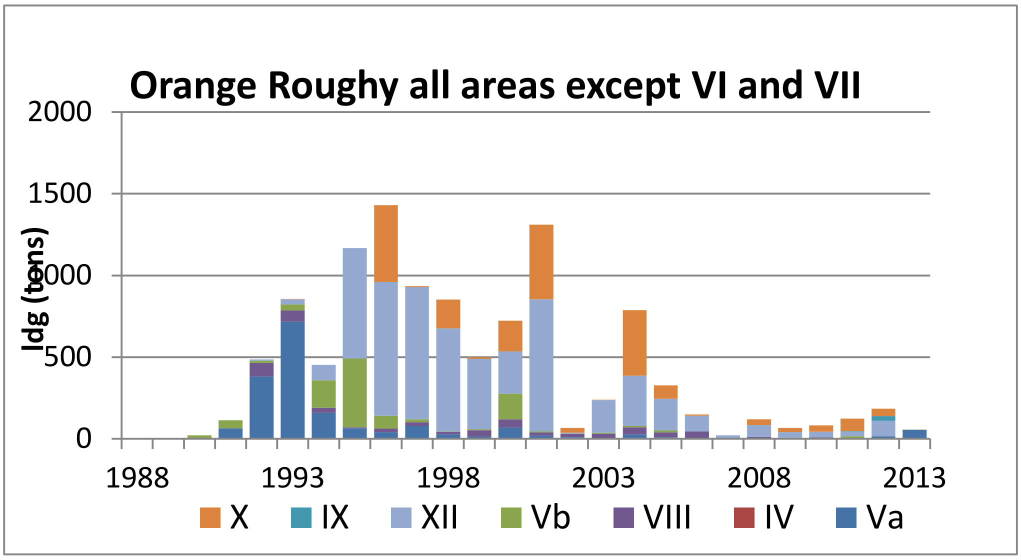


Figure 8.4.1. Time-series of orange roughy landings by in all areas (except VI and VII).

8.4.3 ICES Advice

The ICES advice for 2013 and 2014 is "Due to its very low productivity, orange roughy can only sustain very low rates of exploitation. Currently, it is not possible to manage a sustainable fishery for this species. ICES recommends no directed fisheries for this species. Bycatches in mixed fisheries should be as low as possible".

8.4.4 Management measures

The EU TAC is set for 0 for 2013 and 2014. 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 the NEAFC area, there are no targeted fisheries for orange roughy permitted in those parts of the NEAFC Regulatory Area that fall within ICES Subareas V, VI and VII. In other areas, directed fishery for orange roughy is limited to a total annual catch of 150 tons for any contracting party and is restricted to vessels of contracting parties having participated in fishery for orange roughy in the NEAFC Regulatory Area in areas other than V, VI and VII prior to 2005 (Recommendation 6: 2013).

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	<1	83
2011	0	4	124
2012	0	28	167
2013	0	0	57

8.4.5 Data available

8.4.5.1 Landings and discards

Landings are in Table 8.4.0.

8.4.5.2 Length composition

No new information.

8.4.5.3 Age composition

No data.

8.4.5.4 Weight-at-age

No data.

8.4.5.5 Maturity and natural mortality

No data.

8.4.5.6 Catch, effort and research vessel data

No data.

8.4.6 Data analysis

Catch information and length distributions were provided from the Faroese exploratory fishery on the Mid-Atlantic Ridge. In order to evaluate the impact of this fishery on discrete orange roughy populations, data are required at the spatial resolution of single seamounts.

Methods on reference points could not be performed specifically on orange roughy in all areas. There were insufficient data on life-history characteristics of orange roughy in all areas which would merit a separate analysis to the one performed on orange roughy in VI and VII.

8.4.7 Management considerations

The advice for the fishery given in 2008/2010 is still appropriate: "Due to its very low productivity, orange roughy can only sustain very low rates of exploitation. Currently, it is not possible to manage a sustainable fishery for this species. ICES recommends no directed fisheries for this species. Bycatches in mixed fisheries should be as low as possible."

Table 8.4.0a. 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
2011	4	4
2012	16	16
2013	54	54

Table 8.4.0b. 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
2011	0	0	0
2012	0	0	0
2013	1		1

Table 8.4.0c. 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
2011	0			0
2012	0			0
2013*	0			0

Table 8.4.0d. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Subarea IX.

Year	Portugal	Spain	Total
1990	0	-	0
1991	0	-	0
1992	0	-	0
1993	0	-	0
1994	0	-	0
1995	0	-	0
1996	0	-	0
1997	0	1	1
1998	0	1	1
1999	0	1	1
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
2011	4	0	4
2012	28		28
2013*	0		0

Table 8.4.0e. 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
2011	77						77
2012	45						45
2013*	0						0

Table 8.4.0f. 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
2011	27								27
2012	94								94
2013*	0								1**

1 tonne unallocated.

Table 8.4.0g. 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
2011	0	4	0	0	<1	77	27	108
2012		16	0	0	28	45	94	167
2013*		54	1	0	0	0	0	55
Total	21	1762	1017	545	35	2057	5648	11070

***Preliminary.**

9 Roundnose grenadier (*Coryphaenoides rupestris*)

9.1 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 for population substructure and local adaptation to depth. A study by Knutsen *et al*. (in press and summarised by Bergstad (WGDEEP 2012, WD 03)), covered a larger geographic range and significant genetic structure was observed. Parts of this structure, notably in peripheral (Canada) and bathymetrically isolated basins (Skaggerak and Trondheimsleia (off Norway)), obviously represent distinct biological populations with limited present connectivity. In other areas, off the British Isles (Irish slope, Rockall, and Rosemary Bank), the magnitude of genetic structure is weaker and less clearly defined. This lack of definition could reflect that samples from this area represent a single, widespread population. On the other hand, a recent study of coastal Atlantic cod (Knutsen *et al*., 2011) reported highly restricted connectivity (less than 0.5% adult fish exchanged per year) among two populations that were only weakly differentiated at microsatellite loci. This level is similar to that found between Greenland, Mid-Atlantic Ridge, Rockall, and Rosemary Bank, and the possibility that some of these sites represent distinct biological populations cannot be excluded.

9.2 Roundnose Grenadier (*Coryphaenoides rupestris*) in Division Vb and XIIb, Subareas VI and VII

9.2.1 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.

9.2.2 Landings trends

Official French landings have been revised for 2012 and are preliminary for 2013.

Evidences of substantial mismatches between observer and official Spanish data of landings in Subarea VI and Division XIIb were 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*). This issue is still present for XIIb and VIb landings but according to official Spanish catch data it concerns a much smaller proportion of grenadier catch. Catches of *Macrourus berglax* and *Trachyrincus scabrus* were almost absent from the catches over the 2009–2011 period. In 2012, 6 t of *Trachyrincus scabrus* were reported in VI, 188 t in XIIb. Provisional 2013 landings data show around 179 t and 195 t of *Macrourus berglax* reported in VIb and XIIb respectively. No landings were reported for *Trachyrincus scabrus* in the preliminary 2013 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 1840 t in 2005 and then decreased to 74 t in 2011. In 2013, the provisional landings in Vb are 45 t. These landings are 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 2410 t in 2012. Provisional landings are 1410 t in 2013. Most of these landings are caught by French and Spanish 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, 34 t in 2011). In 2012, provisional landings are 39 t and only from France

In ICES Division XIIb, the recent fishery is exclusively from Spanish trawlers. After a peak to more than 12 200 t in 2004, reported landings have decreased to about 5335 t in 2009, 1580 t in 2011 and 657 t (provisional) in 2012. Provisional landings were 796 t in 2013. 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 2007–2013.

The landings data are considered uncertain in Division XIIb, because of the possibility of unreported landings in international waters, which is a serious issue for assessment. In addition to this, none of the national landings data were reported by new ICES divisions and some landings were allocated to divisions according to working group knowledge of the fisheries.

9.2.3 ICES Advice

The ICES advice for 2013 and 2014 is: "Based on the MSY approach, catches should be no more than 6000 t (4500 t for Division Vb and Subareas VI and VII, and 1500 t (the 2011 catch) for Division XIIb)."

9.2.4 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 4297 t for 2013 and 2014.

In Subareas VIII, IX, X, XII and XIV the TAC was set at 3581 t in 2013 and 3223 t for 2014. 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	14 558
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	3461	5197	2759	6220
2011	2924	1577	4573	1578	3155
2012	2546	1440	3979	657	9094[1]
2013	4297	1498*	3581	796*	3815*[1]
2014	4297		3223		

***: provisional.**

[1]: official + unallocated catches

After the introduction of TACs in 2003 and 2005, the reported landings have decreased. However, the observed decrease may be confounded by problems related to species reporting particularly in XIIb.

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.

9.2.5 Data available

9.2.5.1 Landings and discards

Landings time-series data per ICES areas are presented in Table 9.2.0.

Landings data by new ICES areas were available from France, Norway and UK (England and 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.

French observer program: Discards data are available routinely from France since 2008 through the Obsmer (observers at sea) program. The length distributions of discards from all these observations has been consistent and stable for the period 2004–2010 with about 30% of the weight and 50% of the number of roundnose grenadier caught being discarded, because of small size. This figure is higher than from previous sampling programme where the discarding rate in the French fisheries was estimated slightly above 20% in 1997–1998 (Allain *et al.*, 2003). These differences may have 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. Since then, the discard rate has been reduced to 12% of the weight of the catch (29% in number of individuals) in 2011 and 6% in weight in 2012 (24% in number)s. In 2013, discards accounts for 15% of the catch in weight and 32% in number. The reduction of discards is related to:

1) a change of depth of the French fleet towards shallower waters; and

2) attempts to avoid areas where discards are high.

Spanish Observer programme (Hatton Bank): discard data are available from the Spanish Observer Programme. For the period 2004–2013, *observers have cover*ed on average 15±10% (range 3–39%) of the fleet fishing days in division VIb, and 12±8% (range 2–33%) in Division XIIb. Although occasionally the discards reached 26% of the total observed weight catch in the period 1996–2013, they are negligible in most sampled months. Annual average discards are 7% (range 0 to 21%) in weight in both Divisions VIb and XIIb (range 0 to 26%). These discards, however, correspond to undersized individuals. Discards data for 2011 were not presented as they are considered to be inaccurate but provided again for 2012 and 2013.

9.2.5.2 Length composition of the landings and discards

Length composition of landings and discards were available from France and Spain covering different periods and areas (Figures 9.2.1–9.2.6).

9.2.5.3 Age composition

No new data.

9.2.5.4 Weight-at-age

No new data.

9.2.5.5 Maturity and natural mortality

No new data.

9.2.5.6 Research vessel survey and cpue

Research vessel survey

Data were available from the Marine Scotland deep-water survey since the years 1998 and from stats squares 41E0 through 45E0.

Lpues from the French trawl fishery to the west of the British Isles

Haul by haul data from French skipper's personal tallybooks were updated for 2012 and 2013. Discards are not available from those datasets therefore only lpues are calculated and provided for roundnose grenadier. Owing to the decreasing of quotas in recent years, the fishery now operates on a smaller area. Further, in 2012 data for only two vessels were available at the time of the working group. As a result, the data only covered two of the five small areas previously considered for this lpue series. The time-series should then be interpreted with caution. The observed lpue is unlikely to represent properly the trend in the stock because the change in abundance in unfished areas are not considered.

Lpue from the Faeroese commercial fleet

The commercial cpue series is from trawlers, where the criteria were that grenadier contributed more than 30% of the total catch.

Logbook data for the period 1985–2009 have been quality controlled. The cpue are from a subset of the commercial ships: all available logbooks from 6–8 otterboard trawlers mainly fishing in deep water, 4–8 pair trawlers fishing on the slope from about 150 m and 4–5 longliners (GRT >110). The data for 2010–present are selected directly from the database at the Faroese Coastal Guard and all available logbooks have been available. For comparison the same ships were selected as used previously in the WG.

A general linear model (GLM) was used to standardize all the cpue(kg/h) series for the commercial fleet where the independent variables were the following: vessel (actually the pair ID for the pair trawlers, otterboard trawlers or longliners), month (January–April, May–August, September–December), fishing area (Vb1, Vb2) and year. The dependent variable was the log-transformed kg per hour measure for each trawl haul/setting, which was back-transformed prior to use. The reason for this selection of hauls was to try to get a series that represents changes in stock abundance.

Roundnose grenadier is only fished by large trawlers and the main fishing area is on the slope around the Faroe Bank.

The cpue data were available in 2013 but the figure is likely to be inaccurate because of a low number of individuals caught that year.

Lpue from the Spanish commercial fleet in XIIb

Some basic lpue indices where estimated for the Spanish fleet in order to include the XIIb landings into the assessment. The level of aggregation (month by month total landings and horsepower units) did not permit to estimate a proper standard deviation.

9.2.6 Data analyses

9.2.6.1 Benchmark assessments

Trends from length distribution

For France, the modal discarded length has remained constant (Figures 9.2.1–9.2.2) at around 12 cm while the average pre-anal length of the individuals in the landings has decreased from 20.8 cm in 1990 to 15.1 cm in 2013 (Figure 9.2.7).

Size–frequency data provided by Spain for the period 2002–2011 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 9.2.8). The modal length of discards is around 9.5 cm. Over the period 2002–2012, there is no apparent trend in size of discards. However for landed individuals, both the average size for male and female have decreased by 1cm (from 15.5 cm to 14cm for females and 13.5 to 12.4 cm for males) until 2009. Over the period 2009–2013, in both VI and XIIb, the mean length in landings has increased by two centimetres for both males and females in 2010–2011 before decreasing back to 2009 values. Few discards data were available by the time of the working group. No new information is available on Spanish discards.

The difference of modes of the length distributions of landed catch between the Spanish fleet in Divisions VI 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.

Trends in abundance indices

Marine Scotland Deep-water Science survey

The working group was provided this year with an update of the survey indices. There is an increasing trend of abundance over the period 2011-2013. The confidence intervals are however large (Figure 9.2.9).

Lpue from the Faeroese commercial fleet

The cpue is stable for the period 2009–2010 although it is above average in 2011 and below average in 2012–2013 (Figure 9.2.10).

Lpue from the Spanish commercial fleet in XIIb

The lpue has declined over the time-series stable with a peak in 2003 followed by a decline until 2005. A second peak occurred in 2008. The lpue has been declining since then (Figure 9.2.11).

Lpue from the French tallybooks

The overall trend in abundance (Figure 9.2.12–9.2.13) shows a decline from 2000 to 2003 and has been stable since until 2013 where the abundance index is substantially higher.

Multi-Year Catch Curves (MYCC)

MYCC this year could not be updated because age data are not available for recent years.

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).

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 but due to uncertainties in the catch in Division XIIb, assessment has been restrained to Vb, VI, VII in 2008 and 2009. The WKDEEP benchmark agreed in 2010 that *"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."* The reference assessment ("Ref") is therefore restrained to Vb, VI, VII while a full exploratory assessment including XIIb is presented further in this section.

The following datasets were used for the benchmark assessment:

- Landings in Vb, VI, VII (1988–2013);
- Overall standardized abundances indices from the French tallybooks (2000–2012) based on rectangles (edge6, other6);
- Life-history parameters to provide initial estimates for the model (Figure 9.2.14).

Diagnostics plot are available on Figures 9.2.15–9.2.16 and indicates a relatively good fit of the model except for the last year due to the strong change in the abundance index. Outputs of the assessments are presented on Figure 9.2.17.

Harvest rate H_y can be seen as a proxy of fishing mortality as it is the ratio between landings and stock biomass B_y on year *y*. The surplus production model provides also B_{MSY} and H_{MSY} indicators. B_{MSY} is assumed by the model to be half of K, the carrying capacity, considered here by the model to be equal to stock biomass estimates in 1988. H_{MSY} is the ratio between a sustainable catch C_{MSY} and B_{MSY}. C_{MSY} is equal to r*K/4, *r* being the intrinsic growth rate of the population. For this particular value of catch, the stock biomass is expected to reach a theoretical equilibrium.

The shape of the harvest rates is driven by the shape of the landings time-series and has been over H_{MSY} since 1992 until 2007, peaking over the period 2000–2004 at around 0.25. Since then, the median of the harvest rate distribution has been close or below H_{MSY} which is around 0.08+/-0.01. Stock biomass has been continuously below B_{MSY} since 2002.

Virgin biomass was estimated to be around 138 kt (+/-5 kt). The magnitude of this number is in line with estimates from previous working groups. Stock biomass in 2013 is around 50 kt (+/-15 kt). B_{MSY} is estimated to be 69 kt (+/-3 kt). MSY $B_{trigger}$ is set at 41 kt (B_{loss} value for 2006).

In 2013, the probability of this stock (Vb, VI, VII) to be above MSY $B_{trigger}$ is 91%, 9% to be above B_{MSY}, 99% to be below H_{MSY} (Table 9.2.2). Model outputs suggest that any TAC set below C_{MSY} (5266 t +/-513 tons) is likely to allow the increase of stock biomass. Some projections are developed further in this section for different management options.

This assessment does not change the perception that biomass is recovering slowly after a low historical level in 2006. The exploitation rate appears to be below MSY limits and biomass estimates show a slight upwards trend.

9.2.6.2 Exploratory assessments

The benchmarked assessment methodology uses data only from Vb, VI and VII. This year, some additional exploratory assessments were carried out to take account of landings in XIIb and uncertainty regarding potential misreporting in VI and XIIb.

Each run has a name according to the spatial aggregation of landings data:

- Run "Vb-VI-VII-XIIb" is the standard run using XIIb landings data. French and Spanish standardized lpues are combined with a weighting corresponding to the amount of landings in XIIb and Vb, VI, VII.
- Run "Vb-VI-VII-XIIbinf" includes VI and XIIb landings data of *Macrourus berglax* and *Trachyrincus scabrus*.
- Additional assessments were made considering short-term forecast and different management options in Vb, VI, VII (runs 1–6).

The various times-series used for those runs are listed in Table 9.2.1.

Exploratory run in Vb, VI, VII and XIIb (Vb-VI-VII-XIIb run)

The inclusion of landings of XIIb requires a combined abundance indices from the landings and efforts of the Spanish fleet XIIb and the indices from the French tallybooks (Figure 9.2.18). The weighting between indices relies on proportion of landings between the Vb,VI,VII regions and XIIb (Table 9.2.1).

Figure 9.2.19 shows the estimates of biomass and harvest rates. Harvest rates have been over H_{MSY} since 1999 with a peak in 2004 before declining to levels slightly above H_{MSY} since 2008. Harvest rates were below H_{MSY} in 2011 and 2013.

Biomass has been continuously below B_{MSY} since 2003 and is currently stable at low level.

The carrying capacity was estimated to be around 217 kt (+/-0.4 kt). Stock biomass in 2013 is around 77 kt (+/-16 kt). B_{MSY} is estimated to be 109 kt (+/-0.2 kt). From this run, the probability of this stock to be above MSY $B_{trigger}$ (73 kt) is 72,3% to be above B_{MSY} and 99% to be below H_{MSY}. Median C_{MSY} is estimated to be 8734 t (+/-776). Any catch below this level should lead to an increase of stock biomass.

It is important to note that the confidence over this assessment including XIIb is lower than for the one restricted to Vb, VI, VII because of the uncertainty of the landings in XIIb linked to species reporting and evidence of reporting from other areas. Landings in XIIb contributes strongly therefore it should be emphasized that Member States should provide accurate landings and effort information regarding the fishing activity in XIIb as uncertainties associated with the high level of landings in XIIb strongly impact any assessment.

Exploratory run in Vb, VI, VII, XIIb with inflated landings in XIIb to account of Spanish misreporting of grenadier species (run Vb-VI-VII-XIIbinf)

The fit of the model was not as good as for the reference assessment despite using the same settings possibly because the assumption made on misreporting are not exactly reflected by the indices. The results are however within the same ranges than the previous assessment including XIIb but with more uncertainty (Table 9.2.2).

Carrying capacity was estimated to be around 219 kt (+/-0.6 kt). Stock biomass in 2013 is around 73 kt (+/-17 kt). B_{MSY} is estimated to be 110 kt (+/-0.3 kt). From this run, the probability of this stock to be above MSY $B_{trigger}$ (76kt) is 37%, 2% to be above B_{MSY} and

97% to be below H_{MSY} (Figure 9.2.20). In conclusion, the use of inflated landings does not lead to substantial changes in estimates of biomass and complicates the setup of the model leading to more uncertainties.

Short-term forecasts

Exploratory short-term forecasts in Vb, VI, VII (run 1 to 6)

The Bayesian context allows introducing the notion of risk into the assessment through catch options and probabilities to be above or below limits such as MSY indicators. Several stocks at ICES provide probabilities with catch options (e.g. Bay of Biscay anchovy, Greenland halibut).

With this stock potentially on a rebuilt trajectory, several catch options were tested to provide projections of the potential catches in the next years and the probability to reach B_{MSY}.

Several runs were considered forecasting the period 2014–2020. For 2014, the landings were considered to be equal to the current TAC in Vb, VI, VII. For the following years, several catch options were considered (Figure 9.2.21):

- Run 1: *Status quo* catch: TAC_y remains constant over time according to the TAC set by EU for 2014. TAC in 2014 is then used each following years
- Run 2: TAC_y gradually decreases every two years by 15%.
- Run 3: TAC_y follows the ICES WKFRAME3 approach.
- Run 4: Closure of the fishery (TAC_y=0).
- Run 5: TAC_y equals C_{MSY} levels.
- Run 6: TAC so that harvest rate stays at H_{MSY} levels.

Run 3 is based on the ICES WKFRAME3 approach. The following rules are applied:

- If B_y is below B_{MSY},

$$H_y = H_{msy} \cdot \frac{B_{y-1}}{B_{msy}}$$

As catch level C_y is simply H_y*B_y, recommended TAC_y would be expected to be:

$$TAC_y = H_{msy} \cdot \frac{{B_{y-1}}^2}{B_{msy}}$$

- If B_y is above or equal to B_{MSY},

$$TAC_y = H_{msy} \cdot B_{y-1}$$

Run 6 has constant harvest rates set at HMSY. In order to keep H at HMSY, it is necessary to project the available biomass B_y the upcoming year using the surplus production model equation. This gives the following harvest control rule:

$$TAC_y = H_{msy} \cdot \frac{B_{y-1} + r \cdot B_{y-1} \cdot \left(\frac{1 - B_{y-1}}{K}\right)}{1 + H_{msy}}$$

The corresponding TACs are shown in Figure 9.2.21 and the table below. Runs 3 and 6 (WKFRAME approach and H_{MSY}) are the only scenarios where TAC is increasing.

.Run		TAC2014	TAC2015	TAC2016	TAC2017	TAC2018	TAC2019	TAC2020
1	EU TAC	4297	4297	4297	4297	4297	4297	4297
2	85% TAC	4297	3652	3652	3105	3105	2639	2639
3	WKFRAME	4297	2822	3064	3290	3520	3736	3912
4	TAC=0t	4297	0	0	0	0	0	0
5	C_{MSY}	4297	5266	5266	5266	5266	5266	5266
6	H_{MSY} TAC	4297	3952	4019	4080	4145	4208	4274

Run 5 (C_{MSY}) has the highest of all TAC options for the next years. H_{SMY}TACs (Run 6) are in line with the previous TAC levels for in 2013 and 2014 while WKFRAME (Run 3) has the lowest values (excluding to the closure scenario). Both H_{MSY}TAC and WKFRAME have increasing TACs over the years. TACs from Run 2 are decreasing with time.

In regards to reference points, the results of the different scenarios (Figures 9.2.22–24, Tables 9.2.3–9.2.5) are discussed below.

Probability of being above MSY Btrigger

In all cases, biomass will stay above MSY Btrigger. Except for Run 5 (C_{MSY}), the probabilities of being above that level will increase with and will reach 100% for Run 6 (H_{MSY}) and Run 3 (Closure).

Probability of being above B_{MSY}

Except the H_{MSY} run, any scenario might theoretically bring the stock biomass to MSY levels at some point in the future. The faster way to reach BMSY is to close the fishery or applying an 85% TAC (Run 2) because in both cases TAC will decrease. With the H_{MSY} run, the probability stays constant. This is likely to be linked to the way the TAC is calculated and may not be a realistic indicator here. Median biomass still increases but the confidence intervals decrease at the same pace. Both effects compensate leaving the false impression of biomass not increasing to B_{MSY}.

Probability of being below H_{MSY}

Harvest rates are in all cases below H_{MSY}. The probability of being below that level increases through time except for Run 5 (C_{MSY}) which becomes only close H_{MSY} by 2029. Run 6 (H_{MSY}) stays constants at H_{MSY}, which validates the TAC formula used for this scenario.

Runs	P (B>MSY Btrigger)	2014	2015	2016	2017	2018	2019	2020
1	EU TAC	0.89	0.87	0.84	0.82	0.81	0.80	0.78
2	85% TAC	0.89	0.89	0.88	0.89	0.89	0.90	0.91
3	WKFRAME	0.89	0.90	0.90	0.91	0.90	0.90	0.90
4	Closure (TAC = 0)	0.89	0.95	0.98	1.00	1.00	1.00	1.00
5	C_{MSY}	0.89	0.83	0.78	0.74	0.70	0.67	0.64
6	H_{MSY} TAC	0.89	0.92	0.93	0.95	0.96	0.98	0.99

Runs	P(B>B_{MSY})	2014	2015	2016	2017	2018	2019	2020
1	EU TAC	0.11	0.14	0.17	0.20	0.22	0.25	0.26
2	85% TAC	0.11	0.15	0.19	0.24	0.28	0.32	0.37
3	WKFRAME	0.11	0.17	0.22	0.25	0.29	0.31	0.35
4	Closure (TAC = 0)	0.11	0.22	0.31	0.43	0.54	0.63	0.73
5	C_{MSY}	0.11	0.13	0.13	0.14	0.15	0.16	0.17
6	H_{MSY} TAC	0.11	0.11	0.11	0.11	0.11	0.11	0.11

Runs	P(H<H_{MSY})	2014	2015	2016	2017	2018	2019	2020
1	EU TAC	0.39	0.40	0.42	0.43	0.45	0.47	0.48
2	85% TAC	0.39	0.57	0.59	0.73	0.75	0.85	0.86
3	WKFRAME	0.39	0.78	0.74	0.71	0.67	0.64	0.62
4	Closure (TAC = 0)	0.39	1.00	1.00	1.00	1.00	1.00	1.00
5	C_{MSY}	0.39	0.22	0.23	0.23	0.24	0.25	0.26
6	H_{MSY} TAC	0.39	0.21	0.20	0.21	0.20	0.20	0.20

Conclusions

Overall, the resulting distributions of total biomass have increasing probabilities of being above B_{MSY} and MSY $B_{trigger}$ over time. In 2014, assuming the TAC will be taken completely, the probability of being above B_{MSY} will be 11% (against 9% for 2013).

By 2020, a closure of the fishery would give a probability of 73% of being above B_{MSY} while run 3 and its TAC based on WKFRAME would be at 35%. A progressive reduction of TAC of 15% every two years (Run 2) would allow a probability of 37% of being above B_{MSY} by 2020. A closure would allow to reach such level between 2016 and 2017. Overall, following an 85% TAC, WKFRAME rules allows a recovery of the stock while maintaining fishing activity.

The slow recovery towards MSY suggests that any management plan, forecast should probably span over a decade.

This work has been extended to Vb, VI, VII, XIIb with additional set TACs for management options. Forecasts have been done up to 2020. Results are presented in Tables 9.2.3–9.2.5. The results with XIIb added do not contradict the analysis in Vb, VI, VII as biomass also increases for any option chosen as long as it is below C_{MSY} (5266 t +/-513 in Vb, VI, VII and 8734 t +/-776 in Vb, VI, VII, XIIb).

9.2.7 Management considerations

The harvest rate for roundnose grenadier appears to be below H_{MSY} in Vb, VI, VII and also for runs in XIIb. SSB is below B_{MSY} in all regions and at low levels. For Vb, VI, VII, the assessment suggests a slow recovery of the stock while the inclusion of XIIb landings suggests a more stable situation.

Table 9.2.0a. 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	245			6		76	835
2005	440	139	0		1	0	48	628
2006	19	82	0			0	0	101
2007	838	59	0					897
2008	665	23						688
2009	15	2					2	18
2010		15	0				1	16
2011								0
2012		1						1
2013*								0

*** Provisional.**

Table 9.2.0b. 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	1271	0	0	0	2	0	0	1498	1.2	23	2809
2011	0	4	1112	0	0	0	0	0	0	345	0	8	1469
2012	0	0	1088	0	0	0	0	0	0	258	2	0	1348
2013*	0	0	925	0	0	0	0	0	0	482	6	0	1414

*** Provisional.**

Table 9.2.0c. 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		41				41
2011		34				34
2012		48				48
2013*		39				39

Table 9.2.0d. 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

Year	Estonia	Faroes	France**	Germany	Iceland	Ireland	Lithuania	Spain	USSR/Russia	UK (E+W)	UK (Scotl.)	Norway	Total
2009								5335					5335
2010			1					2758					2759
2011		3						1575					1578
2012		9						657					666
2013*								796					796

*** Preliminary.**

**** French landings reported in former ICES Subarea XII allocated to XIIb.**

Table 9.2.0e. 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	
2010	
2011	
2012	4515
2013*	929

*** Provisional.**

Table 9.2.0f. 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	10104	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	611	2809	41	2759	0	3461	6220
2011	74	1469	34	1578	0	1577	3155
2012	44	1348	48	657	6997	1440	9094
2013*	45	1414	39	796	1522	1498	3815

*** Preliminary.**

Table 9.2.1. Time-series of landings and lpues used for the reference and exploratory assessments.

	Landings 1988–2013			LPUE indices	Combined lpues
Simulations	Reference	Vb-VI-VII-XIIb	Vb-VIinf-VII-XIIbinf	Reference	Vb, VI, VII, XIIb Vb-VIinf-VII-XIIbinf
1988	33	33	33	-	-
1989	2698	2750	2750	-	-
1990	7279	7279	7279	-	-
1991	10 104	10 276	10 276	-	-
1992	12 155	12 168	12 168	-	-
1993	11 802	12 130	12 130	-	-
1994	8528	9014	9014	-	-
1995	8990	9634	9634	-	-
1996	8173	9701	9701	-	-
1997	8182	10 231	10 231	-	-
1998	8031	12 428	12 428	-	-
1999	8534	17 107	17 107	-	-
2000	11 606	17 801	17 801	1.000	1.000
2001	18 143	24 445	24 445	1.078	1.078
2002	13 627	24 210	24 210	1.757	1.757
2003	8717	21 904	21 904	0.460	1.239
2004	9872	22 668	22 690	0.465	0.970
2005	5777	14 558	17 128	0.434	0.948
2006	4676	9037	13 056	0.361	0.808
2007	3778	8036	13 062	0.502	0.875
2008	3102	5534	6705	0.593	0.904
2009	4046	9381	9381	0.548	0.846
2010	3461	6220	6220	0.473	0.682
2011	1577	3155	3169	0.448	0.718
2012	2501	7982	8480	0.527	0.651
2013*	1498	3035	3230	0.858	0.988

Table 9.2.2. Summary of results from the exploratory assessments.

			SIMULATIONS							
	Simulation	Year	Area	Vb-VI-VII		Area Vb-VI-VII-XIIb			Area Vb-VI-VII-XIIbinf	
			Reference run			XIIb landings added			inflatedXIIb landings	
	Medianbiomass	1988	137 950	+/-	5403	217 303	+/-	413	219 032	+/-	675
	+/- stddev	2013	49 703	+/-	14 730	77 296	+/-	15 910	73 135	+/-	17 099
	(tons)										
Standard	Average biomass	1988	138 660			217 253			218 959		
outputs	(tons)	2013	50 928			77 877			73 735		
	Med. Harvest rate	1988	0	+/-	0	0	+/-	0	0	+/-	0
	+/- stddev	2013	0.03	+/-	0.01	0.04	+/-	0.01	0.04	+/-	0.01
	Median B_{MSY}	all	68 975	+/-	2719	108 652	+/-	207	109 516	+/-	338
	(tons)										
MSY	MSY Btrigger	2006	41 437	+/-	8551	72 321	+/-	7324	76 403	+/-	7515
reference	(tons)										
points	Median H_{MSY}	all	0.08	+/-	0.01	0.08	+/-	0.01	0.09	+/-	0.01
	Target C_{MSY}	all	5266	+/-	513	8734	+/-	776	9311	+/-	828
	(tons)										
	P(B>B_{MSY})	2013		0.09			0.03			0.02	
Risks	P(H<H_{MSY})	2013		0.99			0.99			0.97	
	P(B>Btrig)	2013		0.91			0.72			0.37	

Table 9.2.3. Probabilities of being above MSY $B_{trigger}$ in regards to different management options.Probabilities to be above MSY Btrigger.

Areas V,VI,VII	2014	2015	2016	2017	2018	2019	2020
EU TAC	89%	87%	84%	82%	81%	80%	78%
85% TAC	89%	89%	88%	89%	89%	90%	91%
WKFRAME	89%	90%	90%	91%	90%	90%	90%
Cmsy	89%	83%	78%	74%	70%	67%	64%
Hmsy TAC	89%	92%	93%	95%	96%	98%	99%
TAC=0t	89%	95%	98%	100%	100%	100%	100%
TAC=500t	89%	94%	97%	99%	100%	100%	100%
TAC=1000t	89%	93%	96%	98%	99%	100%	100%
TAC=2000t	89%	92%	94%	95%	96%	97%	98%
Status quo (2012)	89%	90%	93%	93%	94%	94%	95%
TAC=3000t	89%	90%	90%	91%	92%	92%	93%
TAC=4000t	89%	87%	86%	85%	84%	83%	82%
TAC=5000t	89%	84%	80%	77%	73%	71%	68%
TAC=6000t	89%	81%	73%	67%	62%	58%	54%
TAC=7000t	89%	77%	65%	58%	51%	43%	37%
TAC=8000t	89%	73%	60%	47%	37%	29%	24%
Areas V,VI,VII, XIIb	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
EU TAC	71%	70%	69%	69%	69%	68%	68%
85% TAC	71%	73%	74%	78%	80%	83%	86%
WKFRAME	71%	78%	82%	85%	86%	87%	87%
Cmsy	71%	67%	62%	59%	55%	52%	51%
Hmsy TAC	71%	77%	82%	86%	90%	93%	95%
TAC=0t	71%	88%	96%	99%	100%	100%	100%
TAC=500t	71%	87%	95%	98%	99%	100%	100%
TAC=1000t	71%	85%	93%	98%	99%	100%	100%
TAC=2000t	71%	83%	92%	96%	98%	99%	99%
TAC=3000t	71%	81%	89%	92%	95%	97%	98%
TAC=4000t	71%	79%	85%	89%	92%	93%	95%
TAC=5000t	71%	77%	80%	84%	86%	89%	90%
TAC=6000t	71%	74%	77%	78%	79%	81%	82%
TAC=7000t	71%	71%	72%	72%	72%	73%	73%
Status quo (2012)	71%	69%	67%	66%	63%	62%	61%
TAC=8000 t	71%	69%	67%	65%	63%	62%	61%

Probabilities to be above B_{MSY}.

Table 9.2.4. Probabilities of being above B_{MSY} in regards to different management options.

Areas V,VI,VII	2014	2015	2016	2017	2018	2019	2020
EU TAC	11%	14%	17%	20%	22%	25%	26%
85% TAC	11%	15%	19%	24%	28%	32%	37%
WKFRAME	11%	17%	22%	25%	29%	31%	35%
Cmsy	11%	13%	13%	14%	15%	16%	17%
Hmsy TAC	11%	11%	11%	11%	11%	11%	11%
TAC=0t	11%	22%	31%	43%	54%	63%	73%
TAC=500t	11%	21%	29%	39%	50%	59%	66%
TAC=1000t	11%	21%	29%	37%	45%	54%	60%
TAC=2000t	11%	18%	25%	30%	37%	43%	50%
Status quo (2012)	11%	17%	24%	29%	34%	39%	44%
TAC=3000t	11%	17%	21%	26%	29%	35%	38%
TAC=4000t	11%	14%	18%	21%	25%	26%	29%
TAC=5000t	11%	13%	14%	16%	17%	18%	20%
TAC=6000t	11%	11%	11%	11%	11%	11%	11%
TAC=7000t	11%	10%	9%	8%	7%	6%	5%
TAC=8000t	11%	9%	7%	5%	4%	3%	3%
Areas V,VI,VII, XIIb	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
EU TAC	5%	7%	8%	9%	11%	13%	15%
85% TAC	5%	7%	9%	13%	17%	24%	30%
WKFRAME	5%	8%	12%	17%	22%	26%	31%
Cmsy	5%	5%	7%	7%	8%	8%	9%
Hmsy TAC	5%	5%	5%	5%	5%	5%	5%
TAC=0t	5%	12%	24%	39%	54%	69%	79%
TAC=500t	5%	11%	23%	36%	51%	66%	76%
TAC=1000t	5%	11%	22%	35%	48%	61%	72%
TAC=2000t	5%	10%	18%	30%	40%	51%	63%
TAC=3000t	5%	9%	16%	25%	34%	43%	52%
TAC=4000t	5%	9%	14%	20%	28%	35%	42%
TAC=5000t	5%	8%	12%	17%	22%	28%	34%
TAC=6000t	5%	7%	10%	14%	17%	22%	26%
TAC=7000t	5%	7%	8%	10%	13%	16%	18%
Status quo (2012)	5%	6%	7%	8%	9%	11%	12%
TAC=8000t	5%	6%	7%	8%	9%	11%	12%

Table 9.2.5. Probabilities of being below H_{MSY} in regards to different management options.

Probabilities to be below H_{MSY}.

Areas V,VI,VII	2014	2015	2016	2017	2018	2019	2020
EU TAC	39%	40%	42%	43%	45%	47%	48%
85% TAC	39%	57%	59%	73%	75%	85%	86%
WKFRAME	39%	78%	74%	71%	67%	64%	62%
Cmsy	39%	22%	23%	23%	24%	25%	26%
Hmsy TAC	39%	21%	20%	21%	20%	20%	20%
TAC=0t	39%	100%	100%	100%	100%	100%	100%
TAC=500t	39%	100%	100%	100%	100%	100%	100%
TAC=1000t	39%	100%	100%	100%	100%	100%	100%
TAC=2000t	39%	94%	95%	96%	96%	97%	97%
Status quo (2012)	39%	86%	88%	89%	90%	91%	92%
TAC=3000t	39%	73%	76%	77%	78%	80%	82%
TAC=4000t	39%	48%	50%	52%	53%	55%	56%
TAC=5000t	39%	27%	27%	28%	29%	29%	30%
TAC=6000t	39%	11%	11%	11%	11%	12%	14%
TAC=7000t	39%	3%	3%	3%	4%	6%	9%
TAC=8000t	39%	1%	1%	1%	3%	7%	13%
Areas V,VI,VII, XIIb	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
EU TAC	27%	30%	31%	33%	34%	35%	36%
85% TAC	27%	50%	51%	72%	74%	85%	87%
WKFRAME	27%	85%	82%	78%	74%	71%	69%
Cmsy	27%	14%	15%	15%	16%	17%	17%
Hmsy TAC	27%	23%	22%	23%	24%	22%	20%
TAC=0t	27%	100%	100%	100%	100%	100%	100%
TAC=500t	27%	100%	100%	100%	100%	100%	100%
TAC=1000t	27%	100%	100%	100%	100%	100%	100%
TAC=2000t	27%	100%	100%	100%	100%	100%	100%
TAC=3000t	27%	99%	99%	99%	99%	100%	100%
TAC=4000t	27%	92%	93%	94%	95%	96%	97%
TAC=5000t	27%	77%	79%	82%	83%	85%	86%
TAC=6000t	27%	59%	61%	63%	67%	68%	69%
TAC=7000t	27%	37%	40%	41%	43%	45%	47%
Status quo (2012)	27%	22%	24%	25%	26%	27%	28%
TAC=8000t	27%	22%	24%	25%	26%	27%	28%

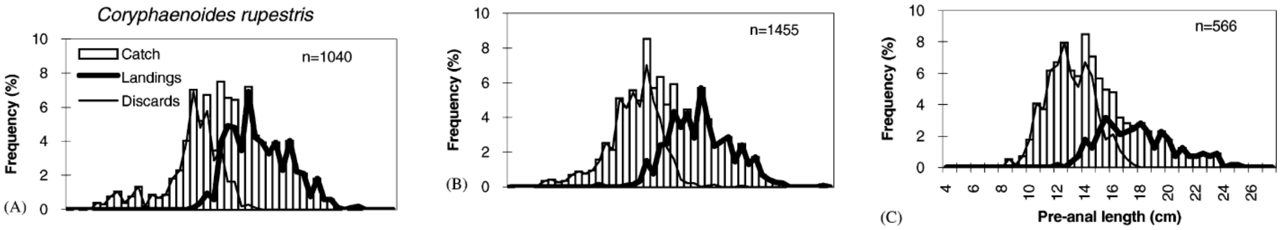


Figure 9.2.1. Length distribution of the discards and landings of roundnose grenadier in 1996–1997 by depth, left: 800–1000 m, centre: 100–1200 m, right: 1200–1400 m, sampled on board French vessels, (redrawn from Allain, 2003).

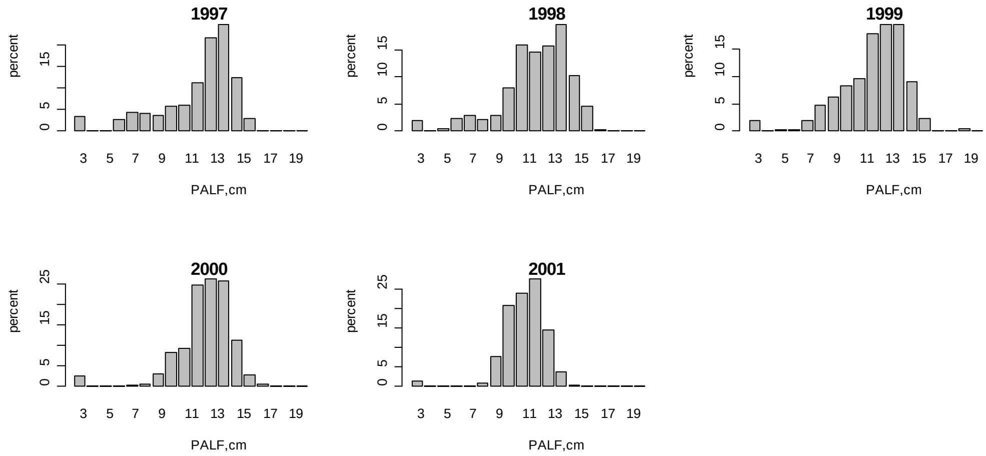


Figure 9.2.2. Length distribution of the discards of the French fleet, sampled on board French vessels by Scottish observers, 1997–2001.

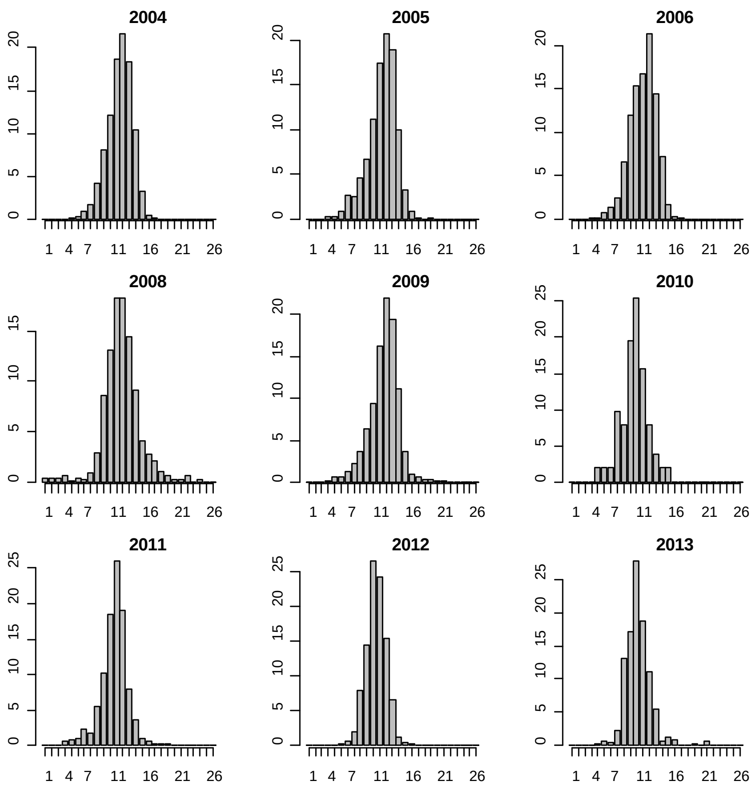


Figure 9.2.3. Sampling of the length distribution of discards of roundnose grenadier from the on-board observation programme 2004–2013.

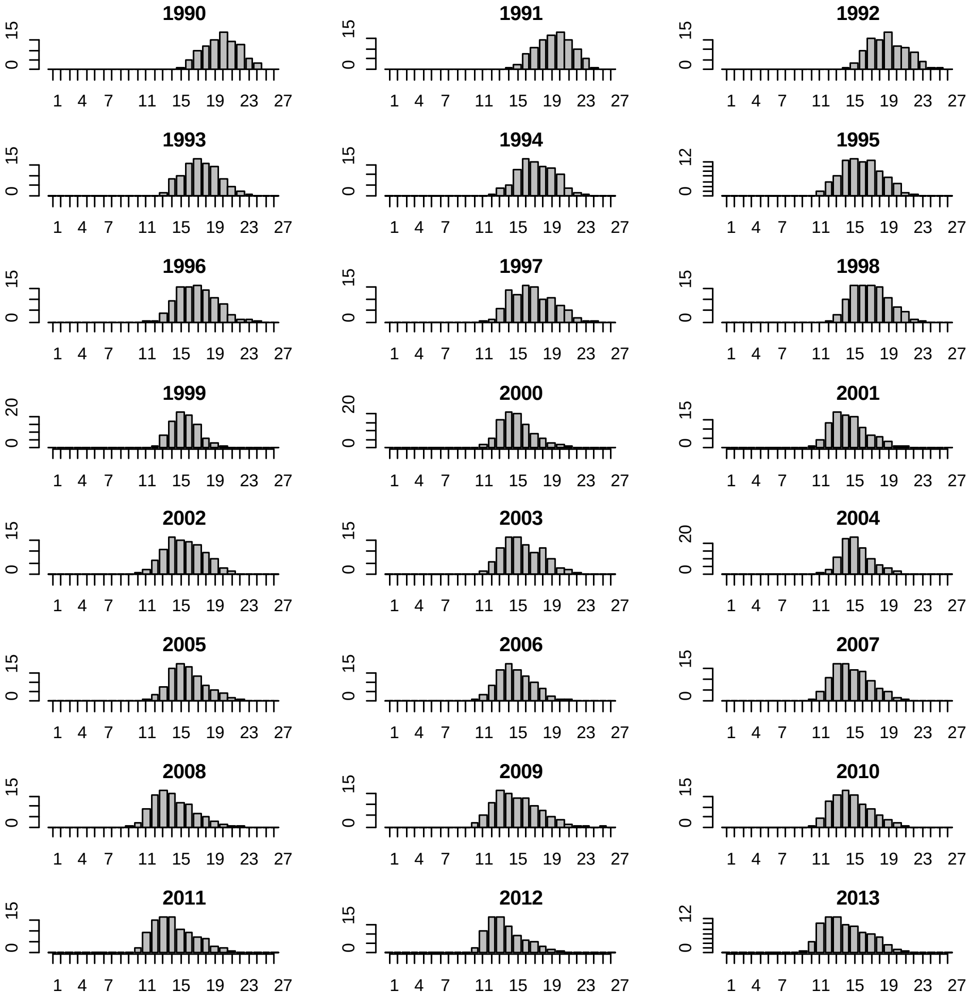


Figure 9.2.4. Length distribution (PAFL, cm) of the landings of the French fleet, sampled at fish markets, 1997–2013.

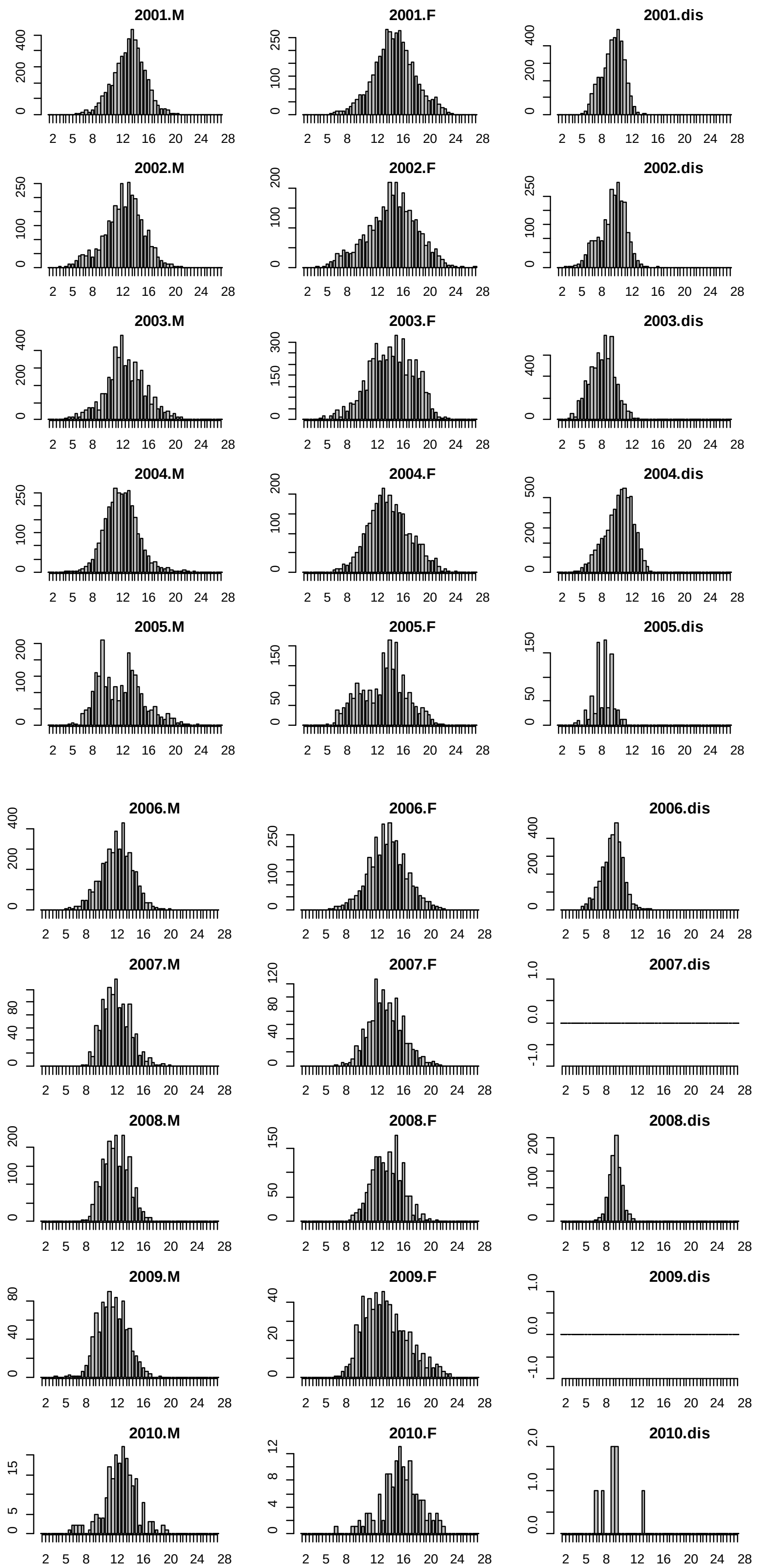


Figure 9.2.5. Length distribution of the landings by sex and discards of the Spanish fleet in Division VIb based from on-board observations, 2001–2013.

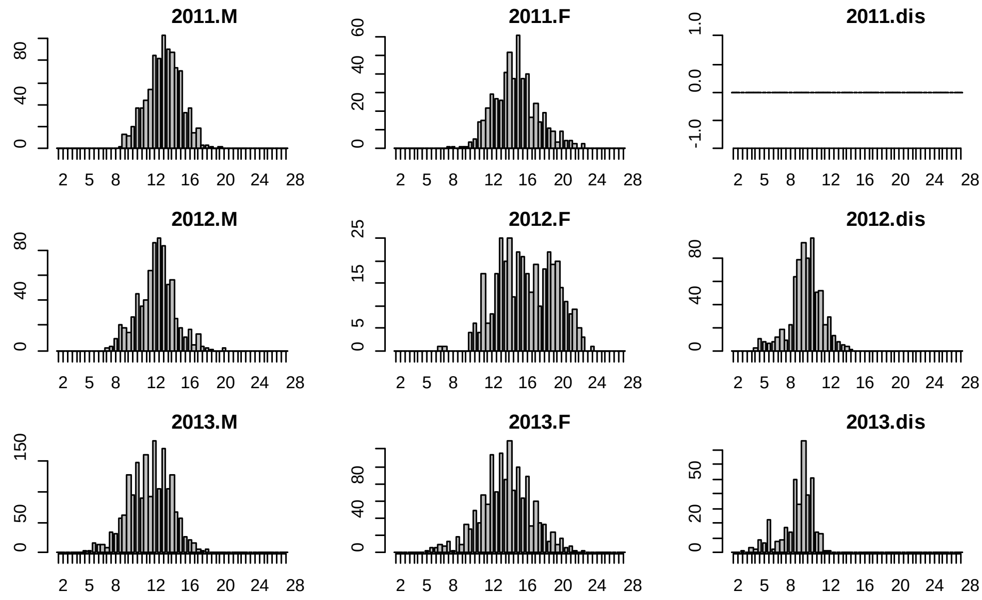


Figure 9.2.5. Cont. Length distribution of the landings by sex and discards of the Spanish fleet in Division VIb based from on-board observations, 2001–2013.

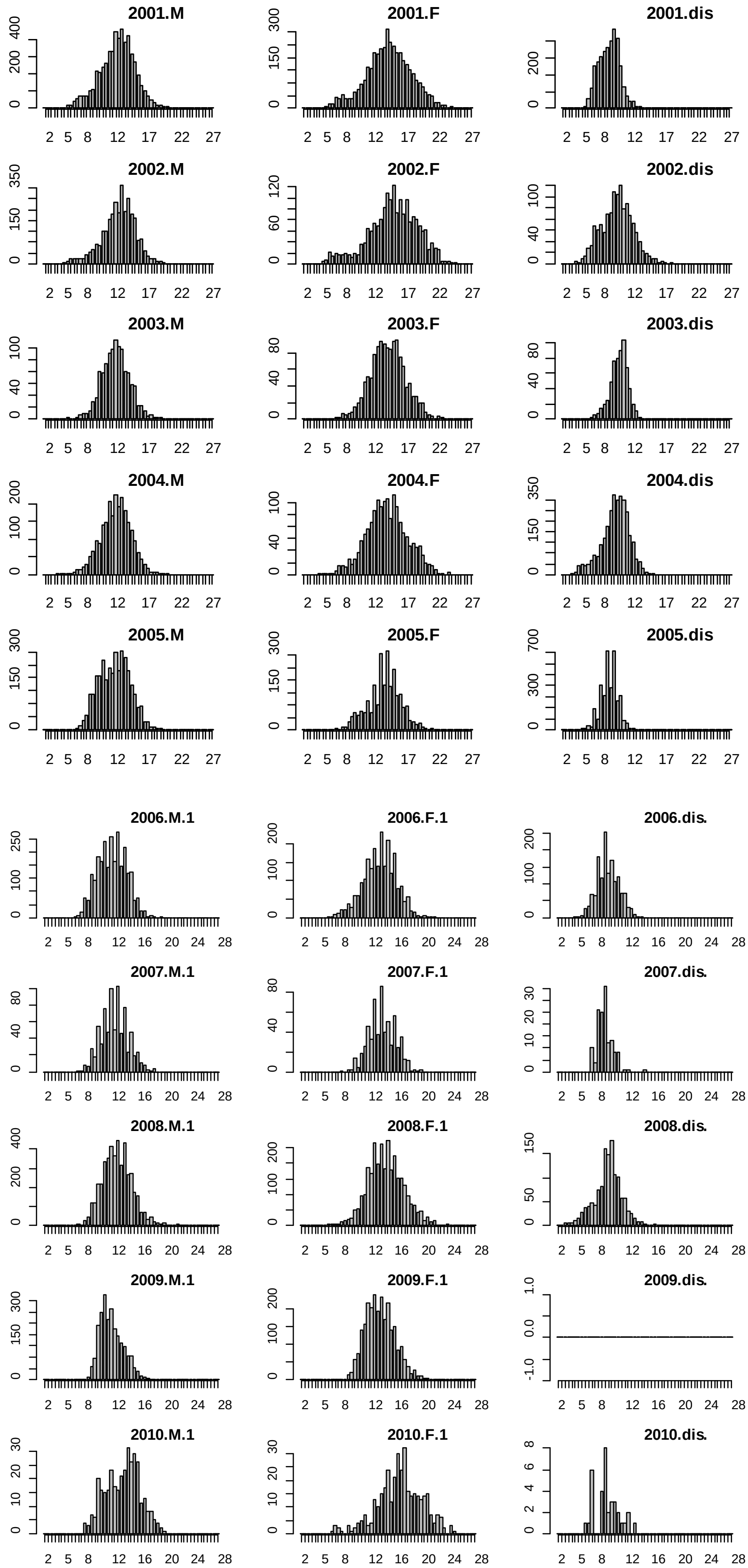


Figure 9.2.6. Length distribution of the landings by sex and discards of the Spanish fleet in Division XIIb based from on-board observations, 2001–2013.

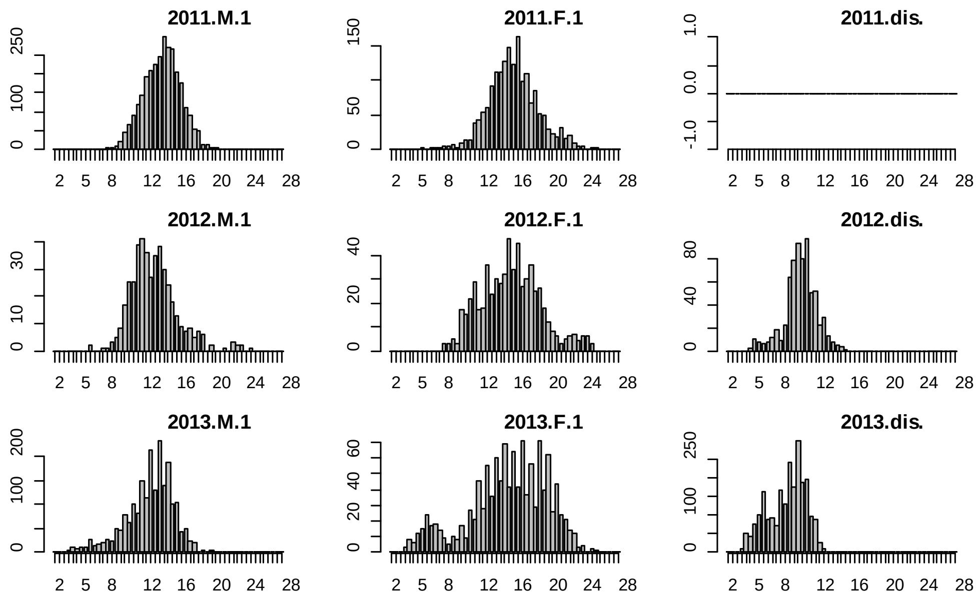


Figure 9.2.6. Cont. Length distribution of the landings by sex and discards of the Spanish fleet in Division XIIb based from on-board observations, 2001-2013.

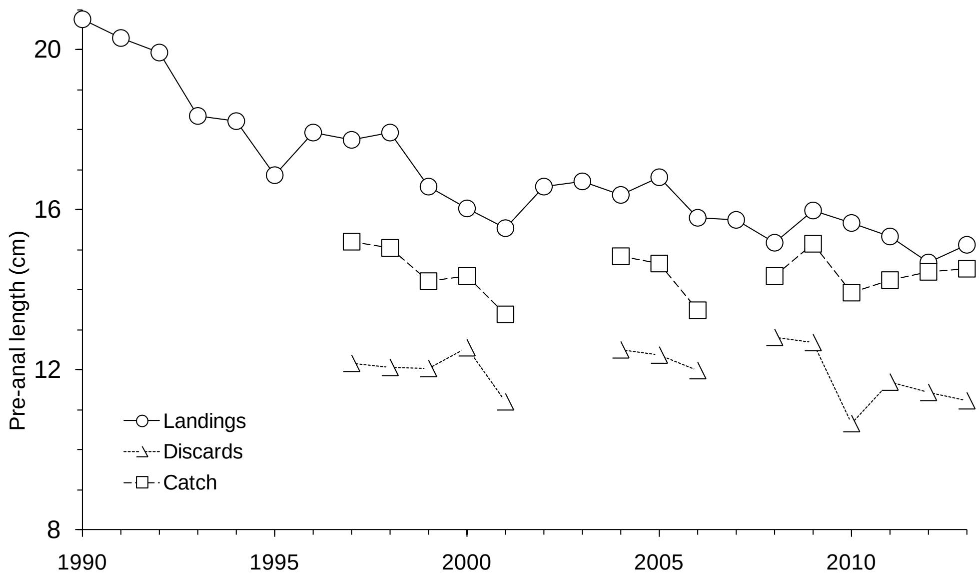


Figure 9.2.7. Evolution of the pre-anal length of roundnose grenadier in the French landings, catch and discards, 1990–2013.

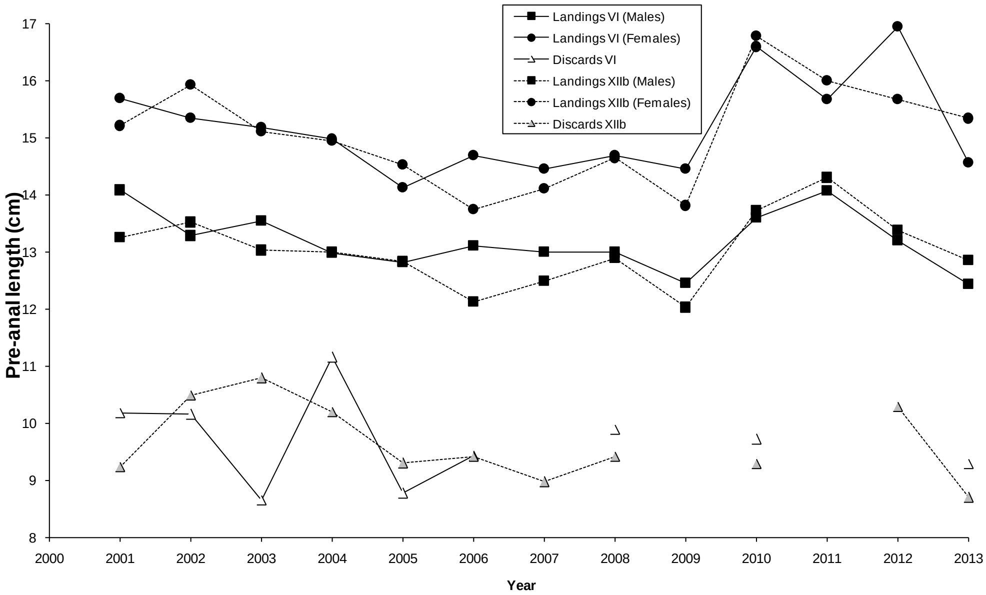


Figure 9.2.8.Evolution of the pre-anal length of roundnose grenadier in the Spanish landings and discards in Divisions VIb and XIIb, 2001–2013.

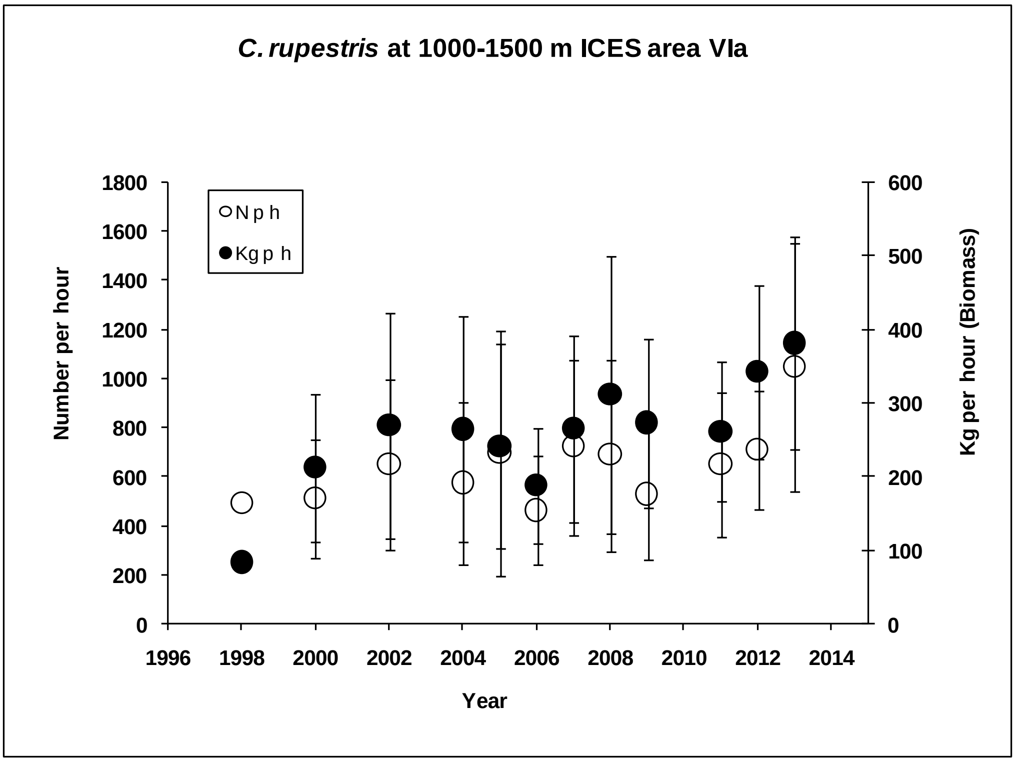


Figure 9.2.9. Abundance indices of roundnose grenadier according to Marine Scotland deep-water survey in VIa.

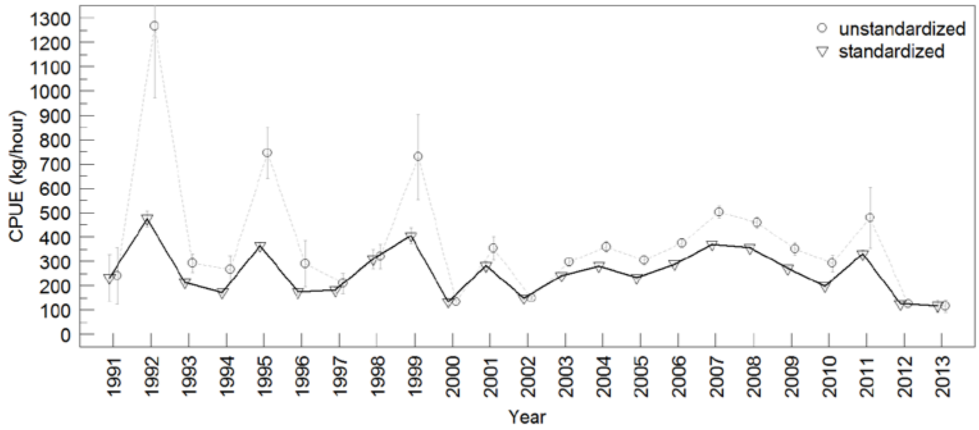


Figure 9.2.10.Roundnose grenadier in Vb. Cpue from otterboard trawlers. Criteria: >30% of roundnose grenadier in the catch.

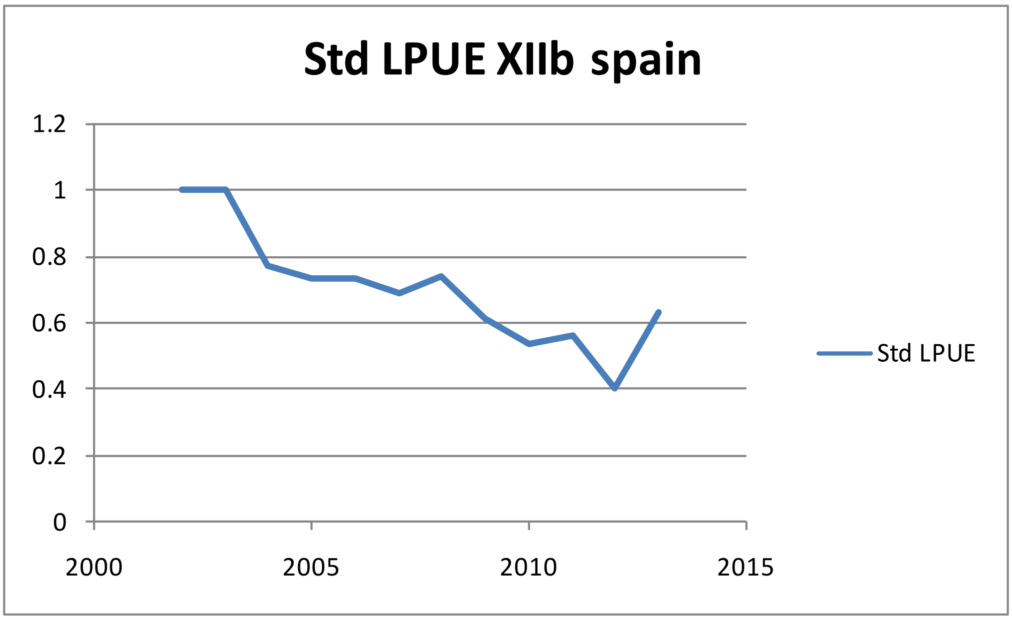


Figure 9.2.11. Lpue from the Spanish commercial fleet operating in XIIb.

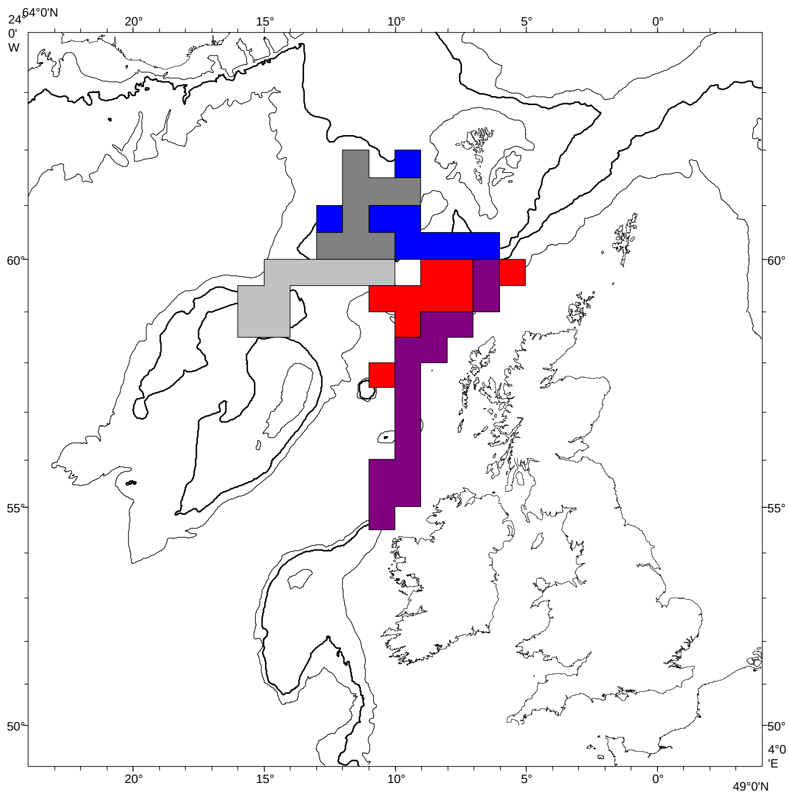


Figure 9.2.12. Reference areas (set of statistical rectangles) used to calculate French lpues (brown: New grounds in V (new5), grey new grounds in VI (new6); red: others in VI (other6); purple: edge in VI (edge6); blue: all grounds in VII (ref7). Depth contours are 200, 1000 and 2000 m.

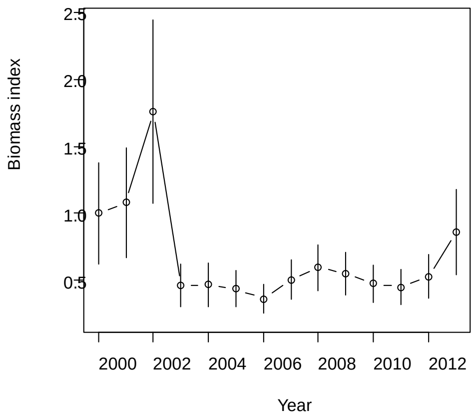


Figure 9.2.13. Time-series of abundance indices (calculated based upon the tallybook data). The grenadier abundance was predicted for the mean length of all tow carried out in every rectangle of the two small areas (edge6, other6) and averaged across rectangle.

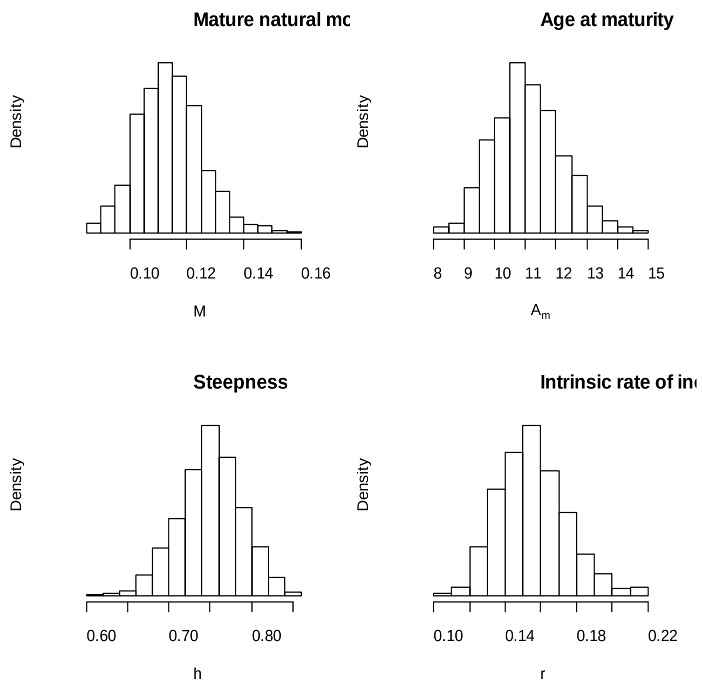


Figure 9.2.14. Distribution of initial life-history parameters used in the surplus production model.

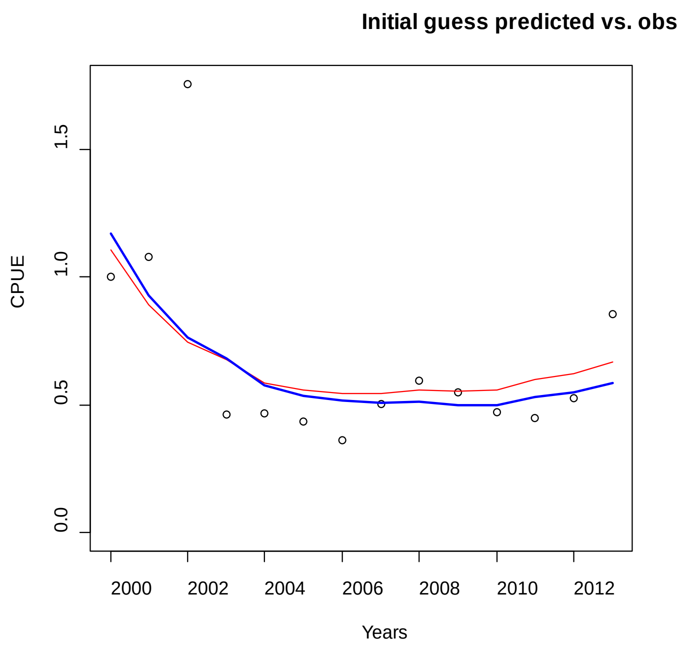


Figure 9.2.15. Predicted vs initial guess vs estimates of lpue for roundnose grenadier in Vb, VI, VII, based on commercial data.

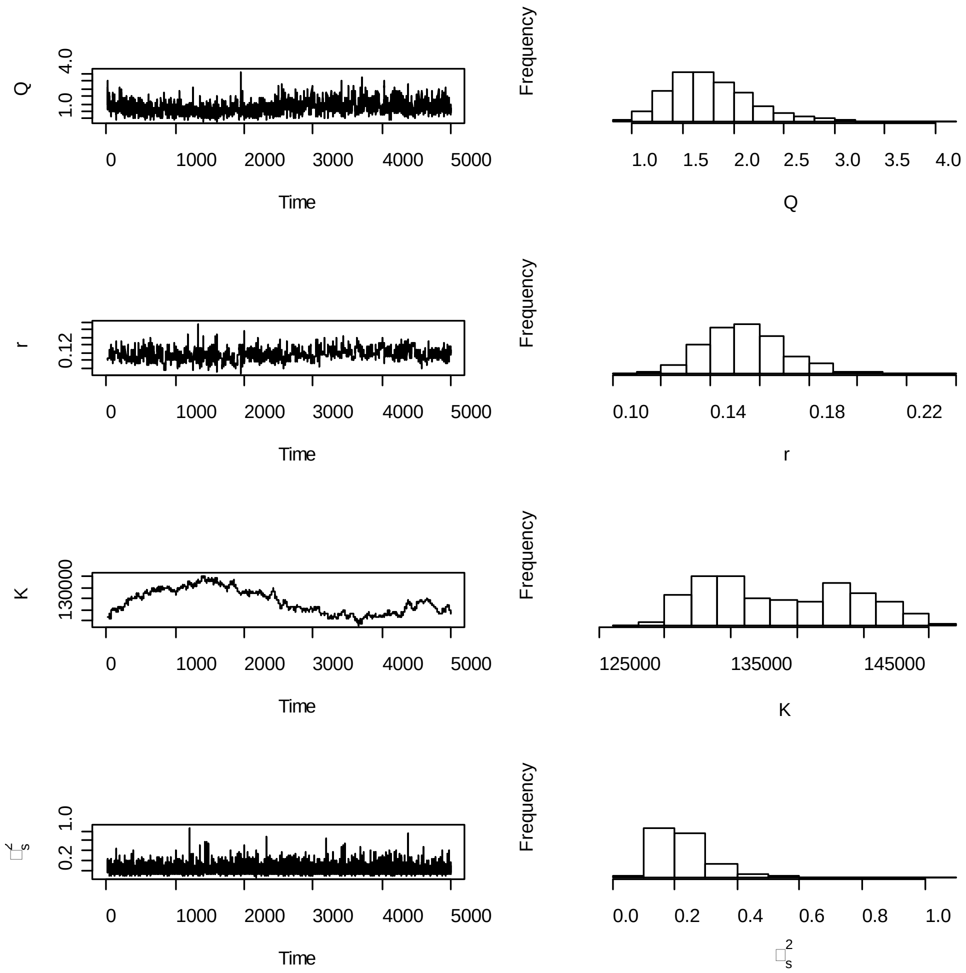


Figure 9.2.16. Diagnostic plots of the reference assessment on roundnose grenadier in Vb, VI, VII.

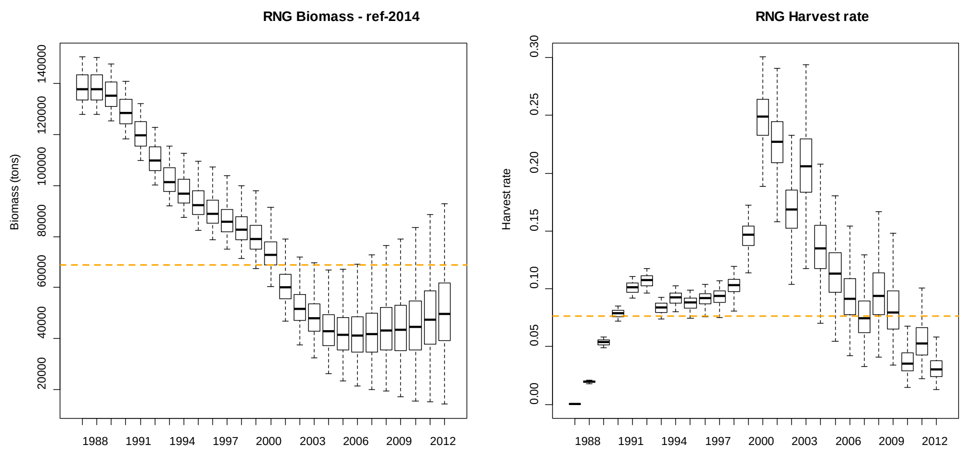


Figure 9.2.17. Estimated biomass and harvest rates from the reference simulation (Vb, VI, VII). Dotted lines are respectively B_{MSY} (left panel) and H_{MSY} levels (right panels).

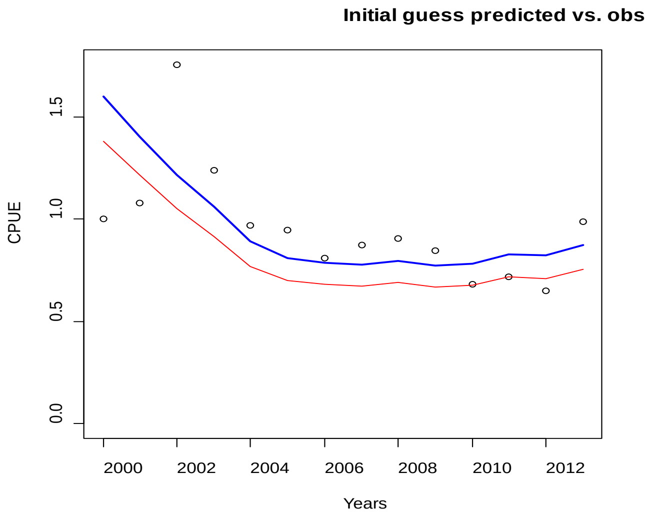


Figure 9.2.18. Predicted vs initial guess vs. estimates of lpue for roundnose grenadier in Vb, VI, VII, XIIb based on commercial data.

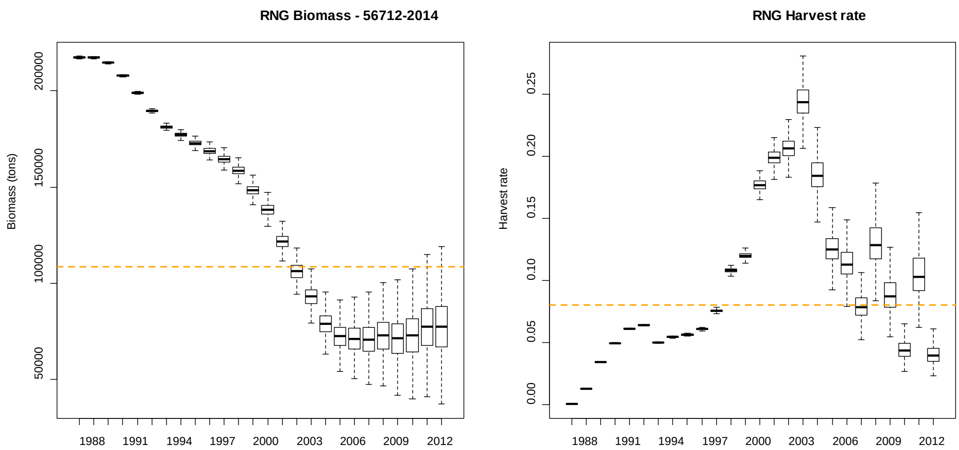


Figure 9.2.19. Estimated biomass and harvest rates using landings in Vb, VI, VII and XIIb.

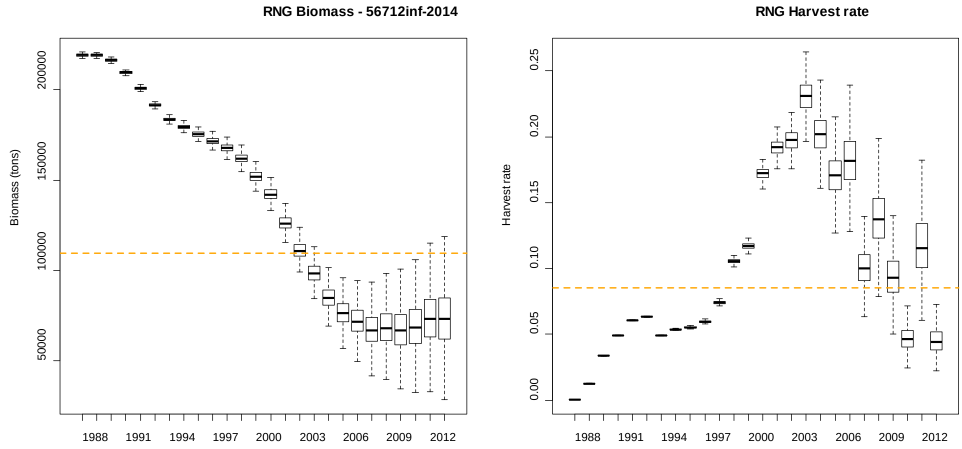


Figure 9.2.20. Estimated biomass and harvest rates in Vb, VI, VII, XIIb using inflated Spanish landings in XIIb.

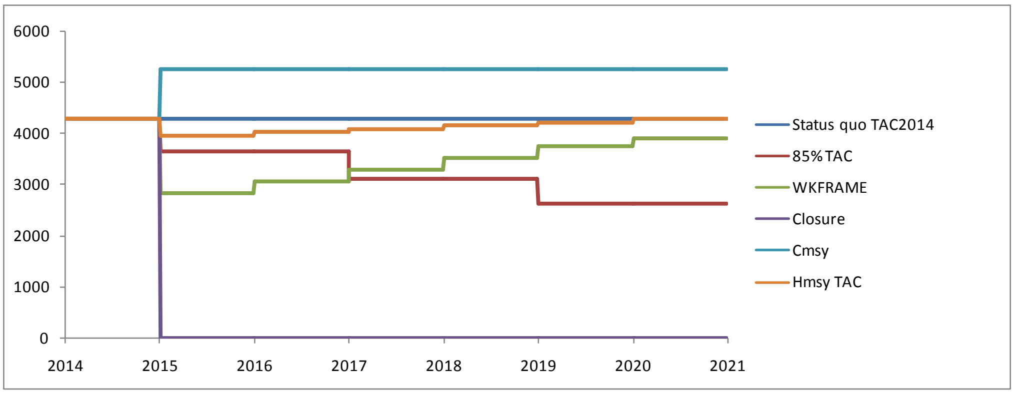


Figure 9.2.21. Values of TACs for the different runs.

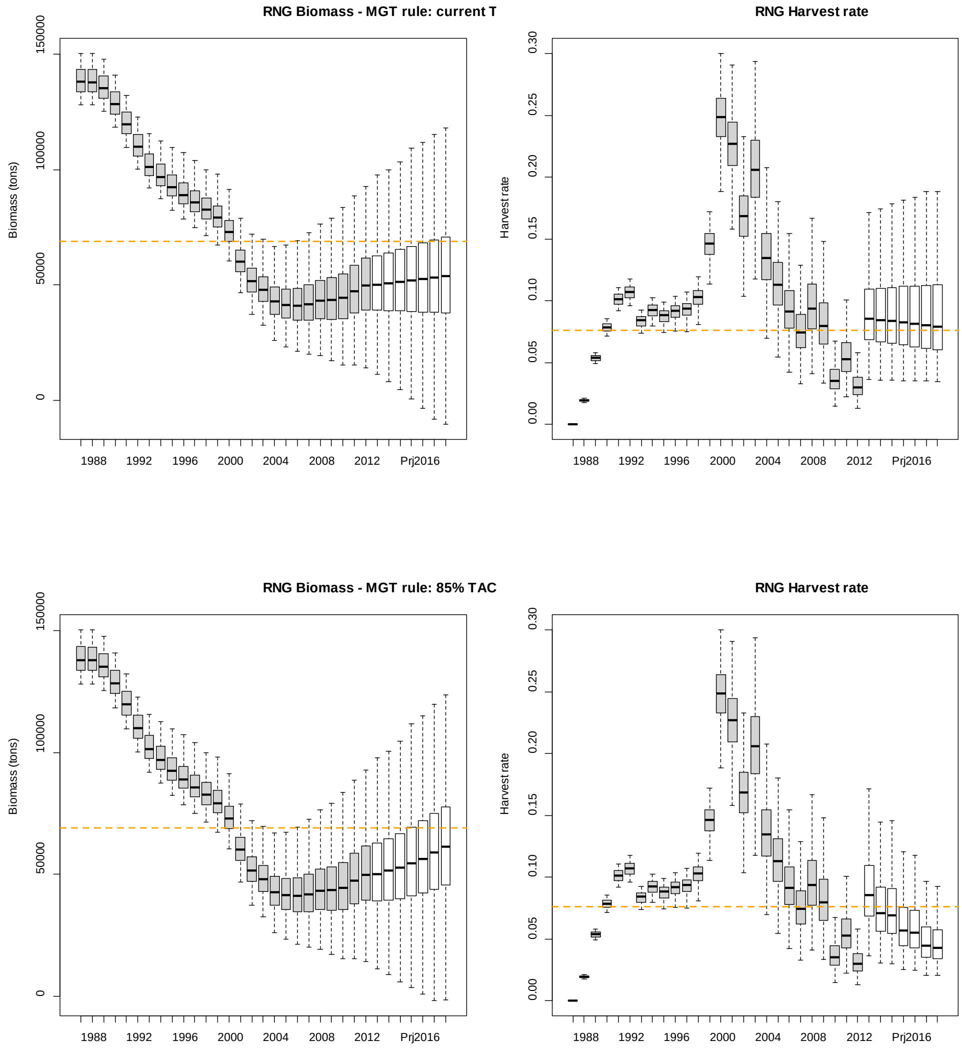


Figure 9.2.22. Simulation and short-term forecasts according to management options: (Up: Run 1 - *status quo TAC*, Down: Run 2 - 85% of previous TAC every two years).

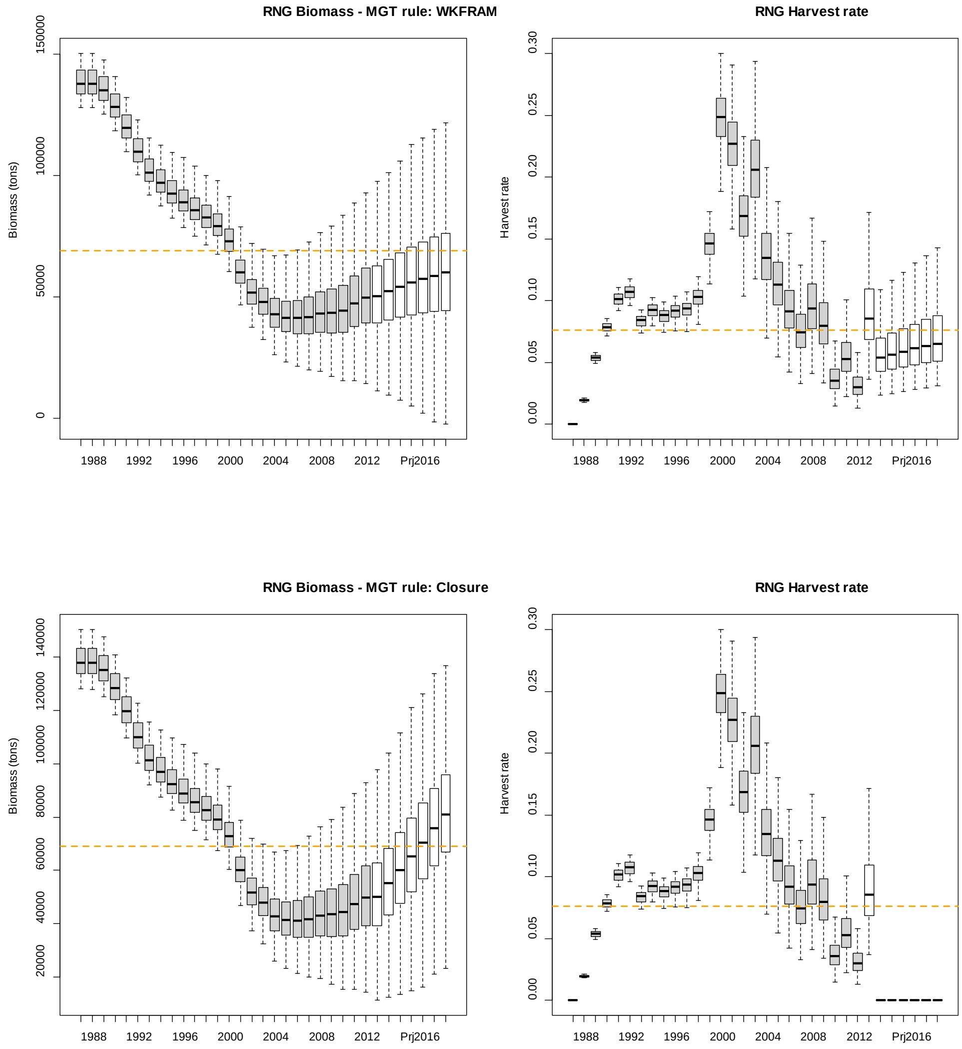


Figure 9.2.23. Simulation and short-term forecasts according to management options: (Up: Run 3 WKFRAME approach, Down: Run 4 - Closure of the fishery.

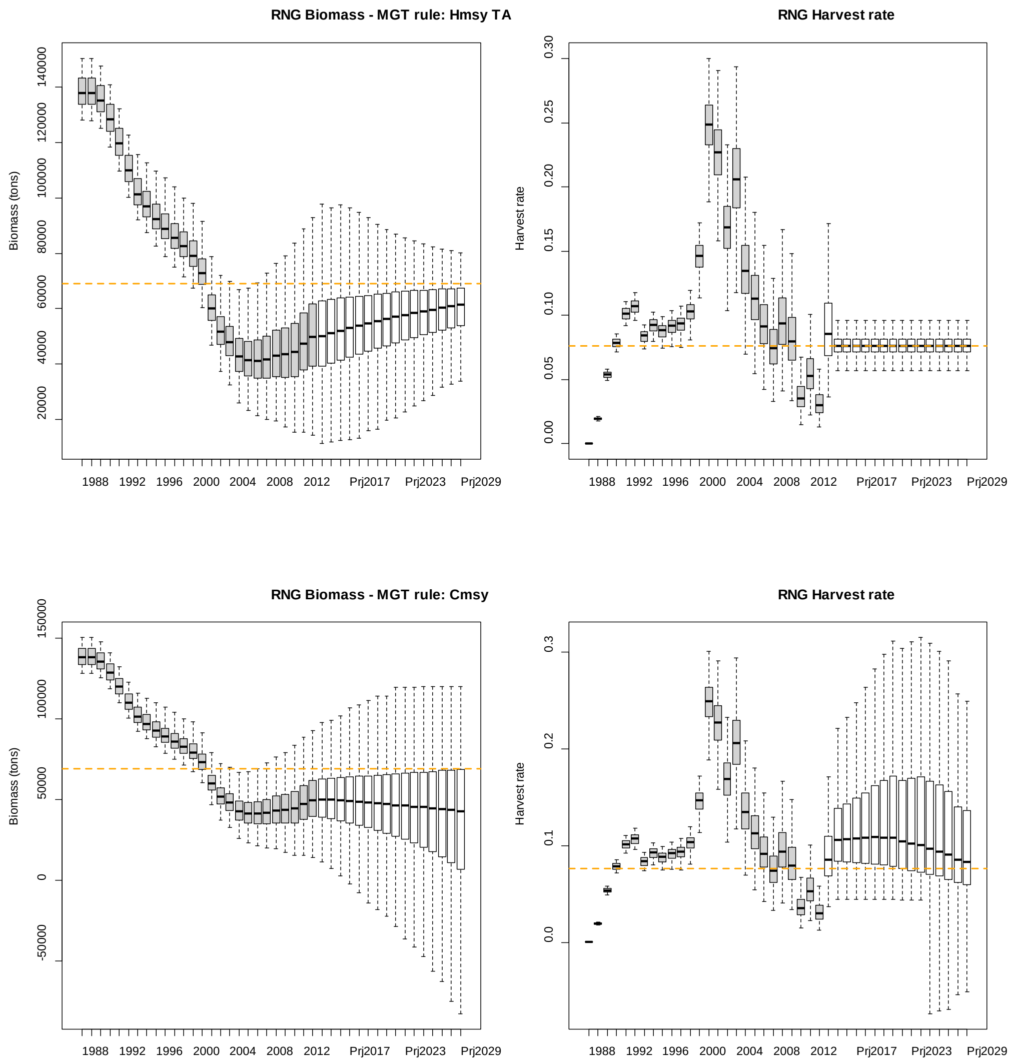


Figure 9.2.24. Simulation and short-term forecasts according to management options: (Up: Run 5 - Catch at C_{MSY} level, Down: Run 6 - TAC at H_{MSY} levels).

9.3 Roundnose Grenadier (*Coryphaenoides rupestris*) in Division IIIa

9.3.1 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 2006 due to implementation of new agreed regulations between EU and Norway.

At present, there are no directed fisheries for roundnose grenadier in Division IIIa.

9.3.2 Landings trends

The total landings by all countries from 1988–2013 are shown in Table 9.3.0 and Figure 9.3.0.

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.

9.3.3 ICES Advice

The Advice for 2013 and 2014 is: "Fishery should not be allowed to expand, unless proven to be sustainable".

9.3.4 Management

There has been no directed fishery for roundnose grenadier since 2006. 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 1262/2012, fixing for 2013 and 2014 the fishing opportunities for EU vessels for fish stocks of certain deep-sea fish species, a TAC was set to 680 and 544 tonnes, respectively for EU vessels in EU waters and international waters of Subarea III. Pending consultations between EU and Norway, no directed fishery for roundnose grenadier is allowed in Division IIIa. Norway has not implemented unilateral regulations except a discarding ban.

9.3.5 Data available

9.3.5.1 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 9.3.1).

9.3.5.2 Age composition

New age data are available (Bergstad *et al.*, 2013).

9.3.5.3 Bycatch effort and cpue

ICES 2013 gives information on estimated bycatch of roundnose grenadier in Norwegian shrimp fishery in ICES Division IVa and IIIa (Figure 9.3.2). These bycatch estimates were not obtained by sampling of the commercial catches but derived using the mean annual Norwegian shrimp-trawl survey catches of grenadier a depths <400 m and annual effort in the shrimp trawl fishery. The shrimp fishery in this area is mainly conducted shallower than the primary depth range of roundnose grenadier. It should be noted that commercial vessels fishing in the relevant areas use sorting grids to reduce bycatch, a device not used in the survey, hence survey-based estimates are likely to be overestimates.

9.3.5.4 Survey indices

The Norwegian annual shrimp survey conducted since 1984 samples deeper parts of the Skagerrak and northeastern North Sea (IIIA and IVa), including the depth range where the roundnose grenadier occurs (mainly 300–600 m. The minor area >600 m is an ammunition and warship dumping ground with warning against fishing).

9.3.6 Data analyses

A recent study analysed the time-series of abundance of roundose grenadier through the time-series (Bergstad *et al.*, 2013). Catch rates in terms of biomass (kg/h) and abundance (nos/h) were calculated for stations 300 m and deeper (Figure 9.3.3). Stations with zero catches were included, and the catches at non-zero stations were standardized by tow duration. The published analysis also includes a time-series of small grenadier, i.e. <5 cm PAFL, illustrating variation in recruitment.

9.3.6.1 Trends in landings, effort and estimated bycatches

Collated information on landings and survey-based estimates of bycatch suggest that the removals of roundnose grenadier are now at low levels in Division IVa and IIIa.

There is no longer a directed fishery for grenadier in this area and data on effort and cpue is therefore not available from the commercial catches. The earlier evaluation of the Danish cpue data were presented in ICES (2007) but these cpue data do not provide any clear indications of stock development and status for the time of the directed fishery which ceased in mid-2006.

Landings are now insignificant and represent bycatches from other fisheries. The estimated bycatches of roundnose grenadier from the Norwegian shrimp fishery is shown to be at low levels (less than 100 tonnes /year).

9.3.6.2 Size compositions

The recent length distributions from the Norwegian survey data contrasts with the 1991–2004 distributions by their low proportions of small fish (Bergstad *et al.*, 2013). The pulse of juveniles appearing in the early 1990s appears to have represented the only major recruitment event through the time-series 1984–present. Recently some small juveniles appear every year in the survey, but there is no indication of a pronounced recruitment pulse as observed in the early 1990s.

The Danish and Norwegian length distributions, sampled from commercial landings and survey catches, respectively, agree well for those years covered by samples from both countries (1987 and 2004–2006) (See Stock Annex for information on the Danish length distributions from the directed fishery). Note that both in 1987 and 2004 there appear to be two clearly distinguishable components in the Danish length compositions. In the Norwegian data, several years show two modes and it is possible to follow the more abundant occurrence of juveniles<5 cm (PAL) through several years.

9.3.6.3 Biomass and abundances indices from survey

The estimates survey catch rates in terms of biomass (kg/h) and abundance (nos/h) varied strongly through the time-series, but elevated levels were observed from 1998 to 2005. The indices have declined since 2004 with both biomass and abundance being lowest on record in 2013, also below the level observed in the period prior to the exploitation pulse in 2003–2005. Data for 2014 show biomass and abundance indices remaining at a low level.

9.3.6.4 Age data

The age distribution from recent years contrasts with distributions from the 1980s (Bergstad, 1990b) in terms of proportions of old fish (e.g. >20 years) (Figure 9.3.4). After the exploitation pulse in 2003–2005, the proportion of old fish has declined to very low levels (Bergstad *et al*., 2013). In recent years, i.e. after 2006 the mean age in the catches has increased somewhat, but the proportion of fish >20 years remains low.

Analyses of size distributions and the time-series of survey abundance of small juveniles by Bergstad *et al*. (2013) suggested that only a single very abundant recruitment event occurred during the time period 1985–2013, perhaps only a single major year class. This event rejuvenated the stock and enhanced abundance in subsequent years.

Biological reference points

No biological reference points for category 6 or 7 stocks.

9.3.7 Comments on assessment

No analytical assessment was carried out. The abundance indices from the Norwegian survey, derived from the relevant depth range of the species in this area, provides currently the only source of abundance information.

9.3.8 Management considerations

The decline in abundance after 2005–2006 suggested by the Norwegian shrimp survey catch rates probably reflect the combined effect of the enhanced targeted exploitation in 2003–2005 and low recruitment in the years following the single recruitment pulse in the early 1990s. The percentage of fish >15 cm is at the same level as in the late 1980s and early 1990s, however, there is no suggestion of a new recruitment pulse as seen in the 1990s. Recent age distributions almost lack the >20 year old component which was prominent in the 1980s.

Since the targeted fishery has stopped and the bycatch in the shrimp fishery seems low and probably decreasing, the potential for recovery of the roundnose grenadier in Skagerrak may be good. However, current abundance levels appear the lowest recorded during the survey time period 1984–2013 and rejuvenation and growth of the population would at present seem unlikely due to low recruitment during the recent decade.

Table 9.3.0. 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
2011		0		0
2012	1	0		10
2013	1			1

*** Preliminary data.**

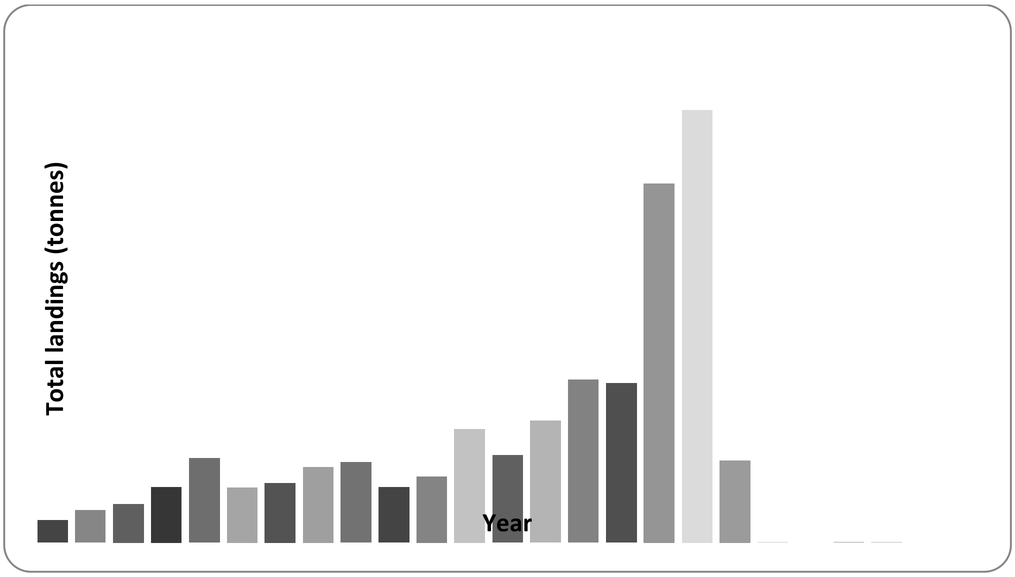


Figure 9.3.0. Landings of roundnose grenadier from Division IIIa. Landings from 2007–2013 are insignificant.

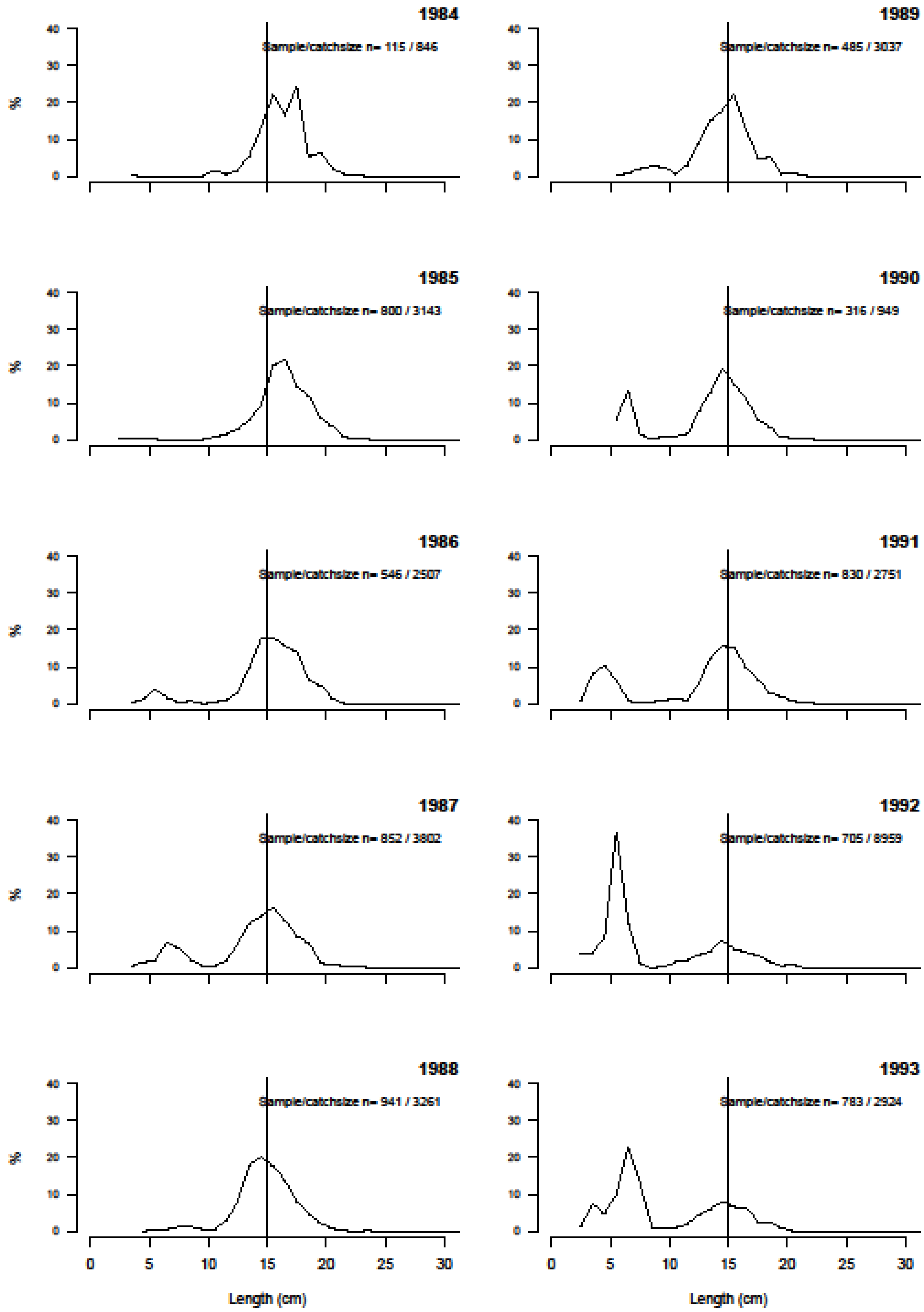


Figure 9.3.1. Length–frequency distributions for roundnose grenadier, 1984–2013. Data from Norwegian shrimp survey, all catches deeper than 300 m. Length is measured as pre-anal fin length in cm. The distributions are calculated as percent number of fish in each cm length interval standardized to total catch number and trawling distance for each station each year.

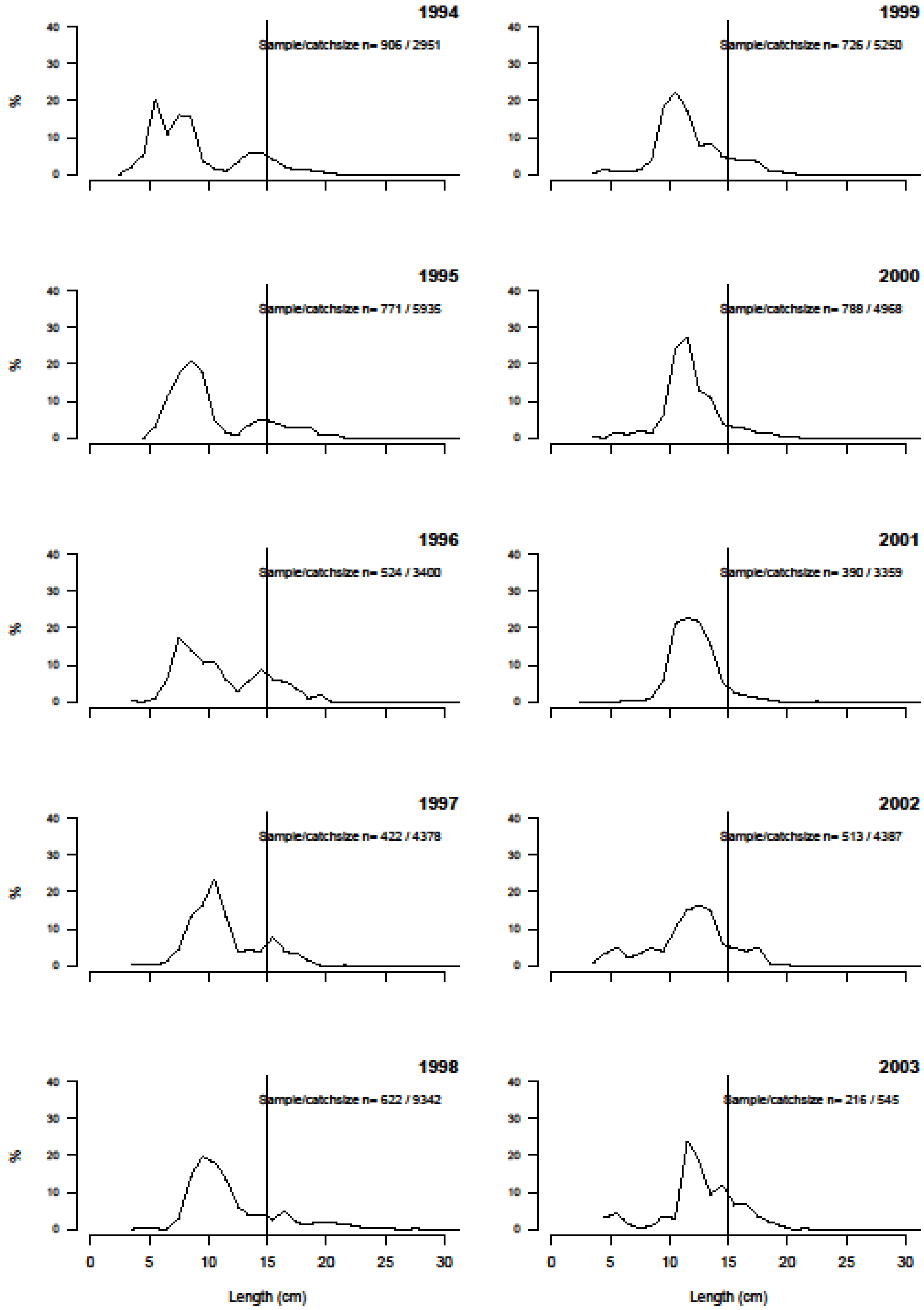


Figure 9.3.1. (Con't).

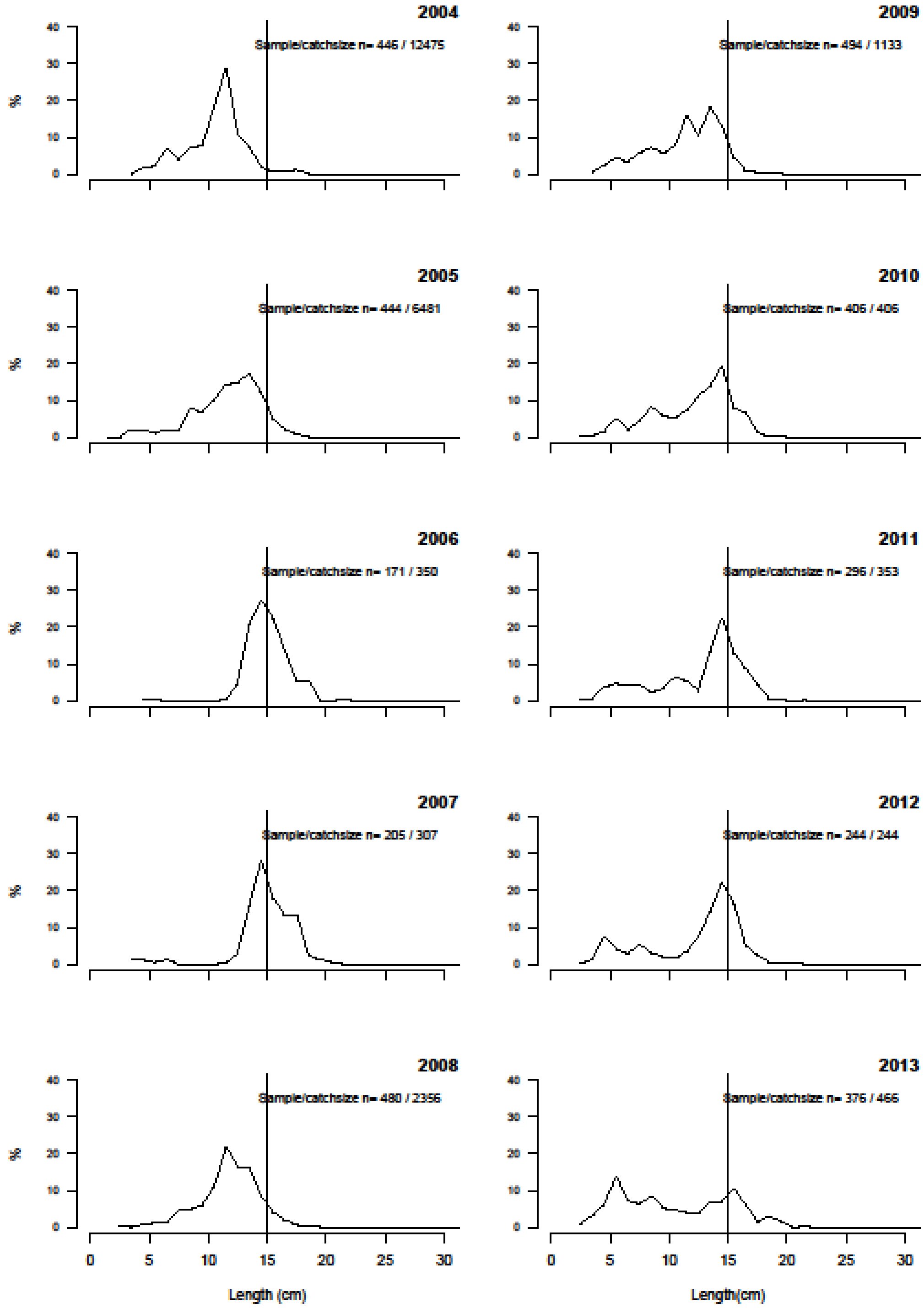


Figure 9.3.1. (Con't).

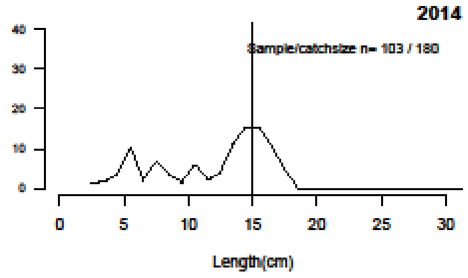


Figure 9.3.1. (Con't).

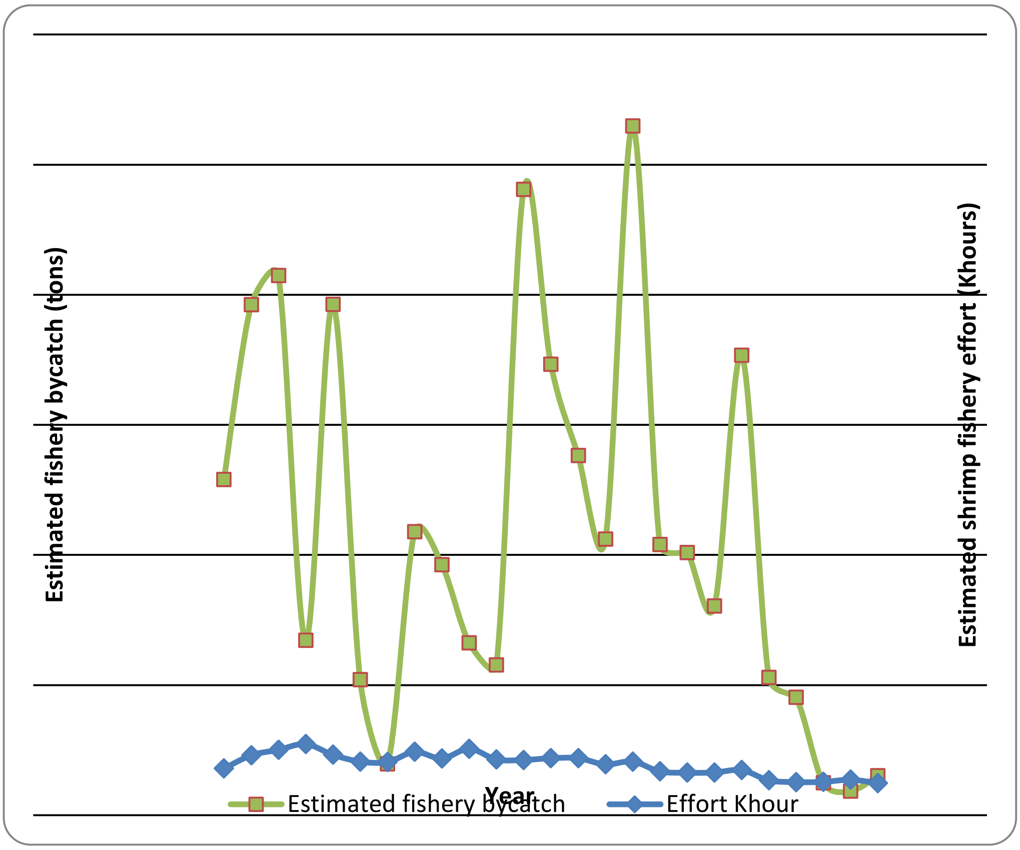


Figure 9.3.2. Estimated bycatch of roundnose grenadier in the Norwegian shrimp fishery in ICES Division IVa and IIIa, and the estimated commercial shrimp fishery effort in the same area. See text for explanation.

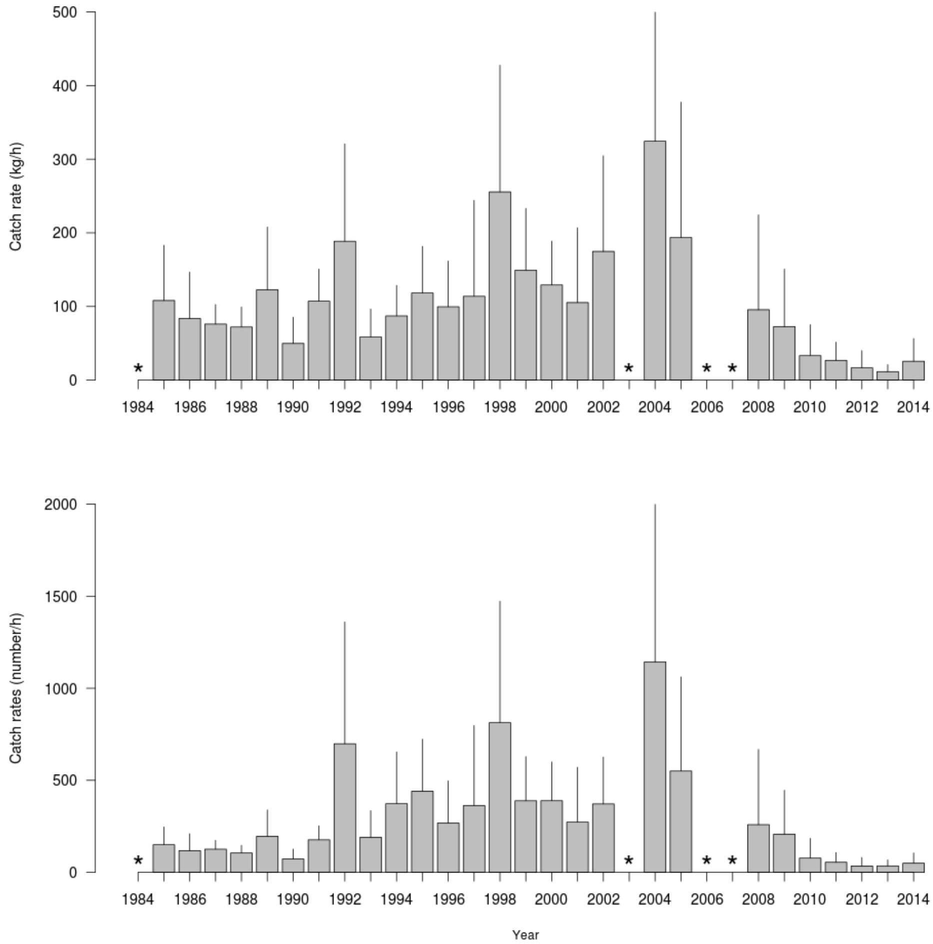


Figure 9.3.3. Survey catch rates in biomass (kg/h) and abundance (nos/h) of grenadier 1984–2014. Note: in 1984, 2003, 2006, and 2007 only a single or no trawls were made deeper than 400 m, thus the primary grenadier habitat was not sampled. Lines indicate estimates of 2SE (Updated from Bergstad *et al.*, 2013).

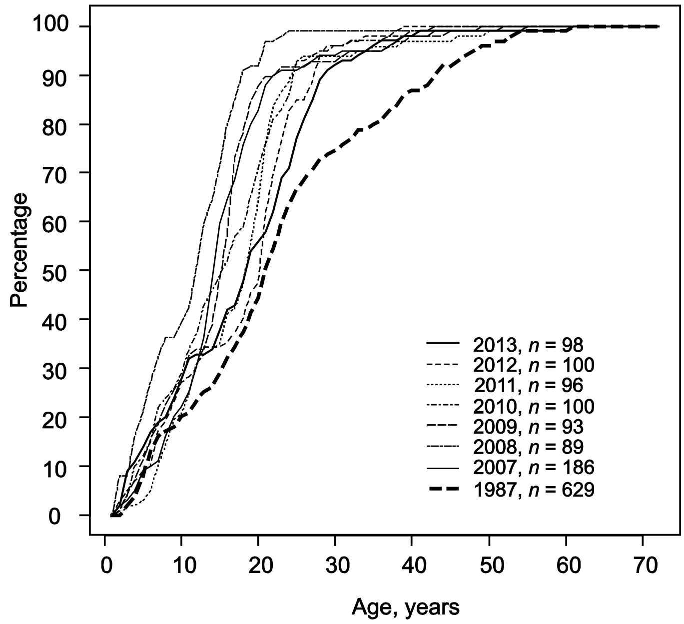


Figure 9.3.4. Cumulative age distributions of roundnose grenadier in the Skagerrak. Data from survey catches in the Skagerrak in 1987 and 2007–2013. The distribution from 1987 was modified from Bergstad (1990). Data from 2007 were collected on the deep-water fish survey in April.

9.3.9 References

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9.4 Roundnose Grenadier (*Coryphaenoides rupestris*) in Divisions Xb, XIIc and Subdivisions Va1, XIIa1, XIVb1

9.4.1 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. Since the early nineties fisheries on MAR have been sporadic and much smaller in scale. The main nations participating in the fishery since 2000 are Spain and Russia.

9.4.1.1 Landings trends

The greatest annual catch (almost 30 000 t) was taken by the Soviet Union in 1975 (Tables 9.4.1–9.4.4, Figure 9.4.1) 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 by-catch 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, Russian trawler caught 73 t roundnose grenadier during a short-term fishery (two days) in the southern part of the Division Xb.

Also in 2010, the Spanish fleet targeting redfish on the MAR reported catches of roundnose grenadier in XIVb totalling 242 tones. The following year, roundnose grenadier became a target species, with catches increasing to 2440 t in XIVb, according to official statistics. After this increase, catches have stabilised somewhat, with a total of 2724 t caught in XIIa and XIVb in 2012. The preliminary official catch for 2013 is 1907 t for XIIa and XIVb combined. These are official figures obtained from updated official data made available very recently. They differ from figures published in previous WGDEEP reports for several reasons. In some instances (2010), catches of both *M. berglax* and *C. rupestris* where combined. Besides, from 2012 onwards only official data can be used in WGs. Since the dataseries is so short and the first data year (2010) the fishery was merely experimental, it was considered more appropriate to use official data only. On the other hand, observer coverage for this fishery has been very limited, increasing the uncertainty of WG estimates. Finally better data quality has made possible to separate roundnose grenadier catches from XIIa and XIIb in 2012 and 2013. Thus data from 2012 and 2013 are considered more reliable than those from previous years considering the available information to date. It is nevertheless necessary to improve the spatial resolution, accuracy and reliability of these data.

9.4.1.2 ICES Advice

ICES advice for 2013 and 2014 was:

"catches should decrease by 20% compared to the average catch of the last three years, corresponding to catches of no more than 1350 t in 2013 and subsequent years".

9.4.1.3 Management

There is TAC-based species-specific management of the roundnose grenadier fisheries in Subareas VIII, IX, X, XII, XIV for European Community vessels (See Section 9.1.2). On the 32th Annual session of NEAFC was adopted TAC of 1350 t for roundnose grenadier in the international waters of Divisions Xb and XIIc, Subdivisions XIIa1 and XIVb1. In addition, the measure of regulations of efforts in the fisheries for deep-water species was adopted again (in the same redaction, as earlier). This measures in force until 31 December 2014.

9.4.2 Data available

9.4.2.1 Landings and discards

Landings are given in Tables 9.4.1–9.4.4. There were no discards of roundnose grenadier on Russian trawlers where smallest fish and waste were used for fish meal processing. There is no information on discards quantity by vessels of other countries.

9.4.2.2 Length compositions

According to last Russian research data (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 9.4.2). The retrospective data analysis demonstrates that the length of fish caught in 2003–2010 in the surveyed area decreased as compared to 1980s. The length distributions in 2003 and 2010 are generally similar, however, in 2010 the number of small immature grenadier up to 50 cm in length was lower.

The pelagic trawl Spanish fishery in 2012–2013 caught individuals from 6 to 23 cm pre-anal length. The length compositions of landings and discards of this fishery are presented in Figure 9.4.3.

In 2013 juvenile individuals were occasionally caught by pelagic trawl during Redfish survey in the Irminger Sea at a depth 500–900 m. Total length of 28 specimens varied from 7 to 32 cm.

9.4.2.3 Age compositions

No new data on age compositions were presented.

9.4.2.4 Weight-at-age

No new weight-at-age data are available.

9.4.2.5 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 pre-spawning 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).

9.4.2.6 Catch, effort and research vessel data

Catch and cpue data are given in Tables 9.4.1–9.4.5 and Figures 9.4.1 and 9.4.4. 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 2006–2009 (data for some years cannot be used owing to short fishing periods). Effort data separated by subareas and divisions are available for Russian fleet in 2003–2005 (Table 9.4.5). The Spanish official effort data are 60 and 141 days for XIIa and XIVb, respectively) in 2012; and 18 and 108 days for XIIa and XIVb, respectively, in 2013. Thus mean catch per fishing day was 14.5 and 13.2 t in XIIa and XIVb, respectively, in 2012; and 6.5 and 16.5 t in XIIa and XIVb, respectively, in 2013.

9.4.3 Data analyses

The only source of information on abundance trends was the cpue series from the Soviet/Russian official data (Table 9.4.5, Figure 9.4.4). The cpue varied strongly, but generally declined in the 1970s, 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.

From 2012 the official Spanish cpue and effort data are available. The current effort is low compared to the effort developed by USSR vessels in the 1970s and the cpue seems also low, long-term comparison is however undermined by the absence of standardisation of fleet and vessel type.

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 9.4.5). 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 9.4.6) as compared to 1970s–1980s, when it was mainly from 600 to 1200 m (Chuksin and 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 9.4.6). The average biomass per one seamount increased from 3900 t in 2003 to 4600 t in 2010. Some increasing of biomass, stable 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.

9.4.4 Biological reference points

No attempt was made to propose reference points for this stock.

9.4.5 Comments on the assessment

No analytical assessments were carried out.

9.4.6 Management considerations

The fishery was resumed in recent years after the long break. The landings series is too short now. In fact, active fishery started in 2011. WGDEEP considers that the latest approach for management is applicable for this stock; the TAC in average catch for three recent years.

Table 9.4.1. Working group estimates of catch of roundnose genadier from Subdivision Va1.

Year	USSR/ Russia	Total
1973	820	820
1974	12 561	12 561

Table 9.4.2. Working group estimates of catch of roundnose genadier from Subarea Xb.

Year	USSR/ Russia	Faroes[1]	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			

Table 9.4.3. Working group estimates of catch of roundnose genadier from sub-areas XIIa1 and XIIc.

YEAR	USSR/ RUSSIA	POLAND[2]	LATVIA[2]	FAROES[2]	SPAIN	TOTAL
1973	226					226
1974	5874					5874
1975	29894					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	3214[1]		4296			7510[1]
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						
2011						
2012[1]					864	
2013[3]					118	

[1]– revised catch data [2]– official ICES data [3]– preliminary data.

Table 9.4.4. Working group estimates of catch of roundnose genadier from Subdivision XIVb1.

YEAR	USSR/ RUSSIA	SPAIN	UNALLOCATED	TOTAL
1976	11			11
1982	153			153
1997	3361			3361
1998				
1999				
2000	5			5
2001	69			69
2002	4	235[2]		239
2003		272[2]		272
2004	201			201
2005				
2006				
2007				
2008				
2009				
2010		242[1]		242[2]
2011		2440[1]		2440[1]
2012		1860	1098	2958
2013[3]		1789		1789

[1]– revised catch data [2]– official ICES data [3]—preliminary data

Table 9.4.5. Soviet/Russian efforts and cpue on roundnose grenadier fishery by the MAR area.

Year	ICES Sub area 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		
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, XIVb1, Xb		
1995	XIIa1+XIIc, XIVb1, Xb		
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	XIIa1+XIIc, XIVb1, Xb		
2007	XIIa1+XIIc, XIVb1, Xb		
2008	XIIc	7	
2009	XIIc	1	

Table 9.4.6. Biomass of roundnose grenadier (t) according results of the Russian 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.**

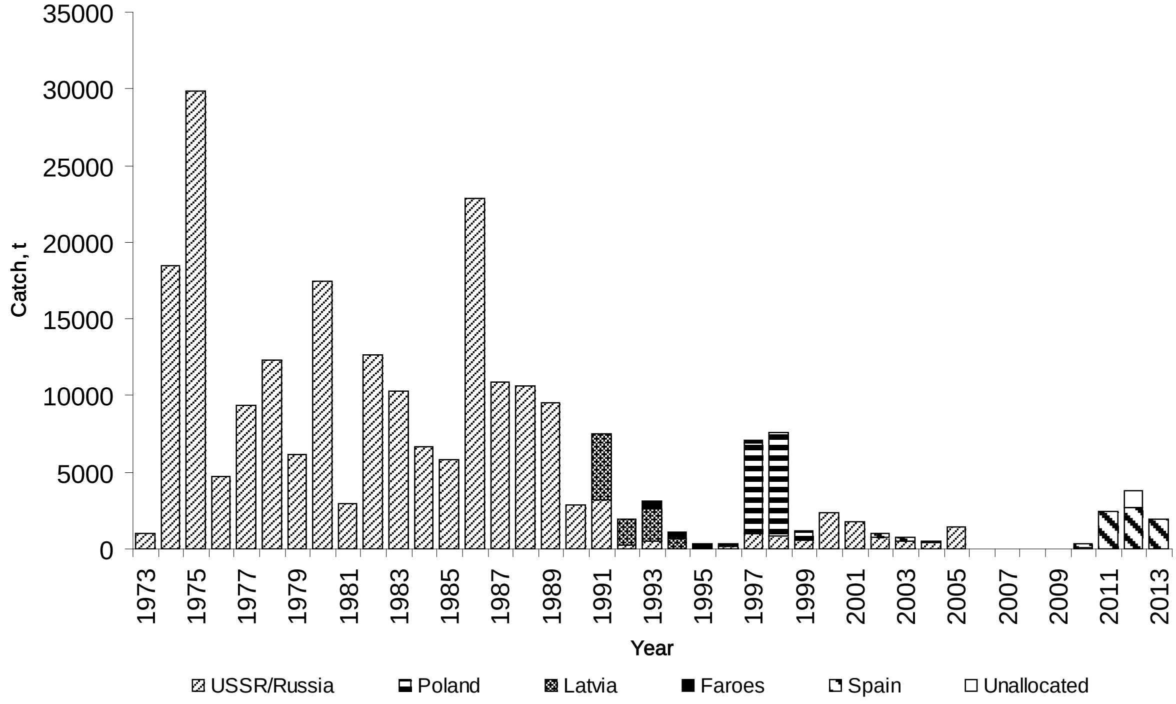

Figure 9.4.1. International catch in 1973–2013, of roundnose grenadier on the MAR in 1973–2005.

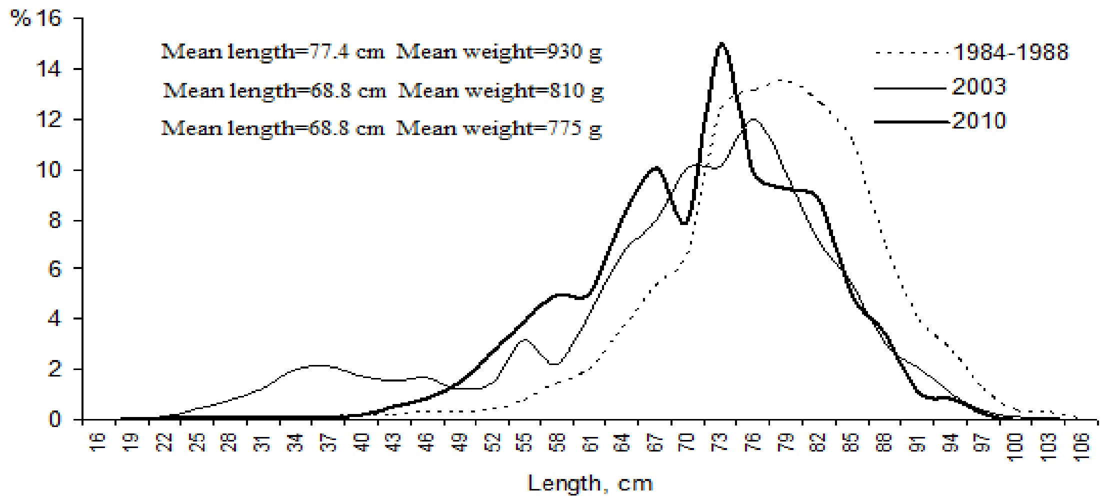

Figure 9.4.2. Total length composition of roundnose grenadier on the MAR in 1984–1988 (47–51°N), in 2003 (47–51°N) and in 2010 (47–50°N).

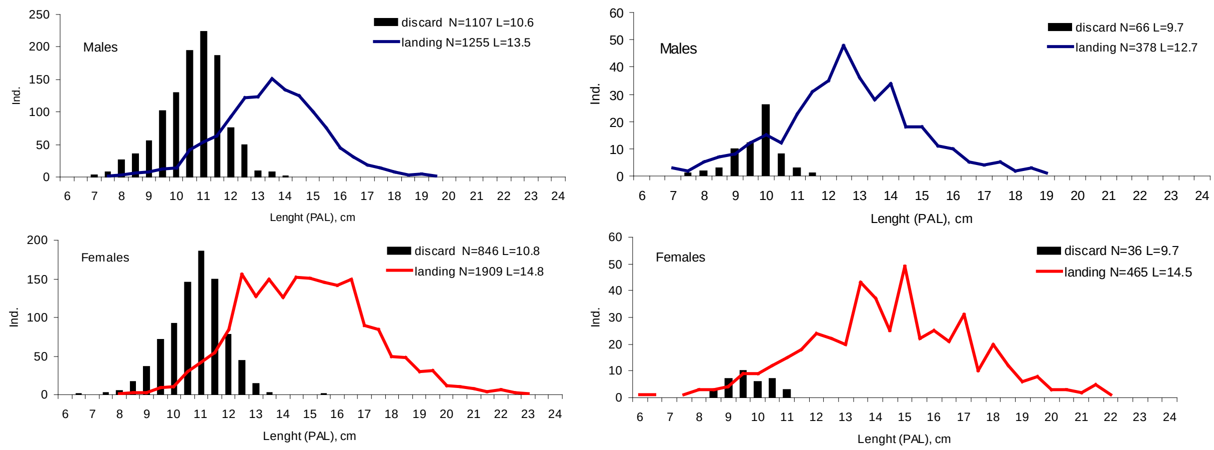

Figure 9.4.3. Length composition (PAL) of landings and discards of roundnose grenadier on Spanish commercial trawl fishery.

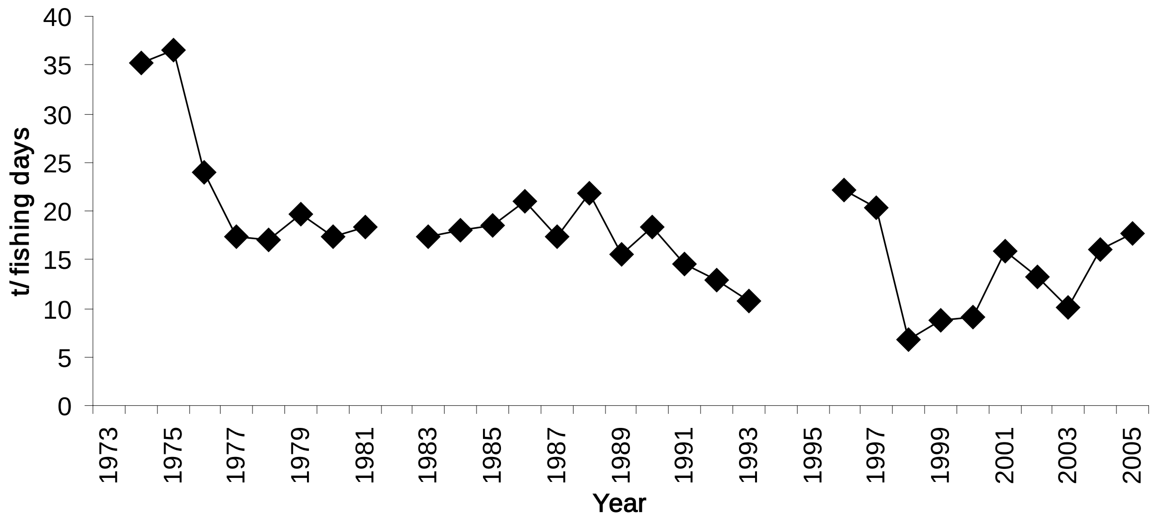

Figure 9.4.4. Soviet/Russian cpue of roundnose grenadier on the MAR in 1973–2005.

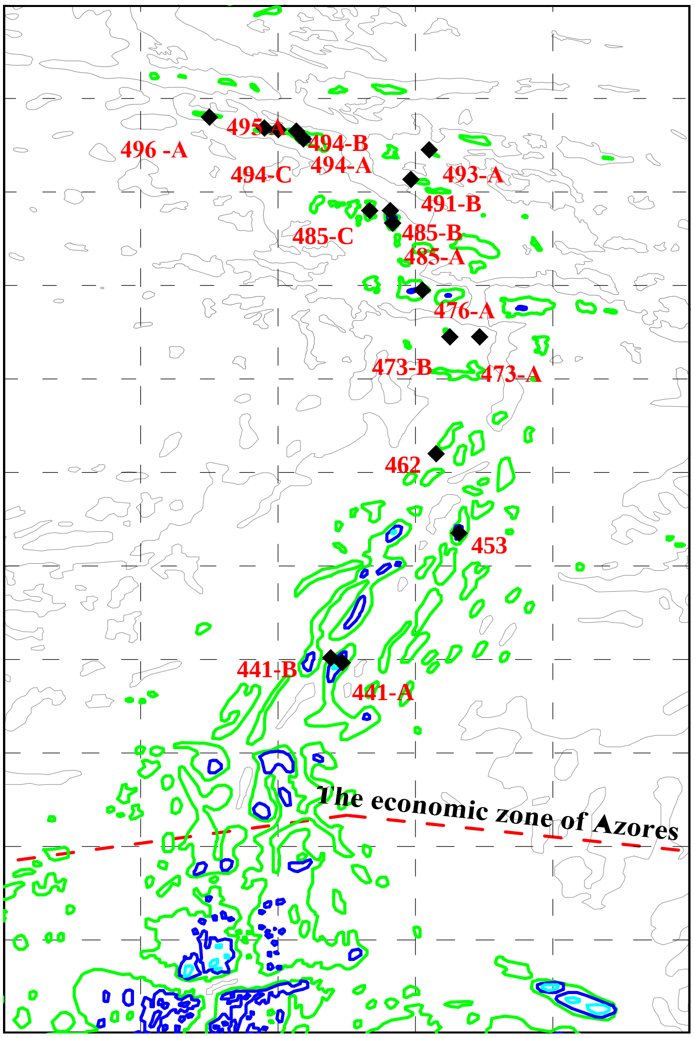

Figure 9.4.5. Location of seamounts surveyed at RV "Atlantida" on the MAR in October 2010.

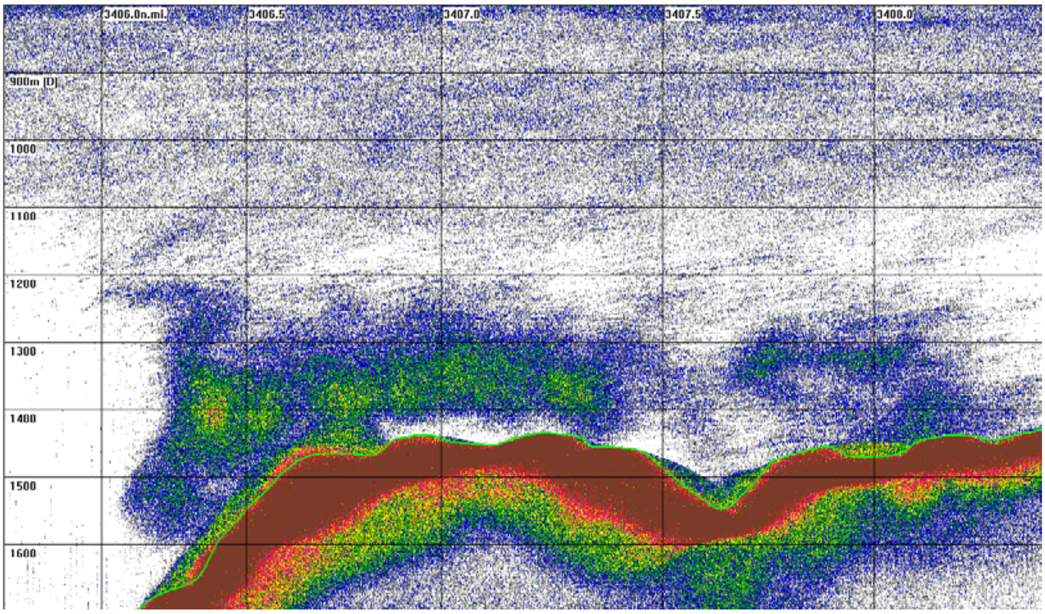

Figure 9.4.6. Echo-records of roundnose grenadier at the MAR seamount 494-A in October 2010.

9.5 Roundnose grenadier (*Coryphaenoides rupestris*) in other areas (I, II, IV, Va2, VIII, IX, XIVa, XIVb2)

9.5.1 The fishery

Outside of the main fisheries covered in other sections, landings of roundnose grenadier were insignificant.

9.5.1.1 Landings trends

Landing statistics by nations in the period 1990–2013 are presented in Tables 9.5.1–9.5.5.

In the Subareas I and II the catch of roundnose grenadier in 2013 amounted 17 t and was taken as bycatch by Norwegian fleet. From 1990 landings varied from 0 to 101 t (Figure 9.5.1). The major contribution to the total catch 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. Earlier French landings, that reached 41 t, were assigned to this species however a recent revision of the data indicates that previous landings are more likely to correspond to roughead grenadier.

In Subarea IV, the catch of roundnose grenadier in 2013 comprised less than 1 t which was taken by the Norwegian fleet. During 1990–2012 total landings in this area varied between 0 and 372 t (Figure 9.5.2). The main contribution to the total catch was made by the Danish fleet in 2004. Roundnose grenadier is caught as incidental bycatch in this area by Scottish and Norwegian vessels in insignificant amount as well. As detected for French landings of this species in Subareas I and II, earlier landings of roundnose grenadier in Subarea IV are likely to correspond to roughead grenadier.

During 1990–2013, the landings of roundnose grenadier within Icelandic waters (Division Va) varied 2 to 398 t and were made by Iceland (Figure 9.5.3). Maximum landings were registered in 1992–1997 when 198–398 t were caught annually as bycatch in mixed deep-water fisheries. In recent years, roundnose grenadier landings from 16 to 81 t were taken in Icelandic waters as bycatch in trawl fisheries for Greenland halibut and redfish. In 2013 catch in Va amounted 84 t.

Roundnose grenadier landings in Subareas VIII and IX during 1990–2013 were minor and amounted 0 to 28 t annually (Figure 9.5.4). The main contribution to the total catch was made by France. In 2013 landings from the subareas comprised 1 t.

Total catch in Greenland waters (Subdivision XIVb2) in 1990–2013 amounted 2126 t (Figure 9.5.5). There is no directed fishery for roundnose grenadier in these areas. The majority of landings is taken as bycatch by Greenland, Germany and Norway during Greenland halibut bottom-trawl fisheries.

In the period 2003–2005 the unallocated landings were assigned to Subareas I, II, IV. VIII, IX and Division Va2 and XIVb2 and the values were 208, 504, and 952 t respectively.

9.5.1.2 ICES advice

ICES advice for 2013 and 2014 was: "Based on the ICES approach for data-limited stocks, ICES advises that fisheries should not be allowed to expand from 120 t until there is evidence that this is sustainable."

9.5.1.3 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 9.5.6). In international waters there are NEAFC regulation of efforts in the fisheries for deep-water species.

9.5.2 Data available

9.5.2.1 Landings and discards

Landings are given in Table 9.5.1–9.5.5. Estimated discards on Spanish fishery did not exceed 2 and 1 t in 2012 and 2013 respectively.

9.5.2.2 Length compositions

No data.

9.5.2.3 Age compositions

No data.

9.5.2.4 Weight-at-age

No data.

9.5.2.5 Maturity and natural mortality

No data.

9.5.2.6 Catch, effort and research vessel data

No data.

9.5.3 Data analyses

No assessment was carried out for this stock in 2012.

Biological reference points

WKLIFE has not yet suggested methods to estimate biological reference points for stocks which have only landings data or are bycatch species in other fisheries. Therefore, no attempt was made to propose reference points for this stock.

9.5.4 Comments on the assessment

No assessment was carried out for this stock in 2012.

9.5.5 Management considerations

This is a bycatch fishery and advice should take into account advice for other stocks.

Table 9.5.1. Working group estimates of landings of roundnose genadier from Subareas I and II.

Year	Faroes	Denmark	Germany	Norway	Russia/USSR	Germany	UK (E+W)	UK (Scot)	TOTAL
1990			2		12	3			17
1991			3	28					31
1992		1		29					30
1993				2					2
1994			12						12
1995									0
1996									0
1997	1			100					101
1998				87	13				100
1999				44	2				46
2000									0
2001							2		2
2002				11	1				12
2003				4					4
2004				27					27
2005				12					12
2006				6	2				8
2007				11	1				12
2008				10					10
2009				8					8
2010				17	6				23
2011				16					16
2012				5					5
2013*				17					17

*** Preliminary data.**

Table 9.5.2. Working group estimates of landings of roundnose genadier from Subarea IV.

Year	Germany	Norway	UK (Scot)	Denmark	TOTAL
1990	2				2
1991	4				4
1992			4	1	5
1993	4				4
1994	2			25	27
1995	1		15		16
1996			5	7	12
1997			10		10
1998					0
1999		5			5
2000					0
2001				17	17
2002		1	26		27
2003		1	11		12
2004			1	371	372
2005		2			2
2006		4			4
2007		1			1
2008					0
2009					0
2010		2	0		2
2011		0	0		0
2012		1			1
2013					0

***Preliminary data.**

Table 9.5.3. Working group estimates of landings of roundnose genadier from Division Va.

YEAR	FAROES	ICELAND**	NORWAY	UK (E+W)	TOTAL
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		57			57
2004		181			181
2005		76			76
2006		62			62
2007	1	13	2		16
2008		29			29
2009		46			46
2010		59			59
2011		62			62
2012	0	80			81
2013		84			84

*** Preliminary data. ** includes other grenadiers from 1990 to 1996.**

Table 9.5.4. Working group estimates of landings of roundnose genadier from Subareas VIII and IX.

YEAR	FRANCE	SPAIN	TOTAL
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	1		1
2011	1		1
2012	0		0
2013*			

*** Preliminary data.**

Table 9.5.5. Working group estimates of landings of roundnose genadier from Division XIVb2.

Year	Faroes	Germany	Greenland	Iceland	Norway	UK (E+ W)	UK (Scot)	Russia	TOTAL
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		33			7				40
2011		32			4				36
2012					1				1
2013*					2				2

*** Preliminary data.**

Table 9.5.6. 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
1990	17	2	7	5	47	0	78
1991	31	4	48	1	29	0	113
1992	30	5	210	12	31	0	288
1993	2	4	276	18	26	0	326
1994	12	27	210	5	15	0	269
1995	0	16	398	0	27	0	441
1996	0	12	140	1	25	0	178
1997	101	10	198	0	57	0	366
1998	100	0	120	20	126	0	366
1999	46	5	129	16	124	0	320
2000	0	0	54	5	57	0	116
2001	2	17	40	7	97	208	163
2002	12	27	60	3	47	504	149
2003	4	12	57	2	21	952	96
2004	27	372	181	2	30	0	612
2005	12	2	76	7	14	0	111
2006	8	4	62	28	53	0	155
2007	12	1	16	10	2	0	41
2008	10	0	29	8	12	0	59
2009	8	0	46	1	2		57
2010	23	2	59	1	40		125
2011	16	0	62	1	36		115
2012	5	1	81	1	1		89
2013*	17	0	84	0	2		103

*** Preliminary data.**

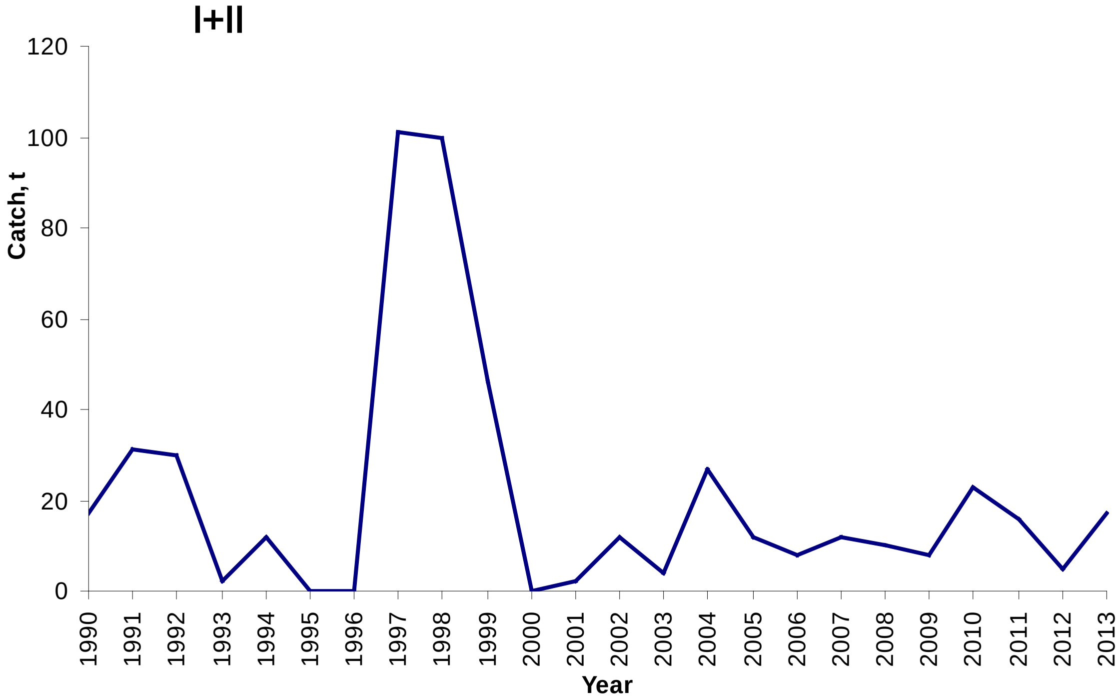

Figure 9.5.1. Roundnose grenadier landings in Subareas I and II, 1990–2013 (data for 2013 is preliminary).

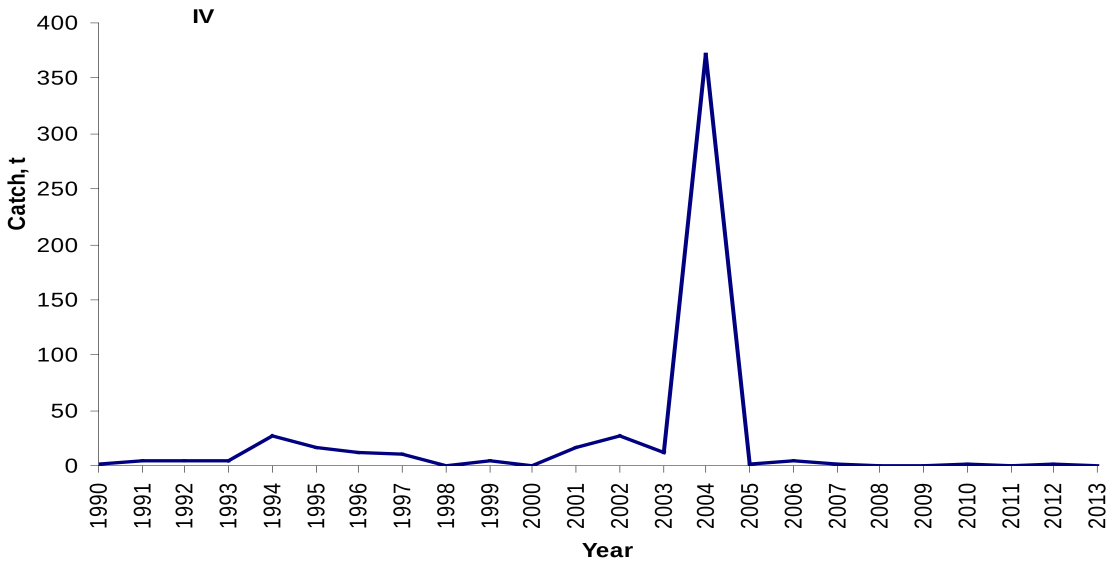

Figure 9.5.2. Roundnose grenadier landings in Subareas IV, 1990–2013 (data for 2013 is preliminary).

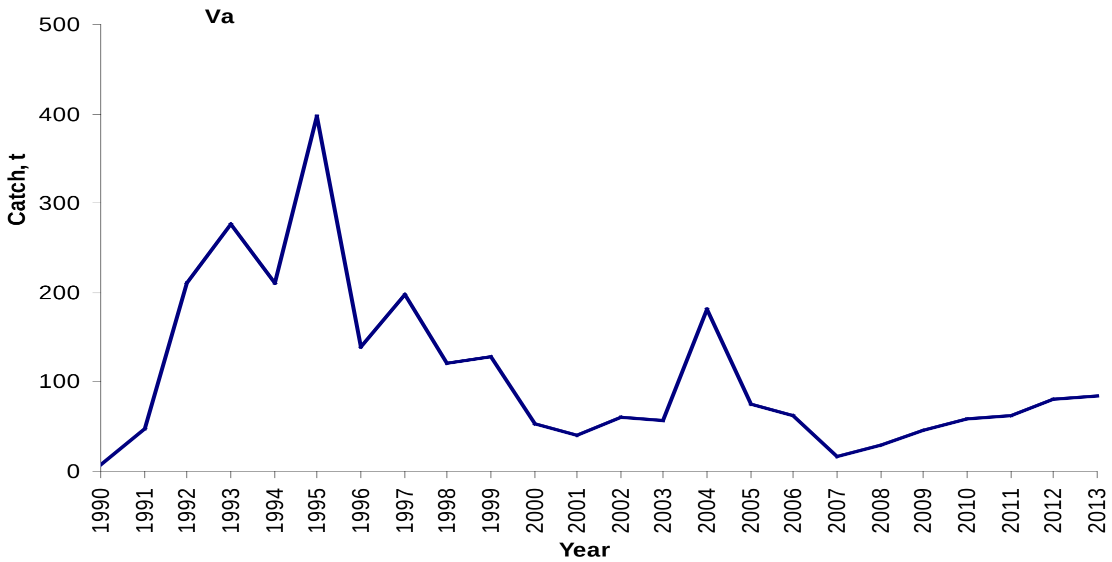

Figure 9.5.3. Roundnose grenadier landings in Division Va, 1990–2013 (data for 2013 is preliminary).

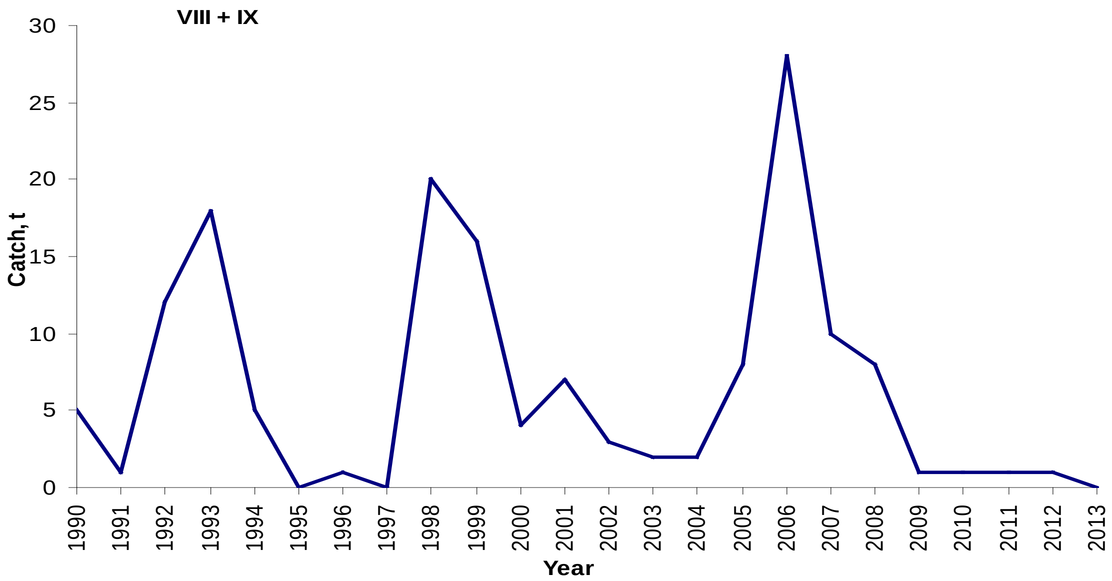

Figure 9.5.4. Roundnose grenadier landings in Subareas VIII–IX, 1990–2013 (data for 2013 is preliminary).

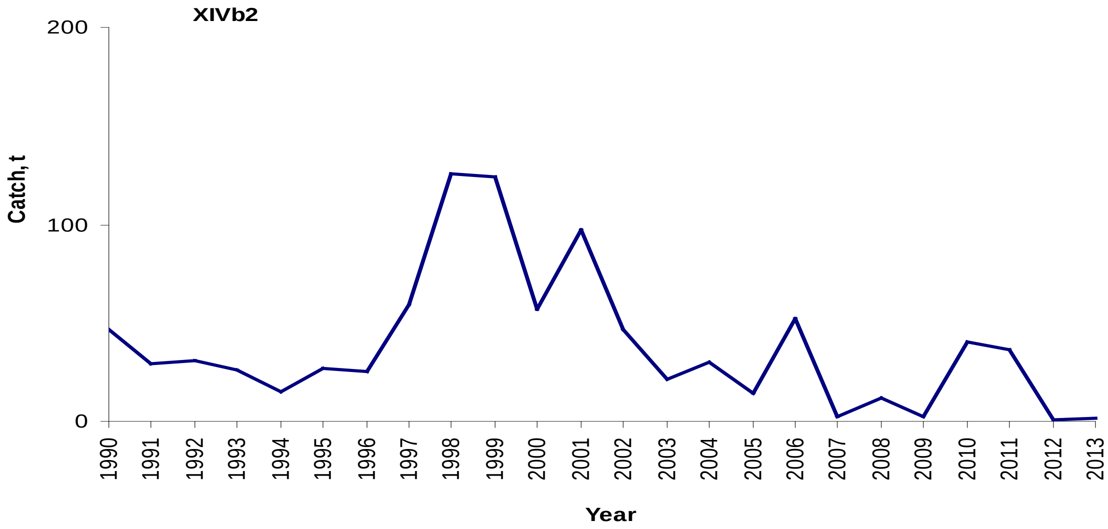

Figure 9.5.5. Roundnose grenadier landings in Subarea XIVb2, 1990–2013 (data for 2013 is preliminary).

10 Black scabbardfish (*Aphanopus carbo*) in the Northeast Atlantic

10.1 Stock description and management units

The species is distributed on both sides of the North Atlantic and on seamounts and ridges south to about 30°N. It occurs only sporadically north of the Scotland-Iceland-Greenland ridges. Juveniles are mesopelagic and adults are benthopelagic.The life cycle is not completed in just one area and either small or large scale migrations occur seasonally.

The stock structure in the whole northeast Atlantic is still uncertain. All available information support the assumption of a single stock from Faroese waters and the west of the British Isles down to Portugal (Farias *et al.*, 2013). The links with other areas (mainly Iceland and the Azores) is less clear.

Prior to the 2014 benchmark meeting (WKDEEP, 2014), WGDEEP has considered three assessment units for black scabbardfish (ICES, 2011):

1) Northern (Divisions Vb and XIIb and Subareas VI and VII);
2) Southern (Subareas VIII and IX);
3) Other areas (Divisions IIIa and Va Subareas I, II, IV, X, and XIV).

The northern component comprises fish 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.

Based upon the linkage between the northern and southern management units, WKDEEP 2014 concluded that the status for all areas should be considered as whole when management advice is given for each of these units.

The different exploitation regimes (different fishing gears and exploited size ranges of the species) between the northern and southern components justifies keeping them distinct for management. However, as all evidence suggest one single stock doing a clockwise migration in these areas, a dynamics population model was fitted to data from the northern and southern component, this model was benchmarked at WKDEEP. The link between the northern and southern components and other areas (mainly Iceland and the Azores) is less clear and these areas were smaller fisheries occur were treated separately. The report will be structured maintaining the initial separation between units, except for topics related with assessment and advice.

10.2 Black scabbardfish in Divisions Vb and XIIb and Subareas VI and VII

In this section fisheries, landings trends, management applicable are presented for Divisions Vb and XIIb and Subareas VI and VII, but the data available, data analyses and management considerations apply to these areas combined to ICES Subareas VIII and Division IXa.

10.2.1 The fishery

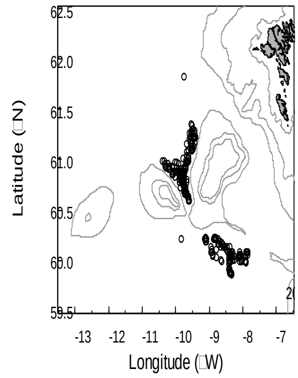

Figure10.2.1. Faroese main fishing grounds of black scabbardfish in Subarea Vb (fishing hauls in which the species contributed with more than 50% of the total catch).

In Subarea Vb black scabbardfish is fished by large trawlers and the main fishing area is on the slope around the Faroe Bank (Figure 10.2.1).

In 2014, there was no updated information on the fisheries taking place in Subareas XIIb and Divisions VI and VII.

10.2.2 Landings trends

The historic landings trends on this assessment unit are described in the stock annex.

Total landings from the ICES Division Vb and Subareas VI, VII and XII show a markedly increasing trend from 1999 to 2002 followed by a decreasing trend till 2005 (Figure 10.2.2). In 2006 there was a peak in landings and then there was a decrease mainly due to a continuous decrease of landings, driving by TAC management, from ICES Divisions VI and VII (Figure 10.2.2). From 2009 till 2012 landings fluctuated around 4000 t and in 2012 landings from ICES Subarea XII remarkably increased.

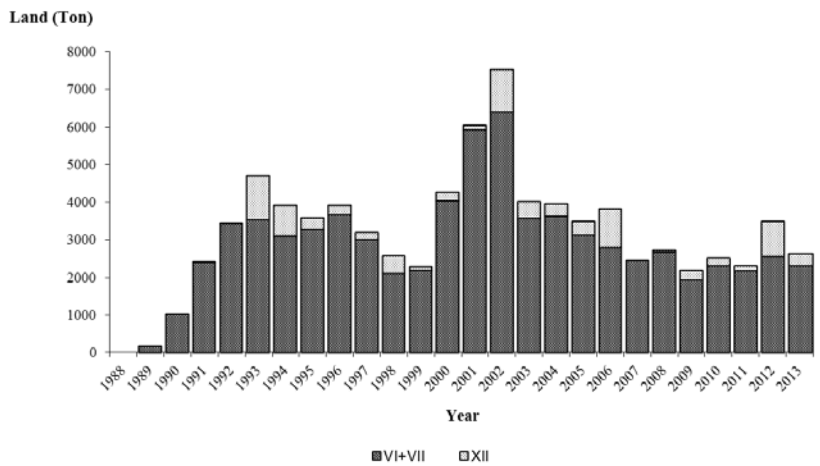

Figure10.2.2. Time-series of annual landings for ICES Division Vb and Subareas VI+VII and XII (2013 provisional data).

In earlier years French landings represent more than 75% of the northern component total landings. In 2000 and 2006 French landing represent about 50%. During that period both Faroese and Spanish landings increase their relative contribution for the landings (Figure 10.2.3). The situation changed after 2010, both in 2011 and 2013 French landings represented nearly 80% of the total landings which are mainly derived from ICES Subarea VI.

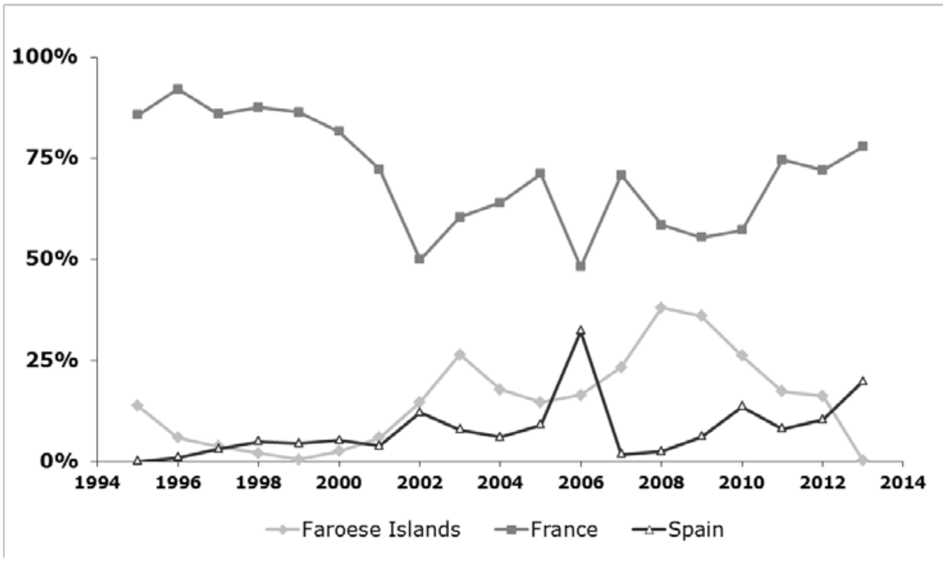

Figure 10.2.3. French, Spanish and Faroese relative contribution to the annual landings for northern component.

10.2.2.1 ICES Advice

The latest ICES advice for 2013 and 2014, based on the ICES approach for data-limited stocks was: "catches should be no more than 4700 tonnes".

10.2.3 Management

Since 2003, management of black scabbardfish by EU vessels fishing in EU and international waters includes a combination of TAC and licensing system. Both TACS and EU total landings in Subareas V, VI, VII and XII from 2006 to 2013 are presented in the table below. The difference between the TAC and landings may not necessarily be regarded as TAC overshoot as some catches occur in waters under the jurisdiction of third countries and are therefore not covered by the TAC.

Year	EU TAC V, VI, VII & XII	EU Landinds Vb, VI, VII and XII
2006	3042	7455
2007	3042	4885
2008	3042	3722
2009	2738	3082
2010	2547	2582
2011	2356	2350
2012	2179	2155
2013*	3051	2772

*** Preliminary.**

10.2.4 Data available

10.2.4.1 Landings and discards

Updated landing data were made available for the major fishing countries operating in the ICES Subareas Vb, VI, VII and XII (Table 10.2.1). Spanish landing data from 2006 and 2013 were thoroughly scrutinized during the meeting because some of the figures were considered unreliable.

Estimates of deep-sea discards from Spanish bottom fleet operating in the Northeast Atlantic ICES Subareas VI and VII and in Divisions VIIIc, North IXa for the period 2007–2011 are presented in Table 10.2.0. Excluding 2007 in ICES Subareas VI and VII, the annual discards of black scabbardfish were low.

Table 10.2.0. Raised discards estimates (tonnes) for the Spanish "fresh" fleet in ICES areas (these data do not include the Basque country fleet nor the Spanish freezer fleet of Hatton Bank). The coefficient of variation (CV) of the estimate is presented in brackets.

ICES	2003	2004	2005	2006	2007	2008	2009	2010	2011
Subareas VI–VII	0.0	0.0	69.5	0.0	125.2	1.8	0.0	12.2	6.5
(CV)	-	-	(99.7)	-	(99.7)	(99.4)	-	(95.2)	(99.7)
Division VIIIc. IXa	4.5	0.0	0.0	2.9	10.2	0.2	1.1	6.7	0
(CV)	(99.8)	-		(99.4)	(59.6)	(111.4)	(69.4)	(69.9)	

Previous estimates of deep-sea discards from French bottom trawl fleet also indicates low levels of discarding.

As a consequence of Spanish and French discard results it is concluded that discards of black scabbardfish are negligible

10.2.4.2 Length compositions

Length–frequency distributions available from the French trawlers observers were used to separate the northern component into the two length classes for the assessment model adopted by the WKDEEP 2014. According to this model the catch is partitioned into two length classes: C2 from 70 to 103 cm TL (total length) and C3> 130 cm TL. No other length–frequency distributions were presented during WGDEEP 2014. However compared to length distributions previously presented for the Spanish fleet no marked difference were detected between the length distribution of the catch of the Spanish and French fleets.

Table 10.2.1 presents the total catch in tonnes and in number by length class, C2 and C3 for the period 1999–2013 by six month time period, adopted as the time unit in the model and defined as: Sem1= months 3–8 of the year Sem 2=month 9–12 of the year plus months 1 and 2 of the following year.

Table 10.2.1. Total catch estimates (in tonnes) and total catch estimates (in number) in length group C2 and C3 by Six month time period (Sem1 and Sem 2) for the years 1999 to 2013.

	Catch (in tonnes)		Catch (in number		Catch (in number	
			C2		C3	
Year	Sem 1	Sem 2	Sem 1	Sem 2	Sem 1	Sem 2
1999		1551		1 262 900		197 135
2000	2060	3205	1 567 307	2 608 615	244 651	407 196
2001	2891	3817	2 199 464	3 107 398	343 329	485 055
2002	3726	4463	2 834 272	3 632 740	442 421	567 059
2003	2419	2866	1 839 919	2 332 935	287 205	364 164
2004	2164	2220	1 646 578	1 806 745	257 025	282 027
2005	1994	1972	1 516 724	1 605 490	236 756	250 612
2006	2770	1836	2 107 379	1 494 580	328 955	233 299
2007	1639	1824	1 247 249	1 484 708	194 691	231 758
2008	1879	2120	1 429 385	1 725 677	223 122	269 373
2009	1742	1685	1 325 360	1 371 873	206 884	214 145
2010	1903	1405	1 448 088	1 143 788	226 042	178 542
2011	1677	1475	1 275 673	1 200 510	199 128	187 396
2012	1443	738	1 098 117	600 378.6	171 413	93 717
2013	1915	1306*	1 456 797	1 063 318*	227 401	165 980*

*** Incomplete since catches January and February 2014 were not available.**

10.2.4.3 Age compositions

The population is not structured by ages because the approach followed to assess the stock is a stage-based model. However, growth parameters are used to construct a prior distribution for the probability for specimen to transit from the C2 to the C3 length group during one semester (for further details see the Stock Annex).

10.2.4.4 Weight-at-age

No data on weight-at-age are available.

10.2.4.5 Maturity and natural mortality

The information available for ICES Subareas Vb, VI, VII and XII consistently points out to the predominance of small and immature specimens.

10.2.4.6 Catch, effort and research vessel data

Standardized French cpue series covering the period 1998–2013 are presented in Figure 10.2.4. Estimates were made for one vessel in each rectangle, for the mean fishing depth by rectangle, and estimates by area were obtained by averaging over rectangles by area. Cpue was estimated by semesters (Figure 10.2.4a) and by six month time period as: Sem1= months 3–8 of the year, Sem 2=month 9–12 of the year, plus months 1 and 2 of the next year. The use of an index by semester instead of a yearly index was driven by a clear seasonal pattern in cpue with higher catch rates in autumn-winter.

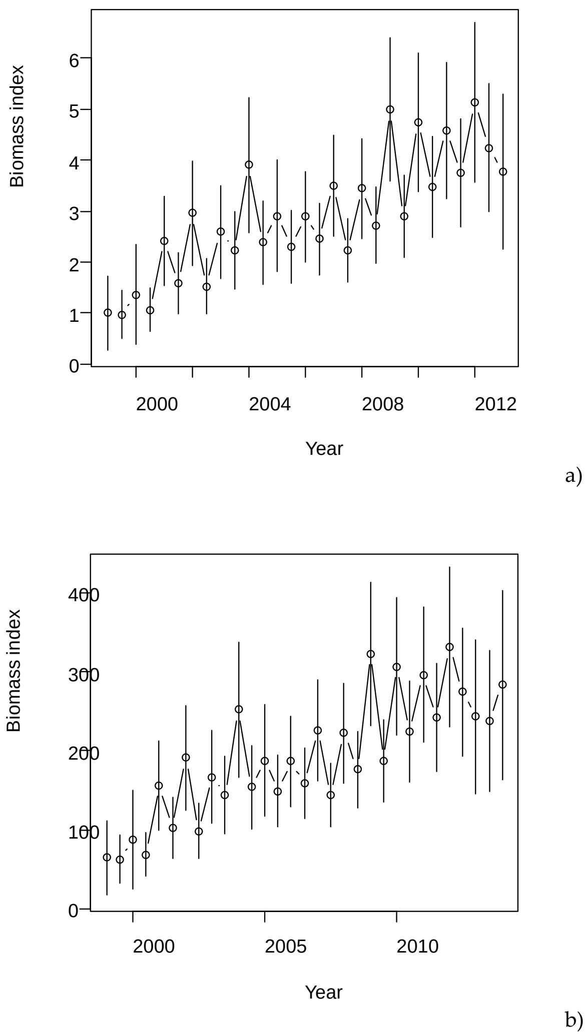

Figure 10.2.4. Cpue by semesters: a) time-series provided for WKDEEP 2014 a) and b) new time-series by new semesters, i.e. Semester1= months 3–8 of the year and Semester 2=month 9–12 of the year, plus months 1 and 2 of the next year. Data for Semester 2 in 2013 is incomplete as month 1 and 2 of 2014 were not available.

The second cpue series was used to estimate the standardized fishing effort (more details in the stock annex) which was then used to define initial prior for the catchability parameter. This parameter is admitted to follow a lognormal distribution with (-5:44; 0:83) which implies the adoption of a C.V.= 1 for the prior.

Scottish research survey data have been provided to WGDEEP. The biomass and abundance indices estimates obtained for the depth stratum deeper than 1000 m (depth stratum considered as the core of the species distribution in the surveyed area) are presented in Figure 10.2.5.

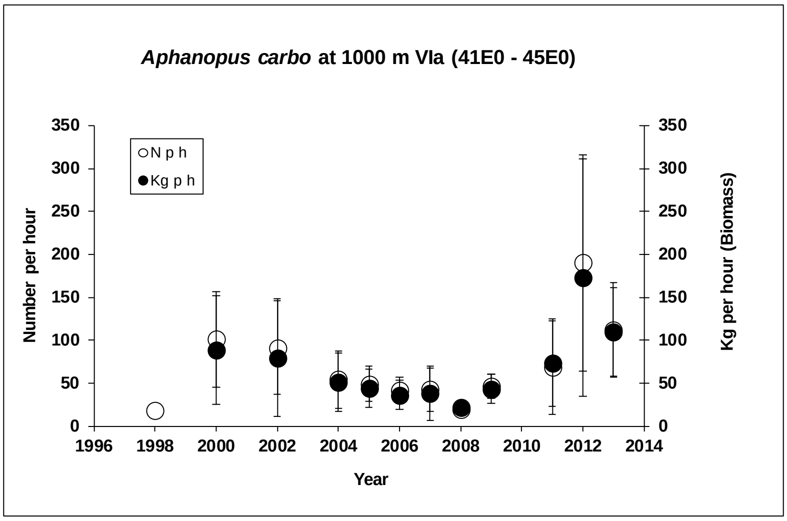

Figure 10.2.5. Abundance (left axis) and biomass indices of black scabbardfish in ICES Division VIa from the Scottish deep-water survey.

10.2.5 Data analyses

There is some uncertainty on the catches estimates, especially for some countries at the northern component. However for the major fishing countries exploiting the stock in the ICES area the landing data are considered reliable. The catches in weight are transformed in numbers and aggregated by six month time periods defined as: Sem1= months 3–8 of the year Sem 2=month 9–12 of the year plus months 1 and 2 of the next year. The assessment model, introduces a parameter that accommodates for the uncertainty on the input catch data, in numbers.

The lack of a reliable recruitment index requires the use of a parameter with a non-informative prior distribution. As the Scottish survey is carried out in one season it does not allow inferring the proportion of C2 that enter in each second semester of the year. To do this 2 annual surveys in different seasons would be necessary.

The cpue series used in the model are standardized cpue for the French and Portuguese longline fisheries. Based on these estimates, the standardized fishing effort by Sem1 and Sem2, obtained by dividing the total landed weight by the corresponding standardized cpue are determined. A full recruitment model with log-normal error linking the fishing effort estimate by semester with catchability coefficient is used to define the prior parameter of survivorship to fishing.

Stock assessment and model settings

Bayesian state–space models are developed which estimate abundances on the northern and southern areas based on an observational process given by the semestrial catches. Under the model two separated processes run simultaneously but not independently, since the migration from northern to the southern areas is taken into account when fitting the southern model. The fitted models also provide posterior distributions for the parameters of several stochastic state process subdivisions chosen to be related with the species life cycle and migration patterns. More details of the model are described in the stock annex.

The prior distributions for the parameters in the model were selected in a way that each of them incorporates as much information both on the biology or fishery as available for the species. More details on the definition of the prior distributions are described in the stock annex.

Model adequacy

The quality of the fitting was evaluated for each model separately. For the northern component model, the catch estimates for the C2 and C3 length groups, in semester s, correspond to the median of the a posterior distributions of the state process vector components corresponding to the two length groups, in that semester. In each component the catch estimates correspond to the median of the sums of the abundance estimates of the state process vector components representing the C2 and C3 length group fished in each iteration. For the southern model, the catch estimates in semester s were obtained, in the same way. The evaluation of the model's adequacy based on the expected deviance estimates (northern component 1353.1 and southern component 1191) together and the credible intervals (intervals in the domain of the posterior probability distributions) indicate a good fitting (Figure 10.2.6).

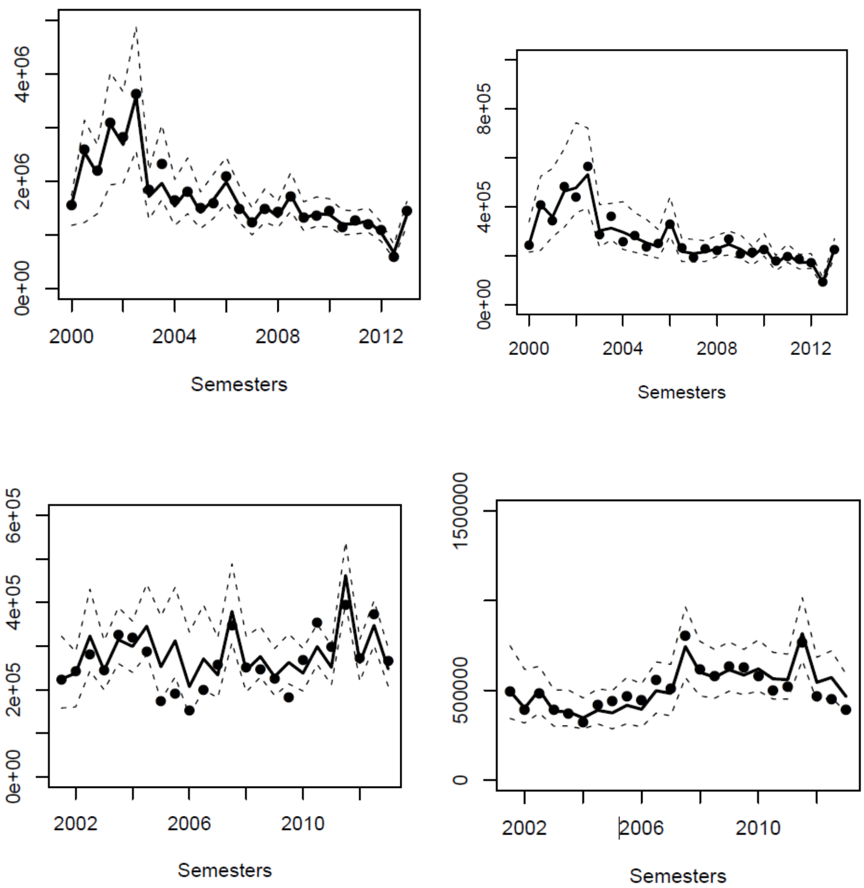

Figure 10.2.6. Estimated catches (solid line) and 95% credible intervals (dashed lines), for northern component C2 length group (upper left), C3 length group (upper right) and southern component C2 length group (lower left) C3 length group (low right) .Observed catches are represented by black dots.

Results

The catch estimates (posterior medians) of both length classes combined and the corresponding observed catch in northern and southern components show a good adjustment. For both components the ranges of the 95% credible intervals are relatively narrow, particularly for the semesters at the end of the studied period (Figure 10.2.7).

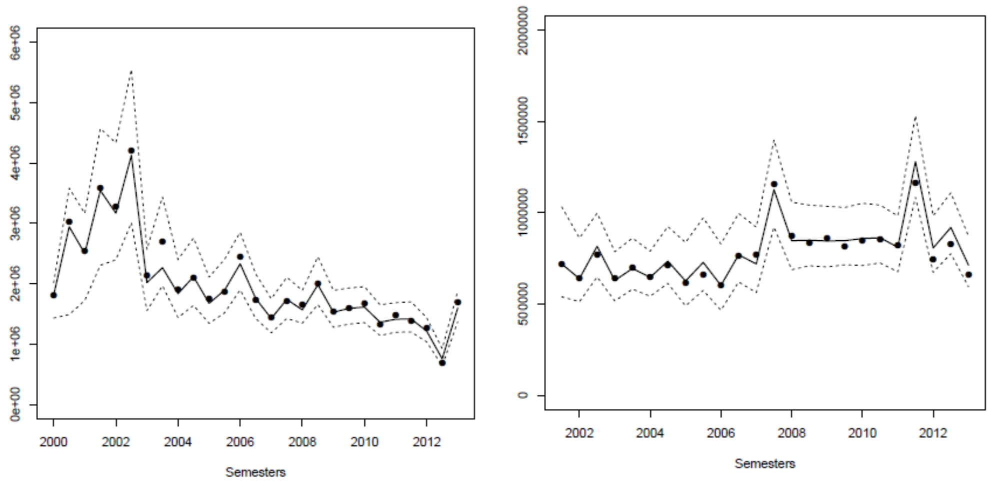

Figure 10.2.7. Catch estimates (posterior medians) and the corresponding observed (dots) in Northern (left) and Southern (right) components.

The time-series of the estimates of the total abundance in northern component for the C2 and C3 length group shows an approximately steady trend. For both length groups the credible intervals are wider at the beginning of the time-series particularly for the C3 length group which is less represented in the northern component (Figure 10.2.8).

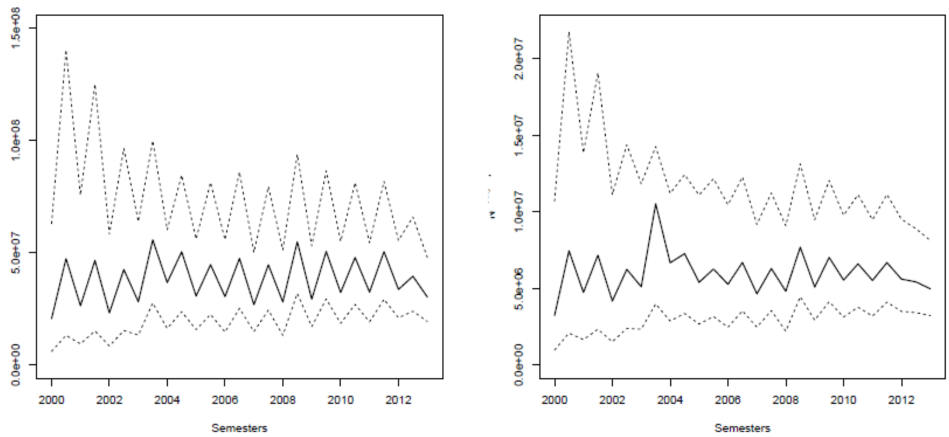

Figure 10.2.8. Northern component. Estimated BSF abundances for C2 (left) and C3 (right) length groups.

The evolution of the estimates of the total abundance in the southern component for the C2 and C3 length group is presented in Figure 10.2.8. For both length groups the credible intervals are wider at the beginning of the time-series (Figure 10.2.9), reflecting the fact that the immigration coming from northern component is set to be a deterministic subprocess in the model. Both C2 and C3 length groups, have 95% credible interval ranges that narrow by the end of the time-series. Despite the evolution of the estimates of the total abundance of black scabbardfish in both length groups, after a quite irregular beginning, does not show any evident upward or downward trend in the more recent part of the series.

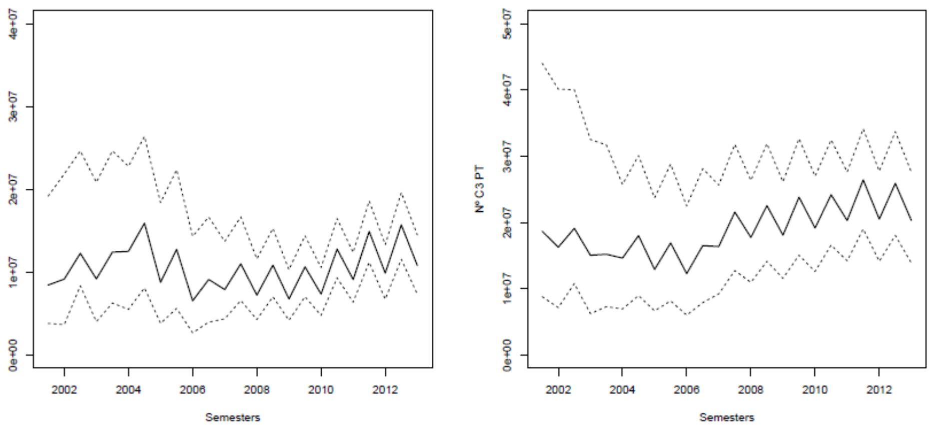

Figure 10.2.9. Southern component -Estimated BSF abundances for C2 (left) and C3 (right) length groups.

The posterior distributions for all the parameters of for the northern and southern components are presented in Figures 10.2.10 and 10.2.11 respectively.

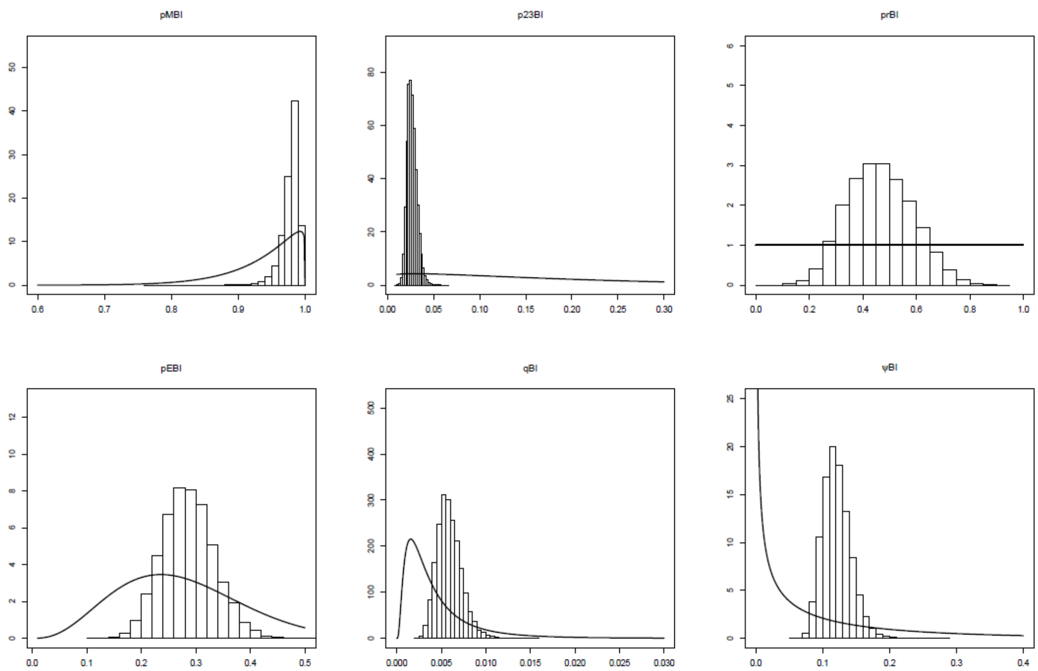

Figure 10.2.10. Prior (thick line) and posterior distributions (histogram) for parameters of the northern component. pMBI Probability of surviving to natural mortality; p23BI Probability that a specimen from the northern component transits from C2 to C3 during one semester. prBI Probability that an specimen enter into the length group C2 in the northern component during the second semester; pEBI Probability that a specimen belonging to length group C2 or C3 leave the northern component in the first semester; qBI Probability of catchability in the northern component; ΨBi probability distribution for error of the observations in northern component.

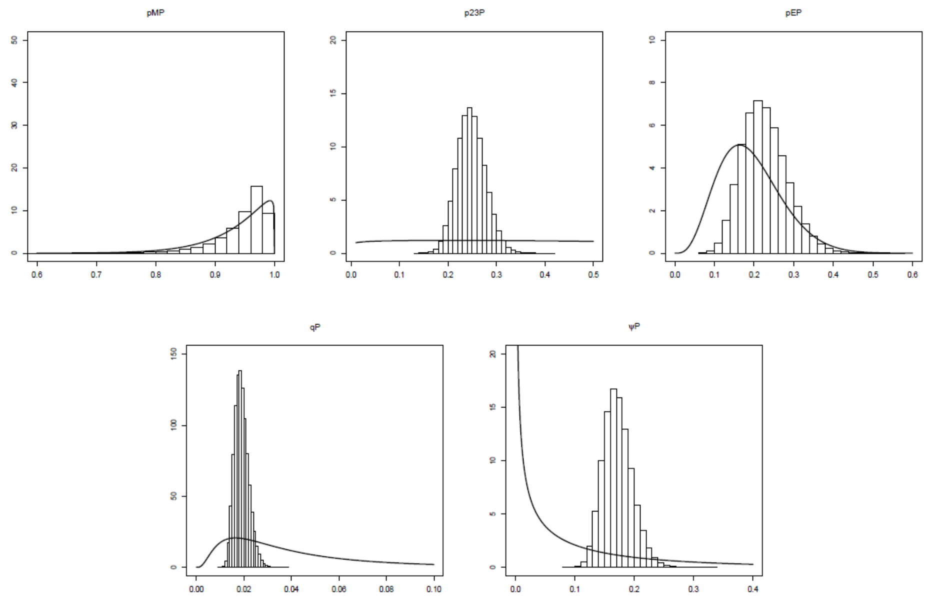

Figure 10.2.11. Prior (thick line) and posterior distributions (histogram) for parameters of the southern component. pMP Probability of surviving to natural mortality; p23P Probability that a specimen from the southern component transits from C2 to C3 during one semester. pEP Probability that a specimen belonging to length group C3 leave the southern component in the first semester; qP Probability of catchability in the southern component; ΨP probability distribution for error of the observations in southern component.

Most of the *a priori* distributions adopted for the parameters have quite large coefficients of variation. These high values were introduced to be precautionary in terms of the adopted values of the parameters associated with the species life cycle and its dynamics. For most of the parameters posterior distributions (Figures 10.2.10 and 10.2.11) becomes evident that the observational data provided enough information to update their *a priori* distributions. In addition, the posterior distribution means are not in general far apart from the initial guess. An exception is the parameter associated with class transition in northern component, p23BI , reflecting the growth and the size structure of specimens living in the area, which is much lower than it has been initially anticipated. In southern component, the posterior distribution mean of the corresponding transition parameter seems consistent with what has been initially considered for the species.

Reference points

At the WKDEEP 2014 and in view of the probable linkage between the northern and southern fishery components, it is agreed that the status of the stock as a whole should be considered when giving management advice for either fishery component. However, given the presumed sequential nature of the exploitation pattern, management should also take into consideration trends occurring in the separate areas.

WKDEEP 2104 proposed that the harvest control rule should adjust catches in both areas according to recent trends in total abundance for the two components combined as estimated by the state–space model (estimated by a regression fitted to the posterior median estimates of abundance of the most recent five years). This will be applied in combination with a simple harvest control rule that specifies that catch advice should only increase when the abundance trends for both fishery components are increasing. If the abundance in either component is stable or decreasing, the advised catch for both areas should be adjusted according to the rate of change in the area showing the decrease.

The results obtained indicate that the abundance in the two components do not show a clear upward or downward trends. The estimates of slope obtained for the regressions of posterior median estimate of year y versus posterior median estimate at the previous year (y-1) for semesters Sem 1 and Sem 2 for the last five year are around 1 (Table 10.2.2.). Thus according to harvest control rule the catches should be kept at same level as last year.

Table 10.2.2. Slope estimates of the regressions of posterior median estimate of year y versus posterior median estimate at the previous year (y-1) for semester Sem 1 and Sem 2 for the last five years.

	Northern component	Southern component
Sem 1	1.0093	0.9499
	(r^2 = 0.89)	(r^2 = 0.82)
Sem 2	0.9723	1.0494
	(r2 = 0.89)	(r2 = 0.81)

10.2.6 Management considerations

Available information does not unequivocally supports the assumption of a single stock for the whole NE Atlantic area although most available evidences do support it. In face of this evidence it is recommended that ICES Division Va should be, in the future, included in the northern component.

ICES did not assessed fisheries in Madeira which are outside the ICES area. The incorporation CECAF data would allow for more accurate estimation of the dynamics of the whole stock.

Management advice is given based on the harvest control rule proposed by WKDEEP 2014 (see the stock annex for further details).

Table 10.2.1a. Landings of black scabbardfish from Division Vb. Working group estimates.

Year	Faroese Islands			France	Germany*		Scotland	E&W&NI	Total
	Vb 1	Vb 2	Vb	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	-		135	-	-	6	-	**154**
2000			116	186	-	-	9	-	**311**
2001	122	281		457	-	-	20	-	**880**
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		93	-	-	-	-	**784**
2007	78	596		116	-	-	-	-	**790**
2008	94	787	828	159	.	.	-	-	**1868**
2009	117	852	-	96	.	.	1	-	**1067**
2010	102	715	-	142	.	.	31	-	**990**
2011	67	371		115	-	-	-	-	**553**
2012	45	370		115	-	-	-	-	**530**
2013				160					**160**

Table 10.2.1b. Landings of black scabbardfish from Division XII. Working group estimates.

Year	France	Spain	Scotland	Russia(XIIc)**	Poland*	Unallocated	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	1009		.	-		1009
2007	-	9	0	.	-		9
2008	-	53	0	4	.		57
2009	-	103		-	.		103
2010	1	180	-	-	.		181
2011	1	113	-	-			114
2012	-	47	-	-		907	954
2013		50				289	339

***STATLAND data.**

***STATLAND data from 1988 to 2011.**

Table 10.2.1b. Continued.

Year	Faroes	Germany	Ireland	E&W&NI	Iceland*	Lituania*	Estonia	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	-	**2**
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**
2011	24	-	-	-			.	**24**
2012								
2013	8	-	-	-			.	**8**

*** STATLAND data.**

Table 10.2.1c. Landings of black scabbardfish from subarea VI. Working group estimates.

YEAR	FRANCE			FAROES		GERMANY*		IRELAND	SCOTLAND		NETHERLANDS *		LITUANIA*	ESTONIA *	POLAND*	RUSSIA*	SPAIN	UNALLOCATED	TOTAL
	VI	**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		**1820**
2000	-	2971	27			-	-		333	41	7	-	-	-	-	-	1		**3380**
2001	-	3791	29		3	-	-		486	145	-	-	3	225	-	226	150		**5058**
2002	-	3833	156	2		-	-		603	300	21	2	9	-	2	-			**4928**
2003	-	2934	67	45		-	-		78	9	-	2	12	7	2	7			**3162**
2004	-	2637	99	59		-	-		100	24	-	-	85	5	-	5	62		**3075**
2005	3	2533	59	38		-	-		18	62	-	-	5	11	-	11	126		**2867**
2006	-	1713	36	59		-	-	1	63	0	-	-	1	3	-	3	475		**2353**
2007	-	1991	4	44	37	-	-	0	53	0	-	-	-	-	-	-	50		**2179**
2008	-	2348	0	37	0	.	.	0	26	0	14	.	-	.	.	1	60		**2487**
2009	15	1609	1	39	0	.	.	0	80	0	.	.	.	.	.	-	95		**1840**
2010	-	1778	1	72		.	.	0	73	0	.	.			.	-	297		**2220**
2011	5	1791	3	31		-	-		1	0	.	.				-	116		**1946**
2012	-	1618	0	3		-	-		34	0						-	68	690	**2414**
2013		1818							57								44	189	**2108**

Table 10.2.1d. Landings of black scabbardfish from Division VII. Working group estimates.

Year	France								Ireland			Scotland	E&W&NI	Spain	
	VII	VIIa	VIIb	VIIc	VIId-g	VIIh	VIIj	VIIk	VIIb,j	VIIc	VIIk	VIIb,c,j,k	VIIj,k	VII	Total
1988															
1989		0	-	-	-		-	-				-			0
1990		0	2	8	0		0	-				-			10
1991		0	14	17	7		7	49				-			94
1992		0	9	69	11		49	183				-			322
1993		0	24	149	16		170	109				-			468
1994		0	32	165	8		120	336				-			662
1995		0	52	121	9		74	385				-			641
1996		0	104	130	2		60	360				-			658
1997		0	24	200	1		33	202				-		1	462
1998		0	15	104	6		52	211				-		2	390
1999	-	-	7	97	0	2	70	177				-		0	355
2000	-	-	25	173	1	4	100	253				3		0	559
2001	-	-	40	237	0	3	180	267				41		0	768
2002	-	0	33	105	2	7	138	49				53			386
2003	-	-	15	29	1	3	159	36				1			245
2004	-	-	31	28	8	9	115	63				0			253
2005	0	5	6	11	1	17	105	23				-			169
2006	-	-	3	10	1	24	315	20	1	32	37	0	2		445
2007	-	-	2	7	0	4	168	7	0	52	17	-	-		257
2008	-	-	2	19	0	6	148	4	-	-	-	0	-		179
2009	-	-	-	29	1	2	53	4	-	-	-	-	-		90
2010	-	-	2	40	0	2	36	-	-	-	-	-	-	-	81
2011	-	-	0	81	0	2	129	-	-	-	-	-	-		212
2012	-	-	15	41	0	5	55	6	-	-	-	-	-	12	133
2013			21	86	1	12	67	1							187

Table 10.2.1e. Landings of black scabbardfish 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	-	**79**
2006	-	-	**0**
2007	-	-	**0**
2008	-	-	**0**
2009	-	-	**0**
2010	-	-	**0**
2011	-	-	**0**
2012	-	-	**0**
2013	-	-	**0**

10.3 Black scabbardfish in Subareas VIII, IX

10.3.1 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 mainly in Subareas VI and VII have a small marginal activity in Subarea VIII.

10.3.2 Landings trends

Landings in Subareas VIII and IX are almost all from the Portuguese longline fishery that takes place in Subarea IXa, representing more than 99% of the total landings (Figure 10.3.1).

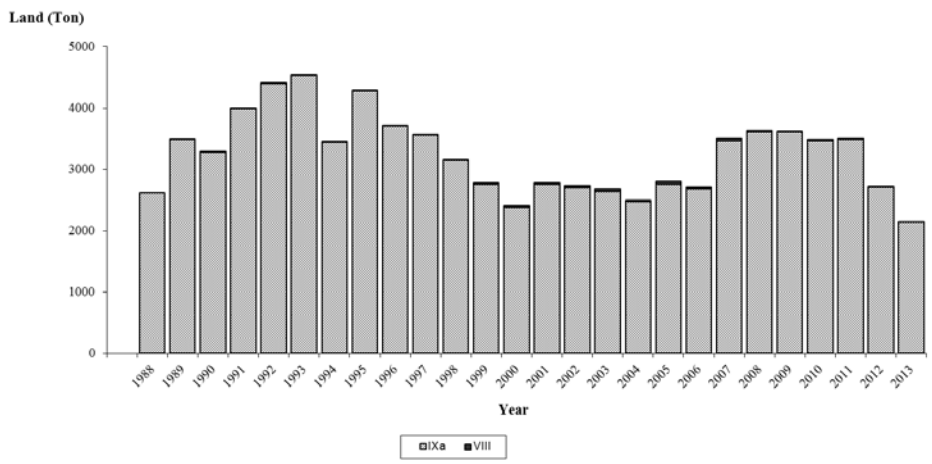

Figure 10.3.1. Annual landings for ICES Subareas VIII and Division IXa (2013 provisional data).

10.3.3 ICES Advice

The latest ICES advice for 2013 and 2014, based on the ICES approach for data-limited stocks was: "catches should be no more than 3700 tonnes".

10.3.4 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 2006 till 2013, as well as, the total landings in Subareas VIII, IX and X are next presented.

Year	EU TAC VIII, IX and X	EU Landinds in VIII and IX	EU Landinds in X
2006	3042	2791	65
2007	4000	3556	
2008	4000	3719	75
2009	3600	3601	162
2010	3348	3453	102
2011	3348	3476	139
2012	3348	2726	458
2013*	3 700	2137	206

*** 2012 landing estimates are preliminary.**

10.3.5 Data available

10.3.5.1 Landings and discards

New information on the discards of deep-water species produced by the Portuguese on-board sampling programme (EU DCR/NP) between 2004 and 2013 was presented (Prista and Fernandes, 2014 WD). The working document presented also includes a description of the on-board sampling programme, the estimation algorithms and the data quality assurance procedures (Prista and Fernandes, 2013 WD). Sampling levels attained by on-board sampling programme in the deep-water set longlines that target black scabbardfish (LLS_DWS) between 2005 and 2013 are presented in Table 10.3.0.

Table 10.3.0. Discards (in number per set) of WGDEEP 2014 species in the LLS_DWS fishery (2005–2013); ___ indicates no occurrence. (a) BSF data includes fish which good parts (i.e., parts not affected by predation marks) may have been marketed.

	BSF			GFB			RNG		
Year	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
2005 (a)	98.0	10.0	88-108	1.7	2.9	0-5	0.3	0.6	0-1
2006 (a)	114.4	79.3	8-195	—	—	—	—	—	—
2007 (a)	70.0	103.3	4-189	—	—	—	—	—	—
2008	52.8	36.5	23-99	0.8	1.5	0-3	—	—	—
2009	29.3	12.5	13-48	0.2	0.4	0-1	—	—	—
2010	49.7	26.9	13-96	0.2	0.4	0-1	—	—	—
2011	30.5	28.6	0-78	0.5	0.8	0-2	—	—	—
2012	40.3	28.9	5-96	0.2	0.7	0-2	—	—	—
2013	40.5	6.4	36-45	0.5	0.7	0-1	—	—	—

Discards of most WGDEEP 2014 species carried out by Portuguese vessels operating deep-water set longlines (targeting black scabbardfish) within the Portuguese ICES Division IXa were not quantified at fleet level. However, the low frequency of occurrence (and number of specimens) registered in the sampled hauls and sets indicates discards can be assumed null or negligible for most assessment purposes. The black scabbardfish discard mortality is mainly caused by shark and cetacean predation on hooked black scabbardfish and is relatively low when compared to landings. Consequently discards are not likely to play a significant role in the assessment of this species. In what concerns discards of greater forkbeards, the values reported in this working document are low compared to the ca. 1000 tonnes of annual landings registered in the ICES Northeast Atlantic but may be worth consideration by WGDEEP in what respects mortality taking place in the ICES Division IXa (Prista and Fernandes, 2014 WD).

10.3.5.2 Length compositions

Length–frequency distribution of the black scabbardfish landed at Sesimbra landing port (ICES IXa) by the Portuguese longline fleet obtained under the DCF/EU landing sampling programme were used to separate the southern component into the two length groups (TL (total length): 70 cm C2 <103 and C3≥130 cm) defined by the assessment approach adopted by the WKDEEP 2014.

Table 10.3.1. Total catch estimates (in ton)) for the years 1999 to 2013 and total catch estimates (in number) in length group C2 and C3 by Six month time period (Sem1 and Sem 2) for the years 2001 to 2013..

	Catch (in ton)		Catch (in number		Catch (in number	
			C2		C3	
Year	Sem 1	Sem 2	Sem 1	Sem 2	Sem 1	Sem 2
1999	969	1254				
2000	1022	1073				
2001	1025	1162	166 255	224512	454 294	494 926
2002	994	1205	242 627	281845	394 790	486 076
2003	1001	1038	246 200	326925	391 912	369 658
2004	939	1087	319 954	289114	326 133	421 767
2005	1001	1068	173 811	191031	441 320	470 265
2006	970	1229	154 077	200083	447 828	561 937
2007	1162	1713	258 842	348131	512 897	808 791
2008	1392	1335	252 886	248574	617 378	582 175
2009	1390	1346	225 098	183532	633 817	627 814
2010	1464	1287	267 945	353994	579 164	501 186
2011	1257	1808	299 508	395972	520 973	768 757
2012	1188	1245	273 648	374823	470 397	454 947
2013	1011	784*	266 160	234017*	393 448	286 990*

*** incomplete since catches January and February 2014 were not available.**

10.3.5.3 Age compositions

The population is not structured by ages because the approach followed to assess the stock is a stage-based model. The age growth parameters are used to construct the prior distribution for the probability a specimen transits from C2 to C3 length group during one semester taking into account the length structure of the population inhabiting the Southern area (for further details see the Stock Annex).

10.3.5.4 Weight-at-age

No new information on age was presented.

10.3.5.5 Maturity and natural mortality

In ICES Subarea IXa only immature and early developing specimens have been observed (Figueiredo, 2009, WGDEEP 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 different species may occur in these areas.

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; the percentages of non-reproductive females between 21% and 37% (Vieira *et al.*, 2009).

10.3.5.6 Catch, effort and research vessel data

Standardized Portuguese cpue series covering the period 1998 2013 are presented Figure (10.3.2) by six month time period, as : Sem1= months 3–8 of the year Sem 2=month 9–12 of the year plus months 1 and 2 of the next year. Estimates of cpue obtained through the adjustment of a GLM model, in which monthly cpue is the response variable and Year, Month and Vessel are the factors. The monthly cpue was calculated for each vessel as the ratio of the total landed weight (Kg) and the number of fishing trips. Only vessels having total annual landings ≥1000 Kg and more than one year of landings were considered.

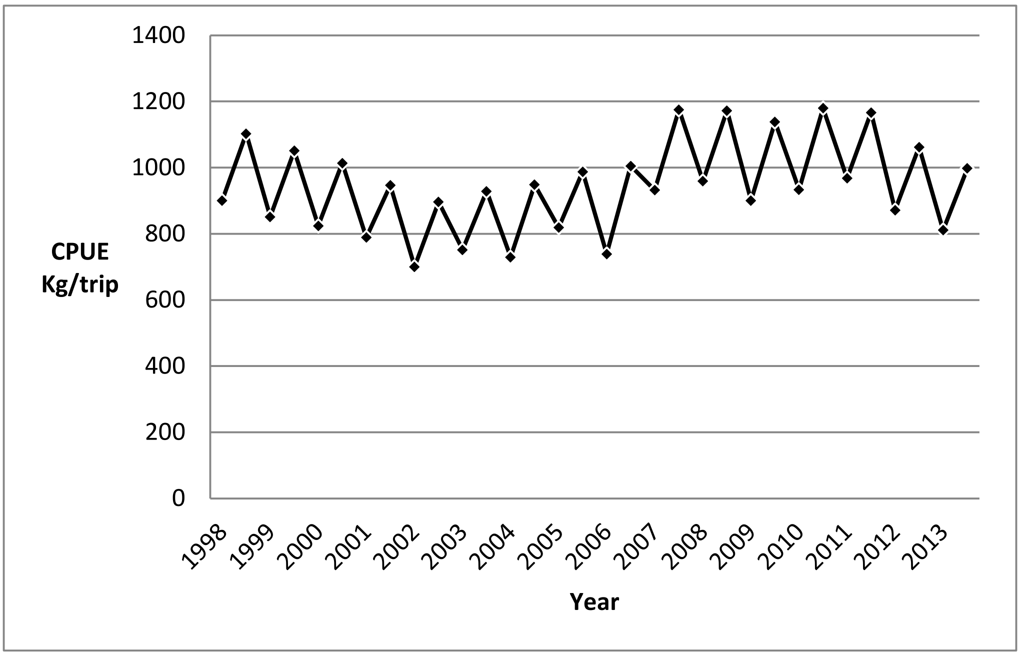

Figure 10.3.2. Portuguese cpue by semester time-series provided for WKDEEP 2014.

10.3.6 Data analyses

Data analyses are described in Section 10.1.5, as one single assessment, which combines data from the two fisheries areas in Vb, VI, VII and XIIb on the one hand and VIII and IX on the other hand is carried out. The same migrating stock is exploited in the two fisheries areas.

10.3.7 Management considerations

Management considerations are described in Section 10.1.6.

Table 10.3.1a. Black scabbardfish from Subarea IX; Working group estimates of landings.

Year	Portugal	France	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	0		2630
2004	2463	-		2463
2005	2746	-		2746
2006	2674	-		2674
2007	3453	-		3453
2008	3602	-		3602
2009	3601	-		3601
2010	3453	-	0	3453
2011	3476	-		3476
2012	2668	-	34	2702
2013	2130			2130

Table 10.3.1b. Black scabbardfish from Subarea VIII; Working group estimates of landings.

YEAR	FRANCE						SPAIN	
	VIII	VIIIa	VIIIb	VIIIc	VIIId	VIIIe		Total
1988								0
1989		-	-		-			0
1990		-	-		0			0
1991		1	-		0			1
1992		4	-		4			9
1993		5	-		7			11
1994		3	-		2			5
1995		0	-		-			0
1996		0	-		0		3	3
1997		1	-		0		1	2
1998		2	-		0		3	6
1999	-	7	-	-	4	-	0	12
2000	-	15	0	-	20	0	1	36
2001	-	16	0	-	12	0	1	29
2002	-	17	2	-	16	-	1	36
2003	-	25	-	-	8	-	1	34
2004	0	25	0	-	14	-	1	40
2005	-	19	0	-	6	-	1	26
2006	-	30	2	0	19	-	0	52
2007	-	14	1	-	13	-	1	29
2008	-	10	0	-	35	-	1	45
2009	-	15	1	0	3	-	1	19
2010	0	13	1	0	3	-	-	17
2011	-	4	0	0	14	-	-	18
2012	-	3	0	-	3	-	18	24
2013		5	0		2			7

10.4 Black scabbardfish other areas (I, II, IIIa, IV, X, Va, XIV)

10.4.1 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, such as in I–IV. Those levels may just indicate that the species has a low occurrence in those areas. On the contrary, landings from other areas, particularly in X, indicate that the level of abundance of species appears to be significant.

No further information is available on the Faroese exploratory trawl fishery that was taking place in the Mid-Atlantic Ridge area, starting from 2008.

10.4.2 Landings trends

In ICES Subarea X landings have been variable but in recent years landings have increased, reaching 464 tonnes in 2012. Since 2010 Icelandic landings in ICES Subarea Va have significantly increased, reaching 365 tonnes in 2012. The 111 tonnes reported in 2010 in ICES Division XIV is considered to be misreported.

10.4.3 ICES Advice

The ICES advice for 2013 and 2014 was: "Fisheries should not be allowed to expand until there is sufficient information showing that the fishery is sustainable."

10.4.4 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 2013 by subarea are presented next.

Both in 2009 and 2010 the TACs have been exceeded, particularly in the former 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	5
2010	12	15
2011	12	1
2012*	9	1
2013	9	0

*** 2012 landing estimates are preliminary. TACs and landings for Subarea X are included in Table 10.3.4**

10.4.5 Data available

10.4.5.1 Landings and discards

Landings are given in Tables 10.4.1a–e and in Figure 10.4.1. In Subareas II, IV and XIV reported landings are considered to be misreported although the extent of this is unknown.

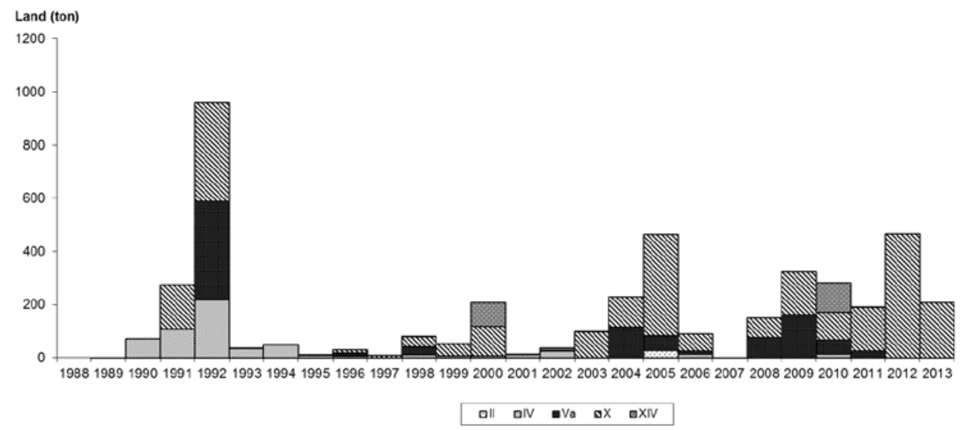

Figure 10.4.1. Annual landings for black scabbardfish by ICES Subareas II, IV, V, X and XIV.

10.4.5.2 Length compositions

Length–frequency distributions based on the Icelandic Autumn surveys for the period 2000–2013 are presented in Figure 10.4.2.

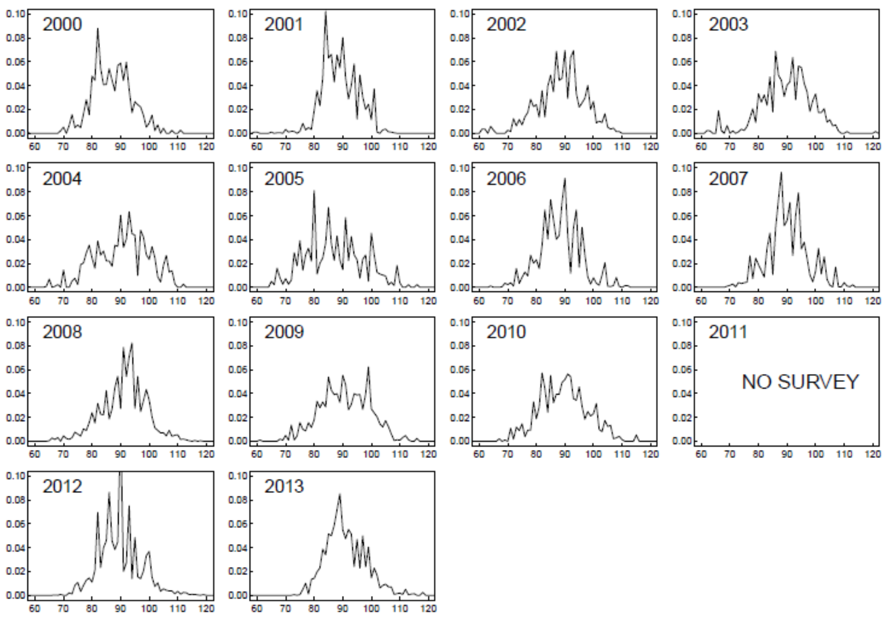

Figure 10.4.2. Black scabbardfish in Va: length distribution from the Icelandic Autumn survey, 2000 to 2013.

10.4.5.3 Age compositions

No data were available.

10.4.5.4 Weight-at-age

No data were available.

10.4.5.5 Maturity and natural mortality

No new data were available.

10.4.5.6 Catch, effort and research vessel data

New series of biomass indices for all sizes (Total biomass) and for specimens larger than 90 cm and 110 cm are shown along with abundance of black scabbardfish smaller than 80 cm from the Icelandic Autumn survey were provided by Iceland (Figure 10.4.3).

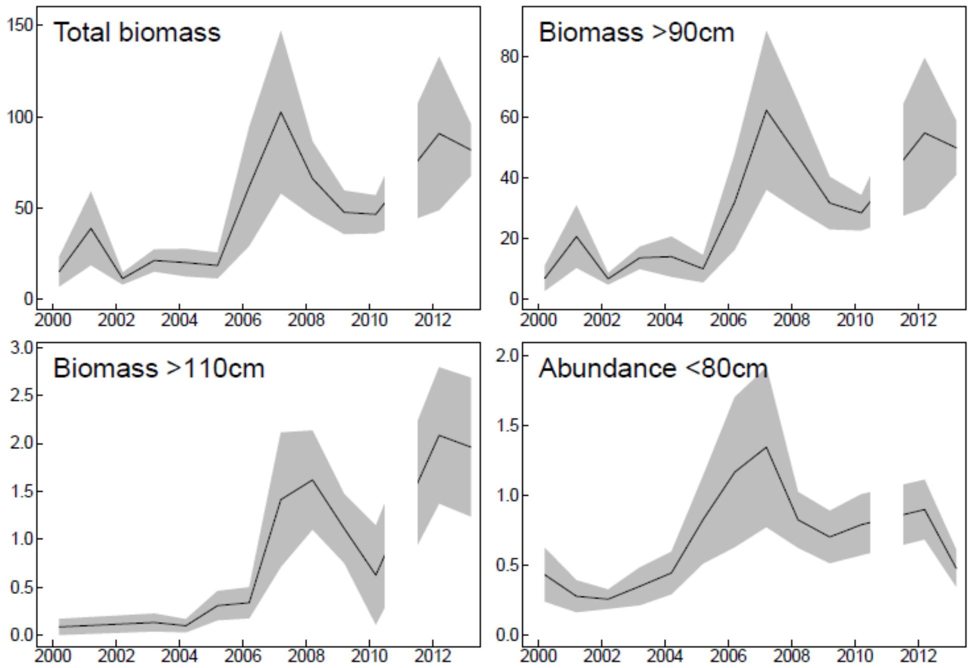

Figure 10.4.3. Abundance and biomass indices from the Icelandic autumn survey.

Total biomass and Abundance as well as their respective coefficient of variation are presented in Table 10.4.2.

Table 10.4.2. Black scabbardfish in Va: Trends in indices from the Icelandic Autumn survey in 2000 to 2012.

Year	Biomass index	CV	Abundance index	CV
2000	14898.6	0.551	2288.9	0.528
2001	38587.4	0.523	5388.5	0.522
2002	11022.1	0.294	1544.2	0.291
2003	20965.9	0.291	2817.5	0.302
2004	19778.2	0.382	2591.6	0.339
2005	18222.5	0.390	2644.8	0.380
2006	61616.1	0.529	8806.2	0.532
2007	102484.0	0.435	13710.2	0.445
2008	65885.9	0.310	8474.7	0.300
2009	47421.2	0.252	6209.6	0.254
2010	46311.8	0.225	6282.2	0.233
2012	90725.5	0.464	12330.0	0.474
2013	81727.3	0.175	10669.9	0.179

10.4.6 Data analyses

In Subarea X, the commercial interest for the exploitation of the species has been increasing over time, but apart from the data presented for Faroese exploratory survey in 2008, the data available are only landings.

Recent results from the Azores (MARPROF project unpublished data), based on counting of the vertebra indicate that two species of *Aphanopus* coexist in the in ICES Division Xa, *A.carbo* and *A. intermedius* (Besugo *et al*., 2014 WD). Furthermore genetic results derived from a recent request from the Azorean Government provided spatial estimates of the proportion of co-occurrence of the two species (Figure 10.4.4). According to these results the overall proportion of *A. intermedius* in relation to the overall catches of *Aphanopus* species is about 0.75, however some caution need to be taken because the proportion can vary accordingly to the sampling location.

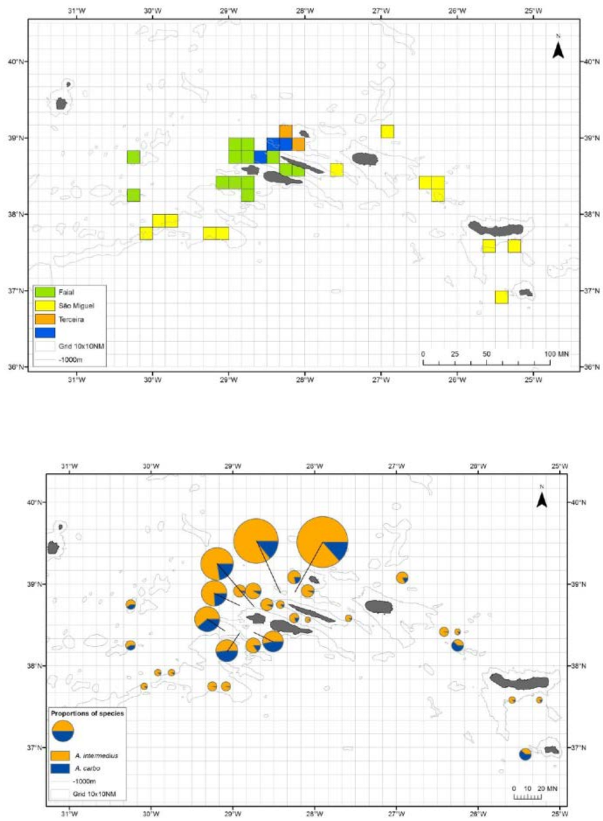

Figure 10.4.4. Map of the sampling locations (upper) and estimates of the proportion of each *A. carbo* and *A. intermedius* at different sampling points.

The time-series of biomass indices for all sizes (Total biomass) and for specimens larger than 90 cm and 110 cm estimated based on Icelandic Autumn surveys (Figure 10.4.3) show some variability although consistent increasing trends are observed for the latter years of the time-series. The abundance trend of abundance of black scabbardfish smaller than 80 cm show similar trend except for the last year during which a decrease on the index was observed (Figure 10.4.3).

10.4.7 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 in ICES Division X. This spatial aspect is consistent with the current perception on the spatial distribution of the species at NE Atlantic. However the co-occurence of two different species *A. carbo* and *A. intermedius* in ICES Area X (Besugo *et al*., 2014 WD) needs to be, in the future, taken into consideration to provide advice for this stock.

10.4.8 Management considerations

The information available do not unequivocally supports the assumption of a single stock for the whole NE Atlantic area however most of the evidence available does support it. In face of this evidence it is recommended that ICES Division Va should, in the future, be included in the northern component.

The co-occurence of two different species *A. carbo* and *A. intermedius* in ICES Area X needs to, in the future, considered providing advice for this stock.

Table 10.4.1a. Black scabbardfish other Areas II. Working group estimates of landings.

Year	France	Faroese Islands	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
2000	-		0
2001	-		0
2002	-		0
2003	-		0
2004	-		0
2005	0	27	27
2006	-	-	0
2007	-	0	0
2008	-	-	0
2009	-	-	0
2010	0	-	0
2011	-	-	0
2012	-	-	0
2013	-	-	0

Table 10.4.1b. Black scabbardfish other Areas IV. Working group estimates of landings.

		IVa	IVb	IVc	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		4			3			-	-	7
2000		2			3			-	-	5
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		-			-		1
2008		0			0			-		0
2009		5	0		-	-	-	-	-	5
2010		13	2		-	-	-	-	-	15
2011		-	1		-	-	-	-	-	1
2012		0			-	-	-	-	-	0
2013		1	0		-	-	-			1

Table 10.4.1c. Black scabbardfish 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
2011	172	172
2012	365	365
2013	324	324

Table 10.4.1d. Black scabbardfish 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	-		46
2000	-	112	-		112
2001	-	+	-		0
2002	2	+	-		2
2003		91	0		91
2004	111	2	-		113
2005	56	323	-	0	379
2006	10	55	-		65
2007	0	0	-	0	0
2008	75	0	-	0	75
2009	157	5	-	0	162
2010	53	49	-	0	102
2011	25	139	-		164
2012	4	458	-	-	462
2013		206			206

Table 10.4.1f. Black scabbardfish other Areas XIV. Working group estimates of landings.

YEAR	FAROES	SPAIN	UNALLOCATED	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
2011	0	-		0
2012	-	39	49	88
2013		50	40	90

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Farias, I., Morales-Nin, B., Lorance, P. and Figueiredo, I. 2013. Black scabbardfish, *Aphanopus carbo*, in the Northeast Atlantic: distribution and hypothetical migratory cycle. Aquatic Living Resources 26, 333–342.

Prista and Fernandes. 2014. WD. Discards of deepwater species by the Portuguese bottom otter trawl and deepwater set longline fissheries operating in ICES Division Xia (2004–2013).

Besugo, A., Menezes G. and Silva, H. 2014. WD. Genetic differentiation of black scabbardfish *Aphanopus carbo* and *Aphanopus intermedius* at the 2012 and 2013 Azorean commercial landings.

11 Greater forkbeard (*Phycis blennoides*) in all ecoregions

11.1 The fishery

Greater forkbeard is 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, VIII and IX.

Since 1988, 77% of landings have come from Subareas VI and VII. Spanish, French, Norwegian 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 but since 2006 the landings of this country have been reduced strongly. Russian fisheries in the Northeast 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 13% 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 the Strait of Gibraltar by the longliner fleet targeting scabbardfish in Algeciras, Barbate and Conil. Portuguese landings of *P. blennoides* are scarce, but important amounts of *Phycis* spp and *Phycis phycis* species are reported every year in Subarea IX.

Minor quantities of *Phycis blennoides* are landed by Portugal in Subarea X and by Norwegian and in recent years Faroese vessels in Divisions Va and Vb. 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 *P. blennoides*, representing less than 1% of total deep-water landings in the last three years, can be considered as bycatch.

11.2 Landings trends

Tables 11.0a–h and Figure 11.1 show landings of greater forkbeard by country and subarea.

In Subareas I, II, III and IV only Norwegian landings are significant. In the last two years, in Va and Vb the Faroes became the most important country in landings reaching 310 t in 2011.

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 to 83 t in 2013.

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 average around 49 t/year; however in 2001 Norway did not report any landings, and only 4 t were reported by France and UK(E+W).

Traditionally the most important landings in the Northeast Atlantic come from VI and VII from France, Norway, UK(Scotland) and Spain in some years of the series. Historical landings decreased since the peak of 4967 t in 2000 and they are especially low in 2009, 2010 and 2012 due to the low landings reported by Spain.

The main landings from Subareas VIII and IX come from Spanish fleets. The average landings in the last ten years is 323 t with a peak of 556 t in 2007.In 2009 and 2010 landings were the lowest of the series mainly due to the reduction of landings reported by Spain.

In Subarea X landings come only from Portugal and peaked at 136 t in 1994 and 91 t in 2000. Since this year landings have continuously decreased with the lowest landing recorded in 2012 (6 t).

Although many countries were involved in the fishery in former years, landings in Subarea XII are negligible since 2009 and only France reported 16 kg in 2012.

Landings in 2013 by fishing gear for Iceland, Ireland, Portugal, Russia, Spain UK(E&W) and UK (Scotland) are shown in the Table 11.1.

11.3 ICES Advice

For 2013 and 2014 ICES advised; "Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 1000 tonnes".

11.4 Management

Biannual EU TACs in 2013 and 2014 and landings in 2012 and 2013 by ICES Subarea are shown below. Landings in Subareas I, II, III and IV include Norwegian landings while only EU TACs are shown, resulting in the landings exceeding the TAC. Total landings, including Norwegian landings were higher than the EU TAC in 2012 and lower in 2013.

PHYCIS BLENNOIDES	EU TAC	TOTAL INTERNATIONAL LANDINGS	
Subarea	2013–2014	2012	2013
I,II,III,IV	31	299	166
V,VI,VII	2028	1965	1390
VIII, IX	267	366	272
X,XII	54	6	8
Total	2380	2636	1836

***preliminary ** landings include *P. phycis*.**

11.5 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.

11.6 Data available

11.6.1 Landings and discard

Landings are presented in Table 11.0a–h.

Amongst ten countries involved in the exploitation of this stock four have reported discard data for the year 2013. Estimated preliminary discards in weight from Spanish fisheries in Subareas VI, VII, VIII and North of IXa are presented in Table 11.2a and for French, Danish and Swedish fleets in 2013 in the table 11.2b.

11.6.2 Length compositions

Figure 11.2 presents length–frequency distributions from 2001–2011 Spanish bottom-trawl surveys in on the Porcupine Bank.

11.6.3 Age compositions

No new data available.

11.6.4 Weight-at-age

No new data available.

11.6.5 Maturity and natural mortality

No new data available.

11.6.6 Catch, effort and research vessel data

In 2014 four different surveys were used to derive biomass and mean length indices:

- Spanish bottom-trawl survey (DivisionsVIIc and VIIk). Biomass and abundance of greater forkbeard on the Porcupine Bank from 2001 to 2013 are presented in Figure 11.3.
- French IBTS (Divisions VIIf,g,h,j; VIIIa,b,d). Data of abundance and mean length of the catches have been provided for a series until 2012 (Figure 11.4).
- Irish IGFS (Divisions VIa South and VIIb). Abundance and biomass Indices (nº per hour and kg per hour) from the period 2005 to 2013. This survey provides abundance indices for the total catches and for individuals <32 cm by shelf and slope strata (Figure 11.5).
- Northern Spanish Shelf bottom-trawl survey (Divisions IXa and VIIIc). Biomass and abundance (kg/30 min tow and No/30 min tow) of greater forkbeard in the Cantabrian Sea from 1990 to 2013 are presented in Figure 11.6.

Itsasteka Basque Survey (Basque coast in the Division VIIIc). This survey covered a total of 7.21 km^2 in 23 fishing hauls and provided biomass indices until 400 m. Data of abundance from 2011 to 2013 are presented in the Table 11.3. This survey was not used in the assessment due to its short time-series.

11.7 Data analyses

The geographical representation of *Phycis blennoides* catches in the Spanish Porcupine survey (Figure 11.7) shows that greater forkbeard is distributed almost uniformly along the bank, except for the northwestern and southern parts of the central mound. Higher abundances seem to occur in the southern and eastern part of the area especially in 2012 and 2013. Compared to 2011, greater forkbeard shows a remarkable increase in 2012 and 2013, in both biomass (25.8 kg/haul: 220% increase and 37.3 kg/haul: 318% respectively) and numbers (73.8 ind/haul: 192% increase and 116.9 ind/haul: 304% increase). These results represent values similar to those of 2005–2006, that followed the passage of the 2002 cohort through the fishery. This increase in number was already observable in 2011, with an important increase in number (38.5 individuals per haul) doubling the numbers observed in the three previous years. The increase in the number of individuals by haul can also be observed in the Irish GFS and Northern Spanish Shelf bottom-trawl surveys since 2009.

The Itsasteka survey, with a short series of data, shows that greater forkbeard is found on the Basque coast (VIIIc) only in the strata below 120 m. In 2013, a maximum abundance in of 30.3 kg/km^2 and 18.2 kg/30 min) was recorded at depths between 201 and 400 m. This was twice the level observed in previous years. In the northern Spanish Shelf bottom-trawl survey (Divisions IXa and VIIIc) the increase of biomass abundance (kg/tow) has been observed since 2005 with the highest values in the time-series in 2011 and 2013.

Similar trends have been also observed in French EVHOE and Irish IGFS with marked increases in biomass and abundance since 2011.

The discards are high. In several years of the series and for some countries discards of greater forkbeard are similar to or higher than landings. Some of the fleets and countries that report discards do not report any landings, i.e. these fleets discard 100% of their catch of greater forkbeard.

In 2014, following the DLS method 3.2, the overall trend the survey indices have been calculated from the average of the trends in the four available biomass indices, based on a comparison of the two most recent survey index values with the three preceding values. Two of the surveys (Irish GFS, and Spanish Porcupine) indicate a clear increase in biomass in the last two years while the Northern Spanish Shelf bottom-trawl and French EVHOE show a more or less stable biomass (Figure 11.8). Thus, the average of the four Survey Index results in a value of 2.1. According to the DLS method 3.2 the WG advises that catches should increase by 20%, i.e. catches should be not more than 2628 t (Table 11.4).

As "substantial increases in abundance indices or other stock indices are consistently observed" the Precautionary Buffer was not apply to catch advice (ICES DLS Guidance Report 2012).

WGDEEP reminds that neither the available surveys nor discard data cover the entire distributional area of the stock.

11.7.1 Exploratory assessment

No analytical assessment was presented in WGDEEP 2014.

11.7.2 Comments on the assessment

No analytical assessment was presented in WGDEEP 2014.

11.8 Management considerations

As this is a bycatch species in both deep-water and shelf fisheries, advice should take account of advice for the targeted species in those fisheries. The life-history traits do not suggest it is particularly vulnerable.

The working group realised that for a particular year the landings data considered as preliminary can change significantly when these data are revised the following year. That was especially noticeable in the preliminary landings reported in 2012 for of all ecoregions in 2011 (1202 t) revised to1813 t in 2013. After revision of these data in the WGDEEP 2013–2014 landings in 2011 increased by a factor of 1.83 reaching 2201 t and landings in 2012 increased for a factor of 1.45 reaching in this case 2636 t. These differences between the preliminary and definitive data for a given year could lead to misinterpretation of the analysis of the landings trend, affecting also the assessment of the stock and therefore the biannual advice.

As greater forkbeard is a bycatch of the traditional demersal trawl and longline mixed fisheries, discards of this species are considered high. According to the information available, reported discards by country were often similar to or higher than the annual landings.

Table 11.0a. 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	533	29	0	2477
1989	0	12	1	1815	663	42	0	2533
1990	23	115	38	1921	814	50	0	2961
1991	39	181	53	1574	681	68	0	2596
1992	33	145	49	1640	702	91	1	2661
1993	1	34	27	1462	828	115	1	2468
1994	0	12	4	1571	742	136	3	2468
1995	0	3	9	2138	747	71	4	2972
1996	0	18	7	3590	814	45	2	4476
1997	0	7	7	2335	753	30	2	3134
1998	0	12	8	3040	1081	38	1	4180
1999	0	31	34	3455	673	41	0	4234
2000	0	11	32	4967	724	91	6	5831
2001	8	27	102	4405	727	83	8	5360
2002	318	585	149	3417	715	57	81	5321
2003	155	233	73	3287	661	45	82	4536
2004	75	143	50	2606	720	37	54	3685
2005	51	83	46	2290	519	22	77	3087
2006	49	139	39	2081	560	15	42	2925
2007	47	239	56	1995	586	17	37	2978
2008	117	245	45	1418	446	18	17	2307
2009	82	149	22	796	203	13	44	1309
2010	132	186	61	824	69	14	0	1287
2011	113	179	319	1257	321	11	0	2201
2012	98	98	163	1802	366	6	0	2534
2013*	83	83	11	1379	272	8	0	1836

***preliminary.**

Table 11.0b. Greater forkbeard *(Phycis blennoides)* in Subareas I and II. Working group estimates of landings.

YEAR	NORWAY	FRANCE	RUSSIA	UK (SCOT)	GERMANY	UK (EWNI)	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	4							132
2011	107	6							113
2012	98	0							98
2013*	83	0		0					83

***preliminary.**

Table 11.0c. 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	3	182		1		186
2011	17	160		1		179
2012	98	0				98
2013*	83	0		0		83

***preliminary.**

(1) Includes Moridae, in 2005 only data from January to June.

Table 11.0d. Greater forkbeard (*Phycis blennoides*) in Division Vb. Working group estimates of landings.

YEAR	FRANCE	NORWAY	UK(SCOT)[1]	UK(EWNI)	FAROEISLANDS	RUSSIA	ICELAND	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				102
2002	10	133	5	0				149
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	0	58
2008	10	20	0		4	11	1	46
2009	0	13	3		3	2	0	24
2010	2	45	3	1	11		2	62
2011	7				310		1	319
2012	6	5			145		6	163
2013*	7	3	0				7	11

(1) Includes Moridae in 2005 only data from January to June.

***preliminary.**

Table 11.0e. Greater forkbeard (*Phycis blennoides*) in Subareas VI and VII. Working group estimates of landings.

YEAR	FRANCE	IRELAND	NORWAY	SPAIN(1)	UK (EWNI)	UK (SCOT) (2)	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		1995
2008	711	43	174	236	31	196		27	0	1418
2009	304	7	222	48	31	184		1		796
2010	383	8	219	23	14	173		3	1	824
2011	378	6	309	326	27	210				1257
2012	381	9	225	992	1	194				1802
2013*	453	16	289	371	4	246		0		1379

(1) landings of *Phycis* spp Included from 1988 to 2012.

(2)Includes Moridae in 2005 only data from January to June.

*** Preliminary.**

Table 11.0f. 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	29	74				110
1989	7	42	138				187
1990	16	50	218				284
1991	18	68	108				194
1992	9	91	162				262
1993	0	115	387				502
1994		136	320				456
1995	54	71	330				455
1996	25	45	429				499
1997	4	30	356				390
1998	3	38	656				697
1999	8	41	361				410
2000	36	91	375				502
2001	36	83	453				573
2002	67	57	418				542
2003	28	45	387				461
2004	44	37	446				527
2005	58	22	312	0			392
2006	54	10	257				321
2007	32	14	510	0			556
2008	41	13	123				178
2009	8	13	183	0			203
2010	10	12	48			0	69
2011	13	13	295				321
2012	46	5	315				366
2013*	30	8	234	0			272

***Preliminary.**

(1) **Landings of *Phycis spp* Included from 1988 to 2012.**

Table 11.0g. Greater forkbeard (*Phycis blennoides*) in Subarea X. Working group estimates of landings.

YEAR	PORTUGAL	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
2011	11	11
2012	6	6
2013*	8	8

***Preliminary.**

Table 11.0h. Greater forkbeard (*Phycis blennoides*) in Subarea XII. Working group estimates of landings.

YEAR	FRANCE	UK(SCOT)(1)	NORWAY	UK(EWNI)	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	74		81
2003	3		8	0	71		82
2004	3		6		44		54
2005	1	0	0		75		77
2006					42		42
2007					37		37
2008	0				17		17
2009	1		0		37	6	44
2010	0						0
2011	0						0
2012	0						0
2013*							0

***Preliminary.**

(1)Includes Moridae in 2005 only data from January to June.

(2) Landings of *Phycis spp* Included from 1988 to 2012.

Table 11.1. ***Phycis*** **spp. European landings (t) by fishing gear in 2013.**

	Landings (t)
Iceland	
LLS_DEF	0
Ireland	
OTB_CRU	3
OTB_DEF	13
Portugal	
LLS_DWS	0
MIS_MIS_0_0_0	8
OTB	0
Russia	
Longline	0
Spain	
LLS_DEF_0_0_0	359
MIS_MIS_0_0_0_HC	168
OTB_DEF	79
UK(England)	
LLS_DWS	3
UK(Scotland)	
GNS_DEF_>=220_0_0_all	20
LLS_DEF_0_0_0_all	126
MIS_MIS_0_0_0_HC	2
OTB_DEF_>=120_0_0_all	100

Table 11.2a. Discard estimates (biomass (tonnes) and associated CV) of *Phycis blennoides* by the Spanish OTB in VI, VII, VIII and North IXa from 2003 to 2013.

		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*	2013*
VI, VII	biomass (ton)	914	586	3096	493	617	1175	513	436	1611	487	431
VIII, North IXa		18	7	8	24	115	11	59	39	38	3	82

*** Only discards in IXa.**

Table 11.2b. Discard estimates (tonnes) of *Phycis blennoides* by French, Danish and Swedish fleets in 2013.

Discards (tons)	OT_CRU	OTB_DEF_WS	OTB_DWS	OTB_GG	OTB_MC
France	47.6	15.2	4.5	29.1	220.1
Denmark		334.0			
Sweden	0.14	0.8			

Table 11.3. Abundance indices of Greater forkbeard from Itsasteka survey in the Basque coast (VIIIc). Abundance Biomass indices in kg/km² and kg/30 min haul.

	DEPTH STRATA			
	121–200 (m)		201–400 (m)	
year	(kg/km²)	Var.	(kg/km²)	Var.
2011	7,8	136,3	10,8	0,0
2012	10,4	163,3	13,8	64,1
2013	8.2	144.7	30.3	2389.6
	(kg/30 min)	Var.	(kg/30 min)	Var.
2011	5,0	57,5	5,6	0,6
2012	6,0	55,3	6,5	9,5
2013	5.1	53.4	18.2	879.4

Table 11.4. Calculation of Advice according the DLS Method 3.2. Survey Index ratio = ratio of the mean of the two most recent survey index values with the three preceding values.

	Mean biomass index		Survey Index ratio
Surveys	(2013–2012)	(2009–2011)	(2013–2012)/(2009–2011)
Irish GFS	1.69	0.49	3.5
Spanish Porcupine	31.5	11.7	2.7
French EVHOE	16.1	15.1	1.1
Spanish Demersal	0.81	0.76	1.1
Average of Survey index ratios			2.07
C_{y-1}= landings average (t) of last three years (2011–2013)			2190
ADVICE: Apply Uncertainty Cap* , **			2628

*** = As S.I. >20%, an increase of 20% of landings (t) is recommended.**

*** * As "substantial increases in abundance indices or other stock indices are consistently observed" the Precautionary Buffer was not apply to catch advice (ICES DLS Guidance Report 2012; pp 17).**

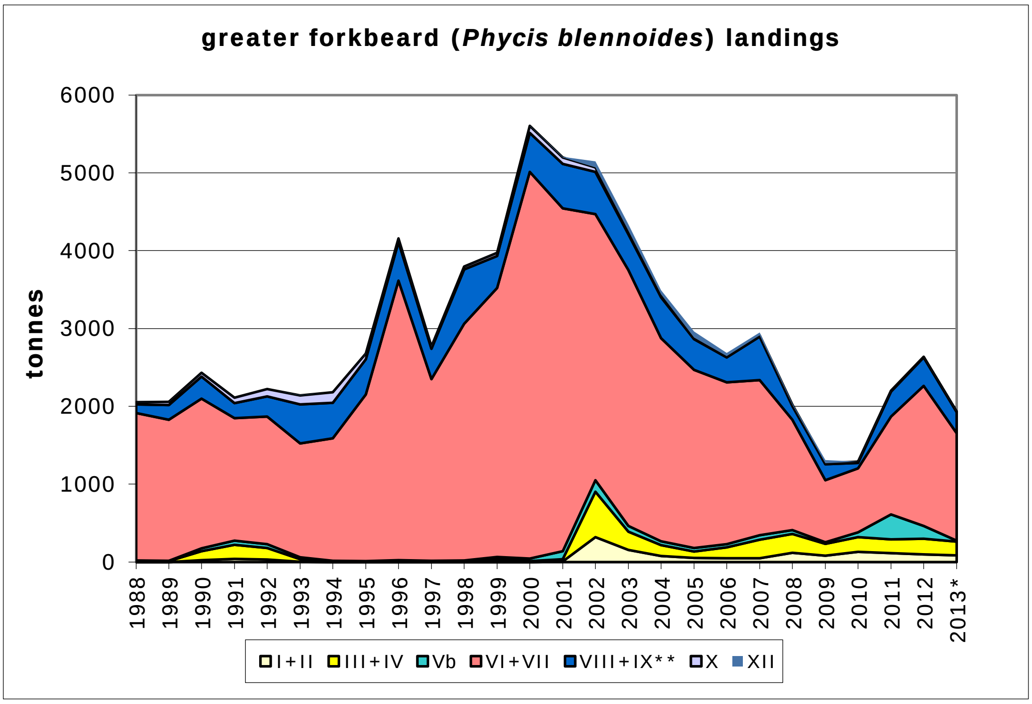

Figure 11.1. Greater forkbeard landing trends in all ICES subareas since 1988 (preliminary data in 2013).

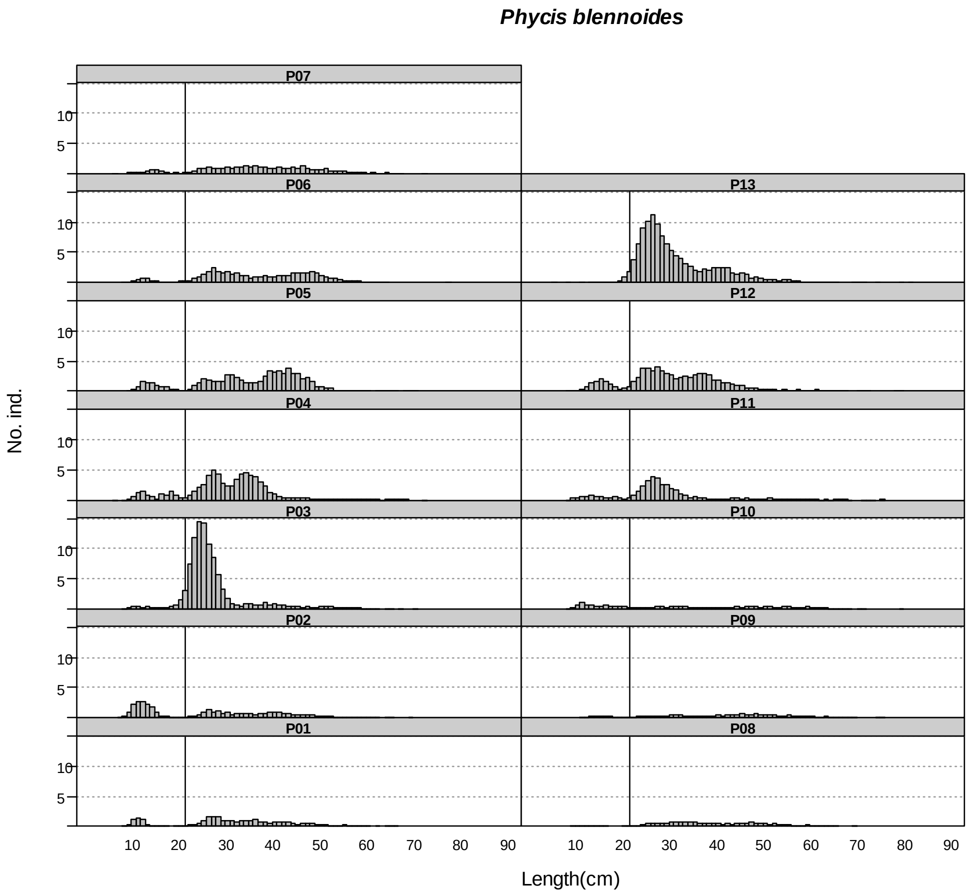

Figure 11.2. Mean stratified length distributions of *Phycis blennoides* in Spanish Porcupine surveys (2001–2013).

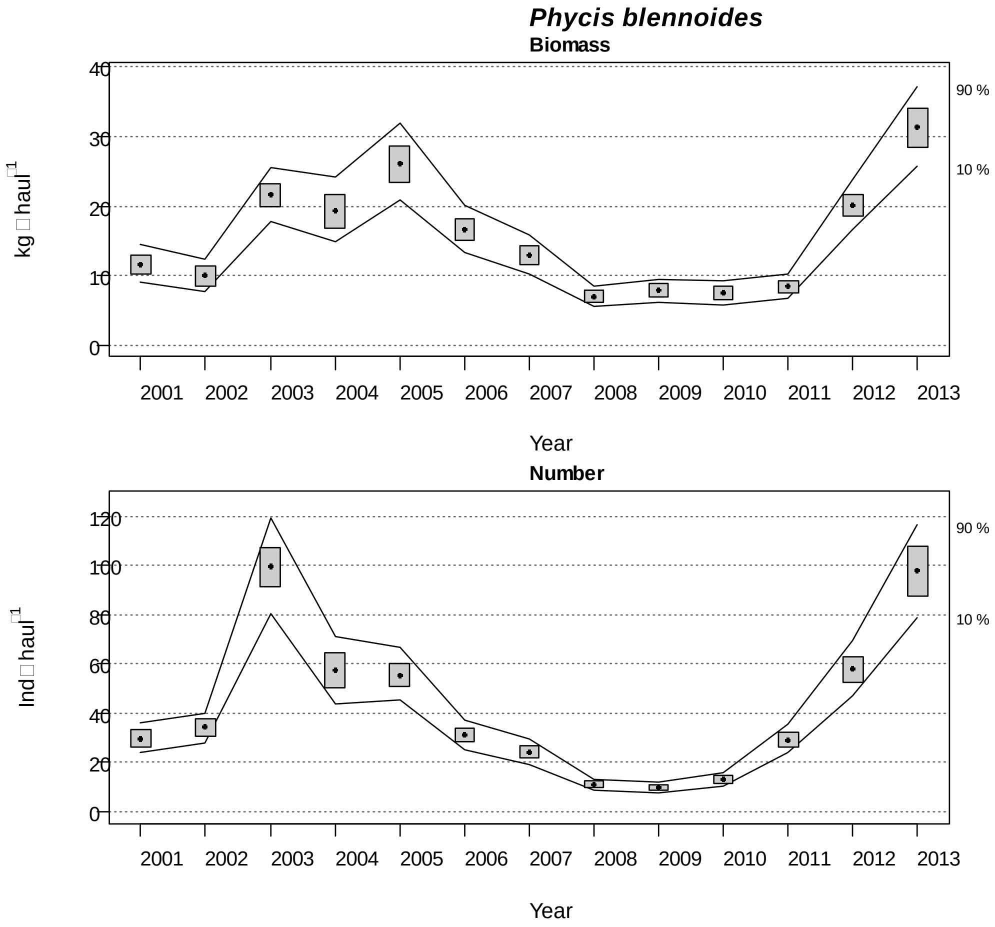

Figure 11.3. Time-series in *Phycis blennoides* biomass (top) and abundance (bottom) indices in the Porcupine survey (2001–2013). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (□ = 0.80, bootstrap iter
pers. comm.).

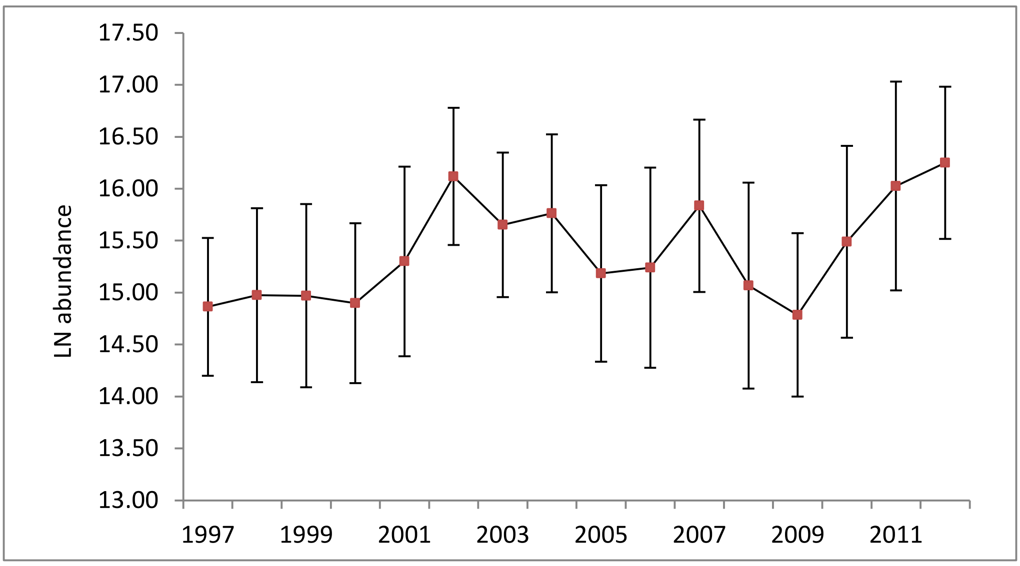

Figure 11.4. Greater forkbeard series of abundance (LN of abundance) from the French IBTS survey in Celtic waters until 2012.

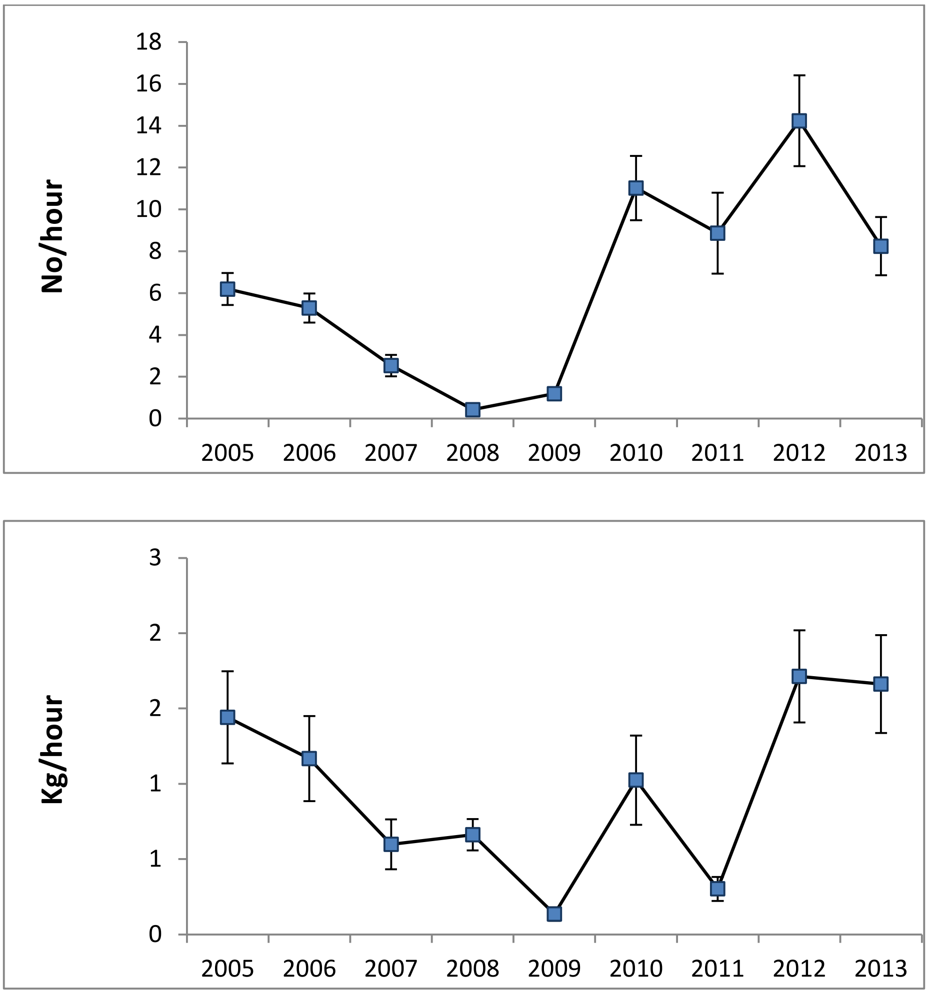

Figure 11.5. Abundance and biomass Indices (nº per hour and kg per hour) of total catches and for individuals <32 cm of the Irish IGFS Survey in the slope and shelf strata, from 2005 to 2013.

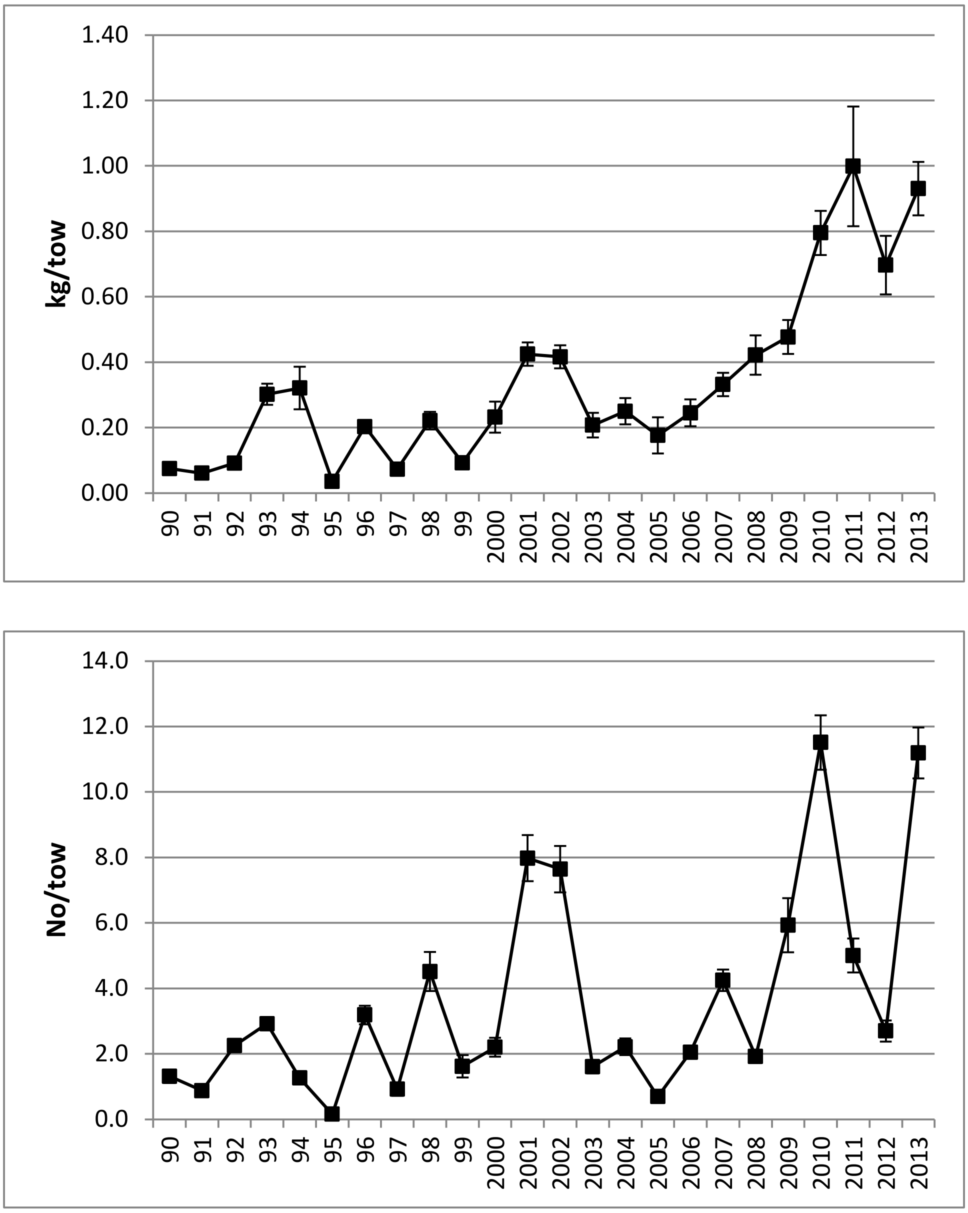

Figure 11.6. Changes in *Phycis blennoides* abundance index (kg/tow and No/tow) during northern Spanish Shelf bottom-trawl survey time-series (1990–2013) in (Divisions IXa and VIIIc).

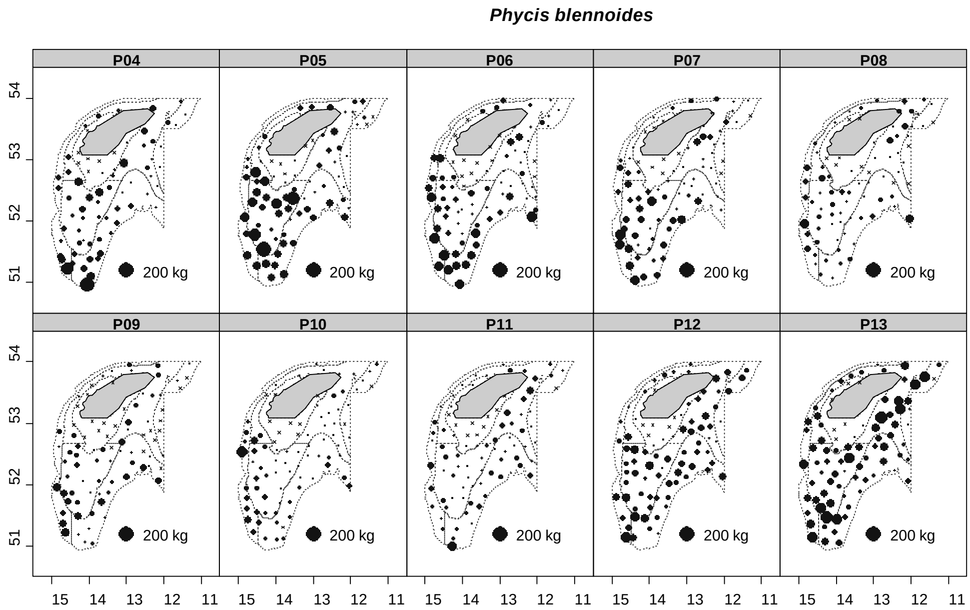

Figure 11.7. Geographic distribution of *Phycis blennoides* catches (kg/30 min haul) in Porcupine surveys between 2001 and 2013.

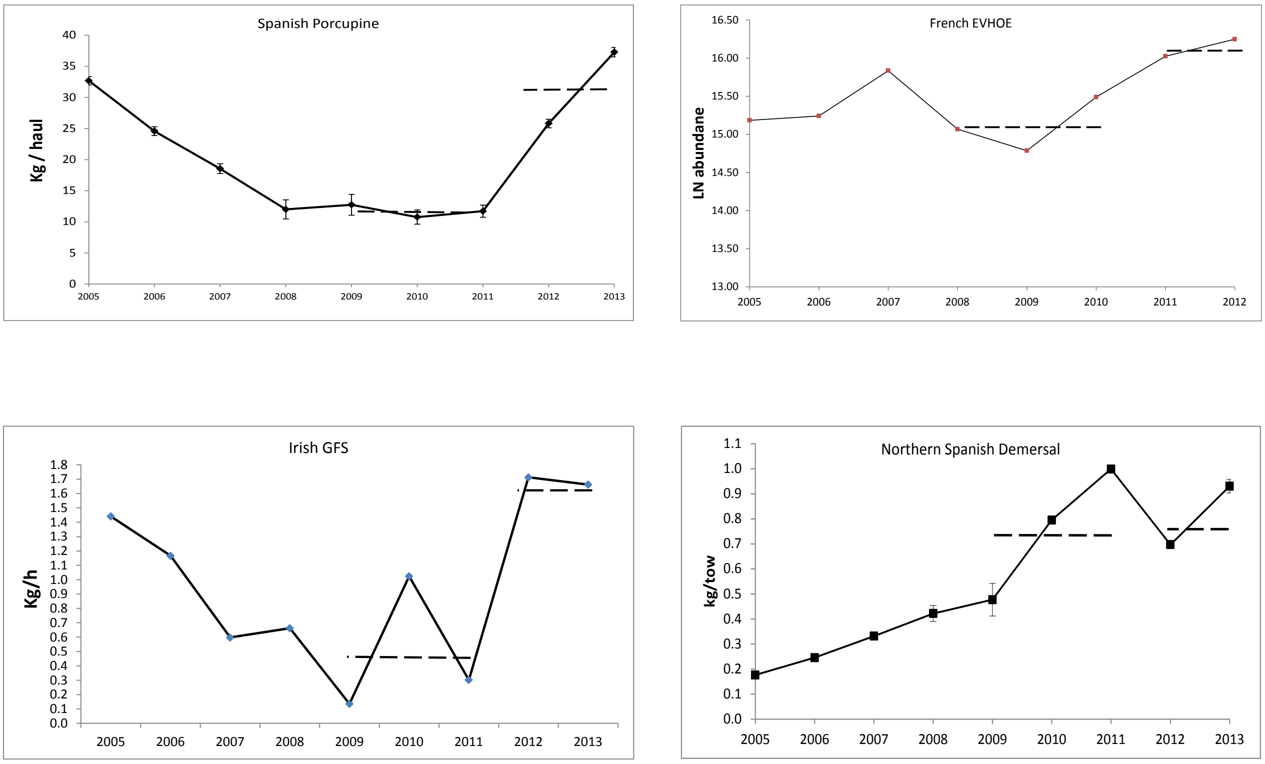

Figure 11.8. Trend of the two last years of the Survey Index compared with the three preceding years; Dashed lines average of the respective year range.

12 Alfonsinos/Golden eye perch (*Beryx* spp.) in all ecoregions

12.1 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 20% 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.

There were landings from a targeted fishery by Russian vessels in the NEAFC area (Xb) between 1993 and 2000 and some minor landings as bycatch in fisheries targeting other species since 2000. (See Table 12.1e).

12.2 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 12.1(a–g), 12.2 and 12.3 and Figures 12.1–12.5. Total landings stabilize around 377 t since 2003.

12.3 ICES Advice

ICES Advice for 2013 and 2014 was: "Catches should be no more than 280 tonnes".

12.4 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 until 2016.

There are NEAFC regulations of effort in the fisheries for deep-water species and closed areas to protect vulnerable habitats.

12.5 Stock identity

No new information.

12.6 Data available

12.6.1 Landings and discards

Tables 12.1a–g, describe the alfonsinos landings by subarea and country. Discards results for the Azorean longliners were updated (WD, Pinho, 2014). Annual longline discard estimates by year for the sampled trip vessels with alfonsinos catches during the period 2004–2011 range from 0,8% to 8.6% for *B splendens* and 0.07% to 10.2% for the *B. decadactylus* (Table 12.4). These discards are mostly a result of the management measures such as TAC and minimum length.

12.6.2 Length compositions

Fishery length compositions were updated (WD Pinho *et al.*, 2014). These are summarised for both species in Figures 12.6 and 12.7 for the last ten years.

Survey length compositions were updated for both species and are presented in Figures 12.8 and 12.9.

Annual mean length from the fishery and survey for both species were updated and are presented in Figures 12.10 to 12.13.

12.6.3 Age compositions

No information about age compositions of *Beryx* species was available during the WGDEEP meeting.

12.6.4 Weight-at-age

No new information.

12.6.5 Maturity, sex-ratio, length-weight and natural mortality

No new information was available to the working group. This DCF information was summarized in the 2010 report and there are no relevant changes on the biology of the species.

12.6.6 Catch, effort and research vessel data

No new information on the abundance indices from the fishery as data for recent years are not yet standardised.

Abundance indices from the Azorean longline survey were updated and are presented for the alfonsino (*Beryx splendens*) (Figure 12.14) and golden eye perch (*Beryx decadactylus*) (Figure 12.15).

12.7 Data analyses

Total landings declined in the late 1990s and have since stabilised at about 370 tonnes (for the two species combined), with a peak of 605 t in 2012 due to the landings reported by Spain for Areas VI–VII. Species-specific landings trends in the Azores fishery showed similar trends for both species (Figure 12.5).

A reduction on the small fish (<20 cm) is observed on the landings for *B splendens* since 2005 due to the minimum length regulations. Length compositions present in general a mode around 30 cm with the exception of the period 2004–2007 (Figure 12.6).

Fishery length compositions for *B decadatylus* show a bimodal or trimodal distribution. A well-defined mode is observed annually around 24 cm. The other two modes vary annually being centred around 32 cm and 42 cm during the last five years (Figure 12.7).

Survey length compositions for *B splendens* and *B decadactylus* show that relatively low numbers of individuals of this species are caught on the survey on the sampled depth strata (50–600 m) (Figures 12.8 and 12.9).

Fishery mean length of *B. splendens* presents a slight decrease along time (Figure 12.10) and for *B. decadactylus* is stable around 35 cm (Figure 12.11).

Survey mean length for *B splendens*, shows an increase from 1995 (27 cm) to 1997 (32 cm) and maintained since 1999 around 27 cm fork length (Figure 12.12). For *B decadactylus* a decrease is observed from 1995 (37 cm) to 1997 (34 cm), with a peak in 1996 (39 cm) and maintained since 1999 around 35 cm (Figure 12.13).

Survey abundance index for *B splendens*, declined significantly between 1995 and 1997 and has since remained at very low levels until 2007. An increasing trend on the abundance has been observed during the last four years (Figure 12.14). For *B. decadactylus* a decrease is observed from 1995 to 1996, maintained thereafter until 2003 at low levels. It increased then from 2003 to 2007 and maintained thereafter at high levels, suggesting an overall increase of the abundance on the recent years (Figure 12.15).

The working group express concerns on the reliability of these indices as an indicator of abundance index due to the relatively low numbers of individuals caught each year. The survey may not be designed for these high mobile and aggregative species particularly for *B decadactylus*. Therefore the working group thinks the approach taken in 2012, i.e. to base advice on catch history to be appropriate.

12.8 Comments on the assessment

No analytical assessment was carried out last year.

12.9 Management considerations

As a consequence of their spatial distribution associated with seamounts, their life history and their aggregating behaviour, alfonsinos are considered to be easily overexploited by trawl fishing; they can only sustain low rates of exploitation. Fisheries on such species should not be allowed to expand above current levels unless it can be demonstrated that such expansion is sustainable. To prevent wiping out entire subpopulations that have not yet been mapped and assessed the exploitation of new seamounts should not be allowed.

Table 12.1a. 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
2011	0	0
2012	0	0
2013	0	0

***Preliminary.**

Table 12.1b. Alfonsinos (*Beryx* spp.) Vb.

Year	Faroes	France	TOTAL
988			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
2011	0	0	0
2012	0	0	0
2013*	0	0	0

***Preliminary.**

Table 12.1c. 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
2011	4	0	0	0	0	4
2012	3	0	10	0	0	13
2013*	13	1,17	63	0	0	77

***Preliminary.**

Table 12.1d. 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	105
2004	21	53	209	0	283
2005	9	45	141	0	195
2006	8	20	64	3	97
2007	8	45	67	0	120
2008	5	42	54	0	101
2009	1	42	18	0	61
2010	12	27	1	0	41
2011	2	7	132	0	141
2012	4	11	27	0	42
2013	5	0	4	0	9

*** Preliminary.**

Table 12.1e. 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
2011	226	0	0	5	0	231
2012	213	10	0	0	0	222
2013	168	0	0	0	0	168

*** Preliminary.**

**** Not official data from ICES Area Xb.**

Table 12.1f. 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
2011	2	2
2012	0	0
2013	0	0

*** Preliminary.**

Table 12.1g. 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*		
2011*		
2012*		
2013*		

*** No information.**

Table 12.2. 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		485
2005			70	195	157	0		422
2006			78	97	192	0		367
2007			65	120	211	0		396
2008	0	0	54	101	250	2		407
2009			10	61	311	1		383
2010	0	0	5	41	240	5		291
2011	0	0	40	65	226	9	2	342
2012	0	0	341	80	213	10		315
2013*	0	0	77	9	168	0		254

***Preliminary.**

Table 12.3. Reported landings of *Beryx splendens* and *B. decadactylus* in the 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
2011	179	47	226
2012	175	37	213
2013*	140	28	168

***Preliminary.**

Table 12.4. Annual percentage of *Beryx* spp. discarded by year in the Azores (ICES Division Xa) from the sampled trip vessels that caught and discard alfonsinos.

SPECIES	2004	2005	2006	2007	2008	2009	2010	2011
Beryx splendens	1,79	1,87	1,55	1,02	1,19	8,64	4,69	0,76
Beryx decadactylus	0,37	0,07	1,31	0,14	0,57	10,18	2,36	0,95

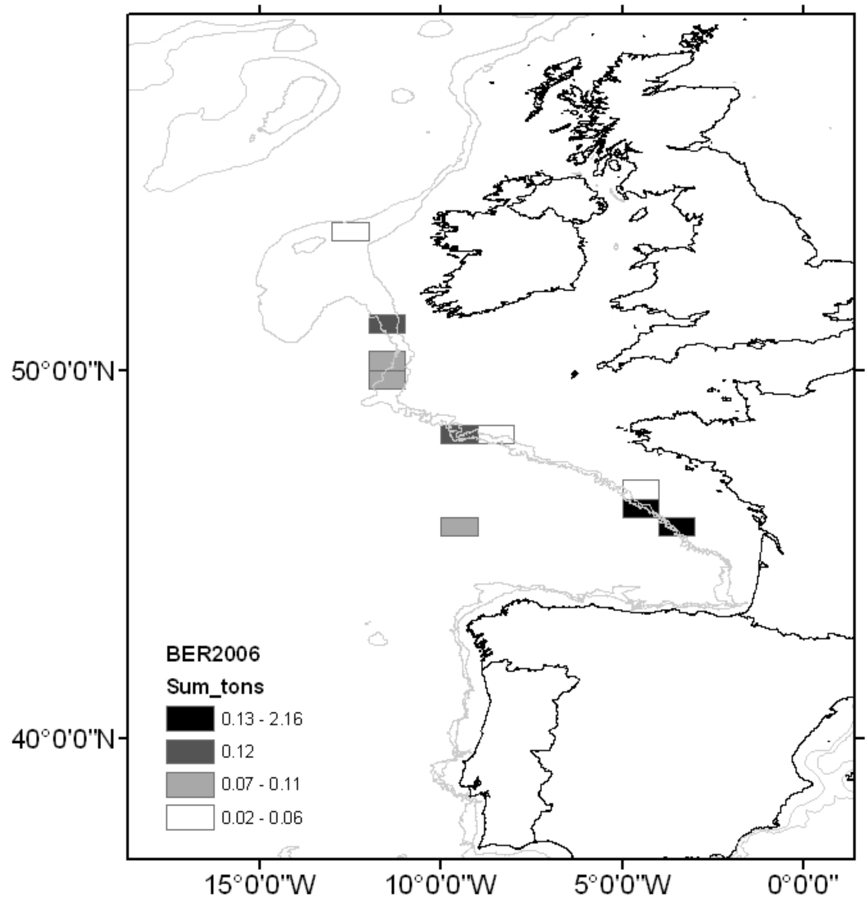

Figure 12.1. Catches of alfonsinos by French, Irish, UK (England and Wales and Scotland) and Icelandic vessels, 2006.

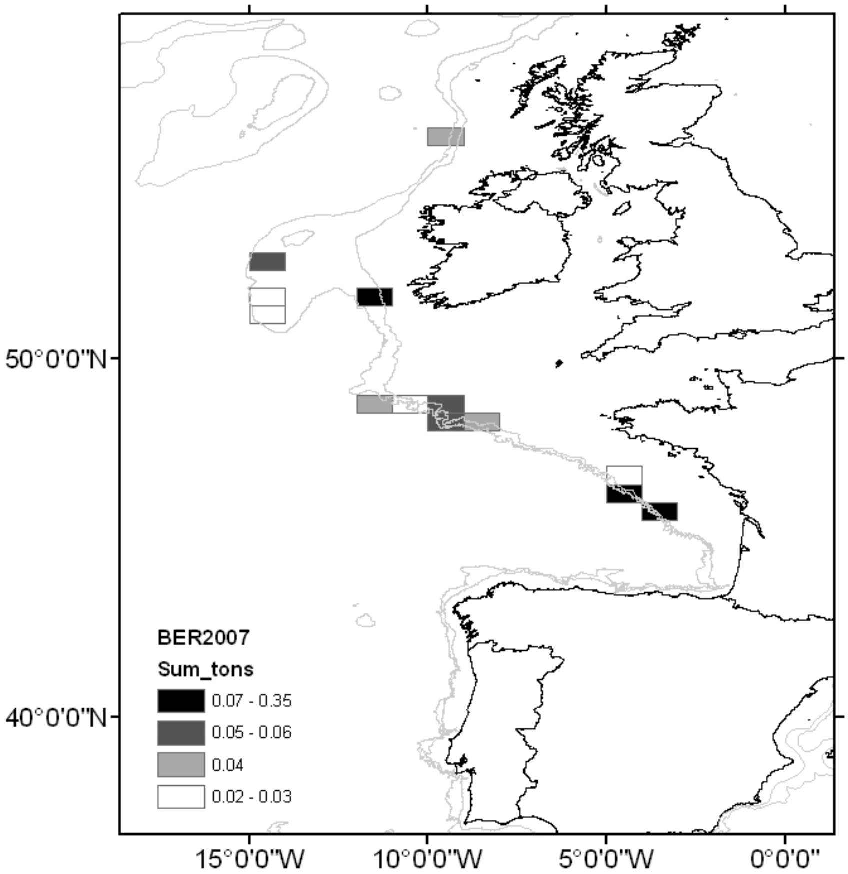

Figure 12.2. Catches of alfonsinos by French, Irish, UK (England and Wales and Scotland) and Icelandic vessels, 2007.

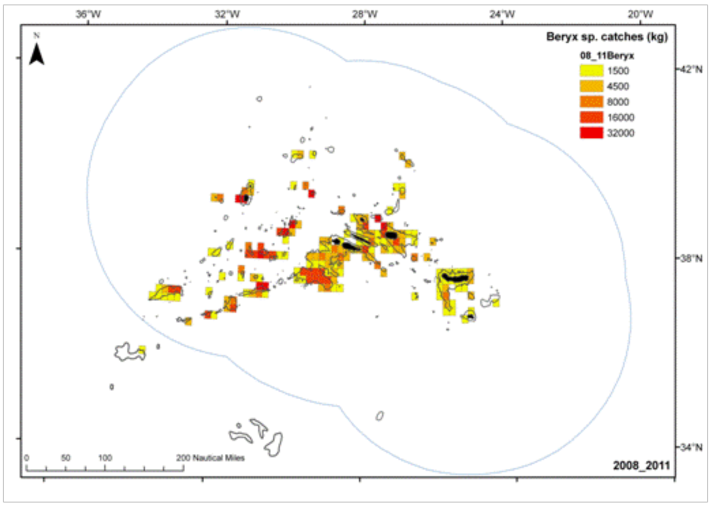

Figure 12.3. Catches of alfonsinos by Azores vessels, 2008–2011 (ICES, Xa2).

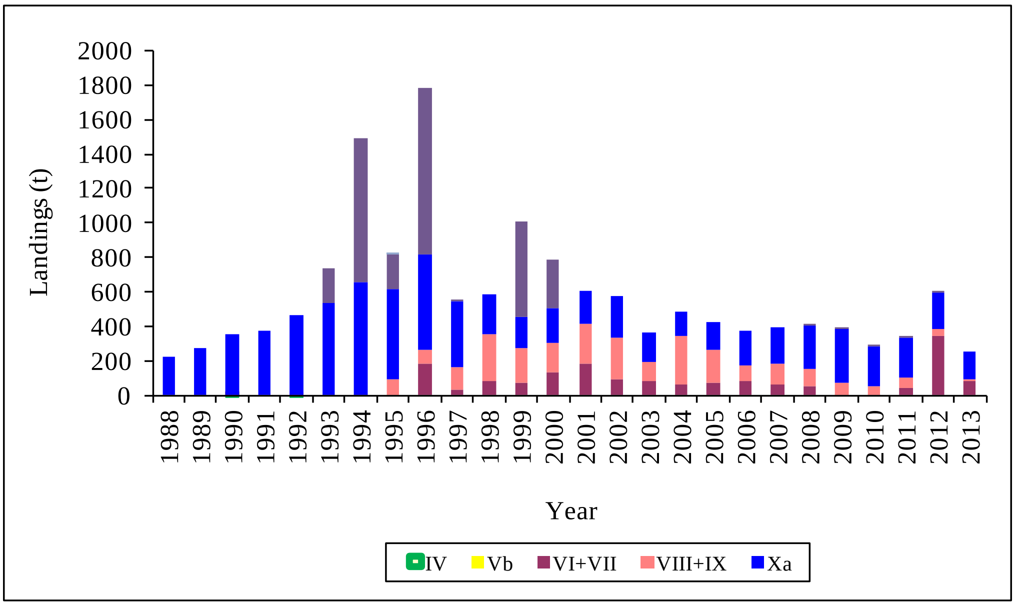

Figure 12.4. Reported landings for the alfonsinos, (*Beryx* spp), by ICES subareas/divisions.

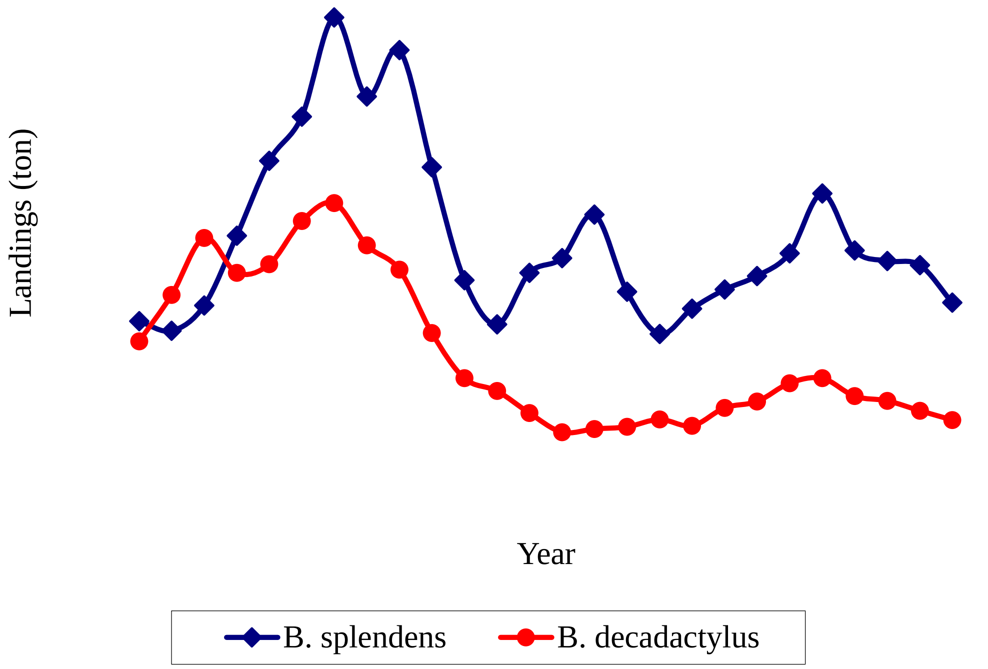

Figure 12.5. Landings of *Beryx splendens* and *B. decadactylus* in Azores (ICES Subarea X).

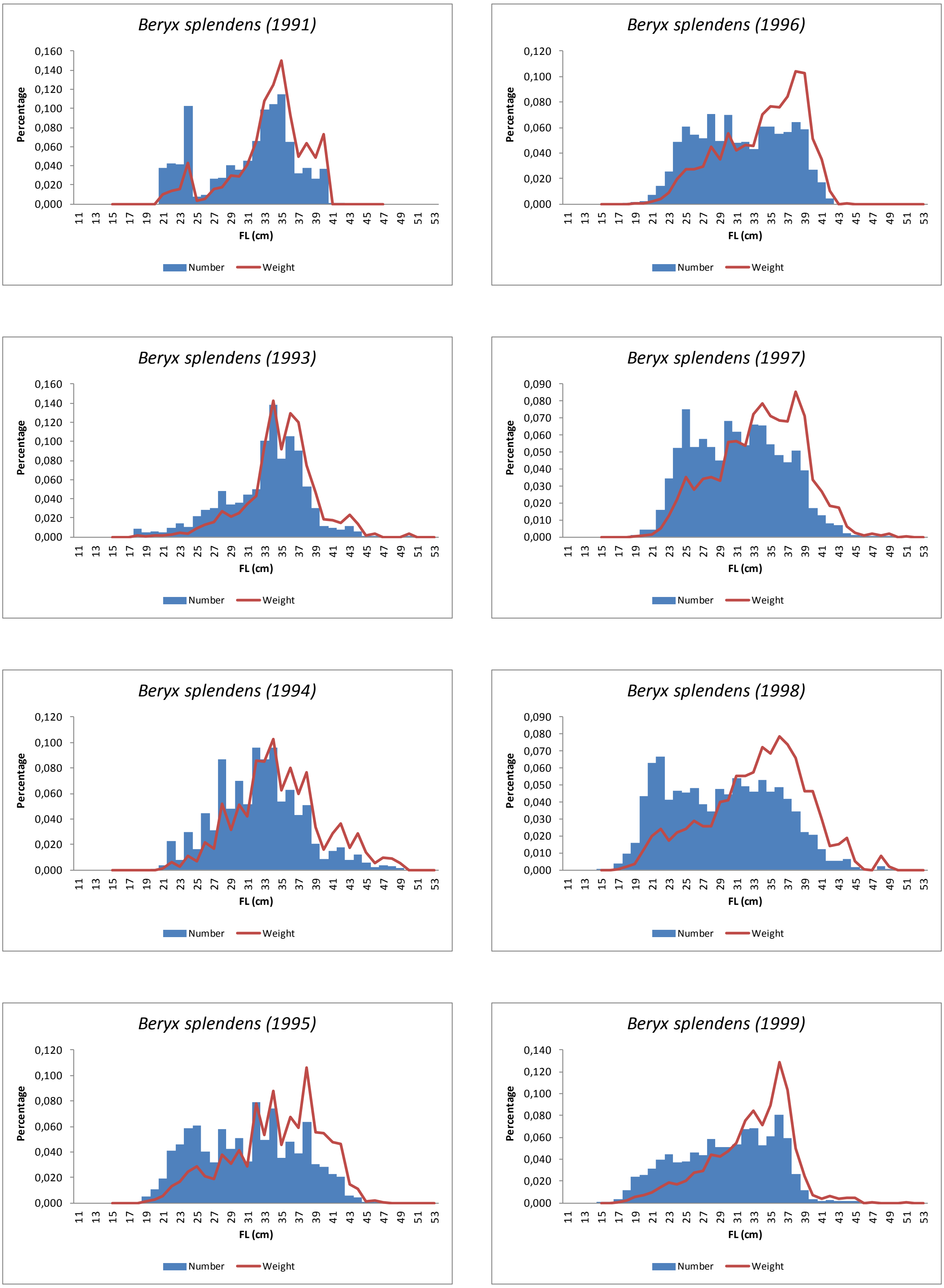

Figure 12.6. ***Beryx splendens*** **Length distribution of the catch from the Azores (ICES Subarea X). Bars represent the proportion in number of every size class and the red line represents the proportion in weight.**

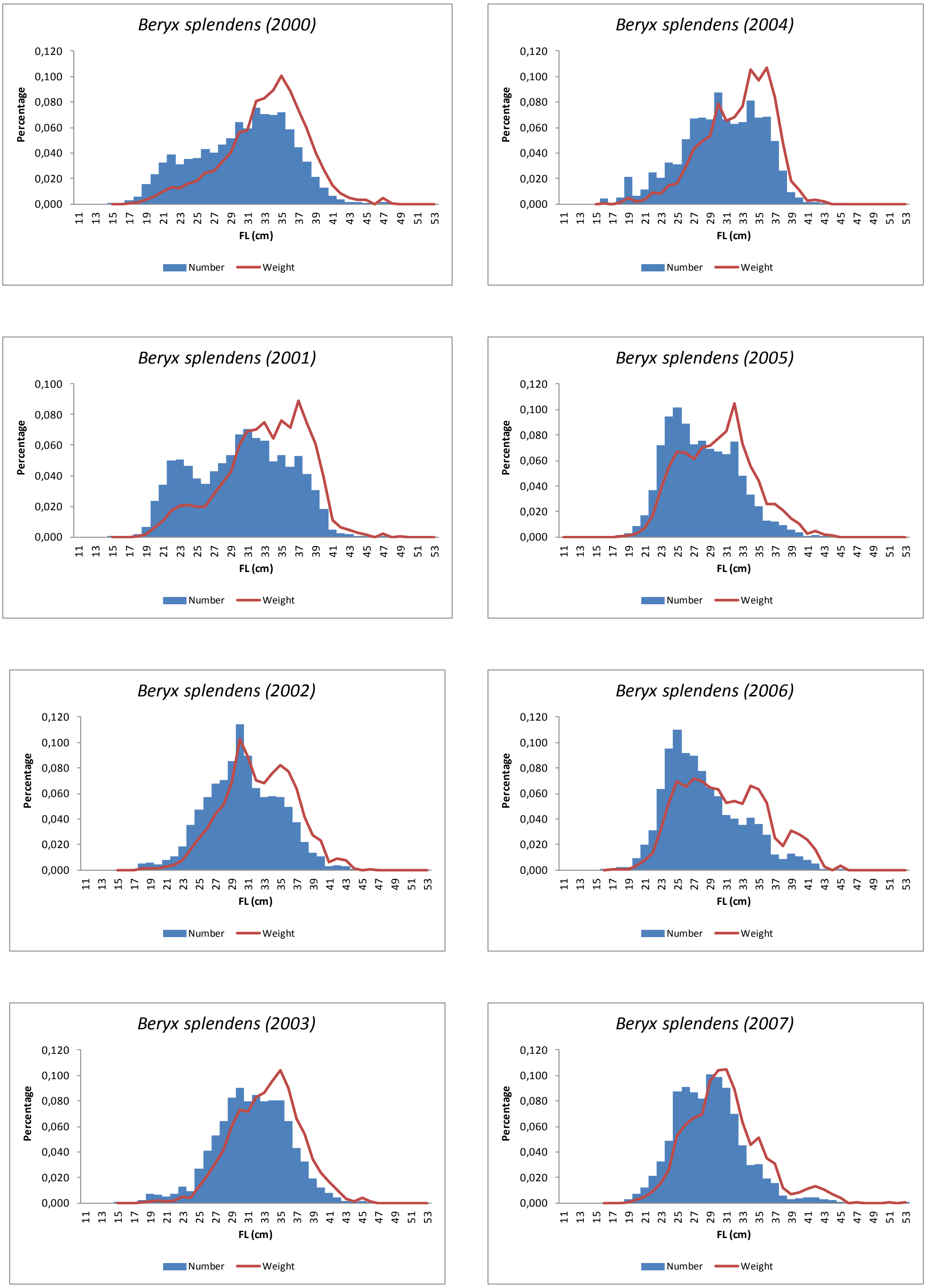

Figure 12.6. ***Beryx splendens*** **Length distribution of the catch from the Azores (ICES Subarea X). Bars represent the proportion in number of every size class and the red line represents the proportion in the weight.**

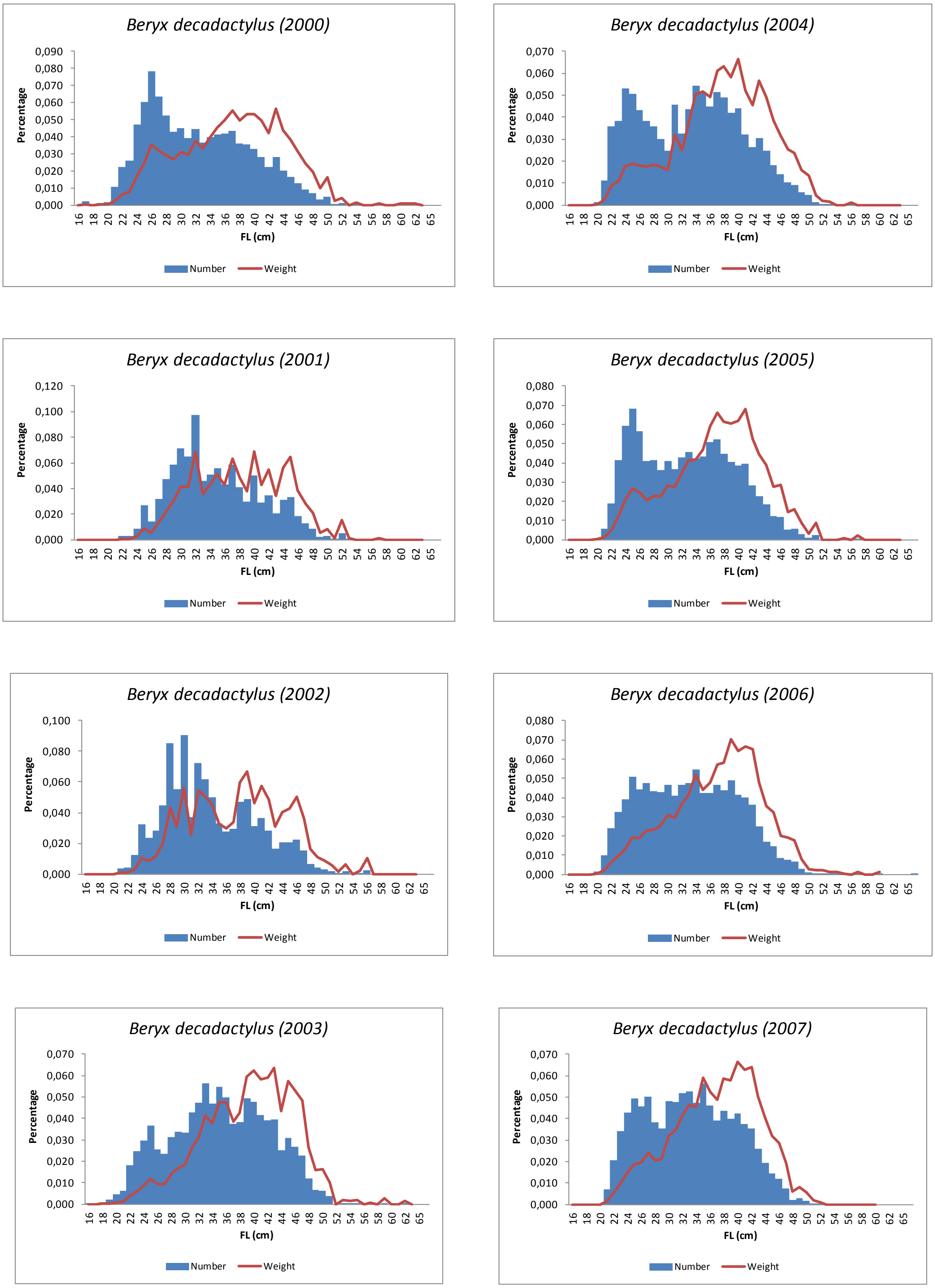

Figure 12.7. ***Beryx decadactylus*** **Length distribution of the catch from the Azores (ICES Subarea X). Bars represent the proportion in number of every size class and the red line represents the proportion in the weight.**

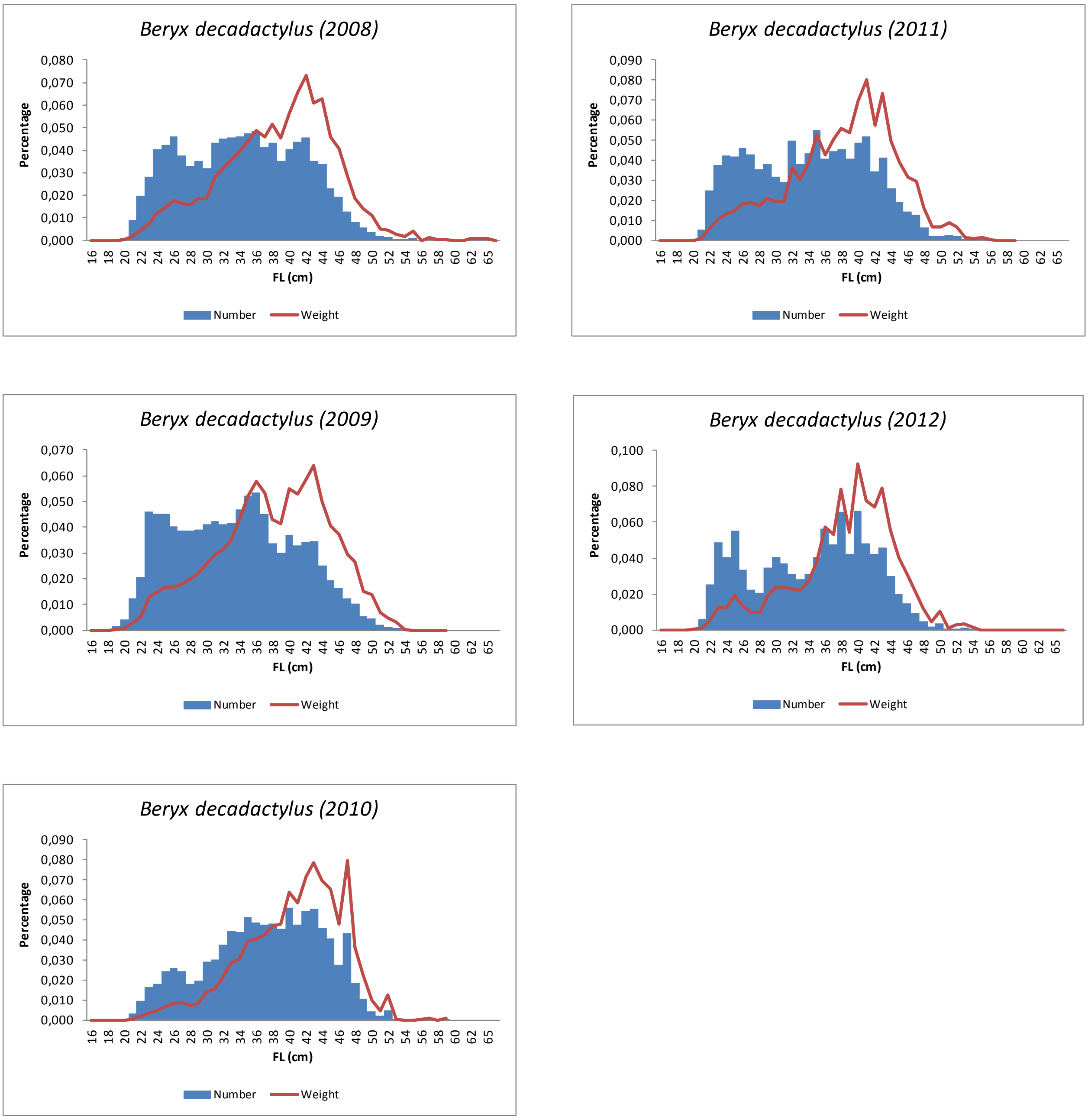

Figure 12.7. ***Beryx decadactylus*** **Length distribution of the catch from the Azores (ICES Subarea X). Bars represent the proportion in number of every size class and the red line represents the proportion in the weight.**

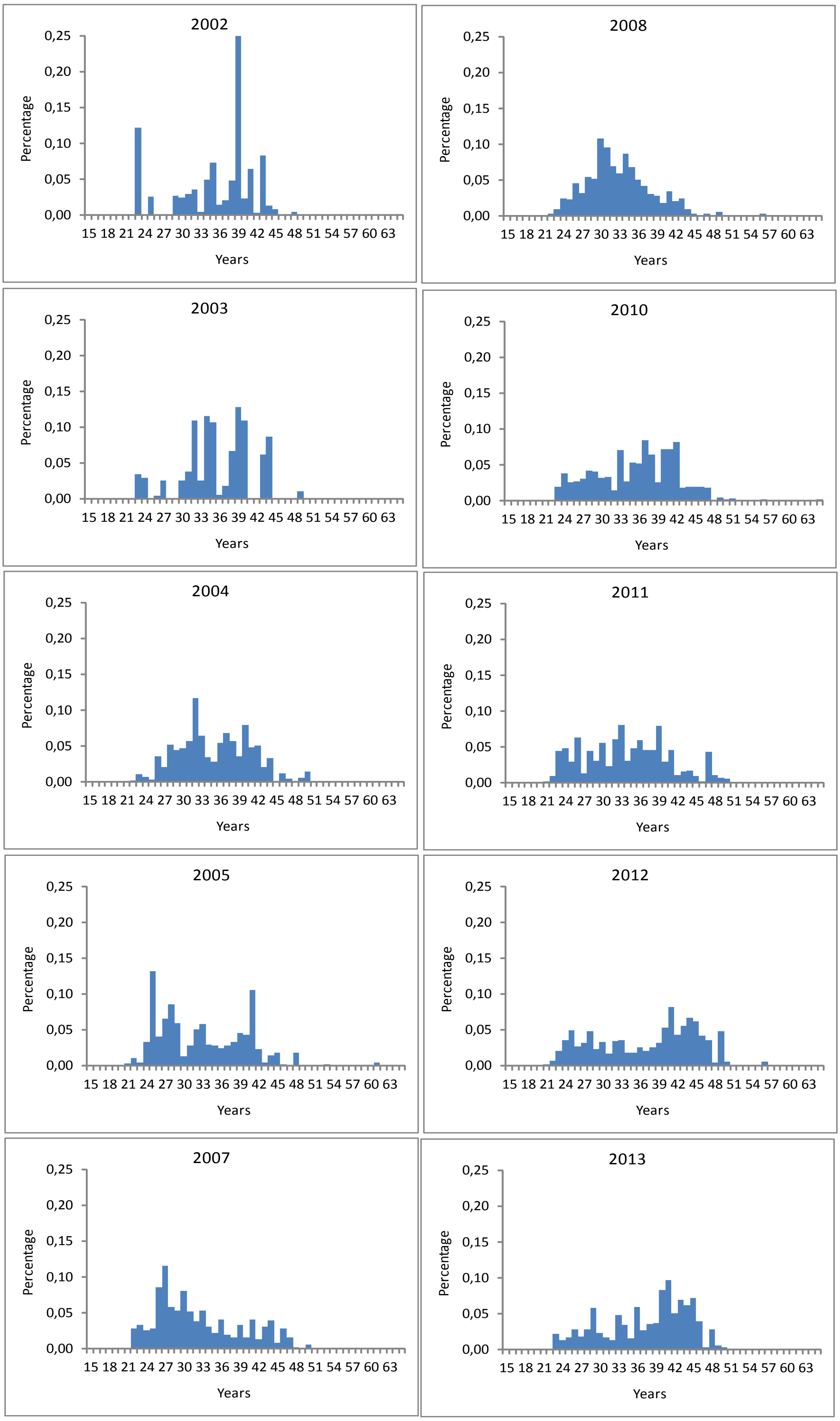

Figure 12.8. ***Beryx decadactylus*** **survey length compositions by year from the Azores (ICES Subarea X).**

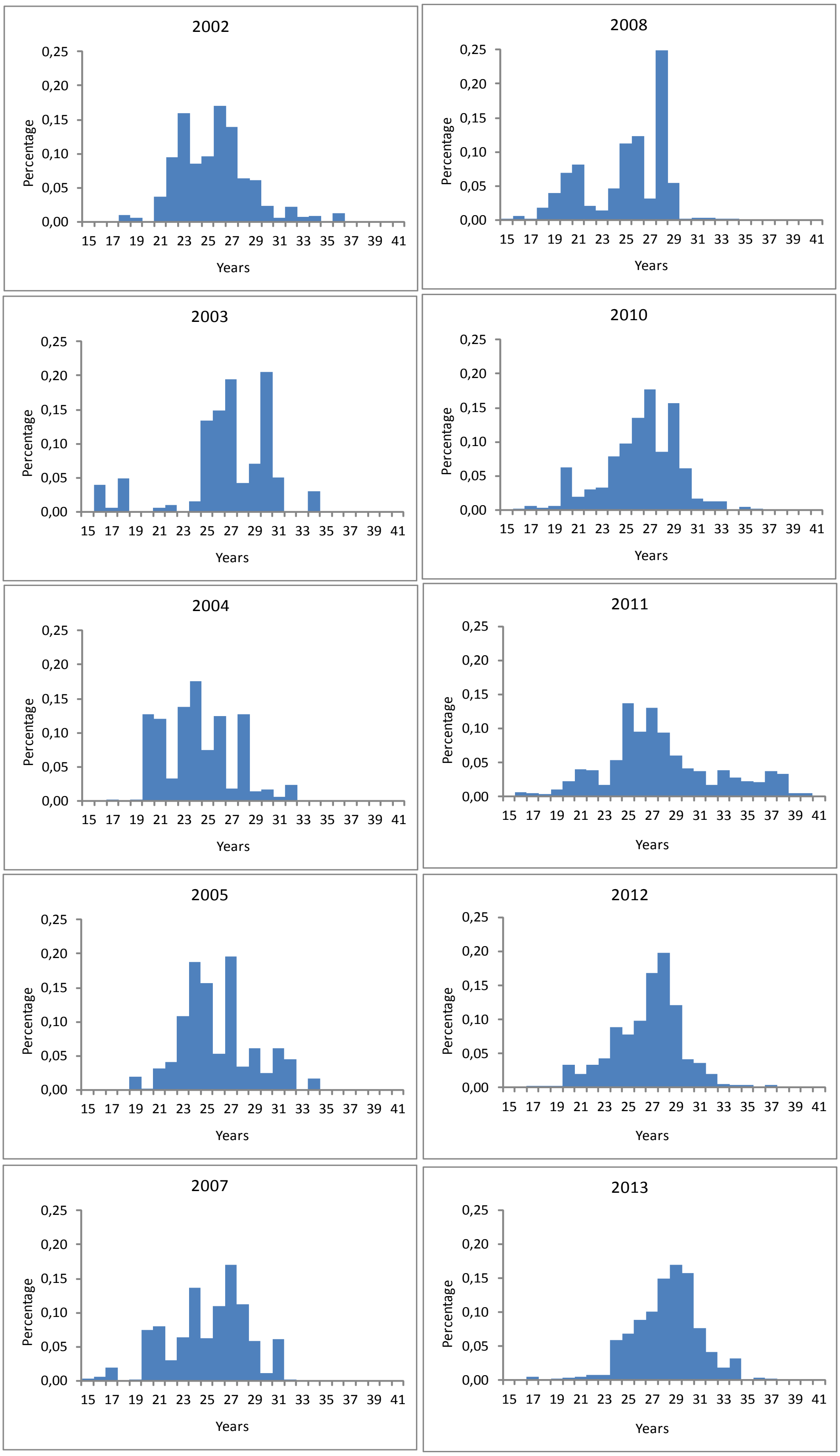

Figure 12.9. ***Beryx splendens*** **survey length compositions, by year from the Azores (ICES Subarea X).**

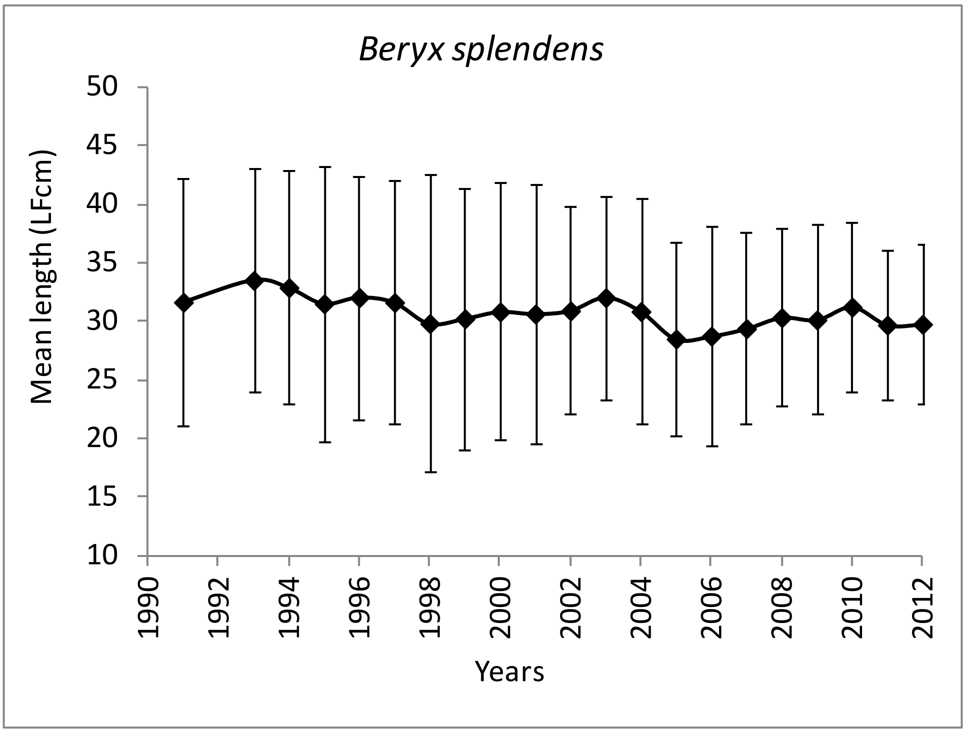

Figure 12.10. Annual mean length of *Beryx splendens* from the Azorean fishery (ICES Subarea X).Bars are 95% confidence interval.

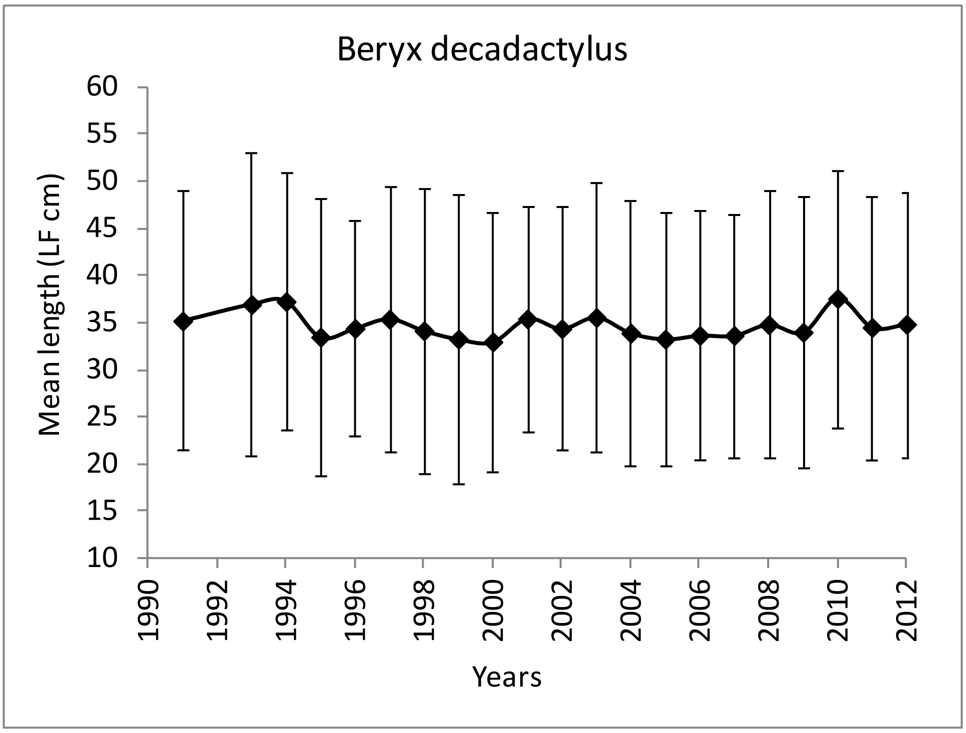

Figure 12.11. Annual mean length of *Beryx decadactylus* from the Azorean fishery (ICES Subarea X).Bars are 95% confidence interval.

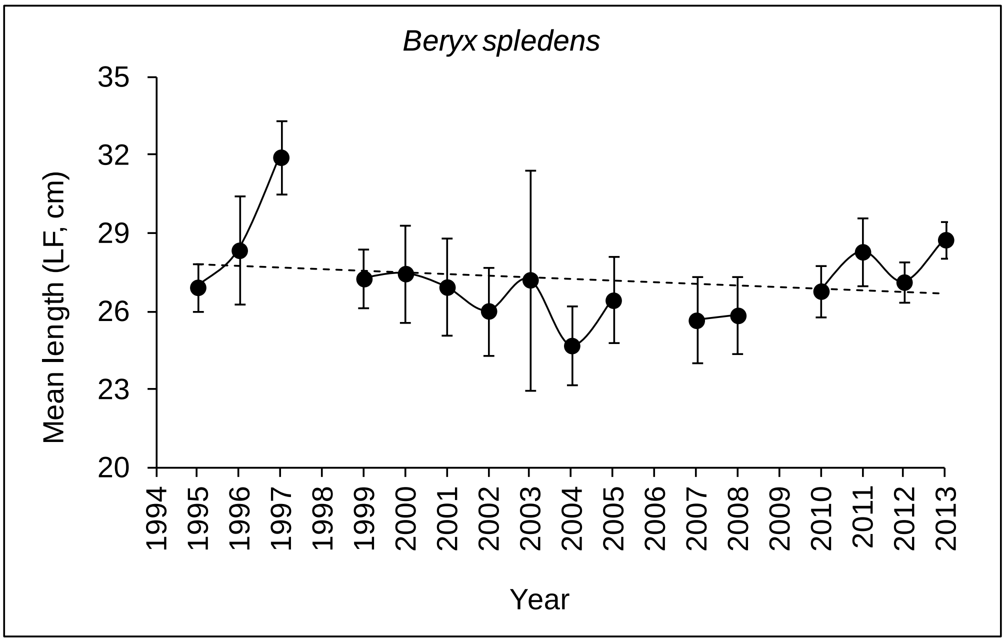

Figure 12.12. Annual mean length of *Beryx splendens* from the bottom longline survey (ICES Subarea X).Bars are 95% confidence interval.

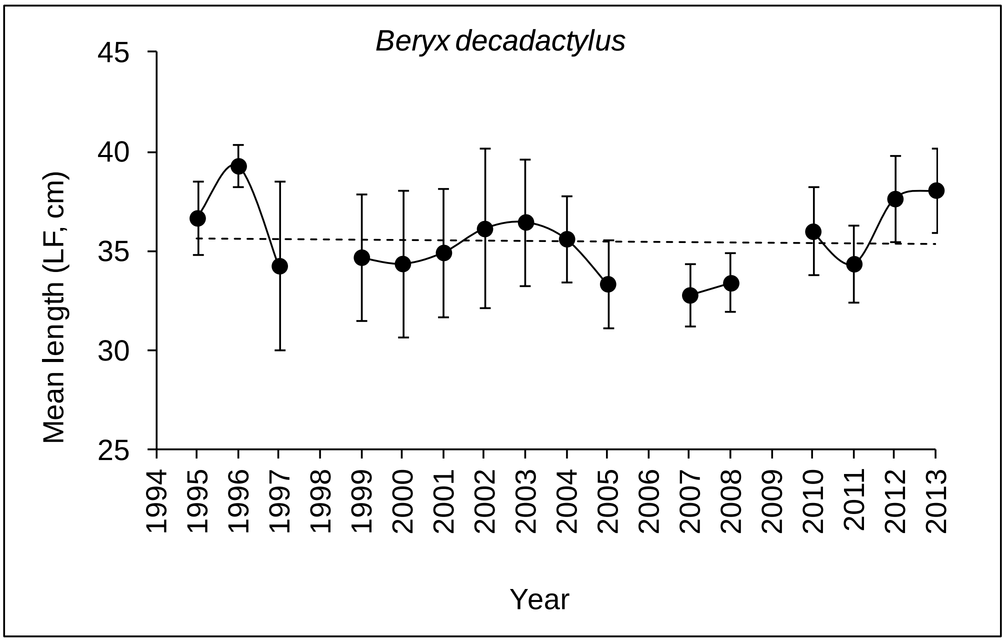

Figure 12.13. Annual mean length of *Beryx decadactylus* from the bottom longline survey (ICES Subarea X).Bars are 95% confidence interval.

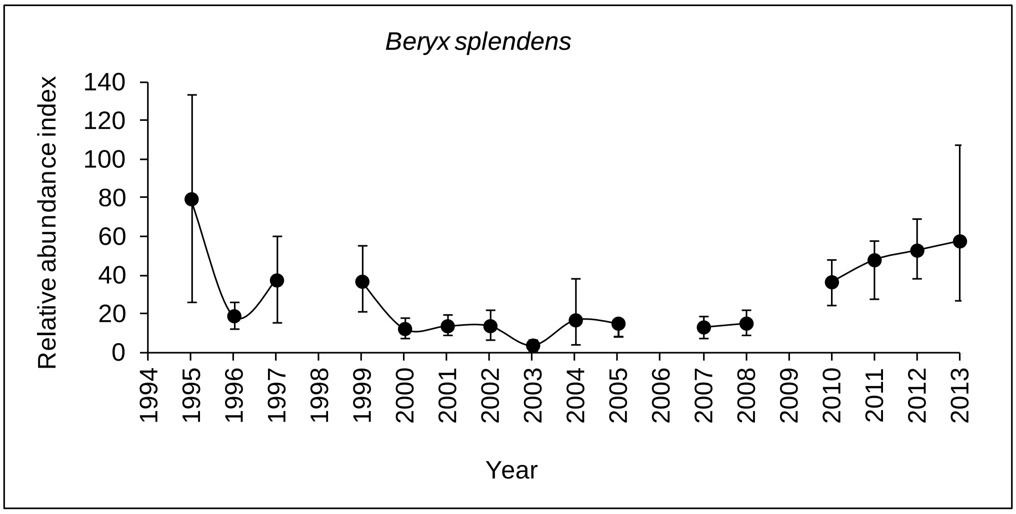

Figure 12.14. Annual bottom longline survey abundance index in number available for the alfonsinos (*Beryx splendens*) from the Azorean deep-water species surveys (ICES Subarea X).

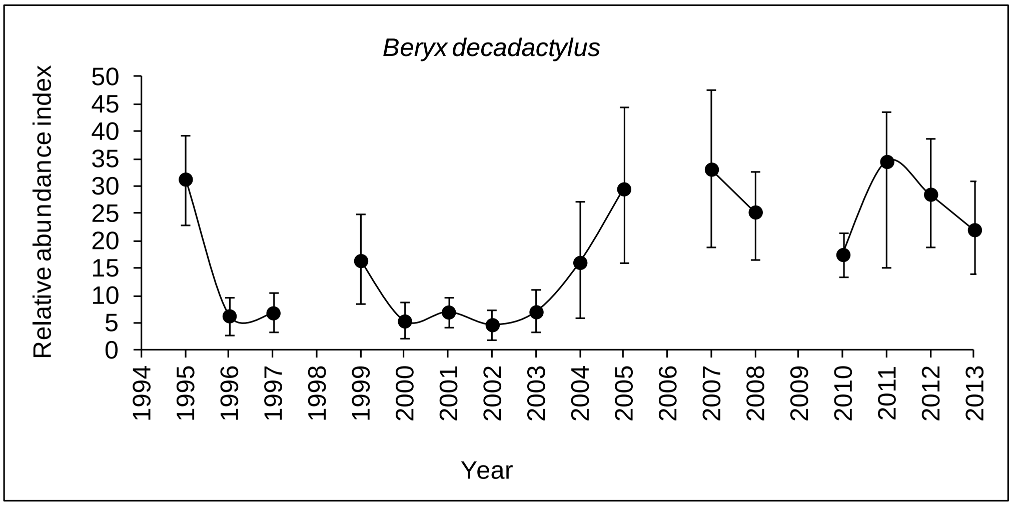

Figure 12.15. Annual bottom longline survey abundance index in number available for the golden eye perch (*B. decadactylus*) from the Azorean deep-water species surveys (ICES Subarea X).

13 Red (black spot) seabream (*Pagellus bogaraveo*)

13.1 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).

The interrelationships of the (blackspot) seabream 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 current fishery currently occurs.

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).

13.2 Red (blackspot) seabream in Subareas VI, VII & VIII

13.2.1 The fishery

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, 2011). Currently, EU Regulations state that no directed fisheries are permitted under the quota, therefore catches should be only bycatches.

In the period considered (1988–2013), most of the estimated landings from the Subareas VI, VII and VIII were taken by Spain (67%), followed by France (19%), UK (12%) and Ireland (2%).

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 seabream catches in these areas are almost all bycatches of longline and otter trawl fleets from France, Ireland and Spain.

13.2.2 Landings trends

Landings data by ICES Subareas reported to the working group are shown in Table 13.2.1a–c. Figure 13.2.1a presents an overview of the historical series of landings in Subareas VI, VII and VIII since the middle of the last century. Figure 13.2.1b shows, in greater detail, landings of the same subareas since 1988.

For these three subareas combined, landings fell from more than 461 t in 1989 to 52 t in 1996, increased again to a peak in 2007 (322 t) and then decreased in following years to 156 t in 2013.

13.2.3 ICES Advice

The advice for this stock is biennial and valid for 2013 and 2014 (see ICES, 2012): No directed fisheries, and measures should be put in place to reduce bycatch.

13.2.4 Management

The EU TAC for the Subareas VI, VII and VIII was 196t for 2012 and 178 t for 2013. Landings in 2012 were above the TAC and in 2013 were below the TAC. A minimum landing size of 35 cm (total length) applies in 2010.

Pagellus bogaraveo	Landings		TAC	TAC
Subarea	2012	2013*	2012	2013
VI, VII, VIII	221	156	196	178

***preliminary.**

13.2.5 Data available

13.2.5.1 Landings and discards

A Spanish, French and UK extended landing-series of *P. bogaraveo* in Northeast Atlantic was updated in 2014 (Figure 13.2.1).

Information from observers in the Basque country OTB and pair-trawl fleets in Subareas VI, VII and VIII indicates that there were no discard for this species in the period 2003–2013. Other countries involved in this fishery also reported 0 discards this year.

13.2.5.2 Length compositions

No length data were available to the working group.

13.2.5.3 Age compositions

No age data were available to the working group.

13.2.5.4 Weight-at-age

Mean size and weight-at-age (Table 13.2.2) derived from Guéguen (1969) and Krug (1998) were used by Lorance (2011) in a yield-per-recruit model to simulate the effect of fishing mortality on a red blackspot sea bream stock of Bay of Biscay.

13.2.5.5 Maturity and natural mortality

Natural mortality of 0.2 was estimated by Lorance (2011). 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)).

13.2.5.6 Catch, effort and research vessel data

At the current level of abundance, the black spot seabream is rarely caught in the northern surveys by French IBTS (Divisions VIIf,g,h,j; VIIIa,b, and VIId) and Irish IGFS (Divisions VIa South and VIIb) and in the Cantabrian Sea (VIIIc) by the Itsasteka and Northern Spanish Shelf bottom-trawl surveys, not at all in most years (Figures 13.2.2, 3 and 4).

In French surveys, similar to the current western IBTS, from early 1980s when the stocks were already low it was still in 40 to 60% of the hauls. This proportion dropped to close to zero by 1985 (Lorance, 2011). This observation indicates that the current survey is appropriate to detect and monitor a recovery of the stock if ever it happens.

13.2.6 Data analyses

2013 was the first year with the new RV *Miguel Oliver* carrying the *Demersales* groundfish survey on the northern Spanish Shelf. Despite the intercalibration carried out in 2012 between the new vessel and RV *Cornide de Saavedra*, which performed these surveys in the rest of the time-series, differences in the catchability of some species, specially the benthic ones, have been detected. Nevertheless the possible effect in species with a more "pelagic" behaviour, such as blackspot seabream, are not clear. However given the variability and the fact that this species appears mainly in the shallower hauls not considered within the stratified abundance indices, the importance of the change of vessel for this species is expected minor.

Series of the *Demersales* on the northern Spanish abundance shows sparse catches in the series with peaks in 1998, 1999 and 2005 but always with catches less than 1 kg/tow.

13.2.7 Biological reference points

WKLIFE has not yet suggested methods to estimate biological reference points for stocks which have only landings data or are bycatch species in other fisheries. Therefore, no attempt was made to propose reference points for this stock.

13.2.8 Management considerations

This stock is collapsed and the advice is to reduce mortality by all means to allow the stock to rebuild.

Measures should include protection for areas in which juveniles occur. Recreational fisheries may be a significant proportion of the mortality.

The TAC was exceeded in 2007, 2010 and 2012.

Table 13.2.1a. Red seabream 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	34	1	16	10		61
2010	22	0	40	1		62
2011	21		11	4		37
2012	38		82			120
2013*	28		7	4		39

*** preliminary.**

Table 13.2.1b. Red seabream in Subarea VIII; WG estimates of landings by country.

YEAR	FRANCE*	SPAIN	UK (E & W))	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	5	137	0	142
2010	61	157	0	218
2011	19	122	0	141
2012*	18	82	0	101
2013*	26	91	0	117

*** preliminary.**

Table 13.2.1c. Red seabream 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	61	142	203
2010	62	218	281
2011	37	141	177
2012*	120	101	221
2013	39	117	156

*** preliminary.**

Table 13.2.2 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

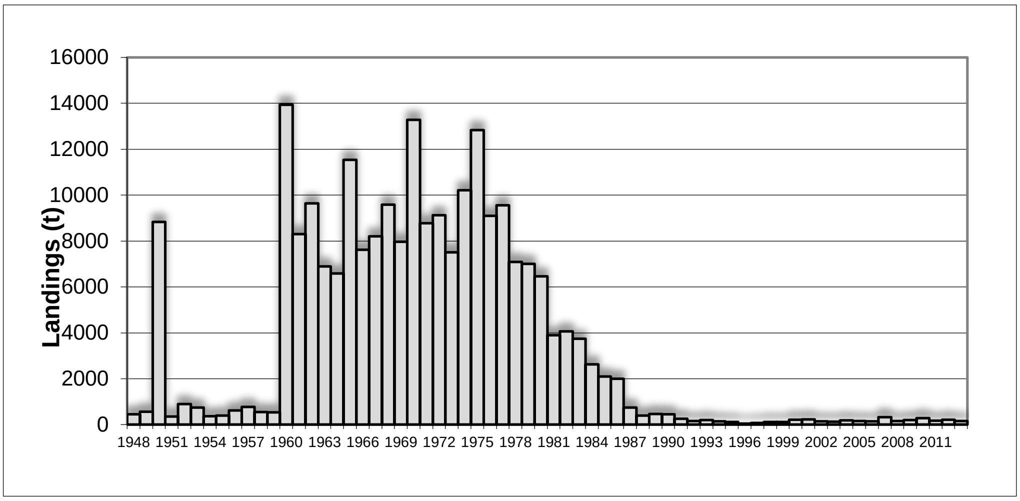

Figure 13.2.1a. Time-series of red seabream landings from 1948 to 2013 in Northeast Atlantic (Subareas VI, VII and VIII).

Reference/Source (1) of reconstructed landings data for red seabream 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. -Years 1950–1984: Landings of *Pagellus* sp. ("seabreams") 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). -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. ("seabreams") from the Northeast Atlantic. Source: Anuarios de Pesca maritima. Castro (1990). SGDeep 1996.Table 13.2.3. -Years 1983–1987: Landings of *P.bogaraveo* (*sic*) from Division IXa correspond only to southern IXa (Tarifa and Algeciras ports). Source: Cofradias de Pescadores.(WD Gil, 2004) and Cofradias de Pescadores. (Lucio, 1996). -Years 1985–1987: Landings of *Pagellus* sp. (mainly *P. bogaraveo*). Source: SGDeep 1996. Table 13.2.4. -Years 1948–1984: Landings of *P.bogaraveo* (*sic*) from "Division VIIIc" -mainly Division VIIIc (eastern) and Division 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 -Years 1988–2013 WGDeep official data

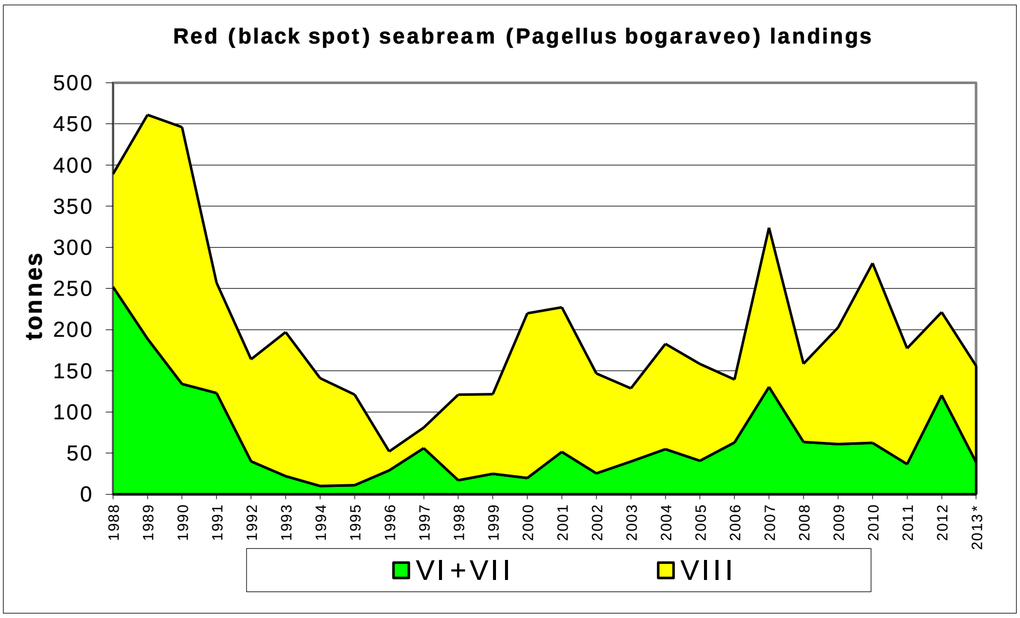

Figure 13.2.1b. Red seabream landing trends in ICES subareas VI and VII since 1988 (preliminary data in 2013).

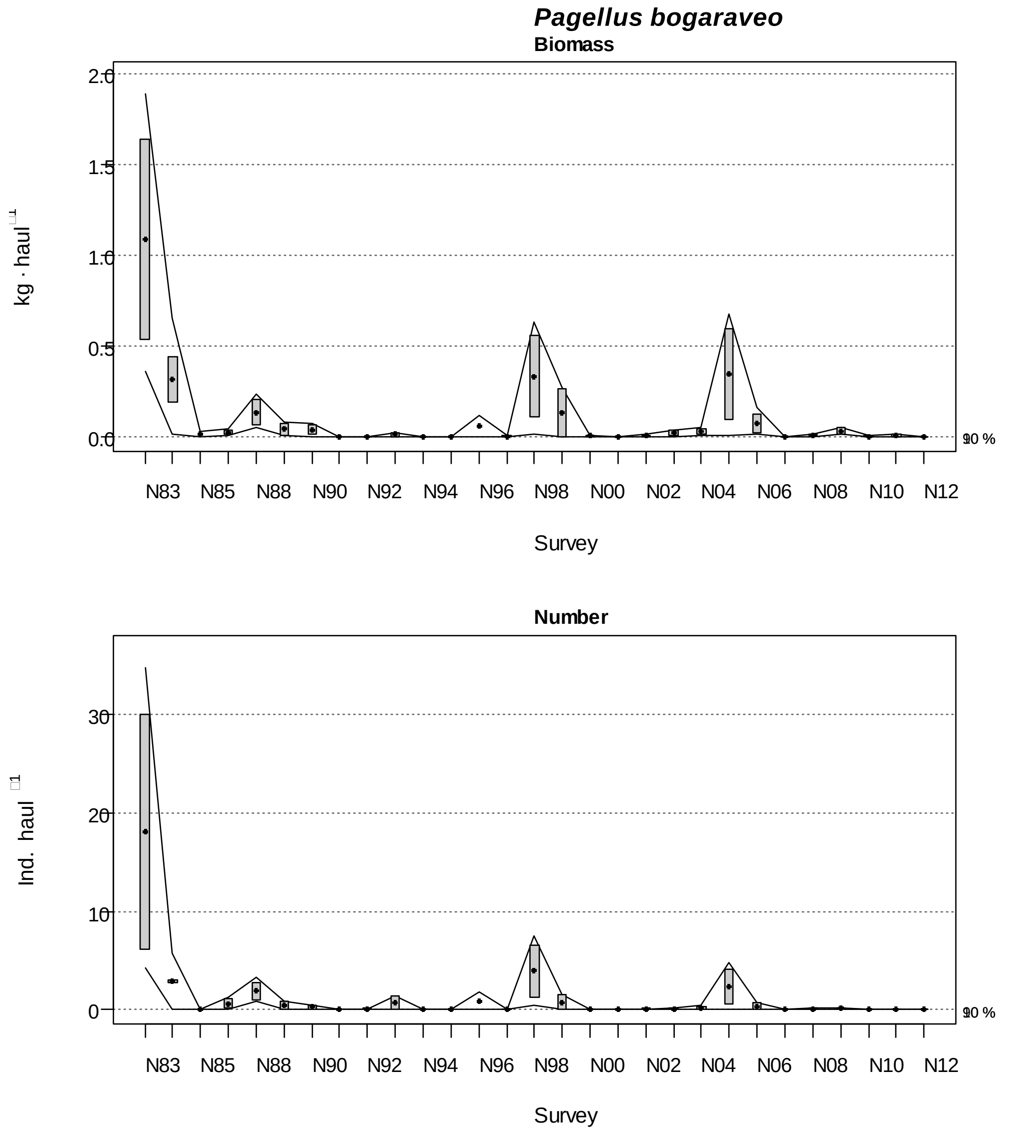

Figure 13.2.2. Evolution of blackspot seabream (*P. bogaraveo*) mean stratified abundance in Northern Spanish Shelf survey time-series (1983–2013, except in 1987).

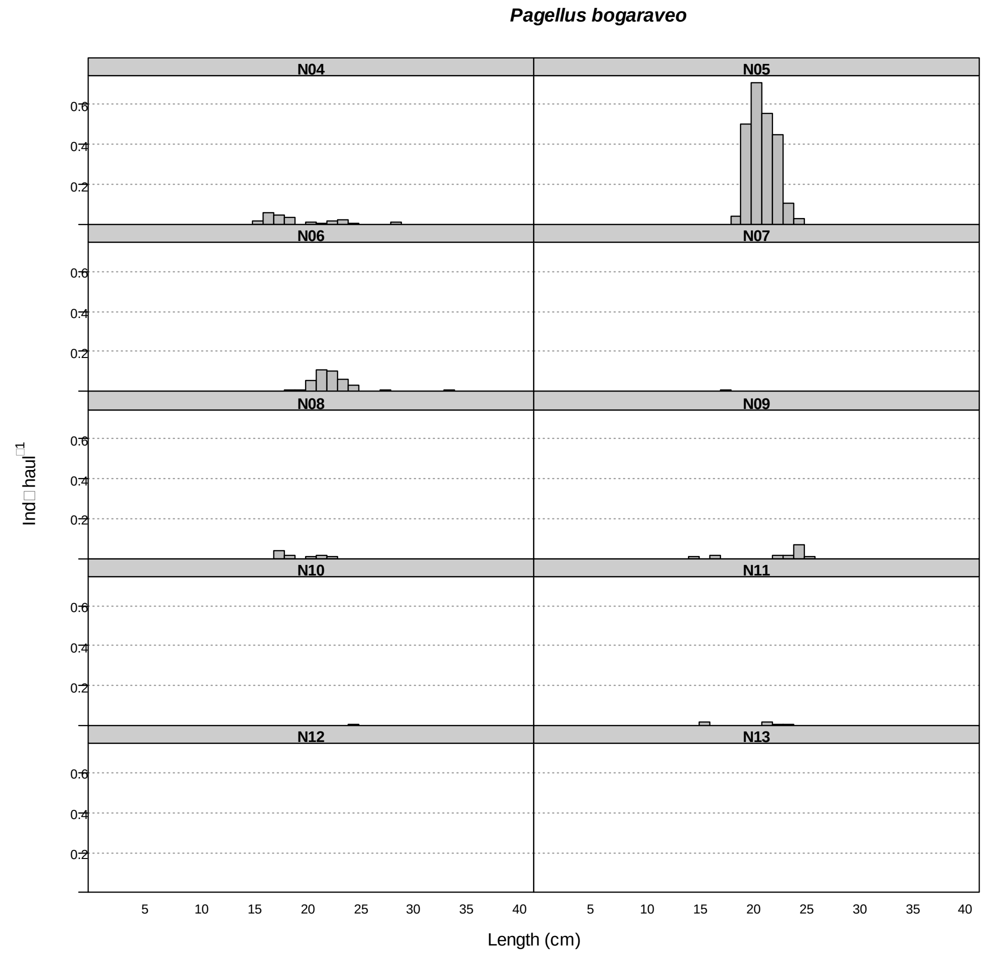

Figure 13.2.3. Mean stratified length distributions of blackspot seabream (*P. bogaraveo*) in Northern Spanish Shelf surveys (2003–2013).

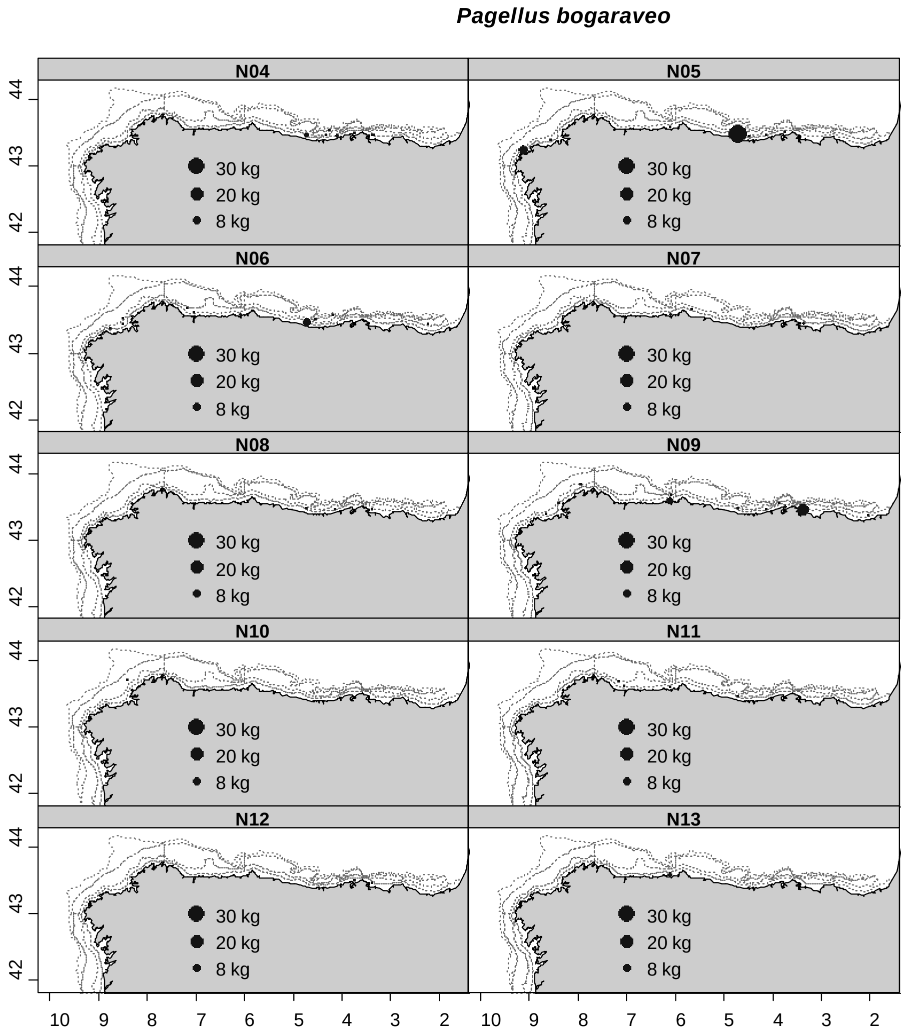

Figure 13.2.4. Catches in biomass of blackspot seabream on the Northern Spanish Shelf bottom-trawl surveys during the last decade: 2003–2013.

13.3 Red (blackspot) seabream (*Pagellus bogaraveo*) in Subarea IX

13.3.1 The fishery

Pagellus bogaraveo is caught by Spanish and Portuguese fleets in Subarea IX. Spanish landings data from this area are available from 1983, Portuguese data from 1988 and Morocco information from 2001 onwards. European landings in Subarea IX; most of them taken with lines-are from Spain (62%) and Portugal (38%) 2011–2013.

An update of the description of the Spanish fishery and the available information, from the southern part of Subarea IX close to the Strait of Gibraltar, has been provided to the Working Group (Gil *et al.*, WD to the WGDEEP 2014). Currently, about 60 Spanish boats are involved in the fishery. The fishing grounds of the Spanish fleet are on both sides of the Strait of Gibraltar and quite close, i.e. mostly less than 20 nmi, to the main ports (Tarifa and Algeciras). Fishing is carried out taking advantage of the coming and going of the tide at depths from 350 to 700 m with "*voracera*" gear, a mechanised handline. Since 2002 other artisanal boats have joined the red (blackspot) seabream fishery from Conil port, although they operate in other fishing grounds and use longlines. Nowadays, this section of the fleet counts about six boats. Landings are sorted into commercial categories due to the wide size range of the catch and size varying prices. These categories have varied with time but from 1999 have remained the same in all ports.

In addition, Moroccan longliners have been fishing in the Strait of Gibraltar area since 2001. Around 102 boats are mainly based in Tangier and their average technical characteristics are: 20 GRT, 160 CV and about ten years old. Moreover, 435 artisanal boats (±15 CV, ≤2 GRT and 4–6 m length) also target this species in the Strait of Gibraltar area (S. Benchoucha, *pers.com*.). The WG considers the account of Moroccan data appropriate as the fishery operates in the same area as the Spanish fishery and obviously targets the same stock. Unfortunately, no updated information was available in 2014 and no new information from the Moroccan fishery has been received in the last two years.

The majority of deep-water species landings as fresh fish in mainland Portugal correspond to the artisanal fleet, which uses mainly longlines (I. Figueiredo, *pers. com*.).

13.3.2 Landing trends

The maximum catch in this period was obtained in 1993–1994 and 1997 (about 1000 t) and the minimum (180 t) in the most recent year, 2013 (Figure and Table 13.3.1).

13.3.3 Advice

The ICES advice for 2013 and 2014was: “no increase in effort and that catches should be no more than 500 t.”

13.3.4 Management

Since 2003, TAC and Quotas have been applied to the *P. bogaraveo* fishery in Subarea IX. The following table shows a summary of *P. Bogaraveo* TAC in this subarea:

P. bogaraveo	2007-2008		2009-2010		2011-2012		2013-2014	
ICES Subarea	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings
IX	1080	601–718	918–780	718–484	780–780	333–295	780–780	180–

In addition to the TAC for 2011–2012 a minimum landing size of 35 cm (total length) shall be respected. However, 15% of fish landed may have a minimum landing size of at least 30 cm (total length). Furthermore, a maximum of 8% of each quota may be fished in EU and international waters of VI, VII and VIII. Currently, there is no longer a minimum landing size in the TAC regulation. European landings have always been far below the adopted TACs although these have been reduced over years.

13.3.5 Stock identity

Several tagging surveys (56 days at sea in 2001, 2002, 2004, 2006 and 2008) have been conducted in the Strait of Gibraltar area. 4500 fish were tagged and 404 recaptures have been reported. No significant movements have been observed, although local migrations were noted: feeding grounds are distributed along the entire Strait of Gibraltar and the species seems to remain within this area as a resident population (Gil, 2006). Recaptures of tagged fish have also been reported by the Moroccan fishery.

13.3.6 Data available

13.3.6.1 Landings and discards

Historical landing dataseries available to the Working Group are described in Section 13.3.1 and detailed in Figure 13.3.1. Portuguese and Spanish discard information was available to the Working Group from on-board sampling programme (EU DCF/NP). For this species discards can be assumed to be zero or negligible for most assessment purposes and are mainly related to catches of small individuals. Therefore for this stock all catches are assumed to be landed.

13.3.6.2 Length compositions

Length frequencies of landings are only available for the Spanish "*voracera*" red (blackspot) seabream fishery in the Strait of Gibraltar (1983–2013). Figure 13.3.2 show the updated length distribution data (from Gil *et al.*, WD to the WGDEEP 2014). The table below shows the mean and median landed size since 1990:

Year	Mean	Median	Year	Mean	Median
1990	38.9	39	2002	38.6	38
1991	40.4	40	2003	38.9	38
1992	40.6	40	2004	37.1	35
1993	40.5	40	2005	37.3	35
1994	40.4	40	2006	36.4	35
1995	37.2	36	2007	37.8	36
1996	37.2	35	2008	38.3	36
1997	36.5	35	2009	38.8	37
1998	34.8	34	2010	36.6	35
1999	36.7	36	2011	36.8	34
2000	37.3	36	2012	36.9	35
2001	37.6	37	2013	35.3	34

Only one mean value (in 1998) is lower than the last year´s mean landing size. Median values are well below the mean in recent years.

13.3.6.3 Age compositions

Age and growth based on otolith readings were revised along the ICES WKAMDEEP meeting (October, 2013): No more than ten years of age was estimated from otolith readings in the Strait of Gibraltar area but two recaptures from the tag–recapture programme have remained at sea for more than ten years. Moreover, growth estimates from tag–recapture experiments suggest that otolith readings may underestimate age and that some hyaline rings are uncounted and/or missing. The use of biased age estimates may have important consequences.

13.3.6.4 Weight-at-age

No new information was presented to the group.

13.3.6.5 Maturity and natural mortality

No new information was presented to the group.

13.3.6.6 Catch, effort and research vessel data

Figure 13.3.3 shows the spatial information from VMS analysis of the "*voracera*" fleet. Filtering process, lpue and missing effort estimates are described in Burgos *et al.* (2013). Effort allocation was concentred in certain fishing grounds, both sides of the Strait of Gibraltar.

Figure 13.3.4 presents lpue information, available only for the Strait of Gibraltar fishery (Gil *et al.*, WD to the WGDEEP 2014). Effort, as indicated, from sales sheets is not standardized and may be underestimated in some years because the effort unit chosen may be inappropriate. However, the recent lpue decrease, even overestimated, shows a clear decline which is quite consistent with recent landings. Moreover, 2009–2013 lpue estimated from VMS analysis shows lower values but the same decreasing trend.

13.3.7 Data analyses

In Figure 13.3.1 the trend is fairly clear; despite Moroccan landings from the Strait of Gibraltar are not available in the years 2012 and 2013. It is however assumed that these landings follow a decreasing trend. Landings have declined significantly over the last four years and may be considered as a substantial reduction in exploitable biomass. Mean length distribution and lpue decreasing trends may also be consistent with overexploited population signals.

13.3.8 Comments on the assessment

No analytical assessment was attempted at the meeting. Results from gadget exploratory analysis that was presented should be considered preliminary as the model needs a better parameterization (see ToR e).

13.3.9 Management considerations

A regime of TAC (780 t) was established for 2013 and 2014 for whole Subarea IX. Recent landings are far below the TAC level.

The Group recommends the adoption of a harmonized minimum landing size and that catches should be no more than 115 t for the whole Subarea IX. The recommended catch is based upon DLS method 3.2, where Cy+1 was taken as Cy-1 instead of the mean of the three last years, because a steep decline in the catch and in the index occurred in the three last years. Applying the 20% Uncertainty Cap and the 20% Precautionary Buffer to the 180 t catch in 2013 results in the recommended catch for 2015. Also WGDEEP advises the re-establishment of a recovery plan for the Strait of Gibraltar fisheries: crucial to its success is the involvement of non-EU countries (primarily Morocco).

Table 13.3.1. Red (blackspot) seabream (*Pagellus bogaraveo*) in Subarea IX: Working Group estimates of landings (in tonnes). Spanish landings from 2012 are official statistics.

Year	Portugal	Spain	Morocco	Unallocated	TOTAL
1983		101			101
1984		166			166
1985		196			196
1986		225			225
1987		296			296
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	18		392
2002	111	248	35		394
2003	142	329	23		494
2004	183	297	33		514
2005	129	365	39		533
2006	104	440	74		618
2007	185	407	89		681
2008	158	443	76		677
2009	124	594	98		817
2010	105	379	146		630
2011	74	259	154		487
2012	143	60	n/a	92	295
2013	90	90	n/a		180

Table 13.3.2. Spanish "*voracera*" red (blackspot) seabream fishery of the Strait of Gibraltar (ICES Subarea IX): Estimated lpue using sales sheets or VMS data as effort unit(adapted from Gil *et al.*, WD to the 2014 WGDEP).

Year	LPUE	VMS LPUE
1983	78	
1984	76	
1985	71	
1986	61	
1987	76	
1988	73	
1989	89	
1990	77	
1991	70	
1992	86	
1993	85	
1994	94	
1995	60	
1996	104	
1997	77	
1998	61	
1999	55	
2000	45	
2001	56	
2002	47	
2003	53	
2004	47	
2005	68	
2006	70	
2007	51	
2008	52	
2009	67	55
2010	46	38
2011	42	31
2012	35	21
2013	30	14

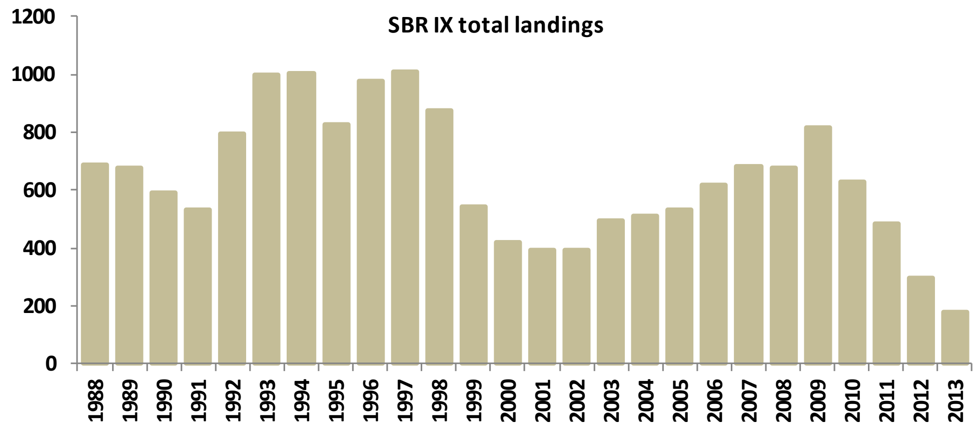

Figure 13.3.1. Red (blackspot) seabream in ICES Subarea IX: Total landings.

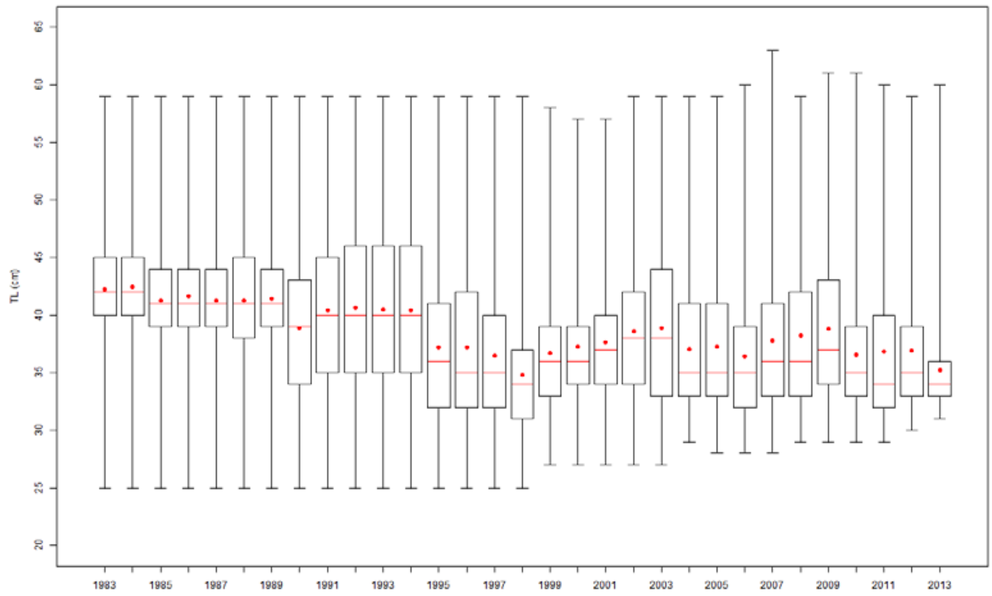

Figure 13.3.2. Spanish "*voracera*" red (blackspot) seabream fishery of the Strait of Gibraltar (ICES Subarea IX): 1983–2012 landings mean length distribution (from Gil *et al.*, WD to the 2014 WGDEEP).

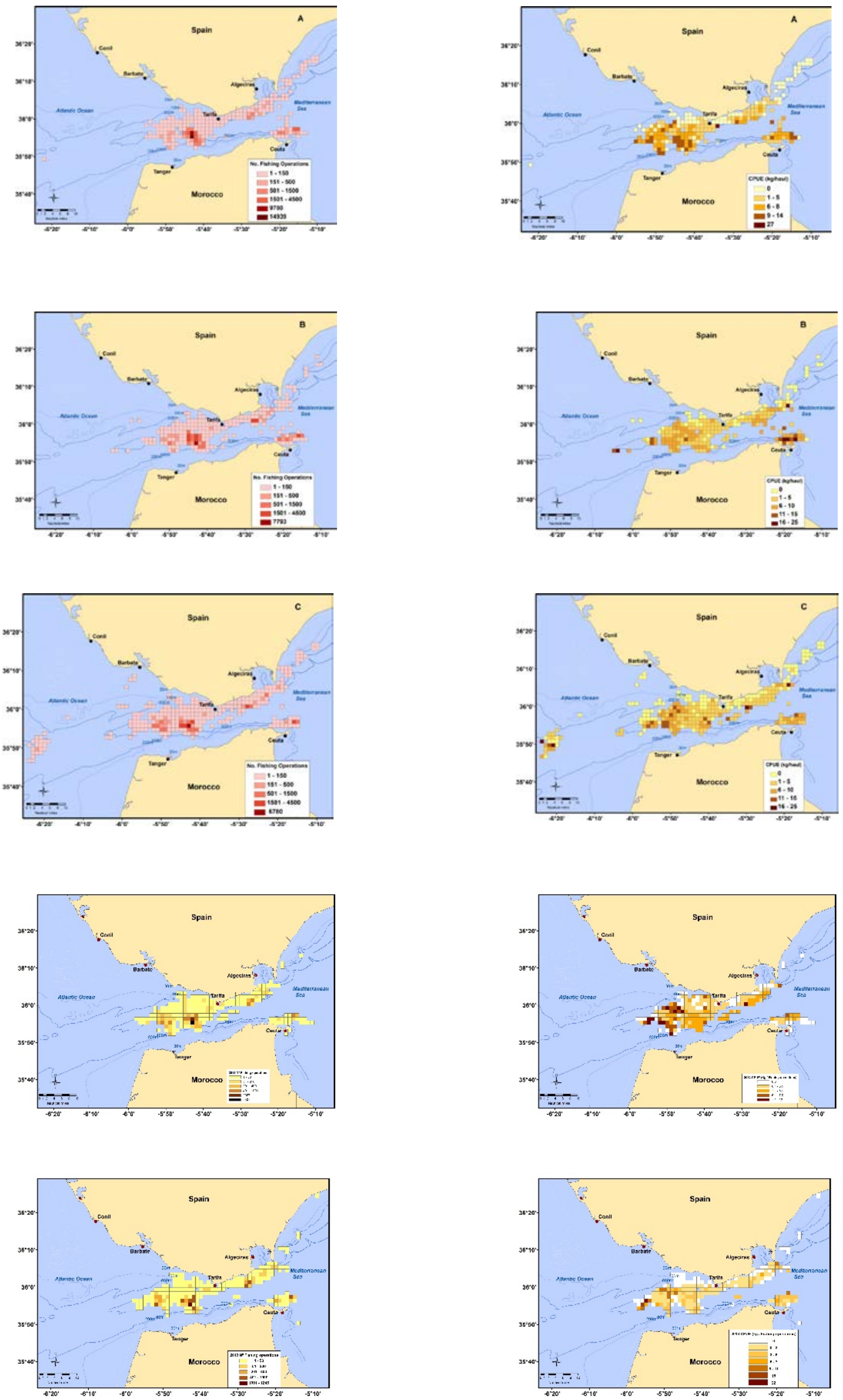

Figure 13.3.3. Spanish "*voracera*" red (blackspot) seabream fishery of the Strait of Gibraltar (ICES Subarea IX): Estimated number of fishing operations (hauls) by 1 nm² cells from SLSEPA data (left column) and spatial distribution of the estimated lpue in kg/haul (right column). (A) 2009; (B) 2010; (C) 2011; (D) 2012 and (E) 2013. Data from 2009 to 2011 from Burgos *et al.* (2013) and from 2012 and 2013from Gil *et al.* (WD to the 2014 WGDEEP).

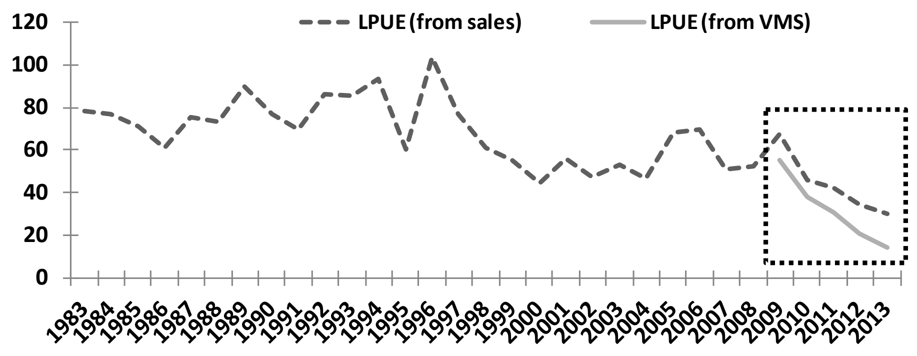

Figure 13.3.4. Spanish "*voracera*" red (blackspot) seabream fishery of the Strait of Gibraltar (ICES Subarea IX): Estimated lpue using sales sheets (dashed line) and VMS data as unit of effort (continued line) (adapted from Gil *et al.* WD to the 2014 WGDEP).

References

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Gil, J. 2006. Biología y pesca del voraz [*Pagellus bogaraveo* (Brünnich, 1768)] en el Estrecho de Gibraltar. Tesis Doctoral, Universidad de Cádiz (UCA, Spain).

Gil, J., C. Farias, C. Burgos, J. J. Acosta and J. Canoura. 2014. The red seabream fishery in the Strait of Gibraltar: an update of the available information. Working Document to the 2014 ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP).

13.4 Red (blackspot) seabream (*Pagellus bogaraveo*) in Division Xa

13.4.1 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 juveniles are also caught by the recreational rod and reel fishery and coastal pelagic fishery as live bait (WD06, WGDEEP 2012).

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.

13.4.2 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 13.4.1), 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). Between 1990 and 2009 the annual landings have fluctuated around 1000 t, with a peak in 2005. During the last four years (2010–2013) the landings decreased significantly to an average of 654 t which correspond to about 59% of the TAC during that period. In general a continuous decrease has been observed since 2005.

13.4.3 ICES Advice

The ICES advice for 2013 and 2014 is: "Catches should be no more than 400 tonnes."

13.4.4 Management

Under the European Union Common Fisheries policy a TAC was introduced in 2003 (EC. Reg. 2340/2002). TACs and landings are given below.

	Reg (CE) Nº. 2015/2006				Reg (CE) Nº. 1359/2008			
P. bogaraveo	**2007**		**2008**		**2009**		**2010**	
ICES Sub-Area	**TAC**	**Landings**	**TAC**	**Landings**	**TAC**	**Landings**	**TAC**	**Landings**
Xa2	**1136**	**1070**	**1136**	**1089**	**1136**	**1042**	**1136**	**687**
	Reg (CE) Nº. 1225/2010				Reg (CE) Nº. 1262/2012			
P. bogaraveo	**2011**		**2012**		**2013**		**2014**	
ICES Sub-Area	**TAC**	**Landings**	**TAC**	**Landings**	**TAC**	**Landings**	**TAC**	**Landings**
Xa2	1136	624	1136	613	1022	692	920	

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 until 2016 to allow a multidisciplinary research (ecological, oceanography and geological).

13.4.5 Data available

13.4.5.1 Landings and discards

Total annual landings data are available since 1980. However, detailed and precise landing data are available for the assessment since 1990 (WD Pinho *et al.*, 2013). Landings from Area Xa2 are presented in the Table 14.2.1 and Figure 14.2.1.

Information on the discards in the longline fishery has been collected in the Azores by a team of observers on board the longline fleet. This information was presented during the 2012 meeting and updated (WD, Pinho, 2014). On average about0,6% of blackspot sea bream was discarded annually on sampled trips between 2004 and 2011.

13.4.5.2 Length compositions

Length composition data of the catch of the fishery is available for the period 1990 to 2012. However data from 1990 to 1994 is based on low sampling coverage and so are not presented here. Data for subsequent years are presented in Figure 13.4.2.

Length compositions are similar to those from surveys (Figure 13.4.3) with a mode around 25–28 cm. Large quantities of adult individuals greater than 40 cm are observed in the fishery for the years 1999, 2002 and 2005 decreasing thereafter. This increase may relate to catchability factors or due to an expansion of the fishery to offshore areas and deeper depth strata.

13.4.5.3 Age compositions

The information is available from the fishery and surveys but no new information was presented to the group because there are no relevant changes on the biology of the species.

13.4.5.4 Weight-at-age

No new information was presented to the group because there are no relevant changes on the biology of the species.

13.4.5.5 Maturity, sex-ratio and natural mortality

Maturity and sex-ratio data were updated in accordance with the methods outlined in the stock annex.

13.4.5.6 Catch, effort and research vessel data

Standardized fishery cpue was not updated. Available information from last year is resumed on the Figure 13.4.4. Catch rates for the period 1990–2010 were estimated using a Generalized Linear Mixed modelling approach assuming a delta-lognormal error distribution. The explanatory variables considered for standardization comprise geographical area, season, vessel category and port of fishing operation.

Survey data were updated accordance the methods in the stock annex (WD, Pinho, 2014).

13.4.6 Data analyses

The fishery cpue has been variable but shows no overall trend (Table 13.4.2; Figure no. 13.4.4). In recent years, the cpue appears to have shown a declining trend from a high point in 2005 with current cpue around the lowest observed level. This coincides with a declining trend in landings over the same period.

The Azorean bottom longline survey targeting *Pagellus bogaraveo* is reliable for abundance estimates, since the survey design is adapted to the stock behaviour covering most of the species habitat (with exception of seamounts around Mid-Atlantic Ridge) (Table 13.4.3). Survey indices from 1995 to 2013 show no trend with a high value every three years until 2005 (Figure 13.4.5). 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), reproduction (protandric forming spawning aggregations) of the species or due to environmental effects. However, the last four years of the survey abundance indices are on the range of lowest values with a decrease trend. This period correspond to the lowest catch observed during the last 19 years being on average 60% of the precedent years (1995–2009) (Figure

13.4.1).Survey abundance indices of mature and immature follows the same trend of the total abundance estimates (Figure 13.4.6).

Annual mean length data from the fishery and from the survey follow a similar trend (Figure 13.4.7). An increase on the mean length by year, with interannual variability, is observed.

Mean length of mature stock for the entire period (1995–2013) is around 37 cm (Figure 13.4.8) and immature about 25 cm (Figure 13.4.9) Mature fish mean length increased from 36 cm in 1995 to 40 cm in 1999 and decreased thereafter until 36 cm. Variance of the estimates is high and no trend is seen on the whole time-series.

No analytical assessment was carried out this year.

13.4.7 Management considerations

TACs should be consistent with catches in recent years.

Table 13.4.1. 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
2011	624	624
2012	613	613
2013	692	692

Table 13.4.2. Standardized bottom longline fishery abundance index (cpue) of the backspot sea-bream (*Pagellus bogaraveo)* in Subarea X.

Year	Nominal cpue	Standardized cPUE	CV
1990	0.895	0.803	0.24
1991	1.063	0.903	0.25
1992	1.610	0.865	0.27
1993	0.753	0.819	0.23
1994	0.963	0.900	0.23
1995	0.892	1.063	0.23
1996	1.181	1.245	0.25
1997	1.213	1.125	0.24
1998	1.073	1.058	0.25
1999	0.734	0.750	0.26
2000	0.549	0.398	0.26
2001	0.794	0.810	0.24
2002	0.943	0.866	0.25
2003	0.842	0.911	0.24
2004	1.058	1.122	0.24
2005	1.400	2.022	0.23
2006	1.092	1.163	0.24
2007	1.194	1.474	0.25
2008	1.010	1.220	0.26
2009	1.217	0.957	0.24
2010	0.523	0.526	0.23

Table 13.4.3. Survey relative abundance index in number of *Pagellus bogaraveo* from the Azores (ICES Area Xa2).

	RPN	CV
1995	127,0	0,10
1996	41,7	0,10
1997	62,1	0,12
1998		
1999	141,5	0,13
2000	68,9	0,12
2001	84,3	0,07
2002	151,9	0,05
2003	97,5	0,10
2004	106,2	0,13
2005	186,7	0,08
2006		
2007	93,2	0,15
2008	101,7	0,09
2009		
2010	80,5	0,10
2011	87,9	0,12
2012	83,80	0,08
2013	61,05	0,11

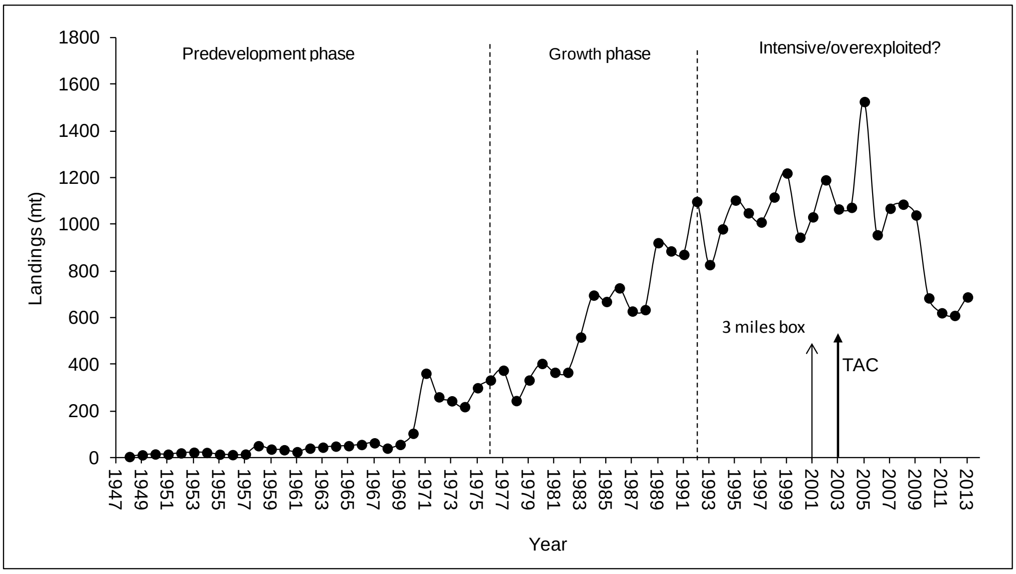

Figure 13.4.1. Historical landings of *Pagellus bogaraveo* from the Azores (ICES Area Xa2). Main technical management measures introduced to the fishery are also shown on the graph.

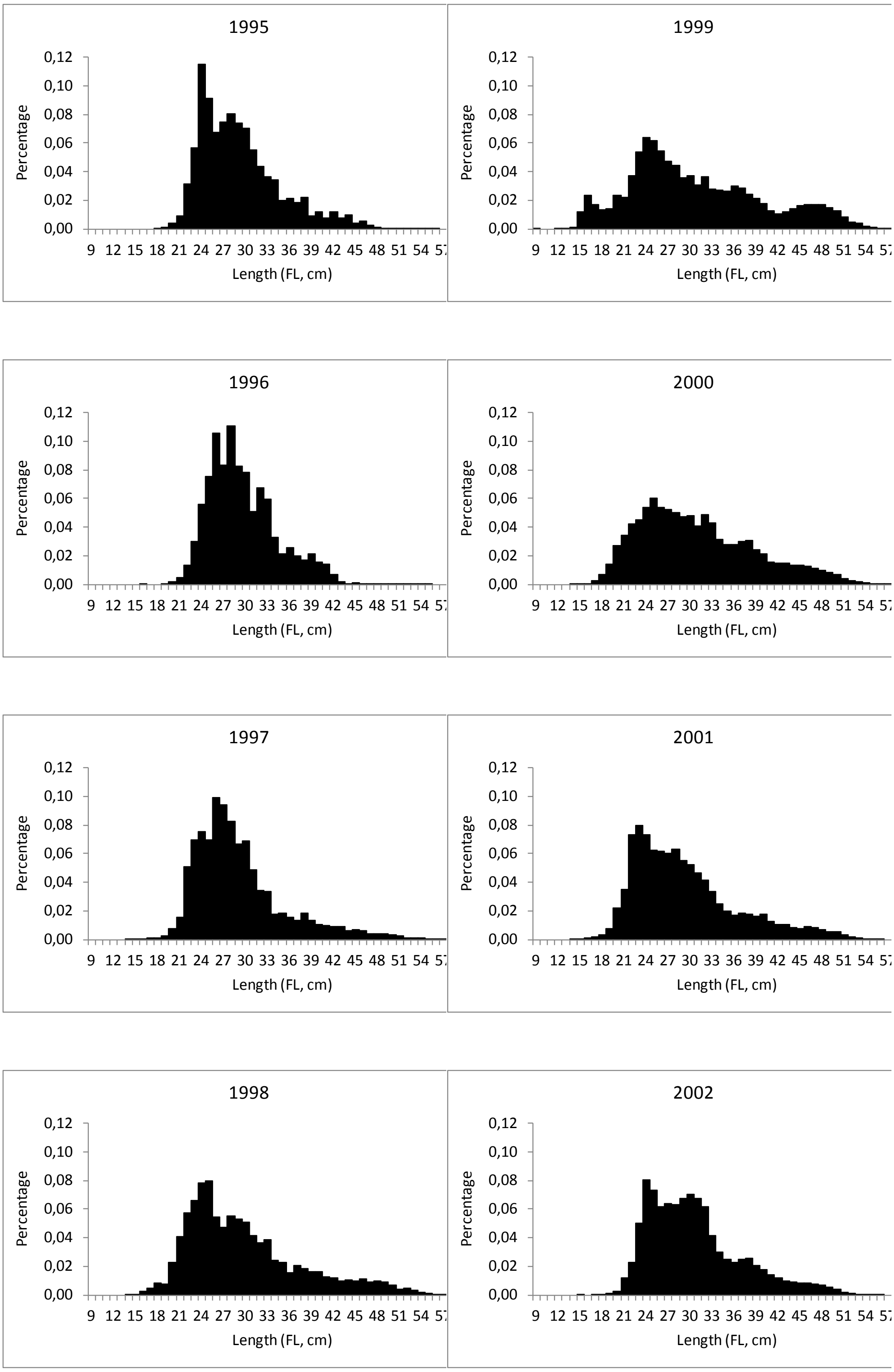

Figure 13.4.2. Annual length composition of *Pagellus bogaraveo* from the fishery for the period 1995–2012 (ICES Area Xa2).

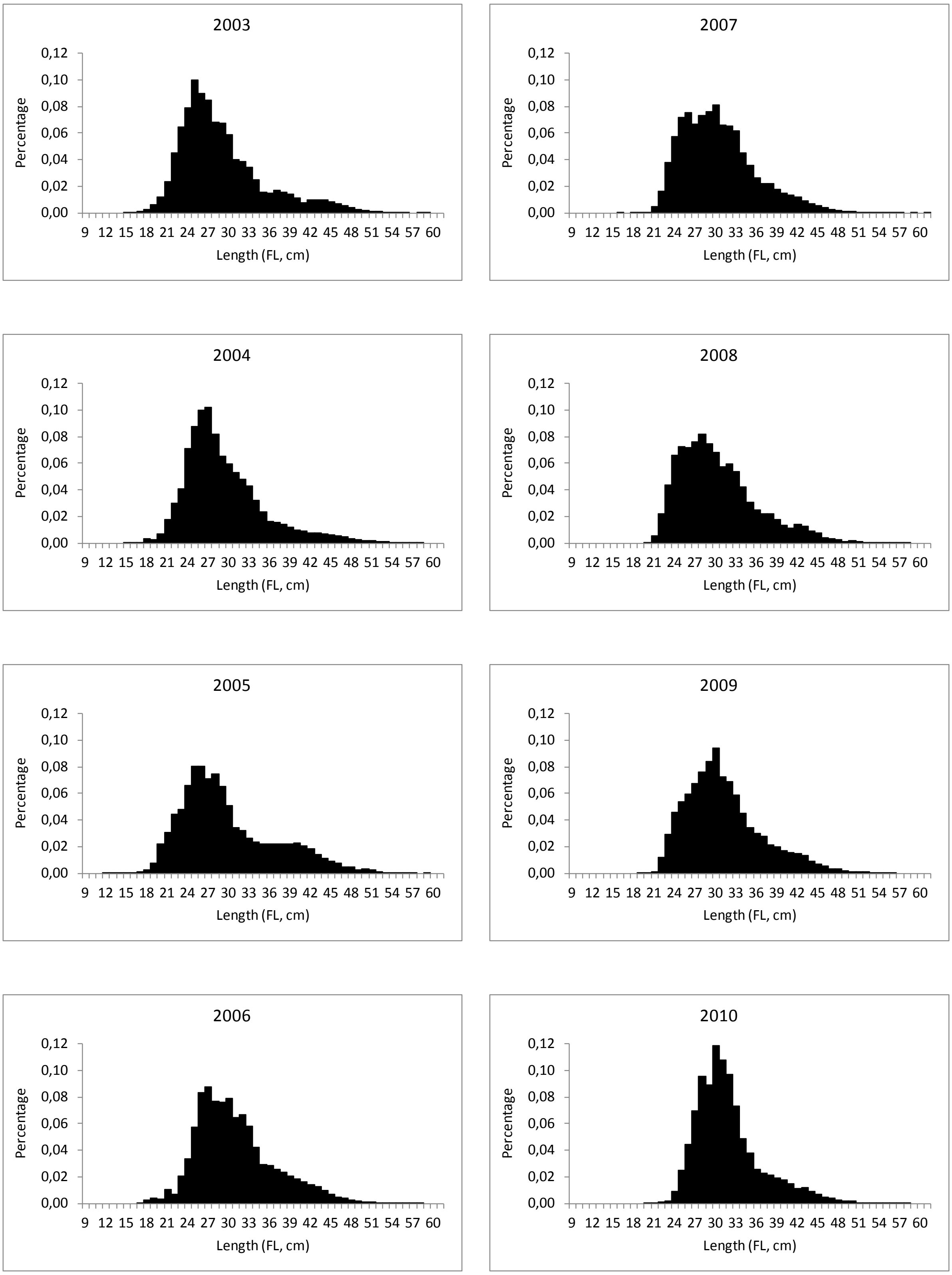

Figure 13.4.2. (Cont.). Annual length composition of *Pagellus bogaraveo* from the fishery for the period 1990–2012 (ICES Area Xa2).

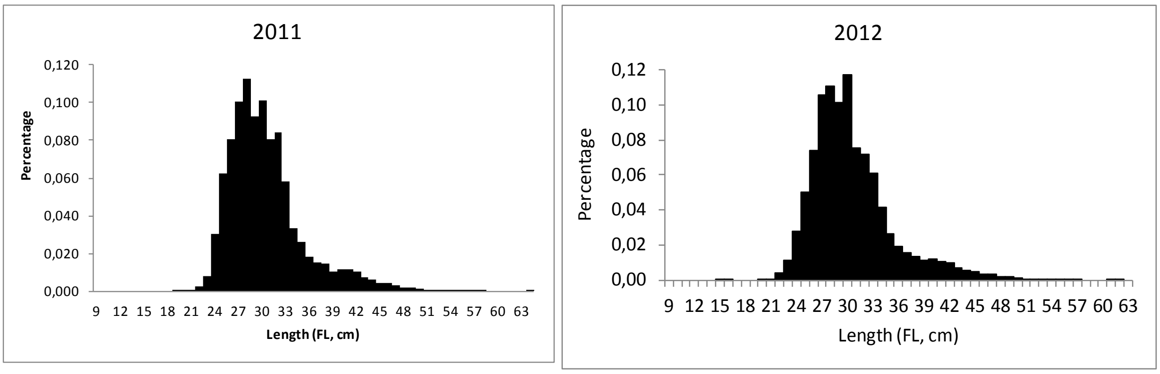

Figure 13.4.2. (Cont.) Annual length composition of *Pagellus bogaraveo* from the fishery for the period 1990–2012 (ICES Area Xa2).

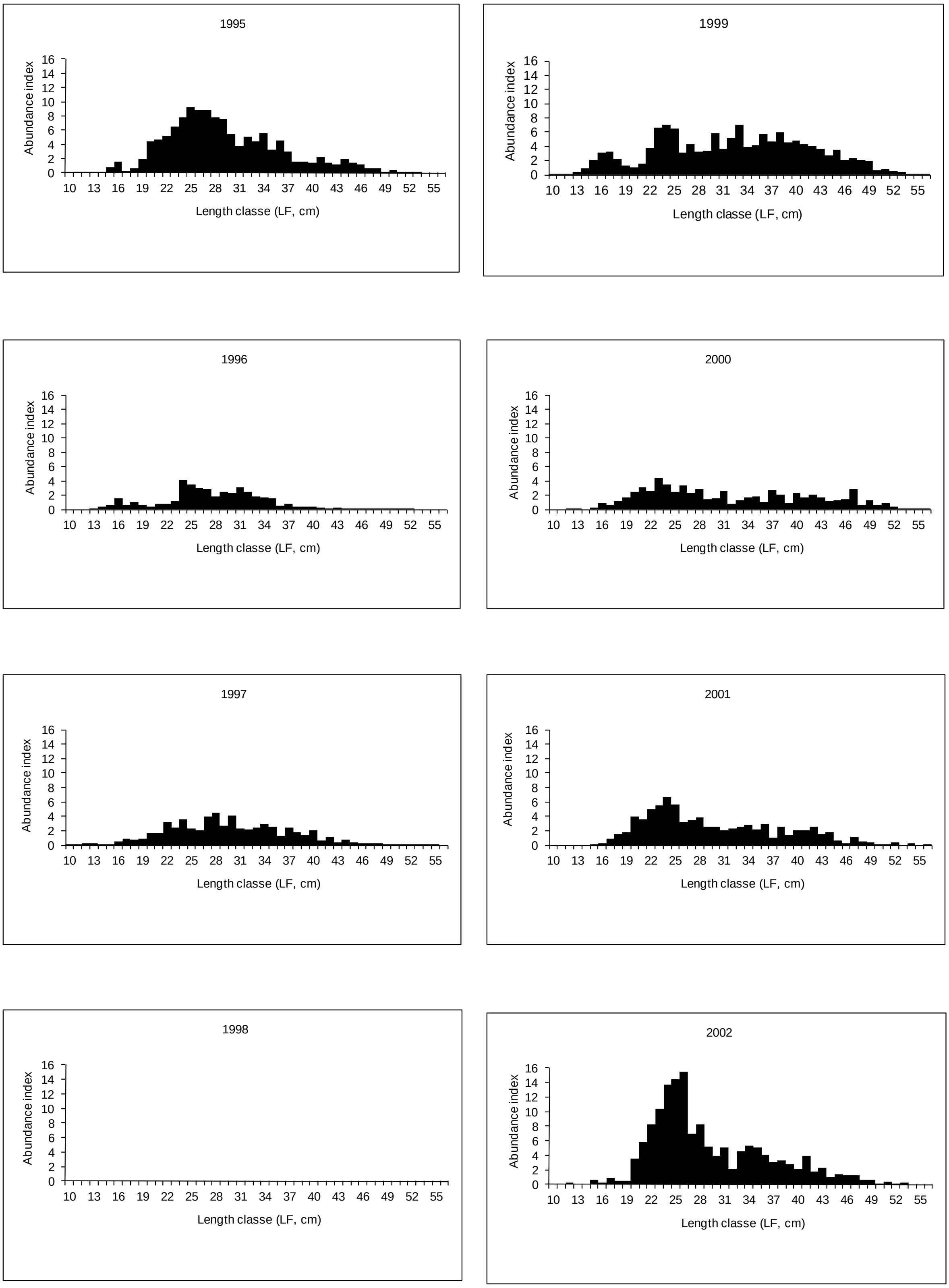

Figure 13.4.3. Annual length composition of *Pagellus bogaraveo* from the Azorean spring bottom longline survey for the period 1995–2003 (ICES Area Xa2).

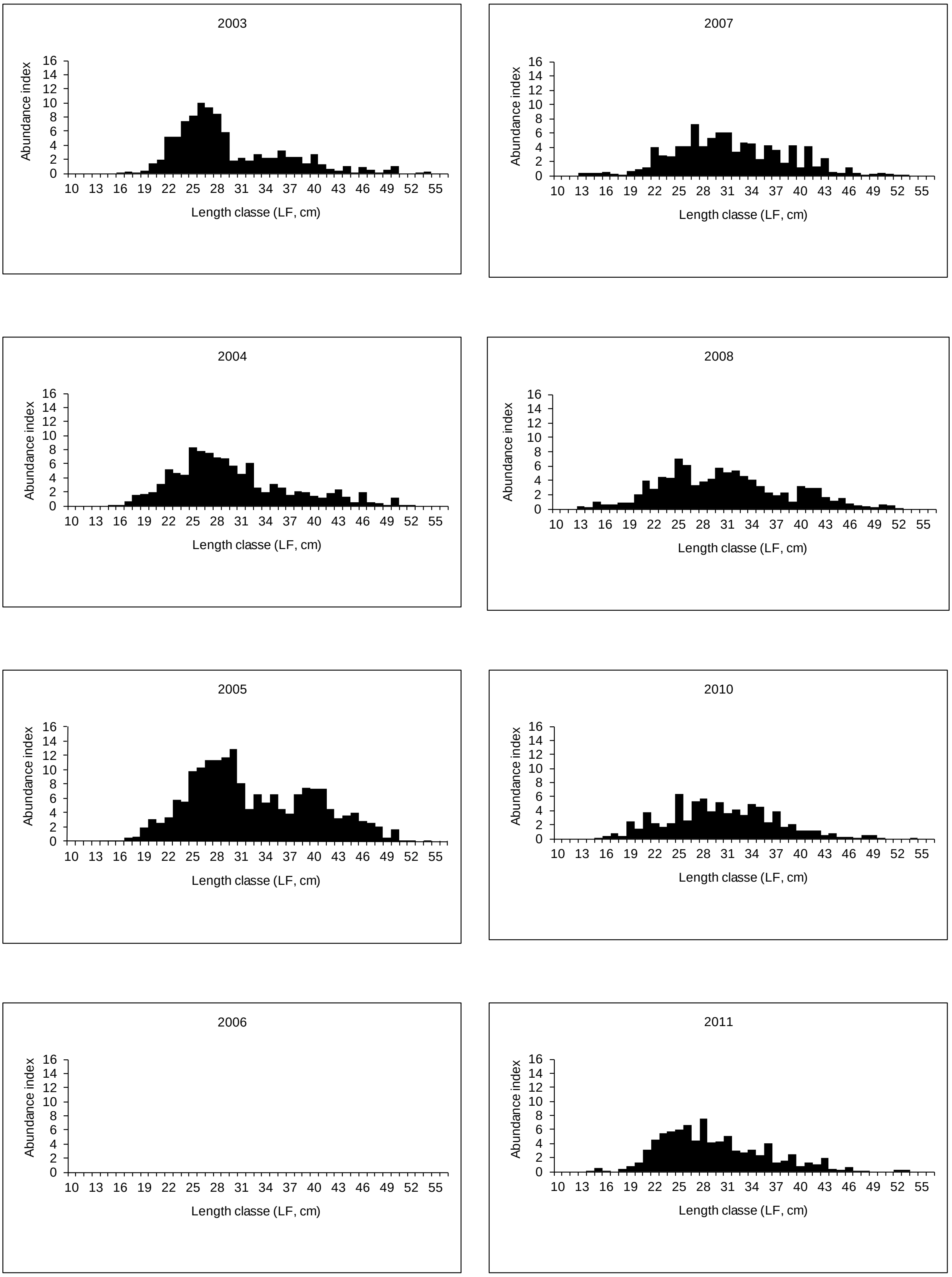

Figure 13.4.3. (Con't). Annual length composition of *Pagellus bogaraveo* from the Azorean spring bottom longline survey for the period 2003–2013 (ICES Area Xa2).

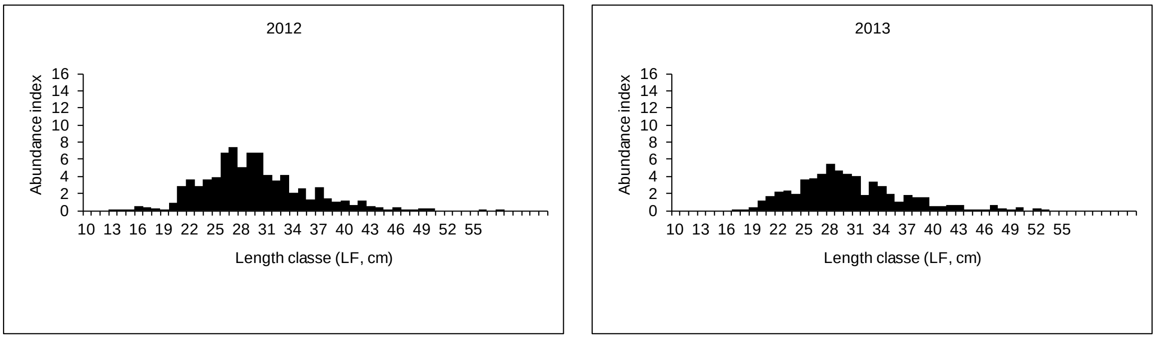

Figure 13.4.3. (Con't) Annual length composition of *Pagellus bogaraveo* from the Azorean spring bottom longline survey for the period 2003–2013 (ICES Area Xa2).

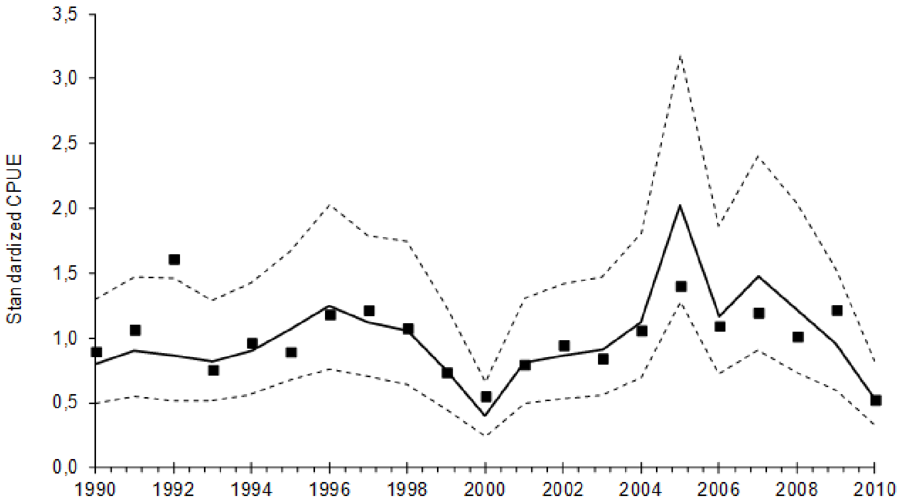

Figure 13.4.4. Standardized fishery catch rates of *Pagellus bogaraveo* from ICES Area Xa2. In the graph are shown the nominal cpue (squares), standardized cpue (solid line) and confidence intervals (dashed line).

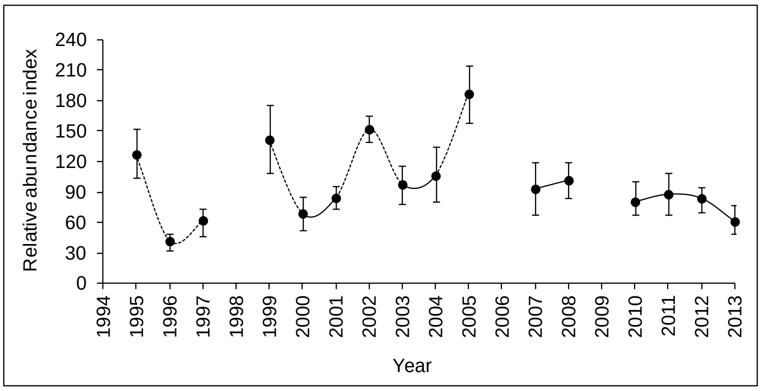

Figure 13.4.5. Annual abundance in number (Relative Population Number) and in weight (Relative Population Weight) of *Pagellus bogaraveo* from surveys for ICES Area Xa2.

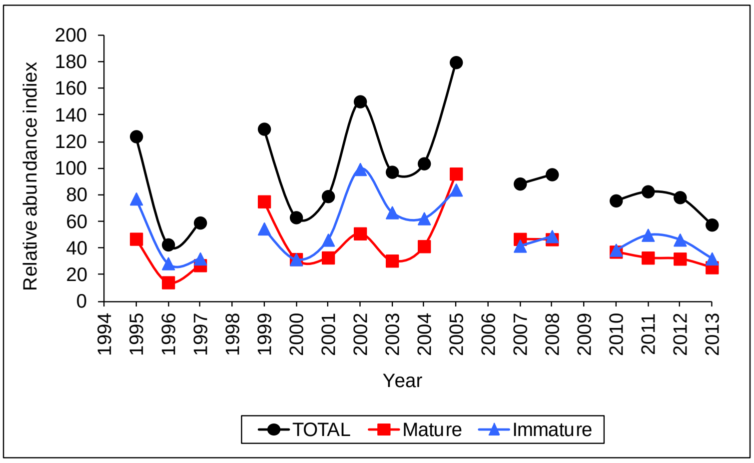

Figure 13.4.6. Survey abundance indices for mature and immature stock.

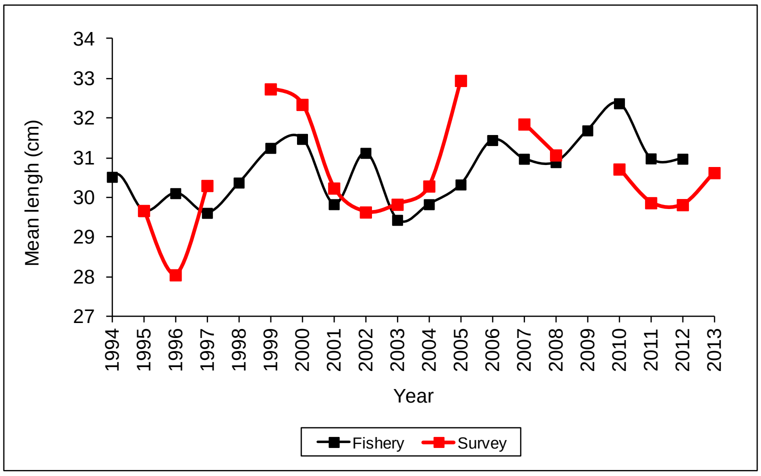

Figure 13.4.7. Annual mean length from the fishery (1990–2010) and from survey length compositions (1995–2008).

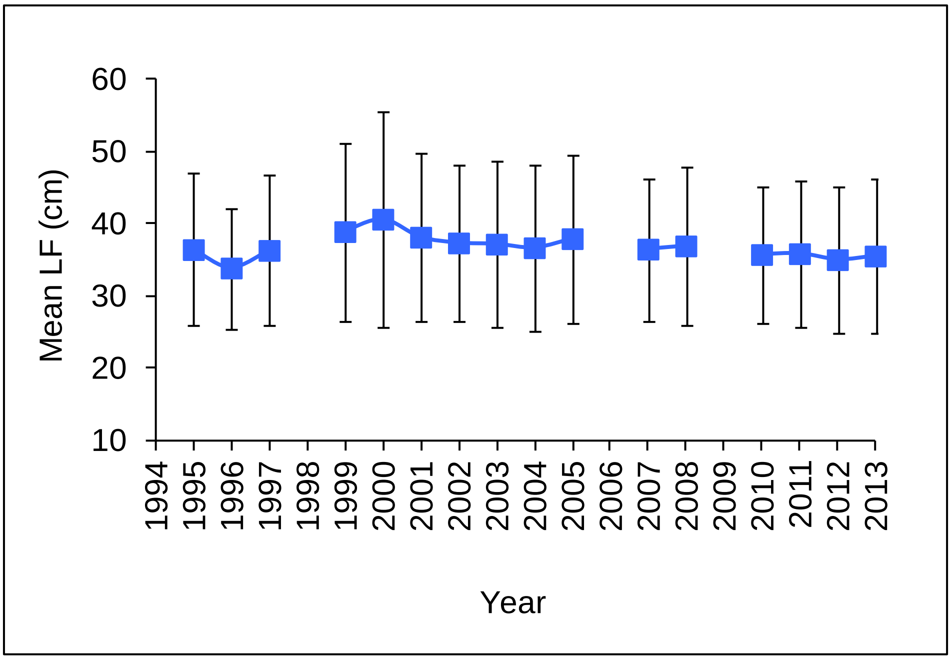

Figure 13.4.8. Annual mean length of mature individuals from the Azorean longline survey.

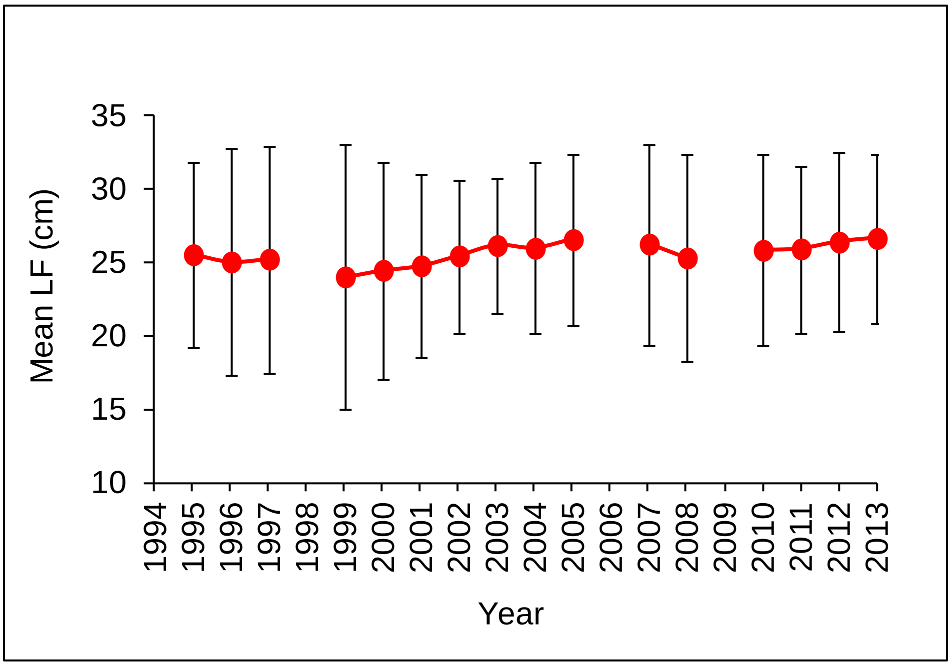

Figure 13.4.9. Annual mean length of immature individuals from the Azorean longline survey.

14 Other deep-water species in the Northeast Atlantic

14.1 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*), blackbelly rosefish (*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. Since 2010, Spanish trawlers have reported significant landings of this species in subarea XIV. Mora, rabbitfish, smoothheads, blackbelly rosefish 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.

Mora, wreckfish, blackbelly rosefish 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 trap fisheries principally in Subareas VI and VII.

14.1.1 Landings trends

Landings are presented in Tables 14.1–14.9. Landings data for 2013 are incomplete due to changes in the way data are reported to the working group. Since 2014, data have been requested through a DCF data-call on a specific list of stocks. Since none of the species covered here were included, many countries did not supply data to the working group. It is expected that the missing data will be updated form STATLANT next year.

14.1.2 ICES Advice

ICES has not previously given specific advice on the management of any of the stocks considered in this chapter.

14.1.3 Management

No TACs 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.

14.2 Stock identity

No information available.

14.3 Data available

14.3.1 Landings and discards

Landings for all of these species are presented in Tables 14.1–14.9.

14.3.2 Length compositions

Length–frequency distributions by year for roughhead grenadier in Norwegian surveys in the northeastern Norwegian Sea (Subareas I and II) are presented in Figure 14.1. Further information on these surveys can be found in Bergstad *et al*., 2014 (WD).

Trends in mean length of blackbelly rosefish, silver scabbardfish, *Mora moro* and wreckfish in Azorean surveys are presented 14.2 to 14.5.

New data on length–frequency distribution for rabbitfish and blackbelly rosefish from Russian bottom-trawl catches on the Rockall Bank and Faroese EEZ are presented in Vinnichenko, 2014 (WD).

14.3.3 Age compositions

No new information.

14.3.4 Weight-at-age

No new information.

14.3.5 Maturity and natural mortality

No new information.

14.3.6 Catch, effort and research vessel data

Trends in abundance of roughhead grenadier in Norwegian surveys in the northeastern Norwegian Sea (Subareas I and II) between 2002 and 2012 are presented in Figure 14.6. Further information on these surveys can be found in Bergstad *et al*., 2014 (WD).

A standardized abundance index for blackbelly rosefish in the Spanish Porcupine Bank Survey from 2001 to 2010 is shown in Figure 14.7. The geographic distribution of catch rates is given in Figure 14.8. These series have not been updated in 2014, but the survey is ongoing and it is expected that they will be updated in future.

Updated abundance indices for blackbelly rosefish silver scabbard, *Mora moro* and wreckfish fish from the Portuguese survey at the Azores are given in Figures 14.9 to 14.12.

14.3.7 Data analysis

The Norwegian survey abundance indices for roughhead grenadier in Norwegian surveys in the northeastern Norwegian Sea (Subareas I and II) showed no significant trend over the period 2002 to 2012. There is also no apparent change in size distribution over this period although there is evidence of relatively large numbers of small individuals in some years which may indicate periodic recruitment.

Standardised abundance indices for blackbelly rosefish in the Spanish Porcupine Bank Survey declined between 2005 and 2008 but have remained stable since then.

The standardized abundance index for blackbelly rosefish in the Azores longline survey shows no continuous trend between 1995 and 2008 but catch rates since 2010 have been low with 2012 being the lowest in the time-series (Figure 14.10). Mean length has declined slightly across the time-series.

The standardized abundance index for silver scabbard fish in the Azores longline survey declined between 1995 and 2000 and has remained at very low levels since then. Mean length has declined across the time-series.

The cpue for wreckfish in the Azores longline survey fluctuated greatly with no overall trend between 1995 and 2008. Since 2010, the level has continuously been very low, with the lowest value in 2013. .Mean length showed no significant trend between 1995 and 2013.

The cpue for *Mora moro* in the Azores longline survey displayed no obvious trend between 1999 and 2008. Since 2010, cpue has been at a considerably lower level. There was been an overall increasing trend in mean length across the time-series.

No data other than landings are available to assess any of the other stocks included in this section. These data are not considered sufficient to assess the status of the stocks.

14.3.8 Comments on the assessment

None.

14.3.9 Management considerations

No advice was required for these stocks this year.

Table 14.1. Working group estimates of landings of roughhead grenadier (t). Data from 2012 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
2011	29	2	21		4		2	264	322
2012	54	1	16	3	195		526	2740	3535
2013	36	1	16	2	181		210	835	1281

Table 14.2. Working group estimates of landings of *Mora moro* and *Moridae* (t). Data from 2012 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
2011		7	86	4	55			152
2012		5	71	1	31			108
2013			99	1	52			152

Table 14.3. Working group estimates of landings of rabbitfish (t) (*Chimaera monstrosa* and *Hydrolagus* spp.) Data from 2012 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
2011	150	7	4	2	88				251
2012	104	17	4	29	475	2	434		1065
2013	103	40	2	30	160	1	56		392

Table 14.4. 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	12 538	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
2011			187	252		252
2012			335	472		472
2013			342	351		693

Table 14.5. Working group estimates of landings of wreckfish (t). Data from 2012 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
2011		150	266	416
2012		256	226	482
2013			209	209

Table 14.6. Working group estimates of landings of blackbelly rosefish (t). Data from 2012 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
2011			6	14	149	231	400
2012		2	22	944	1332	190	2490
2013			2	20		235	275

Table 14.7. Working group estimates of landings of silver scabbardfish (t). Data from 2012 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	3	1039
2007	88	649	55	1	793
2008	40	845	63	0	948
2009	44	898	64	25	1031
2010	32	829	68	43	972
2011		927	148	82	1157
2012	655	36	271	244	1206
2013	200		478	123	801

Table 14.8. Working group estimates of landings of deep-water cardinal fish (t). Data from 2012 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
2011		3	2	128	5		138
2012		16	4	2	4		26
2013		10	1	1	4		16

Table 14.9. 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
2009						0
2010						0
2011						0
2012						0

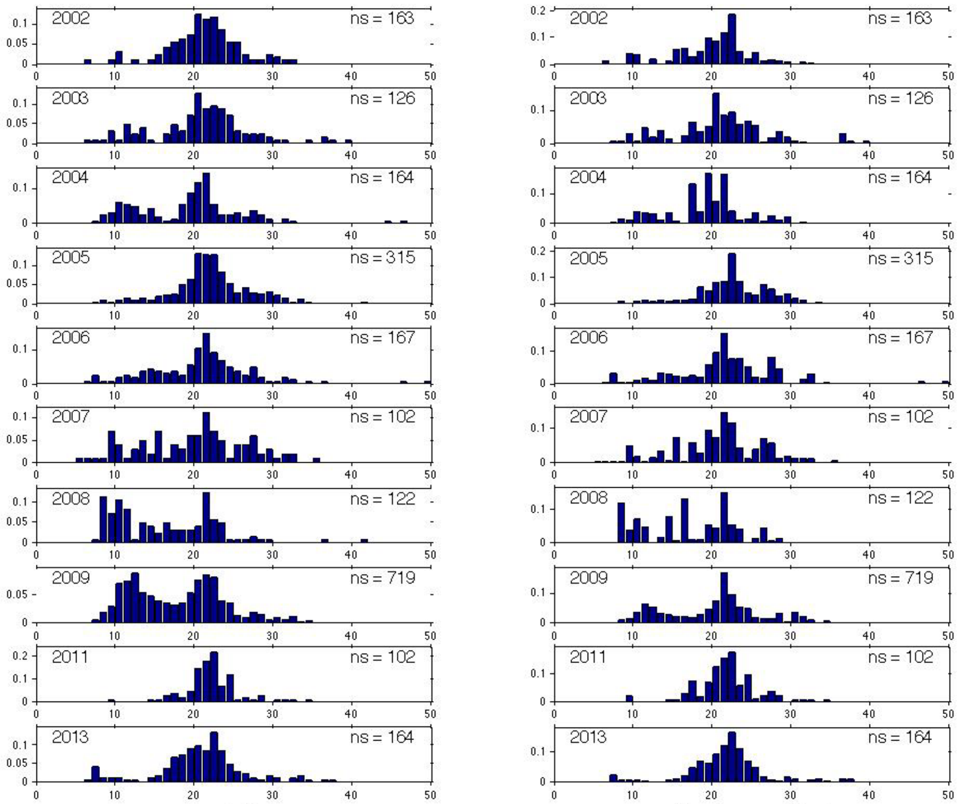

Figure 14.1. Size distributions of roughhead grenadier (PAFL, cm) from the surveys, 2002–2013. Left panel: unweighted, Right panel: weighted with stratum density in numbers.

The Porcupine bank (2001–2011).

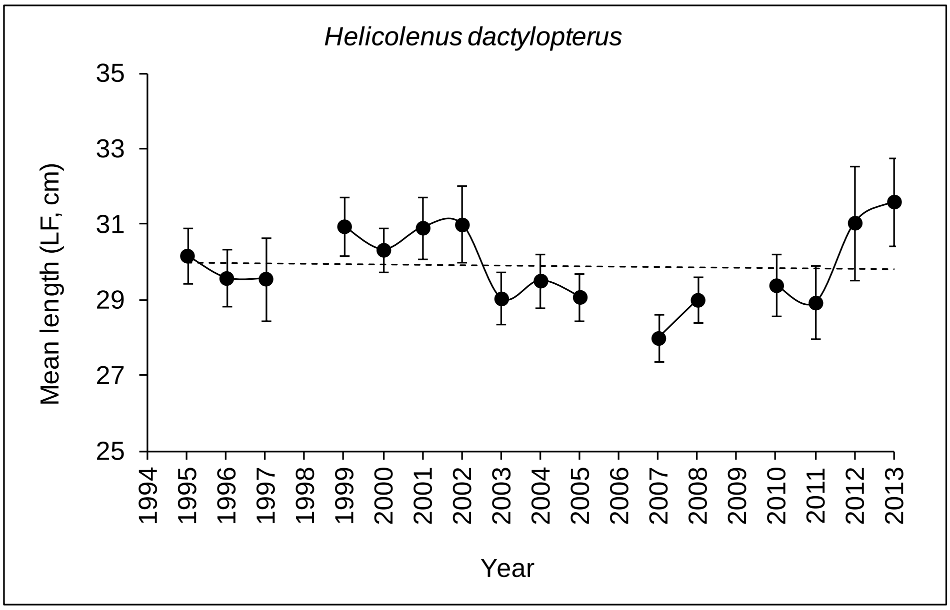

Figure 14.2. Mean length of blackbelly rosefish in Azores bottom longline survey 1995–2013.

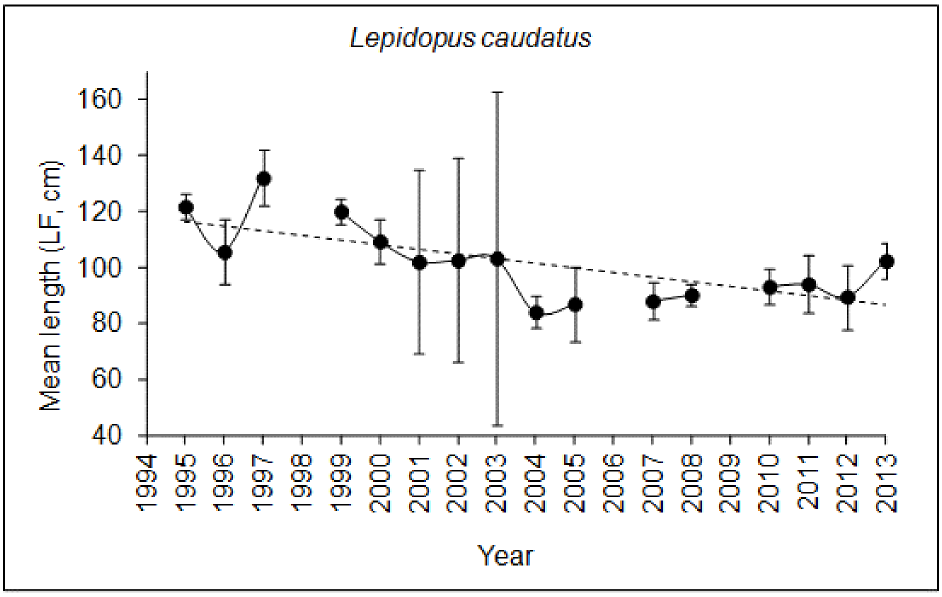

Figure 14.3. Mean length of silver scabbardfish in Azores bottom longline survey 1995–2013.

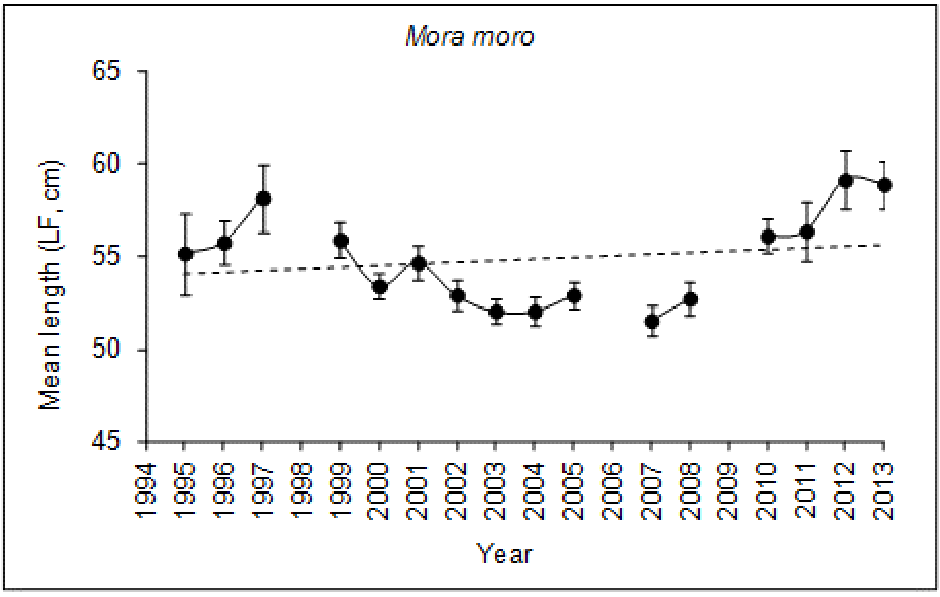

Figure 14.4. Mean length of *Mora moro* in Azores bottom longline survey 1995–2013.

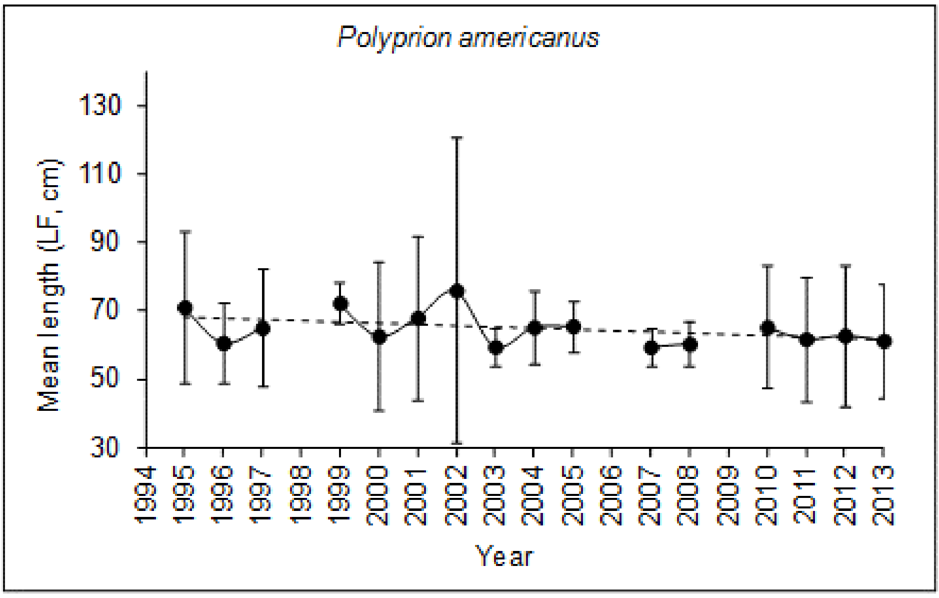

Figure 14.5. Mean length of wreckfish in Azores bottom longline survey 1995–2013.

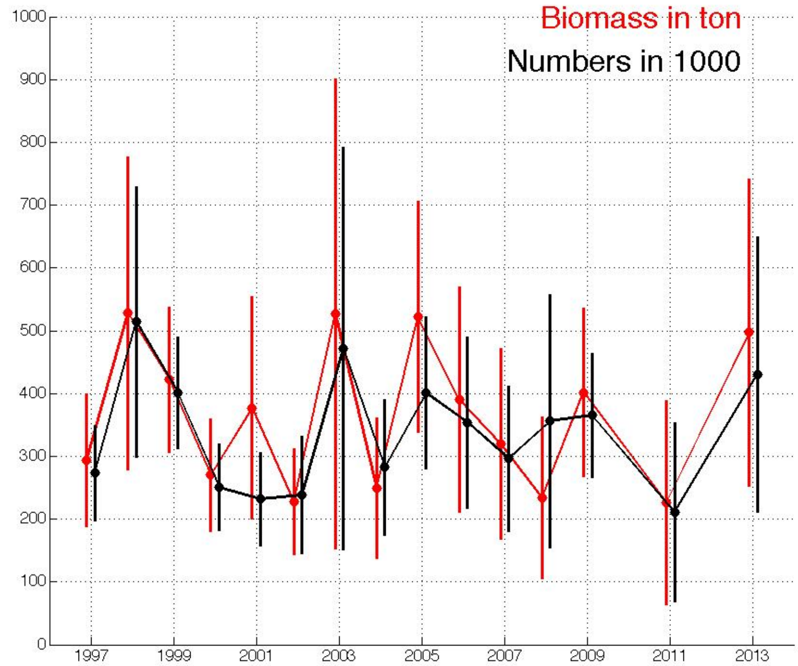

Figure 14.6. Estimates of abundance in numbers (black) and biomass (red) of roughhead grenadier (*Macrourus berglax*) on the shelf edge of the northeastern Norwegian Sea. Error bars show approximate 95% confidence intervals. The same height on the y-axis for the red and black curves is synonymous with a one kg fish. Note that just above 300 at the y-axis the very most of the intervals cover this y-value, indicating no apparent temporal trend.

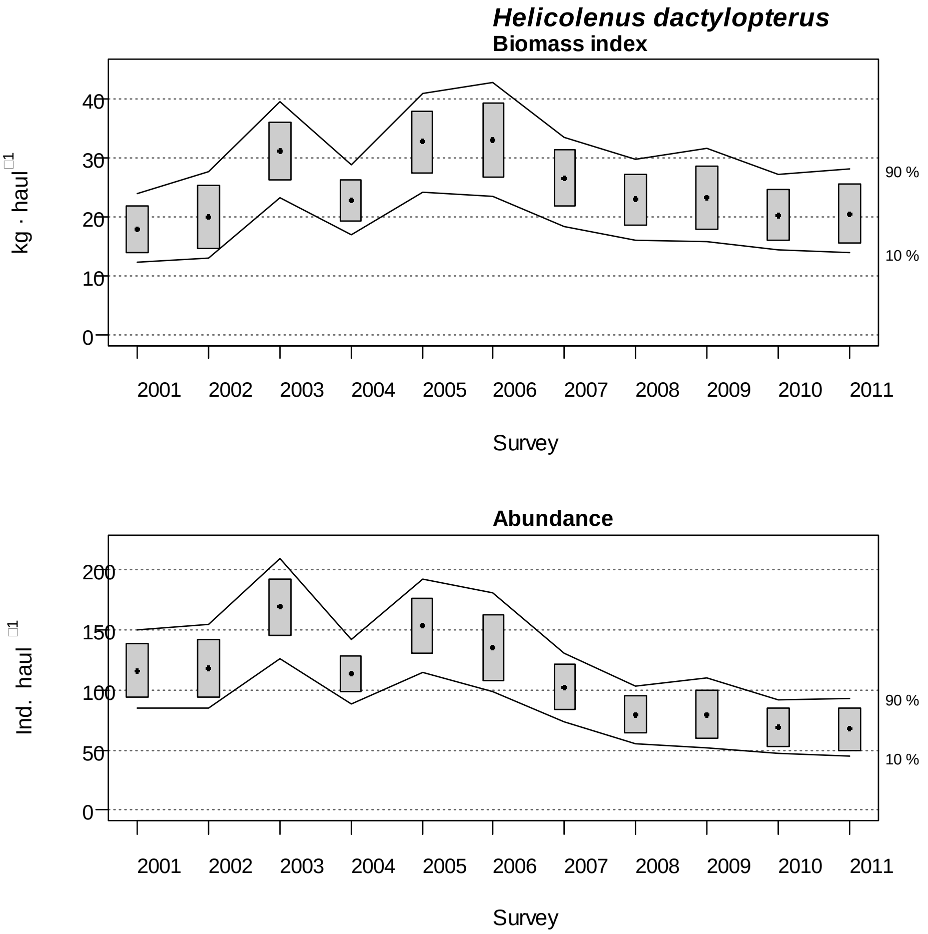

Figure 14.7. Changes in *Helicolenus dactylopterus* biomass and abundance indices during Porcupine Survey time-series (2001–2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

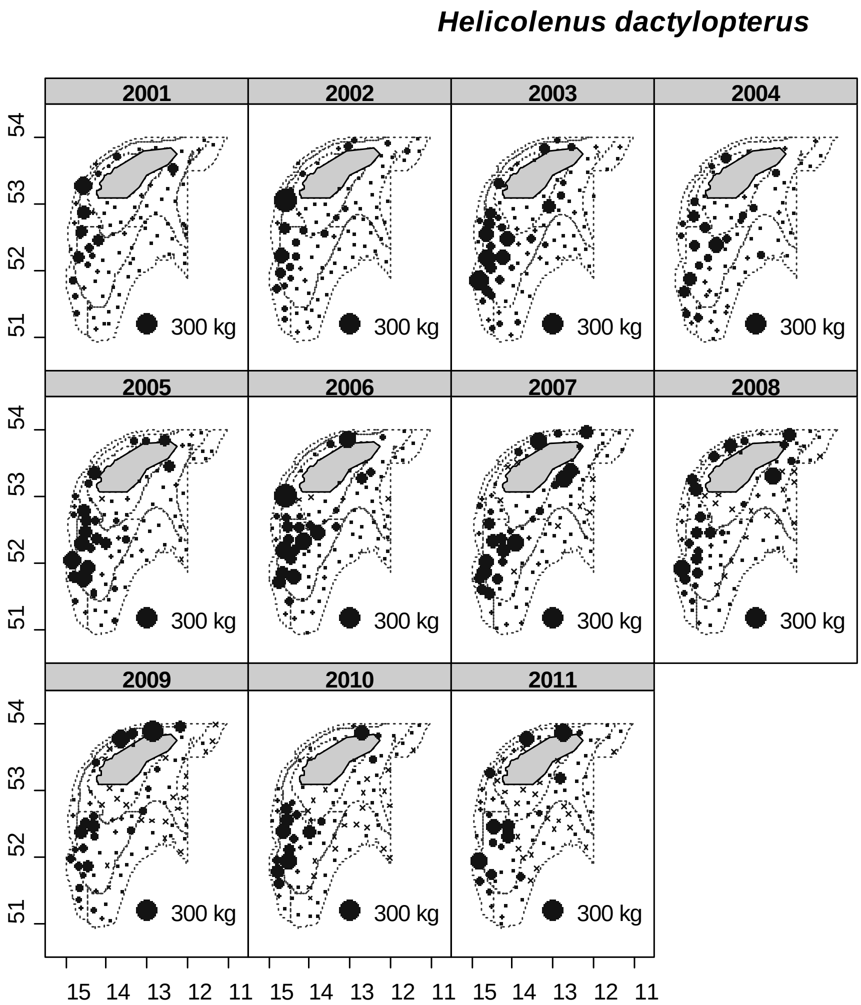

Figure 14.8. Geographic distribution of *Helicolenus dactylopterus* catches (kg/30 min haul) in Porcupine surveys (2001–2011).

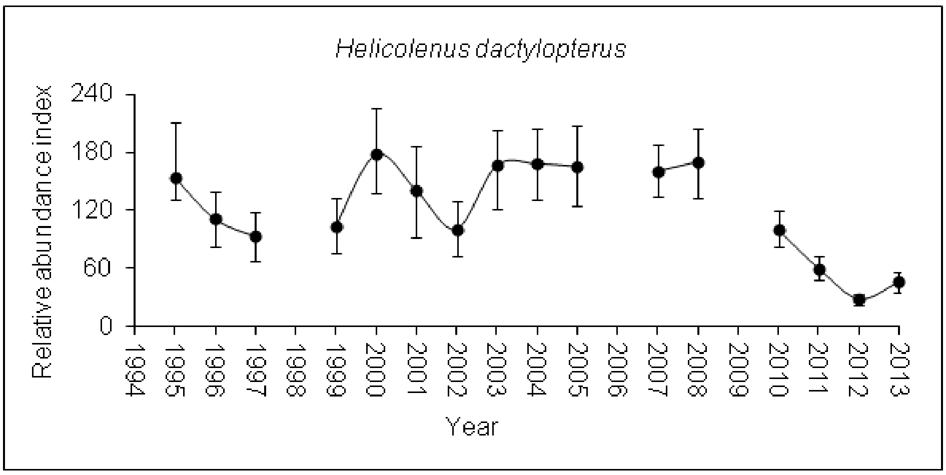

Figure 14.9. Annual bottom longline survey abundance index (number) for blackbelly rosefish in Azorean bottom longline surveys.

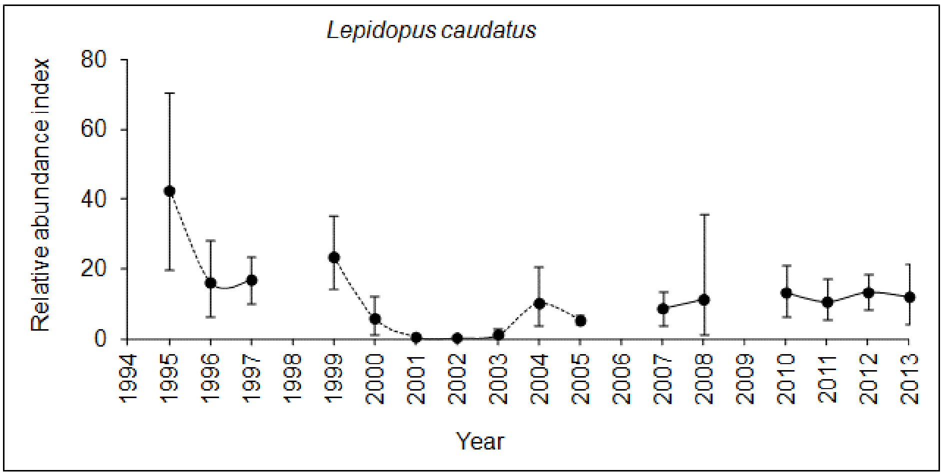

Figure 14.10. Annual bottom longline survey abundance index (numbers) for silver scabbardfish in Azorean bottom longline surveys.

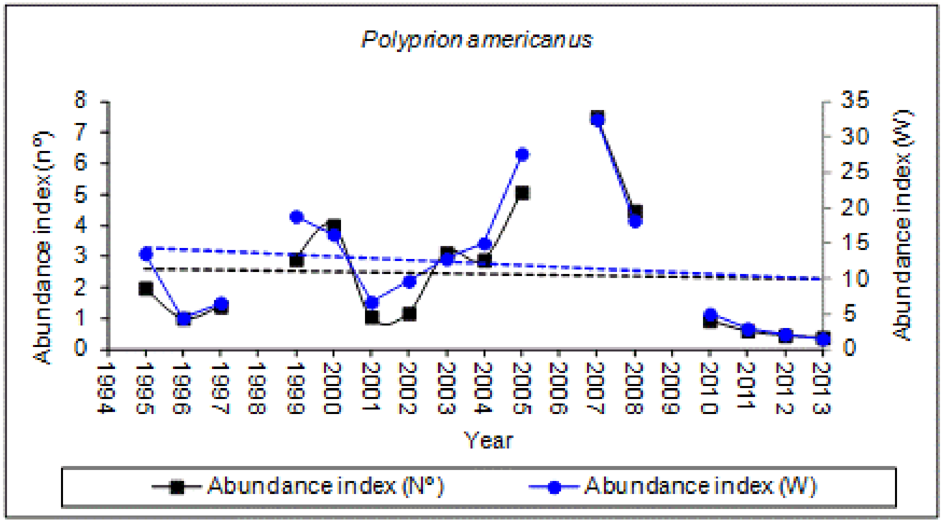

Figure 14.11. Annual bottom longline survey nominal cpue for wreckfish in Azorean bottom longline surveys.

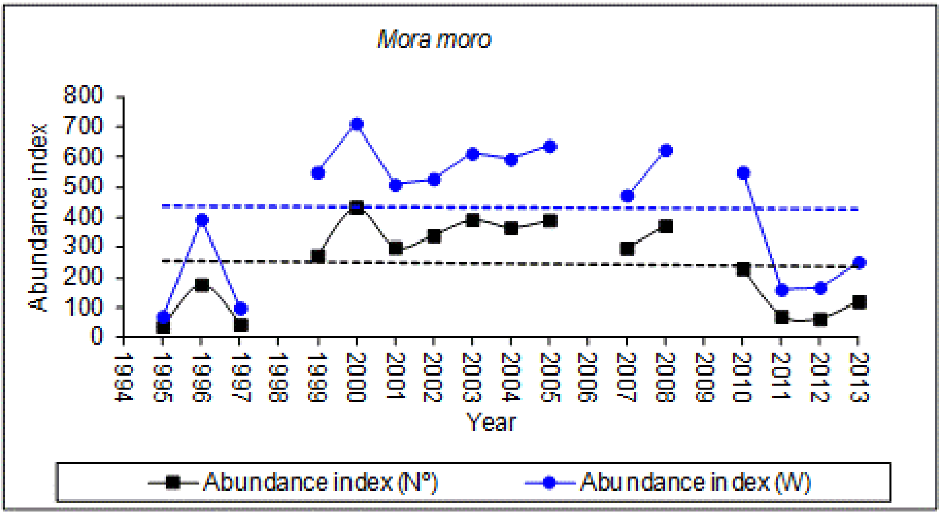

Figure 14.12. Annual bottom longline survey nominal cpue for *Mora moro* in Azorean bottom longline surveys.

15 ToR d) Update the description of deep-water fisheries in both the NEAFC and ICES area(s)

NEAFC request/

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

15.1 Landings in the NEAFC regulatory area

Working group estimates of landings of deep-water species from the NEAFC Regulatory Area are presented in Table 15.1.

Deep-water fisheries in the NEAFC Regulatory Area occurred predominantly in two regions; the Mid-Atlantic ridge (ICES Divisions Xb, XIIa1 XIIc and XIVb1) and the Rockall-Hatton area (Divisions VIb1 and XIIb). Descriptions of fisheries in these areas are given in the area overviews for the Oceanic Northeast Atlantic and Celtic Seas ecoregions (Section 3.4 and 3.7). There are also minor landings from Subdivision Vb1which is an extension of the longline fishery that occurs in the Faroese EEZ into ABNJ. This fishery is described in Section 3.1.

Figure 15.1 to 15.6 show reported landings of roundnose grenadier, black scabbardfish, blue ling, ling tusk and alfonsino in the ICES area by statistical rectangle. Landings were not available at this spatial resolution for all countries: the percentage of landings available by statistical rectangle and the countries for which these data were available are given in the figure captions. In particular, landings data from the Spanish fleet working in Division VIb1, XIIb, and XIVb1 were incomplete (between 5% and 55% of reported landings available by statistical rectangle, depending on species). In some cases, observer estimates of catches in this fishery differed from official landings data. Where this was the case, additional catches estimated by observers were included in Working Group's estimates of catches as "unallocated landings". These landings were not available by statistical rectangle and so are not included in the maps. Landings of deep-water species from the NEAFC RA are therefore considerably underestimated in these maps.

Landings of deep-water species from the NEAFC regulatory area on the Mid-Atlantic Ridge are shown in figure 15.7. ICES 2013 reported total catches of roundnose grenadier on the Mid-Atlantic Ridge (Division XIVb1) to have been 9202 tonnes in 2012, of which 7326 tonnes were categorised as unallocated landings. In 2014, these figures were revised and ICES now considers the total catch from Division XIVb1 to have been 2956 tonnes, of which 1098 tonnes were unallocated. Landings from this area in 2013 were 1789, with no unallocated landings.

The Working Group notes as a new development the increase in the reported landings of roughhead grenadier on the mid-Atlantic Ridge in 2012 and 2013 reaching 2726 tonnes and 868 tonnes, respectively(Ch.3). Catches in previous years were mostly well below 10 tonnes. Roughhead grenadier occurs on the MAR, but published catch rates in research trawls are very low (Hareide and Garnes, 2001; Bergstad *et al.*, 2008), hence it is surprising that landings may reach levels of the much more abundant roundnose grenadier.

ICES does not have sufficient information to characterise these trawl fisheries for grenadiers in terms of activity levels or gear characteristics.

15.2 Spawning aggregations and areas of local depletion in the NEAFC Regulatory Area

Little information is available regarding the location of spawning aggregations in the NEAFC Regulatory area. There are many records of captures of fish of various species in spawning condition but these cannot be assumed to constitute aggregations as the species in question may be widespread spawners.

Blue ling is known to form discrete and predictable spawning aggregations including some in the NEAFC area. Available information on the location of blue ling spawning in the Northeast Atlantic was collated by Large *et al.*, 2010 and a separate piece of ICES advice to the European commission in 2009. 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 16.1. 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.

Known spawning areas in the NEAFC RA are located on the northeastern margins of Hatton Bank (VIb) and along the eastern and southern margins of Hatton Bank (VIb). NEAFC has had a seasonal closure in force since 2010 (http://neafc.org/managing_fisheries/measures/current).

ICES does not have any information relating to areas of recent local depletion of deep-water fish stocks in the NEAFC Regulatory Area. Russian reports from the late 1990s suggested that alfonsino on seamounts north of the Azores remained depleted at that time. The spatial resolution of information provided currently does not facilitate assessment of the current state or recovery rates of locally depleted stocks.

ICES does not have sufficient information to evaluate the abundance of orange roughy associated with the seamounts of the Mid-Atlantic Ridge where a fishery has continued in recent years under a NEAFC regulation. No landings were reported from these areas in 2013.

Table 15.1. Landings of deep-water species from the NEAFC Regulatory Area and EEZs in the ICES area, 2013.

Stock	EEZ landings	NEAFC Regulatory Area landings	Location of NEAFC fisheries	ICES divisions	Description of NEAFC fisheries
Ling Va	11 657	0	NA	NA	NA
Ling Vb	4086	0	NA	NA	NA
Ling I, II	9027	0	NA	NA	NA
Ling - Other stocks	18 652	180	Rockall Bank (see Figure 15.4)	VIb1	longline fisheries on Rockall bank. The majority of the fishery occurs within the EU fishing zone, but it extends very slightly into the NEAFC Regulatory Area.
Blue ling Va, XIV	2525	0	NA	NA	NA
Blue ling Vb, VI, VII	2651	34	Rockall, Hatton and Lousy Banks (see Figure 15.3)	Vb1a, VIb1	Mixed deep-water trawl fisheries on Rockall and Hatton Banks. Longline fishery on Lousy Bank
Blue ling - Other stocks	214	255	Hatton Bank. (see Figure 15.3)	XIIb	Landings in XIIb come from the same fishery and assessment unit as those in VIb. WGDEEP has recommended that the stock definition be reviewed and XIIb included in the Vb, VI and VII assessment unit.
Tusk Va, XIV	6283	0	NA	NA	NA
Tusk I,II	8637	0	NA	NA	NA
Tusk Mid-Atlantic Ridge	0	0	Mid Atlantic Ridge	XII XIV	Sporadic small catches have occurred in the past. No reported catches in 2013

Stock	EEZ landings	NEAFC Regulatory Area landings	location of NEAFC fisheries	ICES divisions	description of NEAFC fisheries
Tusk VIb	48	9	Rockall (See Figure 15.5)	VIb1	longline fisheries on Rockall bank. The majority of the fishery occurs within the EU fishing zone, but it extends very slightly into NEAFC waters
Tusk Other areas	4863	5	Lousy Bank (se Figure 15.5)	Vb1a	Longline fisheries in Vb1a. The majority of the fishery occurs within the Faroes EEZ, but it extends very slightly into NEAFC waters
Great Silver Smelt Va	7154	0	NA	NA	NA
Great Silver Smelt - Other stocks	30 709	0	NA	NA	NA
Orange roughy VI	0	0	NA	NA	NA
Orange roughy VII	0	0	NA	NA	NA
Orange roughy - Other stocks	55	0	Mid-Atlantic Ridge	X, XII	Directed fisheries have occurred on the Mid-Atlantic Ridge in the past. No reported catches in 2013
Roundnose grenadier - Vb, VI, VII, XIIb	964	2779	Rockall and Hatton Bank	VIb1 and XIIb	Mixed deep-water trawl fisheries on Rockall and Hatton Banks. Landings figures presented here include official landings data and "unallocated" landings derived from observer data. In 2013, 1403 tonnes were unallocated.
Roundnose grenadier IIIa, IV	0	0	NA	NA	NA
Roundnose grenadier other areas	0	0	NA	NA	NA

Stock	EEZ landings	NEAFC Regulatory Area landings	Location of NEAFC fisheries	ICES divisions	Description of NEAFC fisheries
Roundnose grenadier Mid-Atlantic Ridge	0	1789	NA	NA	Recently developed deep-water trawl fishery on the Mid-Atlantic Ridge. In previous years, ICES landings data have included considerable "unallocated" landings derived from observer data. However, in 2013 observer estimates did not exceed official landings so there were no unallocated landings in this fishery.
Black scabbardfish Vb, VI, VII, XII	2738	549	Rockall Bank, Hatton Bank (see Figure 15.2)	VIb1 XIIb	Mixed deep-water trawl fisheries on Rockall and Hatton Banks. Landings figures presented here include official landings data and "unallocated" landings derived from observer data. In 2013, 455 tonnes were unallocated.
Black scabbardfish VIII, IX	2021	0	NA	NA	NA
Black scabbardfish - Other stocks	528	0	Mid-Atlantic Ridge	X, XII	Catches by Faroese vessels have been as high as 150 t in recent years. No reported catches in 2013
Greater forkbeard - All stocks	1836	0	NA	NA	NA
Beryx spp - All areas	254	0	Mid-Atlantic Ridge	Xb	Directed trawl fisheries existed in this area in the past. No reported catches in 2013

Stock	EEZ landings	NEAFC Regulatory Area landings	location of NEAFC fisheries	ICES divisions	description of NEAFC fisheries
Red Seabream IX	180	0	NA	NA	NA
Red Seabream X	692	0	NA	NA	NA
Red Seabream VI, VII, VIII	156	0			NA
Roughhead Grenadier	57	1192	Mid-Atlantic Ridge, Hatton Bank	/	Recently developed deep-water trawl fishery on the Mid-Atlantic Ridge. Also reported from fisheries in the Hatton/Rockall area.

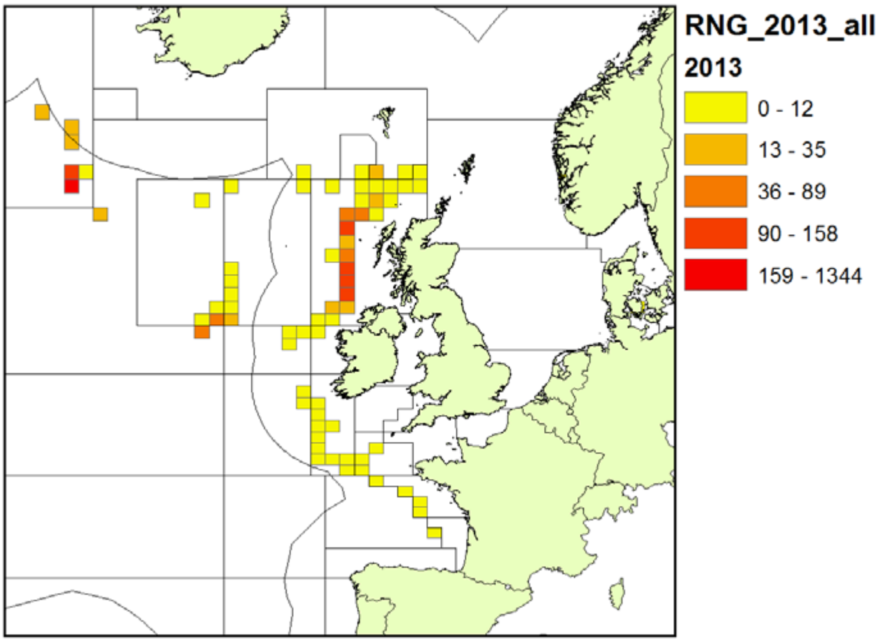

Figure 15.1. Reported landings of roundnose grenadier in the ICES area by statistical rectangle, 2013. Data from the France, UK (England and Wales), and Spain. Landings shown in this figure account for 84% of all reported landings in the ICES area. Landings data by statistical rectangle in the NEAFC area (subareas VIb, XIIb and XIVb) are incomplete with only 1740 tonnes (55% of reported landings) reported by statistical rectangle. Data on unallocated landings in the NEAFC area of VIb and XIIb (1403 tonnes) were not reported to the working group by statistical rectangles and hence not included in this figure.

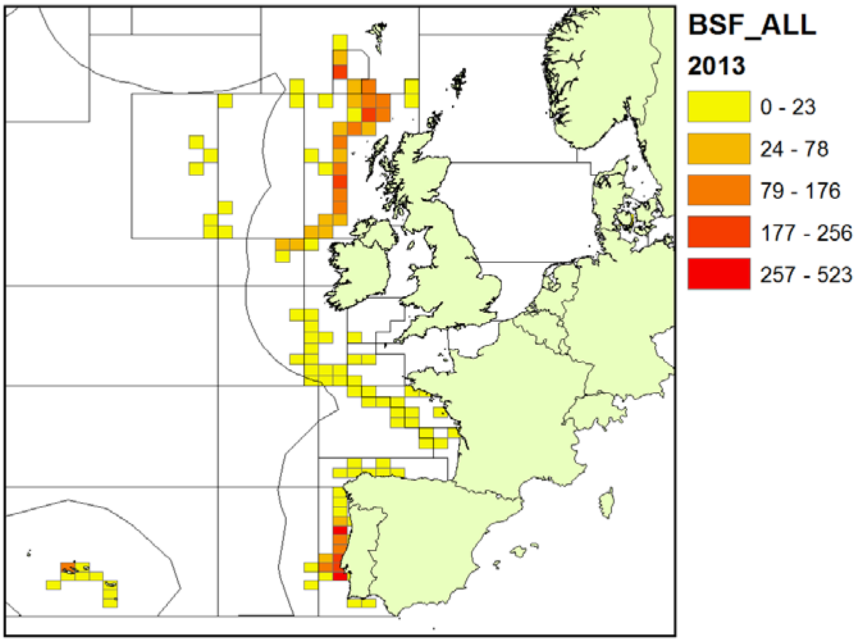

Figure 15.2. Reported landings of black scabbardfish in the ICES area by statistical rectangle, 2013. Data from the Faroes, France, UK (England and Wales), Spain and Portugal. Landings shown in this figure account for 92% of all reported landings in the ICES area. Landings data by statistical rectangle in the NEAFC area (Subareas VIb and XIIb) are incomplete with only 4.9 tonnes (5% of reported landings) reported by statistical rectangle. Data on unallocated landings in the NEAFC area of VIb and XIIb (455 tonnes) were not reported to the working group by statistical rectangles and hence not included in this figure.

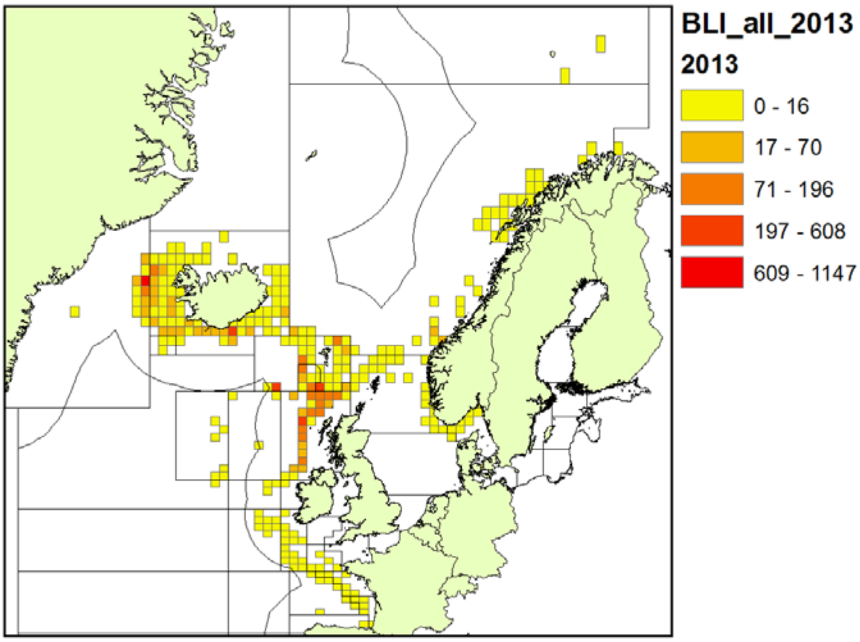

Figure 15.3. Reported landings of blue ling in the ICES area by statistical rectangle, 2013. Data from the Faroes, Norway, France, UK (England and Wales), and Spain. Landings shown in this figure account for 96% of all reported landings in the ICES area. Landings data by statistical rectangle in the NEAFC area (Subareas VIb and XIIb) are incomplete with only 27 tonnes (15% of reported landings) reported by statistical rectangle. Data on unallocated landings in the NEAFC area of Division XIIb (86 tonnes) were not reported to the working group by statistical rectangles and hence not included in this figure.

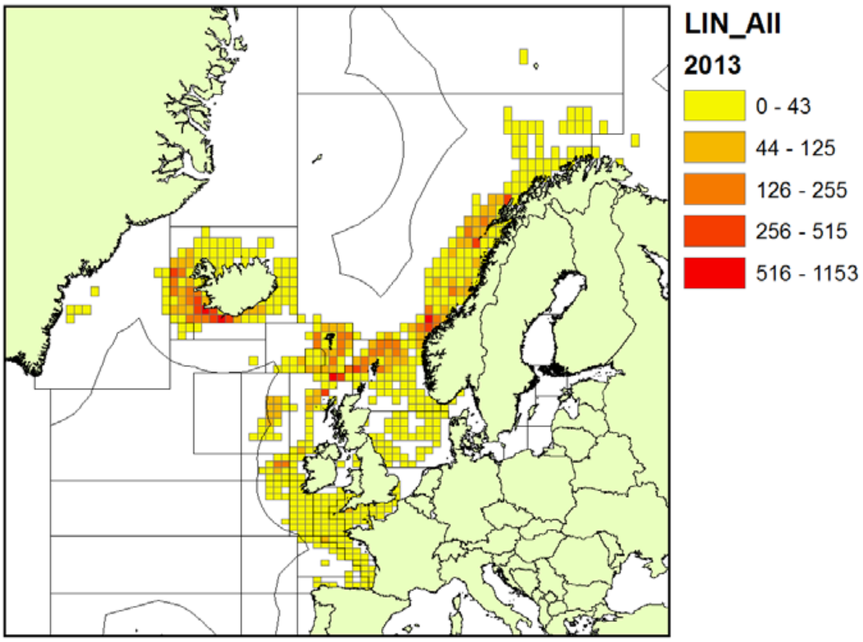

Figure 15.4. Reported landings of Ling in the ICES area by statistical rectangle, 2013. Data from Norway, Faroes, Iceland, UK (England and Wales) and Spain. Landings shown in this figure account for 53% of all reported landings in the ICES area.

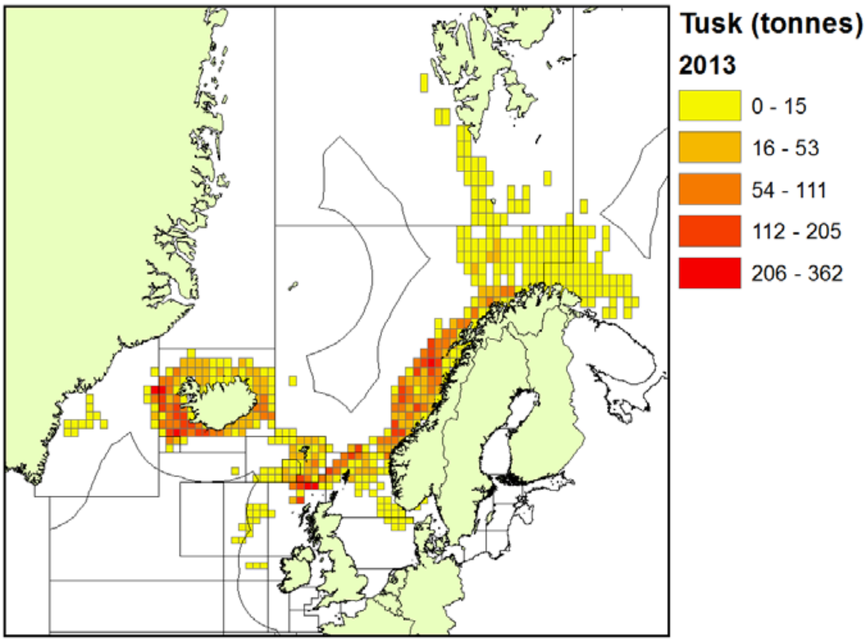

Figure 15.5. Reported landings of tusk in the ICES area by statistical rectangle, 2013. Data from Norway, Faroes, Iceland, France, UK (England and Wales) and Spain. Landings shown in this figure account for 99% of all reported landings in the ICES area.

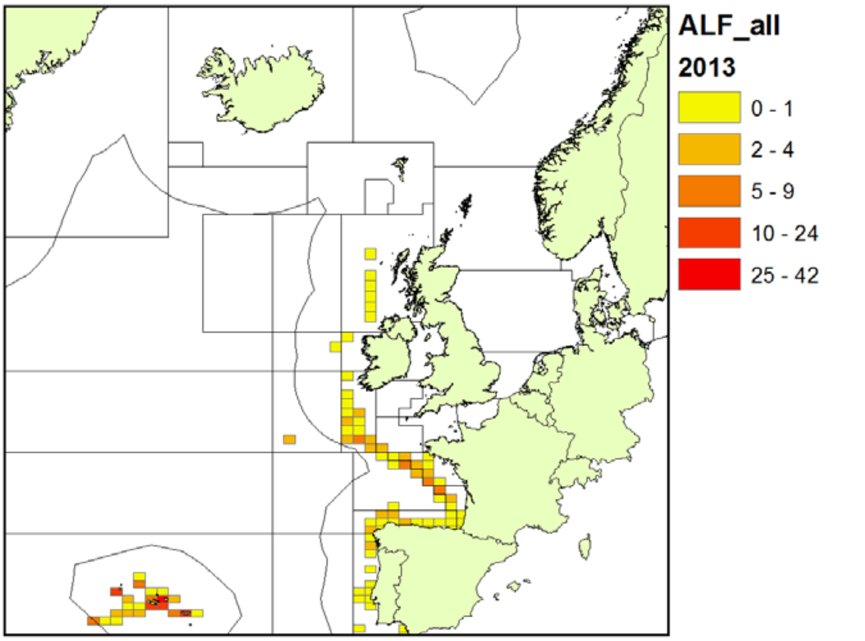

Figure 15.6. Reported landings of *Beryx* spp in the ICES area by statistical rectangle, 2013. Data from Portugal, France, and Spain. Landings shown in this figure account for 97% of all reported landings in the ICES area.

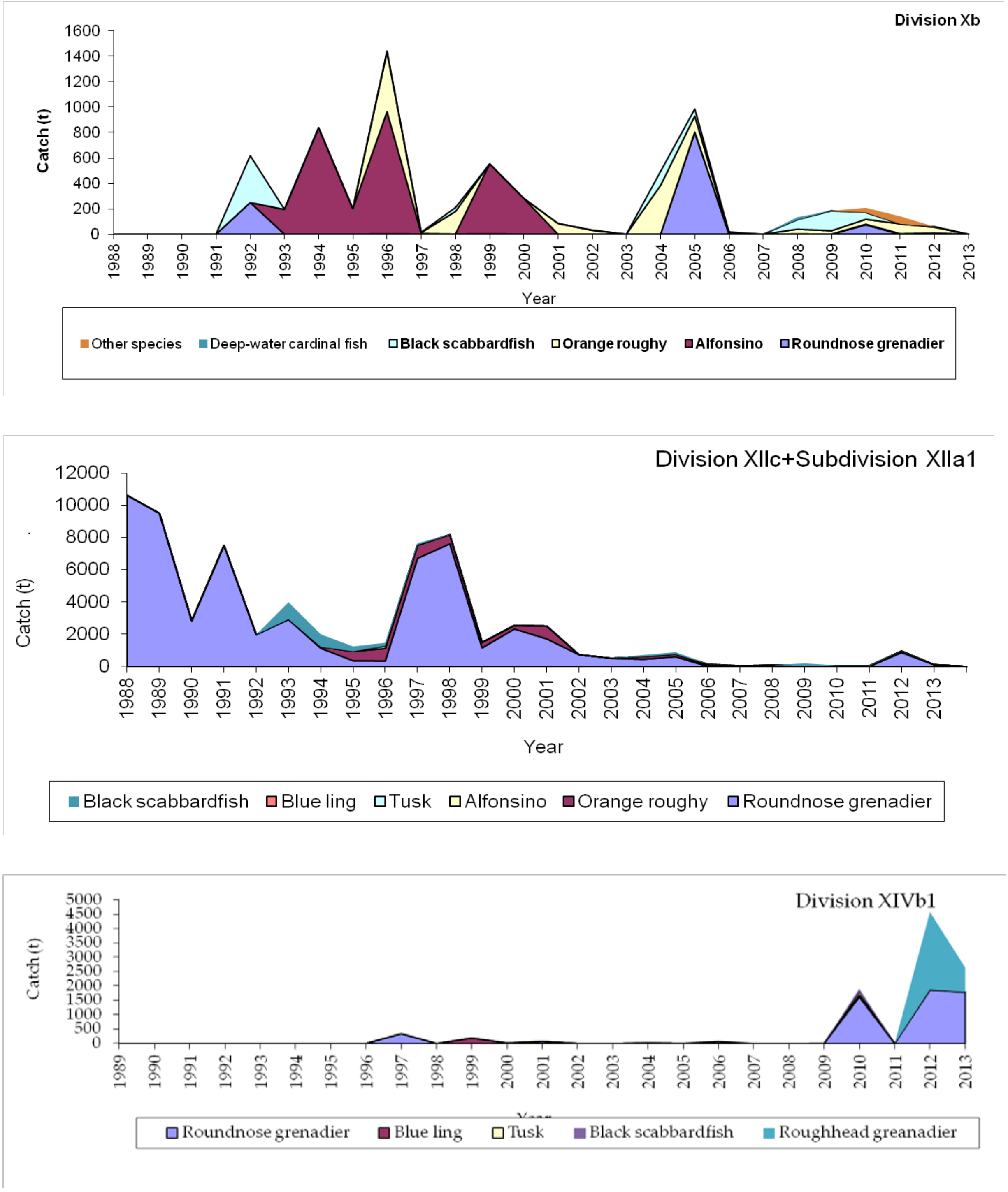

Figure 15.7. Landings of deep water species from the NEAFC Regulatory Area in the oceanic Mid-Atlantic.

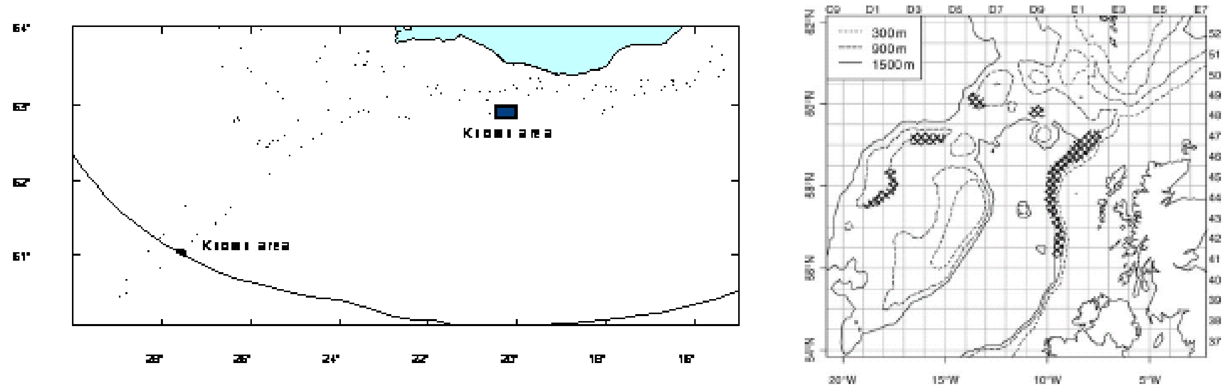

Figure 15.8. Known spawning areas of blue ling in Icelandic water (a) and to the West of Scotland (b), from Large *et al*., 2010.

Annex 1: Participants list

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Annex 2: Working documents

The following Working Documents were presented and are included below in Annex 2 of the WGDEEP 2014 report.

1) Black Scabbard Fish in Va
2) Ling genetics (OAB)
3) *Macrourus berglax* (OAB)
4) Cpue ling and Tusk
5) Genetics *Aphanopus*
6) GSS Vb exploratory assessment
7) Ling Vb exploratory assessment
8) Portugal discard monitoring
9) Russian Fisheries
10) GSS stock units

Scientific investigations on Black Scabbard fish (*Aphanopus carbo*) in Va

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February 18, 2014

Abstract

This document describes the main findings of scientific investigations on black scabbard fish (*Aphanopus carbo*) from the Icelandic Autumn survey in 2000 to 2013.

1 Trends in indices of biomass and abundance in 2000 to 2012

In figure 1 trends in biomass indices for all sizes (Total biomass) and larger than 90cm and 110cm are shown along with abundance of black scabbard fish smaller than 80cm from the Icelandic Autumn survey are shown. Total indices are presented in table 1.

2 Stratified length distributions from the Autumn survey

In figure 2 the stratified length distributions of black scabbard fish as measured in the Autumn survey are shown.

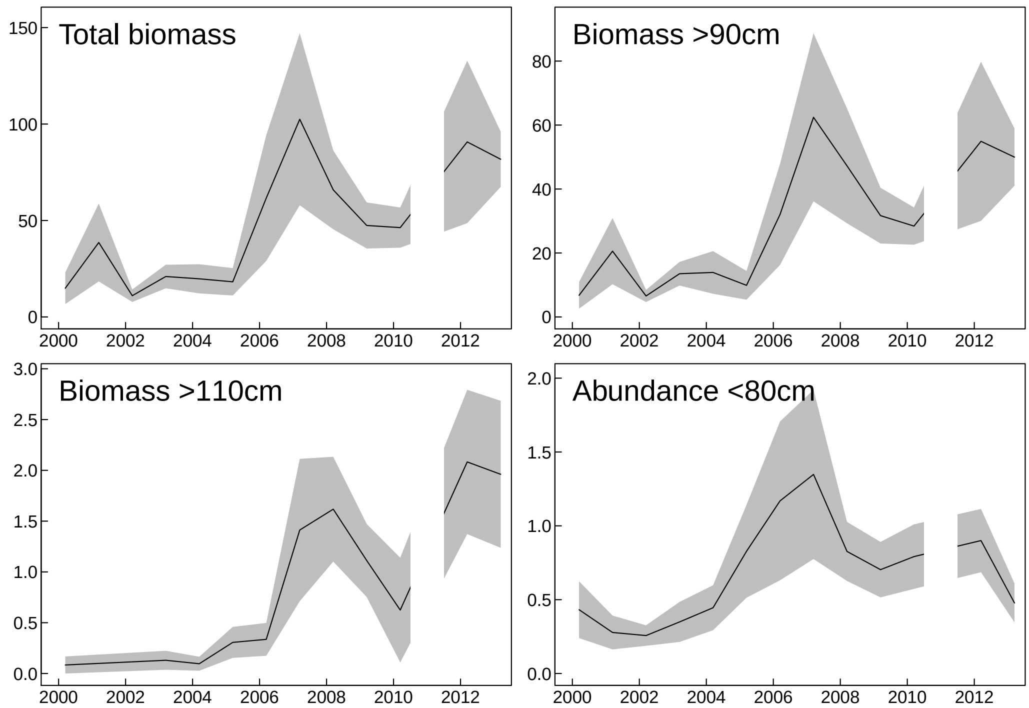

Figure 1: Black scabbard fish in Va: Trends in indices from the Icelandic Autumn survey in 2000 to 2012.

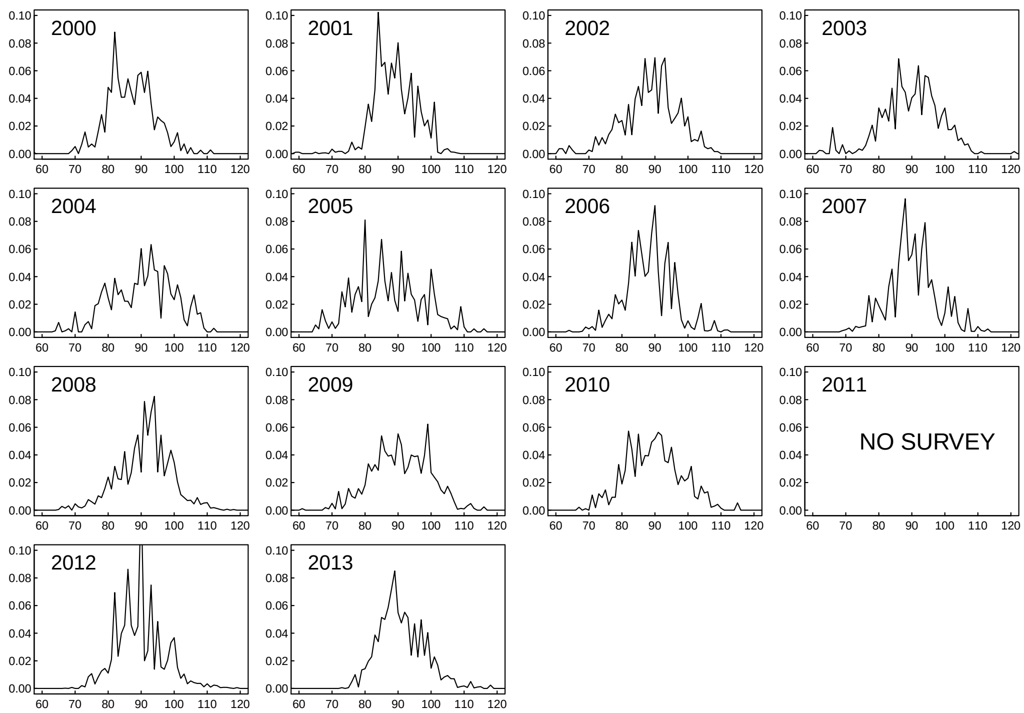

Figure 2: Black scabbard fish in Va: Trends in indices from the Icelandic Autumn survey in 2000 to 2012.

2 Stratified length distributions from the Autumn survey

Table 1: Black scabbard fish in Va. Total biomass and abundance indices from the Icelandic Autumn survey.

Year	Biomass index	CV	Abundance index	CV
2000	14898.6	0.551	2288.9	0.528
2001	38587.4	0.523	5388.5	0.522
2002	11022.1	0.294	1544.2	0.291
2003	20965.9	0.291	2817.5	0.302
2004	19778.2	0.382	2591.6	0.339
2005	18222.5	0.390	2644.8	0.380
2006	61616.1	0.529	8806.2	0.532
2007	102484.0	0.435	13710.2	0.445
2008	65885.9	0.310	8474.7	0.300
2009	47421.2	0.252	6209.6	0.254
2010	46311.8	0.225	6282.2	0.233
2012	90725.5	0.464	12330.0	0.474
2013	81727.3	0.175	10669.9	0.179

3 Spatial distribution of black scabbard fish

In figure 3 stations where black scabbard fish is caught are shown.

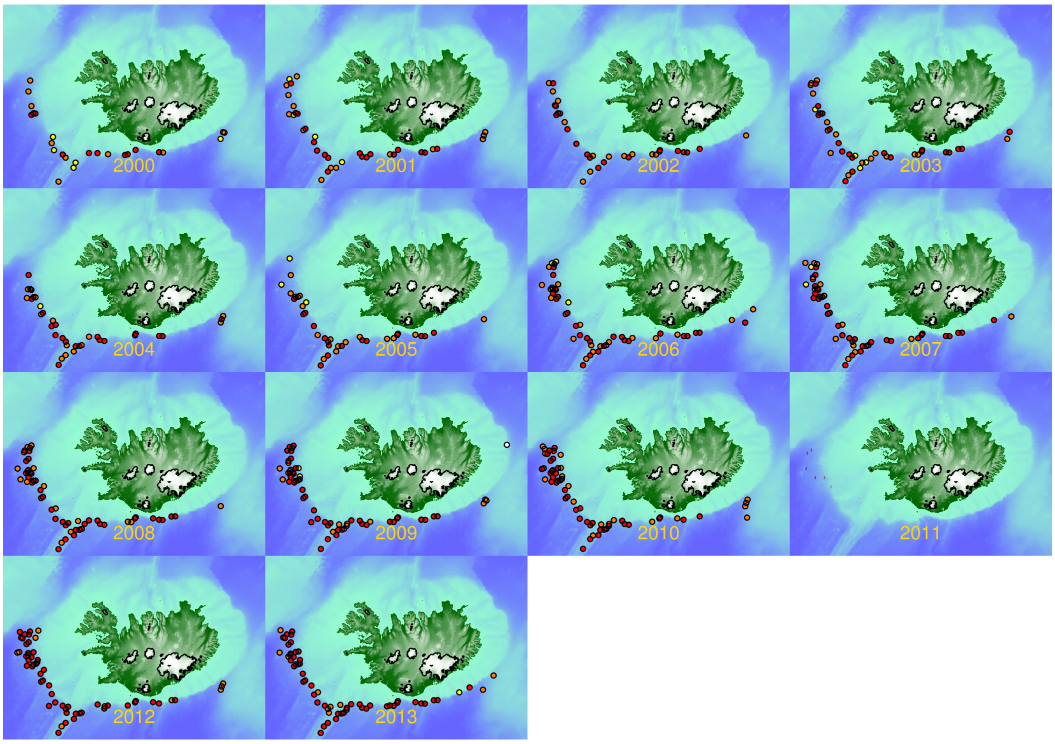

Figure 3: Black scabbard fish in Va: Changes in spatial distribution as obseved in the Icelandic Autumn survey.

Working Document 02 for ICES WGDEEP, Copenhagen 2014

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Genetic analyses of ling (*Molva molva*) in the Northeast Atlantic reveal patterns relevant to stock assessments and management advice

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This document is submitted for information only. The annexed manuscript by Blanco Gonzales *et al.* was recently submitted as an article to the ICES Journal of Marine Science. It contains information of relevance to the ICES WGDEEP.

The abstract of the article summarises the information of greatest relevance to WGDEEP:

The ling is a commercially exploited demersal gadid fish distributed throughout the Northeast Atlantic. Here, we provide the first study of population genetic structure by genotyping six geographically distinct samples with eleven microsatellite DNA markers. The results reject the hypothesis of a single ling stock in the Northeast Atlantic, and rather suggest the existence of two or more groups, with the main grouping represented by a western (Rockall and Iceland) and an eastern groups (Faroe Bank, Norway). Significant genetic differences coincide with an expanse of deep water that probably limits connectivity facilitated by migration. Retention in gyres and directional oceanic circulation may also prevent drift and admixture during planktonic life stages. On the other hand, the apparent absence of genetic differentiation within the eastern part of the distribution range indicates gene flow, perhaps by larval drift and migration, over considerable distances. Our findings should contribute to improving stock assessments and monitoring and thus fisheries management advice.

Annex: full manuscript by Bianco et al., may be cited as ‘submitted’ but not distributed.

ANNEX

Genetic analyses of ling (*Molva molva*) in the Northeast Atlantic reveal patterns relevant to stock assessments and management advice

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Abstract

The ling is a commercially exploited demersal gadid fish distributed throughout the Northeast Atlantic. Here, we provide the first study of population genetic structure by genotyping six geographically distinct samples with eleven microsatellite DNA markers. The results reject the hypothesis of a single ling stock in the Northeast Atlantic, and rather suggest the existence of two or more groups, with the main grouping represented by a western (Rockall and Iceland) and an eastern groups (Faroe Bank, Norway). Significant genetic differences coincide with an expanse of deep water that probably limits connectivity facilitated by migration. Retention in gyres and directional oceanic circulation may also prevent drift and admixture during planktonic life stages. On the other hand, the apparent absence of genetic differentiation within the eastern part of the distribution range indicates gene flow, perhaps by larval drift and migration, over considerable distances. Our findings should contribute to improving stock assessments and monitoring and thus fisheries management advice.

Key words: population structure, microsatellite, fishery management advice, deep-sea, teleostei, gadidae

Introduction

Monitoring of marine fish resources and management of fisheries is often hampered by limited knowledge of key biological and ecological characteristics, including population structure (Reiss *et al*., 2009). The need for knowledge is particular acute for deep-living species, as has been expressed, e.g. for the Northeast Atlantic (ICES, 2001; Gordon, 2003). Various means have been employed to acquire the crucial information, including data on life-history traits, parasite load, and otolith chemistry (Gonzalez *et al*., 2003; Longmore *et al*., 2011; ICES, 2012b and references therein). However, in the last couple of decades, genetic markers such as microsatellite DNA, have found wide application in discriminating among conspecific populations (Roques *et al*., 2002; Ryan *et al*., 2005; Knutsen *et al*., 2007b, 2009, 2012; McCusker *et al*., 2010; Glover et al., 2011).

Ling (*Molva molva*), a widespread gadid species in the Northeast Atlantic (Svetovidov, 1986), is one example of a poorly studied species of particular interest. Fisheries have exploited this species for centuries, most significantly as a target species of longline fisheries but also as a valued by-catch in other fisheries (e.g. Molander, 1956; Bergstad and Hareide, 1996; Poulsen, 2007; ICES, 2012a).

While categorized by e.g. ICES amongst deep-sea species, ling is primarily neritic and does not really share the life-history and behavioural characteristics that render some deepwater species highly vulnerable to overfishing (e.g. low productivity due to slow growth, high maximum ages, low fecundity, strong tendencies to aggregate). Ling has a life-span of 20 years or more and reach up to 2 m in length (Svetovidov, 1986; Bergstad and Hareide, 1996), i.e. it is a rather fast-growing fish with a life-history similar to other large neritic gadids.

Ling are mainly caught by longlines, but also by gillnets and as bycatch in trawl fisheries (ICES, 2001, 2012a). Historical developments in landings reflect the development of fishing technologies and range expansion of vessels, especially the advances in longlining technology during the mid 20th century, leading to a strong rise in landings and effort (Bergstad and Hareide, 1996). Ling is a significant target species in several ICES subareas, yet temporal variation in catches also appears correlated with fishing opportunities for other more favored species such as Atlantic cod, *Gadus morhua* (Bergstad and Hareide, 1996; ICES, 2006, 2012a). Landings declined substantially during the 1970s and 1980s, but have subsequently remained rather stable (Bergstad and Hareide, 1996, ICES, 2006, 2012a).

While recognizing the need for information on population structure, ICES (2006) states that: ‘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’. Accordingly, separate assessments and advice statements are provided for subareas such as Iceland (ICES Div. Va), the Faroes (Vb), Norway (ICES Subareas I and II), but collectively for all other subareas and divisions where the species occurs including distant fishing areas such as the Skagerrak and Rockall (ICES, 2012c).

Although little is known regarding active dispersal in ling, its elongated body shape designed for slow cruising (e.g. Koslow, 1996) and the limited dispersal ranges displayed in search of food (Løkkeberg *et al.*, 2000) suggest limited migration of adults (Svetovidov, 1986). On the other hand, the relatively long pelagic phase (Svetovidov, 1986; Bergstad and Hareide, 1996 and references therein) infers a high potential for oceanic drift during early life stages.

Here we provide the first large-scale study of population genetic structure of ling in the Northeast Atlantic by genotyping geographically distinct samples using recently developed microsatellite markers (Ring *et al.*, 2009). We discuss the interplay and relative significance of the different mechanisms probably shaping population structure of the species and indicate implications and recommendations of our findings for management advice strategies.

Materials and methods

The species

Ling is highly fecund and attains maturity at 3-8 years old, recruiting to the fisheries at age 4-7 years and length 50-70 cm (Bergstad and Hareide, 1996). Spawning takes place between March and July, and eggs and larvae remain pelagic for 2-5 months, depending on location (Svetovidov, 1986; Bergstad and Hareide, 1996 and references therein). Pioneer ichthyoplankton surveys conducted in the early 1900s reported aggregations of ling eggs and larvae within the upper 100 m of the water column around Iceland, the Hebrides and Rockall and in the North Sea, with sporadic presence in the Skagerrak and the Norwegian shelf northwards to Lofoten. Centres of spawning were suggested at

Iceland, the Faroes and the Hebrides, and the northern North Sea (Ehrenbaum, 1905; Schmidt, 1906, 1909). Records from a range of later egg- and larval surveys, yet few and scattered, appear to confirm the results of the early studies (Bergstad and Hareide, 1996 and references therein). After an epipelagic early life stage, juveniles adopt a demersal lifestyle in the shallower parts of the range, moving deeper with size and age (Molander, 1956, Joenoes, 1961; Svetovidov, 1986). As adults, the typical depth range is 100-400 m, and distribution area comprises mainly the eastern North Atlantic continental and island shelves northeastwards to the southwestern Barents Sea (Svetovidov, 1986). Its presence in the western Atlantic and the southern part of the Iberian Peninsula is rare (Templeman and Fleming, 1954; Svetovidov, 1986).

Sampling

Between 2005 and 2008 ling were sampled at six locations across the Northeast Atlantic (details provided in Table 1 and Fig. 1): Bergen (BE), Faroe Islands (FI), Iceland (IS), Rockall (RA), Storegga (SE) and Tromsøflaket (TF). A total of 674 adult ling were collected by the following vessels: the Scottish research vessel *Scotia* (bottom trawl, sample locality RA); from commercial longline catches by the Norwegian reference fleet (FI, IS, SE and TF) (the reference fleet refers to a group of Norwegian commercial fishing vessels that on a regular basis provide samples to IMR as well as detailed information about their fishing activity and catches. The sampling and data management procedures are similar to the system used on board IMR’s research vessels: Borge *et al*., 2010); and catches by sport fishing anglers (BE). Temporal replicate samples were collected from RA in 2007 and 2008 and at TF in 2005 and 2008. Muscle tissue was collected from fresh or frozen specimens and preserved until DNA extraction in 96% ethanol, either at sea or immediately after thawing in the laboratory.

Genetic analysis

DNA was extracted from ethanol preserved muscle tissue using the Viogene Inc. extraction kit (Sunnyvale, CA). Microsatellite DNA fragments (below) were separated using the capillary CEQ 8000 (Beckmann) automated sequencer. We applied Eppendorf 5 Prime Taq DNA Polymerase for the PCR reactions, using the supplied self-adjusting magnesium 10X buffer. We screened 12 microsatellite loci including *Bbrom*2, *Bbrom*21 (originally developed for tusk: Knutsen *et al*., 2007a), *Mmol*M1, *Mmol*M12, *Mmol*A6, *Mmol*B2, *Mmol*B115, *Mmol*C1, *Mmol*C5, *Mmol*D131, *Mmol*D132, *Mmol*D137 (developed specifically for ling: Ring *et al*., 2009). However, locus *Mmol*C5 was subsequent found to display a high frequency of null alleles and was excluded from further analysis, which were based on the remaining 11 loci. As a guard against potential genotyping errors, all capillary traces were scored independently by two trained persons, and in case of disagreement, new PCR reactions were performed and individual genotypes were re-scored.

Statistical Analysis

Genotypic data was examined and checked for the presence of null alleles or other problems using MICROCHECKER software (van Oosterhout *et al*., 2004). Deviations from Hardy-Weinberg (HW) genotype proportions were examined by means of F_{IS} (Weir and Cockerham, 1984) and the exact probability test in Genepop v.4.0 (Rousset, 2008). Here, we adopted the false discovery rate (FDR) approach (Benjamini and Hochberg, 1995) when interpreting test significances. Linkage disequilibrium (LD) between all pairs of loci was tested in Genepop v.4.0 (Rousset, 2008), using a Fisher's exact test with 10 000 dememorizations, 100 batches and 1000 iterations per batch.

Levels of genetic variation were characterized by observed number of alleles (A), allelic richness (A_r) and gene diversity within samples (H_S) and the average for all samples (H_T) based on Nei and Chesser (1983), using the FSTAT software (Goudet, 1995).

Genetic differentiation among samples were quantified by Wright's F_{ST}, using Weir and Cockerham's (1984) estimator θ in all samples and also within pairs of sample localities. Initially, each temporal replicate were analysed independently. However, as genetic differentiation between sample years within each location was found to be insignificant (below), temporal replicates were pooled in subsequent analyses to increase statistical power of detecting spatial differences. The statistical significance of the analysis was examined by exact tests with 10 000 dememorizations and batches, using 10 000 iterations per batch with Genepop v.4.0 (Rousset, 2008). The p values were calculated for each locus separately and summed over loci by Fisher's summation procedure following Ryman and Jorde (2001). When interpreting the table of p values arising from pairs of samples, we employed Benjamini & Yukutieli's (2001) FDR approach, which is applicable also to non-independent tests. Briefly, in a table with m pairwise tests, we considered as significant at the $\alpha = 0.05$ level only those that came out with a p value smaller than or equal to the quantity $\alpha / \sum_{i=1}^{m} (1/i)$.

Temporal stability of spatial structure was tested for with AMOVA analyses of spatial samples and temporal replicates, using Arlequin ver. 3.5 (Excoffier and Lischer, 2010). In this analysis, temporal replicates from RA and TF were analysed independently. Statistical evidence for selection was tested for by two simulation-based outlier tests implemented in Lositan (Antao *et al*., 2008) and Bayescan (Foll and Gaggiotti, 2008); however, no evidence for selection was found for any locus (results not shown).

Spatial genetic differentiation patterns were examined by a Principal Component Analysis (PCA) based upon covariance matrix of allele frequencies, and visualized using PCAGEN 1.2.1 (Goudet, 1999). Geographic patterns of genetic structure were further investigated by testing putative correlations between genetic and geographic distances (Rousset, 1997). Pairwise F_{ST} estimates among pairs of sample locations were linearized, $F_{ST}/(1-F_{ST})$, and regressed against the shortest downstream distance connecting them, following the predominant ocean currents (Fig. 1). Adopting this one-dimension approach, we tested the hypothesis of gene flow based on transport of pelagic egg and larvae by ocean currents. This hypothesis, instead of an alternative one of two-dimension adult dispersal, was chosen because current knowledge suggests limited migration of adults (above). Isolation by distance effects were tested by a Mantel test performed in IBDWS v. 3.23 (Jensen *et al*., 2005; http://ibdws.sdsu.edu/~ibdws/). The software BARRIER (Manni *et al*., 2004) was used to identify barriers to gene flow among locations. As input for the program, we used sample coordinates (Table 1) and pairwise F_{ST} estimates along all pairs of localities (pooling temporal replicates). This analysis was performed for each locus separately and also including all loci. The latter denotes the rank of importance of the barriers, while the analysis at individual locus infers the support for each barrier.

Results

Genetic variability

Genotyping coverage of the total sample of 647 individuals achieved almost 99% success rate, with only 1 (>99%, at locus *Mmol*D137) to 42 (6%, *Bbrom*2) individuals not scored at each locus. All loci showed high levels of polymorphism, accounting for a total of 150 alleles in the entire data set and from 7 alleles per sample location at locus *Bbrom*21 and *Mmol*B115 to 22 alleles at *Bbrom*2 (Table 1). Amounts of genetic variability were similar among sample locations, with estimated allelic richness (A_r, based on a sample size of n = 61) ranging from 8.5 to 9.7 and heterozygosity, H_S, from 0.647 to 0.684.

Deviation from Hardy-Weinberg (HW) equilibrium was observed in 8 out of 66 (12.2%) cases (loci*localities), and five tests (7.5%) remained statistically significant at the 5% level after FDR correction (Table 1). All significant cases refer to deficiency of heterozygotes, and affected two samples (FI at loci *Bbrom*2, *Mmol*M12 and *Mmol*C1 and TF at loci *Bbrom*21 and *Mmol*M12). As scoring rate was high in these samples (except for *Bbrom*2 in sample FI), deviation from HW proportions appears unlike to be due to low DNA quality. In addition to *Bbrom*2 in sample FI, MICROCHECKER also suggested the presence of null alleles at *Mmol*M12 in samples FI and TF. However, inspection of F_{IS} estimates for each allele separately in each sample did not indicate any spatial pattern in the departure from HW genotype proportions.

Linkage disequilibrium was found to be significant (at the 5% level) in 16 out of 330 pairwise tests (4.8%). Thirteen of these remained statistically significant under the FDR approach (at the 5% level). Significant outcomes appeared randomly distributed among samples and pairs of loci, and our results give no reason to assume that the loci are physically linked.

Genetic differentiation and population structure

The overall estimate of genetic divergence among ling sample locations was low (F_{ST} = 0.0017), yet allele frequencies differed significantly among localities (joint null hypothesis of no differentiation $p < 0.001$: Table 2). When considering each locus separately, differences were significant only at two loci: *Mmol*B2 (F_{ST} = 0.0026, p = 0.003) and *Mmol*D137 (F_{ST} = 0.0067, $p < 0.001$: Table 2). Pairwise comparisons between temporal replicates from RA (2007 vs. 2008) and TF (2005 vs. 2008) were very low and not significant (RA: F_{ST} = 0.00040, p = 0.38; TF: F_{ST} = 0.00004, p = 0.45). Thus, temporal samples from the same location were pooled together in subsequent analysis.

Pairwise comparisons among spatial samples (temporal replicates pooled) revealed significant differentiation in 8 out of 15 pairs, although 3 of them disappeared after the FDR (cf. Table 3). Considering particular sample localities, all comparison involving locality RA were statistically significant (at $p \approx 0.000$), or nearly so (RA vs. IS: p = 0.06). The only other significant test involved SE vs. IS (F_{ST} = 0.0039 and $p \approx 0.000$). AMOVA analysis confirmed temporal stability in patterns of population differentiation among sample localities (spatial: F_{CT} = 0.0025 and $p \approx 0$ among localities, and temporal: F_{SC} = 0.0003 and p = 0.327 among temporal replicates).

The PCA plot (Fig 2) indicated separation of ling into two major genetic components, separating RA with IS from the other four localities (BE, FI, SE, TF) along the first component (X axis: 37% of the overall variation), while the second component (Y–axis: 21% of the overall variation) separated SE from the others, resulting in a tentative three clusters. The landscape genetic analysis conducted with BARRIER confirmed the most important barrier to gene flow between western (RA and IS) and eastern (FI, BE, SE, TF) samples (Fig. 3). A second weaker barrier would isolate the sample from SE (barrier not shown).

There was an apparent tendency for increasing genetic differentiation with ocean currents distances among sample localities (slope = 1.17×10^{-6}, Fig 4), but it was not statistically significant (Mantel $R^2 = 0.127$, $p = 0.108$).

Discussion

The main result of this study is weak but significant genetic structure for the eleven microsatellite markers, rejecting the hypothesis of a single panmictic population of ling in the Northeast Atlantic. While distance could play a part in generating population structure, the largest genetic break was found between the western and eastern part of the study area, where comparisons involving samples surrounded by great depths were generally genetically more divergent. This pattern suggests that overall meso- and microscale ocean dynamics (Hansen, 1992; Hansen *et al*., 1998; New and Smythe-Wright, 2001) overcome the main eastward North Atlantic Current component, and that larval retention prevails over oceanic drift. Hence, it is likely that isolation of the Rockall (RA), and to perhaps a lesser extent Iceland (IS) is explained by the combination of the bathymetry, restricted adults migratory behavior, and prevalence of micro- and mesoscale ocean dynamics over large-scale oceanic drift.

Barriers to gene flow and isolation of western populations of ling comply with previous studies conducted on other demersal deep-sea fish with low dispersal rates and a pelagic larval stage (Knutsen *et al*., 2009, 2012; McCusker and Bentzen, 2010). Meanwhile, the less abrupt bathymetry in the eastern part of the study area would seem to permit also interconnectivity among localities, perhaps by a combination of larval drift with the current and active migration. Demersal adult and juvenile fish could swim along continuous shelves and ridges, within depth ranges where the species are usually found (Giæver and Forthun, 1999; Knutsen *et al*., 2009, McCusker and Bentzen, 2010).

While historical fishing records (Poulsen, 2007) and time-series of abundance indices extending from around 1970 onwards (Bergstad and Hareide, 1996; ICES, 2006) suggest significant declines in abundance in many fishing areas, ling remains a significant target species in bottom fisheries in the North East Atlantic. At present, the management advice for ling in the Northeast Atlantic is provided by 'assessment units' (ICES, 2012c). Current fishery regulations pertinent to ling vary spatially, reflecting unilateral decisions and/or regulations agreed bi- or multilaterally between fishing nations and the EU. Regulations have included area restrictions, effort limitations, minimum landing sizes and area- and fleet-specific total allowable catches (TACs).

Our findings appear to support the assumption by ICES of limited mixing and thus separate 'assessment units' at Iceland, on the Norwegian Coast, and at the Faroe Islands and Faroe Bank (e.g. ICES, 2012c). On the other hand, the results also suggest that the pooling into a single assessment unit comprising west of the British Isles waters and the North Sea-Skagerrak (ICES, 2006, 2012c) lacks biological justification and is incompatible with present genetic information. Given the geographically course-scaled sampling of ling, we cannot provide a full account of spatial population structure and it is likely that more subtle sub-structuring at finer geographic scales also exist. To enhance spatial resolution, increasing the number of markers analysed (Glover *et al*., 2010), together with more rigorous sampling across the whole distribution range of the species will be required.

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Tables

Table 1. Sample location, year of collection, abbreviation (ID), latitude, longitude, ICES division, sample size (n), heterozygosity (H_S), number of alleles (A), allelic richness (A_r, n = 61) and F_{IS}. Loci deviating from Hardy-Weinberg proportions (either direction) are given in parenthesis (no adjustment for multiple tests).

Location	Year	ID	Latitude	Longitude	ICES	n	H_S	A	A_r	F_{IS}
Bergen	2008	BE	60.23	5.19	IVa	63	0.647	8.8	8.8	-0.034
Faroe Islands	2005	FI	61.03	-5.37	Vb	88	0.663	9.2	8.8	0.080 (*Bbrom*2, *Mmol*M12, *Mmol*C1)
Iceland	2006	IS	63.12	-20.05	Va	84	0.675	9.3	8.6	0.027 (*Bbrom*2)
Rockall	2007, 2008	RA	58.11	-13.49	VIb	135	0.680	10.0	8.5	0.003 (*Mmol*D137)
Storegga	2005	SE	64.09	5.49	IIa	89	0.684	10.6	9.7	0
Trømsoflaket	2005, 2008	TF	69.02	13.44	IIa	188	0.666	11.4	9.3	0.008 (*Bbrom*21, *Mmol*M12, *Mmol*A6)

Table 2. Genetic diversity among ling samples at 11 loci. Allele counting (*A*), allelic richness (A_r, n = 61), average heterozygosity within samples (H_S), level of genetic differentiation between the samples (F_{ST}) and exact test *p* values for allele frequency homogeneity (summed over all loci).

Locus Name	*A*	A_r	H_S	F_{ST}	*p*
*Bbrom*2	22	15.7	0.895	-0.0003	0.589
*Bbrom*21	7	4.1	0.489	-0.0014	0.176
*Mmol*M1	13	8.0	0.688	-0.0009	0.196
*Mmol*M12	20	10.2	0.667	0.0053	0.051
*Mmol*A6	16	10.4	0.729	0.0004	0.059
*Mmol*B2	9	5.1	0.569	0.0026	0.003
*Mmol*B115	7	4.6	0.248	0.0022	0.183
*Mmol*C1	18	13.3	0.906	0.0002	0.523
*Mmol*D131	17	13.7	0.861	0.0006	0.252
*Mmol*D132	10	6.8	0.569	0.0040	0.096
*Mmol*D137	11	7.6	0.742	0.0067	0.000
Average	13.6	9.1	0.669	0.0017	0.000
SD	5.3	3.9			

Table 3. Estimated pairwise F_{ST} values (averaged over loci: below diagonal) and corresponding *p* values for tests of allele frequency differences (summed over loci: above diagonal) among ling sample localities based upon data from 11 microsatellite loci. Bold *p* values are statistically significant at 5% level after FDR (Benjamini and Yekutieli, 2001) correction (q = 0.015).

	BE	**IS**	**FI**	**RA**	**TF**	**SE**
BE		0.651	0.500	**0.000**	0.621	0.024
IS	0.0009		0.129	0.065	0.035	**0.000**
FI	-0.0011	0.0014		**0.000**	0.956	0.083
RA	0.0041	0.0006	0.0023		**0.000**	**0.000**
TF	-0.0005	0.0025	-0.0011	0.0025		0.015
SE	0.0012	0.0039	0.0005	0.0045	0.0017	

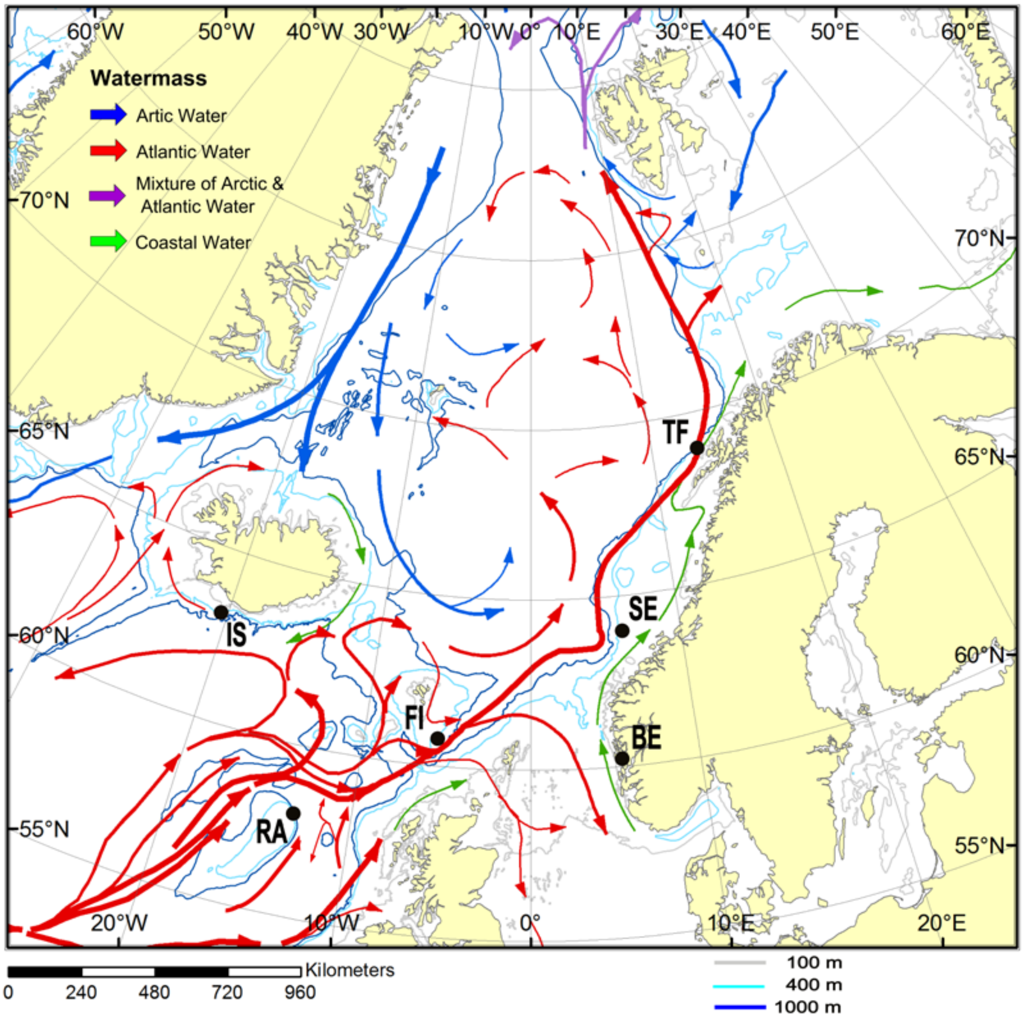

Figure 1. Sampling locations (solid circles, for details see Table 1), bathymetry (100, 400 and 1000 m isobaths), and main circulatory features associated with major water masses of the Northeast Atlantic. Ling is distributed in the areas where Atlantic water predominates. Note that Rockall (RA) is surrounded by channels exceeding 1000 m, i.e. deeper than the maximum distribution range of ling.

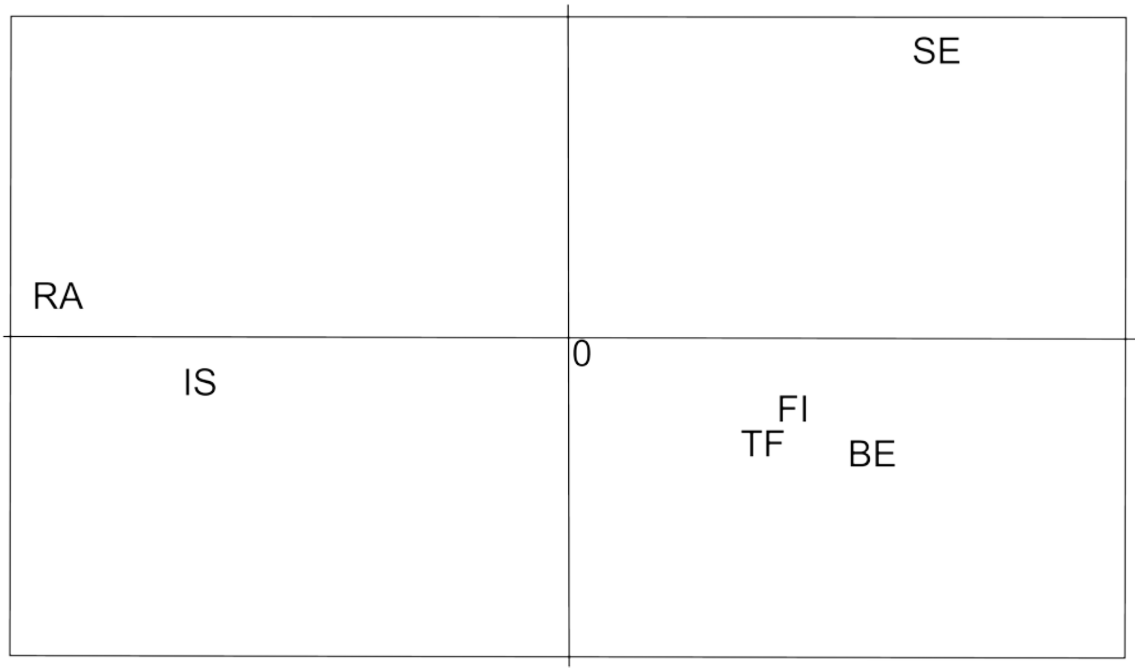

Figure 2. Principal Components Analysis (PCA) on allele frequencies. The plot displays the two principal axis accounting for 37.4% (X–axis) and 21.2% (Y–axis) of the total variation.

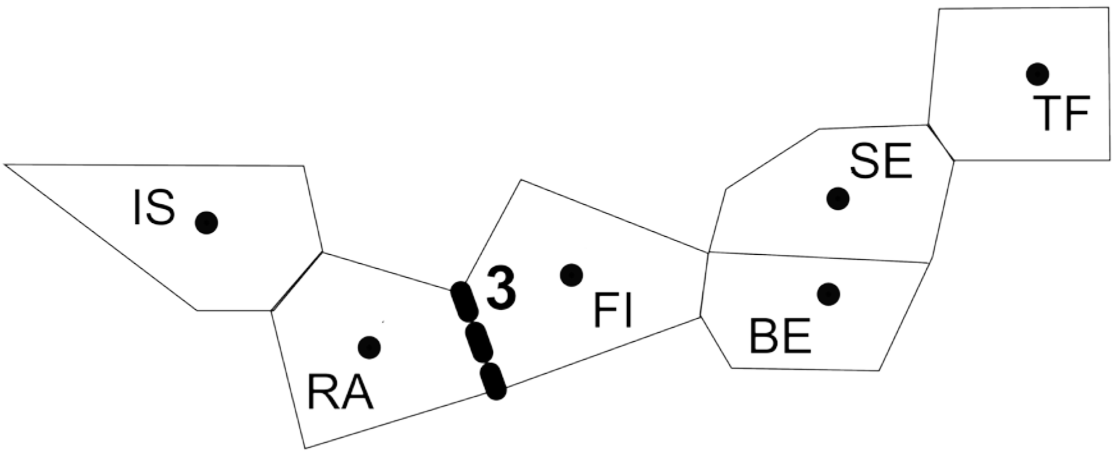

Figure 3. BARRIER-inferred gene flow patterns among ling localities (Table 1) based on 11 microsatellite loci. Broken lines indicate the location of the barrier which is supported by 3 loci.

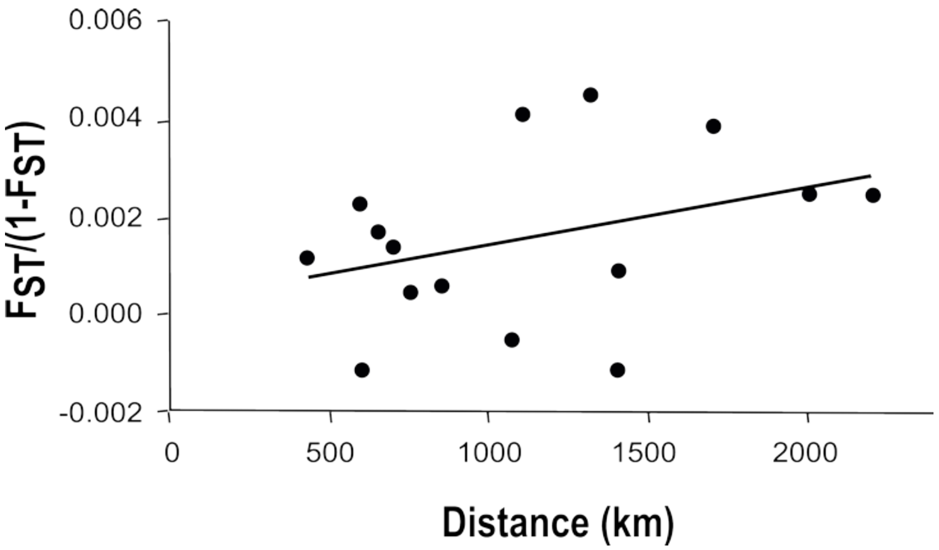

Figure 4. Isolation by distance (IBD). The line indicates the linear regression of genetic divergence, $F_{ST}/(1-F_{ST})$, against oceanographic distance.

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Norwegian survey data on distribution, abundance and size structure of roughhead grenadier (*Macrourus berglax*) on the shelf edge of the northeastern Norwegian Sea (ICES Subarea II a&b), 1997-2013.

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Abstract

On the upper continental slope off of Norway and Spitsbergen, in the ICES Subareas I and II between 68-80^{O}N, *Macrourus berglax* was widely distributed at depths between 500-800m. Abundance declined to low levels towards northern areas along the Spitsbergen shelf, but corresponding decline was not observed towards the south, reflecting that the distribution area extends beyond the sampling area. Through the bottom trawl survey time series 1997-2013 abundance and biomass varied without any apparent temporal trend. Size distributions comprised the entire size range, and the proportion of small fish (PAFL<15cm) varied and was comparatively high in some years (e.g. 2008 and 2009), suggesting some temporal variation in recruitment.

Introduction

This document summarises data collected on the subarctic macrourid roughhead grenadier, *Macrourus berglax*, on shelf-edge and upper slope surveys montoring deepwater species. The surveys were conducted by Norwegian research vessels and chartered fishing vessels in the period 1997-2013.

Roughhead grenadier is a common by-catch in longline and trawl fisheries targeting other species such as Greenland halibut and redfish (e.g. Dolgov et al. 2008). Landings were always minor, i.e. at most a few hundred tonnes per annum. Russian catches were estimated to be less than 100 tonnes.yr^{-1} in the period 1996-2002. Previous Russian and Norwegian studies off of North Norway have demonstrated that this area is a spawning area of the species (Eliassen and Falk-Petersen 1985; Savvatimsky 1986), and that the upper slope and deep shelf area between North Norway and Spitsbergen ranks amongst subareas of the North Atlantic range where the species is particularly abundant (Savvatimsky 1989).

Following on from a similar and more comprehensive account of Russian time-series by Dolgov et al (2008), we analysed variation in distribution, abundance, and size structure for a continuous time series spanning a time period of 17 years from this area of ICES subareas I and II.

Methods

Data on catch in terms of numbers and weight were collected on chartered commercial trawlers (1997-2009) and Norwegian research vessels (2011, 2013) during research surveys targeting deepwater species along the Norwegian outer continental shelf and uppers slope between 68^{O} and 80^{O} N. Sampling years, periods and number of trawls are listed in Table 1. The trawl used in the surveys was a commercial Alfredo-5 bottom trawl, except in 2011 and 2013 when an Alfredo-3 was adopted. The average headline height (vertical opening) varied between 3.6m and 4.2m, and the average width between otter boards varied between 160m (2013) and 181m (2004). From every catch, the catch of roughhead grenadiers was counted and weighed. Individual fish were measured (pre-anal fin length to nearest cm below). Otoliths were extracted for future age determination.

Abundance estimation

The study area was stratified by latitude (68-70.5-73.5-76-80 degrees North) and bottom depth (400-500-700-1000-1500 m). The abundance in numbers and biomass was calculated within each stratum by traditional swept area technique, assuming an efficient trawl width of 80m and using the average abundance density (per unit area) over the trawl haul samples within the stratum. The total abundance was then found by accumulating the strata estimates. Approximate 95% confidence intervals were calculated based on the assumption that the underlying distribution of total trawl catch was the same as if the trawl locations were uniformly distributed, and under the assumption of approximately normal distributed total trawl catches within each stratum.

Size distribution

The size distributions (length frequencies) from each survey were calculated in two ways. The simplest alternative was to just accumulate all size distributions from all trawl hauls without any weighting. The other alternative was to weight the accumulated size distribution within each stratum with the estimated density (by numbers per $nmi.^{-2}$) in the actual stratum. If the two approaches give apparently different results, this indicates that the size distribution depends on density.

Results

Roughhead grenadier occurred in all surveys and in the entire survey area (Fig. 1 & 2), and there was little variation and no obvious temporal trend through the time-series in the pattern of distribution by depth and latitude. (Some surveys were interrupted or hampered by bad weather, e.g. 2011, and the distribution of positive catches in these years did not reflect the entire distribution of the species in the area.) The species primarily occurred on the shelf-break and upper slope at intermediate depths, with peak abundance at around 700m.

There was a decline in abundance towards the north along the shelf off of Spitsbergen, but no corresponding decline towards the south along the Norway coast. The depth range was somewhat wider at intermediate latitudes, probably reflecting widening of the range into the Bear Island Channel (Fig. 1).

The time-series of abundance and biomass estimates varied extensively, but without any apparent temporal trend (Fig. 3).

Size distributions (Fig. 4, unweighted based on samples alone, and weighted based on catch in numbers), showed that the entire size range of the species was sampled. In years with relatively high proportions of small fish of PAFL<15cm distributions are bimodal. In selected years, e.g. 2008 and 2009, the abundance of small fish was particularly high, suggesting elevated recruitment in preceding years. This conclusion is the same for the unweighted and the stratum-density weighted size distributions.

Discussion and conclusions

The shelf-break and upper slope off of North Norway and Spitsbergen is a subarea of the extensive North Atlantic range of the species which includes upper slope waters of the Northwest Atlantic, and the European margin at least south to the Hatton Bank, as well as Iceland and the northern mid-Atlantic Ridge (Geistdoerfer 1986; Savvatimsky 1989; Bergstad et al. 1999, 2008 a,b; Langedal and Hareide 2000; Hareide and Garnes 2001).

The 17 year long time-series of fisheries-independent data on distribution, abundance and size distribution of roughhead grenadier (*Macrourus berglax*) suggested neither changes in distribution patterns nor abundance and biomass in the survey area. Distribution patterns corresponded with those presented earlier by Savvatimsky (1983) and Eliassen (1983), and also Dolgov et al. (2008) who also included observations from shallower parts of the southwestern Barents Sea.

The data from the Russian and Norwegian surveys provide relatively recent monitoring data for roughhead grenadier from Subarea I and II. Due to the lack of comparable data from years prior to the mid-1990s, it is unknown how present abundance levels compare with historical levels or whether trends in abundance occurred prior to the survey period. Russian research vessel catches from the same shelf section in 1982-83 showed catch levels up to 1440 tonnes/trawl hour but usually much less (Savvatimsky 1983), but the gears in that investigation and the Norwegian survey may not be comparable. Eliassen (1983) fished selected sites off North Norway with a shrimp trawl (i.e. a considerably smaller gear than that used in recent surveys) and obtained only minor catches (10 or less individuals/hour).

Research survey data from the Canadian Atlantic margin, where the catches were several thousand tonnes through the 1990s until about 2004, suggested a declining trend in the decade following expansion of upper slope fisheries in the 1970s (Devine et al., 2006). However, through the 1990s and onwards both surveys and assessments show an increasing biomass trend and much reduced fishing mortality (González-Costas 2010). In the 1960s and 70s, fisheries for Greenland halibut and redfish also expanded along the shelf off Norway and Spitsbergen, and this may have reduced abundance levels of roughhead grenadier here as well. However, if a decline happened during the 1960s-1990s, then the decline seems to have halted during subsequent decades until present. Fishing for Greenland halibut and redfish continues, primarily with longlines and trawls, but at a much reduced level compared with e.g. the 1970s.

Data from the northwest Atlantic suggest considerable recruitment variation (Gonzalez-Costas 2010). The size distributions from the Norwegian surveys also indicated temporal variation in the abundance of small fish, probably reflecting recruitment variation, but this aspect will have to be analysed more thoroughly in the future. The size range in the catches appeared the same throughout the time-series. Otoliths were collected but have thus far not been used to obtain age data.

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Table 1. Summary of data from the bottom trawl survey series, 1997-2013

Year	Survey month	Vessel	Vessel Type	Trawl	# trawls	Vertical opening (m)	Wingspread (m)
2002	July/Aug	ALOW	Comm. trawler	Alfredo-5	191	4.1	191
2003	Aug	ALOW	Comm. trawler	Alfredo-5	191	4.2	184
2004	Aug	GJMX	Comm. trawler	Alfredo-5	193	3.6	181
2005	Aug	JNQX	Comm. trawler	Alfredo-5	182	3.9	201
2006	July/Aug	JNQX	Comm. trawler	Alfredo-5	192	4.2	206
2007	July/Aug	LMT	Comm. trawler	Alfredo-5	194	3.4	203
2008	July/Aug	LMT	Comm. trawler	Alfredo-5	191	3.8	190
2009	July/Aug	LMT	Comm. trawler	Alfredo-5	188	3.8	186
2011	Nov/Dec	HJ	Research vessel	Alfredo-3	59	4.5	176
2013	Oct	GS	Research vessel	Alfredo-3	101	4.0	160

HJ and GS are the research vessels “Johan Hjort” and “G.O. Sars”, respectively.

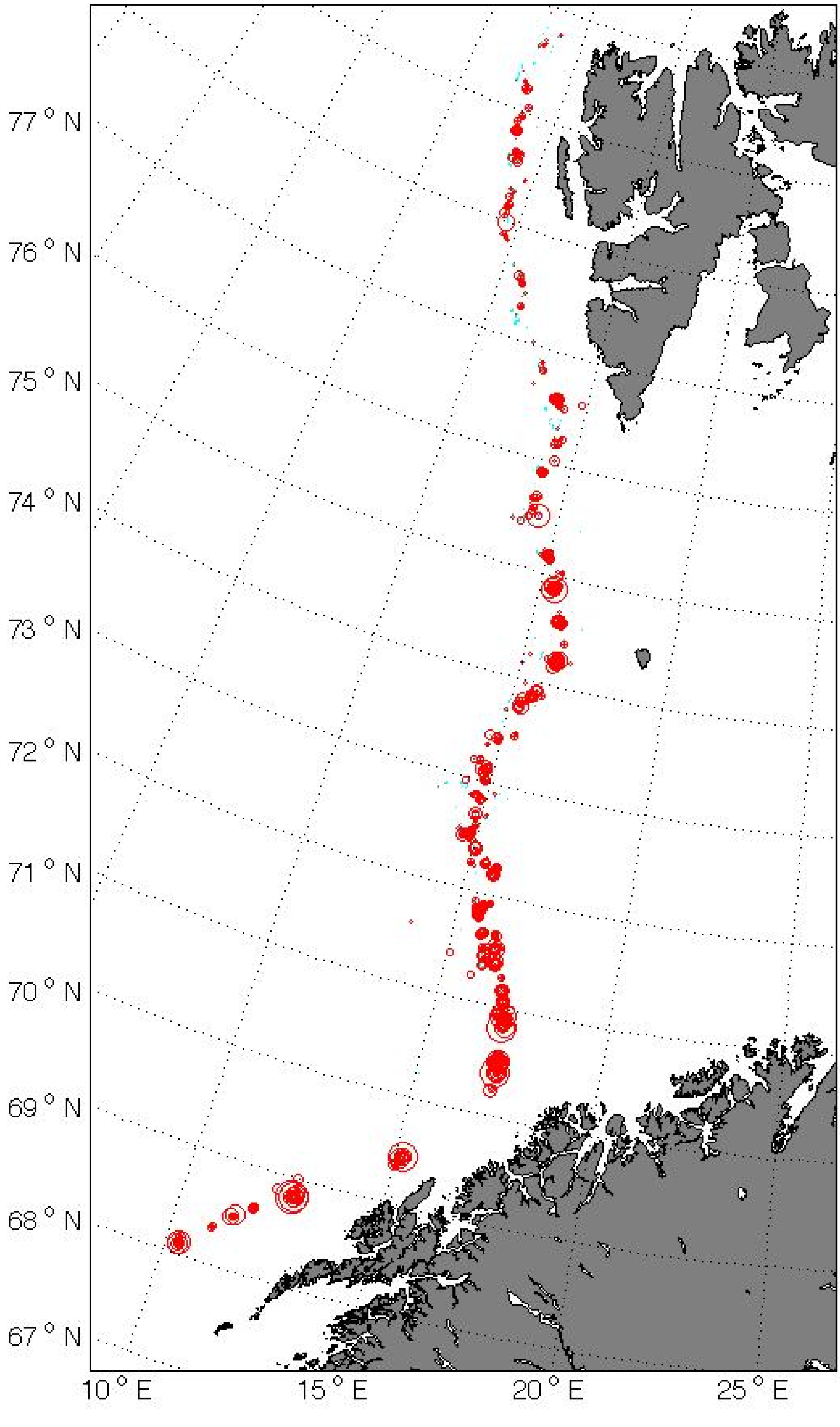

Figure 1. Distribution of survey catches of roughhead grenadier, 1997-2013. Maximum bubble size is 909 g.nmi^{-2}

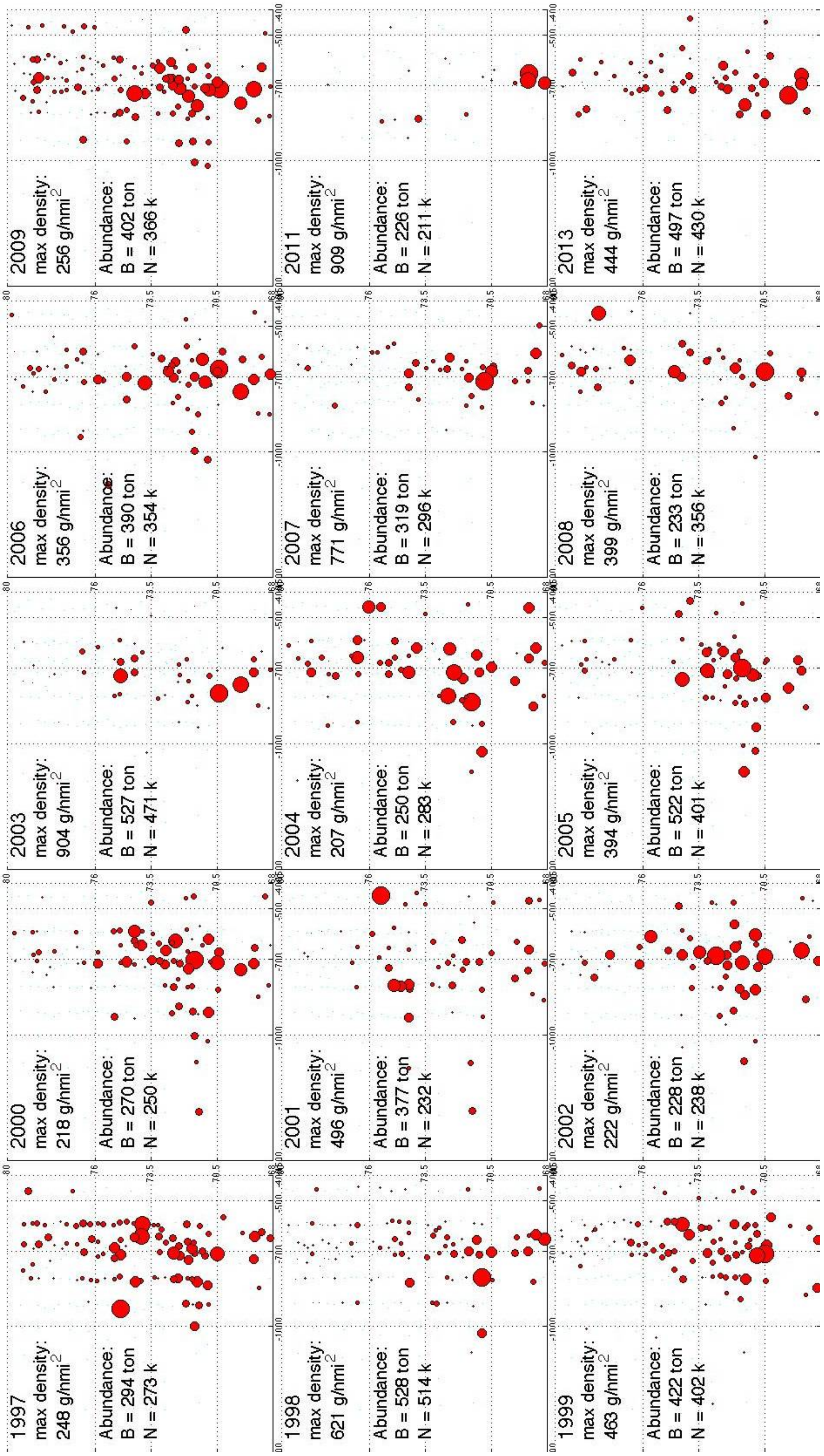

Figure 2. Distribution of survey catch rates by latitude and depth, 1997-2013. Bubble size is proportional to density within one survey year with same maximum bubble size in each survey year (hence same bubble size corresponds to different densities from year to year).

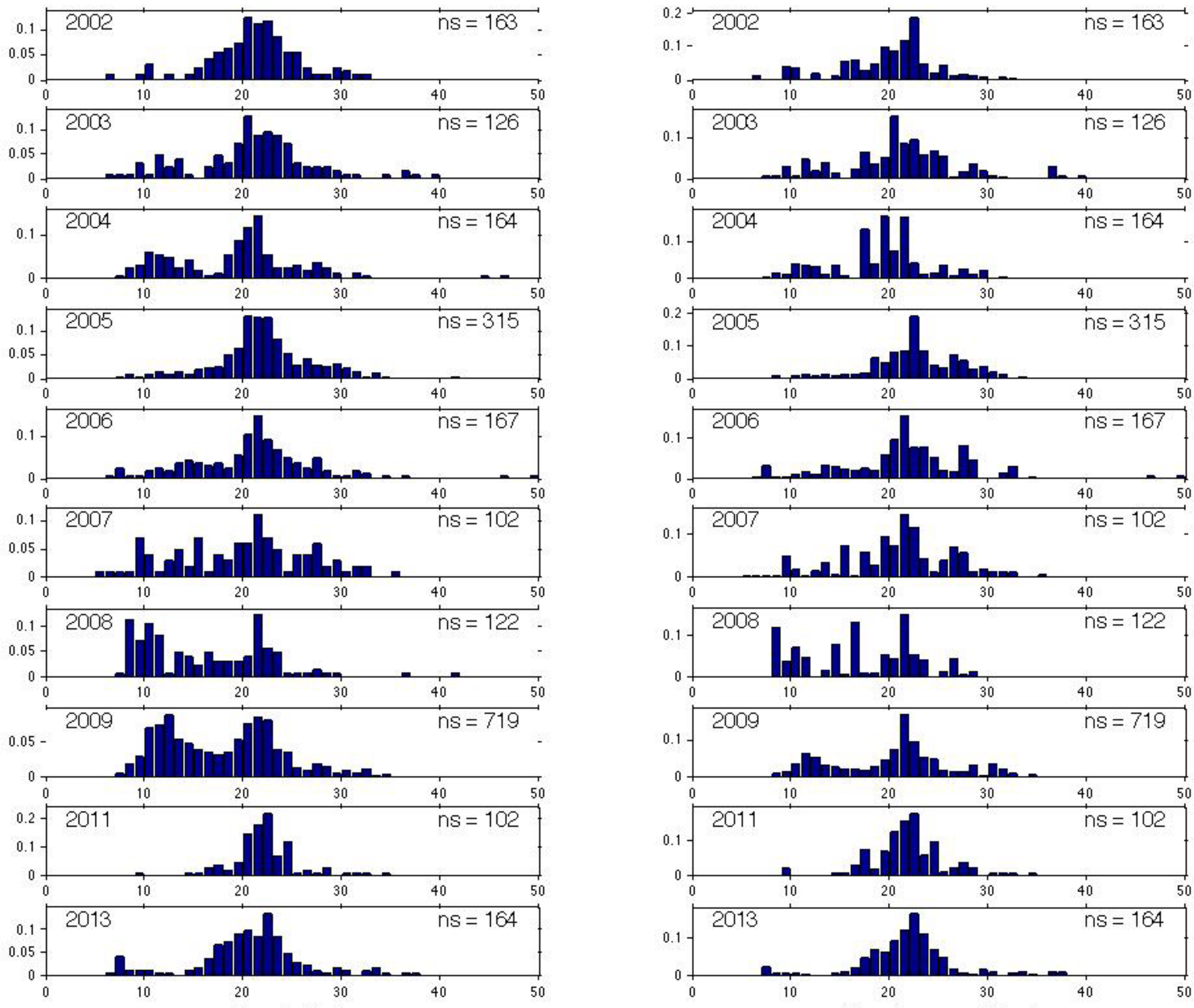

Figure 3. Size distributions of roughhead grenadier (PAFL, cm) from the surveys, 2002-2013.

Left panel: unweighted, Right panel: weighted with stratum density in numbers.

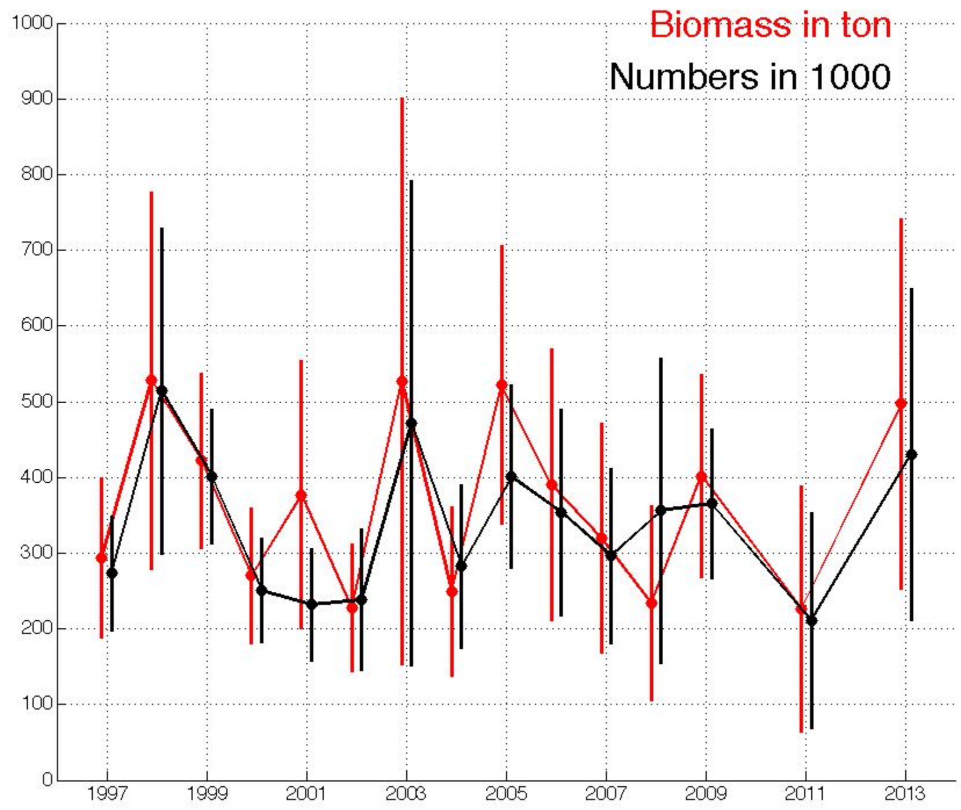

Figure 4. Estimates of abundance in numbers (black) and biomass (red) with approximate 95% confidence intervals. The same height on the y-axis for the red and black curves is synonymous with a one kg fish. Note that just above 300 at the y-axis the very most of the intervals cover this y-value, indicating no apparent temporal trend.

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Development of a standardized CPUE for ling and tusk based on Norwegian longline logbooks

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Abstract

Ling and tusk are important species for the Norwegian longline fishery. Based on the logbook data, we constructed two CPUE series for the period 2000 through 2013: one based on all the data and a series based on selected catches that seemed to have targeted ling and tusk. It was concluded that these CPUE series indicated that the abundance of ling in most of the ICES subareas has been fairly stable or increasing since 2000. Even though both series indicated increasing abundance, estimates of how much the ling and tusk stocks has increased depended on the data set on which the CPUE series was based.

1. Introduction

Ling (*Molva molva*) and Tusk (*Brosme brosme*) have been fished by Norway for centuries, and the amount landed has been recorded since 1896. Most of the commercial catch of ling and especially is taken by longline vessels, either as the target species or as bycatch (ICES, 2012). Although the fishery is widespread, between 70 to 80 percent of the Norwegian catch is taken on the Norwegian continental shelf.

Scientific surveys do not cover the main habitats occupied by ling (Helle and Pennington, 2004). Consequently, to track the health of the stock it is necessary to develop indicators based on commercial data. For the Norwegian longline ling fishery, there are two sources of data for assessing the condition of the stock; the official landing statistics, and the logbook records collected by the Norwegian Directorate of Fisheries.

The annual ling landings may reflect trends in the state of the stock, but this signal is confounded to a very large degree by changes in fleet size and pertinent fishery regulations. Therefore, total landings may not be a good indicator of the condition of the ling stock. In particular, the longline fleet has experienced large changes in vessel and gear efficiency over the last 60 years (Bjordal and Løkkeborg, 1996). The vessel efficiency increased greatly in 1977 due to the introduction of autolines, which are longlines that are automatically baited, and by the end of the 1980s the fleet consisted of about 53 vessels larger than 21 m, and about 95% of the vessels were equipped with autolines (Magnusson et al.,1997). From 1977, the year autolines were introduced, the number of vessels in the fleet increased continuously until 2000.

Because of the large and increasing longline fleet, the fishery authorities, and even the fishers, were concerned that the fishing pressure would become too great. Therefore, regulations were introduced in 2000 that resulted in the reduction of the number of boats in the fleet from 72 in 2000 to 35 in 2006. In addition to changing the regulations for the ling fishery, the Institute of Marine Research (IMR), in cooperation with the Norwegian Directorate of Fisheries, decided in 2003 to develop a more precise ling CPUE series based on fishers' logbooks to monitor the stock more closely.

Since 2006 the size of the fleet has been rather stable. Other than changes in fleet size, there have been few significant changes in fishing techniques or vessel characteristics since 2000.

A standardized CPUE series have been developed using GLM to follow the development of the two species based on all available data and one where the total catch of ling or tusk exceeded more than 30 % of the total catch in one day

2. Materials and methods

2.1 Data sources and stratification

The Norwegian Directorate of Fisheries provided the logbook records for longliners in the fleet that were longer than 21 m and had a total landings of ling (*Molva molva*), tusk (*Brosme brosme*), and blue ling (*Molva dipterygia*) greater than 8 tons in a given year. These data included the total daily catch, where the vessel was fishing, and the number of hooks set each day.

The number of logbooks collected varied considerably over the time series. From 2000 to 2010 only handwritten logbooks were available, while from 2011 all vessels delivered electronic logbooks. In 2010, a transition year, comparably few logbooks were submitted (Table 1).

There are no ling quotas for Norwegian longliners, only a licensing scheme that limits the total number of longline vessels.

2.2 All catches or targeted catches: two data sets

At a meeting with scientists, representatives of the Norwegian longline fleet suggested that a CPUE series for ling in Norwegian waters, which was based on all catches, would include catches whether or not ling or tusk were targeted. Unfortunately, the handwritten logbooks do not record the target species. Therefore, the longline fishers recommended that the CPUE series for ling should be based only on those daily catches for which ling were more than 30% (in weight) of the total catch.

In this paper, two data sets were used to generate CPUE series for ling. The first series was based on all the data. The second data set was the one suggested by the longline fishers; to include only sets that seem to have had targeted ling or tusk, that is those catches containing 30% or more by weight of ling.

2.3 Calculating CPUE series

The two CPUE series for ling were estimated using a generalized linear model (GLM; see, for example, McCulloch and Searle, 2001; Bishop et al., 2004; Maunder and Punt, 2004; Venables and Dichmont, 2004; Yu et al., 2011). In particular, the model

$$y_{i,j,k,l} = c + \mu_i + \alpha_j + \beta_k + e_{i,j,k,l} \qquad (1)$$

was found to be appropriate where: $y_{i,j,k,l}$ is the catch (kg) per hook in year i, month *j* for set *l* by vessel *k*; *c* is a constant; μ_i, *i* = 2000-2013, is the year effect; α_j, *j* = 1-12, is the month effect; β_k is the vessel effect, *k* depends on the data set; and $e_{i,j,k,l}$ is the error term.

3. Results

In Figures 1 and 2 are graphs of the estimated CPUE series for the most important ICES subareas for the ling and tusk fishery: one based on all available data, and a series based on only those catches that ling and tusk appeared to have been targeted; along with the estimated 95% confidence intervals.

For ling there is a positive development in CPUE for all areas. Norway has not been allowed to fish in area Vb since 2010, and thus only a few catches from international waters are available. This may bias the estimates and, therefore, the series may not represent the true development of the stock. A large part of Rockall (area VIb) was closed for fishing in the beginning of 2007. After 2007 the CPUE for ling has increased considerably.

Also for tusk there has been a positive development in all areas except in area VIb where the CPUE series declined from 2000 to 2006 and after this series has remained stable though at very low level.

4. Discussion

The two CPUE series for ling and tusk resulted in CPUE series that generally showed similar trends (Figures 1 and 2). In particular, all series indicated that the abundance of ling and tusk increased significantly during the time period 2000-2013 (Table 2). The Norwegian logline fleet has been rather homogenous over the last 15 years; however there have been some changes, such as different hook types and baiting machine upgrades, none of which appeared to affect the CPUE estimates. For example, the greatest change was that the average number of hooks set per day has increased from 31 000 in 2001 to 37 000 in 2012, while the average catch versus the number of hooks set increased linearly, that is the average catch per hook did not depend on the number of hooks set (Helle and Pennington, in prep).

Our results showing a stable or increasing CPUE along with the fact that there was not any downward trend in landings, suggest that ling and tusk are not being overfished in any of the ICES subareas, or at the least that there was no scientific evidence to that effect.

As always, it should be emphasized that commercial catch data are typically observational data: that is there was no scientific control on how or from where the data were collected (see, for example, Rosenbaum, 2002). Therefore, the level of uncertainty associated with any conclusions based on such observational data is often unknowable.

The unfortunate classification of ling as Near Threatened in 2006 (Kålås et al. 2006), leading to its inclusion on the Norwegian Red List, is an example of how a CPUE series based on observational data can result in the incorrect conclusion that a stock is being overfished (ICES, 2006). In 2010 ling was taken off the Norwegian Redlist (Kålås et al., 2010). Because of the red listing, the sales of ling in the important Swedish market have declined 30% since it was red listed (personal communication, Bengt Gunnarson). On the other hand, there are also examples of a stock being considered in good condition, based on a misleading CPUE series, resulting in disastrous consequences (Hilborn and Walters, 1992; Walter and Maguire, 1996; Pennington and Strømme, 1998; Pilkey and Pilkey-Jarvis, 2007).

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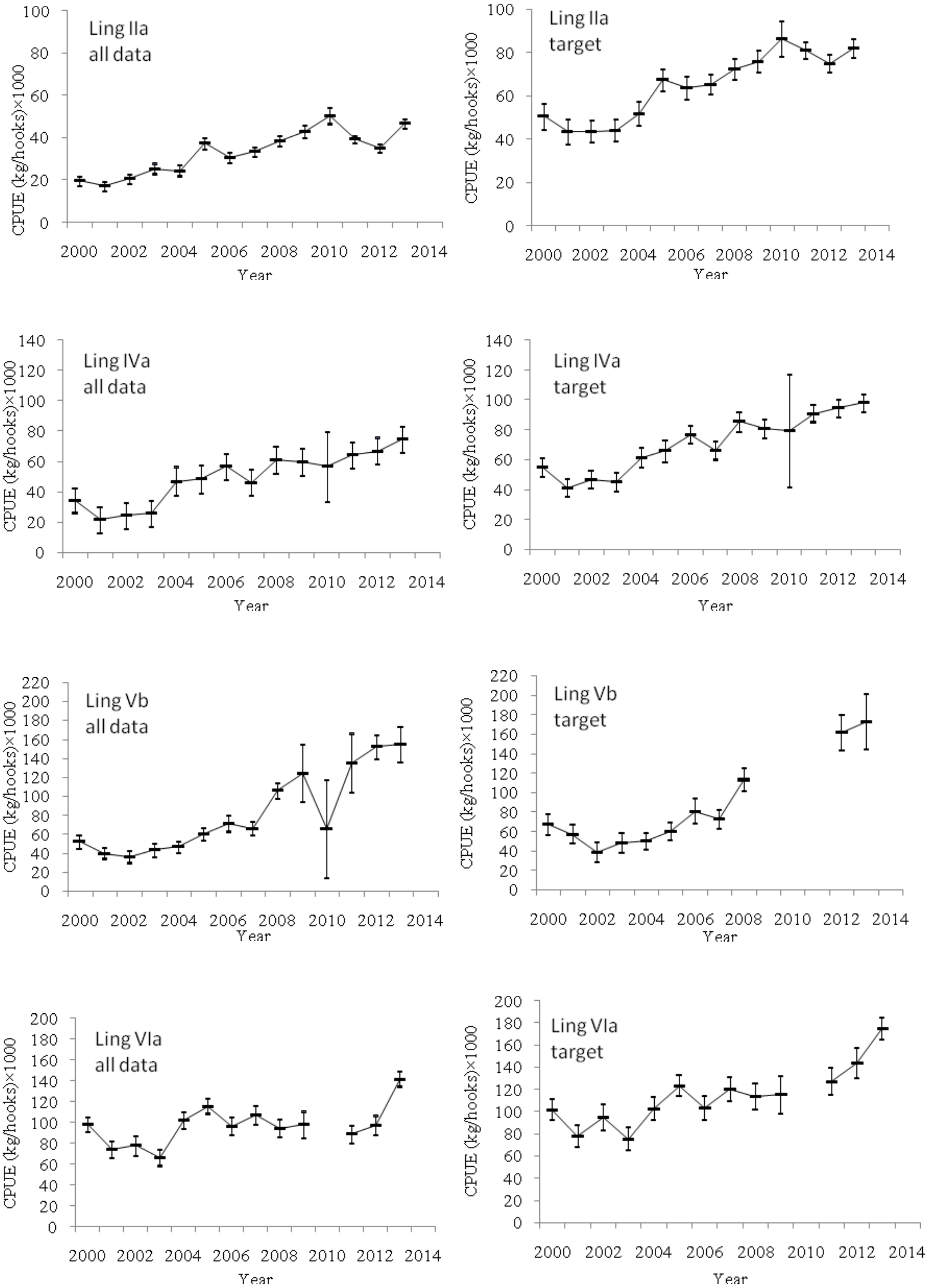
Ling IIa
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Ling VIa
all data
Ling VIa
target
CPUE (kg/hooks)×1000
Year

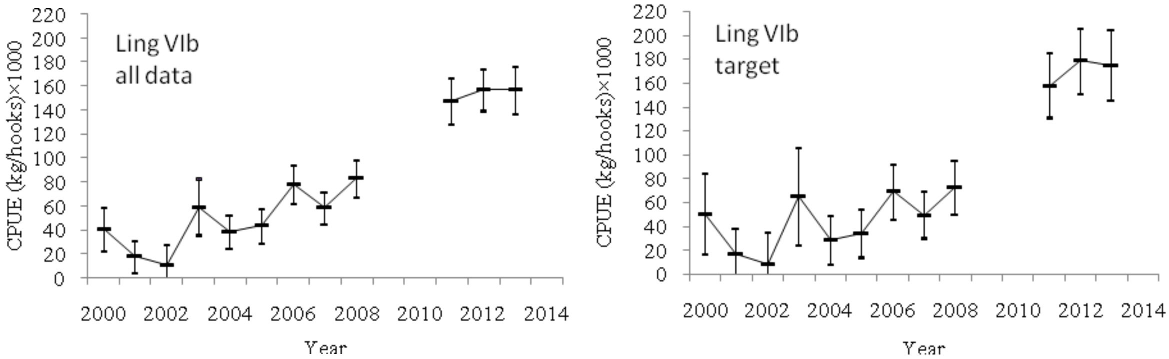
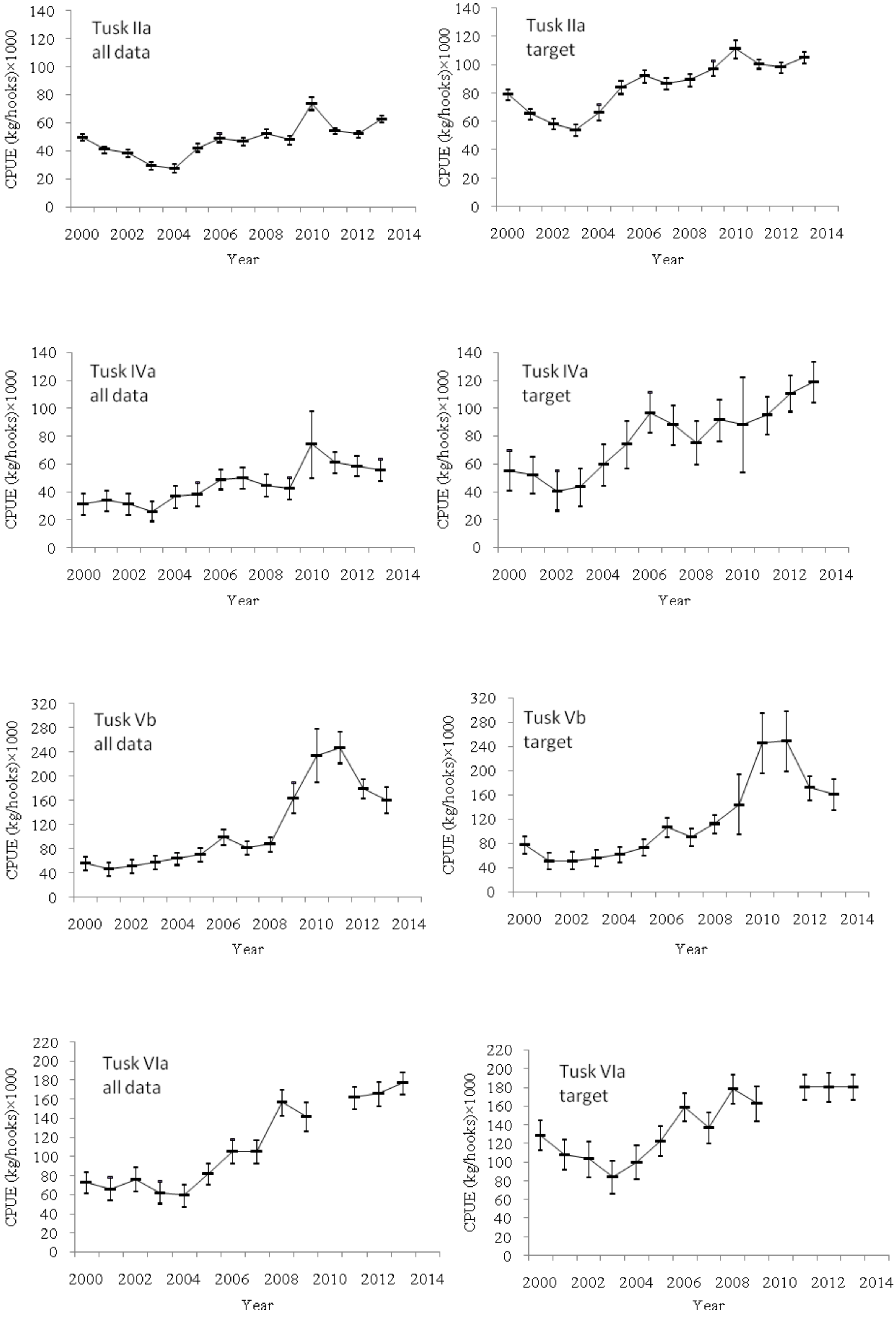


Figure 1. Estimates CPUE (kg/1000 hooks) of ling in Subareas IIa, IVa, Vb, VIa and VIb based on skipper's logbooks (during the period 2000-2013. The bars denote the 95% confidence intervals).


Tusk IIa
all data
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Tusk VIa
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CPUE (kg/hooks)×1000
Year

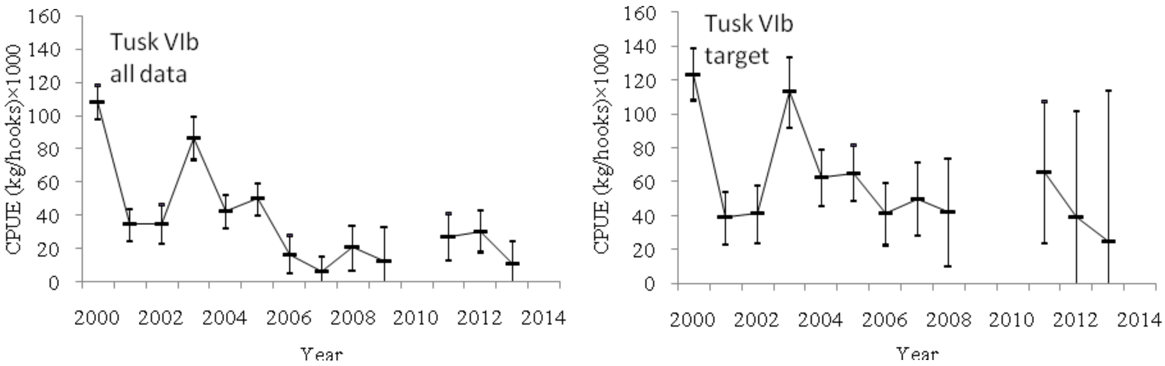

Figure 2. Estimates CPUE (kg/1000 hooks) of tusk in Subareas IIa, IVa, Vb, VIa and VIb based on skipper's logbooks (during the period 2000-2013. The bars denote the 95% confidence intervals).

The ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP 2013).

Genetic differentiation of black scabbard fish *Aphanopus carbo* and *Aphanopus intermedius* at the 2012 and 2013 Azorean commercial landings.

By

Ana Besugo, Gui Menezes and Hélder Silva

Introduction

In the Azores, the intensification of traditional fisheries, created a need to explore new fishing grounds and resources, particularly deep (>700m) (ICES, 2012). The black scabbard fish has been one of the resources (among others) for which incentives have been introduced in order to develop a target species as a fishing diversification plan to remove effort from the traditional demersal/deep water species. Experimental fishing started in 1990, was intensified after 1998 (Machete *et al.*, 2010) but only recently (last three years) became a target fishery more consolidated.

Landings of this species have been increase considerable during the last two years (139t in 2011 and 458t during 2012) being predicted an increase on the landings during the next years as a consequence of the effectiveness of the actual incentives to the exploitation and commercialization. However, there is no specific quota for the Azores fleet (ICES sub area X) being the actual TAC shared with mainland (ICES sub area IX) assuming that all the stock in the Atlantic is *Aphanopus carbo*. ICES, has been suggested that effort targeting *A. carbo* should not be permitted to increase until sustainability being demonstrated (ICES, 2012). Azorean fishing sector have been argued that two species occurred in the sub area X and CECAF areas in order to justify the development of a local fishing.

Monitoring of the actual fishery is done under the European Data Collection Framework (DCF). However, because two species are identified in the Azores (*Aphanopus carbo* and *Aphanopus intermedius*) (Nakamura and Parin, 1993) studies to discriminate the populations on the landings have been suggested in order to adjust the management and monitoring process. Recent studies (Biscoito *et al*., 2011) have been suggested that it is possible to separate the two species by counting of the vertebras, as suggested by Parin (1983). Recent results from the Azores (MARPROF project unpublished data), based on counting of the vertebras, suggested a proportion of X% A. intermedius. Results from these studies suggest that *A. intermedius* is more abundant on the landings. From a recent request from the Azorean Government a genetics study was developed in order to better understand the structure of catches.

This paper has the objective to analyse and describe the proportions of occurrence by species of black scabbard fish (*Aphanopus sp.*) on the Azores landings using genetics techniques.

Materials & Methods

Sampling

Samples were taking from the Azorean vessels licensed for the black scabbard fish and landing on the Azores ports of Faial, Terceira and São Miguel islands (ICES sub area X) during 2012 and 2013, following a random stratified sampling plan. Within each port landings were randomly selected and 30 individuals of black scabbard fish were sampled randomly (following the stratification by size whenever applied on the landings) from each.

Statistical information about the catch (location, depth, gear type, effort, etc.) was recorded for each landing. Biological sampling was performed on the selected individuals measuring (total length) to nearest cm all individuals. From each animal sampled a piece of gill (avoiding undervalued the commercial value of the fish) was removed for genetics analysis, following a specific sampling protocol to avoid sample contamination. Tissue samples were preserved in 95% alcohol and maintained until the extraction of genomic DNA.

Genetic analysis

The laboratory technique consist in extracting the total genomic DNA by cutting small portions of the previously collected tissue (1-3mg of tissue), and extracting the DNA with the help of a DNA extraction kit. The extraction process using the kit consists basically in digestion of the cells of the tissue sample, washing to remove impurities DNA from the cells and eluting the DNA. Then it will proceed to the amplification of mitochondrial DNA regions corresponding to the Control Region (CR) and cytochrome oxidase subunit I (COI) by the technique of Polymerase Chain Reaction (PCR) using the primers and reaction conditions as described in Stefanni *et al.* (2009). This technique referred to as "restriction fragment length polymorphism" (RFLP-PCR) involves the application of enzymes cutting in post-PCR products. The main action of these enzymes is to recognize certain sequences of nucleotides that bind to a specific sequence and make a cut that area.

Closely related species, such as the black scabbard fish, despite having very similar sequences have some differences. These differences are represented by the nucleotide sequences in areas that are recognized by these enzymes. Just after the application of enzymes cutting the PCR products will proceed to prepare an electrophoresis gel such products where you can see the profile of cuts made through the number of bands present on the gel (Fig. 1 and Fig. 2). The profile of the bands is different for each species of black-blade being possible to distinguish them easily without resorting to more expensive techniques such as sequencing.

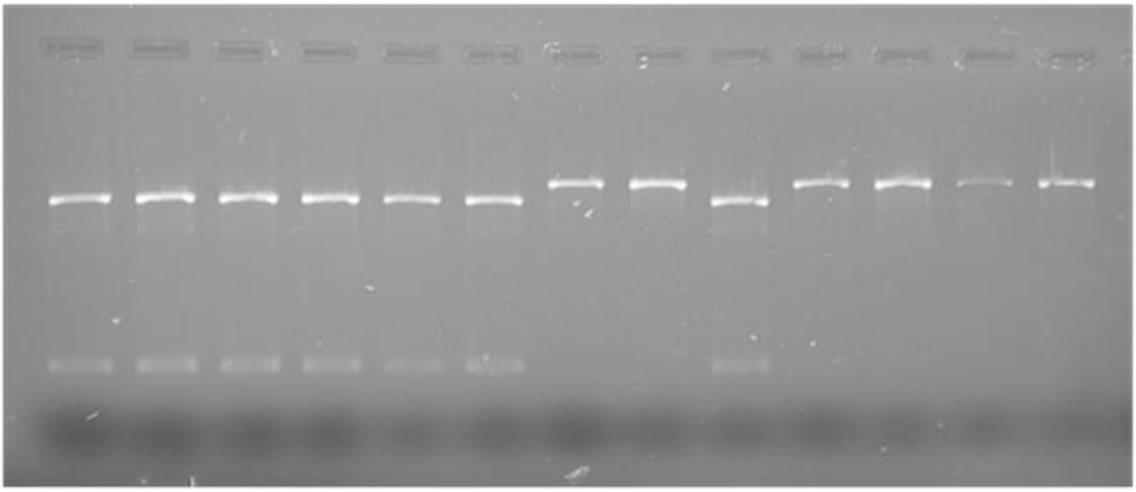

Fig. 1 - CR after cutting (or no) enzyme HaeII. From left to right, the type of profile identifies the presence of 6 *A. intermedius* followed by 2 *A. carbo*, 1 *A. inermedius* and finally 4 *A. carbo*.

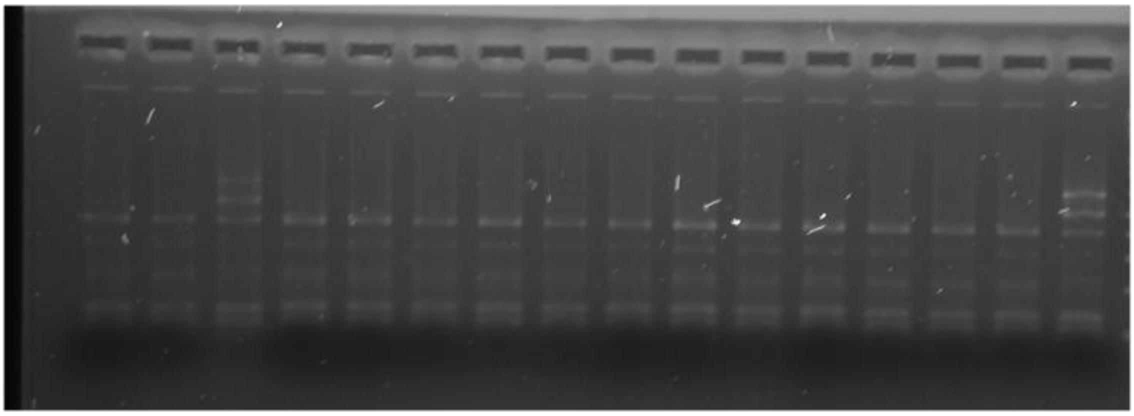

Fig. 2 - COI after enzyme Sau3AI cuts. From left to right, the type of profile identifies the presence of 2 *A. carbo* followed by 1 *A. intermedius*, 12 *A. carbo* and finally 1 *A. intermedius*.

Results

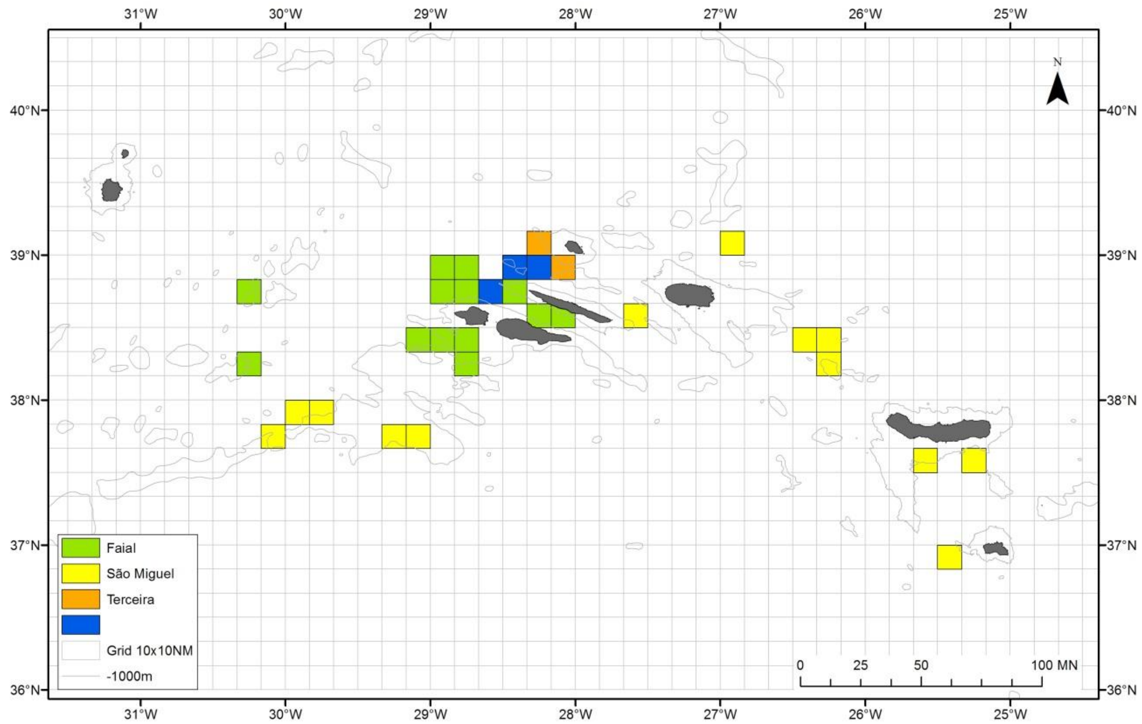

Fig. 3 - Map with catch locals of black scabbard fish

Table 1- Summary of the samples tested so far and the number of samples identified as *A. carbo* and *A. intermedius*.

	Total
Aphanopus carbo	293
Aphanopus intermedius	865
Total	1158

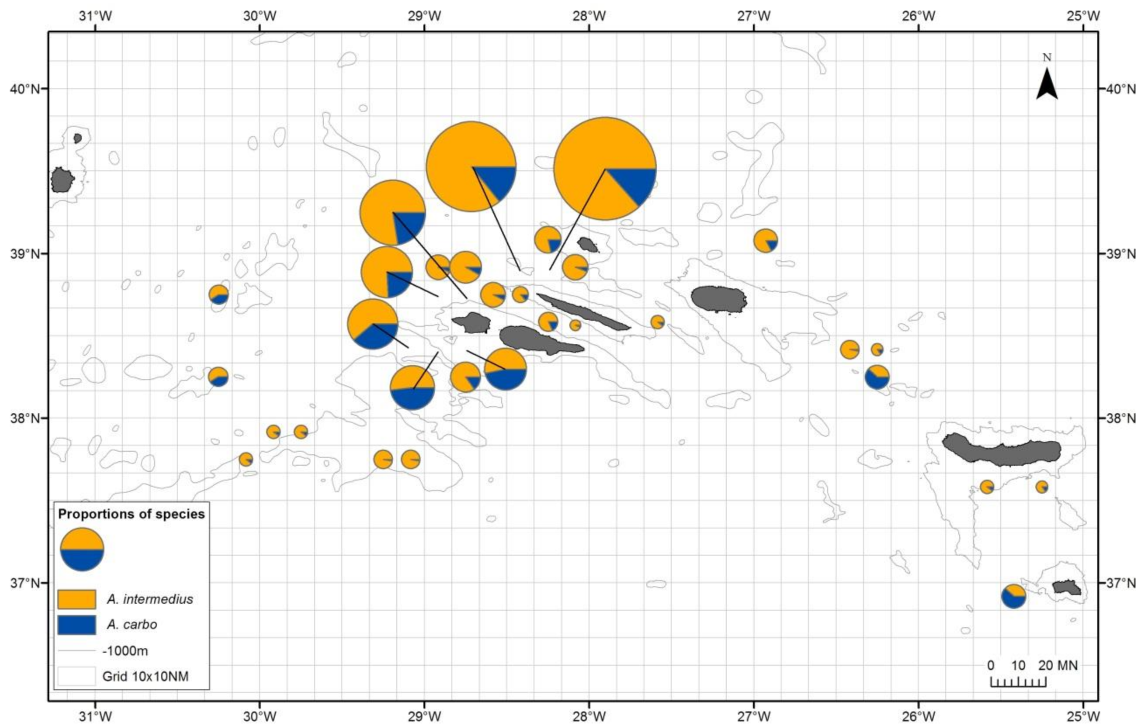

Fig. 4 - Proportion of species of black scabbard fish by fishing statistical rectangle in the Azores archipelago.

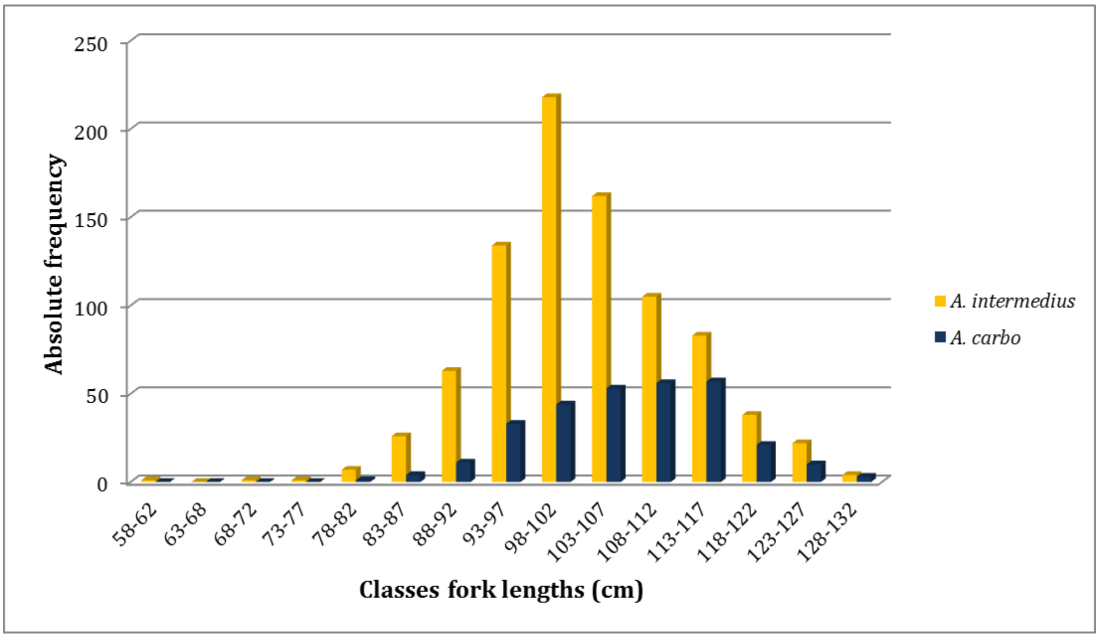

Fig. 5 - Absolute frequencies observed for the length classes of the two species of black scabbard fish in the Azores archipelago.

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ICES (2012). Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources. ICES Document CM 2012/ACOM: 17. 942 pp.

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Stefanni, S., Bettencourt, R., Knutsen, H. and Menezes, G. (2009). Rapid polymerase chain reaction–restriction fragment length polymorphism method for discrimination of the two Atlantic cryptic deep-sea species of scabbardfish. Molecular Ecology Resources, 9: 528–530.

WD 06 ICES WGDEEP 2014

Stock assessment of greater silver smelt in Faroese waters (Vb).

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Introduction

In this working document, we highlight the issue of the definition of assessment/management areas for greater silver smelt (GSS) in the North Atlantic. We also present an age based assessment of GSS in Faroese waters.

Stock description and assessment/management units

The definition of assessment/management units for greater silver smelt has been an issue in WGDEEP for several years and in the benchmark of GSS in 2010, this issue was discussed- but still no agreement was reached (WKDEEP, 2010). Traditionally, ICES has recognised two population management/assessment units: 1) GSS fished in Va (Iceland) and 2) GSS-others which is GSS fished from sub area I (Barents Sea) in the north to sub-area X (Iberian Peninsula) in the south (WGDEEP, 2013).

Recently, however, there have been suggestions to change the definition of these assessment areas. In WGDEEP 2013 it was stated by the group that: 'There is insufficient scientific information to establish the extent of putative stock; however, greater silver smelt may be sufficiently isolated at separate fishing grounds to be considered as individual assessment units. On this basis advice is presented for the following units: 1) Division Va (Iceland); and 2) Subareas I, II, IV, VII, VIII, IX, X, XII, and XIV, and Divisions IIIa and Vb (other areas). The latter group is a combination of isolated fishing grounds and these areas are grouped due to their mutual lack of data. WGDEEP suggests that fishing grounds in area Vb and fishing grounds in area I-II may also be sufficient isolated to be considered as individual assessment units. In both areas ripe fish is commonly found both in catches and in surveys and might indicate separate spawning grounds.' Also, in the 2013 advice for GSS ACOM stated that 'greater silver smelt may be sufficiently isolated at separate fishing grounds to be considered as individual assessment units'.

One benefit of having several assessment units, rather than just two, is that the advice becomes more relevant to these respective fisheries. In this working document, we suggest to adopt four assessment units: 1) Icelandic waters (Va), 2) Norwegian waters (I, II, III, IV), 3) Faroese waters (Vb), and 4) EU-waters (VI, VII, VIII, IX, XII). The criteria to split GSS into these assessment/management units are mainly the separate fishing grounds and there are three major directed fisheries in the northeast Atlantic which are off Iceland, Faroe Islands and Norway. In addition, there are life history data such as local observations of pelagic larvae, juveniles and spawning fish in Iceland, Faroes and Norway (WDs in WKDEEP, 2010; Bergstad, 1993) that support dividing these areas into separate assessment/management units.

Other organizations have also suggested that the GSS fishery in Faroese waters should be regarded as a separate management unit. In connection with the MSC certification of the fishery for GSS in Faroese waters, it is stated that 'there is no apparent reason why this assessment should not be put on a par with that for Icelandic GSS fishery and assessment, a fishery and assessment for which the assumptions concerning stock isolation seem to no more nor less robust than those upon which the FaMRI assessment is based' (www.dnv.com, Report No. 2013-021).

1 The fishery

Historically, greater silver smelt were only taken as bycatch in shelf-edge deep-water fisheries and either discarded or landed in small quantities. Targeted fishery for GSS in Faroese waters did not develop until the mid-1990s. In 2013 the three pairs of pair trawlers fished 13860 t greater silver smelt in Faroese waters (Figure 1). The decrease in catch during the last two years (2012 and 2013) can be because the trawlers also participated in the mackerel fishery. The landing presented are the official landings from 1985-2013, but for the period after 2008 is the Faroese landings in VIa added since the fishery in VIa is inside the Faroese 200 nm EEZ just south of Vb border (Figure 1, 2).

The geographical range of the directed GSS fishery in Faroe Island was in 2013 west and north of the Faroe Plateau, around the Faroe Bank, Lousy Bank and on the Wyville-Thompson ridge south of the Islands (Figure 2). The fishing depths were around 300-700 m. The fishery has explored new fishing sites during the period and the newest fishing site was on the Wyville-Thompson ridge south of the Islands (Annex 8).

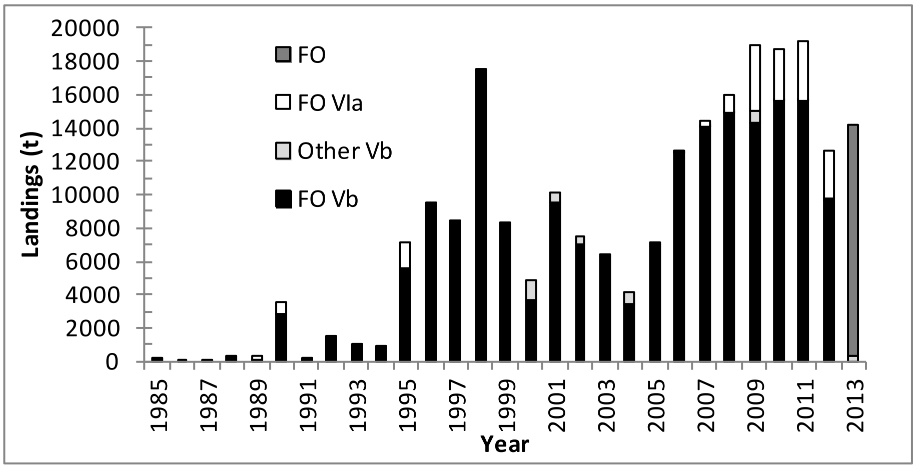


Figure 1. GSS Vb. Landings of GSS from Faroese trawlers. The total catch is higher than reported ICES catch in Vb for 2008-2012 because the catch caught by Faroese fleet in VIa is added to the total catch in Vb (fished just south of the Vb ICES border but inside the Faroese 200 EEZ border).

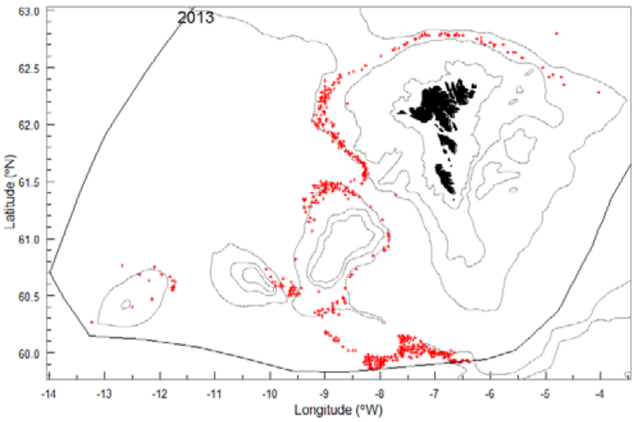


Figure 2. GSS Vb. Distribution of GSS trawl hauls in 2013 where GSS was more than 50% of the total catch.

2 Landings

In the period from 2008 to 2013 the fishery has adopted their own harvest-control rule in the sense that they don't fish more than 20 thousand tons per year. In the WGDEEP 2009 report an exploratory assessment for GSS in Faroese waters was presented, with 20 thousand tons per year set as an upper limit for a sustainable fishery.

3 ICES Advice

The ICES advice in 2011 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.'

The 2012 advice for this stock is biennial and valid for 2013 and 2014 (see ICES, 2012): Based on the ICES approach for data-limited stocks, ICES advices that for GSS in other areas than Va catches should be no more than 31 300 tonnes.

4 Management

For the Faroese fleets, there is no species-specific management of GSS in Vb, although licenses are needed in order to fish. The recommended minimum landing size is 28 cm. Other nations are regulated by TACs. Details on management measures in Faroese waters are given in the Faroe overview.

The Faroese GSS fishery is at the moment managed by an agreement between the Faroese GSS fishery fleet and the Faroese authorities, guided by the stock assessment and scientific advice of FaMRI. The current agreement is that total annual landings should not exceed 18 thousand t.

5 Data available

5.1 Landings and discard

Landing data from Faroese vessels are provided by the Faroese Coastal Guard and the data for 2013 is preliminary. Discarding is banned in Faroese waters and there is no available information on GSS discard.

5.2 Length composition

The majority of the landed GSS in Faroese waters is still between 30 and 45 cm in length, with a mean length varying from 36 to 39 cm during the last 13 years. The length distribution from the commercial catches is presented in Figure 3 and for the surveys in Figure 4 and Figure 5. The mean length in the groundfish surveys varied from 26 to 34 cm in the spring and 26 to 30 cm in the summer. The mean length from the landings has decreased since 1994 from around 45 cm to 38 cm in 1999. Since then the mean length has fluctuated between 37.4 and 39.5 cm. The reason for the decrease in mean length is thought to be directed fishery on a virgin stock (WD WKDEEP 2010). The variation in mean length from the latest years could be due to sampling from different depths in the various areas, as the size of GSS is increasing with depth. In WKDEEP 2010 it was suggested to divide the length composition of GSS from the surveys into juvenile and mature individuals, and then calculate the mean length. This is done here, and there is no decrease of the mean length in the period 1994-2013 (Figure 6).

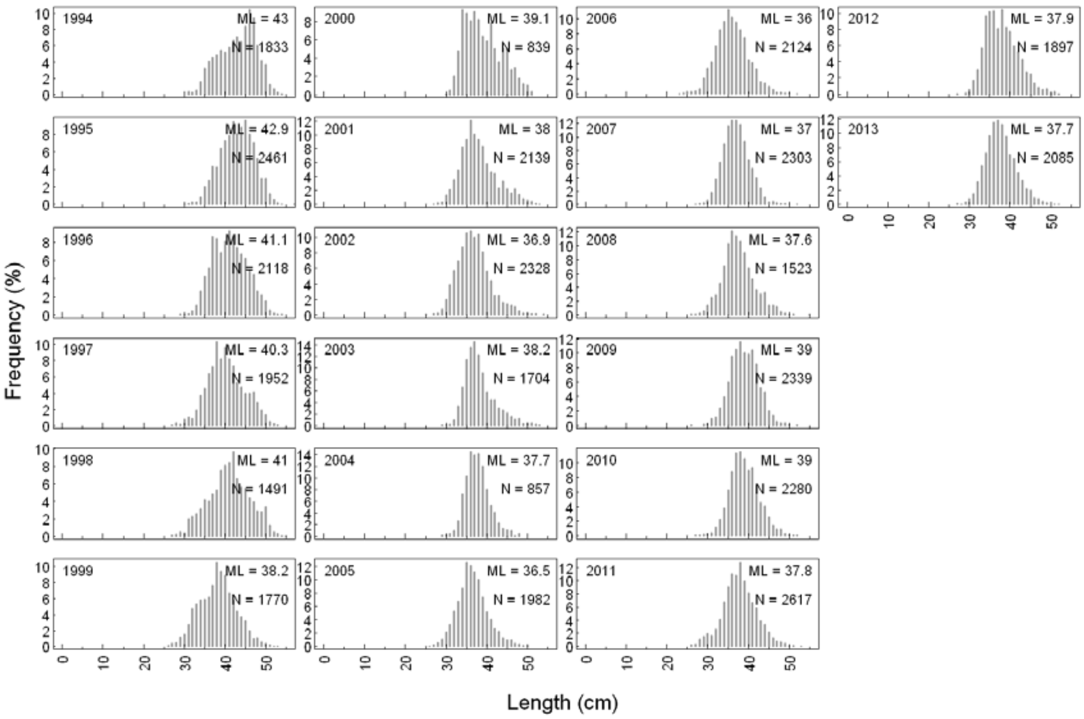


Figure 3. GSS Vb. Length distribution from the commercial trawl landings with mean length (ML) and number of measurements (N).

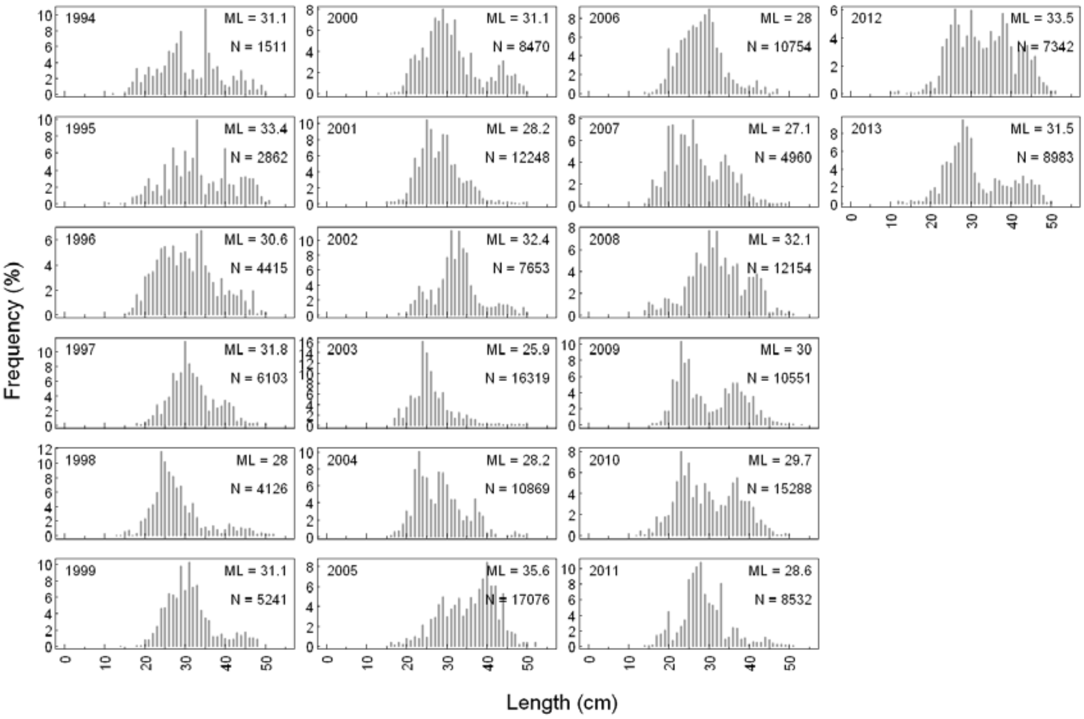


Figure 4. GSS Vb. Length distribution from the spring survey with mean length (ML) and number of calculated length measures (N). GSS is sampled from a subsample of the total catch, so the values are multiplied to total catch.

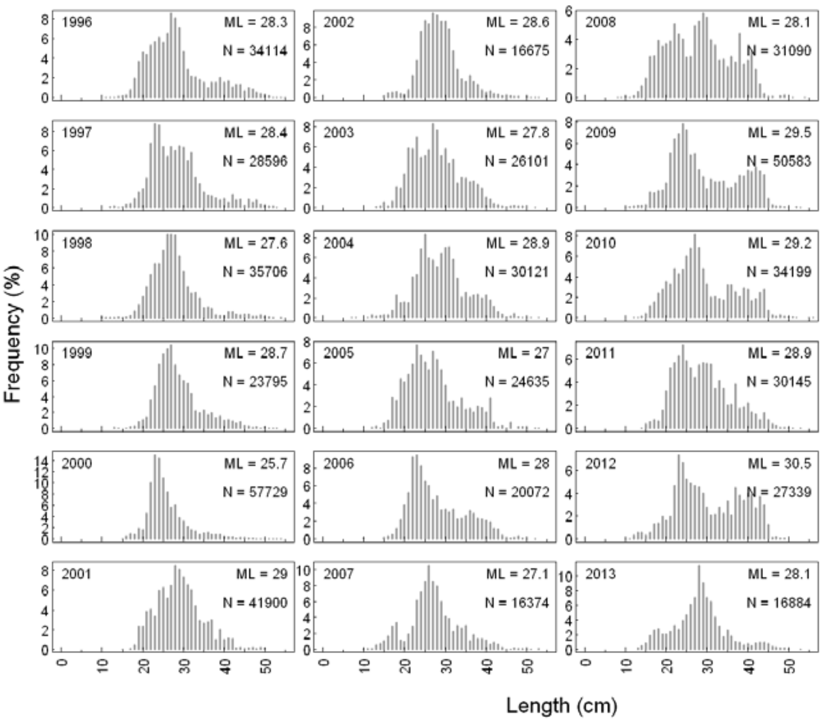


Figure 5. GSS Vb. Length distribution from summer survey with mean length (ML) and number of calculated length measures (N). GSS is sampled from a subsample of the total catch, so the values are multiplied to total catch.

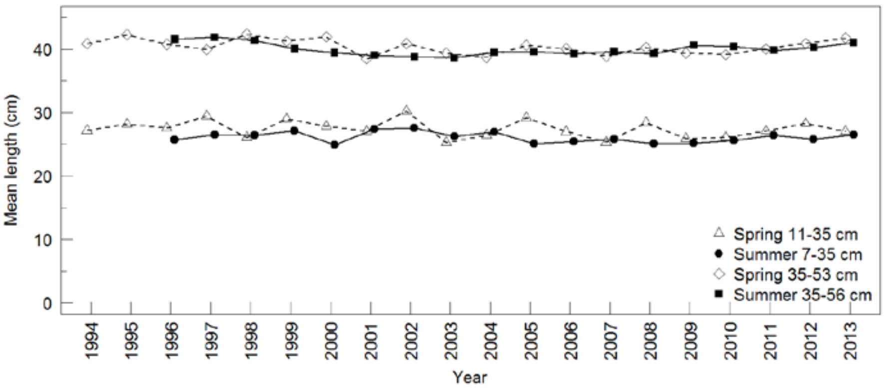


Figure 6. GSS Vb. Mean length for juvenile (<35cm) and mature (>34.9cm) GSS from the two annual groundfish surveys on the Plateau.

5.3 Age composition

The age of landed fish ranged between 4 and 29 years old fish. The age distribution, numbers of individuals available for calculation of ALK, as well as mean age of GSS from the landings in Vb is presented in Figure 7 and Table 1. The mean age in the landings decreased from 13 years in 1994 to 10 years in 2001 and has since then fluctuated between 9-12 years. The increase in mean age the last three years could be due to new and deeper fishing areas. Estimates of catch in numbers are given in Appendix 1.

A small-scale exchange of 50 GSS otolith images was done in 2013 (WKAMDEEP, 2013). The results of this exchange showed that the mean CV of all the 12 age readers was 7.5% and GSS was considered the easiest one to age by all age readers. The conclusion was that the precision is probably high enough to support age-structured analytical assessments (WGDEEP, 2013).

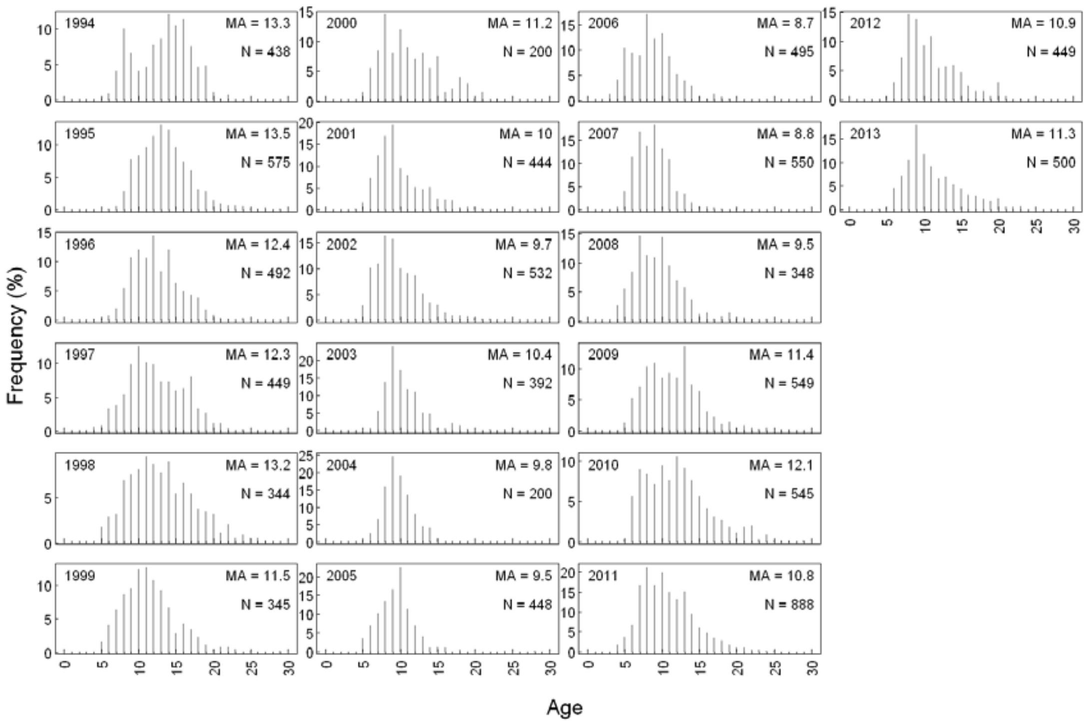


Figure 7. GSS Vb. Age distribution (rawdata) from commercial pair trawlers with mean age (MA) and number aged (N).

Table 1. GSS Vb. Number of gss ages from commercial landings each year and age.

	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+	Total
1994			1	4	18	44	29	18	20	34	38	53	46	50	33	20	21	9	438

1995				1	3	16	45	48	55	65	75	71	55	42	35	18	16	30	575
1996		1	1	4	10	31	59	71	60	77	43	60	32	24	21	19	9	10	532
1997		3	4	15	17	24	44	56	45	44	33	33	27	28	36	15	12	13	449
1998			11	17	17	42	32	31	35	30	29	32	19	23	19	13	12	32	394
1999			6	14	22	30	33	43	44	37	32	23	10	15	12	8	4	12	345
2000			3	11	17	29	16	24	18	14	16	11	15	3	4	8	6	5	200
2001		1	7	32	55	75	86	42	35	23	21	23	11	10	9	2	3	9	444
2002		1	15	54	58	87	83	53	48	46	27	18	16	8	5	5	4	4	532
2003				3	22	54	94	67	46	43	20	19	3	3	8	6	2	2	392
2004			1	5	13	32	49	38	27	16	9	8	2						200
2005			16	31	46	60	74	101	51	31	18	5	6	5		2		2	448
2006	6	20	51	46	44	84	60	66	43	25	19	14	4	2	6	3	2		495
2007		3	22	63	93	76	101	73	60	22	18	8	4	3	2	1		1	550
2008		9	19	29	51	39	38	50	33	24	20	13	4	5	1	3	5	5	348
2009			7	29	39	57	60	47	51	47	75	41	35	17	12	6	8	18	549
2010			2	31	49	46	39	52	42	58	50	42	31	23	17	15	10	38	545
2011		9	20	37	92	117	92	109	82	72	83	52	34	26	19	15	9	20	888
2012			3	14	36	73	69	46	54	27	28	29	23	12	7	7	3	18	449
2013		2	4	42	47	59	93	60	51	34	35	28	22	16	15	11	9	22	550
Total	6	49	193	482	749	1075	1196	1095	900	769	689	583	399	315	261	177	135	85	9158

5.4 Weight at age

There are no clear changes observed in the mean weight at age from commercial catches over the period of time (Figure 8, Appendix 2).

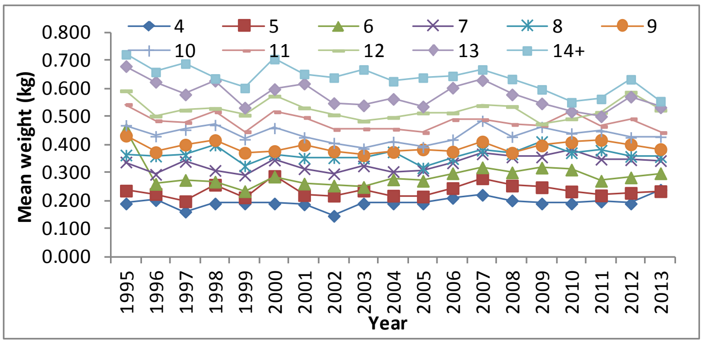


Figure 8. GSS Vb. Mean weight at ages 4-14+ of GSS in the commercial catch.

5.5 Maturity and natural mortality

Estimates of maturity ogive of GSS in Vb were done by using all available data from both surveys and landings and the results were presented at the WKDEEP-2010. In the assessment is proportion mature of gender combined used for all years (Appendix 3). Most of the GSS caught in commercial catches in Vb is mature.

The natural mortality used in the assessment is set at 0.1 and that value comes from a calculation done on the “virgin” stock and was presented in WKDEEP-2010.

5.6 Catch, effort and research vessel data

Catch and effort data of GSS in Faroese waters are available from the commercial fishery and from the groundfish surveys in spring and summer on the Faroe Plateau.

Catch per unit effort (CPUE) on GSS from the commercial fleet is calculated as a mean value for all trawl hauls where the GSS is more than 50% of the total catch per haul (Figure 9). A general linear model (GLM) was used to standardize the CPUE series for the commercial fleet where the independent variables were the following: vessel (actually the pair ID for the pair trawlers), month, fishing area and year. The dependent variable was the log-transformed kg per hour measure for each trawl haul, which was back-transformed prior to use. The reason for this selection of GSS hauls was to try to get a series that represents changes in stock abundance.

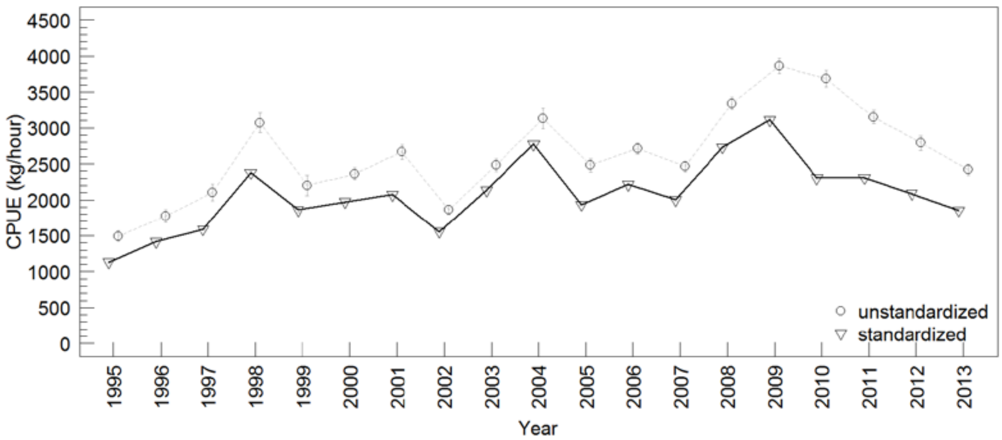


Figure 9. GSS Vb. Standardized CPUE from pair trawlers fishing greater silver smelt where catch of GSS is more than 50% of total catch in each haul. The vertical arrows present standard error.

CPUEs from the groundfish surveys on the Faroe Plateau (Figure 10) were noisy, probably due to the influence of large hauls in large strata or because the surveys do not cover the whole distribution area for GSS as most of the stations are shallower than 300 m. Even so, a closer look at the data on GSS from the summer survey compared with the commercial CPUE series showed a similar signal for the period 1998-2013 (Figure 11). The summer groundfish survey showed a larger variation between years than the commercial series. This could be because the groundfish surveys only cover a part of the GSS distribution area. The distribution of GSS on the Faroe Plateau and Faroe Bank covered by the survey are showed in Figure 12.

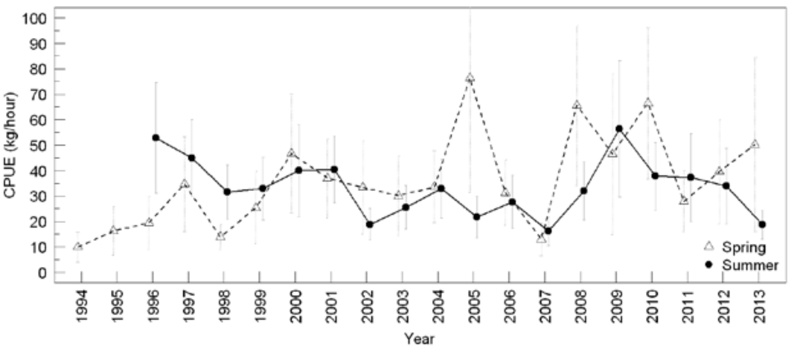


Figure 10. GSS Vb. Standardized CPUE from Faroese groundfish surveys on the Faroe Plateau. The vertical arrows present standard error.

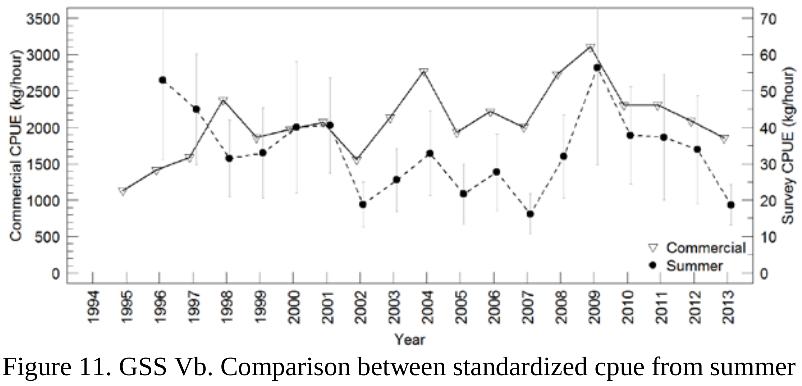


Figure 11. GSS Vb. Comparison between standardized cpue from summer groundfish survey and commercial trawler series. Plotting the two cpues against each other for the period from 1998-2013 gave this linear trend line equation: $y = 25.365x + 1406.9$, $R^2 = 0.4311$

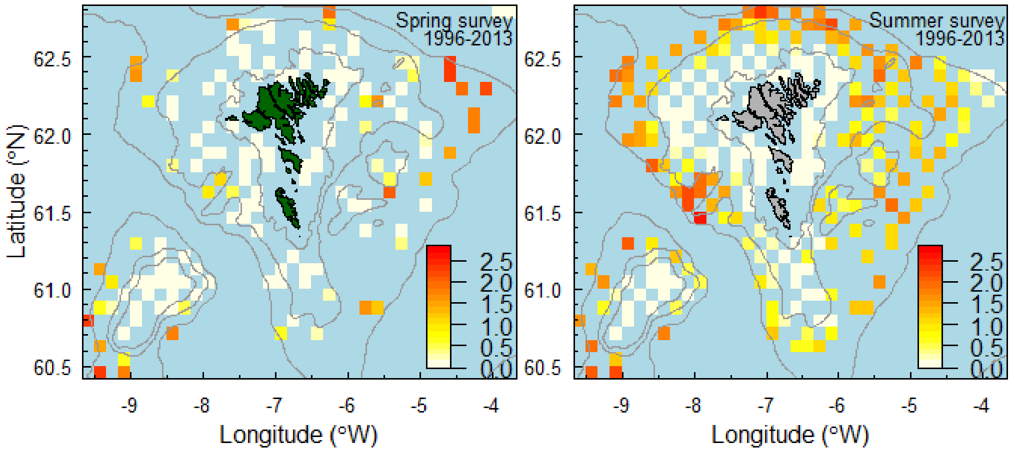


Figure 12. GSS Vb. Distribution of GSS in the annual spring- and summer groundfish surveys as average log(kg/hour+1). Depth contour line is for 100, 200 and 500 m.

6 Data analyses

Landings have increased in Vb from 1995 due to a directed fishery (Figure 1). In the period from 1995-2005 it varied from 4200 t in 2004 to 17800 in 1998. Since 2006 the catches in Vb have been quite stable around 14-15700 t except in 2012 it was 9800 t. Length and age compositions from the landings in Vb have decreased since 1994-2000 and have been stable since then (Figures 3 and 7). The reason for the decrease is thought to be directed fishery on a virgin stock (Ofstad, WD WKDEEP 2010). The variation in mean length from the latest years could be due to sampling from different depths in the various areas, as the size of GSS is increasing with depth. In WKDEEP 2010 it was suggested to divide the length composition of GSS in the survey into juvenile and mature individuals; to check if the trend in mean length changed over time. No change in trends for mean length is found for juveniles, while a slight decrease in mean length since the start of the series for mature fish (Figure 12).

CPUE

The standardized commercial CPUE series showed an increasing trend from 1995-1997 (Figure 9) and this period is treated as a 'learning' period, i.e. the CPUE is not believed to be proportional to abundance in those years and are not used in the assessment tuning series. Mean CPUE from 1998 to 2013 is around 2200 kg/hour. There has been a decrease in the commercial CPUE from around 3100 kg/hour in 2009 to 1900 kg/hour in 2013.

The survey CPUEs fluctuates (Figure 10). 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 changes in year values in the Faroese survey may be noise related. Comparing the CPUE from the summer groundfish survey with the commercial CPUE gave similar trends in the period from 1998-2013 (Figure 11). One need to keep in mind that the survey only cover a small part of the fishing area and the relatively shallow depth range covered by the survey will likely result in poor sampling of adult fish as larger individuals are generally found on greater depths.

Analytical assessment

An exploratory stock assessment of GSS in Vb using XSA was presented. It is basically an update of previous assessments, with new years added to the time series. The input data are presented in Appendix 1-4, XSA diagnostic in Appendix 5 and XSA output for fishing mortality and stock size in Appendix 6-7. The XSA model was tuned with a commercial cpue series (Figure 9, Appendix 4). The CPUE series was on beforehand treated by a Genereal Linear Model (GLM), which standardized the effect of vessel, month, and fishing area.

The XSA model fitted the cpue-data quite well (Figure 13, Appendix 5), at least when comparing with similar assessments of other fish stocks at the Faroes (eg. Faroe saithe).

The results from the XSA model showed that the recruitment was quite stable, i.e., between 50 and 115 millions. The total biomass ranged between 126 and 253 thousand tons, the spawning stock biomass between 78 and 207 thousand tons, and the fishing mortality between 0.04 and 0.13 – the natural mortality was set constantly at 0.1 (Table 3, Figure 14).

The retrospective pattern pointed out the difficulties already seen in previous assessments, i.e., that it was hard for the model to estimate the level of biomass and F (Figure 15). However, the last five lines in the plots indicate that we might have got stable results. As a result, the estimate of F0.1 has ranged between 28 thousand tons (assessment in 2011) and 16 thousand tons (the present assessment in 2014, Figure 16). The difficulties of the XSA model to find the "correct" level of stock size and fishing mortality comes from the fact that there is not much contrast between years in the tuning series (Figure 9), and the "real" stock size might not be discovered until the cpue either increases or decreases markedly in the future.

The fishing mortality decreased in 2012 (Figure 14). This is caused by the shift of the pair trawlers to fish for mackerel instead of GSS. The fishing mortality increased again in 2013. In the previous assessments it has been feared that the catch (and the perception of stock size) would decline when no new areas were available for the trawlers. However, the last "new" fishing site (on the Wyville-Thompson ridge to the south of the Faroes) has been explored for six years (2008-2013) and a small decline in cpue has been observed (although the GLM-model reduced the influence of this fishing site). This indicates that local depletion of subpopulations might not represent any great problem.

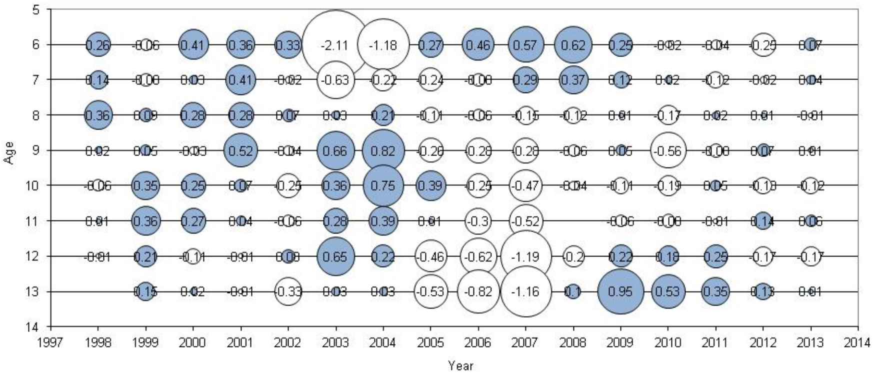


Figure 13. Greater silver smelt Vb. Log catchability residuals for age group 6-11 from XSA diagnostic.

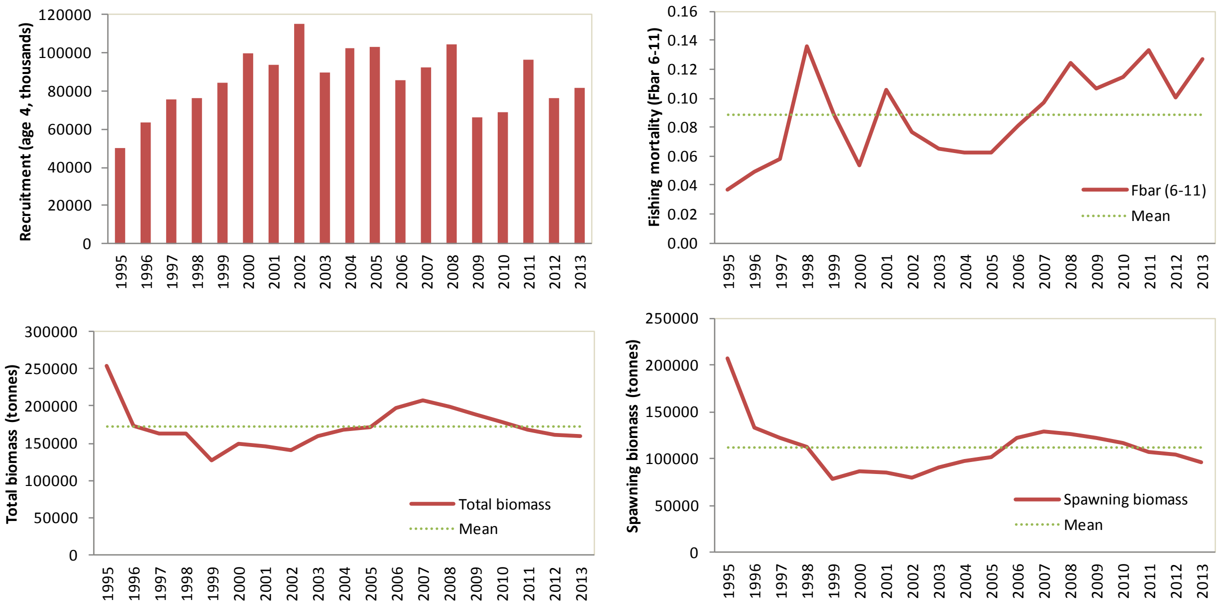


Figure 14. Greater silver smelt Vb. Output from XSA

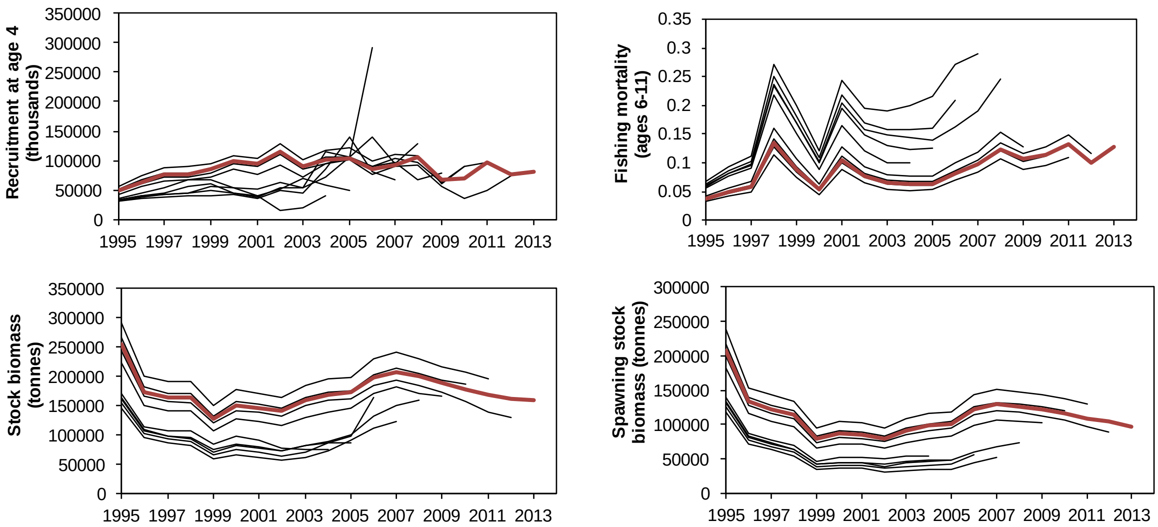
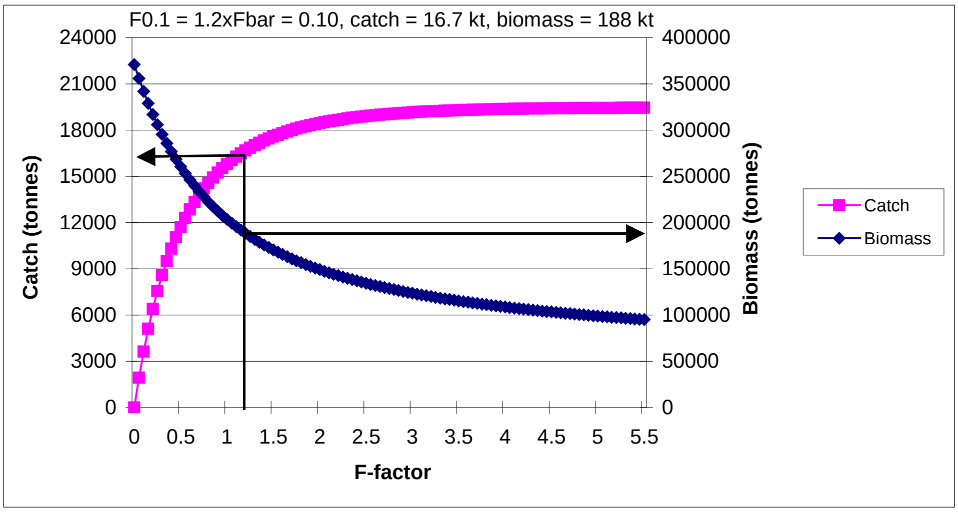


Figure 15. Greater silver smelt Vb. Output from retrospective analysis.

Figure 16. Greater silver smelt in Vb. A modified yield-per-recruit plot. The F0.1 catch is 16 700 tonnes. The



selection pattern, as well as the weights, were calculated as the average for the whole assessment period (1995-2013).

Table 3. Greater silver smelt Vb. Output from XSA

	Recruits Age 4	Totalbio	Totspbio	Landings	Yield/SSB	Fbar 6-11
1995	50106	253910	207486	12286	0.059	0.037
1996	63864	173059	132621	9498	0.072	0.049
1997	75844	163042	121718	8433	0.069	0.058
1998	76379	163285	113288	17570	0.155	0.136
1999	84533	126680	78253	8214	0.105	0.089
2000	99739	150190	86375	5209	0.060	0.054
2001	93997	145903	84712	10081	0.119	0.106
2002	115432	141198	79692	7471	0.094	0.077
2003	89982	159092	90233	6549	0.073	0.065
2004	102182	169068	98170	6451	0.066	0.063
2005	102875	171872	101280	7009	0.069	0.063
2006	85434	197106	122537	12559	0.103	0.081
2007	92737	206985	129313	14093	0.109	0.097
2008	104818	199107	126621	19249	0.152	0.124

2009	66344	188906	122131	19740	0.162	0.107
2010	68847	178127	116178	19190	0.165	0.115
2011	96473	167620	107555	18712	0.174	0.133
2012	76139	161815	103938	12545	0.121	0.101
2013	81899	159897	96276	14149	0.147	0.127
Arith. Mean	85664	172466	111494	12053	0.109	0.088
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

7 Comments on the assessments

The diagnostics for the present assessment are acceptable except for the youngest and oldest ages. The logQ residuals are normally below 0.3, which is lower than for other age-based assessed stocks at the Faroes. The problem with earlier assessments, that the niveau of stock size and fishing mortality was difficult to find, seems to be less in the 2014 assessments.

8 Management considerations

FaMRI has recommended a TAC of 18 thousand tons in Faroese waters for 2014, since the current assessment may not be stable enough to provide reliable estimates.

References

ICES WKDEEP report 2010 (page 133-198)
ICES WGDEEP report 2010
ICES WKAMDEEP report 2013

Appendix 1. GSS Vb. Catch number at age (thousands) from the commercial fleet.

YEAR\AGE	4	5	6	7	8	9	10	11	12	13	14+
1995	0	0	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	0	1558	2686	2963	5333	3912	3936	4143	3820	4428	4705
1999	0	708	1381	1780	2248	2279	2755	2706	2364	2101	1627
2000	0	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	0	0	156	1145	2572	4223	2869	1738	1656	749	897
2004	0	76	372	1270	2833	4414	3093	1827	1041	560	491
2005	0	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	0	903	3211	3838	5355	5895	4181	4674	4234	7294	4125
2010	0	167	3710	5118	4973	3971	5201	4288	5855	5344	4372
2011	712	1309	2279	5049	6455	5156	6116	4512	4311	4828	3256
2012	0	400	1407	2676	5648	4886	3134	3686	2230	2102	2355
2013	194	381	3433	3703	4558	7039	4440	3666	2674	2643	1911

Appendix 2. GSS Vb. Catch weight (kg) at age from the commercial fleet.

YEAR/AGE	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
2010	0.190	0.233	0.311	0.382	0.371	0.409	0.440	0.518	0.492	0.518	0.551
2011	0.197	0.219	0.271	0.348	0.380	0.417	0.448	0.465	0.515	0.501	0.563
2012	0.190	0.228	0.283	0.346	0.358	0.401	0.426	0.492	0.587	0.571	0.633
2013	0.239	0.234	0.298	0.343	0.357	0.384	0.428	0.443	0.523	0.533	0.555

Appendix 3. GSS Vb. 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. GSS Vb. Effort (hours) and catch in numbers at age for commercial pair trawlers (1998-2013).

Argentina Silus (ICES Div. Vb) PairTrawl_hags_6-13.dat

101

PairTrawl >1000 HP

1998

2013

1 1 0 1

6 13

1523	554	610	1099	806	811	854	787	912
717	224	289	365	370	447	440	384	341
2524	1280	1384	2030	1190	1435	1159	794	920
3434	1843	2744	3287	3488	1625	1285	977	993
3074	1871	1764	2350	2140	1261	1021	966	524
2461	125	918	2063	3388	2302	1394	1328	601
951	152	519	1158	1805	1264	747	426	229
3279	1730	2171	2802	2660	3565	1675	927	590
4523	3168	2649	4937	3399	3375	1968	1031	769
5834	4370	5285	4268	5143	3263	2692	881	661
5263	3426	4877	4140	4175	5138	3699	2692	2327
5265	2662	3182	4439	4887	3466	3874	3510	6046
7305	3253	4487	4360	3482	4560	3760	5134	4686
8125	2283	5058	6466	5165	6126	4519	4319	4837
5925	1388	2639	5570	4819	3091	3635	2200	2073
6263	2819	3041	3742	5780	3646	3010	2195	2170

Appendix 5. GSS Vb. Diagnostics from XSA (M=0.1, sh=0.5) with commercial pair trawler tuning series.

```
Lowestoft VPA Version 3.1
   25/03/2014  18:02
 Extended Survivors Analysis

 Argentina Silus (ICES Division Vb)                 AS_IND
 CPUE data from file D:\WGDEEP\WGDEEP2014\SilverSmelt\XSA2013\PairTrawl_hags_6-13.DAT

 Catch data for  19 years. 1995 to 2013. Ages  4 to  14.
      Fleet             First  Last  First  Last  Alpha   Beta
                         year  year   age    age
 PairTrawl >1000 HP                1998  2013    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 93 iterations

Regression weights

.751	.820	.877	.921	.954	.976	.990	.997	1.000	1.000

Fishing mortalities

Age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
4	.000	.000	.026	.006	.014	.000	.000	.008	.000	.002
5	.001	.016	.058	.033	.039	.010	.003	.022	.005	.006
6	.004	.028	.052	.072	.076	.048	.048	.045	.027	.047
7	.020	.030	.055	.100	.108	.076	.090	.076	.062	.084
8	.049	.055	.091	.103	.106	.109	.120	.140	.103	.128
9	.111	.059	.090	.112	.139	.141	.100	.157	.135	.162
10	.113	.123	.101	.101	.156	.132	.160	.196	.122	.157
11	.078	.083	.095	.095	.160	.136	.174	.181	.156	.183
12	.066	.052	.069	.049	.130	.179	.225	.237	.115	.145
13	.054	.048	.057	.050	.176	.372	.319	.261	.155	.174

XSA population numbers (Thousands)

	AGE									
YEAR	4	5	6	7	8	9	10	11	12	13
2004	1.02E+05	8.14E+04	9.45E+04	6.85E+04	6.27E+04	4.42E+04	3.03E+04	2.56E+04	1.72E+04	1.11E+04
2005	1.03E+05	9.25E+04	7.36E+04	8.51E+04	6.08E+04	5.41E+04	3.58E+04	2.45E+04	2.14E+04	1.46E+04
2006	8.54E+04	9.31E+04	8.24E+04	6.48E+04	7.47E+04	5.21E+04	4.61E+04	2.87E+04	2.04E+04	1.84E+04
2007	9.27E+04	7.53E+04	7.95E+04	7.07E+04	5.55E+04	6.17E+04	4.31E+04	3.77E+04	2.36E+04	1.72E+04
2008	1.05E+05	8.34E+04	6.59E+04	6.69E+04	5.79E+04	4.53E+04	5.00E+04	3.52E+04	3.10E+04	2.03E+04
2009	6.63E+04	9.35E+04	7.26E+04	5.53E+04	5.43E+04	4.72E+04	3.57E+04	3.87E+04	2.72E+04	2.47E+04
2010	6.88E+04	6.00E+04	8.37E+04	6.26E+04	4.64E+04	4.41E+04	3.71E+04	2.83E+04	3.05E+04	2.06E+04
2011	9.65E+04	6.23E+04	5.42E+04	7.22E+04	5.18E+04	3.72E+04	3.61E+04	2.86E+04	2.15E+04	2.21E+04
2012	7.61E+04	8.66E+04	5.51E+04	4.68E+04	6.06E+04	4.07E+04	2.88E+04	2.68E+04	2.16E+04	1.54E+04
2013	8.19E+04	6.89E+04	7.80E+04	4.85E+04	3.98E+04	4.94E+04	3.22E+04	2.31E+04	2.08E+04	1.74E+04

Estimated population abundance at 1st Jan 2014

0.00E+00	7.39E+04	6.20E+04	6.73E+04	4.04E+04	3.17E+04	3.80E+04	2.49E+04	1.74E+04	1.63E+04

Taper weighted geometric mean of the VPA populations:

8.76E+04	7.93E+04	7.10E+04	6.07E+04	5.20E+04	4.32E+04	3.40E+04	2.69E+04	2.16E+04	1.73E+04

Standard error of the weighted Log(VPA populations) :

.1677	.1759	.1840	.2000	.2098	.2200	.2421	.2527	.2573	.2671

Log catchability residuals.

Fleet : PairTrawl >1000 HP

Age	1998	1999	2000	2001	2002	2003
6	.26	-.06	.41	.36	.33	-2.11
7	.14	-.08	.03	.41	-.02	-.63
8	.36	.09	.28	.28	.07	.03
9	.02	.05	-.03	.52	-.04	.66
10	-.06	.35	.25	.07	-.25	.36
11	.01	.36	.27	.04	-.06	.28
12	-.01	.21	-.11	-.01	.08	.65
13	.00	.15	.02	-.01	-.33	.03

Age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
6	-1.18	.27	.46	.57	.62	.25	-.02	-.04	-.25	.07
7	-.22	-.24	-.08	.29	.37	.12	.02	-.12	-.02	.04
8	.21	-.11	-.06	-.15	-.12	.01	-.17	.02	.01	-.01
9	.82	-.26	-.28	-.28	-.06	.05	-.56	-.08	.07	.01
10	.75	.39	-.25	-.47	-.04	-.11	-.19	.05	-.13	-.12
11	.39	.01	-.30	-.52	.00	-.06	-.08	-.01	.14	.06
12	.22	-.46	-.62	-1.19	-.20	.22	.18	.25	-.17	-.17
13	.03	-.53	-.82	-1.16	.10	.95	.53	.35	.13	.01

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	-12.0564	-11.4585	-10.9816	-10.7715	-10.6787	-10.6984	-10.6984	-10.6984
S.E(Log q)	.6963	.2517	.1393	.3657	.3135	.2339	.4687	.5619

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	2.62	-.483	13.48	.01	16	1.89	-12.06
7	1.54	-.874	11.70	.21	16	.39	-11.46
8	1.27	-1.024	11.01	.60	16	.18	-10.98
9	2.29	-1.132	10.89	.07	16	.83	-10.77
10	1.88	-1.224	10.89	.16	16	.58	-10.68
11	1.97	-1.969	11.19	.29	16	.41	-10.70
12	1.60	-.663	11.30	.11	16	.75	-10.80
13	.54	1.309	10.28	.45	16	.30	-10.72

```
 Terminal year survivor and F summaries :
Age  4   Catchability dependent on age and year class strength
Year class = 2009
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        79336.     .18                          .890      .002
   F shrinkage mean        41770.     .50                          .110      .004
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     73925.        .17     11.21     2   67.577    .002

Age  5   Catchability dependent on age and year class strength
Year class = 2008
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        71049.     .18                          .881      .005
   F shrinkage mean        22606.     .50                          .119      .016
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     61978.        .17     11.04     2   63.938    .006

Age  6   Catchability constant w.r.t. time and dependent on age
Year class = 2007
Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio      Weights     F
 PairTrawl >1000 HP                71934.    .725        .000     .00    1   .312      .044
   F shrinkage mean        65310.     .50                          .688      .049
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     67309.        .41       .08     2     .195    .047

 Age  7   Catchability constant w.r.t. time and dependent on age
Year class = 2006
Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio      Weights     F
 PairTrawl >1000 HP                40216.    .277        .100     .36    2   .749      .084
   F shrinkage mean        40951.     .50                          .251      .083
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     40399.        .24       .06     3     .253    .084

Age  8   Catchability constant w.r.t. time and dependent on age
Year class = 2005
Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio      Weights     F
 PairTrawl >1000 HP                31054.    .204        .005     .03    3   .836      .131
   F shrinkage mean        35290.     .50                          .164      .116
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     31710.        .19       .03     4     .159    .128

Age  9   Catchability constant w.r.t. time and dependent on age
Year class = 2004
Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio      Weights     F
 PairTrawl >1000 HP                36758.    .180        .034     .19    4   .855      .167
   F shrinkage mean        46499.     .50                          .145      .135
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     38035.        .17       .05     5     .308    .162

Age 10   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                24836.    .159        .043     .27    5   .875      .157
   F shrinkage mean        25491.     .50                          .125      .153
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     24917.        .15       .04     6     .235    .157

Age 11   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                  17091.    .142        .068     .48    6   .892      .186
   F shrinkage mean        19880.     .50                            .108      .162
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     17372.        .14       .06     7     .448    .183

Age 12   Catchability constant w.r.t. time and age (fixed at the value for age) 11
Year class = 2001
Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP                  16709.    .139        .110     .80    7   .889      .142
   F shrinkage mean        13099.     .50                            .111      .177
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     16264.        .14       .10     8     .747    .145

 Age 13   Catchability constant w.r.t. time and age (fixed at the value for age) 11
Year class = 2000
Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP                  13013.    .137        .061     .45    8   .880      .177
   F shrinkage mean        14966.     .50                            .120      .155
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     13233.        .13       .06     9     .420    .174
```

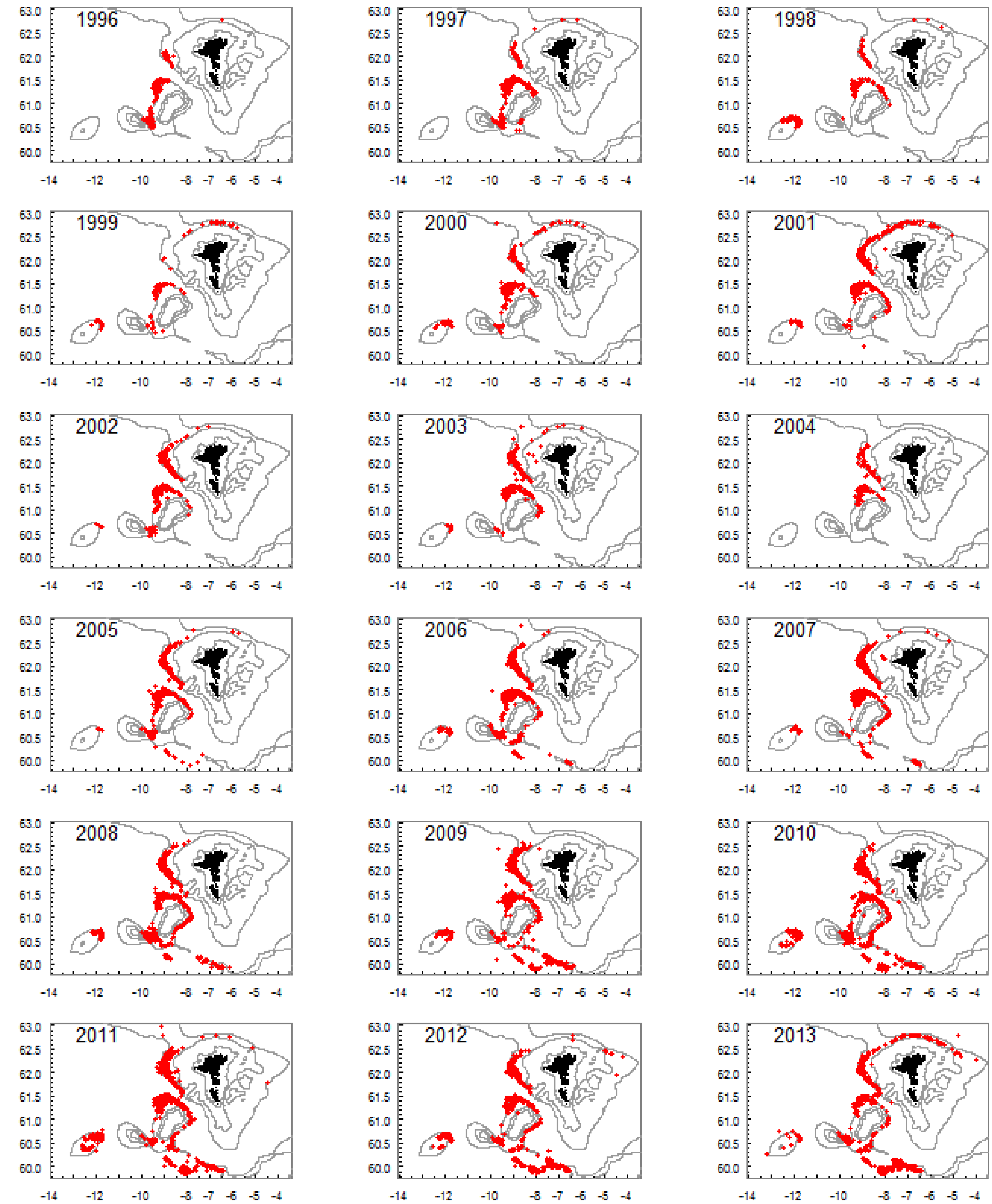
Appendix 6. GSS Vb. Fishing mortality (F) at age.

YEAR\AGE	4	5	6	7	8	9	10	11	12	13	14+	FBAR (6-11)
1995	0.000	0.000	0.001	0.005	0.020	0.060	0.058	0.080	0.110	0.066	0.066	0.037
1996	0.001	0.001	0.005	0.014	0.039	0.074	0.093	0.069	0.120	0.079	0.079	0.049
1997	0.001	0.004	0.023	0.027	0.045	0.079	0.096	0.079	0.068	0.073	0.073	0.058
1998	0.000	0.024	0.056	0.090	0.180	0.159	0.161	0.169	0.165	0.167	0.167	0.136
1999	0.000	0.011	0.024	0.043	0.082	0.098	0.144	0.143	0.123	0.116	0.116	0.089
2000	0.000	0.004	0.023	0.029	0.060	0.054	0.078	0.078	0.054	0.061	0.061	0.054
2001	0.001	0.008	0.041	0.078	0.110	0.172	0.120	0.115	0.109	0.109	0.109	0.106
2002	0.001	0.013	0.039	0.050	0.088	0.097	0.086	0.103	0.118	0.078	0.078	0.077
2003	0.000	0.000	0.002	0.017	0.054	0.124	0.101	0.092	0.132	0.071	0.071	0.065
2004	0.000	0.001	0.004	0.020	0.049	0.111	0.113	0.078	0.066	0.054	0.054	0.063
2005	0.000	0.016	0.028	0.030	0.055	0.059	0.123	0.083	0.052	0.048	0.048	0.063
2006	0.026	0.058	0.052	0.055	0.091	0.090	0.101	0.095	0.069	0.057	0.057	0.081
2007	0.006	0.033	0.072	0.100	0.103	0.112	0.101	0.095	0.049	0.050	0.050	0.097
2008	0.014	0.039	0.076	0.108	0.106	0.139	0.156	0.160	0.130	0.176	0.176	0.124
2009	0.000	0.010	0.048	0.076	0.109	0.141	0.132	0.136	0.179	0.373	0.373	0.107
2010	0.000	0.003	0.048	0.090	0.120	0.100	0.160	0.174	0.225	0.319	0.319	0.115
2011	0.008	0.022	0.045	0.076	0.140	0.157	0.196	0.181	0.237	0.262	0.262	0.133
2012	0.000	0.005	0.027	0.062	0.103	0.135	0.122	0.156	0.115	0.155	0.155	0.101
2013	0.003	0.006	0.047	0.084	0.128	0.162	0.157	0.183	0.145	0.174	0.174	0.127
FBAR	0.003	0.011	0.040	0.074	0.124	0.152	0.158	0.173	0.166	0.197		

Appendix 7. GSS Vb. Stock number at age (start of year, thousands).

YEAR\AGE	4	5	6	7	8	9	10	11	12	13	14+	
1995	50106	47415	40044	42382	45706	44919	49573	38526	34068	70243	72792	535774
1996	63864	45338	42903	36196	38156	40551	38280	42349	32178	27614	44005	451432
1997	75844	57749	40977	38624	32305	33203	34089	31568	35766	25823	37457	443406
1998	76379	68572	52062	36239	34003	27956	27766	28019	26394	30228	32061	439679
1999	84533	69111	60565	44552	29972	25694	21575	21379	21412	20249	15659	414700
2000	99739	76488	61860	53488	38619	24981	21081	16901	16771	17125	15955	443009
2001	93997	90247	68950	54700	47020	32925	21420	17646	14139	14384	14294	469722
2002	115432	84982	81029	59904	45796	38115	25090	17191	14235	11477	8647	501898
2003	89982	1E+05	75922	70540	51583	37948	31309	20829	14039	11446	13693	521678
2004	102182	81419	94453	68549	62738	44228	30320	25600	17194	11127	9748	547557
2005	102875	92458	73599	85111	60817	54073	35820	24492	21426	14567	4136	569375
2006	85434	93085	82352	64777	74730	52085	46131	28665	20401	18413	14824	580899
2007	92737	75306	79491	70741	55457	61737	43079	37720	23592	17231	7077	564169

2008	104818	83421	65904	66912	57944	45281	49960	35234	31041	20336	13725	574576
2009	66344	93502	72585	55268	54333	47157	35654	38661	27170	24658	13896	529229
2010	68847	60031	83745	62624	46358	44068	37062	28284	30536	20557	16766	498878
2011	96473	62296	54159	72247	51796	37216	36097	28588	21514	22061	14839	497285
2012	76139	86615	55122	46837	60569	40727	28770	26844	21575	15365	17186	475750
2013	81899	68893	77992	48538	39835	49432	32203	23051	20784	17401	12558	472587
2014	0	73925	61978	67309	40399	31710	38035	24917	17372	16264	22781	394691
GMST 95-**	84638	73670	64476	56032	47276	39508	33155	27212	22580	19857		
AMST 95-**	86446	75636	66506	57815	48667	40714	34371	28333	23640	22208		



Annex 8. Map of the directed fishery distribution in Faroese waters for the period 1996-2013.

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Ling in Faroese waters (DivisionVb).

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Introduction

The objective for this document is to update information on ling in Faroese waters (Division Vb). In addition, the results of an exploratory assessment are presented.

1 The fishery

A general description of the fisheries in Faroese waters is provided in the Faroe overview section. The latest change in the ling fishery was that the Norwegian longliners are not allowed to fish in Faroese waters in 2011-2013 due to the mackerel allocation. The Faroese are landing almost all the catches and do also utilize the fishing areas that the Norwegian longliners used to fish. Around 50-70% of the ling in Vb was caught by Faroese longliners in 2010-2013 and the rest mainly by trawlers (30-40%). The longline fisheries are mainly on the slope on the Faroe Plateau and some of it is on the Faroe bank area (Figure 1.1). Ling is also caught as bycatch by trawlers mainly fishing saithe on the Faroe Plateau (Figure 1.2).

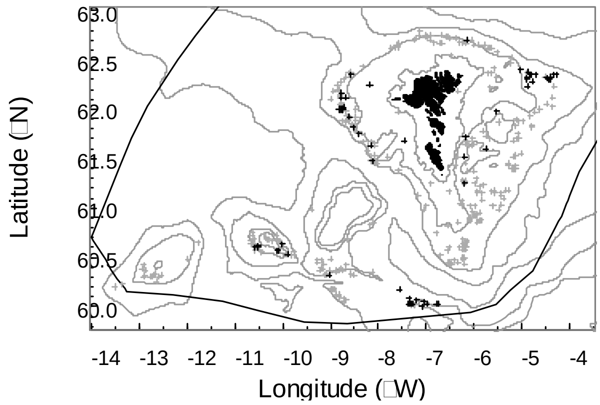


Figure 1.1. Ling in Vb. Long line catches where tusk+ling > 60% of the total catch in 2013 for 4 selected longliners (black) and all longliners (grey).

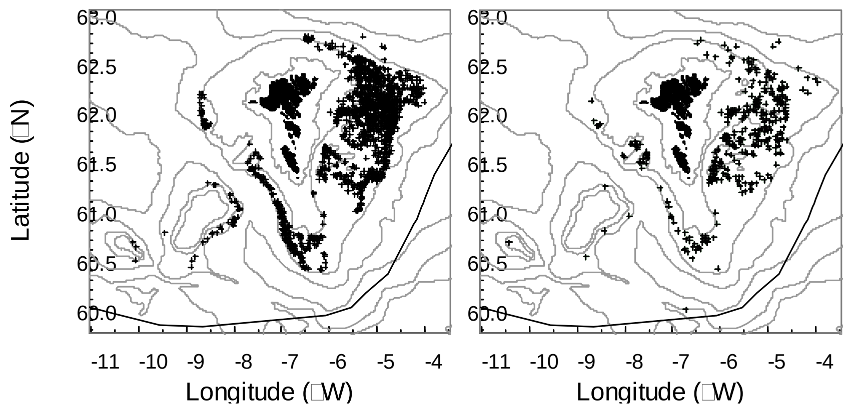


Figure 1.2. Ling in Vb. Distribution of pairtrawler hauls in 2013 with a) ling in catch and >60% saithe of the total catch and b) more than 20% ling of the total catch.

2 Landings trends

Landings data for this stock are available from 1904 onwards; landing statistics for ling by nation for the period 1988–2013 are given in Tables 2.1–2.3 and total landings data from 1950 onwards are shown in Figure 2.1. Total landings in

Division Vb have in general been very stable since the 1970s varying between about 4000 and 7000 tonnes. In the period from 1990-2005 around 20% of the catch were fished in area Vb2, and in the period 2006-2013 this has decreased to around 10%. The preliminary landings of ling in 2013 are 4086 tonnes, of which the Faroes caught 99%. The reason for the low foreign catches is the fact that due to a dispute on mackerel allocation, no bilateral agreement on fishing rights between the Faroes, Norway and EU could be made for 2011-2013.

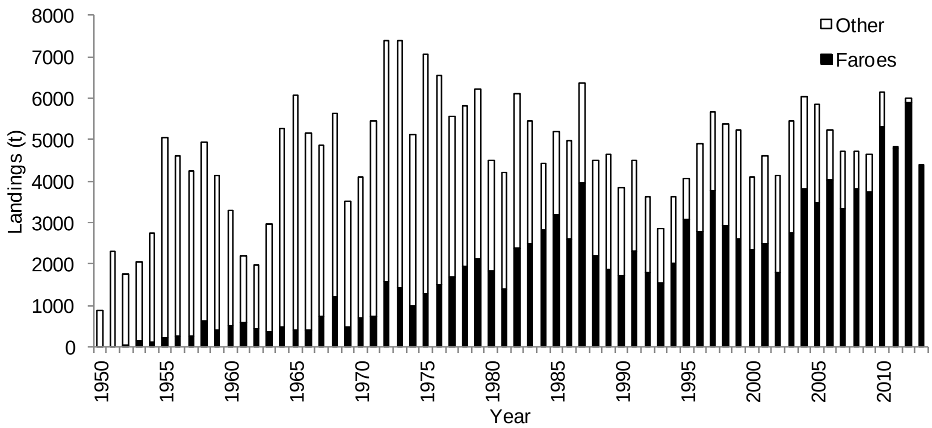


Figure 2.1. Ling in Vb. Total international landings since 1950.

Table 2.1. Ling in Vb1. Nominal landings (1988-2013).

Year	Denmark [2]	Faroes	France	Germany	Norway	E&W [1]	Scotland [1]	Russia	**Total**
1988	42	1383	53	4	884	1	5		**2372**
1989		1498	44	2	1415		3		**2962**
1990		1575	36	1	1441		9		**3062**
1991		1828	37	2	1594		4		**3465**
1992		1218	3		1153	15	11		**2400**
1993		1242	5	1	921	62	11		**2242**
1994		1541	6	13	1047	30	20		**2657**
1995		2789	4	13	446	2	32		**3286**
1996		2672			1284	12	28		**3996**
1997		3224	7		1428	34	40		**4733**
1998		2422	6		1452	4	145		**4029**
1999		2446	17	3	2034	0	71		**4571**
2000		2103	7	1	1305	2	61		**3479**
2001		2069	14	3	1496	5	99		**3686**
2002		1638	6	2	1640	3	239		**3528**
2003		2139	12	2	1526	3	215		**3897**
2004		2733	15	1	1799	3	178	2	**4731**
2005		2886	3		1553	3	175		**4620**
2006	3	3563	6		850		136		**4558**
2007	2	3004	9		1071		6		**4092**
2008		3354	4		740	32	25	11	**4166**
2009	13	3471	2		419		270		**4174**
2010	28	4906	2		442		121		**5500**
2011	49	4270	2		0		0		**4321**
2012	117	5452	7		0		0		**5576**
2013*	3	3820	7		0		0		**3830**

*Preliminary. [1] Includes Vb2.

(2) Greenland 2006-2012

Table 2.2. Ling in Vb2. Nominal landings (1988-2012).

Year	Faroes	France	Norway	**Total**
1988	832		1284	**2116**
1989	362		1328	**1690**
1990	162		633	**795**
1991	492		555	**1047**
1992	577		637	**1214**
1993	282		332	**614**
1994	479		486	**965**
1995	281		503	**784**
1996	102		798	**900**
1997	526		398	**924**
1998	511		819	**1330**
1999	164	4	498	**666**
2000	229	1	399	**629**
2001	420	6	497	**923**
2002	150	4	457	**611**
2003	624	4	927	**1555**
2004	1058	3	247	**1308**
2005	575	7	647	**1229**
2006	472	6	177	**655**
2007	327	4	309	**640**
2008	458	3	120	**580**
2009	270	1	198	**469**
2010	393	1	236	**630**
2011	522	0	0	**522**
2012	434	1	0	**435**
2013*	255	1	0	**256**

*Preliminary.

Table 2.3. Ling in Vb. Nominal landings (1988-2012).

Year	Vb1	Vb2	**Vb**
1988	2372	2116	**4488**
1989	2962	1690	**4652**
1990	3062	795	**3857**
1991	3465	1047	**4512**
1992	2400	1214	**3614**
1993	2242	614	**2856**
1994	2657	965	**3622**
1995	3286	784	**4070**
1996	3996	900	**4896**
1997	4733	924	**5657**
1998	4029	1330	**5359**
1999	4571	666	**5238**
2000	3479	629	**4109**
2001	3686	923	**4609**
2002	3528	611	**4139**
2003	3897	1555	**5453**
2004	4731	1308	**6039**
2005	4620	1229	**5849**
2006	4558	655	**5213**
2007	4092	640	**4731**
2008	4166	580	**4747**
2009	4174	469	**4643**
2010	5500	630	**6129**
2011	4321	522	**4843**
2012	5569	434	**6003**
2013*	3830	256	**4086**

*Preliminary.

3 ICES Advice

The latest Advice from ICES ACOM is from 2011/2012: ICES reiterates the Advice that effort should not be allowed to increase and to collect information that can be used to evaluate a long-term sustainable level of exploitation.

4 Management

For the Faroese fleets, there is no species-specific management of ling in Vb, although licenses are needed in order to fish. The main fleets targeting ling are each year allocated a total allowable number of fishing days to be used in the demersal fishery in the area. The recommended minimum landing size is 60 cm. Other nations are regulated by TACs. Details on management measures in Faroese waters are given in the Faroe overview section.

5 Data available

Data on length, gutted weights and age are available for ling from the Faroese landings and an overview of the levels of sampling since 1996 are given in Table 5.1.

Table 5.1. Overview of the levels of sampling from commercial landings since 1996.

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Length	6399	7900	5912	4536	3512	3805	4299	6585	6827	7167	6503	4031	2521	4373	4345	3405	2810	2477
Gutted weight	410	541	538	360	360	420	180	360	1169	3217	4038	1713	1945	4348	4279	2828	2447	2076
Age	1084	1526	1081	480	360	420	300	661	659	540	276	120	60	232	180	0	50	0

Due to limited resources at Faroe Marine Research Institute (FAMRI), the sampling intensity of ling otoliths has been low from year 2007. Hence, in order to perform an age based assessment, it has been necessary to combine age samples from all fleets/seasons and even between years to make an age–length key.

There are also catch and effort data from logbooks for the Faroese longliners and trawlers. From the two annual Faroese groundfish surveys on the Faroe Plateau, especially designed for cod, haddock and saithe, biological data (length and round weight) as well as catch and effort data are available.

In addition, there are also data available on catch, effort and mean length from Norwegian longliners fishing in Faroese waters.

A three years project on ling and tusk started in January 2013 at FAMRI, which hopefully can give some additional information to the WG.

5.1 Landings and discards

Landings were available for all relevant fleets. No estimates of discards of ling are available. But since the Faroese fleets are not regulated by TACs and there in addition is a ban on discarding in Vb, incentives for illegal discarding are believed to be low. The landings statistics are therefore regarded as being adequate for assessment purposes.

5.2 Length compositions

Length composition data are available from the Faroese commercial longliners, the trawler fleet that captures ling as bycatch and two groundfish surveys (Figure 5.2.1-5.2.4).

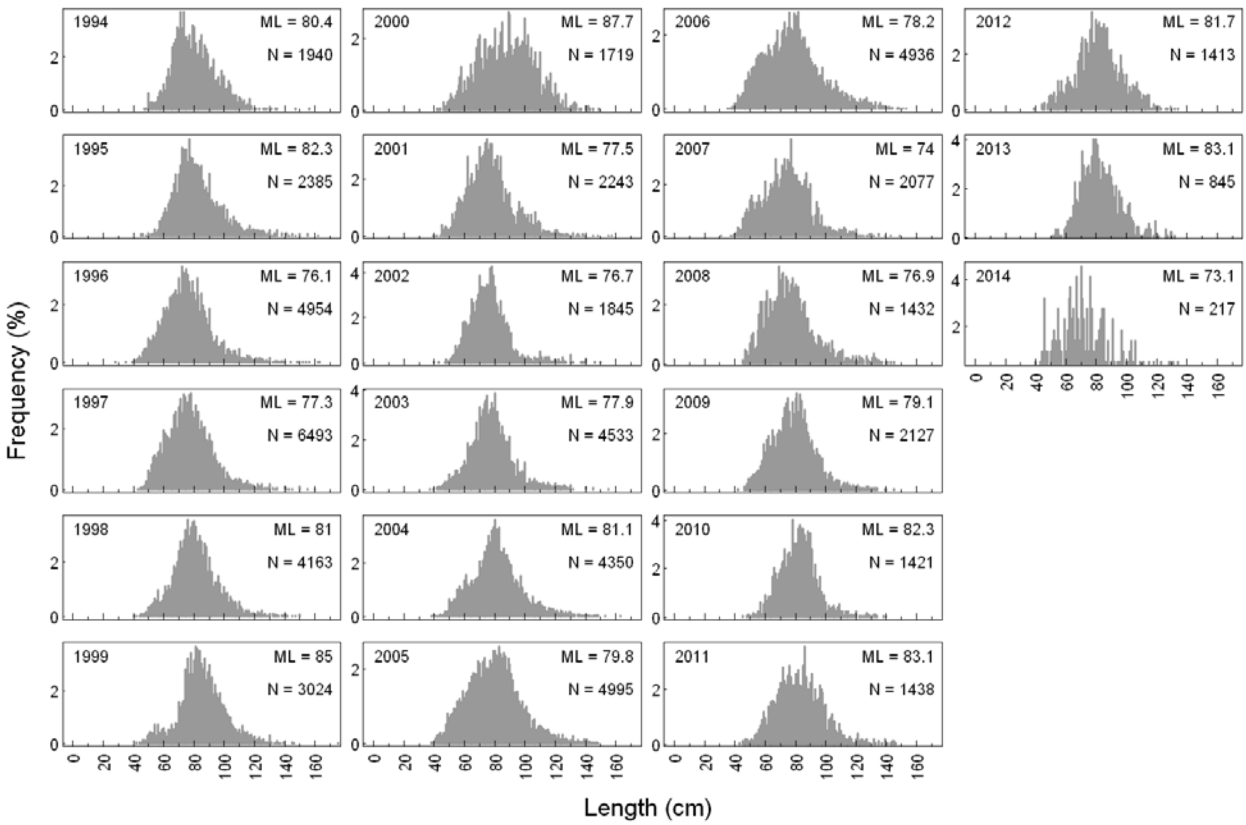


Figure 5.2.1. Ling in Vb. Length distribution in the sampling of the landings from Faroese longliners (>110 GRT) (ML-mean length, N- number sampled).

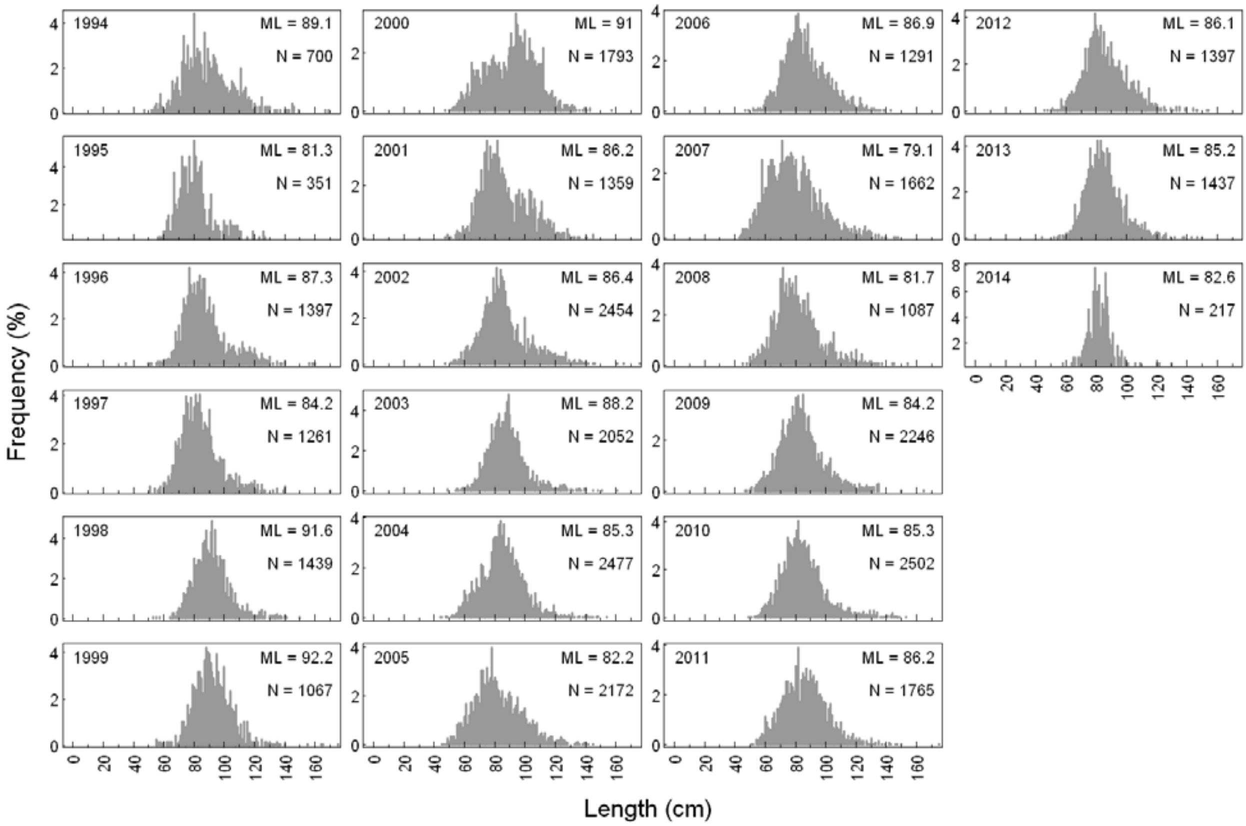


Figure 5.2.2. Ling in Vb. Length distribution in the sampling of the landings from Faroese trawlers (>1000 HP) (ML- mean length, N- number sampled).

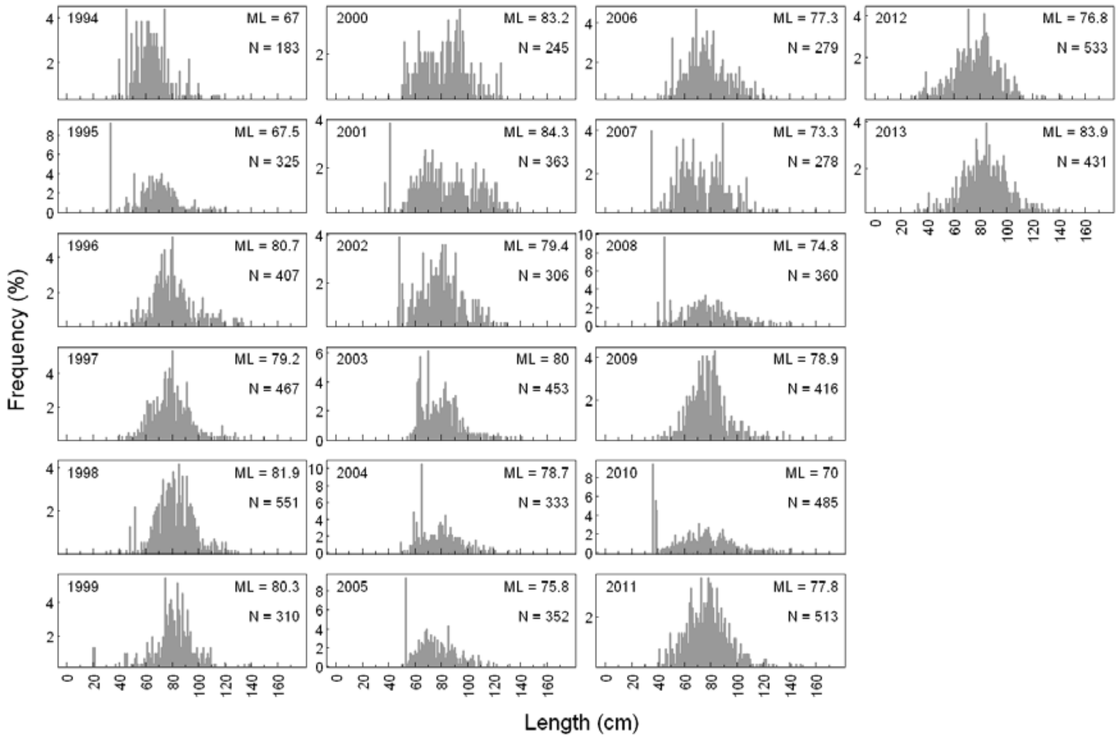


Figure 5.2.3. Ling in Vb. Length distribution from the spring groundfish survey. ML- mean length, N- number of calculated length measures. The small ling are often sampled from a subsample of the total catch, so the values are multiplied to total catch.

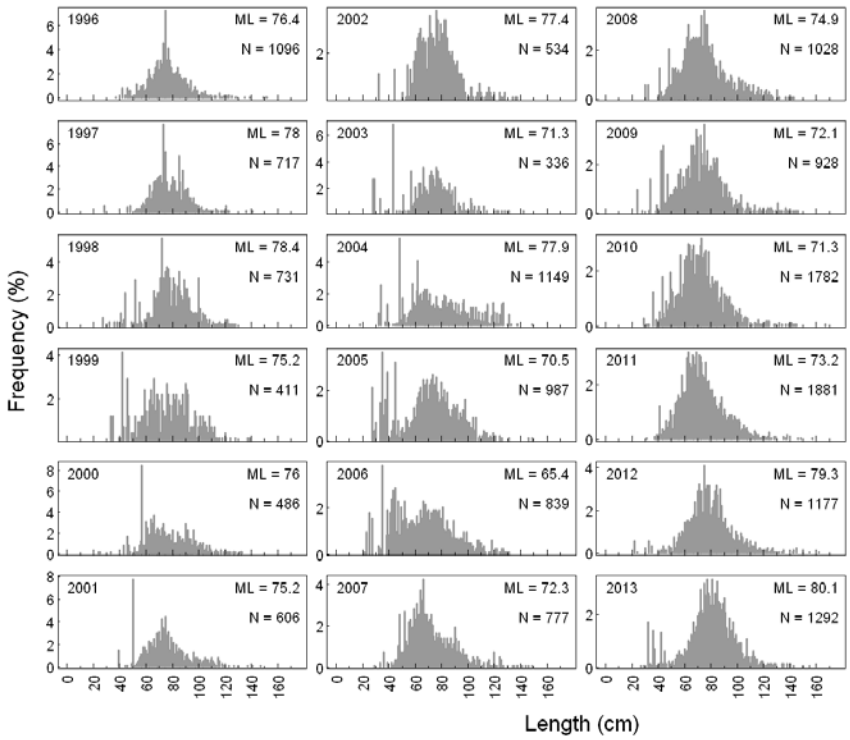


Figure 5.2.4. Ling in Vb. Length distribution from the summer groundfish survey (ML- mean length, N- number sampled).

5.3 Age compositions (and growth)

Catch-at-age data were provided for Faroese landings in Vb 1996–2006 and raised with other nations landings, whereas the catch at age data for 2007-2013 where used the same age length key combined and thereafter distributed on the length distribution for the distinct years and fleets (longliners and trawlers) (Table 5.3.1, Figure 5.3.1). The common ages in the landings are from 5 to 9 years and the mean age is around 7-8 years. The age distribution in the sampling of commercial landings from longliners and trawlers are presented in Figures 5.3.2-5.3.3.

Table 5.3.1. Ling Vb. Catch number at age (thousands) from the commercial fleet.

YEAR\AGE	4	5	6	7	8	9	10	11	12	13	14+
1997	1	219	298	490	411	266	126	41	27	8	6
1998	1	59	159	284	335	369	180	70	33	1	27
1999	18	25	9	167	399	349	176	84	53	33	1
2000	49	134	120	62	123	192	116	61	46	13	2
2001	20	88	311	597	195	111	80	23	27	10	1
2002	61	67	415	447	210	62	81	2	2	2	2
2003	39	65	331	465	428	226	68	22	25	28	0
2004	152	147	196	440	447	224	91	54	18	16	5
2005	76	189	295	316	356	221	108	47	22	23	31
2006	116	153	169	354	310	228	131	93	32	28	22
2007	83	143	375	326	247	135	92	31	20	3	7
2008	41	110	360	326	240	128	93	31	23	11	8
2009	23	67	259	316	285	163	102	28	17	8	5
2010	11	49	276	406	402	241	130	34	21	10	7
2011	14	46	208	254	254	193	140	34	22	9	6
2012	28	65	254	365	350	226	169	47	28	9	4
2013	4	23	174	293	283	171	110	27	17	6	3

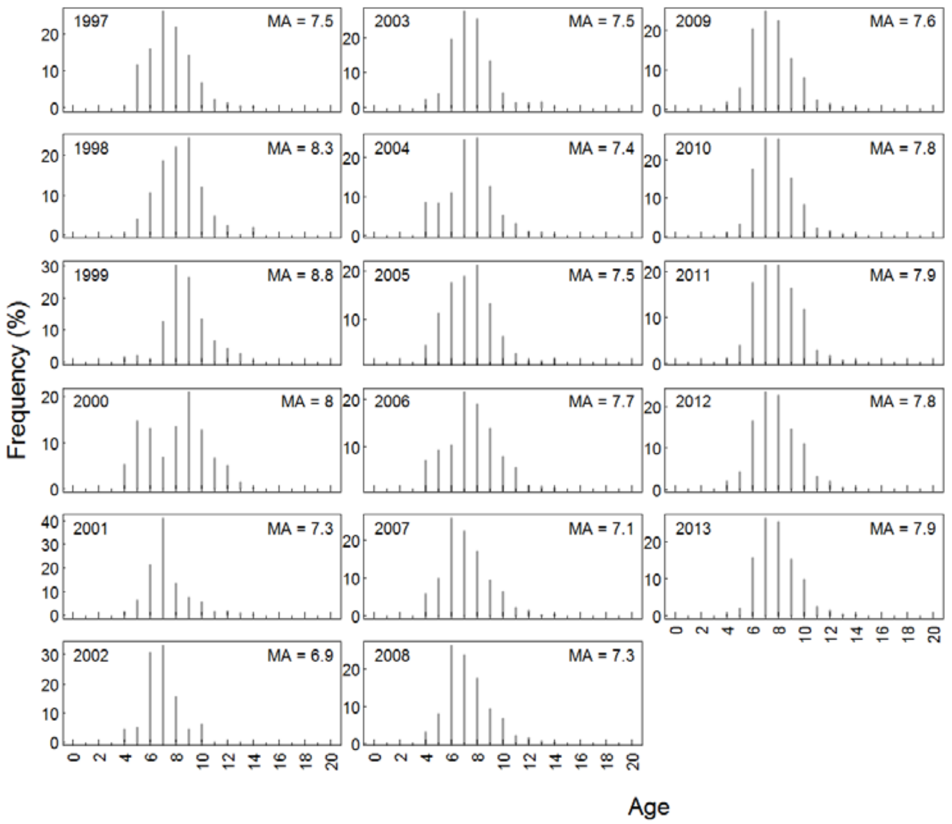


Figure 5.3.1. Ling Vb. Catch at age composition used in the assessment.

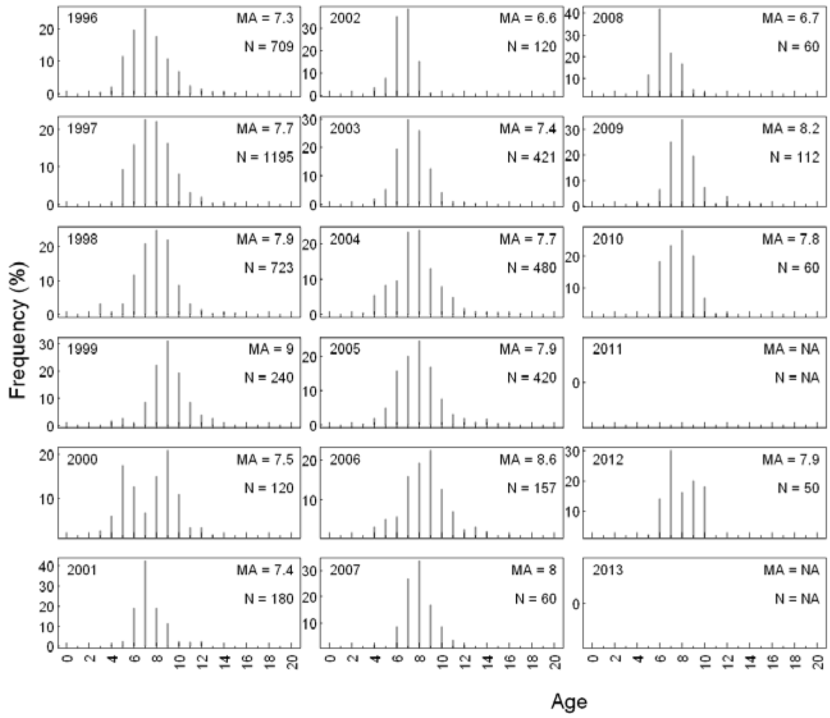


Figure 5.3.2. Ling Vb. Age composition (raw data) from longliners.

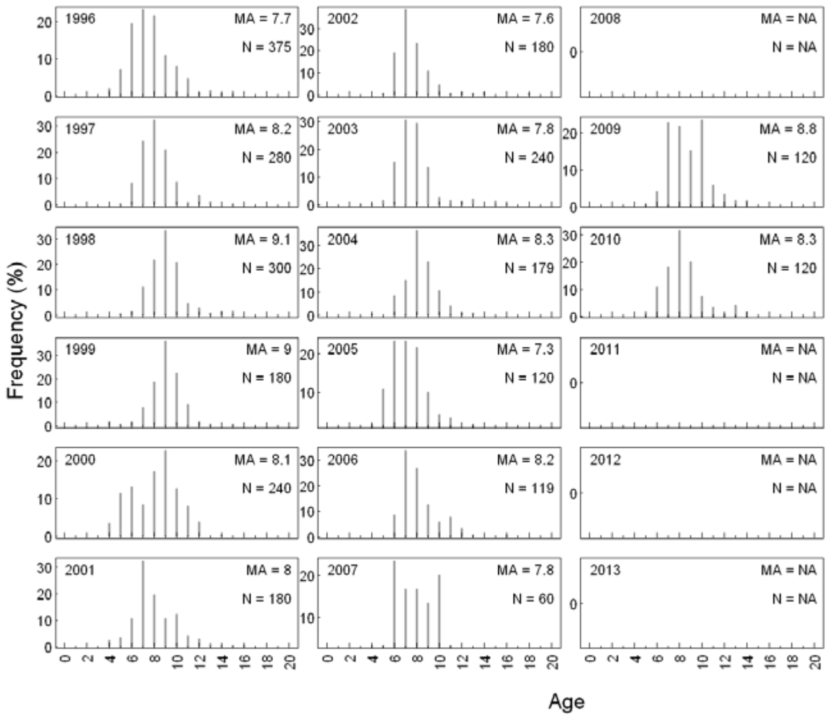


Figure 5.3.3. Ling Vb. Age composition (raw data) from trawlers.

A small-scale exchange of 50 ling otolith images was done in 2013 (WKAMDEEP, 2013). The results of this exchange showed that the mean CV of all the 9 age readers of ling was 10.3% and the conclusion was that the precision is probably high enough to support age-structured analytical assessments (WGDEEP, 2013). The results from the annotations of this exchange highlighted that the problem (in most cases) was to do with edge growth. It is necessary to train an age reader and inform them when to count the first translucent zone (first year) (WKAMDEEP, 2013). Also earlier ling otolith exchanges concluded that there was some inconsistencies between age readers but the differences were not very substantial and could easily be adjusted (Bergstad et al., 1998; Øverbø Hansen, 2012). An analysis of edge growth of ling otoliths is recommended to help on this problem with edge growth.

Ling in Faroese waters seems to have a linear length growth from age 4-13 with an equation of: $y = 7.5946x + 21.459$, $R^2 = 0.996$ (Figure 5.3.4)

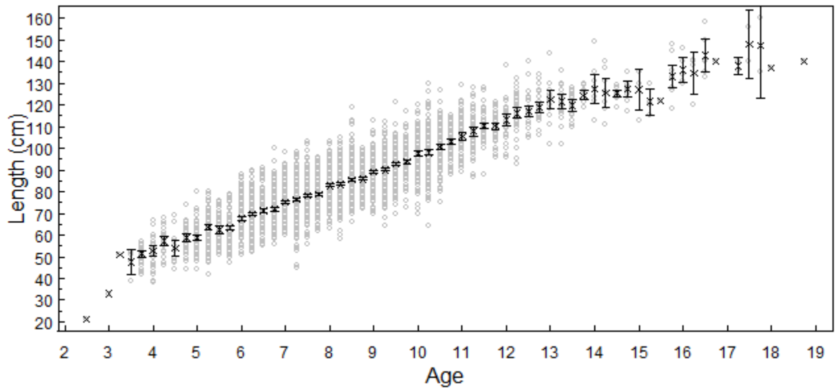


Figure 5.3.4. Ling Vb. Mean length at age of all otoliths that is available from commercial catches. Grey points are single ages and black cross is mean length at age with standard error.

An attempt was done on counting daily growth in the otoliths of 11 ling larvae from the annual 0-group survey in 2013. The results showed that larvae between 12 and 22 mm were from 48 to 84 days old (Bjørn Gunnarsson, Hafro, Iceland) (Figure 5.3.5). These results indicate that ling spawn at least in April-May in Faroese waters.

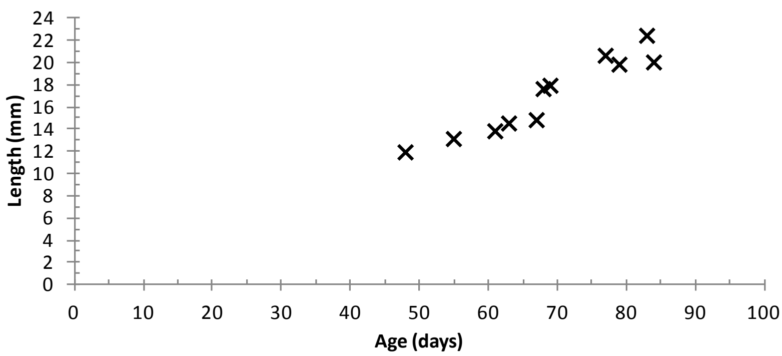


Figure 5.3.5. Ling Vb. Daily growth of ling larvae.

5.4 Weight-at-age

Mean weight-at-age data are provided for the Faroese fishery in Vb from 1996–2013 (Table 5.4.1, Figure 5.4.1). There is no particular decreasing trend in the mean weights over the period. The mean weight-at-age is modelled for the years 2007-2013 due to few age samples.

Table 5.4.1. Ling Vb. Catch weight (kg) at age from the commercial catch.

	4	5	6	7	8	9	10	11	12	13	14+
1997	0.603	1.147	1.782	2.404	3.221	4.058	5.156	7.062	8.216	9.764	11.993
1998	1.157	1.203	1.799	2.437	3.132	4.024	5.018	6.451	7.186	8.582	10.229
1999	1.067	1.088	2.216	2.366	3.118	4.083	5.480	6.227	8.203	7.930	10.466
2000	1.321	1.826	2.617	3.139	4.055	5.056	6.281	7.604	9.931	11.678	9.314
2001	1.061	1.122	1.921	2.604	3.638	5.168	6.587	7.521	9.443	11.990	9.542
2002	1.202	1.512	1.959	2.887	3.872	5.474	8.242	5.198	9.600	11.777	12.506
2003	0.806	1.190	2.088	2.724	3.502	4.044	5.482	6.219	8.761	11.145	11.145
2004	1.104	1.501	2.054	2.721	3.570	4.714	6.232	8.193	9.865	11.329	11.148
2005	0.861	1.118	1.791	2.586	3.586	4.793	6.345	7.731	9.000	10.400	13.558

2006	0.733	0.982	1.537	2.176	2.978	3.955	5.116	6.479	8.573	9.549	10.289
2007	0.854	1.264	1.930	2.883	3.728	4.894	6.765	9.262	10.155	8.799	11.929
2008	1.047	1.399	2.003	2.901	3.692	4.880	6.707	8.992	9.877	10.640	11.518
2009	1.069	1.447	2.066	3.017	3.731	4.750	6.313	8.467	9.259	10.072	11.144
2010	1.210	1.625	2.168	3.102	3.815	4.743	6.215	8.571	9.349	10.277	11.229
2011	1.085	1.524	2.102	3.067	3.943	5.043	6.424	8.461	9.359	10.208	11.465
2012	0.931	1.370	2.074	3.015	3.740	4.876	6.444	8.194	8.841	9.617	11.338
2013	1.274	1.719	2.255	3.074	3.754	4.787	6.247	8.245	9.000	9.636	11.178

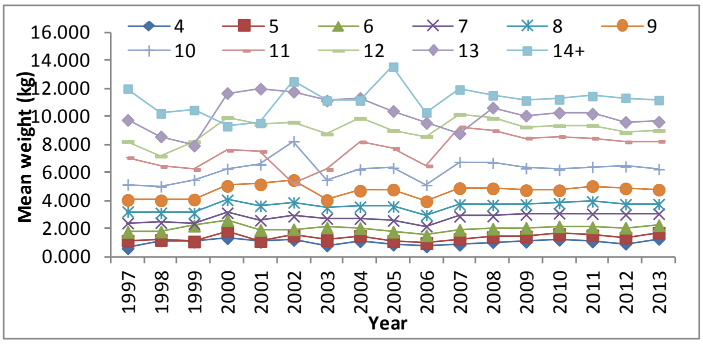


Figure 5.4.1. Ling Vb. Catch weight at age. NB. 2007-2013 data are modelled.

5.5 Maturity and natural mortality

Data from the groundfish surveys in 2013 of 432 ling (lengths from 25-150 cm) indicated a L_{50} at around 70-74 cm and ages from 364 ling (2-16 years old) indicated an A50 around 6 years. This fit well with the statement that ling become mature at ages 5–7 (60–75 cm lengths) in most areas, with males maturing at a slightly lower age than females (Magnusson *et al*., 1997).

No annual measurements of maturity-at-age were available and knife-edge maturity for age 7 and older has been assumed in the assessment.

A natural mortality of 0.2 was assumed for all ages in the assessment.

5.6 Catch, effort and research vessel data

Commercial cpue series

There are catch per unit of effort (cpue) data available for three commercial series, the Faroese longliners, the Faroese pair trawlers and Norwegian longliners fishing in Vb. The Faroese cpue data for the period 1986–2013, are from five longliners (GRT>110) and 6–10 pair trawlers (HP>1000). The effort obtained from the logbooks is estimated as as 1000 hooks from the longliners, number of fishing (trawling) hours from the trawlers and the catch as kg stated in the logbooks.

The Faroese longliner series were from sets where they catch ling and the catch of ling and tusk combined represented more than 50% of the total catch and depth was >150 m. The bycatch series for ling from the Faroese pair trawlers >1000 HP was limited to hauls where they catch ling and the catch of saithe is more than 60% of the total catch in the haul.

A general linear model (GLM) was used to standardize all the cpue series (kg/h or kg/1000 hooks) for the commercial fleet where the independent variables were the following: vessel (actually the pair ID for the pair trawlers, otter-board trawlers or longliners), month (Jan–Apr, May–Aug, Sept–Dec), fishing area (Vb1, Vb2) and year. The dependent variable was the log-transformed kg per hour or kg/1000 hooks measure for each trawl haul or longline setting, which was back-transformed prior to use. The reason for this selection of hauls/settings was to try to get a series that represents changes in stock abundance.

The cpue data from Norwegian longliners fishing in Vb are described in the Stock Annex for ling in IIa and were standardized (Helle and Pennington, WD WGDEEP 2013). The Norwegian and Faroese longliners are comparable and both have ling (and tusk) as target species.

Both the Faroese long line series (directed effort measured as number of 1000 hooks) and the trawl bycatch series was used as tuning series in the exploratory assessments.

Fisheries independent cpue series

Cpue estimates (kg/hour) for ling are available from two annual groundfish surveys on the Faroe Plateau designed for cod, haddock and saithe. Both surveys are restricted to the area on the Faroe Plateau (Vb1) and do as such not cover the whole distribution area for ling since the Faroe Bank (Vb2) is not included. These series have so far not been used for tuning because no age data are available, but in 2013 has a total of 364 otoliths been sampled and the agenda is to sample more ling otoliths in 2014 and hopefully get enough otoliths to do an age-length key from the survey.

The abundance indices from the groundfish surveys are standardized according to number of stations in each stratum and weighted with strata area for all the different strata. The distribution of the strata is shown in Figure 5.6.1 and the distribution of ling in the groundfih surveys is shown in Figure 5.6.2. A potential recruitment index was calculated from ling less than 40 cm from the survey.

In addition, an index was calculated from the annual 0-group survey in June/July on the Faroe Plateau and the distribution shows that ling larvae is caught mostly on the Plateau, not so much on the Bank (Figure 5.6.3).

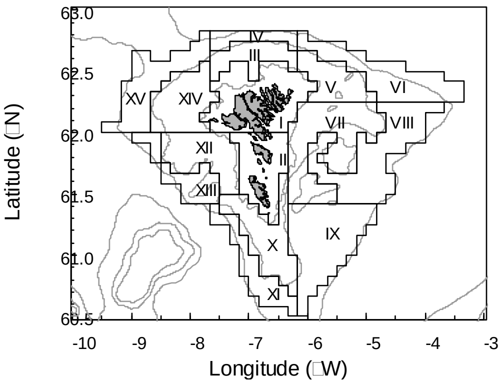


Figure 5.6.1. Stratification of the Faroe Plateau in the groundfish surveys.

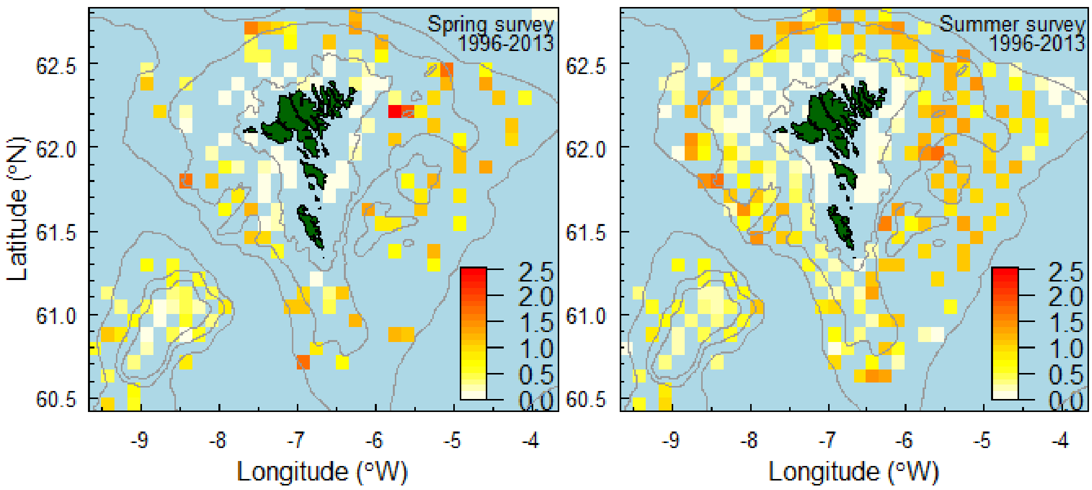


Figure 5.6.2. Ling Vb. Distribution of ling in the annual spring- and summer groundfish surveys as average log(kg/hour+1). Depth contour line for 100, 200 and 500 m.

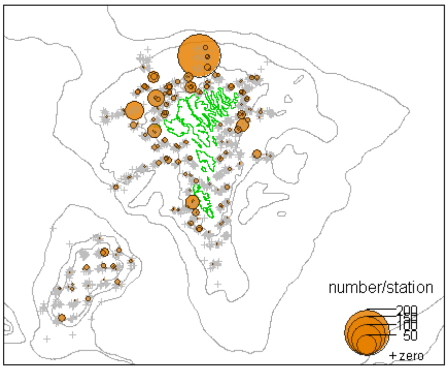


Figure 5.6.3. Ling. Distribution of larvae (number/station) from the annual 0-group survey in June/July for the years 1996-2013.

6 Data analyses

Mean length in the length distribution from commercial catches from Faroese longliners and trawlers showed an increase in mean length from 2007-2013 from 74 to 83 cm (Figure 4.2.1–4.2.2). The mean length in length distributions for the Norwegian longliners fishing in Faroese waters, in the period 2003–2009 were around 87 cm. The Faroese trawlers have a slightly higher mean length in the catches as the Faroese longliners.

Length distributions from the two groundfish surveys in Division Vb showed high interanual variation in mean length, from 65 to 85 cm, which may partly be explained by occasional high abundance of individuals smaller than 60cm (Figures 4.2.4–4.2.5).

Fluctuations in Cpue

Information on abundance trends can be derived from the cpue data from the Faroese longliners (Figure 6.1), from the Faroese pair trawlers (bycatch; Figure 6.1) and from the two Faroese groundfish surveys (Figure 6.2).

The Faroese longline cpue series and the Faroese trawl bycatch cpue series show a positive trend since 2001, but the Norwegian longline series shows a levelling off for the period 2000-2008. There are very few data from Norwegian longliners in 2009-2013. Norwegian and Faroese longliners are comparable and both have ling (and tusk) as target species.

The two survey cpue series indicate a stable situation since the late 1990s and an in-crease in recent years. This is supported by the length distributions indicating improved recruitment (Figures 4.2.4–4.2.5).

A potential recruitment index was calculated from the two surveys as the number of ling smaller than 40 cm (Figures 6.3–6.4). This shows indications of increasing recruitment in recent years. In addition, a potential recruitment index was calculated from the annual 0-group survey on the Faroe Plateau 1983-2013 (Figure 6.5). This figure also supports an indication of increasing recruitment in some years.

Table 6.1. Data on the cpue series from commercial fleets and groundfish surveys. St- standardized and org- is not standardized data.

	Longline		Trawl (bycatch)		Spring survey			Summer survey	
year	st_mean	st_se	st_mean	st_se	org_mean	st_mean	st_se	st_mean	st_se
1983					7.7				
1984					8.3				
1985					5.5				
1986	27.3	0.7			8.6				
1987	43.2	1.6			10.9				
1988	41.2	2.4			6.9				
1989	30.0	1.5			6.6				
1990	24.1	0.6			6.2				
1991	24.1	0.6			8.0				
1992	20.0	0.5			4.0				
1993	21.3	0.5			6.1				
1994	32.2	0.7			4.4	4.3	2.1		
1995	31.3	0.8	15.7	0.1	8.0	7.3	3.6		
1996	17.2	0.6	15.4	0.1	14.2	17.4	11.2	15.3	5.1
1997	59.9	1.7	18.3	0.0	16.0	17.0	7.9	9.4	3.2

1998	41.4	1.8	15.5	0.0	21.3	23.9	15.8	9.9	4.1
1999	33.6	1.1	13.5	0.0	11.1	13.4	7.8	5.8	2.2
2000	24.3	0.7	13.4	0.0	10.1	9.4	5.5	6.8	2.3
2001	27.3	0.4	13.4	0.0	17.7	13.8	8.0	8.1	2.7
2002	22.0	0.4	12.6	0.0	10.8	10.4	4.2	7.9	2.2
2003	27.0	1.2	15.5	0.0	15.3	16.1	6.9	4.0	1.1
2004	56.5	2.2	19.0	0.3	11.0	12.5	6.1	17.9	6.5
2005	54.4	2.0	22.1	0.5	10.6	11.0	4.8	11.4	3.1
2006	54.7	1.5	24.0	0.6	9.0	11.1	4.3	8.4	2.4
2007	39.5	1.1	23.0	0.5	8.3	8.4	4.2	9.9	3.4
2008	50.4	1.0	26.1	0.6	11.3	10.8	5.6	14.0	5.5
2009	50.2	1.1	24.9	0.5	14.2	14.4	6.2	11.7	3.4
2010	63.7	1.2	23.1	0.4	13.6	15.2	5.4	22.1	8.8
2011	74.0	1.1	25.8	0.5	17.1	17.4	7.5	23.3	7.9
2012	68.6	1.4	35.7	0.5	16.7	17.1	7.6	19.8	7.0
2013	72.2	1.1	31.8	0.4	17.7	17.8	9.9	21.4	6.7

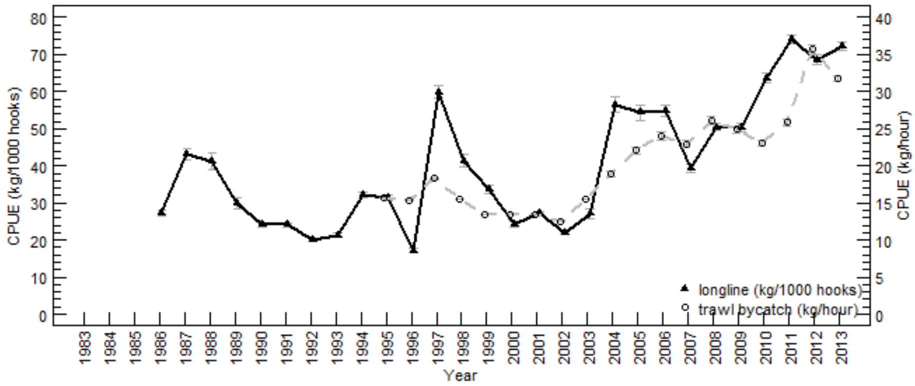


Figure 6.1. Ling in Vb. Standardized CPUE (kg/1000 hooks) from Faroese longliners (>110 GRT) fishing in Faroese waters and standardized CPUE (kg/h) from Faroese pair trawlers (bycatch series). The black line is mean for standardized longline data for settings where ling was caught, ling+tusk>60% of the total catch and the depth was deeper than 150 m. The stippled line is mean from standardized trawl data for hauls where ling was caught and saithe >60% of the total catch. The error bars are SE.

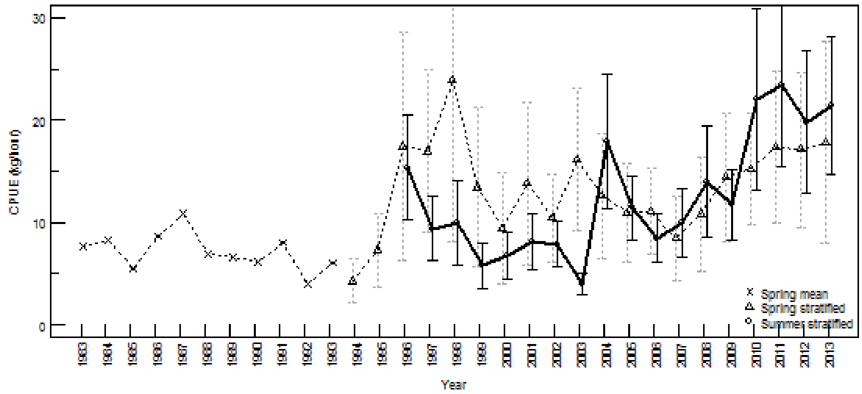


Figure 6.2. Ling in Vb. Standardized CPUE (kg/h) in the two annual Faroese groundfish surveys on the Faroe Plateau. The error bars are SE.

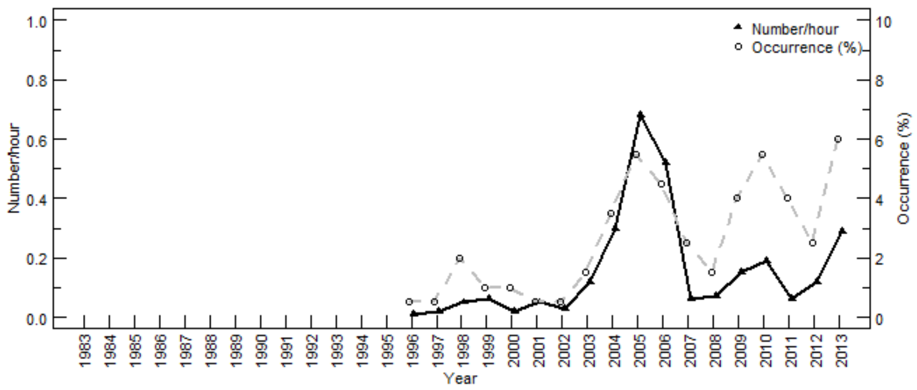


Figure 6.3. Ling Vb. Number/hour and % occurrence per year of ling smaller than 40 cm in the summer survey.

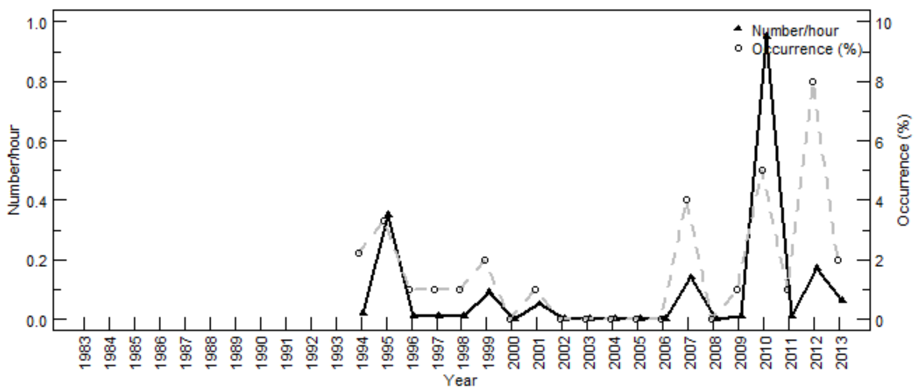


Figure 6.4. Ling Vb. Number/hour and % occurrence per year of ling smaller than 40 cm in the spring survey.

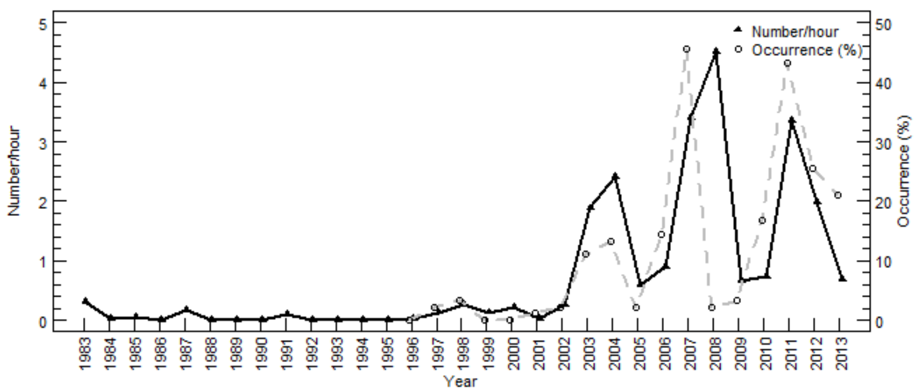


Figure 6.5. Ling. Number/hour and occurrence (%) of larvae on the Faroe Plateau from the annual 0-group survey.

Analytical assessment

An exploratory assessment of ling in Vb was done by running an XSA. Due to few otolith samples in the period from 2007-2013 the otolith samples for these years were combined in the age-length distribution before they where multiplied to the actual years length distributions per fleet. For the period 1997-2006 were there were enough otolith samples the actual samples were used for that actual year.

The input data are presented in Appendix 1-4, XSA diagnostic in Appendix 5 and XSA output for fishing mortality and stock size in Appendix 6-7. The XSA model was tuned with a commercial cpue series (Figure 9, Appendix 4). The CPUE series was on beforehand treated by a Genereal Linear Model (GLM), which standardized the effect of vessel, month, and fishing area.

The XSA model fitted the cpue-data well (Figure 6.6, Appendix 7). Both the longliner series and the trawler bycatch series had approximately same weight in the tuning. The log q residuals showed the problems in following the cohorts.

The results from the XSA model showed that the recruitment was quite stable, i.e., between 2 and 5 millions. The total biomass ranged between 21 and 36 thousand tons with an increase in the past few years. The spawning stock biomass varied between 11 and 22 thousand tons, and the fishing mortality between 0.22 and 0.53 – the natural mortality was set constantly at 0.2 (Table 6.1, Figure 6.7).

The retrospective pattern showed that recruitment and fishing mortality was underestimated, whereas the biomass and SSB was overestimated (Figure 6.8). The estimate of F0.1(F-factor of 0.4 giving an absolute F of 0.16) gave a catch of around 5100 tons and biomass of around 41 thousand tons (Figure 6.9). In this case where the Fmax was well-defined (F-factor of 0.8 giving an absolute F of 0.31) this should be used as the target F. Fishing of Fmax gave a catch of around 5500 tons and a biomass of 31000 tons.

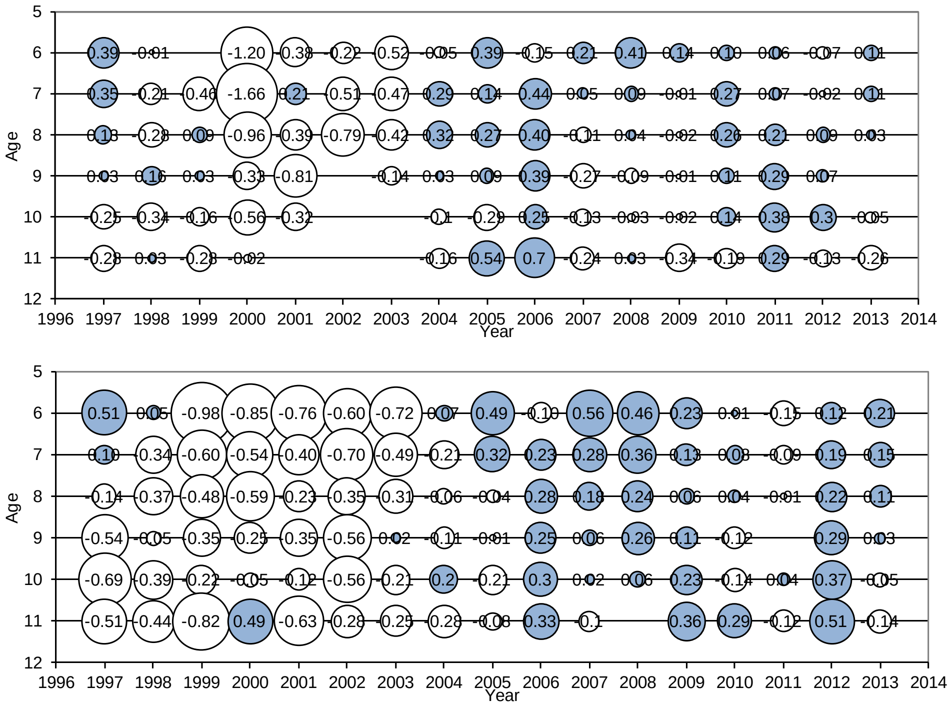
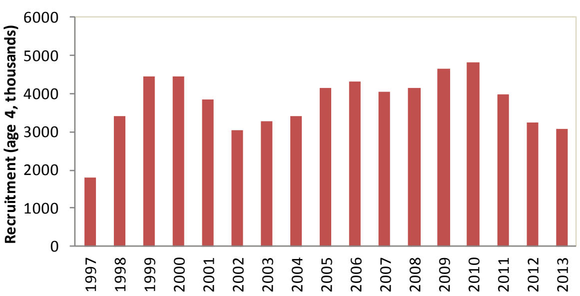
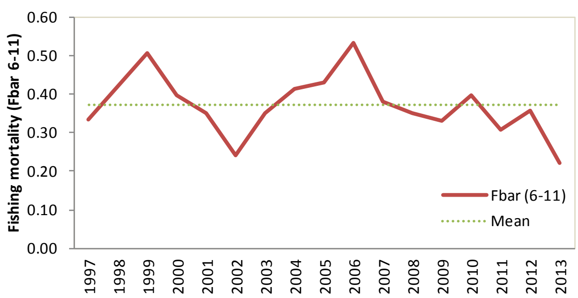


Figure 6.6. Ling Vb. Log catchability residuals for age group 6-11 from XSA diagnostic from longliners (upper figure) and trawl bycatch series (lower figure).





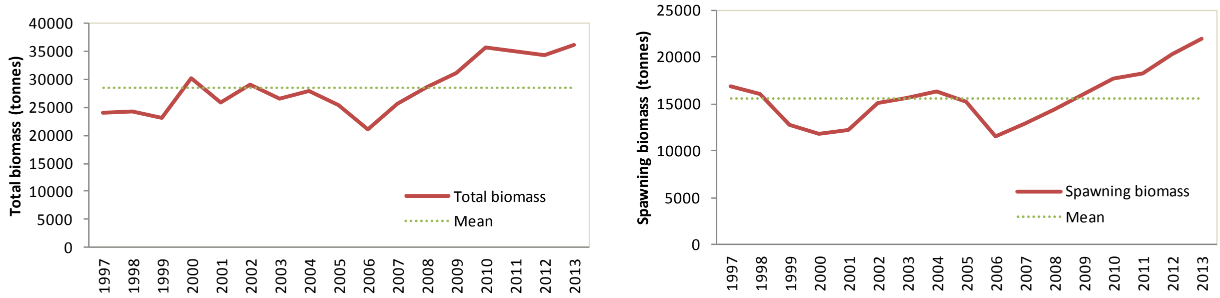


Figure 6.7. Ling Vb. Output from XSA.

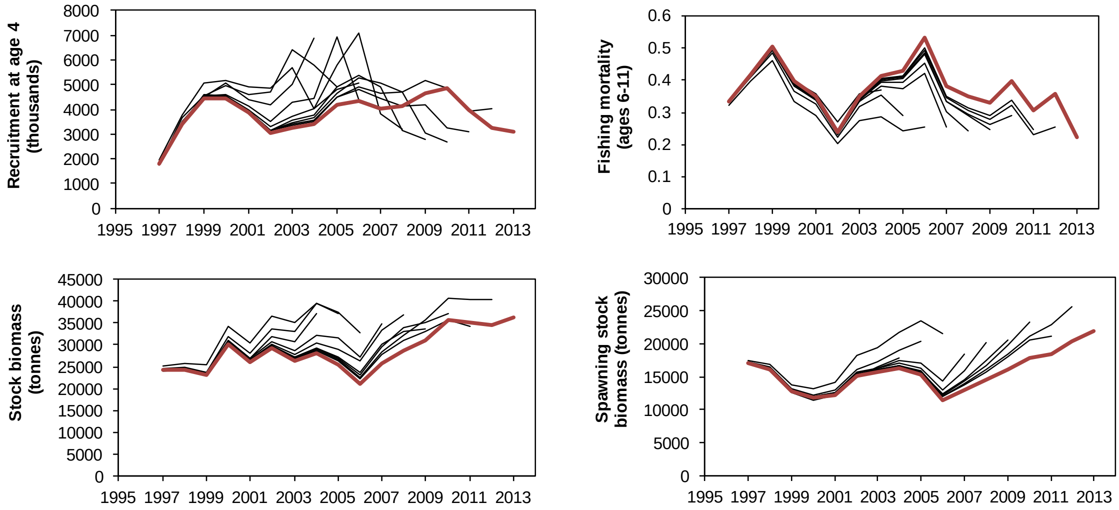


Figure 6.8. Ling Vb. Output from retrospective analysis.

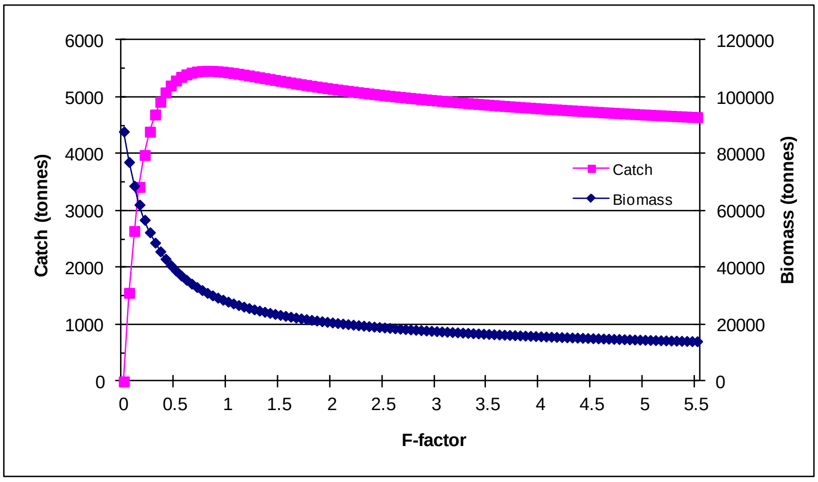


Figure 6.9. Ling Vb. A modified yield-per-recruit plot. The estimate of F0.1 catch is 5100 tonnes and the F max catch is around 5500 tonnes. The selection pattern, as well as the weights, were calculated as the average for the whole assessment period (1997-2013).

Table 6.1. Ling Vb. Summary table from XSA.

	Recruits Age 4	Totalbio	Totspbio	Landings	Yield/SSB	Fbar 6-11
1997	1784	24133	16946	5657	0.334	0.335
1998	3406	24245	16120	5359	0.333	0.419
1999	4465	23154	12827	5238	0.408	0.505
2000	4456	30199	11753	4109	0.350	0.398

2001	3853	25906	12282	4609	0.375	0.352
2002	3050	29135	15102	4139	0.274	0.241
2003	3270	26455	15679	5453	0.348	0.351
2004	3421	28002	16275	6039	0.371	0.413
2005	4164	25398	15200	5849	0.385	0.429
2006	4333	21031	11486	5216	0.454	0.532
2007	4046	25751	12933	4733	0.366	0.380
2008	4148	28710	14451	4736	0.328	0.350
2009	4649	31109	16008	4643	0.290	0.331
2010	4832	35577	17748	6129	0.345	0.397
2011	3996	35080	18309	4843	0.265	0.306
2012	3231	34430	20343	6003	0.295	0.358
2013	3086	36247	21928	4376	0.200	0.222
Arith. Mean	3776	28504	15611	5125	0.336	0.372
Units	(Thousands)	(Tonnes)	(Tonnes)		(Tonnes)	

6.1 Reference points.

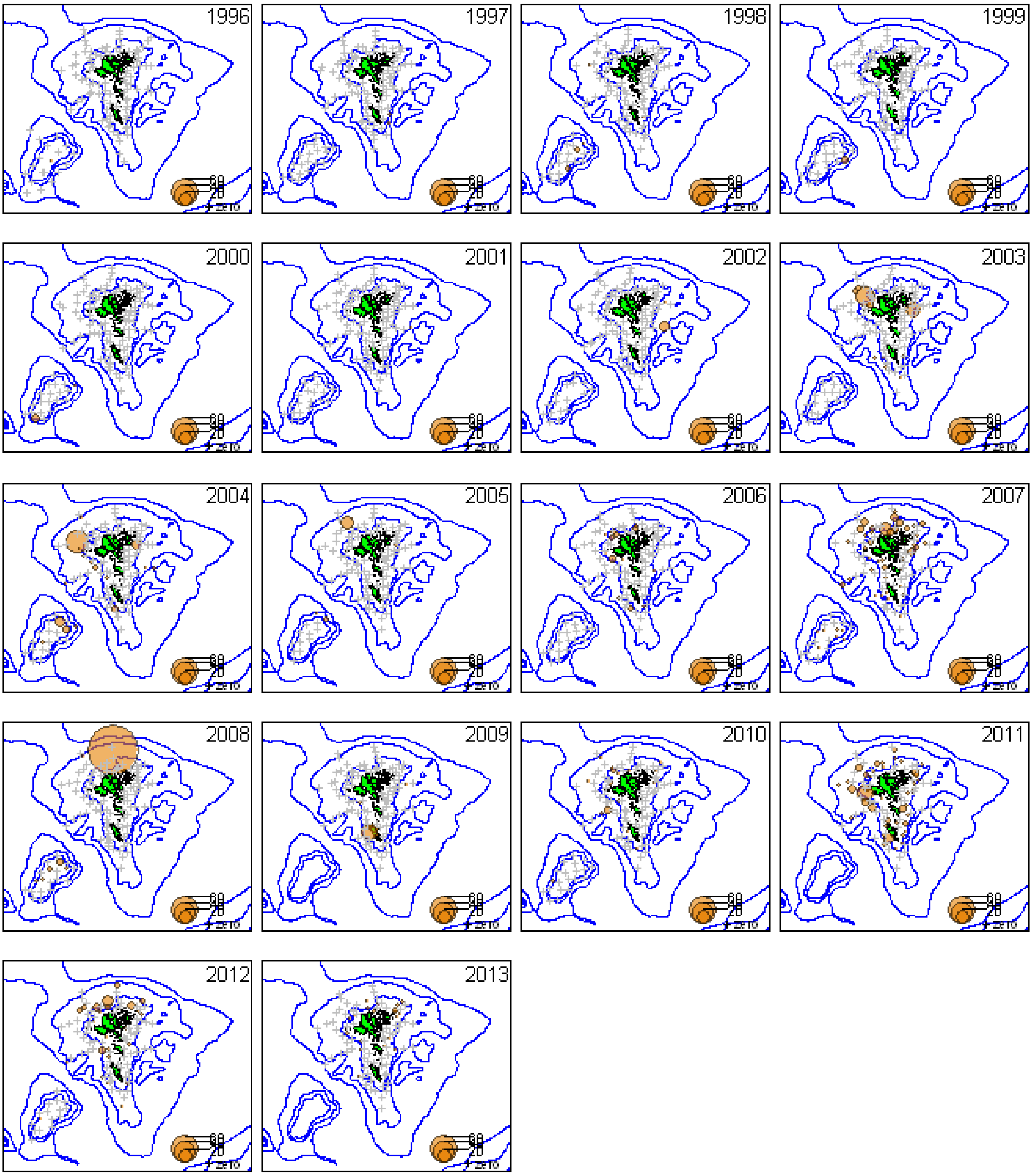
No reference points have been proposed for this stock. However, as adult abundance as measured by surveys is above the average of the time-series, expert judgement considered it likely that SSB is above any candidate values for MSY $B_{trigger}$.

7 Comments on the assessment

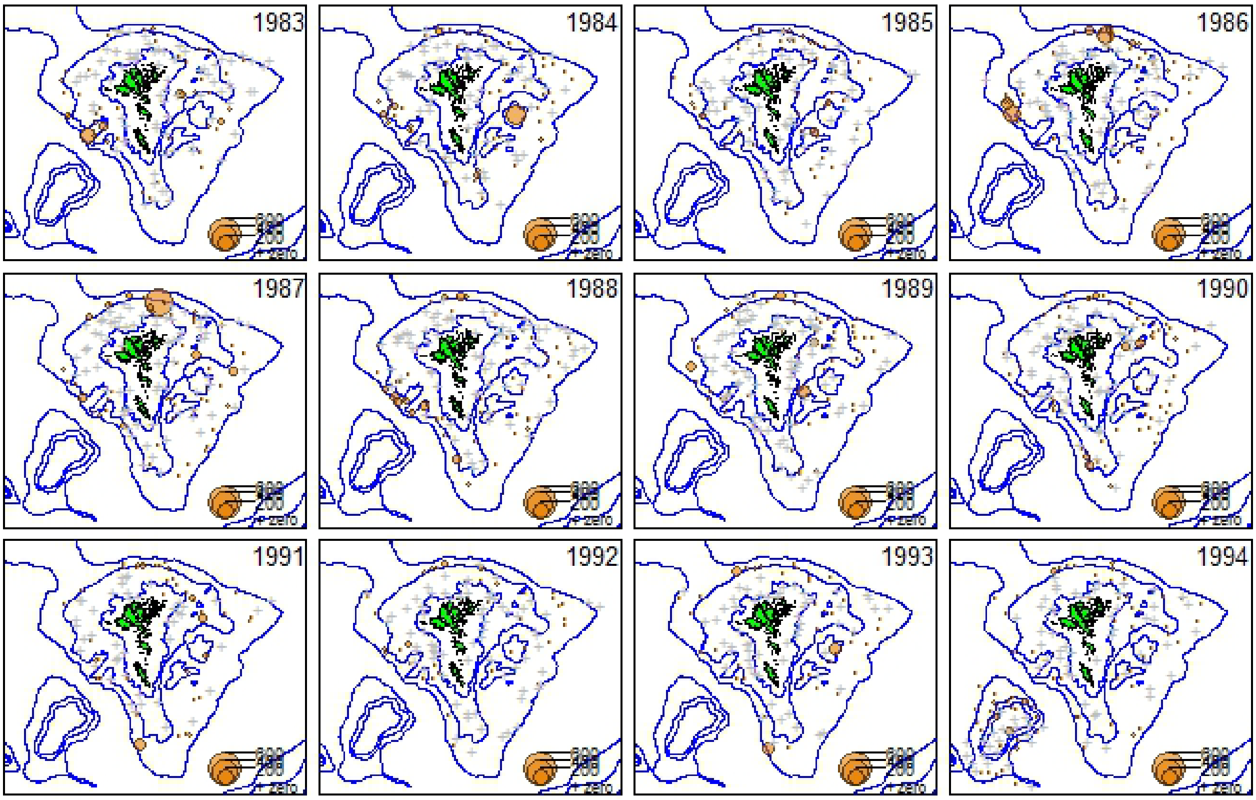
There was done an exploratory XSA assessment with an ALK using all ages for 2007-2013 in that period due to very few otolith samples of ling in Vb in the period from 2007 to present. There is a clear seasonal pattern in log q residuals and there need to be a closer look at the diagnostic to find the best settings. It is a need to look closer at the ALK for the whole period to try to solve the strong log q residual patterns. Still, the assessment shows that there is an increase both in stock biomass and spawning stock biomass during the last five years period. The recruitment seems to be very stable.

It will be further working on the assessment for ling in Vb during a Faroese project that ends in 2015. There is an ongoing work to get enough otoliths from small ling in the survey for use in a tuning series from the summer groundfish survey. Suggestions from a reviewer a few years ago was to try models that do not relay so much on age data such as statistical catch-at-age models and length based models including the information available on age and recruitment.

Appendix 1

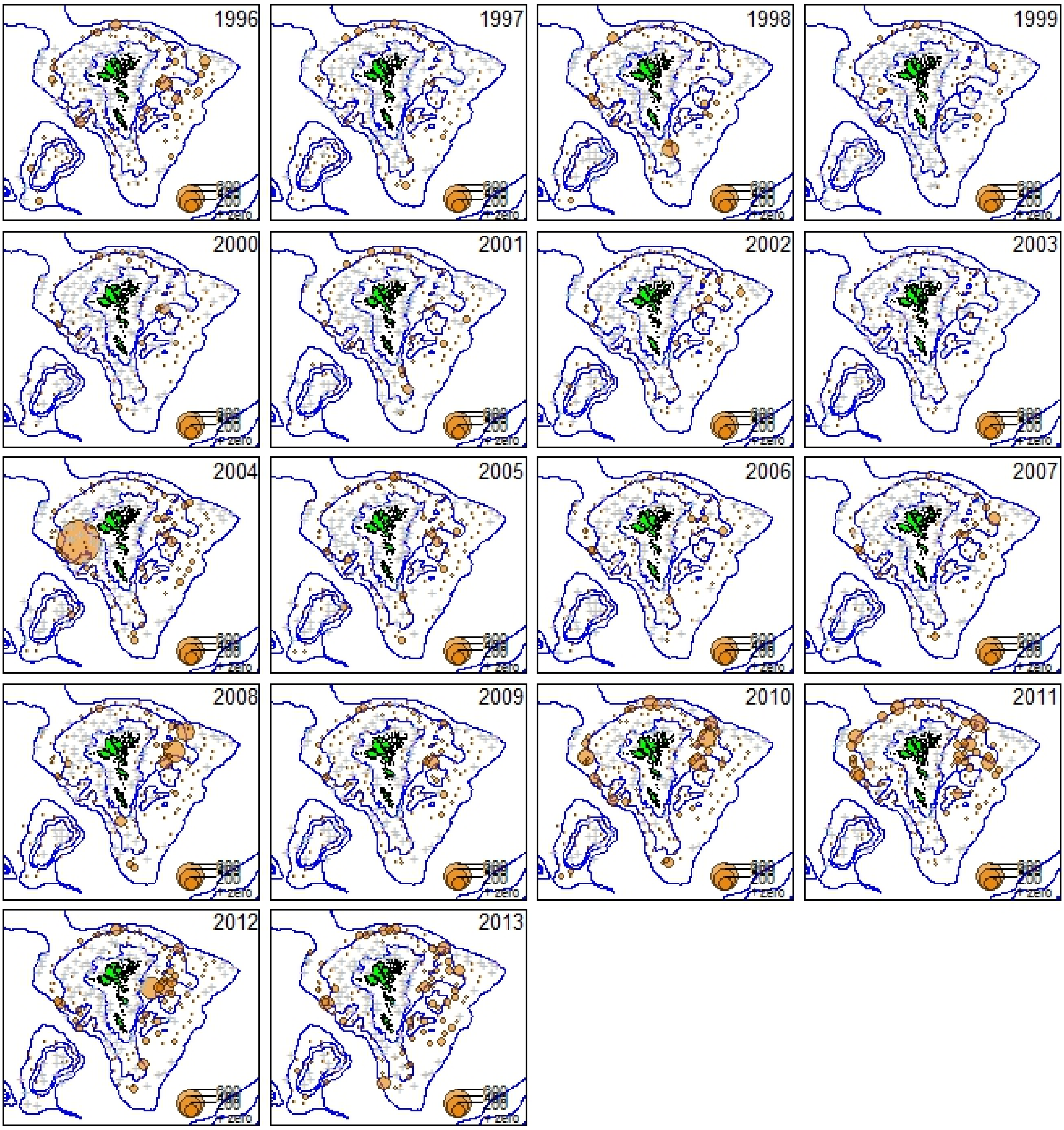


Appendix 2. Ling. Number of larvae per station from the annual 0-group survey 1996-2013.



Appendix 3. Ling Vb. Distribution of ling in the annual spring groundfish survey (kg/h) for the period 1983-1994.

Appendix 4. Ling Vb. Distribution of ling in the annual spring groundfish survey (kg/h) for the period 1995-2013.



Appendix 5. Ling Vb. Distribution of ling in the annual summer groundfish survey (kg/h).

Appendix 6. Ling Vb. Effort (1000 hooks) and catch in numbers for longliners series and pair trawl bycatch series (1997-2013).

Ling in Faroese water (ICES Div. Vb)
LLTR.dat

```
        102
5LongLiners>100GRT (Catch: Numbers) (Effort: 1000 hooks)
1997 2013
1 1 0 1
6 11
       3236   12   20   17   11    5    2
       2592    4    7    8    9    4    2
       3782    0    5   12   10    5    2
       2445    2    1    2    3    2    1
       2655    6   11    4    2    2    0
        765    2    2    1    0    0    0
       1173    2    3    3    2    0    0
       1859    4    9    9    5    2    1
       2941   10   10   12    7    4    2
       4925   10   22   19   14    8    6
       3039   11   10    7    4    3    1
       7112   33   30   22   12    8    3
       6433   22   26   24   14    8    2
       7831   27   40   39   24   13    3
       7266   28   34   34   26   19    5
       6837   24   34   33   21   16    4
       2024    7   12   11    7    4    1
PairTrawl>1000HP bycatch series (Catch: Numbers) (Effort: hours)
1997 2013
1 1 0 1
6 11
       4251    5    8    7    4    2    1
       4344    2    4    5    6    3    1
       6758    1    3    5    6    4    1
       6168    2    3    3    4    4    2
       6872    3    6    5    4    3    1
       5997    3    5    5    3    2    1
       5123    2    5    6    5    3    1
       4385    3    5    6    5    3    1
       5694    6    9    7    6    4    1
       4982    3    7    7    6    4    2
       5541    8    9    7    5    3    1
       5134    7   11    8    6    3    1
       6651    7   12   11    8    5    2
       6720    6   11   11    8    4    2
       4552    4    7    7    6    4    1
       7550    9   18   17   14    9    4
       7454    8   18   18   13    7    2
```

Appendix 7. Ling Vb. Diagnostics from XSA with longline as tuning series.

```
Lowestoft VPA Version 3.1
    1/04/2014  14:20
Extended Survivors Analysis
FAROE LING (ICES DIVISION Vb)                LIN_IND
CPUE data from file D:\WGDEEP\WGDEEP2014\Ling\XSA1996-2013\LLTR_6-11.dat
Catch data for  17 years. 1997 to 2013. Ages  4 to  14.

      Fleet             First  Last  First  Last  Alpha   Beta
                         year  year   age    age
 5LongLiners>100GRT (    1997  2013    6     11    .000   1.000
 PairTrawl>1000HP (Ca    1997  2013    6     11    .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   57 iterations

Regression weights
          .751   .820   .877   .921   .954   .976   .990   .997  1.000  1.000
 Fishing mortalities
    Age  2004   2005   2006   2007   2008   2009   2010   2011   2012   2013
      4  .050   .020   .030   .023   .011   .005   .003   .004   .010   .001
      5  .063   .082   .052   .047   .038   .022   .014   .013   .022   .010
      6  .118   .175   .098   .174   .160   .119   .120   .078   .092   .077
      7  .325   .284   .329   .276   .225   .206   .277   .155   .192   .146
      8  .533   .477   .501   .404   .337   .314   .439   .280   .332   .223
      9  .468   .553   .650   .424   .378   .404   .481   .391   .432   .268
     10  .563   .434   .764   .600   .588   .593   .664   .576   .716   .387
     11  .468   .649   .846   .403   .414   .349   .400   .359   .385   .228
     12  .296   .352  1.424   .430   .598   .420   .482   .491   .569   .232
     13  .595   .771  1.066   .448   .448   .427   .470   .392   .381   .224

XSA population numbers (Thousands)
                                AGE
 YEAR          4          5          6          7          8          9         10         11         12         13
 2004      3.42E+03  2.64E+03  1.94E+03  1.75E+03  1.20E+03  6.62E+02  2.33E+02  1.60E+02  7.76E+01  3.94E+01
 2005      4.16E+03  2.66E+03  2.03E+03  1.41E+03  1.04E+03  5.75E+02  3.39E+02  1.09E+02  8.20E+01  4.73E+01
 2006      4.33E+03  3.34E+03  2.01E+03  1.39E+03  8.70E+02  5.27E+02  2.71E+02  1.80E+02  4.66E+01  4.72E+01
 2007      4.05E+03  3.44E+03  2.60E+03  1.49E+03  8.22E+02  4.31E+02  2.25E+02  1.03E+02  6.32E+01  9.18E+00
 2008      4.15E+03  3.24E+03  2.69E+03  1.79E+03  9.27E+02  4.49E+02  2.31E+02  1.01E+02  5.65E+01  3.37E+01
 2009      4.65E+03  3.36E+03  2.55E+03  1.88E+03  1.17E+03  5.42E+02  2.52E+02  1.05E+02  5.48E+01  2.54E+01
 2010      4.83E+03  3.79E+03  2.69E+03  1.85E+03  1.25E+03  6.98E+02  2.96E+02  1.14E+02  6.07E+01  2.95E+01
 2011      4.00E+03  3.95E+03  3.06E+03  1.95E+03  1.15E+03  6.60E+02  3.53E+02  1.25E+02  6.26E+01  3.07E+01
 2012      3.23E+03  3.26E+03  3.19E+03  2.31E+03  1.37E+03  7.12E+02  3.65E+02  1.63E+02  7.13E+01  3.14E+01
 2013      3.09E+03  2.62E+03  2.61E+03  2.38E+03  1.56E+03  8.04E+02  3.79E+02  1.46E+02  9.07E+01  3.31E+01

 Estimated population abundance at 1st Jan 2014
          0.00E+00  2.52E+03  2.12E+03  1.98E+03  1.68E+03  1.02E+03  5.03E+02  2.11E+02  9.53E+01  5.89E+01
Taper weighted geometric mean of the VPA populations:
          3.85E+03  3.13E+03  2.48E+03  1.76E+03  1.08E+03  5.76E+02  2.86E+02  1.28E+02  6.69E+01  2.91E+01
Standard error of the weighted Log(VPA populations) :
             .1752     .1881     .2155     .2311     .2377     .2309     .2100     .2212     .2410     .6028

Log catchability residuals.
Fleet : 5LongLiners>100GRT (
  Age     1997   1998   1999   2000   2001   2002   2003
     6     .39   -.01  99.99  -1.20   -.38   -.22   -.52
     7     .35   -.21   -.46  -1.66    .21   -.51   -.47
     8     .13   -.28    .09   -.96   -.39   -.79   -.42
     9     .03    .16    .03   -.33   -.81  99.99   -.14
    10    -.25   -.34   -.16   -.56   -.32  99.99  99.99
    11    -.28    .03   -.28   -.02  99.99  99.99  99.99
  Age     2004   2005   2006   2007   2008   2009   2010   2011   2012   2013
     6    -.05    .39   -.15    .21    .41    .14    .10    .06   -.07    .11
     7     .29    .14    .44    .05    .09   -.01    .27    .07   -.02    .11
     8     .32    .27    .40   -.11    .04   -.02    .26    .21    .09    .03
     9     .03    .09    .39   -.27   -.09   -.01    .11    .29    .07    .00
    10    -.10   -.29    .25   -.13   -.03   -.02    .14    .38    .30   -.05
    11    -.16    .54    .70   -.24    .03   -.34   -.19    .29   -.13   -.26

 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
 Mean Log q   -13.5086   -12.8421   -12.3916   -12.1297   -11.8330   -12.1275
 S.E(Log q)      .3403      .4048      .3479      .2588      .2512      .3439

 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      .95      .077      13.25      .23      16      .34   -13.51
  7      .63     1.101      10.88      .48      17      .25   -12.84
  8      .64     1.339      10.43      .58      17      .21   -12.39
  9      .61     2.010       9.87      .74      16      .14   -12.13
 10      .75      .873      10.31      .59      15      .19   -11.83
 11      .79      .498      10.64      .42      14      .29   -12.13

 Fleet : PairTrawl>1000HP (Ca
  Age     1997   1998   1999   2000   2001   2002   2003
     6     .51    .05   -.98   -.85   -.76   -.60   -.72
     7     .10   -.34   -.60   -.54   -.40   -.70   -.49
     8    -.14   -.37   -.48   -.59   -.23   -.35   -.31
     9    -.54   -.05   -.35   -.25   -.35   -.56    .02
```

```
   10    -.69   -.39   -.22   -.05   -.12   -.56   -.21
   11    -.51   -.44   -.82    .49   -.63   -.28   -.25
  Age    2004   2005   2006   2007   2008   2009   2010   2011   2012   2013
    6     .07    .49   -.10    .56    .46    .23    .01   -.15    .12    .21
    7    -.21    .32    .23    .28    .36    .13    .08   -.09    .19    .15
    8    -.06   -.04    .28    .18    .24    .06    .04   -.01    .22    .11
    9    -.11   -.01    .25    .06    .26    .11   -.12    .00    .29    .03
   10     .20   -.21    .30    .02    .06    .23   -.14    .04    .37   -.05
   11    -.28   -.08    .33   -.10    .00    .36    .29   -.12    .51   -.14

 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
 Mean Log q   -14.7769   -13.7868   -13.2818   -12.8450   -12.5806   -12.8660
 S.E(Log q)      .4518      .3324      .2357      .2283      .2479      .3443

 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      .80      .372      13.41      .26      17      .38   -14.78
  7      .85      .392      12.84      .40      17      .29   -13.79
  8      .83      .670      12.21      .61      17      .20   -13.28
  9      .88      .435      12.07      .57      17      .21   -12.84
 10     1.02     -.057      12.73      .41      17      .27   -12.58
 11     1.04     -.074      13.17      .28      17      .37   -12.87

 Terminal year survivor and F summaries :
Age  4   Catchability dependent on age and year class strength
Year class = 2009
Fleet                   Estimated     Int        Ext     Var     N  Scaled   Estimated
                         Survivors     s.e        s.e    Ratio      Weights     F
 5LongLiners>100GRT (          1.    .000        .000     .00    0   .000      .000
 PairTrawl>1000HP (Ca          1.    .000        .000     .00    0   .000      .000
   P shrinkage mean         3127.     .19                            .876      .001
   F shrinkage mean          554.     .50                            .124      .007
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
      2523.        .18      7.85     2   44.610    .001

 Age  5   Catchability dependent on age and year class strength
Year class = 2008
Fleet                   Estimated     Int        Ext     Var     N  Scaled   Estimated
                         Survivors     s.e        s.e    Ratio      Weights     F
 5LongLiners>100GRT (          1.    .000        .000     .00    0   .000      .000
 PairTrawl>1000HP (Ca          1.    .000        .000     .00    0   .000      .000
   P shrinkage mean         2476.     .22                            .843      .008
   F shrinkage mean          932.     .50                            .157      .022
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
      2124.        .20      7.67     2   38.746    .010

Age  6   Catchability constant w.r.t. time and dependent on age
Year class = 2007
Fleet                   Estimated     Int        Ext     Var     N  Scaled   Estimated
                         Survivors     s.e        s.e    Ratio      Weights     F
 5LongLiners>100GRT (       2209.    .355        .000     .00    1   .474      .069
 PairTrawl>1000HP (Ca       2437.    .470        .000     .00    1   .269      .063
   F shrinkage mean         1300.     .50                            .257      .114
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
      1979.        .25       .20     3     .832    .077

Age  7   Catchability constant w.r.t. time and dependent on age
Year class = 2006
Fleet                   Estimated     Int        Ext     Var     N  Scaled   Estimated
                         Survivors     s.e        s.e    Ratio      Weights     F
 5LongLiners>100GRT (       1698.    .272        .087     .32    2   .430      .145
 PairTrawl>1000HP (Ca       1942.    .279        .016     .06    2   .416      .128
   F shrinkage mean         1123.     .50                            .154      .212
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
      1685.        .18       .10     5     .569    .146

Age  8   Catchability constant w.r.t. time and dependent on age
Year class = 2005
Fleet                   Estimated     Int        Ext     Var     N  Scaled   Estimated
                         Survivors     s.e        s.e    Ratio      Weights     F
 5LongLiners>100GRT (       1051.    .219        .021     .10    3   .409      .218
 PairTrawl>1000HP (Ca       1123.    .206        .079     .39    3   .479      .205
   F shrinkage mean          627.     .50                            .112      .343
```

```
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
      1024.        .14       .08     7     .576    .223

 Age  9   Catchability constant w.r.t. time and dependent on age
Year class = 2004
Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 5LongLiners>100GRT (        528.    .182        .026     .14    4   .433      .257
 PairTrawl>1000HP (Ca        535.    .173        .065     .38    4   .474      .254
   F shrinkage mean          296.     .50                            .093      .420
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
       503.        .12       .07     9     .566    .268

Age 10   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
 5LongLiners>100GRT (        224.    .164        .056     .34    5   .438      .367
 PairTrawl>1000HP (Ca        226.    .158        .071     .45    5   .465      .365
   F shrinkage mean          113.     .50                            .097      .633
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
       211.        .11       .08    11     .687    .387

Age 11   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
 5LongLiners>100GRT (        103.    .171        .121     .71    6   .438      .214
 PairTrawl>1000HP (Ca        102.    .166        .094     .57    6   .455      .214
   F shrinkage mean           52.     .50                            .107      .384
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
        95.        .12       .09    13     .771    .228

Age 12   Catchability constant w.r.t. time and age (fixed at the value for age) 11
Year class = 2001
Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 5LongLiners>100GRT (         65.    .167        .093     .56    6   .420      .213
 PairTrawl>1000HP (Ca         73.    .162        .113     .70    6   .438      .191
   F shrinkage mean           23.     .50                            .142      .516
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
        59.        .12       .14    13    1.113    .232

Age 13   Catchability constant w.r.t. time and age (fixed at the value for age) 11
Year class = 2000
Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 5LongLiners>100GRT (         25.    .170        .060     .35    6   .378      .197
 PairTrawl>1000HP (Ca         21.    .165        .070     .42    6   .394      .226
   F shrinkage mean           18.     .50                            .228      .269
Weighted prediction :
Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
        22.        .15       .06    13     .382    .224
```

Appendix 8. Ling Vb. Fishing mortality (F) at age.

YEAR\AGE	4	5	6	7	8	9	10	11	12	13	14+	FBAR (6-11)
1997	0.001	0.137	0.161	0.300	0.371	0.441	0.465	0.273	2.282	0.774	0.774	0.335
1998	0.000	0.046	0.139	0.228	0.345	0.679	0.612	0.513	0.369	0.507	0.507	0.419
1999	0.005	0.010	0.009	0.213	0.578	0.742	0.835	0.656	0.966	0.786	0.786	0.505
2000	0.012	0.042	0.061	0.077	0.240	0.616	0.592	0.804	0.967	0.669	0.669	0.398
2001	0.006	0.027	0.128	0.476	0.366	0.356	0.567	0.218	1.100	0.567	0.567	0.352
2002	0.022	0.024	0.174	0.274	0.304	0.189	0.479	0.024	0.026	0.200	0.200	0.241
2003	0.013	0.030	0.158	0.301	0.461	0.629	0.326	0.228	0.453	0.604	0.604	0.351
2004	0.050	0.064	0.118	0.325	0.533	0.469	0.563	0.468	0.296	0.595	0.595	0.413
2005	0.020	0.082	0.175	0.284	0.477	0.553	0.434	0.649	0.352	0.771	0.771	0.429
2006	0.030	0.052	0.098	0.329	0.501	0.650	0.765	0.846	1.425	1.066	1.066	0.532
2007	0.023	0.047	0.174	0.276	0.404	0.424	0.601	0.403	0.430	0.448	0.448	0.380

2008	0.011	0.038	0.160	0.225	0.337	0.378	0.588	0.414	0.598	0.448	0.448	0.350
2009	0.006	0.022	0.119	0.206	0.314	0.404	0.593	0.349	0.420	0.427	0.427	0.331
2010	0.003	0.014	0.120	0.277	0.439	0.481	0.664	0.400	0.482	0.470	0.470	0.397
2011	0.004	0.013	0.078	0.155	0.280	0.391	0.576	0.359	0.491	0.392	0.392	0.306
2012	0.010	0.022	0.092	0.192	0.332	0.432	0.716	0.385	0.569	0.381	0.381	0.358
2013	0.001	0.010	0.077	0.146	0.223	0.268	0.387	0.228	0.232	0.224	0.224	0.222
FBAR	0.005	0.015	0.082	0.164	0.278	0.364	0.560	0.324	0.431	0.332		

Appendix 9. Ling Vb. Stock number of age (start of year, thousands)

YEAR\AGE	4	5	6	7	8	9	10	11	12	13	14+	
1997	1784	1892	2212	2092	1465	825	375	190	33	16	12	10895
1998	3406	1460	1351	1541	1269	827	435	193	118	3	74	10676
1999	4465	2787	1142	962	1005	736	344	193	95	67	2	11797
2000	4456	3640	2259	927	636	462	287	122	82	29	4	12905
2001	3853	3604	2859	1741	702	410	204	130	45	26	3	13576
2002	3050	3136	2871	2059	885	399	235	95	86	12	12	12840
2003	3270	2442	2507	1975	1281	535	270	119	76	68	0	12544
2004	3421	2642	1940	1753	1196	662	233	160	78	39	12	12137
2005	4164	2663	2030	1411	1037	575	339	109	82	47	63	12520
2006	4333	3340	2009	1395	870	527	271	180	47	47	36	13055
2007	4046	3443	2596	1492	822	431	225	103	63	9	21	13253
2008	4148	3238	2689	1786	927	449	231	101	56	34	24	13684
2009	4649	3359	2551	1876	1168	542	252	105	55	25	16	14597
2010	4832	3786	2689	1854	1250	698	296	114	61	29	20	15630
2011	3996	3946	3055	1952	1151	660	353	125	63	31	20	15351
2012	3231	3259	3189	2313	1368	712	365	163	71	31	14	14717
2013	3086	2620	2609	2381	1564	804	379	146	91	33	16	13729
2014	0	2523	2124	1979	1685	1024	503	211	95	59	32	10235
GMST 95-**	3764	2932	2244	1610	1018	566	283	132	66	25		
AMST 95-**	3858	3025	2317	1655	1044	583	290	136	69	32		

Discards of deepwater species by the Portuguese bottom otter trawl and deepwater set longline fisheries operating in ICES Division XIa (2004-2013)

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Abstract

We compile the information available on the discards produced by Portuguese vessels operating with bottom otter trawl (OTB, target: crustaceans and demersal fish) and deepwater set longlines (LLS_DWS, target: black scabbardfish) in Portuguese ICES Division IXa. Species included are the WGDEEP stocks Black scabbardfish *Aphanopus carbo* (bsf-89), Greater silver smelt *Argentina silus* (arg-rest), Alfonsinos *Beryx* spp. (alf-coomb), Tusk *Brosme brosme* (usk-rest), Roundnose grenadier *Coryphaenoides rupestris* (rng-rest), Orange roughy *Hoplostethus atlanticus* (ory-comb), Blue ling *Molva dypterygia* (bli-rest), Ling *Molva molva* (lin-rest), Blackspot(=red) seabream *Pagellus bogaraveo* (sbr-ix) and Greater forkbeard *Phycis blennoides* (gfb-comb). The data was collected by the Portuguese on-board sampling programme (EU DCR/NP) between 2004 and 2013. We describe the on-board sampling programme, the estimation algorithms and the data quality assurance procedures. We provide discard data for three fisheries: the crustacean bottom otter trawl fishery (OTB_CRU), the demersal bottom otter trawl fish fishery (OTB_DEF) and the deepwater set longline fishery that targets black scabbardfish (LLS_DWS). The low frequency of occurrence (and number of specimens) registered by most species in all fisheries indicates that discards can be assumed negligible in the assessment of most WGDEEP 2014 stocks with possible exception of greater forkbeards.

1 Introduction

This working document compiles the information available on the discards of black scabbardfish (*Aphanopus carbo*), greater silver smelt (*Argentina silus*), alfonsinos (*Beryx* spp.), tusk (*Brosme brosme*), roundnose grenadier (*Coryphaenoides rupestris*), lings (*Molva dypterygia* and *Molva molva*), orange roughy (*Hoplostethus atlanticus*), blackspot(=red) seabream (*Pagellus bogaraveo*) and Greater forkbeard (*Phycis blennoides*) produced by the Portuguese bottom otter trawl fleet (OTB) and deepwater longline fleet operarting in Portuguese ICES Division IXa. The data was collected by the Portuguese on-board sampling programme (EU DCR/NP) between 2004 and 2013. The document starts with a description of the on-board sampling programme and details on estimation algorithms and data quality assurance procedures (Section 2). Then, results on the annual frequency of occurrence of the different species in discards are given alongside total discard estimates and discard length composition of the most frequently discarded species (Section 3). Finally, conclusions are drawn on the importance of discards for WGDEEP

2014 stock assessments (Section 4).

2 Onboard sampling and data analysis

The Portuguese on-board sampling program, included in the EU DCR/NP, is based on a quasi-random sampling of cooperative commercial vessels between 12 and 40 meters long. The programme started in late 2003 and involves on-board sampling of several fishing métiers. These include, amongst other, bottom otter trawl and deepwater set longlines that target black scabbardfish in ICES Division IXa. From these, the bottom otter trawl fleet (OTB) constitutes the most comprehensively sampled fleet. For sampling purposes the OTB fleet is split into two components: a crustacean fishery (OTB_CRU) that operates cod-end mesh sizes 55-59mm and >70mm targeting deep-water rose shrimp, Norway lobster and blue whiting and a demersal fish fishery (OTB_DEF) that operates cod-end mesh size 65-69mm and >70mm and targets horse-mackerel, cephalopods and other finfish. A detailed account of the characteristics in these fisheries is found in Castro et al. (2007). The deepwater set longline fleet that targets black scabbardfish (LLS_DWS) has been sampled from 2005 onwards but sampling intensity in this fishery has been low and fleet coverage suboptimal (Fernandes and Ferreira, 2006; Fernandes et al., 2008; Fernandes et al., 2009). An account of the vessel characteristics of the Portuguese deepwater longline fishery targeting black scabbardfish can be find in Bordalo-Machado and Figueiredo (2009).

2.1 Trip selection

The EU DCR/NP (CR (EC) 199/2008; CD 2010/93/EU) establishes fishing trip as the sampling unit to be used by at-sea discard sampling programmes. The Portuguese onboard sampling programme targeting the bottom otter trawl fleet (OTB_CRU and OTB_DEF) and the deepwater set longline fleet that targets black scabbardfish (LLS_DWS) is based on a quasi-random sampling of trips from a set of cooperative vessels known to operate in each fishery. Annual sampling targets are fixed for each fishery, namely 12 trips in the OTB_CRU fishery, 27 trips in the OTB_DEF fishery and 12 trips in the LLS_DWS fishery. The sampling levels attained in the 2004-2013 period are presented in Table 1 and Table 2. The OTB fisheries have been extensively sampled throughout the period with annual sampling levels generally attaining or surpassing the annual sampling targets (Table 1). Sampling levels achieved in the LLS_DWS fishery are low and have remained below 50% of the annual targets throughpout much of the period. The main reasons for this are difficulties in placing observers onboard smaller vessels (Fernandes et al., 2008), difficulties in transporting observers to the ports of departure/arrival, and the need to observe an increasing number of fisheries, namely set gill/trammel nets targeting demersal fish stocks (GNS_DEF, GTR_DEF).

Table 1: Sampling levels of the Portuguese onboard sampling programme in the two OTB fisheries (2004-2013).

	Trips sampled		Hauls sampled		Hours fished	
Year	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF
2004	17	24	111	125	479	315
2005	15	39	74	159	372	349
2006	7	42	30	194	133	380
2007	12	38	73	162	263	287
2008	12	34	66	128	255	254
2009	16	38	84	135	314	264
2010	16	31	103	116	375	208
2011	13	30	56	83	217	161
2012	13	31	68	60	302	130
2013	6	27	28	50	118	108

Table 2: Sampling levels of the Portuguese onboard sampling programme in the LLS_DWS fishery (2005-2012).

Year	Trips	Sets	Hours fished
2005	3	3	115
2006	6	5	197
2007	3	3	110
2008	4	4	157
2009	6	6	247
2010	9	9	373
2011	6	6	169
2012	9	9	380
2013	2	2	108

2.2 Catch sampling

The sampling protocols used in Portuguese onboard sampling of the OTB and LLS_DWS fisheries are detailed in Prista et al. (2011). A brief account follows. Two observers are deployed per fishing trip. In the OTB fisheries several hauls are made on each fishing trip and observers take a sample from the haul's catch, sort the specimens into retained and discarded fraction and register the weight and length composition of each species fraction. In the LLS_DWS fishing trips a single longline is hauled per trip and the mainline is generally divided into 6-10 short segments (Bordalo-Machado and Figueiredo, 2009). Observers identify and count every specimen caught in a sample of segments and allocate it to one of two categories: retained or discarded. Afterwards, a sample of fish from each species and category is used to determine length composition. In both fleets, observers collect concurrent fishing effort information (hours fished, number of hooks, etc.) and register environmental information (GPS coordinates, depth, bottom type, etc.). The on-board sampling protocols of the OTB_CRU, OTB_DEF and LLS_DWS fisheries have suffered only minor changes and adaptations between 2004 and 2010. In 2011 the size of catch samples taken from the OTB fishery was doubled (from 1 to 2 boxes of catch) and the within-trip selection of hauls and sets was standardized to "at least, every other haul/segment".

2.3 Estimates of discards (haul and set level)

In the OTB fisheries, the total volume discarded (in kg) in each haul is estimated by multiplying the ratio of discard and retained sample weights (all species combined) by the total retained weight in the haul (all species combined). The volume of discards of individual species in each haul is calculated *a posteriori* by multiplying the proportion (in weight) of species discards in the catch sample by the total catch volume estimated for each haul (total volume discarded + total volume landed). In the LLS_DWS fisheries, the number of fish discarded in each species and set is estimated by multiplying the species counts by the inverse of sampling fraction (i.e., total by the ratio of "no. segments in gear" to "no. segments counted").

2.4 Estimates of discards (fleet level)

The procedure generally used to raise discards from haul to fleet level in the Portuguese trawl fisheries is described in Jardim and Fernandes (2013). Using this procedure species with low frequency of occurrence or abundance in discards (i.e., a large number of zeros in the data set) cannot be reliably estimated at fleet level (Jardim et al., 2011). The frequency of occurrence and abundance of WGDEEP 2014 species in the discards of the Portuguese bottom trawl fleet was below 30% (see Section 3.2.). Consequently, annual discard volumes at fleet level were not estimated. Fleet level estimates were also not obtained for the deepwater set longline fisheries targeting black scabbardfish due to low sampling levels and the current lack of a procedure that appropriately corrects for shifts in vessel size and fishing ground coverage throughout the period (see Section 3.2).

2.5 Quality assurance procedures

Data involved in the calculation of discard estimates from Portuguese waters comes from an IPMA database (onboard sampling data) and a DGRM database (logbook and sales data) that are yet to be fully integrated into a single National Fisheries Database. The IPMA onboard database is programmed in Oracle and contains internal routines for the detection of basic errors (e.g., errors in dates). In what concerns the OTB fisheries, the database contains general trip information (vessel information, date, location, haul number, retained weight by species), along with sample information by fraction (retained, discarded) and species, namely weight, number of specimens and length composition. Quality checks involving the manual checking of (at least) 10% of annual trawl records have been routinely carried out since the beginning of the on-board sampling programme. In 2010-2011 a semi-automated R quality assurance procedure was designed and the 2004-2011 trawl database was checked for so far undetected errors. Since then, routine quality assurance procedures include: quarterly checks using the semi-automated R routine and an annual check of 10% of the trawl records that detects observer-related biases, with only minor updates and data reviews being performed in the previous data. DGRM effort and commercial data is supplied to IPMA on an annual basis. The 2004-2011 logbook data supplied by DGRM was based on paper logbooks and displayed increasing fleet coverage. However, in 2012 DGRM discontinued most of its logging of paper logbooks as these were replaced by electronic logbooks. Effort data from electronic logbooks in 2012-2013 were not available at the time of this report so estimates for these two years could not provided. In what concerns the LLS_DWS fishery, the current design of the Portuguese onboard database does not yet allow the logging of all LLS_DWS data with some data still being logged on MS Excel spreadsheets. Because full quality checks have not been carry out in LLS_DWS datasets, results presented for this fishery should be considered provisional until further notice. All data used in the current working document were extracted from the IPMA database in 05/04/2014. The effort data used in discard estimates were compiled from DGRM raw files in 6-18/03/2012.

2.6 Note on species identification

The Portuguese on-board observers are trained in using the FAO 3-alpha code list (ASFIS List of Species for Fishery Statistics Purposes: available at http://www.fao.org/fishery/collection/asfis/en, date: February 2013) to identify species and species groups during field observations. General training in species identification is provided to observers during demersal surveys and/or market sampling. When onboard a commercial fishing trip observers are requested to record fish data at the most appropriate taxonomic level based on the specimen's conservation status, on field logistics, and their own identification expertise. Practice shows that Portuguese on-board observers are quite accurate in the identification of most commercial and non-commercial species but that substantial differences between observers and/or inaccuracies in species identification still exist during the identification of less common species and species that are very similar to others. In this working document we present data on roundnose grenadier (*Coryphaenoides rupestris*) which is rare in the Portuguese continental slope. IPMA has instructed its observers to bring back to the laboratory all roundnose grenadiers they find so that identifications of this species can be independently verified. Until that happens, all roundnose grenadier data should be used with caution. The FAO 3-alpha codes, and scientific and common names of species covered by this working document are shown in Table 3.

Table 3: Species codes and common names

Species	3-alpha code	English name	Portuguese name
Aphanopus carbo	BSF	Black scabbardfish	Peixe-espada-preto
Argentina silus	ARU	Greater argentine	Argentina-dourada
Beryx spp.	ALF	Alfonsino nei	Imperadores
Brosme brosme	USK	Tusk	Bolota
Coryphaenoides rupestris	RNG	Roundnose grenadier	Lagartixa-da-rocha
Hoplostethus atlanticus	ORY	Orange roughy	Olho-de-vidro-laranja
Molva dypterygia	BLI	Blue ling	Maruca-azul
Molva molva	LIN	Ling	Maruca
Pagellus bogaraveo	SBR	Blackspot(=red) seabream	Goraz
Phycis blennoides	GFB	Greater forkbeard	Abrótea-do-alto

3 Species discards

3.1 Frequency of occurrence

3.1.1 Bottom otter trawl fisheries

No discards of greater silver smelt, lings (*Molva* spp.) and tusk were ever observed in the two otter trawl fisheries. The discard frequency of most remaining species was low (ranging 0% to 13% of hauls in OTB_CRU and 0% to 6% in OTB_DEF), with exception of greater forkbeard that was frequently discarded in the OTB_CRU fishery (25 to 65% of hauls). Species rarely discarded were discarded in low numbers: in the 693 hauls sampled in the OTB_CRU fishery only n = 8 alfonsinos (1 *Beryx splendens* and 7 *Beryx decadactylus*), n = 16 black scabbardfish, n = 8 orange roughy, n = 15 groundnose grenadier and n = 4 blackspot(=red) seabream were sampled; and in 1212 hauls sampled in the OTB_DEF fishery only n = 10 black scabbardfish, n = 6 blackspot(=red) seabream and n =

38 greater forkbeards were sampled. Complete data on the frequency of occurrence of the WGDEEP 2014 species in the discards of the OTB_CRU and OTB_DEF fisheries are displayed in Table 4 and Table 5, respectively.

Table 4: Frequency of occurrence (%) of WGDEEP 2014 species in the discards of hauls sampled in the OTB_CRU fishery (2004-2013). See Table 3 for species codes; "—" indicates no occurrence

Year	ALF	ARU	BLI	BSF	GFB	LIN	ORY	RNG	SBR	USK
2004	1	—	—	6	31	—	1	1	—	—
2005	—	—	—	1	42	—	—	1	—	—
2006	13	—	—	—	57	—	—	3	—	—
2007	—	—	—	—	26	—	1	4	3	—
2008	—	—	—	—	65	—	2	—	—	—
2009	—	—	—	—	31	—	—	—	—	—
2010	—	—	—	—	32	—	—	—	1	—
2011	2	—	—	—	25	—	—	2	—	—
2012	—	—	—	—	35	—	—	—	1	—
2013	—	—	—	—	29	—	—	—	—	—

Table 5: Frequency of occurrence (%) of WGDEEP 2014 species in the discards of hauls sampled in the OTB_DEF fishery (2004-2013). See Table 3 for species codes; "—" indicates no occurrence

Year	ALF	ARU	BLI	BSF	GFB	LIN	ORY	RNG	SBR	USK
2004	—	—	—	2	6	—	—	—	—	—
2005	—	—	—	1	—	—	—	—	—	—
2006	—	—	—	2	2	—	—	—	1	—
2007	—	—	—	—	1	—	—	—	1	—
2008	—	—	—	—	—	—	—	—	—	—
2009	—	—	—	—	4	—	—	—	—	—
2010	—	—	—	—	2	—	—	—	—	—
2011	—	—	—	—	—	—	—	—	—	—
2012	—	—	—	—	—	—	—	—	—	—
2013	—	—	—	—	2	—	—	—	—	—

3.1.2 Deepwater set longline fisheries

No discards of greater silver smelt, alfonsinos (*Beryx* spp.), lings (*Molva* spp.), orange roughy, blackspot(=red) seabream or tusk were observed in the deepwater set longline fishery. The frequency of occurrence of black scabbardfish (the target fish for this fishery) was high (range: 83-100%) but those of greater forkbeards and roundnose grenadier were low (generally 0-33%) with only 17 greater forkbeards and 1 roundnose grenadier being observed in discards over the entire 2005-2013 period. Discards of black scabbard fish due to damage caused by sharks and cetaceans were observed in all sets. However, over the 36 sets sampled in 2008-2013 only 1461 individuals were discarded with 39526 being retained corresponding to an almost negligible discard rate (3.7%). Complete data on the frequency of occurrence of the WGDEEP 2014 species discards of the LLS_DWS fishery are displayed in Table 6.

Table 6: Frequency of occurrence (%) of WGDEEP 2014 species in the discards of sets sampled in the LLS_DWS fishery (2005-2013). See Table 3 for species codes; "—" indicates no occurrence. "BSF-D" = black scabbardfish damaged by predation; "BSF-W" = black scabbardfish not damaged by predation (i.e., whole). (a) BSF-D data includes fish which good parts (i.e., parts not affected by predation marks) may have been marketed

Year	ALF	ARU	BLI	BSF-D	BSF-W	GFB	LIN	ORY	RNG	SBR	USK
2005 (a)	—	—	—	100	—	33	—	—	33	—	—
2006 (a)	—	—	—	100	20	—	—	—	—	—	—
2007 (a)	—	—	—	100	33	—	—	—	—	—	—
2008	—	—	—	100	25	25	—	—	—	—	—
2009	—	—	—	100	—	17	—	—	—	—	—
2010	—	—	—	100	—	22	—	—	—	—	—
2011	—	—	—	83	—	33	—	—	—	—	—
2012	—	—	—	100	—	11	—	—	—	—	—
2013	—	—	—	100	—	50	—	—	—	—	—

3.2 Total discards

3.2.1 Bottom otter trawl fisheries

To accurately estimate the discard volume of rare species (i.e., species with low abundance and low frequency of occurrence in the sampled hauls) a large number of observations are generally required. All WGDEEP 2014 species were rare in the discard samples and, when present, were found in low number and weight, with exception of greater forkbeards in the OTB_CRU fishery. The algorithm currently used to estimate trawl discards at fleet level is considered sensitive to large numbers of zeros in the data set (Jardim et al., 2011). Consequently, discard estimates were not calculated at fleet level for most species with only haul level estimates being provided (Table 7 and Table 8). Total discards of greater forkbeard in the years that registered discards in >30% of hauls observed of the OTB_CRU are displayed in Table 9 .

Table 7: Discards (in number per haul) of WGDEEP 2014 species in the OTB_CRU fishery (2004-2013). See Table 3 for species codes; "—" indicates no occurrence

	ALF			BSF			GFB		
Year	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
2004	0.4	4.6	0-48	3.5	19.7	0-174	56.1	240.3	0-2216
2005	—	—	—	0.3	2.5	0-21	29.1	80.5	0-599
2006	47.3	237.2	0-1300	—	—	—	180.8	826.2	0-4550
2007	—	—	—	—	—	—	61.7	409.8	0-3500
2008	—	—	—	—	—	—	94.4	149.8	0-823
2009	—	—	—	—	—	—	27.9	66.2	0-421
2010	—	—	—	—	—	—	43.9	134.7	0-912
2011	0.4	2.8	0-21	—	—	—	13.1	33.8	0-203
2012	—	—	—	—	—	—	23.3	45.2	0-213
2013	—	—	—	—	—	—	13.6	30.8	0-119

	ORY			RNG			SBR		
Year	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
2004	0.1	1.0	0-11	0.7	7.1	0-75	—	—	—
2005	—	—	—	0.2	2.0	0-17	—	—	—
2006	—	—	—	1.2	6.7	0-37	—	—	—
2007	1.9	16.3	0-139	7.0	53.3	0-454	0.3	2.5	0-21
2008	0.3	2.3	0-23	—	—	—	—	—	—
2009	—	—	—	—	—	—	—	—	—
2010	—	—	—	—	—	—	0.5	4.8	0-49
2011	—	—	—	0.4	3.0	0-22	—	—	—
2012	—	—	—	—	—	—	0.4	3.5	0-29
2013	—	—	—	—	—	—	—	—	—

Table 8: Discards (in number per haul) of WGDEEP 2014 species in the OTB_DEF fishery (2004-2013). See Table 3 for species codes; "—" indicates no occurrence

	BSF			GFB			SBR		
Year	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
2004	0.4	3.6	0-37	2.4	12.3	0-106	—	—	—
2005	1.0	10.1	0-121	—	—	—	—	—	—
2006	0.9	8.3	0-109	1.6	12.8	0-140	0.5	5.3	0-72
2007	—	—	—	0.3	2.5	0-25	0.3	2.5	0-24
2008	—	—	—	—	—	—	—	—	—
2009	—	—	—	1.5	10.2	0-106	—	—	—
2010	—	—	—	0.5	4.1	0-36	—	—	—
2011	—	—	—	—	—	—	—	—	—
2012	—	—	—	—	—	—	—	—	—
2013	—	—	—	0.1	0.4	0-3	—	—	—

Table 9: Greater forkbeard discarded in the Portuguese OTB_CRU fishery (2004-2013): volume (in metric tons) and CVs (%, in brackets). See Table 3 for species codes. "—" = no occurrence, "(a)" = low frequency of occurrence; "(b)" electronic logbook effort data not available

YEAR	GFB
2004	30 (33%)
2005	31 (48%)
2006	264 (5%)
2007	(a)
2008	25 (50%)
2009	33 (25%)
2010	18 (31%)
2011	(a)
2012	(b)
2013	(b)

3.2.2 Deepwater set longline fisheries

To accurately estimate the discard volume of longline fisheries at fleet level, a total effort estimate is required along with discard data from an unbiased sample of fishing trips. At the time of this report, the full 2005-2013 data set of effort data on the LLS_DWS fishery was not available to the authors. Furthermore, we have reasons to suspect that the trips observed onboard in recent years are biased towards larger vessels and that these are progressively moving nortward and exploring new fishing grounds. A preliminary comparison of effort data obtained onboard vessels of different sizes throughout the 2005-2012 period indicated that larger vessels deploy more hooks per set and fish different fishing grounds from the remainder of the fleet. Under such circumstances, simple raising procedures involving average discards and total number of trips of the entire fleet would produce biased estimates of volumes discarded. Consequently only set level estimates are provided for the LLS_DWS fishery (Table 10).

Table 10: Discards (in number per set) of WGDEEP 2014 species in the LLS_DWS fishery (2005-2013). See Table 3 for species codes; "—" indicates no occurrence. (a) BSF data includes fish which good parts (i.e., parts not affected by predation marks) may have been marketed

	BSF			GFB			RNG		
Year	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
2005 (a)	98.0	10.0	88-108	1.7	2.9	0-5	0.3	0.6	0-1
2006 (a)	114.4	79.3	8-195	—	—	—	—	—	—
2007 (a)	70.0	103.3	4-189	—	—	—	—	—	—
2008	52.8	36.5	23-99	0.8	1.5	0-3	—	—	—
2009	29.3	12.5	13-48	0.2	0.4	0-1	—	—	—
2010	49.7	26.9	13-96	0.2	0.4	0-1	—	—	—
2011	30.5	28.6	0-78	0.5	0.8	0-2	—	—	—
2012	40.3	28.9	5-96	0.2	0.7	0-2	—	—	—
2013	40.5	6.4	36-45	0.5	0.7	0-1	—	—	—

3.3 Length frequency of discards

3.3.1 Bottom otter trawl fisheries

A summary of the length frequencies of WGDEEP 2014 discards in the trawl fisheries is presented in Table 11.

Table 11: Length frequency of discards (in cm) of WGDEEP 2014 species sampled in the OTB fishery (2004-2013). See Table 3 for species codes

Fishery	Species	n	Mean	SD	Range
OTB_CRU	ALF	8	26.0	3.0	23-32
	BSF	16	60.2	9.9	50-87
	GFB	769	17.4	7.4	6-67
	ORY	8	8.0	2.1	6-12
	RNG	15	7.0	4.6	5-23
	SBR	4	21.5	2.4	20-25
OTB_DEF	BSF	10	56.1	13.0	40-79
	GFB	4	40.2	10.7	32-56
	SBR	6	17.5	2.6	15-21

3.3.2 Deepwater set longline fisheries

Length frequency of discards sampled in the deepwater set longline fisheries are presented in Table 12. Note that black scabbardfish length data displayed in the table refer to discards when these were not damaged by predation and could be measured (BSF-W) with results from the retained catch being supplied for comparative purposes (BSF-W*). Discards of whole black scabbardfish in the LLS_DWS fishery are rare (see section 3.1) and take place mainly for commercial reasons (small sized fish).

Table 12: Length frequency of discards (in cm) of WGDEEP 2014 species sampled in the LLS_DWS fishery (2005-2013). See Table 3 for species codes; "BSF-W" = black scabbardfish not damaged by predation (i.e., whole); "BSF-W*" = black scabbardfish retained on board

Species	n	Mean	SD	Range
BSF-W	7	72.3	6.4	63-80
BSF-W*	7146	108.7	7.6	74-136
RNG	1	14.0	—	14-14

4 Conclusions

Discards of most WGDEEP 2014 species carried out by Portuguese vessels operating bottom otter trawl and deepwater set longlines (targeting black scabbardfish) within the Portuguese ICES Division IXa were not quantified at fleet level. However, the low frequency of occurrence (and number of specimens) registered in the sampled hauls and sets indicates discards can be assumed null or negligible for most assessment purposes. Exception to this may be the discards of black scabbardfish in the set longline fishery and the discards of greater forkbeards in the crustacean otter trawl fishery. The black scabbardfish discard mortality is mainly caused by shark and cetacean predation on hooked black scabbardfish and is relatively low when compared to landings. Consequently discards are not likely to play a significant role in the assessment of this species. In what concerns discards of greater forkbeards, the values reported in this working document are low compared to the ca. 1000 tonnes of annual landings registered in the ICES Northeast Atlantic but may be worth consideration by WGDEEP in what respects mortality taking place in the ICES Division IXa.

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Working Document 09

RUSSIAN FISHERIES AND INVESTIGATIONS OF DEEP-WATER FISH IN THE NORTHEAST ATLANTIC IN 2013

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Introduction

In 2013, Russian target fishery in the deep waters of the Northeast Atlantic was carried out for a short time in the Faroese Fishing Zone (FFZ), on the Hatton and Rockall Banks. The by-catch of deep-water fish was also taken during the fishery in the other areas. In 2013, the total Russian catch of deep-water species amounted to 374.0 t (Table 1).

Materials and methods

Essential materials to be used to prepare this Working Document were as follows:

- daily fishing vessel reports;
- materials collected during research surveys;
- information collected by observers on board fishing vessels.

Catches of deep-water fish were taken by bottom and pelagic trawls with 16-135 mm mesh size.

In greater silver smelt two lengths, a fork length (FL) and a total length (TL), or a fork length only were measured. 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 stages of bluemouth were defined by the scale for redfish including for males: 2 – immature, 3 – maturing, 4 – pre-spawning, 5 – copulating, 6 – post-spawning, 6-2 – post-spawning recovery; for females: 2 – immature, 3 - maturing, 4 – copulating, 5 – fecundation, 6,7,8 – embryo development, 9 – extrusion, 9-2 –

post-spawning recovery. Maturity of all remaining bony 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. Maturity of rabbitfish was determined using the scale proposed by M.F.W. Stehmann (2002): for males: 1 - immature, 2 – maturing, 3 – mature, 4 – copulating; for females: 1 – immature, 2 – maturing, 3 – mature, 4 – copulating, 5 – embryo development, 6 – extrusion.

Intensity of feeding was expressed using the mean index of stomach fullness (MISF). In order to study the stomach fullness the following scale was used: 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.

Fat content on the internal organs was estimated using the following scale: 0 – no fat, 1 – little fat, 2 – mean fatness, a wide band of fat almost covers viscera; 3 – much fat covering completely viscera.

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 ICES statistical areas.

Fisheries

The Faroese Fishing Zone (Divisions Vb and VIa)

In April-May, one bottom trawler fished on the Bill Baileys and Lousy Banks, at 505-670 m depths. Mean fishing efficiency was 9.0 t per a fishing day. In total, caught were greater silver smelt *Argentina silus* – 109.8 t, rabbit fish *Chimaera monstrosa* – 23.1 t, blue ling *Molva dypterygia* – 3.0 t, bluemouth *Helicolenus dactylopterus* - 1.7 t, other species – 2.8 t. In the catches insignificant amounts of greater forkbeard *Phycis blennoides*, common mora *Mora moro*, black cardinal fish *Epigonus telescopus*, blackspot grenadier *Coelorinchus caelorhinchus*, ling *Molva molva*, tusk *Brosme brosme*, black scabbardfish *Aphanopus carbo*, deep-water sharks (*Centroscymnus coelolepis, Etmopterus spinax*, *Deania calcea*, *Galeus melastomus*), skates (*Dipturus oxyrinchus, Rajella lintea, Bathyraja spinicauda, Leucoraja fullonica*) and other species were found.

In April, in the fishery of blue whiting *Micromesistius poutassou*, in the south of the zone, when trawling at 300-600 m depths, small numbers of greater silver smelt, the total catch of which was 17.4 t, were registered.

The Rockall and Hatton Banks (Divisions VIb and XIIb)

In April, during a short five-day trawl fishery of haddock *Melanogrammus aeglefinus*, on the Rockall Bank, at 285-310 m depths, 0.2 t of lesser silver smelt *Argentina sphyraena* and 0.4 t of bluemouth were caught. Found in the bycatch were silver pout *Gadiculus argenteus*, Norway haddock *Sebastes viviparus*, ling, rabbit fish, deep-water sharks.

In May, one long-liner fished on the Rockall Bank, at 175-600 m depths, and on the Hatton Bank, at 690-1420 m, where 14 long-lines with 76 thousand hooks were set. In all, 1.3 t of ling, 0.4 t of tusk, 0.3 t of blue ling, 0.2 t of rabbit fish, 0.04 t of greater forkbeard and 1.5 t of other species were caught. The bycatch mainly consisted of bluemouth, common mora, blue antimora *Antimora rostrata*, long-nose eel (*Synaphobranchus kaupii*) and deep-water sharks.

The Fishing Zone of Greenland (Subdivision XIVb2)

In May-October, in the bottom trawl fishery of Greenland halibut *Reinhardtius hippoglossoides*, at the depths of 665-1,350 m, roughead grenadier *Macrourus berglax* occasionally occurred in the catches. The total catch of the roughead grenadier comprised 32.1 t.

The Norwegian Sea (Divisions IIa and IIb)

Deep-water fish were mainly caught as a by-catch taken by bottom trawls and longlines. Ling *Molva molva*, 114.3 t (all the catch was taken by bottom trawls), tusk *Brosme brosme*, 68.7 t, including 55.9 t taken by longline, and, as well as, the roughead grenadier *Macrourus berglax*, 1.0 t, all the catch of which was obtained by the longline, occurred in the catches.

The Barents Sea (Subarea I)

Small catches of tusk *Brosme brosme*, 0.2 t, were taken as a by-catch in trawl and longline fisheries for demersal fish.

Investigations

Greater silver smelt (Argentina silus)

The Faroese Fishing Zone (Divisions Vb and VIa)

In April-May, the species was caught on the northern and northwestern slopes of the Lousy Bank (505-560 m depths) and on the northern slope of the Bill Baileys Bank (610-670 m depths). Catches per a trawling hour were 0.2-1.5 t and, on the average, 0.7 t.

The catches were consisted of males with the total length of 29-50 cm (mainly, 37-39 cm) and females with that one of 31-50 cm (primarily, 39-41 cm) (Figure 1). The mean weight of males and females was 405g and 522 g, respectively.
All the fish studied were mature. On the Lousy Bank, most of fish were post-spawning. On the Bill Baileys Bank, individuals with prespawning and spawning

gonads predominated (Figure 2). Males prevailed: on the Lousy Bank – in 2.1 times, on the Bill Baileys Bank, - in 1.5 times.

The fish fed poorly. Food was found in stomachs of 6% of the fish examined. The mean index of stomach fullness was 0.1. The diet included euphausiids, shrimps, squids, blue whiting, fish larvae, salpa and digested food. The index of fatness condition, on the average, was equaled to 0.8.

In the southern part of the Faroese Fishing Zone (the Wyville-Thomson Ridge), the males with 26-45 cm fork length and the average one of 32.1 cm and females 28-47 cm in length and 34.1 cm average length were caught by pelagic trawls in the third ten-day period of April. Males were predominating in abundance in two times.

The Shetland Islands (Division IVa)

To the west of the Shetland Islands, in the catch by the research pelagic trawl above the 360 m depth, 15 males with the fork length of 25-31 cm and 4 females with that one of 26-36 cm were found.

The Norwegian Sea (Divisions IIa and IIb)

From February till December, single fishes were occasionally recorded in the catches by bottom research and fishing trawls at 255-540 m depths. The total length of males was 28-42 cm, of females – 27-47 cm.

The Barents Sea (Subarea I)

In June-August, in the south-western part of the sea, the juveniles with the total length of 8-15 cm were taken by bottom research trawl from 200-290 m depths.

Lesser silver smelt (Argentina sphyraena)

The Rockall Bank (Division VIb)

In April, the fish were caught in the trawl fishery of haddock at 285-310 m. The catches were 10 kg/hour, on the average.

The catches consisted of males with the total length of 21-27 cm, primarily, – 22-24 cm and females 21-34 cm in length and, mainly, as long as 24-25 cm (Figure 3).

All the studied fish were mature. Spawning and prespawning individuals predominated (Figure 4). Sex ratio was 1:1.4.

The fish fed poorly. Only 10 % of them had food in the stomachs, the MISF was 0.1. The food boluses contained salpa, euphausiids and highly digested food. The fat condition factor was 1.1, on the average.

The Norwegian Sea (Division IIa)

From March till December, single fishes were found in the catches by bottom research and fishing trawls from 255-400 m depths. The total length of males was 14-36 cm, females – 15-39 cm, juveniles – 11-13 cm (Figure 5).

The Barents Sea (Subarea I)

In December, at 360 m depth, near the Norwegian coast, a female 18 cm in length was caught.

Ling (Molva molva)

The Rockall Bank (Division VIb)

In April, small amounts (to 50 kg/hour) were taken as a by-catch at 285-310 m depths during the trawl fishery of haddock.

The catches contained males as long as 46-110 cm (on the average, 72.6 cm) and females 66-120 cm in length (the average length – 89.0 cm).

Most of fish examined had spawning and prespawning gonads (64% of males and 50% of females). About 20% of males and females were immature. 25 % of females were postspawning. The other fish had maturing gonads.

Majority of fish examined had everted or empty stomachs. A silver pout was only found in one stomach (stomach fullness index – 3).

In May, on the bank, the long-line catches from 175-600 m depths amounted to 8-60 kg/1000 hooks. The greatest ones were taken at 230-450 m depths.

Fish of both sex had the length of 81-121 cm, the average length of males was 107.5 cm, of females – 106.2 cm.

All the studied males were running. Most of females (47 %) had recovering post-spawning gonads, 41 % were having had spawning not long ago. Single fish were mature and running.

Most stomachs (90 %) were everted. Haddock and gurnards were found in the others.

The Faroese Fishing Zone (Divisions Vb and VIa)

In April-May, on the Lousy and Bill Baileys Banks, small numbers of fish were occasionally caught by bottom trawl at 510-630 m depths (mainly, as single individuals, in some catches – to 150 kg/trawling hour).

The caught male length was 71-105 cm, the average one – 91.0 cm. Females were 56-105 cm (87.3 cm, on the average) in length.

Half of the females were pre-spawning, 37% had the signs of having had spawning not long ago. Single immature fish occurred. The majority of males (71%) were running. Also, maturing and pre-spawning individuals were found.

The Norwegian Sea (Division IIa)

The species was caught as a by-catch in the bottom fishery of cods on the Fugløy, Malangen, Vesterålen and Andøy Banks from January to June. The catches were, on the average, 20 kg/trawling hour. Four individuals were examined. They were females 76-90 cm (83.0 cm, on the average) in length.

The Eastern Greenland (Subdivision XIVb2)

In August-October, the fish occasionally occurred in the by-catches (to 20 kg/trawling hour) in the course of Greenland halibut bottom fishery, at 950-1,100 m depths. Males were as long as 71-85 cm, on the average, – 75.1 cm. The female length varied from 81 to 95 cm, the average one was 88.8 cm. All the fish, except for one immature male, had maturing reproductive products. Feeding intensity was low (MISF - 0.9). In the stomachs, shrimps and digested fish occurred.

Blue ling (Molva dypterygia)

The Faroese Fishing Zone (Division Vb)

In April-May, on the Bill Baileys and Lousy Banks, the species occurred at 505-670 m depths in the course of the bottom trawl fishery. The greatest catch, 24 kg/trawling hour was registered on the Bill-Baileys Bank (630-650 m depth).

In the catches, males had the length of 61-106 cm and the average one of 81.6 cm. The female length varied from 51 to 135 cm, the average one was 100.7 cm.

The postspawning fish predominated in the catches. Single specimens with running reproductive products occurred. The stomachs of all the fish examined were everted.

The Hatton Bank (Divisions VIb and XIIb)

In May, the fish were found in the catches by bottom long-line from 690-1,420 m depths. The greatest by-catches (to 43 kg/1,000 hooks) were recorded within the depth range of 690-750 m. At the depths of above 1,000 m single individuals were observed.

In the catches, males had the length of 76-106 cm and the average one of 89.0 cm. The female length varied from 81 to 100 cm and was 87.7 cm, on the average.

Tusk (Brosme brosme)

The Barents Sea (Subarea I)

During the year, the species was caught by bottom fishing and research trawls at the depths of 50-267 m. As a result of the examination of 21 individuals, the length was 10-60 cm (the average one – 48.5 cm).

The Norwegian Sea (Divisions IIa and IIb)

Throughout the year, the species was caught by research and fishing trawls and bottom long-lines at 60-630 m depth.

In all, 25 individuals with length of 10-75 cm (the average one – 50.0 cm) were measured from the trawl catches. All the examined fish (5 individuals) had post-spawning gonads and everted stomachs.

In the catches by bottom long-line the fish as long as 51-60 cm (the average one – 56.3 cm) were found (3 fish were measured).

The Faroese Fishing Zone (Division Vb)

The species seldom occurred in the catches in April-May, during the bottom trawl fishery, on the Lousy and Bill Baileys Banks, at 510-630 m depths. In all, 16 fish as long as 51-90 cm and 66.8 cm, on the average, were recorded. The sex ratio was 1:0.6. Most studied fish were mature. The majority of them (60 % of males and 50 % of females) had the recovering post-spawning gonads, 20 % of males and 33 % of females had the gonads with the recent spawning signs. Besides, single running females and maturing males were registered. The stomachs of all the individuals were everted.

Hatton Bank (Divisions VIb and XIIb)

Small amount (1-12kg/1,000 hooks) of the fish often occurred in the catches by bottom long-line from 175-755 m depths. The greatest catches were registered within 690-755 m depth range. In the catches, the fish length was 51-88 cm and 72.1 cm, on the average.

Greater forkbeard (Phycis blennoides)

The Rockall Bank (Division VIb)

The species seldom occurred at 285-310 m depths, in April, during the haddock fishery. The catches consisted of fish with the length of 21-50 cm and the average one of 35.9 cm. All the examined fish, 11 individuals, were immature females with the everted stomachs.

The small numbers of the fish (to 2 kg/1,000 hooks) were recorded during the long-lining (230-600 m depths). In the catches, the fish length was 33-55 cm and the average one – 43.6 cm.

The Faroese Fishing Zone (Division Vb)

The species occurred at 505-670 m depths, on the Bill Baileys and Lousy Banks, during the bottom trawl fishery, in April-May.

The fish length varied from 18 to 63 cm (primarily, 39-48 cm) (Figure 6).

The majority of fish were immature. A few females were post-spawning, and single maturing ones were registered. As much as 40% of males had maturing gonads (Figure 7).

The stomachs were mainly everted. In the others, blue whiting, digested fish, shrimps and, more seldom, other objects were found. MISF was 1.6.

Common mora (Mora moro)

The Faroese Fishing Zone (Division Vb)

Occasionally the species was found on the Lousy and Bill Baileys Banks (505-670 m depths) in April-May. In the catches fish were 21-41 cm in length, on the average, 32.7 cm. Among 9 studied fish, there were 2 immature males and 7 immature females. The stomachs of all the fish were everted.

The Hatton Bank (Divisions XIIb and VIb)

Small numbers of the fish (3-6 kg/1,000 hooks) were found in the catches of the long-line from 690-755 m depths. In the catches, the length of individuals was 27-61 cm, the average one – 38.9 cm.

Blue antimora (Antimora rostrata)

The Hatton Bank (Divisions XIIb and VIb)

Small numbers of the fish were found during the long-lining (1,400-1,420 m depths) in May. The length of individuals varied from 36 to 40 cm, the average one was 37.6 cm. All 7 fish examined were females.

Rabbit fish (Chimaera monstrosa)

The Rockall Bank (Division VIb)

In April, during the haddock bottom fishery, small by-catches of the species were registered within the 285-310 m range. The catches were represented by males 63-98 cm in length and males as long as 66-107 cm. The length groups of 90-95 cm prevailed (Figure 9a). Sex ratio was – 1:3.6. The individuals, mainly, had developing gonads at stages, however, the active fish were also found (Figure 10a).

Feeding intensity was weak. Only 33 % of the examined fish were feeding. MISF was 0.5. The stomachs contained bottom invertebrates including ophiurans, holothurians, polychaetes (Figure 11a).

The Hatton Bank (Divisions XIIb and VIb)

In May, the by-catch of the species by bottom long-line from 690-1,130 m (more often – 690-755 m) was often registered. The catches were 2-19 kg/1.000 hooks. Males with the length of 91-105cm and the average one of 98.0 cm and females as long as 81-110 cm (on the average – 92.2 cm) were caught. The number of females was 9 times higher than that one of males. Both males and females primarily had developing gonads. Single active individuals were recorded. The stomachs of all the individuals examined were empty.

The Faroese Fishing Zone (Division Vb)

The species was an important by-catch in the bottom trawl fishery on the Lousy and Bill Baileys Banks, in April-May. The greatest catches of that species were registered on the Lousy Bank (505-560 m depths), where they amounted to 0.21 t/trawling hour. On the average, the catches were 0.15 t/trawling hour.

In the catches the length of males varied from 66 to 101 cm and from 90 to 92 cm, on the average. Females had the length of 57-107 cm, 93-95 cm, predominantly (Figure 9b). The number of females in catches was two and a half times higher than that one of males. Majority of fish had developing gonads (Fig.10b).

Feeding intensity was poor (MISF – 0.7). Most food in the stomachs was well-digested. Besides, ophiurans, polychaetes, sea urchins and hermit crab were found (Figure 11b).

The Norwegian Sea (Divisions IIa and IIb)

In November-December, along the continental slope, at 222-430 m depths, 2 mails as long as 91-95 cm and 5 females 76-110 cm in length were caught.

Straightnose rabbitfish (Rhinochimaera atlantica)

The East Greenland (Subdivision XIVb2)

In August-October, during the bottom trawl fishery of Greenland halibut, at 1,130 m depth, 2 maturing males as long as 115 and 117 cm and 1 immature female 105 cm in length were caught. The stomachs of the fish were empty.

Roundnose grenadier (Coryphaenoides rupestris)

The Irminger Sea (Subdivision XIVb1)

In July, in the Irminger Sea, in the catches by research pelagic trawls at 500-900 m depth, above 1,100-4,000 m depths, the fish juveniles occasionally occurred (from 1 to 5 individuals per hauling). All the catches were taken to the west of the Rejkyanes Ridge (58°-64° N, 29°-38° W). They were not registered immediately above the ridge and to the east of the ridge. In all, 28 fish were caught. They had a total length of 71-321 mm, the pre-anal length of 19-73 mm (30 mm, on the average), the weight of 1-81 g, the mean weight of 9 g. The stomachs of most individuals were empty. Copepods (MISF – 1) were once registered.

Roughead grenadier (Macrourus berglax)

The Norwegian Sea (Divisions IIa and IIb)

In May-June, small amounts of that species (to 2 kg/1,000 hooks) were caught by bottom long-line at a depth of 320-470 m in the Bear Island area. In the catches, the length of males varied from 57 to 65 cm (61.0 cm, on the average), females – from 57 cm to 94 cm (66.9 cm, on the average).

In November, the fish were caught by bottom research trawls along the continental slope at 415-720 m depths. In the catches, the male length varied from 14 cm to 65 cm, primarily, - from 46 to 55 cm, the female length – from 26 to 75 cm and, respectively, from 51 to 60 cm (Figure 12).

The East Greenland (Subdivision XIVb2)

In August-October, in the course of the bottom trawl fishery of Greenland halibut, at 1,130 m depth, 2 maturing females, 75 cm and 90 cm in length were found. The stomach of the first female contained octopuses, and that one of the second female was everted.

Blackspot grenadier (Coelorhinchus caelorhinchus)

The Faroese Fishing Zone (Division Vb)

The species was often caught in small numbers on the Lousy and Bill Baileys Banks, at 505-670 m depths.

Males had the length of 22-37 cm and 30-32 cm, on the average, females – 22-40 cm and 33-35 cm, respectively (Figure 13).

The number of females was 1.4 times more than of males. Most studied individuals were maturing (Figure 14).

The grenadier poorly fed (MISF – 1.3) on polychaetes, gammarids and other invertebrates (Figure 15).

The Rockall Bank (Division VIb)

The species occurred in small numbers in April, during the bottom trawl fishery at 285-310 m depths. The catches consisted of males 29-32 cm in length and 30.5 cm, on the average, and females as long as 30-35 cm and 34.2 cm, on the average. All the males and most of females had maturing gonads. Also, the females with ripe roe were found.

Bluemouth (Helicolenus dactylopterus)

The Rockall Bank (Division VIb)

In April, during the bottom trawl fishery of haddock, the species by-catches were 7-22 kg/trawling hour, 15 kg/trawling hour, on the average.

The catches were represented by males 16-33 cm in length and females as long as 15-35 cm (Figure 16a). The number of females was 1.3 times more than that one of males. Males, mainly, had maturing gonads. Majority of females were fertilized at the ovulation stage or at the early stages of embryo development. About 17% were immature. The same percentage of fish had ripe roe (Figure 17a). Feeding intensity was low, MISF equaled to 1.2. Fishes and crustaceans were the primary food objects (Figure 18a).

In May, in the catches by two bottom long-lines, at 310-600 m depths, small by-catches of the species were registered. Five individuals with length of 24-28 cm and the average one of 25.4 cm were analysed. All the fish were males.

The Faroese Fishing Zone (Division Vb)

The species was caught on the Lousy and Bill Baileys Banks, at 505-670 m depths, where the catches were 3-15 kg/trawling hour and 7 kg/trawling hour, on the average.

Males with the length of 16-33 cm and females as long as 15-35 cm were found in the catches (Figure 16b). Sex ratio was almost 1:1, with a minor prevalence of males. Males, mainly, had maturing gonads (Figure 17b). Majority of females were at the early stages of embryo development, 14% were immature. Feeding intensity was low, MISF was estimated at 0.9. Fishes and bottom invertebrates were the primary food items (Figure 18b).

Black scabbardfish (Aphanopus carbo)

The Faroese Fishing Zone (Division Vb)

In April-May, the species in small numbers occurred occasionally on the Bill Baileys Bank in the course of trawlings at 620-630 m depths.

In total, 11 males 86-96 cm in length (91.3 cm, on the average) and 17 females as long as 83-108 cm (94.8 cm, on the average) were caught. The studied individuals were mainly immature. Single males and females with post-spawning gonads were registered. The stomachs of the most fish were everted or empty. Only two of them contained digested fish and deep-water shrimps.

Black cardinal fish (Epigonus telescopus)

The Faroese Fishing Zone (Division Vb)

Single fishes occurred within the depth range of 520-630 m on the Lousy and Bill Baileys Banks. Most of them (14 of 21) were males with the length of 20-33cm and the average one of 23.6 cm. Also, two females as long as 22 cm and 24 cm and 5 juvenile fish with the length of 18-19 cm were caught. All the studied fish were immature. The stomachs (MISF – 2.7) contained euphausiids and digested fish.

Slender alfonsino (Beryx splendens)

The Faroese Fishing Zone (Division Vb)

In April, during the pelagic fishery of blue whiting, in the catch from 300 m depth one fish was found (a female, 27 cm).

Table 1

Russian yield (t) of deep-water fish species in 2013
(preliminary data)

Species	ICES areas						
	I	IIa	IIb	Vb	VIa	VIb1	XIVb2
Greater silver smelt				114	13	+	
Tusk	+	53	16			+	
Ling		114				1	
Blue ling				3		+	
Roughead grenadier		1					32
Bluemouth				2		+	
Rabbit fish				23		+	
Greater forkbeard						+	
Total	+	168	16	142	13	3	32

+ — catches under 0,5 t

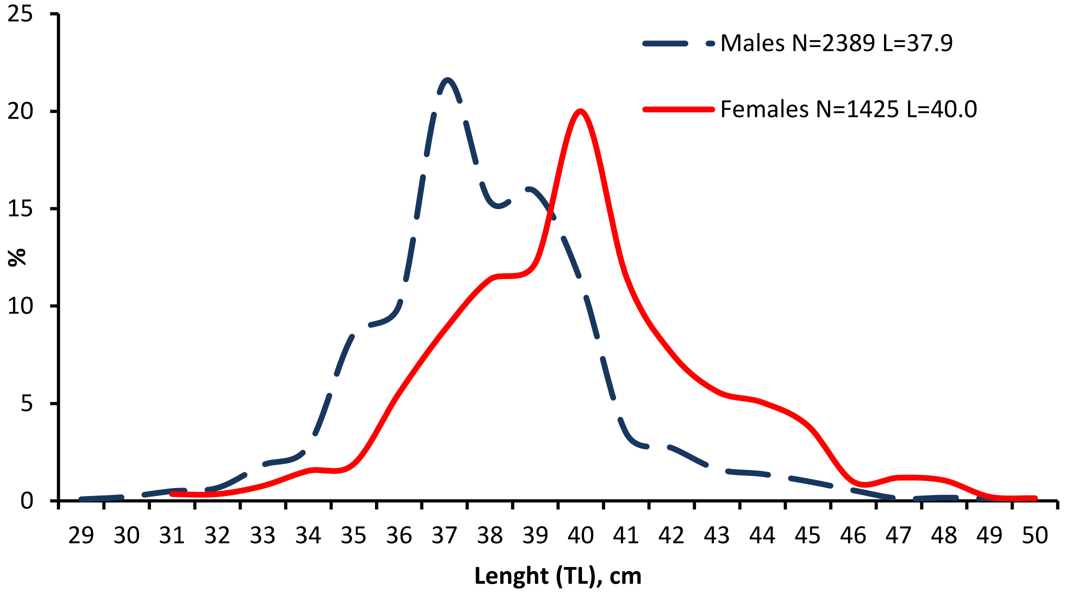

Fig. 1. Length composition of Greater silver smelt from commercial bottom trawl catches in the Faroese EEZ in April-May 2013

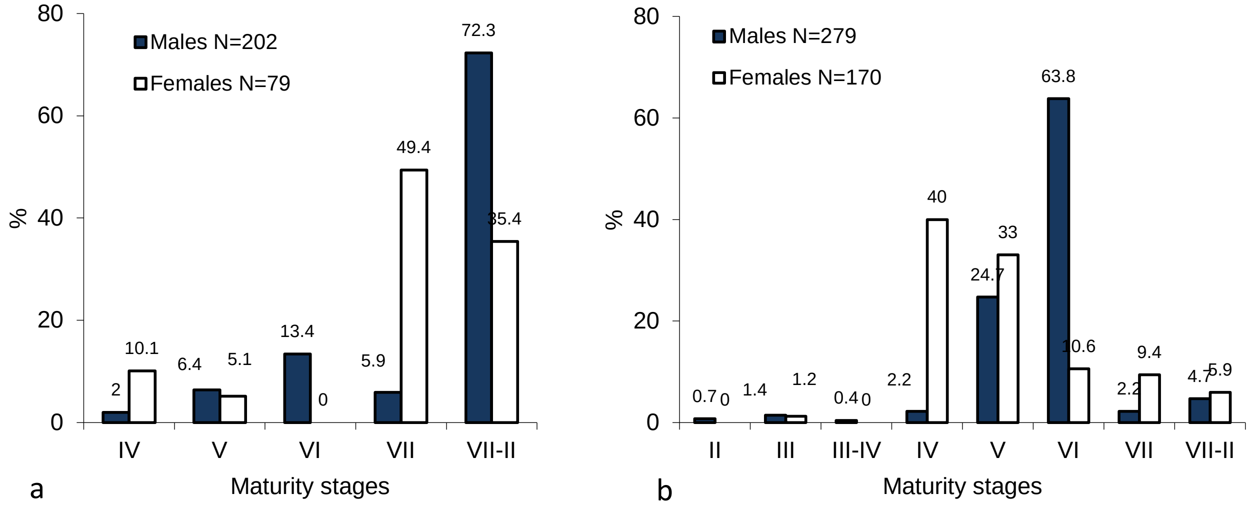

Fig. 2. Maturity of Greater silver smelt from commercial bottom trawl catches in the Faroese EEZ in April-May 2013 (a- Lousy Bank, b-Bill Baileys Bank)

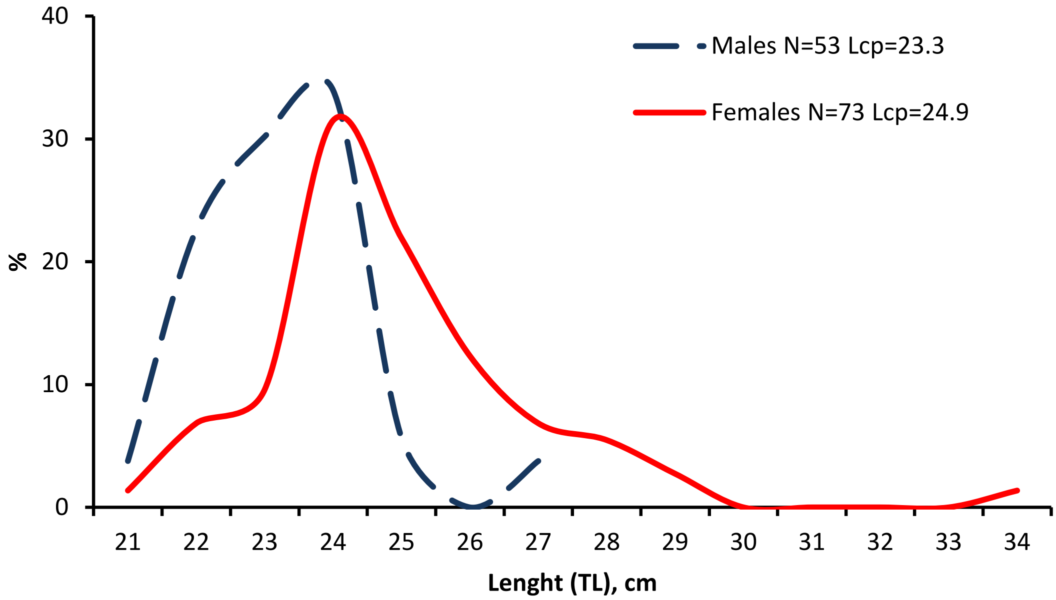

Fig. 3. Length composition of Lesser silver smelt from commercial bottom trawl catches in ICES VIb (Rockall Bank) in April 2013

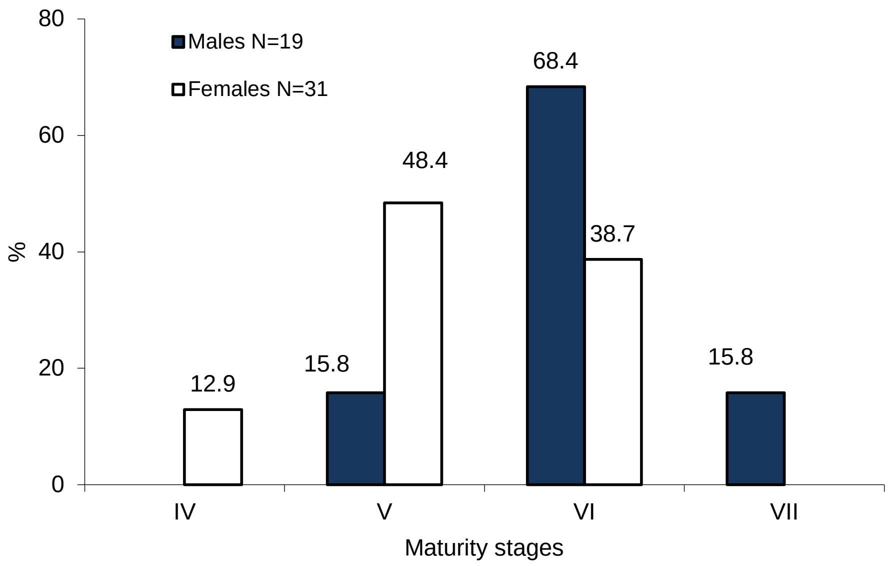

Fig. 4. Maturity of Lesser silver smelt from commercial bottom trawl catches in ICES VIb (Rockall Bank) in April 2013

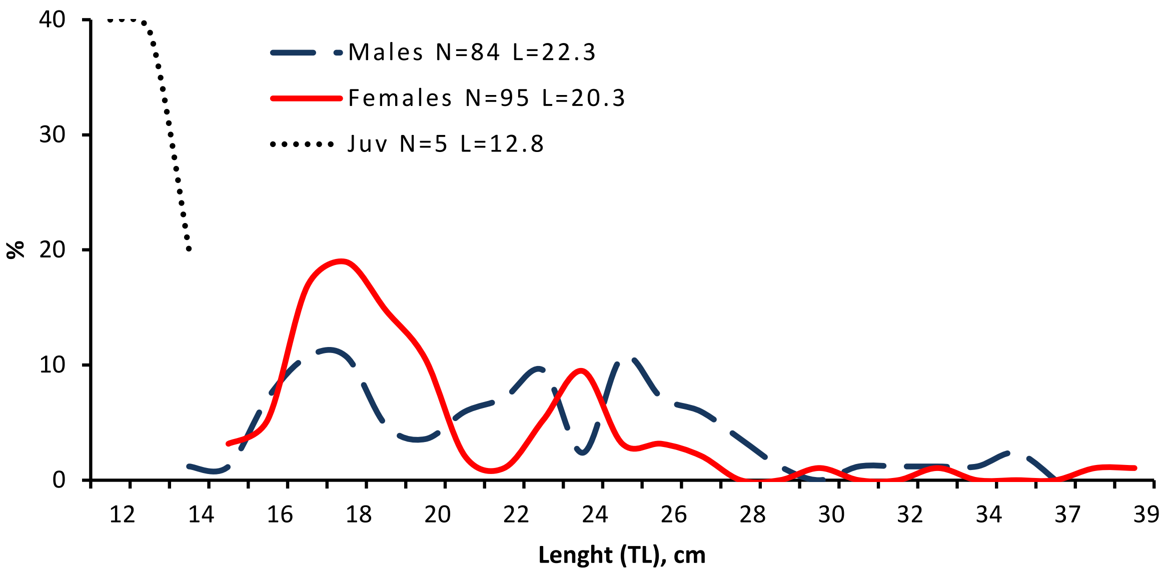

Fig. 5. Length composition of Lesser silver smelt from bottom trawl catches in ICES IIa in 2013

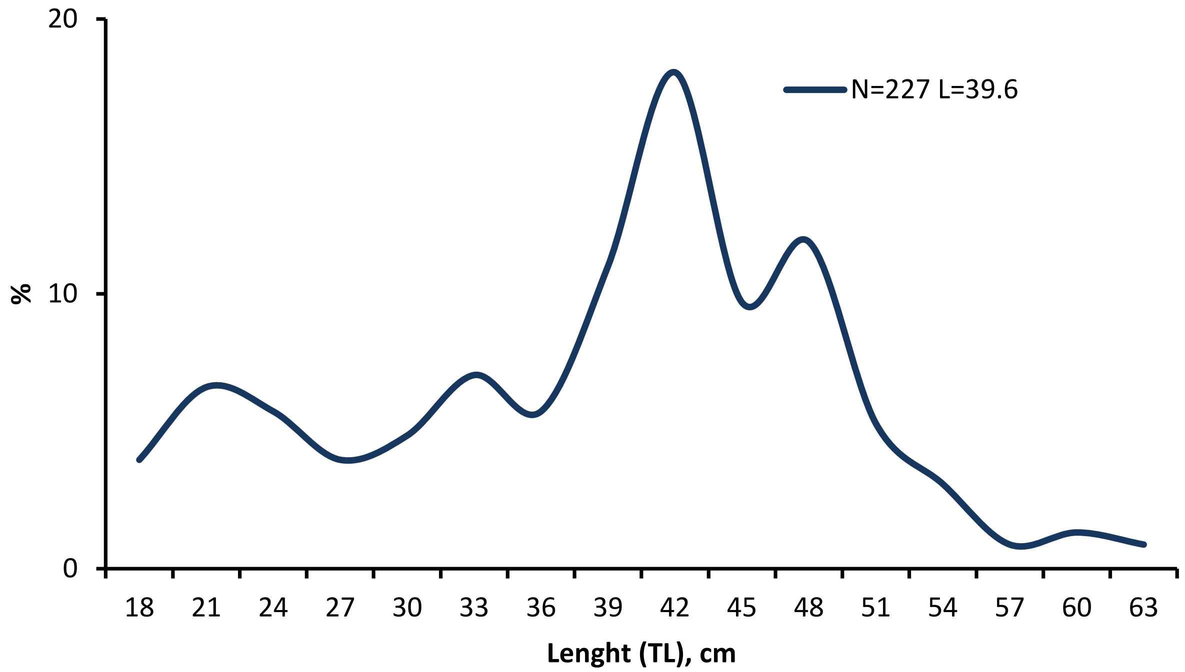

Fig. 6. Length composition of Greater forkbeard from bottom trawl catches in the Faroese EEZ in April-May 2013

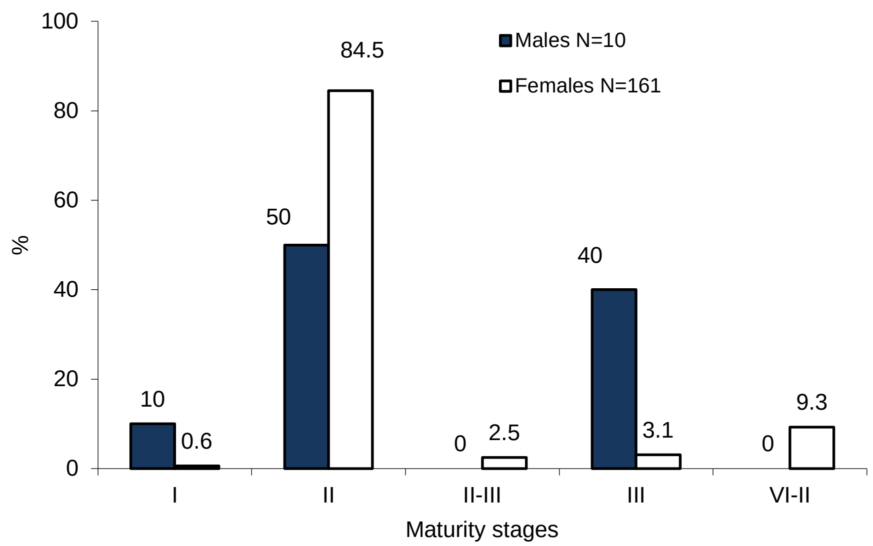

Fig. 7. Maturity of Greater forkbeard from bottom trawl catches in the Faroese EEZ in April-May 2013

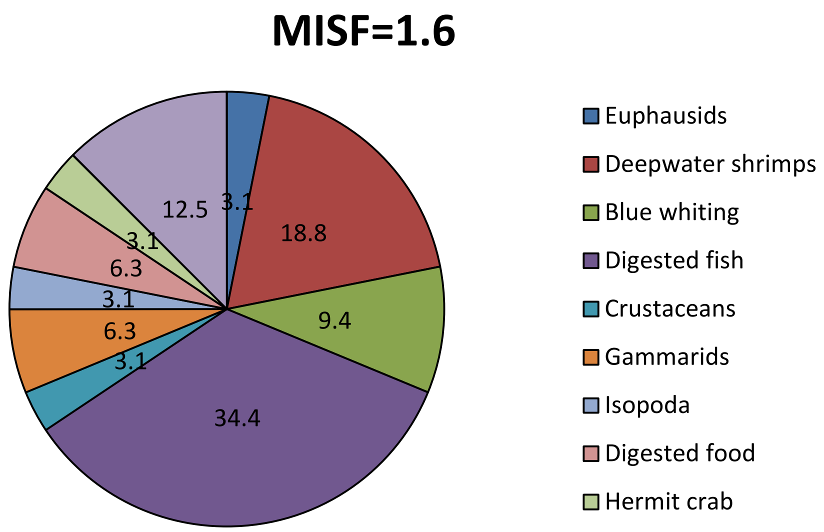

Fig. 8. Food composition of Greater forkbeard from bottom trawl catches in the Faroese EEZ in April-May 2013, % by occurrence in stomachs with food

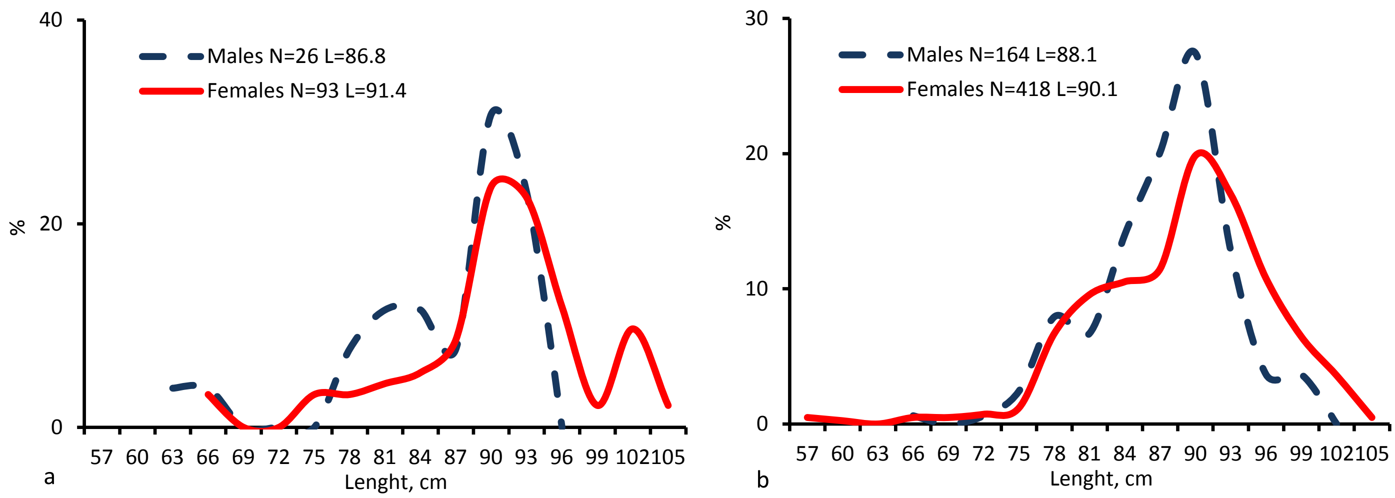

Fig. 9. Length composition of Rabbitfish from bottom trawl catches on the Rockall Bank (a) and in Faroese EEZ (b) in April-May 2013

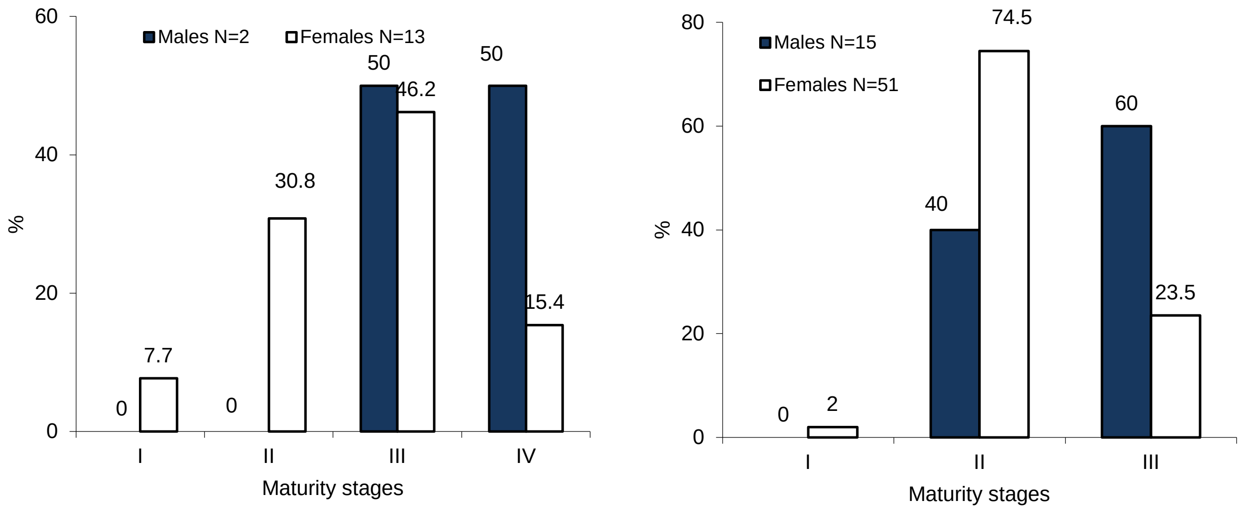

Fig. 10. Maturity of Rabbitfish from bottom trawl catches on the Rockall Bank (a) and in Faroese EEZ (b) in April-May 2013

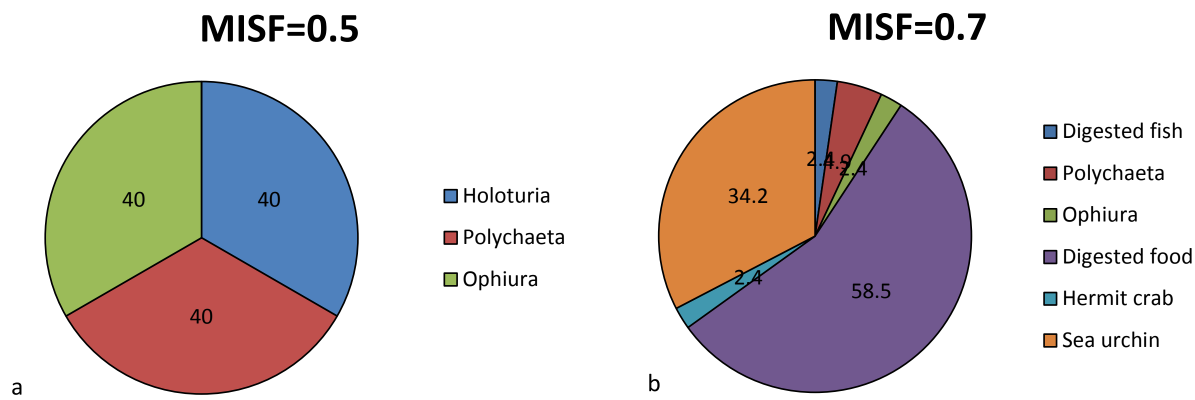

Fig. 11. Food composition of Rabbitfish from bottom trawl catches on the Rockall Bank (a) and in Faroese EEZ (b) in April-May 2013, % by occurrence in stomachs with food

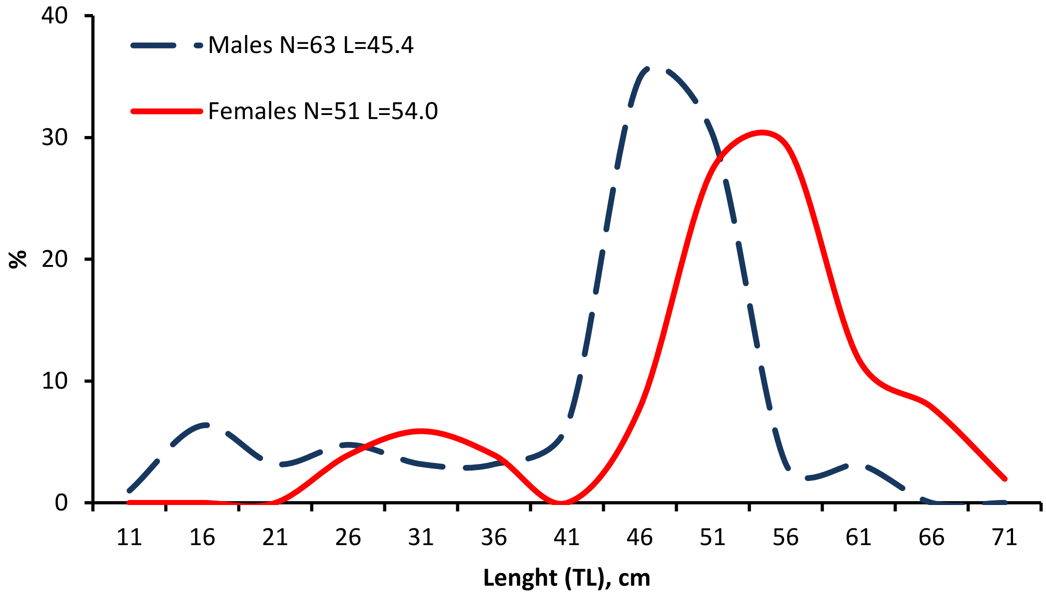

Fig. 12. Length composition of Roughhead grenadier from bottom trawl catches in ICES IIa & IIb in November-December 2013.

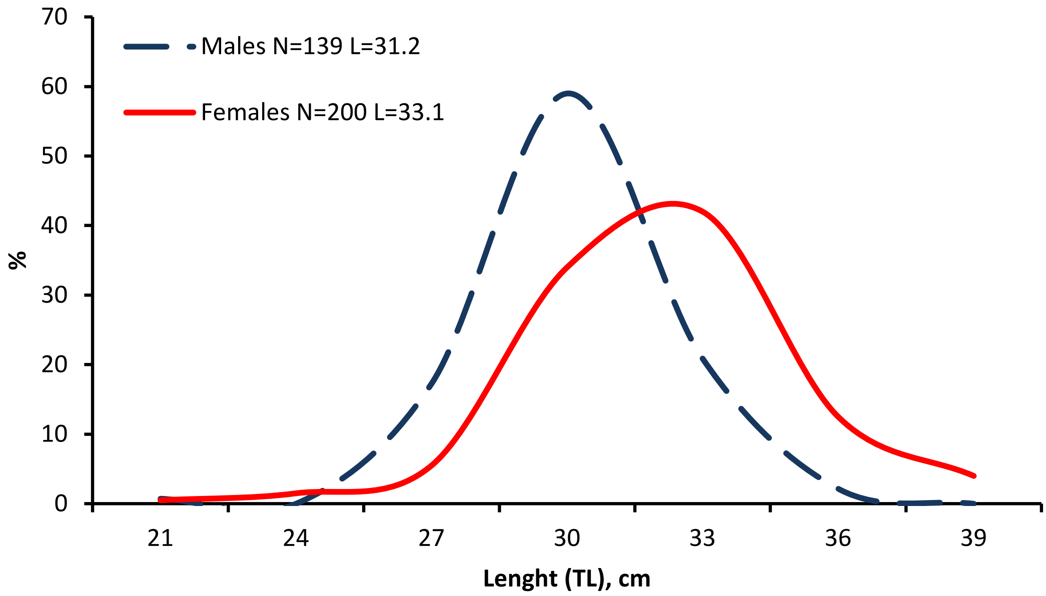

Fig. 13. Length composition of Blackspot grenadier from bottom trawl catches in the Faroese EEZ in April-May 2013

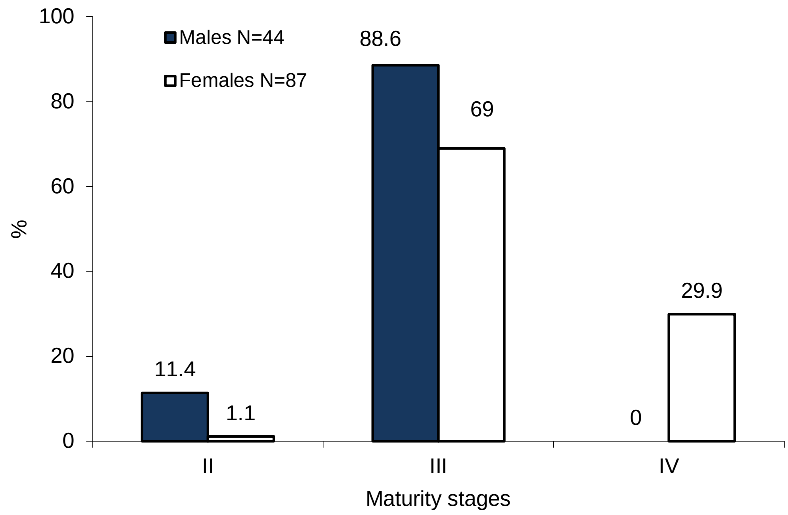

Fig. 14. Maturity of Blackspot grenadier from bottom trawl catches in the Faroese EEZ in April-May 2013

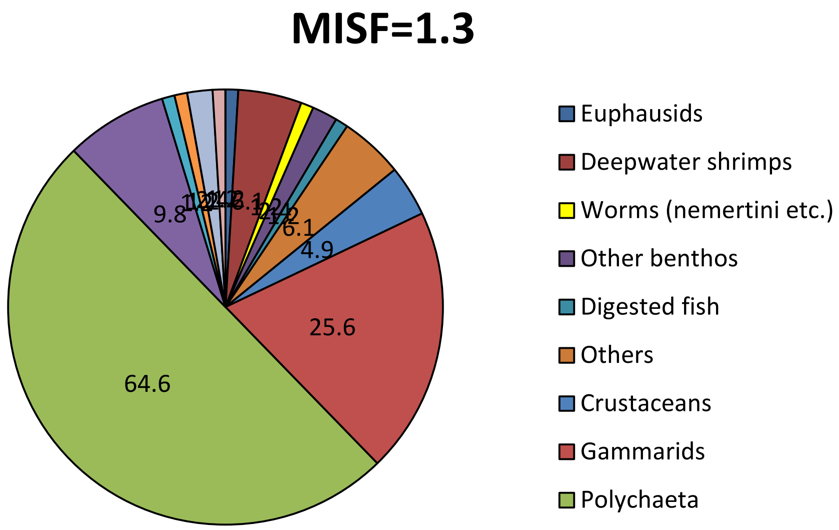

Fig. 15. Food composition of Blackspot grenadier from bottom trawl catches in the Faroese EEZ in April-May 2013, % by occurency in stomach with food

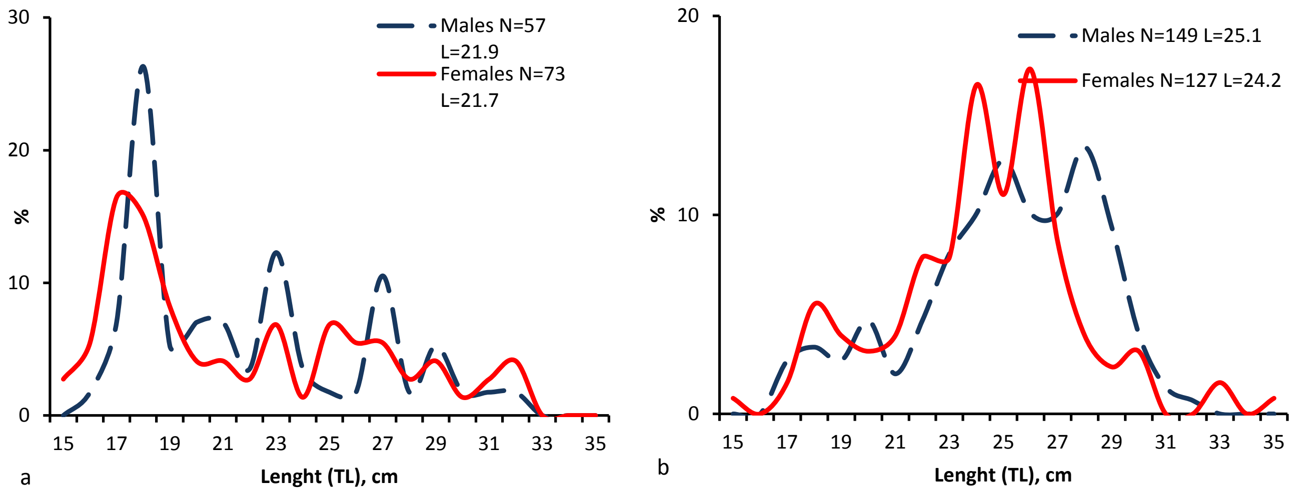

Fig. 16. Length composition of Bluemouth from bottom trawl catches on the Rockall Bank (a) and in Faroese EEZ (b) in April-May 2013

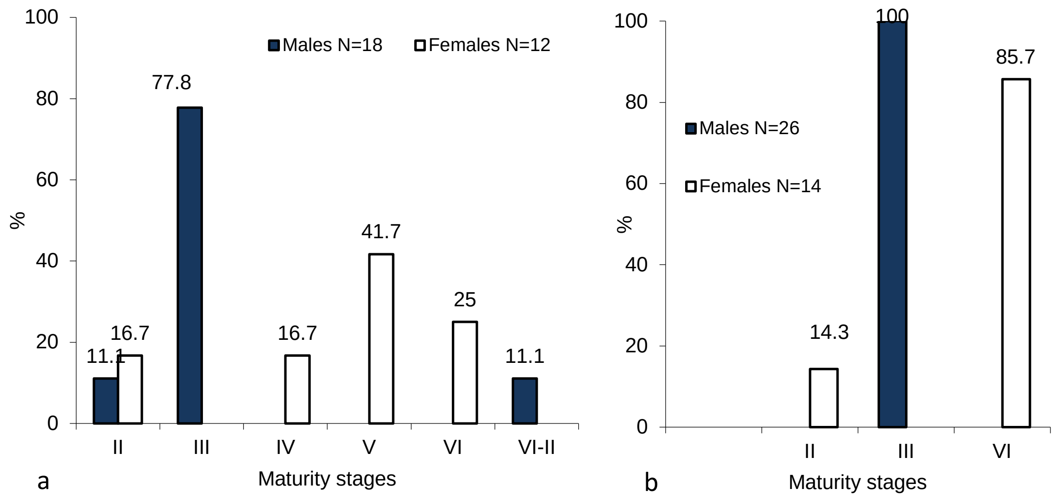

Fig. 17. Maturity of Bluemouth from bottom trawl catches on the Rockall Bank (a) and in Faroese EEZ (b) in April-May 2013

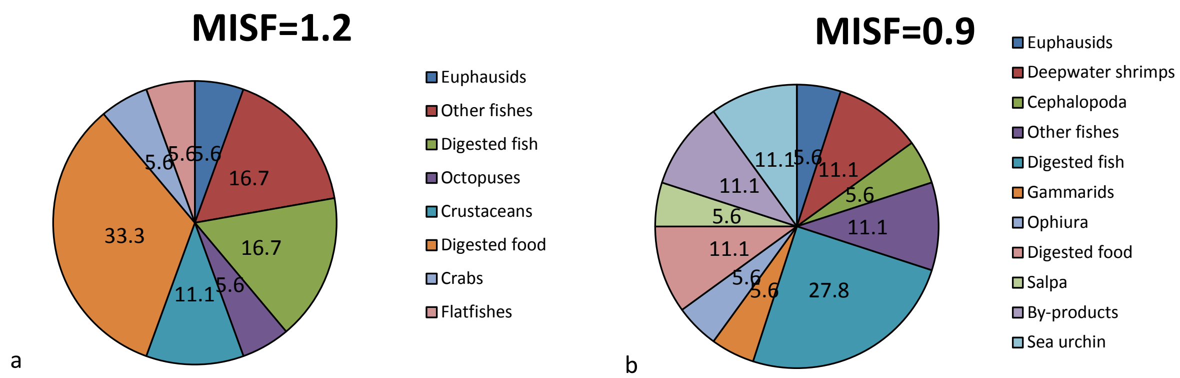

Fig. 18. Food composition of Bluemouth from bottom trawl catches on the Rockall Bank (a) and in Faroese EEZ (b) in April-May 2013, % by occurrence in stomachs with food

Revision of ICES assessment units for greater silver smelt based on the distribution of fishing grounds.

Summary

WGDEEP consider that, in the absence of conclusive information on stock structure and following the data limited approach, fisheries in Iceland, the Faroes/Rockall Trough and Norway are sufficiently isolated from each other to be considered as *de facto* assessment units. We therefore propose four units for this species in the ICES area: 1) Va and XIV, 2) Vb and VIa, 3) IIb, and 4) all other areas where the species occurs (IIIa, IV, VIb, VII, VIII and XII). The last unit, "other areas", are combined to allow recording of catches and monitor the potential development of new fisheries in these areas. Landings from the latter area are currently negligible in the last ten years.

Further work, including genetic studies, will be required to clarify stock structure within the North Atlantic.

Introduction

The 2013 WGDEEP communicated the following request; "In light of the 2013 advice for greater silver smelt where ACOM states that 'greater silver smelt may be sufficiently isolated at separate fishing grounds to be considered as individual assessment units'. As this may also apply to other stocks assessed by WGDEEP the group would ask ACOM to give clear guidance on what criteria has to be met for this to apply". ACOM has replied as follows; "The ICES approach to DLS recognises that it is possible to give advice in data limited situations. A similar approach could be extended to cover the definition of advice units where data is limited and it is unlikely that conclusive evidence on stock identity will be available in the near future."

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 advice unit. Only the greater silver smelt around Iceland (Division Va) is treated as a separate advice unit. Distribution of this semi-pelagic (vertical distribution is approximately 300-900 meters) species is wide (Figure 1). Main fisheries are however concentrated in defined areas far away from each other; around Iceland, around Faroe Island and west of mid-Norway.

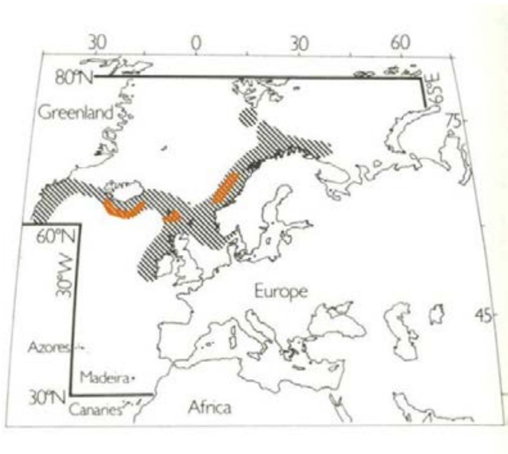

Figure 1. Distribution of greater silver smelt (Cohen 1984), with location of current direct fisheries indicated in orange.

Background

Greater silver smelt are distributed in the eastern Atlantic is from Svalbard to the west coast of Scotland and Ireland, deeper parts of North Sea and across the Wyville Thomson ridge to Denmark Strait (FishBase) (Figure 1). It is a benthopelagic deep-water species and is thought to form shoals close to the bottom.

Fisheries for this species occur in discrete areas around Iceland (divisions Va and XIV), the Faroes and northern Rockall trough (division Vb and VIa) and mid-Norway (subarea II) (Figure 2). Relatively small historic directed fisheries have occurred in subarea VII and IV but only low bycatch occurs in these areas now.

The current ICES view on the stock structure of greater silver smelt in the northeast Atlantic is that:

There is insufficient scientific information to establish the extent of putative stocks; however, greater silver smelt may be sufficiently isolated at separate fishing grounds to be considered as individual assessment units. On this basis advice is presented for the following units:

- *Division Va (Iceland); and*
- *Subareas I, II, IV, VI, VII, VIII, IX, X, XII, and XIV, and Divisions IIIa and Vb (other areas).*

The latter grouping is a combination of isolated fishing grounds and these areas are grouped due to their mutual lack of data.

This is based on examination of the available evidence by SGDEEP 1998 who stated:

I*celandic life history studies suggest that a separate stock might exist in Sub-area Va. Irish investigations on stock discrimination in* ICES WGDEEP Report 2007 *areas VI and VII are inconclusive. A study by Ronan et al. (1993), using morphometrics (box truss analysis) and meristic measurements, suggests that populations from the north of Subarea VI and the south of Sub-area VII form either end of a shape cline with fish in intermediary populations exhibiting a mixture of northern and southern morphologies. Norwegian investigations in 1984–1987 in Divisions IIa, IIIa and IVa appear to show two separate populations in the winter but in the summer the species is widely distributed (Bergstad, 1993).*

In 2007, WGDEEP and SIMWG jointly held a 3 day workshop to examine evidence for stock discrimination in deepwater species (ICES 2007). This group considered available literature as well as comparing trends in length distributions and CPUE the different fishing areas. No genetic information was available for this species. The workshop concluded:

Available information is not sufficient to suggest changes to current ICES interpretation of stock structure. In order to evaluate the stock structure further, sampling for genetic studies from the whole distribution area of greater silver smelt is needed. It is therefore recommended that such work should be initiated as soon as possible.

The inclusion of widespread and disparate areas into a single "other areas" unit has hindered WGDEEP's ability to provide advice on stocks in these areas. For example, it is evident that trends in abundance in subarea VII, where no directed fishery currently exists, are not informative for assessing the status of the exploited stock in subarea II. However, trends in the Porcupine survey are considered as an indicator of the status of the stock in "other areas" and hence influence advice for e.g. the Norwegian fishery.

Because of this, WGDEEP 2013 requested advice from ACOM on how 'sufficiently isolated at separate fishing grounds to be considered as individual assessment units' should be interpreted. ACOM replied: "The ICES approach to DLS recognises that it is possible to give advice in data limited situations. A similar approach could be extended to cover the definition of advice units where data is limited and it is unlikely that conclusive evidence on stock identity will be available in the near future."

On this basis, WGDEEP 2014 re-examined the distribution of current fishing grounds for greater silver smelt in order to determine whether they could be considered sufficiently isolated to be treated as *de facto* assessment units in the absence of conclusive evidence on stock identity.

Current fishing areas

Landings of greater silver smelt in 2013 by statistical rectangle are shown in Figure 2. Three distinct clusters of fishing activity can be observed: around Iceland (Va and XIV), to the west of Norway (II), and around the Faroes, Wyville-Thomson Ridge and Northern Rockall Trough (Vb and VIa). In 2013 96% of landings from the ICES area were taken within these three fishing area and in 2012 it was 99% (Figure 3, Table 1).

Historic landings data indicate that comparatively small directed fisheries occurred in the past in subareas III and IV and subarea VII (Table 1). Catches in this area have been lower in recent years , although the species identity of these catches is uncertain and could include *Argentina sphyraena*.

Presently the main actors in direct fisheries are the Icelandic fleets in Va, Faroese fleets in Vb and VIa, Norwegian fleets in IIa2 and Dutch fleets in VIa. Va are already assessed as one unit in Faroese national assessments. The Faroese and Norwegian landings in Areas Vb, VI, VII and IIa together have since 2005 represented 80–90% of the total landings from this stock; the Dutch landings from Area VIa represent most of the rest of the total landings.

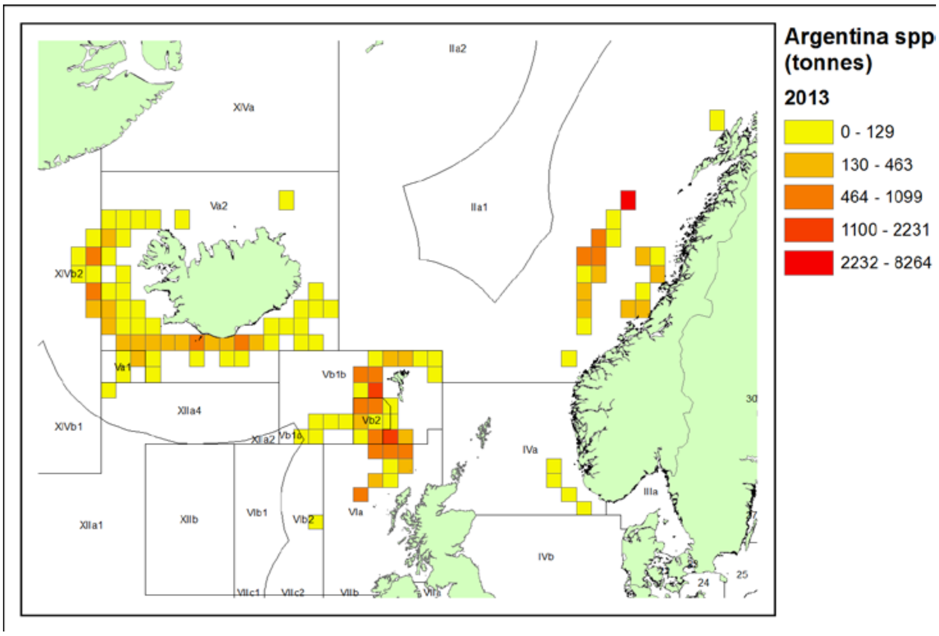

Figure 2. Landings of greater silver smelt by Iceland, Faroes, the Netherlands and Norway in 2013. Some catches of *A. Sphyraena* and *Argentina* unidentified may be included in the Norwegian and Dutch landings.

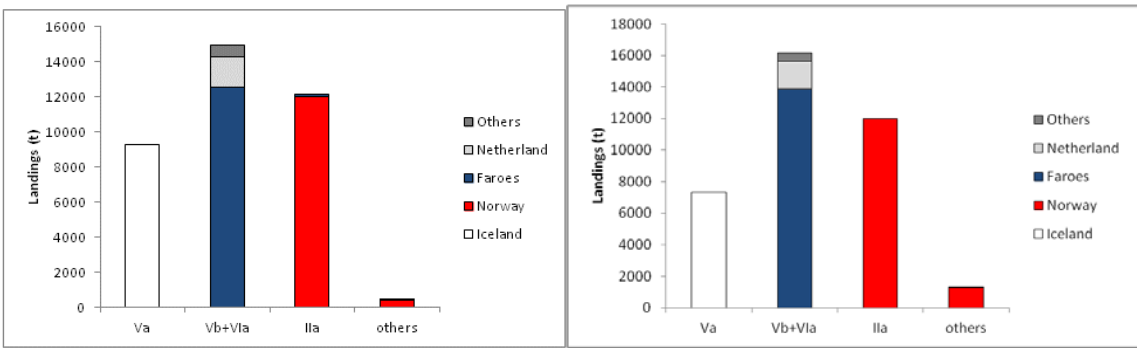

Figure 3. International landings of greater silver smelt in 2012 (left figure) and preiminary data for 2013 (right figure).

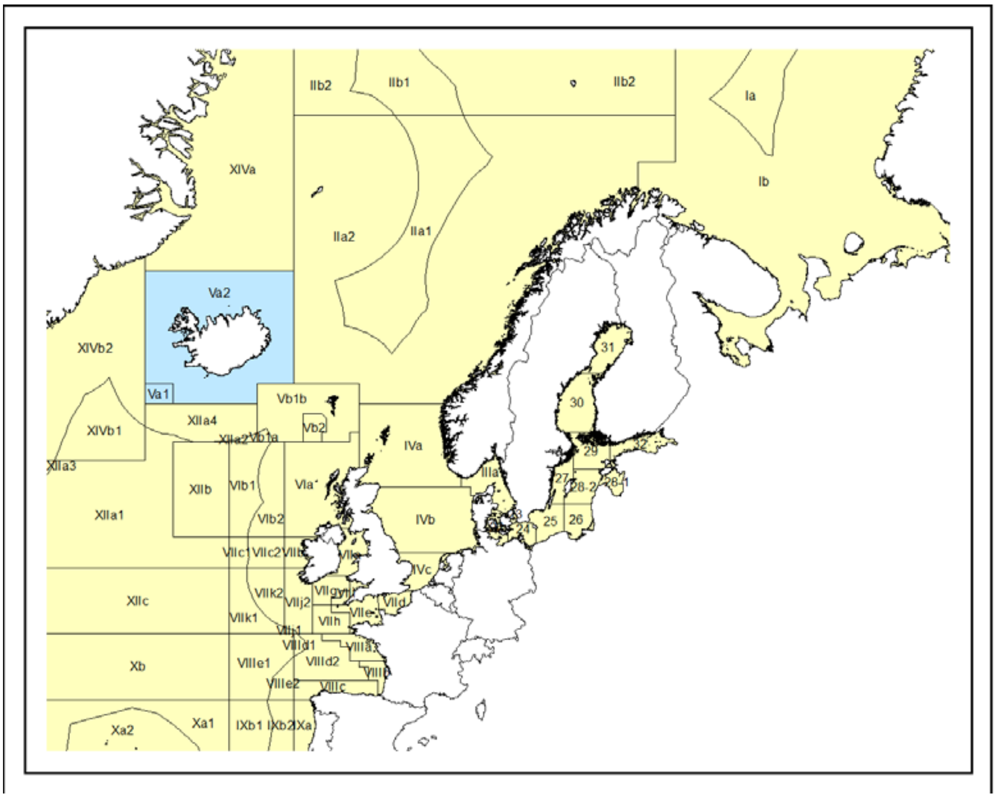

Figure 4. Current ICES advice unit structure for greater silver smelt.

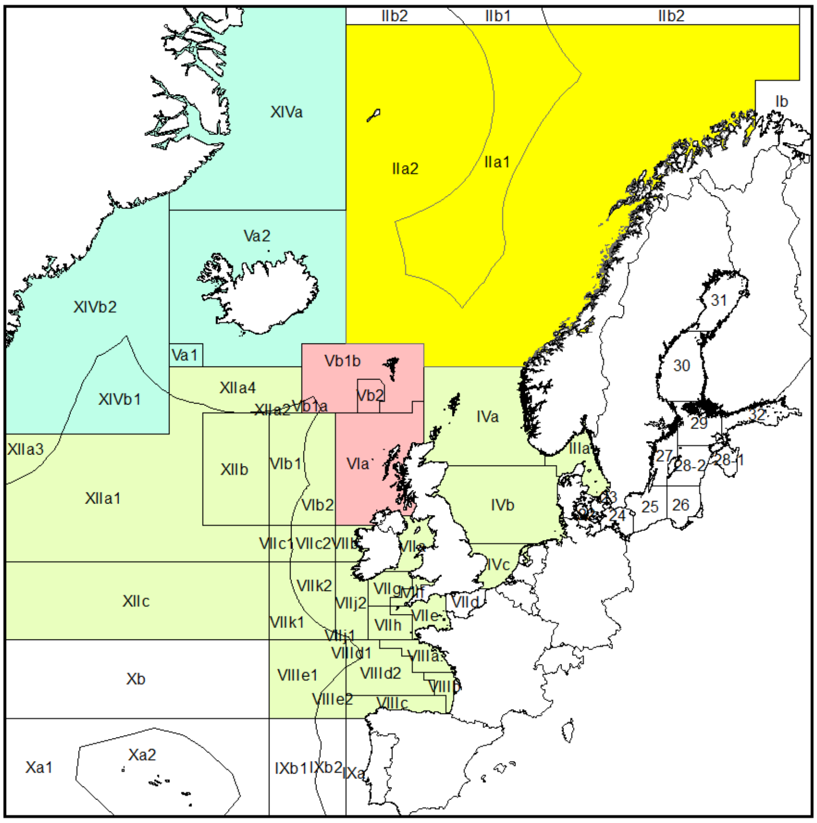

Figure 5. Suggested new unit structure for greater silver smelt based on the main fishing areas

Table 1. Greater silver smelt landings in tonnes. Note that the separation of area VI and VII will not give the exact same value as it is in the WGDEEP report, mainly because of landings of lesser silver smelt.

	I	II	III+IV	Va	Vb	VIa	VIb	VII	VIII	IX	XII	XIV
1988	6	11345	2718	206	287	3040	0	100				
1989		8390	3786	8	227	4694	0	200				
1990		9120	2321	112	2888	522	300	24				6
1991		7741	2554	247	60	10	5	9				
1992	14	8220	5319	657	1443	786	221	254				
1993	277	7636	3269	1255	1063	406	3	505			6	
1994	147	6660	1508	613	960	1375	20	39				
1995		6775	1082	492	12286	465	1114	510				
1996		6604	3300	808	9498	295	0	10			1	
1997		4463	2598	3367	8433	1089	0	12				
1998		8261	3955	13387	17570	405	0	0				
1999	2	7161	4313	6727	8229	351	178	50				
2000		6293	2471	5657	5209	4533	1384	523			2	217
2001	2	14367	2925	3043	10081	10615	132	4415				66
2002	34	7373	1811	4960	7471	7595	30	4437	195			
2003	4	8933	1188	2686	6558	2013	126	119	43			
2004	1	15795	1435	3637	5310	4271	23	47	23		629	
2005		17093	791	4481	7013	3169	4	58	202		362	
2006		21685	4016	4775	12559	1331	0	40				
2007	1	13272	3343	4226	14126	4714	0	34		1		
2008	7	11869	1629	8778	14952	4017	9	0	10	1		
2009		11929	1572	10829	14228	5841	0	8		2		
2010		11854	1091	16428	15609	5995	0	9		2		
2011		11476	585	10515	15586	6707	0	12	1	1		
2012		12134	274	9377	9854	5105	0	3		2	31	
2013		11979	1327	7334	11065	5125	0	0				

Conclusions

The WGDEEP strongly request that the current greater silver smelt unit to be separated in smaller assessment/management units to be able to give better advice to the manager. The groups suggestion is to divide greater silver smelt into 4 units: 1) Va and XIV, 2) Vb and VIa, 3) IIb, and 4) all other areas where the species occurs (IIIa, IV, VIb, VII, VIII and XII). The last unit, "other areas", are combined to allow recording of catches and monitor the potential development of new fisheries in these areas.

Notes from FaMRI: There have been discussions in the group with regards to the stock structure of greater silver smelt. An alternative, which has been discussed, is to use management areas. The result is very similar to the grouping proposed in Figure 5, the main difference being to separate Vb and VIa. The benefits of this alternative are that the advice will be directed to well-defined fleets/managers, and that the corresponding "nations" (Norway, Iceland, Faroes, EU) don't need to cooperate with regards to the assessment or to separate a quota to different management areas. Another benefit is that the age-based assessment in Vb can be used for that area, whereas another approach (e.g. data-limited) can be used for VIa.

The stock structure of greater silver smelt is poorly known. In Vb we have evidence of the existence of all life stages, and the age-based assessment shows that it is possible to follow year classes going through the fishery.

This indicates that intermingling with other populations of GSS may be limited enough to regard Vb as a separate assessment unit.

Annex 3: Recommendations

ID	Recommendation	Comments	Recipient
1	Following the reponse from ACOM, WGDEEP recomends that from the 2015 advisory year arg-oth be split into three advice units, namely arg-arct (Area 2), arg-far (Areas Vb and VIa) and finnally arg-oth. Arguments for this division are put forward in WGDEEP-2014:WD10; *Revision of ICES assessment units for greater silver smelt based on the distribution of fishing grounds.*		SIMWG; WGDEEP

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Annex 5: Stock Annexes

The following stock annexes have been updated and are included in Annex 5 of the WGDEEP 2014 report.

- SA 4.2-Ling in Vb
- SA4.3-Ling in Va
- SA 5.2-Blue ling in Va, XIV
- SA 5.3-Blue ling in Vb, VI and VII
- SA 6.2-Tusk in V and XIV
- SA 7.2-Greater silver smelt in Va
- SA 9.2-Roundnose grenadier in Vb, VII, VIII and XIIb
- SA 10.2-Black scabbardfish
- SA 13.3-Red seabream in IX

Stock Annex 4.2: Ling in Vb

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Ling in Vb
Working Group	WGDEEP
Date	March 2013
Revised by	WGDEEP-2013 / Lise H. Ofstad

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 the 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

During the first half of the 1900 century ling (and tusk) were only caught as bycatch in the British trawl fishery. In the 1950s the longline fishery for ling (and tusk) expanded considerably and was conducted by British, Norwegian and Faroese vessels. The British fishery declined steadily from the beginning of the 1960s and in the late 1970s the Faroese deep-water fisheries started following the expansion of the national EEZs to 200 nm and a wish to reallocate fishing effort from traditional shelf fisheries. The fishery for ling in Vb has not changed substantially in recent years. The demersal fisheries in Vb are detailed described in Chapter 2, Demersal Stocks in the Faroe Area in ICES NWWG Report, 2011.

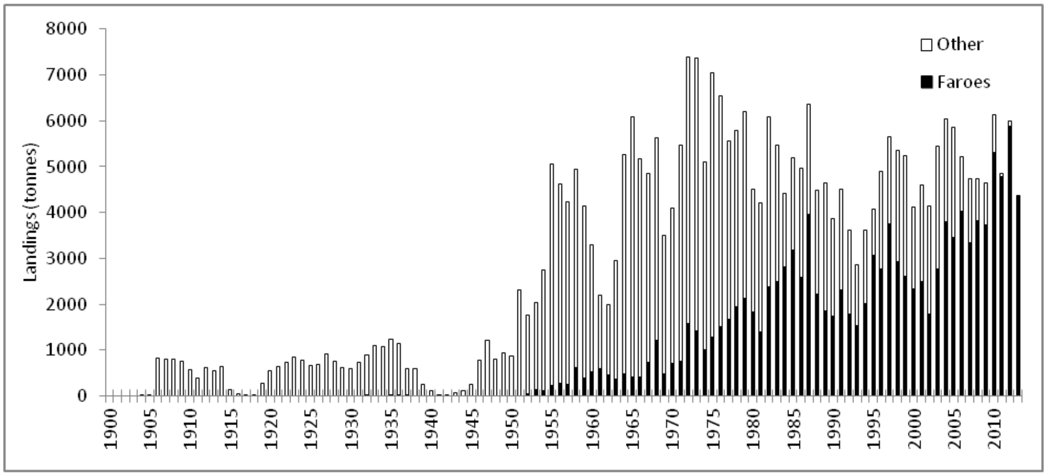

Figure 1. Nominal landings of ling Vb from 1903 to 2013.

The traditional longline fleet fishing ling, tusk and blue ling consist of 24 longliners larger than 110 GRT; they are mainly targeting cod and haddock and in years where the availability of these species is high and market conditions satisfactory, they spend very little effort in deep water. The main deep-water fleet consist of about 13 otter board trawlers with engines larger than 1000 HP. However, due to poor economic conditions especially the very high fuel prices, the number of vessels has declined in the most recent years and the effort towards deep-water species has declined further due to a switch to pair-trawling targeting mainly saithe. The pair trawler fleet consist of xx pair trawlers larger than 1000 HP are mainly targeting saithe, but there are some bycatch of ling in this fishery.

Most of ling in Vb is caught by longlines and the proportion caught by that gear has increased since 2000 to around 65% in 2010. In the resent years about 70–75% of ling in Vb are caught by longliners and the rest mainly by trawlers. Most of the ling caught in Vb by Faroese longliners and trawlers is caught at depths less than 500 meters. The main fishing grounds for ling in Vb as observed from logbooks are on the slope of the Faroe Plateau and Faroe Bank.

A.3. Ecosystem aspects

It seems like the primary production on the Faroe shelf (<130 m) and the subpolar gyre index (for deeper areas) has importance for species like cod, haddock and saithe in Faroese waters (Section 2.1.3 in ICES NWWG report, 2011) - and this could also have impact on the ling.

A.4. Management

The Ministry of Fisheries is responsible for management of the Faroese fisheries and implementation of the legislation. The Ministry issues regulations for commercial fishing for each fishing year. The fishing year started on 1st September and ended 31st August the following year.

During the 1980s and 1990s the Faroe authorities have regulated the fishery and the investment in fishing vessels. In 1987 a system of fishing licenses was introduced. The demersal fishery at the Faroes has been regulated by technical measures (minimum mesh sizes and closed areas). A reduction of effort has been attempted through banning of new licences and buy-back of old licences.

A quota system, based on individual quotas, was introduced in 1994 for cod, haddock, saithe and redfish. A new system entered into force on 1st June 1996 that is based on individual transferable quotas in days within fleet categories. Nearer description of the day quota system is in Section 2.1.2 in the ICES NWWG report, 2011.

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. To prevent fishing of small fish various measures such as mesh size regulation and closure of fishing areas are in place. Discard is banned in the Faroese demersal fishery.

All fishing boats operating in Faroese waters have to maintain a logbook record of catches in each haul/set. The records are available to the stock assessors at the Faroe Marine Research Institute.

B. Data

B.1. Commercial catch

The text Table below shows which data from landings is supplied from ICES Division Vb.

ICES Division Vb	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
Denmark (Greenland)	x				
Faroes	x	x	x		x
France	x				
Norway	x				
Scotland	x				

Faroese ling catch in tonnes by month, area and gear are obtained from Statistical Faroe Islands (www.hagstovan.fo) and Faroese Coast Guard (www.fvg.fo). 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. Good logbook information is available since 1995. Landings from foreign nations fishing in Vb are given by the Faroese Coast Guard and reported to the Directorate of Fisheries.

B.2. Biological

Biological data from the commercial longline and trawl fleet catches are collected from landings by technicians of the Faroe Marine Research Institute (FAMRI). The biological data collected are length (cm), gutted weight, and otoliths for age reading. Most of the fish that otoliths were collected from were also weighted (to the nearest gram). Each sample consists of 200 length measurements and from 1995 were also 60 weights and otoliths taken in some of the samples. From 2007 very few otoliths have been taken of ling, but there are good samplings of lengths and gutted weights.

The biological data from the fishery are stored in a database at FAMRI. The data are used for description of the fishery and abundance indices.

Ling become mature at ages 5–7 (60–75 cm lengths) in most areas, with males maturing at a slightly lower age than females (Magnusson *et al*., 1997). No annual measurements of maturity-at-age were available and knife-edge maturity for age 7 and older has been assumed for previous assessments.

No information is available on natural mortality of ling in Vb, but a natural mortality of 0.15 is assumed for all ages in previous assessments.

Population biology of ling in Vb from Magnússon *et al*., 1997: Ling eggs were observed scattered over wide areas of the Northeast Atlantic and no spawning aggregations of ling have been observed so far. In Faroes waters spawning occur in April to June, in depths of 60 to about 500 m. Ling eggs are planktonic, without oil globule and of 1 mm diameter in size. In Faroese waters pelagic stages of ling have been observed mainly on 0-group surveys which were carried out since 1972 in June/July. 35-40 cm ling are taken on hooks near land. Young ling (<40 cm) are about 2–4 years old. Length–weight relationship from the annual Faroese spring survey in March (1983–1994) was $W=0.0027\ L^{3.1574}$, $R^2=0.97$. For most areas, 50% of the ling seems to become mature at ages 5–7, corresponding to lengths 60–75 cm. Ling is mainly feeding on species as Norway pout, blue whiting, Argentines, herring and cod depending on their availability. Other foods are squids, crustaceans and echinoderms.

B.3. Surveys

The spring groundfish surveys in Faroese waters were initiated in 1983 with the research vessel Magnus Heinason. Up to 1991 three cruises per year were conducted between February and the end of March, with 50 stations per cruise selected each year based on random stratified sampling (by depth) and on general knowledge of the distribution of fish in the area. In 1992 the first cruise was not conducted and one third of the stations used up to 1991 were fixed. Since 1993 all the 100 stations on the Faroe Plateau are fixed.

The summer (August–September) groundfish survey was initiated in 1996 and covers the Faroe Plateau with 200 fixed stations distributed within the 65 to 520 m contour. Half of the stations were the same as in the spring survey. Effort for both surveys is recorded in terms of minutes towed (~60 min).

Survey data for Faroe ling are available to the WG from both the spring- (since 1994) and summer- (since 1996) surveys. There are lengths (cm) and round weights of ling from these two groundfish surveys and a recruitment index was calculated as the stratified number and biomass of ling less than 60 cm. The abundance indices from the groundfish surveys are standardized according to number of stations in each stratum and weighted with strata area for all the different strata.

The summer survey is considered descriptive of biomass trends.

B.4. Commercial cpue

Data used to estimate cpue for ling in Division Vb are obtained from logbooks of the Faroese longline and trawl fleet. The effort obtained from the logbooks is estimated as number of fishing (trawling) hours from the trawlers, as 1000 hooks from the longliners and the catch as kg stated in the logbooks.

Sets where they catch ling and the catch of ling and tusk combined represented more than 60% of the total catch and depth was >150 m were selected for the longliner cpue series. The bycatch series for ling from the Faroese pair trawlers > 1000 HP is limited to hauls where they catch ling and the catch of saithe is more than 60% of the total catch in the haul.

A general linear model (GLM) was used to standardize all the cpue series (kg/h or kg/1000 hooks) for the commercial fleet where the independent variables were the following: vessel (actually the pair ID for the pair trawlers, otter board trawlers or longliners), month (January–April, May–August, September–December), fishing area (Vb1, Vb2) and year. The dependent variable was the log-transformed kg per hour or kg/1000 hooks measure for each trawl haul or longline setting, which was back-transformed prior to use. The reason for this selection of hauls/settings was to try to get a series that represents changes in stock abundance.

B.5. Other relevant data

C. Historical stock development

Assessment: data and method

Ling in Vb is assessed based on trends in survey indices from the Faroese spring and summer survey. Supplementary information includes relevant information from the fishery such as length distributions, maturity data, effort and cpue.

Exploratory analysis

The 2008 WGDEEP Report showed an analytical assessment exercise on ling in Vb (ICES, WGDEEP Report, 2008). This year, several attempts were made by running a traditional XSA but they are not presented here due to the noise because of very few samples of otoliths from the last five year period. It was necessary to combine otolith samples for different fleets/seasons and also across years in order to increase the number of age–length relationships. But the resulting catch-at-age matrix was so noisy that it is very difficult to follow cohorts.

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 Vb. At the 2012 WGDEEP meeting was F_{MAX} and $F_{0.1}$ calculated from a yield per recruit model (Figure 4.2.17). This analysis indicated F_{MAX} to be around 0.33, when the age of first catch, AFC = 5 years and F_{MAX} = 0.27 with AFC = 4 years. Other input values was L_{∞} = 227 cm, K = 0.052, t_0 = -0.93, M = 0.15, L_{50} = 7 years. The results are shown in the table below.

AFC=	4	5	AFC=	4	5
F_{MAX} =	0.27	0.33	F=	0.1	0.1
Y/R =	1.38	1.55	Y/R =	1.07	1.09
SPR =	3.42	3.51	SPR =	8.67	9.58

At the 2012 WGDEEP was also WKLIFE Gislason spreadsheet applied using an L_{MAX} of 180 cm and AFC = 5. The parameters estimated by the model (k = 0.11,) were unrealistic based on what is known about this stock and the F_{MAX} value (F_{MAX} = 0.22) was substantially lower than that estimated by YPR.

H. Other issues

I. References

ICES. 2011. NWWG Report, Section 2.

Magnússon, J., Bergstad, O.A., Hareide, N.R., Magnússon, J. Reinert, J. 1997. Ling, Blue Ling and Tusk of the Northeast Atlantic. TemaNord 1997:535.

Stock Annex 4.3: Ling in Va

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Ling in Va
Working Group	WGDEEP
Date	February 2014
Revised by	WKDEEP-2014 / 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 the 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. On the Icelandic shelf, the species is a southern stock, i.e. is a 'warm water' species. With the warming of the continental shelf around Iceland, especially along the western and northwestern part of the shelf that started around the year 2000 (Figure 1) an increase in ling biomass and distributional range has been observed. This has also been observed for other 'warm-water' species such as tusk, anglerfish and lemon sole. Therefore the increases in temperature may have been a driver for the increase in biomass of Ling in 2000 to 2009. Similarly the decrease in catches in the early seventies compared to the 1950s and 1960s may be partly driven by cooling of the shelf in that period.

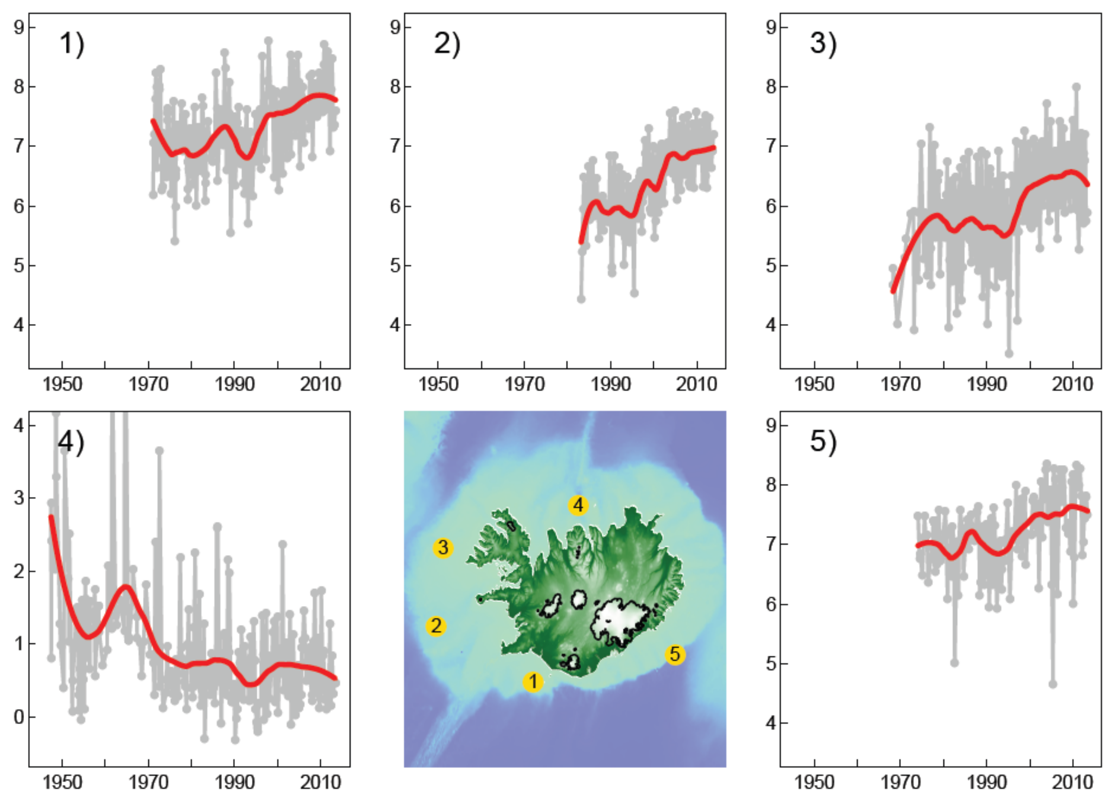

Figure 1. Changes in bottom temperature at five locations on the Icelandic shelf.

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.

In the beginning, only few commercial 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

Icelandic ling catches 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 gram). 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 fishes. Otoliths are extracted from 20 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 un-gutted, the un-gutted weight is measured and the fish is sexed and maturity determined. The remaining 130 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. However ageing was resumed in 2013 and is expected to continue, the main focus being on otoliths from catches and surveys in the current year but older otoliths will be as or if resources are available.

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 but in the assessment it is assumed to be M=0.15.

The biological data from the fishery are stored in a database at the Marine Research Institute. The data are used for description of the fishery.

B.3. Surveys

Two bottom-trawl surveys, conducted by the Marine Research Institute in Va, are considered representative for ling 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*). Though the signals in the autumn survey for ling are similar to those in the spring survey the number of specimens caught in the autumn survey is low, ranging between 20 and 260, therefore the autumn survey is not used for tuning in the assessment model.

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 ling.

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 fishermen and other stakeholders.

To help in the planning, experienced captains were asked to map out and describe the various fishing grounds around Iceland and 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 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 fishermen and fishery scientist at the MRI for decisions of location. The scientist selected random position for their stations, whereas the fishermen 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 Japan-built trawlers were all build 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, foot-rope 180 feet and the trawl weight 4200 kg (1900 kg submerged).

Length of each tow was set 4 nautical miles and towing speed at approximately 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).

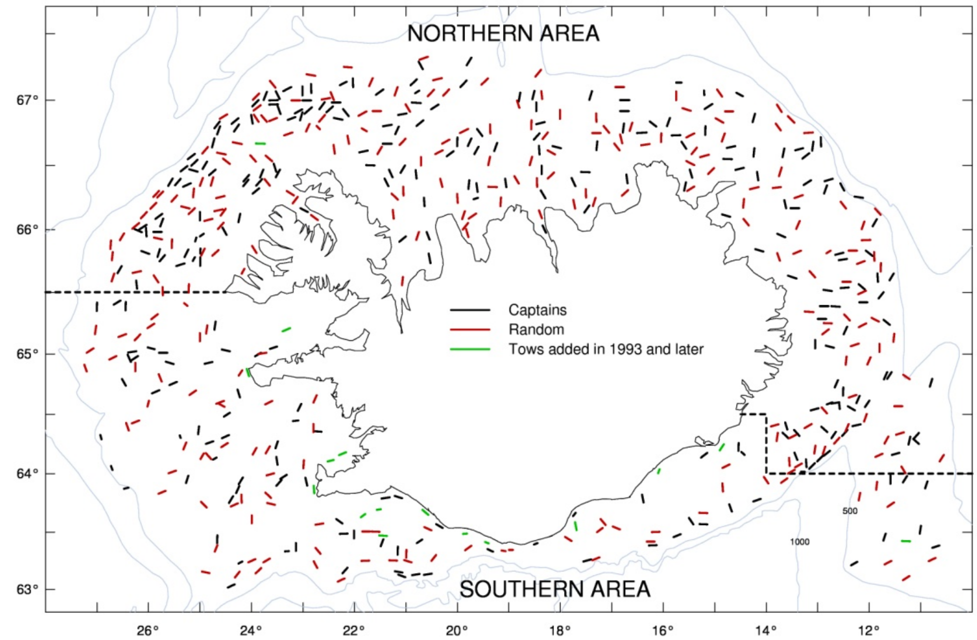

Figure 2. Stations in the spring survey in March. Black lines indicate the tow-stations selected by captains of commercial trawlers, red lines are the tow-stations selected randomly, and green lines are the tow-stations that were added in 1993 or later. The broken black lines indicate the original division 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 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 fishermen's 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, twelve 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 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".

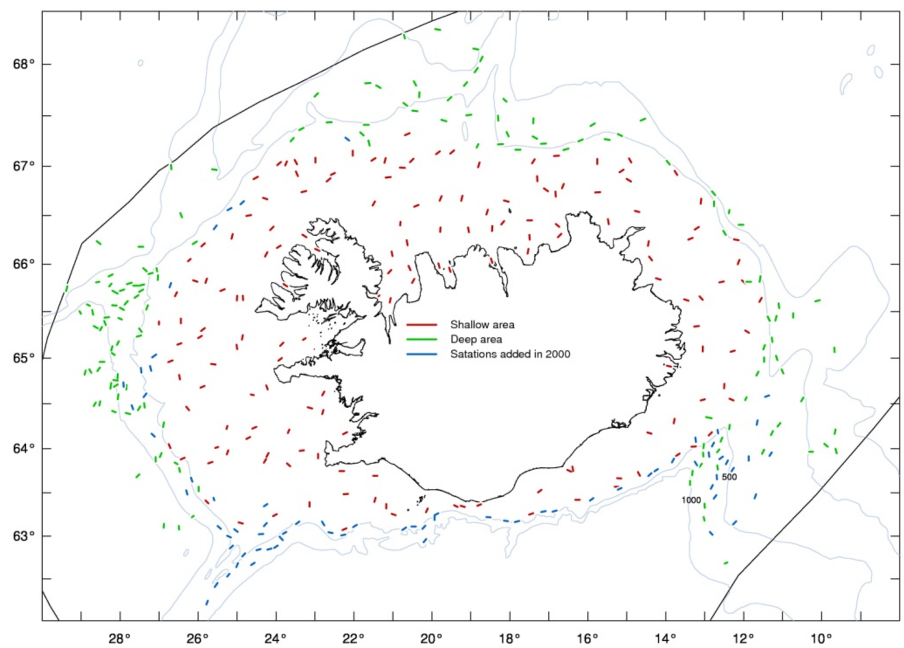

Figure 3. Stations in the Autumn Groundfish Survey (AGS). RV "Bjarni Sæmundsson" takes stations in the shallow-water area (red lines) and RV "Árni Friðriksson" takes stations in the deep-water areas (green lines), the blue lines are stations added in 2000.

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 66.6 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.

"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 66.6 m" 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 ling, the sampling procedure is the same in both surveys except ling is weighed un-gutted 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 ling, 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 ling, is to measure at least four times the length interval of a given species. Example: If the continuous length distribution of ling 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 ling 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 ling from the start of both surveys. Ling is weighted as un-gutted in the autumn survey.

B.3.3.3. Otolith sampling

For ling a minimum of five otoliths 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 lings are caught in a single haul, ten otoliths are sampled.

B.3.3.4. Stomach sampling and analysis

Stomach samples of ling 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 co-operation 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, Wind speed, Bottom temperature °C, Sea surface, Surface temperature °C, Towing depth temperature °C, Cloud cover, Air pressure, Drift ice.

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:

$$P = \frac{n_{measured}}{n_{counted} + n_{measured}} \quad (1)$$

$$n_{L_1-L_2} = \sum_{i=L_1}^{i=L_2} \frac{n_i}{P} \quad (2)$$

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:

$$B_{L_1-L_2} = \sum_{i=L_1}^{i=L_2} \frac{n_i \alpha L_i^{\beta}}{P} \quad (3)$$

Where L_i is length and α and β 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:

$$\bar{Z}_i = \frac{\sum_i Z_i}{N_i} \quad (4)$$

Where $\overline{Z_i}$ is the mean catch (number or biomass) in the *i*-th stratum, Z_i is the total quantity of the index (abundance or biomass) in the I-th stratum and N_i the total number of tows in the *i*-th stratum. The index (abundance or biomass) of a stratum (I_i) is:

$$I_i = \bar{Z}_i \left(\frac{A_i}{A_{tow}} \right) \quad (5)$$

And the sample variance in the *i*-th stratum:

$$\sigma_i^2 = \left(\frac{\sum_i (Z_i - \bar{Z}_i)^2}{N_i - 1} \right) \left(\frac{A_i}{A_{tow}} \right) \quad (6)$$

where A_i is the size of the *i*-th stratum in square nautical miles (nm^2) and A_{tow} is the size of the area surveyed in a single tow in nm^2.

The index in a given region:

$$I_{region} = \sum_{region} I_i \quad (7)$$

The variance is:

$$\sigma_i^2 = \sum_{region} \sigma_i^2 \qquad (8)$$

And the coefficient of variation is:

$$CV_{region} = \frac{\sigma_{region}^2}{I_{region}} \qquad (9)$$

The subareas or strata used in the Icelandic groundfish surveys (same strata division in both surveys) are shown in Figure 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.

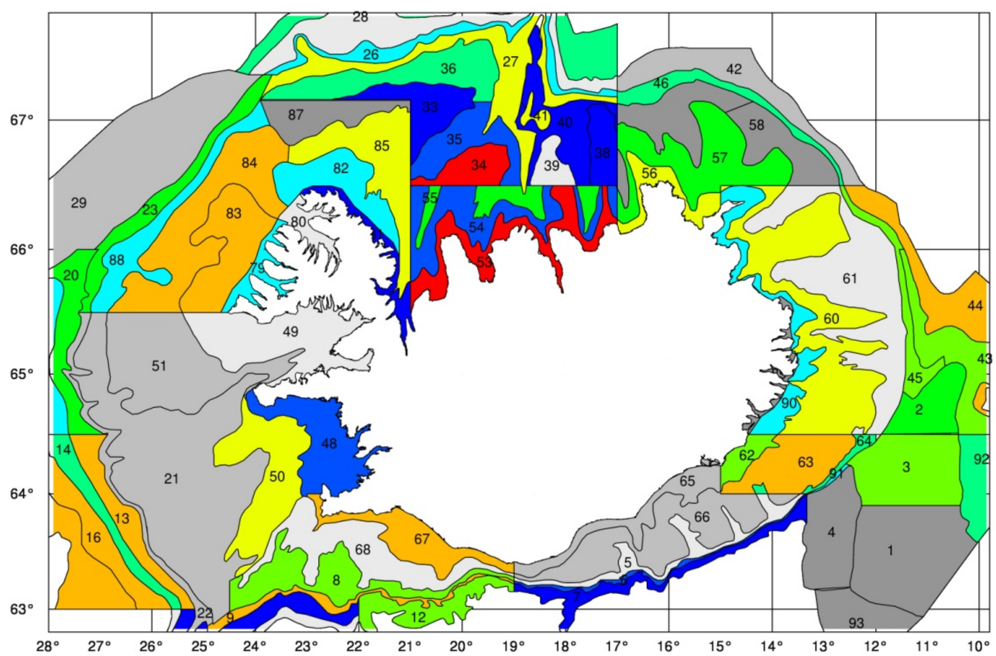

Figure 4. Subareas or strata used for calculation of survey indices in Icelandic waters.

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. The cpue estimates are not used in the assessment of ling in Va.

B.5. Other relevant data

NA.

C. Assessment: data and method

Model used: **Gadget**

Software used: **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 optimisation 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-species, 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 optimisation 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. Optimisation routines then attempt to find the best set of parameter values.

Simulation model

In a typical Gadget model the simulated quantity is the number of individuals, N_{alsyt}, at age a = 3… 25, in a length-group l, representing lengths ranging between 20 and 180 cm in 1 cm length-groups, at year y which is divided into quarters t = 1… 4. The length of the time-step is denoted Δt. The population is governed by the following equations:

$$
\begin{aligned}
N_{aly,t+1} &= \sum_{l'} G_l^{l'} \left[(N_{al'yt} - C_{fal't})e^{-M_a \Delta t}\right] && \text{if } t < 4 \\
N_{a+1,l,y+1,1} &= \sum_{l'} G_l^{l'} \left[(N_{al'y,4} - C_{fal',4})e^{-M_a \Delta t}\right] && \text{if } t = 4 \text{ and } a < 25 \\
N_{a,l,y+1,1} &= \sum_{l'} G_l^{l'} (N_{al'y,4} - C_{fal'y,4} + N_{a-1,l'y,4} - C_{f,a-1,l'y,4})e^{-M_a \Delta t} && \text{if } t = 4 \text{ and } a = 20
\end{aligned}
\qquad (1)
$$

Where $G_1^{l'}$ is the proportion in length-group l that has grown l' - l length-groups in Δt, C_{falsyt} denotes the catches by fleet $f \in \{S, T, G, L\}$, S and C denote the spring survey, trawl, gillnet and longline fleets respectively (The survey fleet catches are given a nominal catch to allow for survey age and length distribution predictions.), M_a the natural mortality-at-age a (A short note on notation, here l is used interchangeably as either the length group or the midpoint of the length interval for that particular length group, depending on the context.).

Growth

Growth in length is modelled as a two-stage process, an average length update in Δt and a growth dispersion around the mean update (Stefansson, 2005). Average length update is modelled by calculating the mean growth for each length group for each time step, using a parametric growth function. In the current model a simplified form of the von Bertanlanffy function has been employed to calculate this mean length update.

$$\Delta l = (l_\infty - l)(1 - e^{-k\Delta t})$$

where l_∞ is the terminal length and k is the annual growth rate.

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:

$$\sum_i p_{il} = 1$$

and

$$\sum_i i p_{il} = \Delta l$$

Here Δl is the calculated mean growth and p_{il} is the proportion of fish in length group l growing i length groups. Here the growth is dispersed according to a beta-binomial distribution parameterised by the following equation:

$$G_l^{l'} = \frac{\Gamma(n+1)}{\Gamma((l'-l)+1)} \frac{\Gamma((l'-l)+\alpha)\Gamma(n-(l'-l)+\beta)}{\Gamma(n-(l'-l)+1)\Gamma(n+\alpha+\beta)} \frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)}$$

Where α is subject to

$$\alpha = \frac{\beta \Delta l}{n - \Delta l}$$

where n denotes the maximum length group growth and (l'-l) the number of length groups grown.

Recruitment and initial abundance

Gadget allows for a number of relationships between stock–recruitment and the size of the spawning stock to be defined. However in this model the number of recruits each year, R_y is estimated directly from the data.

Recruitment enters to the population according to:

$$N_{1l0yt'} = R_y p_l$$

where t' denotes the recruitment time-step, p_l is the proportion in length group l that is recruited which is determined by a normal density with mean according to the growth model and variance σ_y^2.When more data is available the number of recruits, R_y is estimated directly.

A simple formulation of initial abundance in numbers is used for each age group in length group l

$$N_{als11} = \nu_a q_l$$

where υ_a is the initial number-at-age a in the initial year and q_l the proportion at length group l which is determined by a normal density with a mean according to the growth model in use and variance σ_a^2.

Fleet operations

Catches are simulated based on reported total landings and a length-based suitability function for each of the fleets (commercial fleets and surveys). Total landings are assumed to be known and the total biomass is simply offset by the landed catch. The catches for length group l, fleet f at year y and time-step t are calculated as

$$C_{flsyt} = E_{ft} \frac{S_f(l) N_{lsyt} W_{ls}}{\sum_{s'} \sum_{l'} S_f(l') N_{l's'yt} W_{l's'}}$$

where E_{ft} is the landed biomass at time t and $S_f(l)$ is the suitability of length group l by fleet f defined as:

$$S_f(l) = \frac{1}{1 + e^{(-b_f(l - l_{50,f})}}$$

The weight, W_{sl}, at length group l is calculated according to the following stock component specific length–weight relationship:

$$W_{sl} = \mu_s e^{\omega_s l}$$

Observation model

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 data directly means that the model can be used for stocks such as ling in Va where age data are sparse. 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.

In Gadget, data are assimilated using a weighted log-likelihood function. Here three types of data enter the likelihood, length-based survey indices, length distributions from survey and commercial fleets and age–length distribution from the survey and commercial fleets.

Survey indices

For each length range g the survey index is compared to the modelled abundance at year y and time-step t using:

$$l_{gf}^{\mathrm{SI}} = \sum_y \sum_t (\log I_{gfy} - (\log q_f + \log \widehat{N_{gyt}}))^2 \qquad \textbf{(eq 1)}$$

Where

$$\widehat{N_{gyt}} = \sum_{l \in g} \sum_a \sum_s N_{alsyt}$$

Fleet data

Length distributions are compared to predictions using

$$l_f^{\mathrm{LD}} = \sum_y \sum_t \sum_l ({}^L\pi_{lyt} - {}^L\hat{\pi}_{lyt})^2 \qquad \textbf{(eq 2)}$$

where f denotes the fleet where data was sampled from and

$$\pi_{lyt} = \frac{\sum_a \sum_s O_{alsyt}}{\sum_a \sum_{l'} \sum_s O_{alsyt}}$$

and

$$\hat{\pi}_{lyt} = \frac{\sum_a \sum_s N_{alsyt}}{\sum_a \sum_{l'} \sum_s N_{alsyt}}$$

i.e. the observed and modelled proportions in length-group l respectively at year y and time-step t. Similarly age–length data are compared using 1 cm length groups:

$$l_f^{\mathrm{AL}} = \sum_y \sum_t \sum_a \sum_l \sum_s (\pi_{falsyt} - \hat{\pi}_{falsyt})^2$$

where

$$\pi_{alyt} = \frac{\sum_s O_{alsyt}}{\sum_a \sum_{l'} \sum_s O_{alsyt}}$$

and

$$\hat{\pi}_{alyt} = \frac{\sum_s N_{alsyt}}{\sum_a \sum_{l'} \sum_s N_{alsyt}}$$

(eq 3)

Iterative re-weighting

The total objective function used the modelling process combines equations eq 1 to eq 3 using the following formula:

$$l^{\mathrm{T}} = \sum_g w_{gf}^{\mathrm{SI}} l_{g,S}^{\mathrm{SI}} + \sum_{f \in \{S,T,G,L\}} (w_f^{\mathrm{LD}} l_f^{\mathrm{LD}} + w_f^{\mathrm{AL}} l_f^{\mathrm{AL}}) + w^{\mathrm{M}} l^{\mathrm{M}}$$

where f = S, T, G, L or C denotes the spring survey, trawl, gillnet and longline fleets respectively (See subsection and w's are the weights assigned to each likelihood components.

The weights, w_i, are necessary for several reasons. First of all it is used to prevent some components from dominating the likelihood function. Another would be to reduce the effect of low quality data. It can be used as an a priori estimates of the variance in each subset of the data.

Assigning likelihood weights is not a trivial matter, has in the past been the most time consuming part of a Gadget model. Commonly this has been done using some form of 'expert judgement'. General heuristics have recently been developed to estimate these weights objectively. Here the iterative re-weighting heuristic introduced by Stefansson (2003), and subsequently implemented in Taylor (2007}, is used.

The general idea behind the iterative re-weighing is to assign the inverse variance of the fitted residuals as component weights. The variances, and hence the final weights, are calculated according the following algorithm:

1) Calculate the initial sums of squares (SS) given the initial parametrization for all likelihood components. Assign the inverse SS as the initial weight for all likelihood components.
2) For each likelihood component, do an optimization run with the initial SS for that component set to 10 000. Then estimate the residual variance using the resulting SS of that component divided by the degrees of freedom (df*), i.e. $\hat{\sigma}^2 = \frac{SS}{df\,*}$.
3) After the optimization set the final weight for that all components as the inverse of the estimated variance from the step above (weight =1/$\hat{\sigma}^2$).

The number of non-zero data-points (*df**) is used as a proxy for the degrees of freedom. While this may be a satisfactory proxy for larger datasets it could be a gross overestimate of the degrees of freedom for smaller datasets. In particular, if the survey indices are weighed on their own while the yearly recruitment is estimated they could be over-fitted. In general, problem such as these can be solved with component grouping that is in step 2 the likelihood components that should behave similarly, such as survey indices representing similar age ranges, should be heavily weighted and optimized together. In the ling model this kind of grouping is used.

Optimisation

The model has three alternative optimising algorithms linked to it, a wide area search **simulated annealing** (Corana *et al*., 1987), a local search **Hooke and Jeeves algorithm** (Hooke and Jeeves, 1961) and finally one based on the Boyden-Fletcher-Goldfarb-Shanno algorithm 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 optimisation 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 algorithm 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 step-wise search of Hooke and Jeeves and may therefore give a more accurate estimation of the optimum. The BFGS algorithm used in Gadget is derived from that presented by Bertsekas (1999).

The model is able to use all three algorithms in a single optimisation run, attempting to utilise 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 optimisation. This procedure is repeated several times to attempt to avoid converging to a local optimum.

The total objective function to be minimised is a weighted sum of the different components. 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 optimisation was started with simulated annealing to make the results less sensitive to the initial (starting) values and then the optimisation was changed to Hooke and Jeeves when the 'optimum' was approached and then finally the BFGS was run in the end.

Model settings

Population is defined by 1 cm length groups, from 20–180 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 0.15 $year^{-1}$.

The commercial landings are modelled as three fleets, longline, trawl and gillnet, starting in 1982 with a selection patterns 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, except the smallest 20–50 cm and the largest 90–180 cm) from the Icelandic groundfish survey in March 1985–onwards.
- Length distribution from the Icelandic commercial catch since 1982. The sampling effort was though relatively limited until the 1990s.
- Landings data divided into four month periods per year (quarters).
- Age–length data from the survey and from the commercial fleets.

Description	period	by quarter	area	Likelihood component
Length distribution of landings Longline, trawl, gillnet	1982+	All	Iceland	ldist.catch
Length distribution of Icelandic GFS	1985+	1st quarter	Iceland	ldist.survey
Abundace index of Icelandic GFS of 20–49 cm individuals	1985+	1st quarter	Iceland	si2049
Abundace index of Icelandic GFS of 50–69 cm individuals	1985+	1st quarter	Iceland	Si5069
Abundace index of Icelandic GFS of 70–180 cm individuals	1985+	1st quarter	Iceland	Si70180
Age–length key of the landings	See stock section	All	Iceland	alkeys.longline, alkeys.trawl, alkeys.gillnet
Age–length key of the Icelandic GFS	See stock section	1st quarter	Iceland	alkeys.survey

Description of the likelihood components weighting procedure

Component	Description	Group	Quarters	Type
Bounds	Keeps estimates inside bounds	NA	All	8
Understocking	Makes sure there is enough biomass	NA	All	2
Si2049	Survey Index 20–39 cm	Sind	1	1
Si5079	Survey Index 40–59 cm	Sind	1	1
Si70180	Survey Index 60–100 cm	Sind	1	1
Ldist.survey	Length distribution from the spring survey	Survey	1	3
Alkeys.survey	Age–length data from the spring survey	Survey	1	3
Alkeys.longline	Age–length data from the longline fleet	Longline	All	3
Ldist.longline	Length distribution the longline fleet	Longline	All	3
Alkeys.trawl	Age–length data from the trawl fleet	Comm	All	3
Ldist.trawl	Length distribution the trawl fleet	Comm.	All	3
Alkeys.gillnet	Age–length data from the gillnet fleet	Comm	All	3
Ldist.gillnet	Length distribution the gillnet fleet	Comm	All	3

The parameters estimated are:

- The number of fish by age when simulation starts (ages 3 to 12) - 9 parameters. Older ages are assumed to be a fraction of age 12;
- Recruitment each year (1982 and onwards);
- Parameters in the growth equation; Linf is constant at 200 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) 2 parameters;
- The selection pattern of:
    - Separate selection curve (logistic) for the commercial fleets (longline, trawl and gillnet) -6 parameters.
    - Icelandic Spring survey - 2 parameters (logistic curve).

D. Short-term projection

Short-term forecasts for ling in Va can be done in gadget using the settings described below.

Model used: Gadget: Age–length forward projection

Software used: GADGET (script: run.sh)

Initial stock size: abundance-at-age and mean length for ages 3 to 20+

Maturity: Fixed maturity ogive, estimated outside of the model

F and M before spawning: NA

Weight-at-age in the stock: modelled in GADGET with VB parameters and length–weight relationship that is estimated outside of the model.

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. Fleet proportions set as last three years average

Intermediate year assumptions: Catch in first quarter known, catches in quarters 2, 3 and 4 assumed to be equal to last years.

Stock–recruitment model used: Mean of last three years. As recruitment is estimated at age three in the assessment but ling does not appear in the catches until the age of 5 the recruitment assumptions are not important.

Procedures used for splitting projected catches: driven by selection functions and provide by GADGET. Fleet proportions set as last three years average.

E. Medium-term projections

Short-term forecasts for ling in Va can be done in gadget using the settings described below.

Model used: Gadget: Age–length forward projection

Software used: GADGET (script: run.sh)

Initial stock size: abundance-at-age and mean length for ages 3 to 20+

Maturity: Fixed maturity ogive, estimated outside of the model

F and M before spawning: NA

Weight-at-age in the stock: modelled in GADGET with VB parameters and length–weight relationship that is estimated outside of the model.

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. Fleet proportions set as last three years average

Intermediate year assumptions: Catch in first quarter known, catches in quarters 2, 3 and 4 assumed to be equal to last years.

Stock–recruitment model used: Mean of last three years.

Procedures used for splitting projected catches: driven by selection functions and provide by GADGET. Fleet proportions set as last three years average.

Uncertainty models used:

To estimate the uncertainty in the model parameters and derived quantities a specialised bootstrap for disparate datasets is used. The approach is based on spatial subdivisions that can be considered to be i.i.d. Refer to Elvarsson (2014) for further details. The bootstrapping approach consists of the following:

- The base data are stored in a standardized database:
  - Time aggregation: 3 months
  - Spatial aggregation: subdivision
  - Further dis-aggregation is based on a range of categories including fishing gear, fishing vessel class, sampling type (e.g. harbour, sea and survey).
- To bootstrap the data, the list of subdivisions, depicted in figure E1, required for the model is sampled (with replacement) and stored. For a multi-area model one would conduct the re-sampling of subdivisions within each area of the model.
- The list of re-sampled subdivisions is then used to extract data (with replacement so the same dataset may be repeated several times in a given bootstrap sample).
- For a single bootstrap Gadget model, the same list of re-sampled subdivisions is used to extract each likelihood dataset i.e. length distributions, survey indices and age–length frequencies are extracted from the same spatial definition.
- A Gadget model is fitted to the extracted bootstrap dataset using the estimation procedure described above.
- The re-sampling process is repeated until the desired number of bootstrap samples are extracted, which in this case the total sample size is 100.

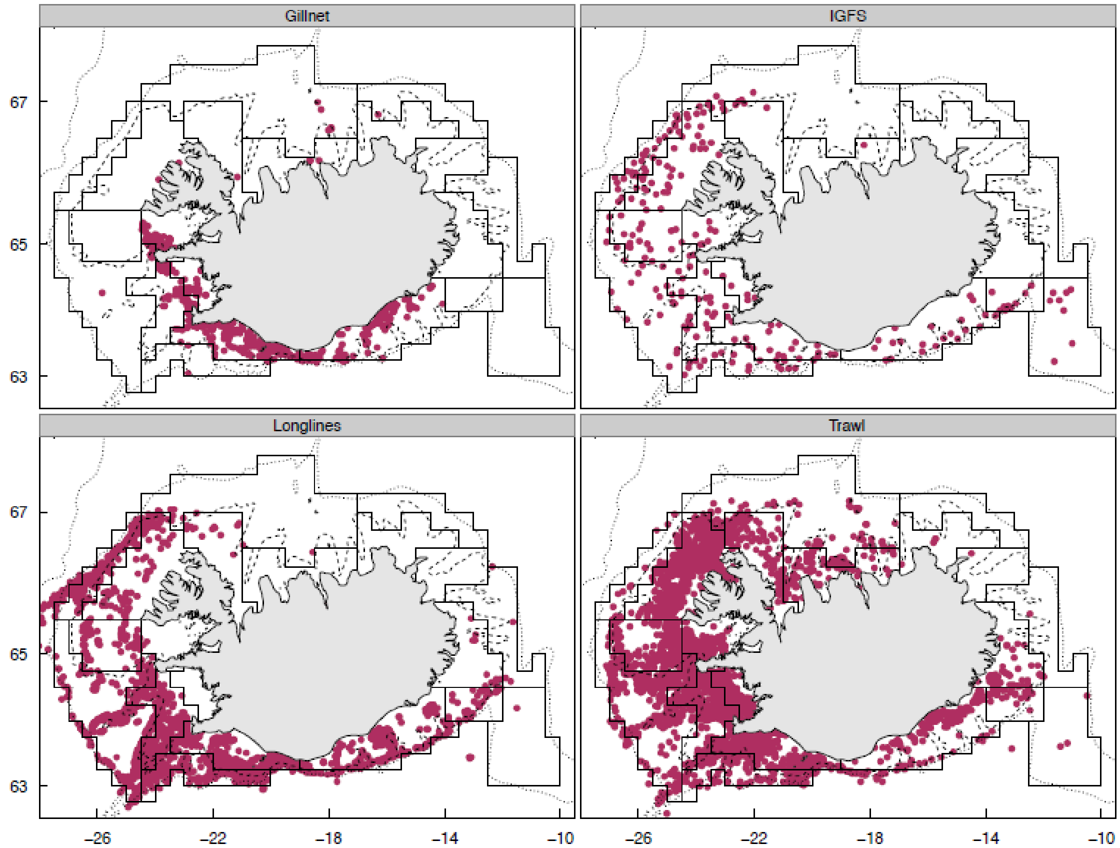

Figure E1. Locations of ling catches in Va in 2012 by commercial and survey fleets relative to the spatial subdivisions on the Icelandic continental shelf.

When re-sampling, data are forced to remain in the correct year and time-step so re-sampling is based on sampling spatially the elementary data units within a given modelled unit of time and space. Thus, within a modelled spatial unit the bootstrap is a re-sampling of subdivisions. This implicitly assumes data contained within each area of the model to be independent and identically distributed. Independence is justified by the definition of subdivisions. Furthermore treating them as they were from the same distribution, i.e. bootstrap replicates, appears to have little negative effect when compared to more traditional methods (Taylor, 2002).

The entire estimation procedure is repeated for each bootstrap sample. In particular, since the estimation procedure includes an iterative re-weighting scheme, this re-weighting is repeated for every bootstrap sample. The point of this is that the bootstrap procedure is no longer conditional on the weights. The procedure as a whole is quite computationally intensive but can easily be run in parallel, e.g. on a computer cluster.

In stark contrast to this, Hessian-based approaches usually only compute the Hessian at the final solution. Thus, they completely omit the effect of re-weighting likelihood components when estimating uncertainty. Such methods are thus conditional on the weights obtained in a pre-estimation stage.

F. Long-term projections

Model used: Gadget

Software used: Gadget

Yield per recruit analysis

Commonly an analysis of the yield per recruit is being used to derive an approximate value for F_{MSY}. Yield-per-recruit is calculated by following one year class 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 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. In general YPR-curves estimated as in Gadget give a more conservative estimates (lower) of $F_{0.1}$ and F_{MAX}. One thing worth noting is the fact that F_{MAX} is generally at least F_{MSY}.

To estimate F_{MSY} the stock status was projected forward by 100 years under varying fishing mortalities. For each bootstrap model estimate (See Section E in this Annex) the stock status is projected ten times, resulting in a total of 1000 samples. Recruitment is calculated by a AR(1) model based on estimates of autocorrelation in recruitment between 1982–2003. Using this period is deemed more conservative as the recent spike in recruitment in 2004–2010 may have been a one off. The variation in recruitment was modelled as an autoregressive process with lag 1:

$$\bar{R}_y = \bar{R}_{y-1} + \epsilon_y$$

where ε_y is a mean zero gaussian with variance σ^2.

From the simulation annual total landings ${}^{F}l_y$ by F were calculated after the 100 years. This is done to ensure that the stock has reached an equilibrium under the new fishing mortality regime. Average annual landings and 95% quantiles were used to determine the yield by F.

G. Biological reference points

	Type	Value	Technical basis
MSY	**MSY $B_{trigger}$**	**9500 t**	**As B_{pa}**
Approach	**F_{MSY}**	**0.24**	**Based on long-term projections**
	B_{lim}	**8100 t**	**Lowest estimated SSB in the time-series**
Precautionary	**B_{pa}**	**9500 t**	**As 97.5% quantile of B_{lim}**
Approach	**F_{lim}**	**NA**	**Explain**
	F_{pa}	**NA**	**Explain**

At WKDEEP-2014 a forward stochastic simulations were presented. In the simulations annual total landings ${}^{F}l_y$ by F were calculated after 100 years. This is done to ensure that the stock had reached an equilibrium under the new fishing mortality regime. Average annual landings and 95% quantiles were used to determine the yield by *F*. The equilibrium yield curve is shown in figure G1, where the maximum yield, under the recruitment assumptions, is 5.306 thousand tons with a 95% interval of 4.776 and 6.059 thousand tons.

F_{MSY} was estimated to be 0.24, with a 95% confidence interval of 0.22 to 0.28. For comparison the median value for F_{MAX} from a yield per recruit analysis is 0.25 while the confidence interval is the same. Equilibrium spawning–stock biomass is shown in Figure G2. The spawning stock at MSY, B_{MSY}, is estimated at 29.959 thousand tons at F=0.24 with an upper quantile of 32.408 thousand tons and lower quantile of 18.801 thousand tons. It was proposed that B_{PA} was set as the 97.5% quantile of the bootstrap estimates of B_{lim} (lowest estimated SSB) and then to set B_{PA} as $B_{Trigger}$. Blim is estimated as 8.1 kt and B_{PA}/$B_{Trigger}$ as 9.5 kt.

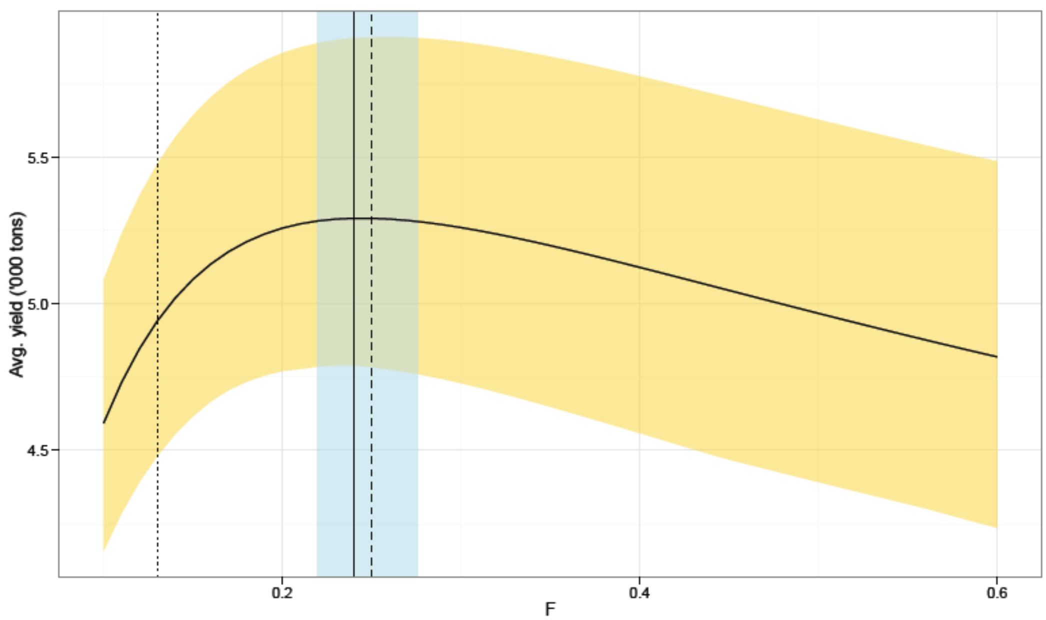

Figure G1. Equilibrium catch curve for ling in Va as a function of *F*. Solid black line indicate the equilibrium catch, solid horizontal line the F_{MSY}, broken horizontal line the median F_{MAX}, yellow the 95% confidence region for the catch and light blue region the 95% confidence region for F_{MSY}.

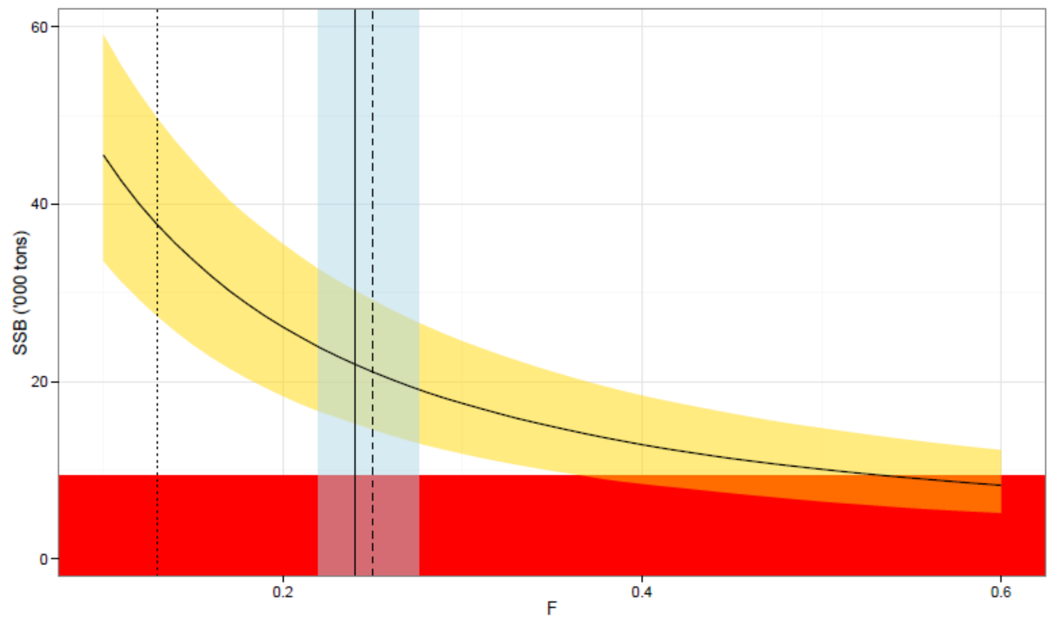

Figure G2. Equilibrium spawning–stock biomass as a function of *F*. Solid black line indicate the equilibrium biomass, solid horizontal line the F_{MSY}, broken horizontal line the median F_{MAX}, yellow the 95% confidence region for the biomass and light blue region the 95% confidence region for F_{MSY}. Red area is B_{PA} ($B_{Trigger}$)

H. Other issues

H.1. Historical overview of previous assessment methods

Before 2007 ling in the NE-Atlantic was assessed as a single management unit.

Between 2007 to 2012 ling in Va was assessed based on trends in survey indices from the Icelandic spring and autumn survey. Supplementary information included relevant information from the fishery such as length distributions, maturity data, effort, cpue and analysis of changes in spatial and temporal distribution.

In 2012 the stock was assessed as a category 3 stock in the ICES-DLS framework and the basis for the ICES advice was

$$F_{proxy} = \frac{Yield}{Index}$$

The rationale for the advice was: For this stock the F_{proxy} of 1.5 is applied as a factor of the average of the most recent survey biomass estimates (average of 2011 and 2012), resulting in catch advice of no more than 12 000 t. i.e. to base the catches in 2013 and 2014 on 1.5 the survey biomass in 2012.

I. References

Stock Annex 5.2: Blue ling in Va and XIV

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Blue ling in Va and XIV
Working Group	WGDEEP
Date	March 2011
Revised by	(WGDEEP-2011 / 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 north-western waters. This increase is likely to be the result of increased availability of blue ling in the north-western 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 by-catch 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 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 un-fished 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.

In 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 are 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				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 gram). 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 un-gutted, the un-gutted 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 are 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 for 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 utumn 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, are 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 in the survey series, particularly in the early years.

I. References

Stock Annex 5.3: Blue ling in Vb, VI and VII

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Blue ling (*Molva dypterygia*) in ICES Division Vb and Subareas VI and VII.
Working Group	WGDEEP
Date	March 2014
Revised by	WKDEEP 2014 / P. Lorance.

A. General

A.1. Stock definition

Based upon biological investigations in the early 1980s it was suggested that at least two adult stock components were found in the Northeast Atlantic, 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. This was considered supported by differences in length and age structures between areas as well as in growth and maturity (Magnússon and Magnússon, 1995). Egg and larval data from early studies also suggested the existence of many spawning grounds in ICES Division Va, Vb and Subarea VI and elsewhere and were considered suggesting further stock separation. However, in most areas, except Icelandic waters, small blue ling below 60 cm do not occur and fish appear in surveys and commercial catches at 60–80 cm suggesting large-scale spatial migrations and therefore limited population structuring. Differences in length-at-age were also reported but these may have come from different interpretations of growth rings in otoliths and the slower growth in Icelandic waters compared to the Faroes and Shetland areas is challenged by the comparison of recent length-at-age of blue ling from areas Vb, VI and VII and mean length-at-age in Icelandic waters estimated in the 1980s. Further recent length-at-age estimates of blue ling from Icelandic waters did not compare well with previous data so that the biological support for stock separation used in the past in questionable.

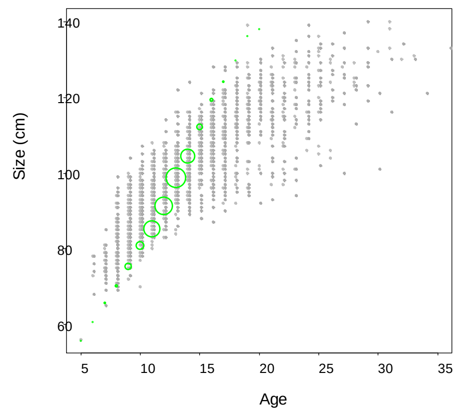

Figure 1. Age–length-key from French age estimates (years 2009–2013 combined, n=2222), compared to mean length-at-age estimated in Icelandic waters in the early 1980s (green circles, the diameter of circle in proportion to the number of fish, n=994, redrawn from Magnússon and Magnússon (1995).

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 in low numbers. These could be used for age and growth estimation purposes (Magnussen, 2007). However numbers caught in Faeroese trawl surveys do not seem significant to the size of the exploited adult stock. Further, unlike in Icelandic waters where small blue ling are caught in shallow (100 m or less waters) and blue ling of than 60 cm caught along the upper slope make in some years more than half the total number caught in trawl surveys, blue ling is almost not caught shallower than 200 m in Faroese waters (Figure 2).

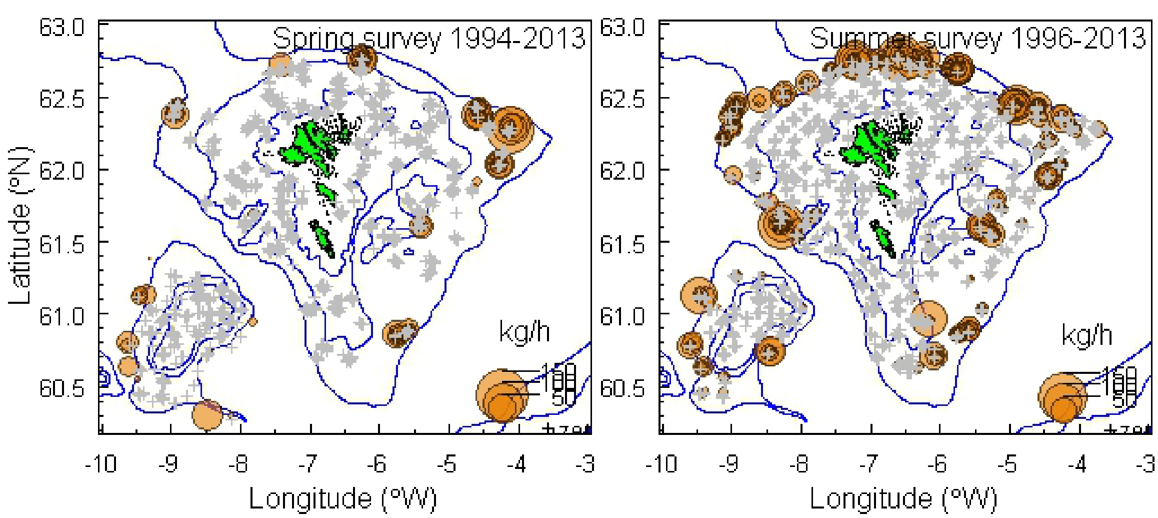

Figure 2. Spatial distribution of blue ling caught in the Faroese spring and summer surveys, depth contours are 100, 200 and 500 m (Ofstad, 2013)

Similarly, the neighbouring ICES Division XIIb, from where landings have been less than 100 tonnes to a few hundred tonnes in recent years but have been higher in the past, only adult fish are known to be caught and as the western Hatton Bank in XIIb is the continuation to the west of the Bank located in VIb, ICES Division XIIb should be considered as the same stock as blue ling in Vb, VI and VII.

As a consequence the identity of biological populations deserves being clarified but this does not precludes blue ling for ICES Subareas VI and VII and Division Vb (and possibly XIIb) to be assessed as a stock unit. In this unit fish recruit to the fishery mostly at an age of 8 and 9 and there is no indication that adult blue ling further emigrates from the area. Therefore the stock assessment based on catch curve of adult fish, estimation of recruitment at age 8–9 and modelisation of the dynamics of adult fish is fully appropriate.

Spawning areas

Blue ling spawning occurs (i) in Vb, on the southern and southwestern margins of Lousy Bank;(ii) in VIa along the continental slope northwest of Scotland and close to of Rosemary Bank; (iii) in VIb on the margins of Hatton Bank (Figure 3) and is considered to take place at depths of 730–1100 m between March and May inclusive in Vb and VIa, and during March and April in VIb. From 1970 to 1990, the bulk of the fishery for blue ling was seasonal fisheries targeting these aggregations. To prevent depletion of the adult population temporal closures were introduced by the EC in 2009 within ICES Division VIa.

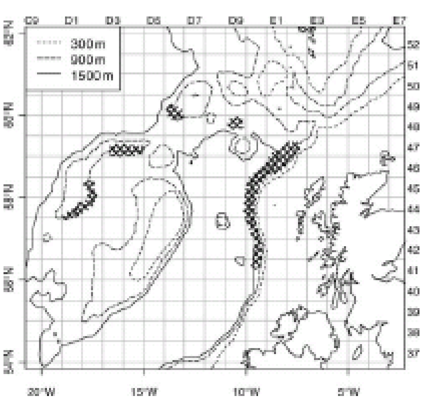

Figure 3. Known spawning areas of blue ling to the west of Scotland (from Large *et al*., 2010).

It is probably useful to note also here that blue ling spawning might occur in the Norwegian deep (considered as a different stock unit for assessment purposes), but also in this area juveniles are not found to any significant level (Bergstad, 1991).

A.2. Fishery

The main fisheries are those by Faroese trawlers in Vb and French trawlers in VI, mostly VIa, 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 (i.) the Norwegian longline fishery for ling and tusk where blue ling is a bycatch and (ii.) Scottish trawlers. Landings from these fleets have been small since the 2000s.

Scottish trawlers landed the species mainly from the mid-1990s to early 2000s when their landings exceeded 1000 t/year. German vessels fished 1000 to 7000 t/year from the late 1960s to early 1980s. Norwegian landings were also up to 4000 t in 1973 but have decreased to less than 100 tonnes after 2000.

Landings from Subareas VIII and IX previously reported as blue ling are now ascribed to the closely related Spanish ling (*Molva macrophthalma*) 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 ICES Division Vb and Subarea VI. However, in recent years blue ling has been taken mainly in a mixed French trawl fishery for roundnose grenadier, black scabbardfish and blue ling. This fishery is further mixed with fishing for shelf species such as saithe, hake, monkfish and megrim.

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 North Western 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 reported landings of blue ling and ling combined.

Landings data by ICES statistical rectangles have been provided by France, UK(Scotland), UK(England and Wales), Spain (Basque country fleet fishing along the continental slope to the West of the British Isles) 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.

B.2. Biological

Available growth parameter in length and weight for blue ling are summarized in Tables 1 and 2 and maturity parameters in Table 3. Estimated length–weight relationships are given in Table 4.

Table 1. Growth parameters and other age-at size data of blue ling, all areas of the Northeast Atlantic.

L_∞ (cm)	k(y^{-1})	t_0	Number of fish	Age range	Sex	Size range	Modal size	Area	Reference
133	0.089	-2.39	2222	7-36	Combined	56–140		ICES VIa	French DCF data 2009-13
160	0.11	N/A	79	3-17	Combined	35–135		Faroe Bank	Magnussen, 2007
165.8	0.084	-0.138	N/A	7 - 20	Female	72–147		ICES VIa	Moguedet, 1985, 1988
112.2	0.158	0.318	N/A	7 - 19	Male	75–110		ICES VIa	(1)
125	0.152	1.559	2619	5-25 (2)	Combined	-	90–100 (2)	Vb VIa,b	
145.2	0.155	1.281	1412	4-28 (3)	Female	39–136		Vb VIa,b	Ehrich and Reinsch, 1985
109.7	0.199	1.833	1391	4-22 (3)	Males	41–108		Vb VIa,b	(3)
116.25	0.17	0.57	590	5-20+	Female	-130		Faroe Islands (4)	
104.2	0.197	0.57	331	5-20+	Male	-107		Faroe Islands (4)	
137.37	0.13	0.46	117	6-18+	Female	-139		Shetland Islands (4)	Thomas, 1987
108.31	0.185	0.57	227	5-20+	Male	-109		Shetland Islands (4)	
			563	20 +	Female	-138.5		Icelandic slope	
			431	17	Male	-115		Icelandic slope	
			1492	20+ (5)	Combined	-137.86 (6)		Icelandic slope	
			?	?	Combined	-150 (7)		Iceland and RR (8)	Magnússon and Magnússon, 1995

L_∞ (cm)	$k(y^{-1})$	t_0	Number of fish	Age range	Sex	Size range	Modal size	Area	Reference
			?	?	Female	-140		Spawning aggreg. RR (8)	
			?	?	Male	-124		Spawning aggreg. RR (8)	
			1399		Combined	35–135 (9)	95–100 (9)	West of the British Isles	Bridger, 1978
					Female	40–140 (10)	120 (10)	West of the British Isles	Ehrich, 1983
					Males	20–115 (10)	95 (10)	West of the British Isles	
			240 (♂+♀)		Female	60–155 (11)	105–110 (11)	West of the British Isles	Gordon and Hunter, 1994
			240 (♂+♀)		Male	70–120 (11)	95–100 (11)	West of the British Isles	Gordon and Hunter, 1994
			197	2–20+ (12)	Combined	-140		Norwegian Deep	Bergstad, 1991

(1) from sampling in 1984–1985; Female>= 130 cm were 3% of total female numbers, minimum size in sample taken for figures in Moguedet (1985); (2) from commercial landings in 1980–1983, the bulk of individual were in age groups 7–20; (3) from surveys; (4) based upon sampling in 1977 and 1979 (Shetland Islands) and 1977 and 1978 (Faroe Islands); areas are defined according to Figure 1 (Thomas,1987); (5) Magnússon and Magnússon (1995) reported mean length by age for the years 1978–1982. In their sample (n=1492), there were seven fish of the age group 20+; (6) mean length of the oldest age group: 6 females and 1 male; (7) visually from length distribution plots; few fish above 130 cm; (8) RR: Reykjanes Ridge; (9) from a plot of length distribution by 5 cm length classes; (10) from plot; (11) from plot by 5 cm classes from SAMS surveys (unpublished data), small number of unsexed individual below 60 cm; (12) more than 20% of 20+.

Table 2. Growth parameters in weight.

W_∞ (g)	K	t_0	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 3. 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".

Table 4. Coefficient a and b of weight–length relationship $W=a*L^b$ for blue ling.

Area	Sex	a	b	Number of fish	size range (cm)	Weight range (g)	Reference
ICES VI	Combined	0.00191	3.14882	280	62–142		Dorel, 1986
	Combined	0.0008748	3.3199	726	~ 30–135		Ehrich and Reinsch, 1985
	Combined	0.0016	3.273	644	~ 83–125		Thomas, 1987
ICES VI	Males	0.002	3.02	NA	69–109	715–2900	Moguedet, 1988
	Females	0.0023	3.00	NA	74–142	1150–8600	
ICES Vb	Combined	0.00184	3.188	3057	25-146	55 - 12200	Ofstad, 2013

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 ling was carried out in the past and was disrupted because consistency between readers was considered poor. 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. Age estimation of blue ling sampled from French landings was resumed in 2009 in application of DCF. Reading scheme for estimating the age of blue ling does not significantly differ for that of most gadoid species although the number of growth increments to count is higher (Figure 4). The protocols for treating otoliths estimating age of blue ling were reviewed by WKAMDEEP 2013. Nevertheless, age estimations for this species are unvalidated.

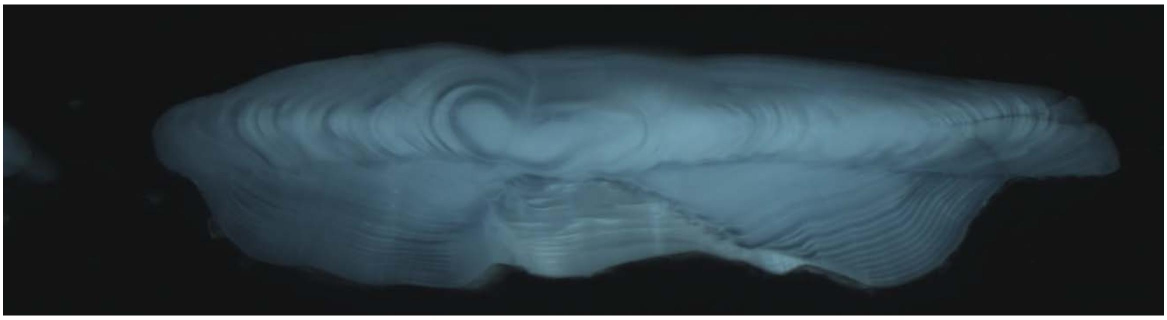

Figure 4. Thin sections of blue ling otolith.

B.2.2 Weight-at-age

No time-series but overall weight-at-age are derived from age–length keys and length–weight relationships.

B.2.3. Maturity and natural mortality

Previously, natural mortality (M). was estimated using the relationship (Annala, J. H., Sullivan, K. J. (1996):

M = ln(100)/maximum age

In this relationship, the maximum age should be set at the age where 1% of a year class is still alive. Age data from the 1980s to 2000s did not include estimated age over 28 years (Table 1). Considering a maximum age of 30 years M was estimated in recent years in the order of 0.15. A small proportion of individual was estimated to reach older ages in French age samples from 2009 to 2013.

Hewitt and Hoenig, (2005) recommended a regression estimator based upon the relationship between M and the observed maximum age for 134 stocks of 79 species to be used instead of the maximum age method. The relationship derived from this empirical regression is:

$$\ln(\hat{M}) = 1.44 - 0.982 \cdot \ln(t_{\max})$$

Where $\hat{M}$ is the estimated natural mortality and t_{MAX} is the observed maximum age, i.e. not the age at which a given proportion of the stock survives.

Using recent data, where older ages than in previous samples were found, t_{MAX} was estimated 36 (one individual over 222 aged fish), which implies $\hat{M} = 0.125$. The empirical relationship from Pauly (1980) was applied by WKLIFE with growth parameters K=0.152 and L_∞.= 125 for both sex combined (Ehrich and Reinsch, 1985) and further using growth estimates from French sampling. *M* estimates from various method are summarised in Table 5.

Table 5. Blue ling natural mortality derived from different life-history correlates and datasets.

Method	Input parameters	Reference	*M* estimate
Hewitt and Hoenig (2005)	T_{MAX}=36	Table 1, French DCF data	0.13
Hewitt and Hoenig (2005)	T_{MAX}=25	Table 1, age estimates from the 1980s	0.18
Pauly (1980)	L_∞=125 cm k=0.152 y^{-1} T=9°C	Table 1, Ehrich and Reinsch (1985)	0.21
Pauly (1980)	L_∞=140 cm k=0.13 y^{-1} T=9°C	Parameters used by WKLIFE (2012)	0.18
Pauly (1980)	L_∞=133 cm k=0.089 y^{-1} T=9°C	Table 1, French DCF data	0.14

Juvenile blue ling are not known to occur in Divisions Vb and Subareas VI and VII to any significant level. Fish recruit to this area and to the spawning stock at an age of seven to nine years. All blue ling occurring in Vb, VI and VII can be considered as mature fish.

B.3. Surveys

Indices of abundance and biomass are available from the spring and summer Faroese bottom-trawl surveys. These surveys are stratified random sampling plans and indices used for blue ling are design-based. The Faroese groundfish surveys are mainly targeting cod, haddock and saithe. The survey has fixed stations. The shallowest are at about 60–70 m depth and the deepest at about 510 m. The stations are distributed in fixed strata; each stratum placed after the 100, 200 and 500 m depth contours (Figure 6). The spring survey in February/March has 100 stations (1994–present) and the summer survey in August has 200 stations (1996–present). In addition to abundance and biomass indices, number and number per hour are provided for small (<80 cm) and large (>80 cm) blue ling. It is stressed that these surveys are limited to depth shallower than 500 m. The biomass index used in the SRA model (see below) is the standardised index for all haul deeper than 200 m.

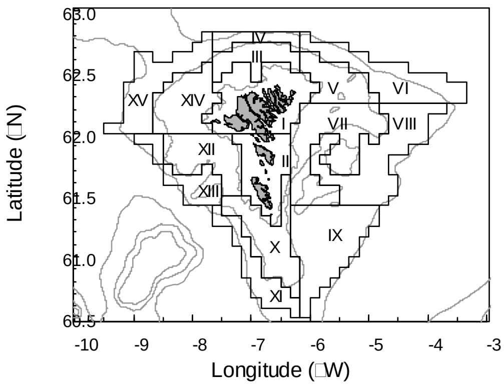

Figure 6. Stratification of the Faroe Plateau in the groundfish surveys.

An index of abundance in number and weight per hour is available from the Scottish deep-water trawl survey carried out on Marine Scotland's FRV Scotia, to the west of Scotland. 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 since 1998. This has focussed 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 indices of abundance and biomass of blue ling. Locations of trawl sites between depths of 500–1500 m are shown in Figure 7. From 1998 to 2008 the bottom trawl was rigged with 21" rock-hopper ground gear, however in 2009, a switch was made to lighter ground gear, with 16" bobbins. This survey was not carried out in 1999, 2001, 2003 and 2010. The abundance and biomass indices for blue ling are based upon hauls of depths > 400 m and <1600 m (considered to be core depth range of blue ling). Haul from this depth range with zero catch of blue ling are included. The indices are calculated as mean number and weight (kg) per hour trawling.

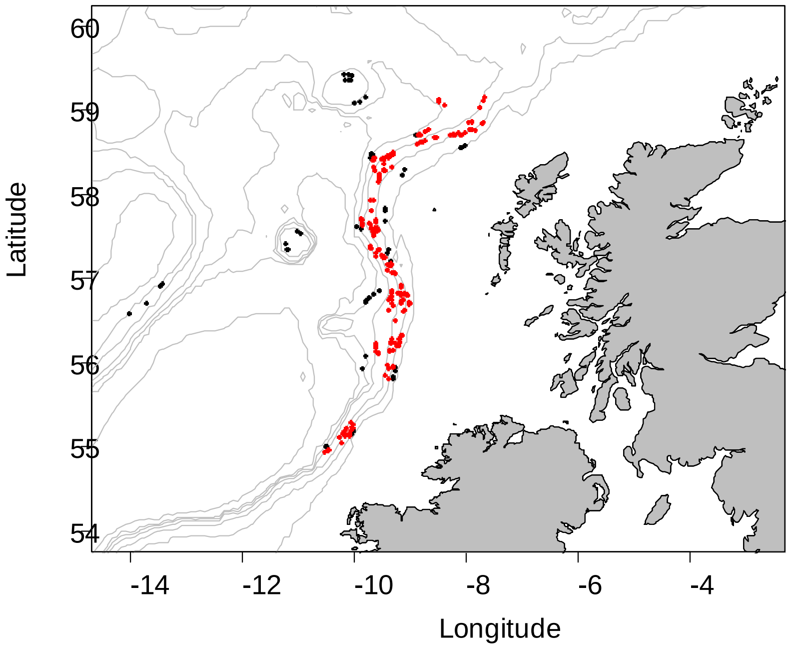

Figure 7. Sites of valid hauls in the 500–1500 m depth band in the Scottish Deep-water Survey dataset, 1998–2009 (in red). Valid hauls at other depths are shown in black.

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 standardised 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 surveys 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 used 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 on 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.

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 8). Fishing area definition was based on a working paper presented at WGDEEP 2006 on analysis of logbook data. In this working document fishing grounds, exploited since the 1990s were denoted ref5 (for reference 5), edge6 (for edge of continental slope) and other6 (for other fishing grounds in VI. New fishing grounds, i.e. not fished by French trawlers before 2000 in ICES Division Vb and Subareas VI were denoted new5 and new6 respectively (Figure 8).

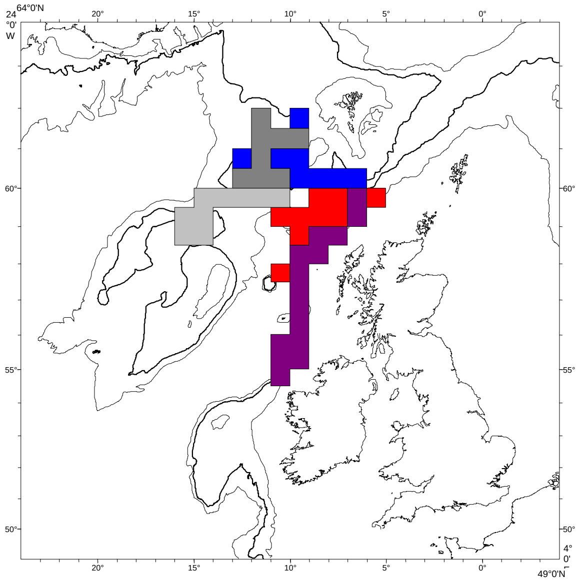

Figure 8. Areas (clusters of statistical rectangles) used to calculate French lpue for blue ling. Dark grey, new grounds in ICES Division Vb (new5); light grey, new grounds in Subarea VI (new6); red, others in Subarea VI (other6); purple, edge in VI (edge6); blue, reference in Division Vb (ref5).

The GAM model used to standardize the haul-by-haul catch data 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 is 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 is 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 μ and variance $\phi\mu^p$, where ϕ 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=1.3 provided the best fit (Lorance *et al.*, 2010).

In 2009, the model fit was restricted to haul durations from 60 to 300 minutes and depth 200–1100 m covering depth where the species is mostly fished and excluding too short and long hauls for which there are a few data. This lpue standardisation method allowed estimating lpue time-trends for the five small areas. The model provided lpue time-trends for the five areas. To derive standardized estimates for the whole study zone, lpue values are predicted for January, for all rectangles in each area (using the average haul depth in each rectangle), a 5-h haul duration, and a vessel that operated during the whole period as prediction variables. Predictions for the entire study zone are then derived as the weighted average of the five area (rectangle average) estimates, with the weights being the number of rectangles in each area (Lorance *et al.*, 2010).

Over time, changes have occurred in the fishery: protection areas for blue ling spawning were introduced in 2009. As these limited the possibility for fishing for blue ling in these areas, hauls carried out in these areas throughout the whole time-series were excluded for lpue calculation in subsequent years. Further, the small areas new5 and new6 have not been not fished after 2011 by vessels contributing to the tallybooks. As a result, the index was based upon the catch in three areas only. The depth and haul duration range was adjusted to reduce the confidence limits of the estimated. Depth range of 500–1200 m and duration of 120–480 minutes were used. These changes impacted little the estimates but reduced the confidence limits.

A standardized index of biomass was also calculated from the Faroese fleet data. The cpue in $kg.h^{-1}$ are based upon subset of the commercial vessels: all available logbooks from 6–8 otter-board trawlers mainly fishing in deep water, 4–8 pair trawlers fishing on the slope from about 150 m and 4–5 longliners (GRT >110). A general linear model (GLM) was used to standardize the cpue, the explanatory variables were: vessel (or pair identifier for the pair trawlers), season ass set of three months (January–April, May–August, September–December), fishing area (Vb1, Vb2) and year. The dependent variable was the log-transformed cpue in $kg.h^{-1}$ per haul or longline. The resulting estimate was back transformed to the original unit ($kg.h^{-1}$).

B.5. Other relevant data

No other relevant data.

C. Assessment: data and method

This stock has been benchmarked in 2014 (WKDEEP, 2014).Two assessment methods are used for this stock. A model call multi-year catch curve (MYCC) which is a random effects population dynamics model based on proportion-at-age and removal is used to estimate the total mortality. An age-structured Stock Reduction Analysis (SRA) is used to assess the trajectory in the population biomass over the catch history starting from 1966. International landings were small before the early 1970s so the biomass in the 1960s can be considered at or close to unexploited levels.

Multi-year catch curve

The multi-year 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.

The population dynamics in numbers are modelled as:

$$N_{a,t} = N_{a-1,t-1}e^{-Z_{t-1}} \qquad a_r \le a \le A_+ \qquad t = 1.........T \qquad (1)$$

$$N_{A_+,t} = (N_{A_+-1,t-1} + N_{A_+,t-1})e^{-Z_{t-1}} \qquad (2)$$

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 log-normal distribution.

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

where μ_R is the mean recruitment and σ_R the standard deviation. For ease of interpretation, the coefficient of variation (CV_R) instead of σ_R was calculated making use of the fact that $var(ln(x)) \approx ln(CV(x)^2+1)$. Recruitment is treated as a random effect in model fitting.

Annual total mortality Zt is modelled by a random effect using a random walk over time:

$$Z_t = Z_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim \mathrm{N}(0,\sigma_Z) \qquad t = 1\ldots\ldots T \tag{4}$$

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

$$N_{a,1} = e^{(a_r - a)Z_0} R_{a_r+1-a} \qquad a_r < a \le A_+ \tag{5}$$

where F_0 is constant historic fishing mortality.

The initial numbers in the plus group $N_{A+,1}$ are estimated by an infinite sum over previous years.

The observation model has two parts, the first one for population numbers-at-age $Y_{a,t}$ and the second for total catch in numbers. Numbers-at-age, assumed to follow a multinomial distribution

$$Y_{a,t} \sim \mathrm{Multinom}(\mathrm{p}_{a,t}, m_t) \qquad a_r \le a \le A_+ \qquad t = 1\ldots\ldots T \tag{6}$$

where $p_{a,t}$ are proportions-at-age and m_t is the effective sample size in year t. 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). As a result the observed variability is much larger than would be expected given the number of measurements. Therefore the effective sample size was estimated from the sampling data using a Dirichlet-multinomial distribution and the dirmult package in R by Twedebrink (2009).

The second observation model for the total catch (in numbers) is assumed to follow a Gamma distribution with parameters α and β.

$$Ct \sim \mathrm{Gamma}(\alpha,\beta) \tag{7}$$

$$E[C_t] = (\frac{Z_t - M}{Z_t})(1 - e^{-Z_t})\sum N_{a,t} \tag{8}$$

The coefficient of variation (CV_c) of the Gamma distribution is related to the α parameter as CVc=1/sqrt(α) and $\beta = \alpha / E[Ct]$. The model is parameterised in terms of CVc.

Not all model parameters **θ**={Z_0,..., Z_t, M, F_0, μ_R, σ_R, $N_{A+,1}$, CV_R, CVc} can be estimated and some need to be fixed. The fixed parameters where set as follows:

-natural mortality M=0.18

-coefficient of variation of landings or catch (*CVc*=0.05) to allow for some misreporting

Estimation of free model parameters **θ i**s 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_θ (**y** | **u,v**) where $\boldsymbol{u}$ = ($R1,...,\ Rn$) is the vector of the latent random recruitment variable with marginal density $h(\boldsymbol{u}\ )$ $\boldsymbol{v}=(Z_1,.........,Z_{T-1})$ is the total mortality random effect variable with marginal density $g(\boldsymbol{v})$. The marginal likelihood function is obtained by integrating out $\boldsymbol{u}$ **and** $\boldsymbol{v}$ from the joint density $\mathcal{L}$.

$$\mathcal{L}(\theta) = \iint f_\theta(y|u,v)h_\theta(u)g_\theta(v)y(u)y(v) \qquad (9)$$

The double integral in (9) 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 data are restricted to the fully recruited age classes, 9 and over, a plus group is set at age 19, called 19+.

Stock Reduction Analysis: 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. A description of the general approach can be found in Kimura and Tagart (1982), Kimura *et al.* (1984) and Kimura (1985 and 1988).

The aim of stock reduction analysis is to estimate past and present biomass for a fishery. Three types of input data are required: biological parameters, abundance indices, and a complete catch history.

SRA is an iterative process, which operates with the following steps:

- A biomass B_0 of the stock at the beginning of the catch history (initial biomass) is chosen;
- The stock biomass over the time-series is calculated by forward projection using, at each time-step the stock-recruitment relationship (derived from the input steepness), the natural mortality and removal to calculate number-at-age at the start of the next time interval;
- The catchability q of each time-series of biomass index and the coefficient of variation c of the index are calculated;
- The likelihood of the value of B_0 and q is calculated.

These four steps are repeated for a range of B_0 and the B_0 that maximises the likelihood of observed abundance indices is retained.

Implicit assumptions of this age-structured SRA include that (i) there is no density-dependence in growth and natural mortality, (ii) the stock–recruitment relationship is of the Beverton and Holt type.

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.

Up to four time-series of indices are used for blue ling, namely the landings per unit of effort (lpue) from French haul-by-haul catch and effort, the Irish bottom-trawl survey from 2006 to 2009; the Scottish bottom-trawl survey starting from 1998 and an index from the Faroese surveys. The two (spring and summer) Faroese surveys are combined in one single mean index. Trials have been conducted with one time-series and results were similar, as the time-series are actually similar. Conversely, the two Faroese surveys should not be included in the model because they only cover a restricted area and if included as two series they would overweight the Scottish survey which cover areas from which there is as much or more catch.

In some case the fit does not converge, the reasons for this have not been identified and this was already reported in a working document in 2011 (Scott *et al*., 2011). Only minor change in the data (e.g. replacing the length–weight relationship by another one producing similar weights-at-age may allow the model to converge or not. This suggests that the problem lies in the minimisation routine. 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.

Input data

Total international landings from 1966 were used in this assessment. Three tuning indices were available: French abundance index derived from skipper tallybook data, Marine Scotland's FRV SCOTIA deep-water survey and Irish (2006 to 2009).

Sensitivity analysis of the SRA results to changes in thee input parameters are recommended and can be carried out by using a range of natural mortality consistent with Table 4, various growth parameters and change in steepness.

Other stock indicators

A time-series of mean length in French landings is used as a further stock indicator and the consistency of this indicator with models outputs should be check in order to detect any possible deviations from models assumptions. For example, estimated increased proportion of older fish in the MYCC should be reflected in increasing mean length in the landings or large recruitment estimates should be reflected by decrease in mean length. Length indicators from the Faroese and Scottish trawl surveys should be used in the same way.

Input data to SRA are chosen from Tables 1–5.

Input data types and characteristics:

Parameter	Symbol	Value
Maximum age	A_{max}	25 to 50
Natural mortality	M	0.10 to 0.18
Steepness of Beverton–Holt stock–recruitment relationship	h	0.75 (varied +/-10%)
Age of first selectivity	A_{sel}	8
Age of maturity	A_{mat}	8
von Bertalanffy growth	L_{∞}	125–132 cm
Parameters	k	0.089–0.152
	t_0	-2.39–1.552
Length–weight parameters	a	2e–6
	b	3.15

D. Short-term projection

The stock numbers estimated from the MYCC model on 1st January of the assessment year are projected forward according to method 1.1 for stock category 1.

E. Medium-term projections

None.

F. Long-term projections

None.

G. Biological reference points

Biological reference points can be estimated in SRA

	Type	Value	Technical basis
MSY	**MSY $B_{trigger}$**	**xxx t**	**Explain**
Approach	**F_{MSY} proxy**	**0.11**	**$F_{50\%SPR}$ from YPR assuming M=0.15 and MSY occurs at SSB=50%SPR**
	F_{MSY} proxy	**0.18**	**$F_{40\%SPR}$ from YPR assuming M=0.18 and MSY occurs at SSB=40%SPR**
	F_{MSY} proxy	**0.144**	**M=0.18 and F_{MSY}=0.8M (Restrepo et al. 1998, Walters and Martell, 2004)**
	F0.1	**0.11 to 0.15**	**Calculated from YPR at equilibrium using natural mortality from 0.1 to 0.13**
	Fmsy	**0.12 to 0.16**	**Calculated from YPR at equilibrium using natural mortality from 0.1 to 0.13**
	MSY B trigger	**33% B0**	**Estimates in Stock reduction analysis vary with input M. In all runs made Bloss was 33 to 38% of B0. Lower relative values, i.e. 33% were derived from runs with lower M assumption fitting higher absolute biomass.**
	B_{lim}	**xxx t**	**Explain**
Precautionary	**B_{pa}**	**xxx t**	**Explain**

Approach	F_{lim}	Xxx	Explain
	F_{pa}	Xxx	Explain

H. Other issues

The only area were juvenile are known to occur in high number is the Icelandic Shelf. No juvenile are known to occur in Subareas VI and VII and number observed in the Faeroese survey (less than five fish smaller than 80 cm per hour) do not seem sufficient to supply the abundance of the adult blue ling stock.

H.1. Historical overview of previous assessment methods

Exploratory assessment carried out far are summarised 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 unstandardised lpue
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	Years: 1995–2006	Years: 1995–2007	Years: 1995–2008	Years: 1995–2009

[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).

Data	2007 assessment	2008 assessment	2009 assessment	2010 assessment
length dist. of Faroese landings				
Quartely age dist.				Year: 2009
Survey: Scottish deep-water			Years: 1998–2008 N° per hour	Years: 1998–2009 N° per hour
Survey: Irish				Years: 2006–2009 N° per hour
Survey: spring and autumn Faroese				Years: 1994–2009 N° per hour Size
Haul-by-haul lpues from French trawlers	Not used	Not used	Years: 2000–2008	Years: 2000–2009
Aggregated unstandardised French lpue	Years: 1989–2006	Years: 1989–2007	Years: 1989–2008	Not used

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Stock Annex 6.2: Tusk in ICES Division Va and XIV

Stock	Tusk (Division Va)
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 southeast, 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.

In 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 1).

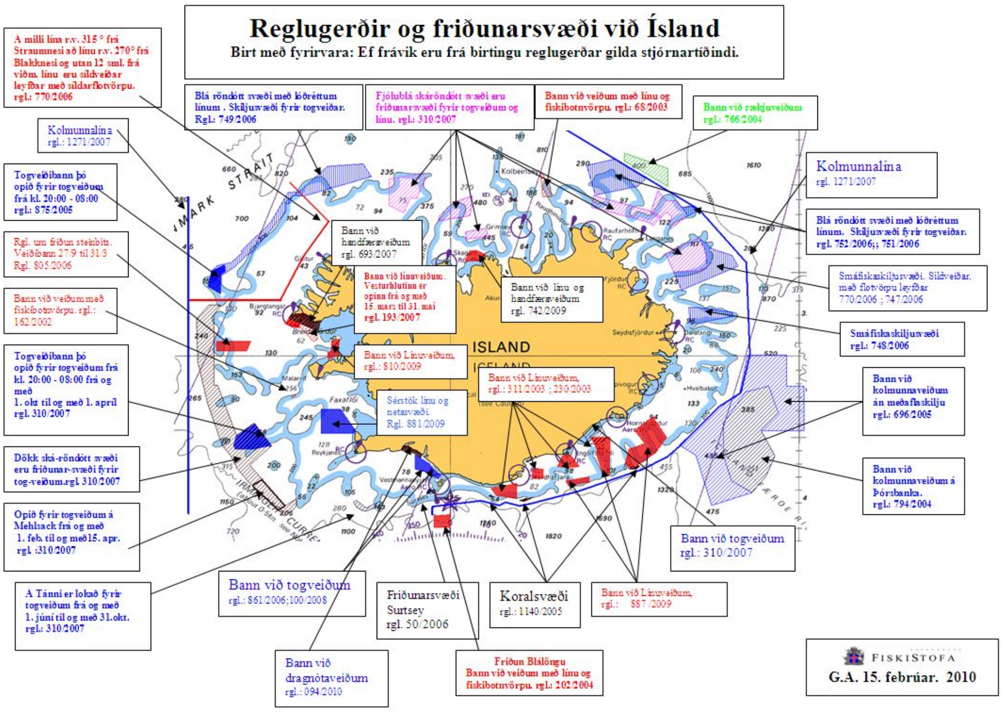

Figure 1. Marine protected areas in Icelandic waters. These areas are closed for various types of fisheries and may be closed permanently (all year around) or temporarily (closed part of the years. Four areas marked red south and southeast of Iceland (reference to the box *Bann við Línuveiðum, rgl.: 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 gram). 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 fishes. 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 un-gutted, the un-gutted 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 fishermen and other stakeholders.

To help in the planning, experienced captains were asked to map out and describe the various fishing grounds around Iceland and 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 these data it made sense to conduct the survey in March.

The total number of stations was decided to be 600 (Figure 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 are 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 fishermen and fishery scientist at the MRI for decisions of location. The scientist selected random position for their stations, whereas the fishermen 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 approximately 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).

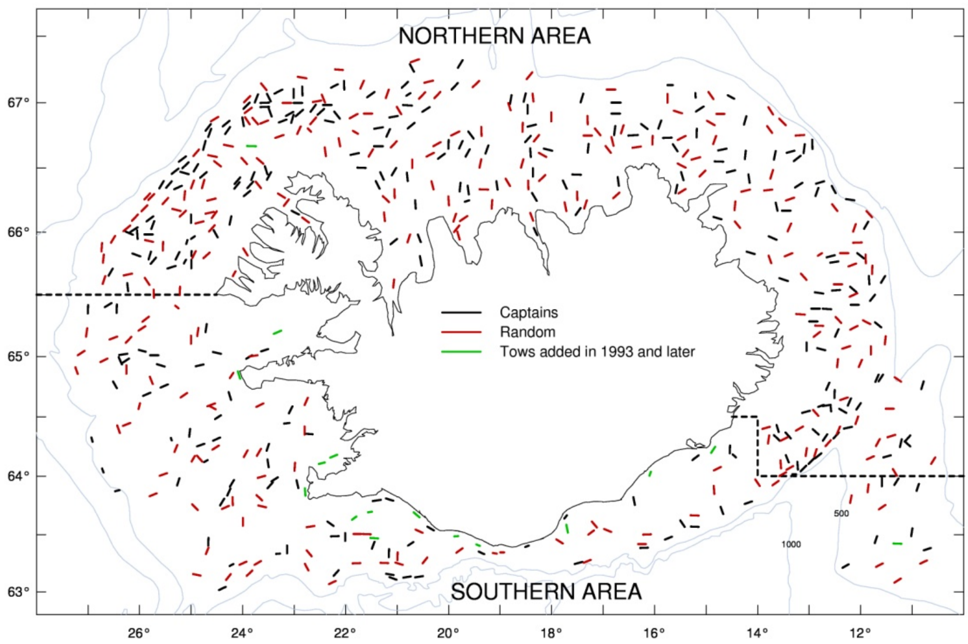

Figure 2. Stations in the spring survey in March. Black lines indicate the tow stations selected by captains of commercial trawlers, red lines are the tow stations selected randomly, and green lines are the tow stations that were added in 1993 or later. The broken black lines indicate the original division 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 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 fishermen's 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, twelve 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 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".

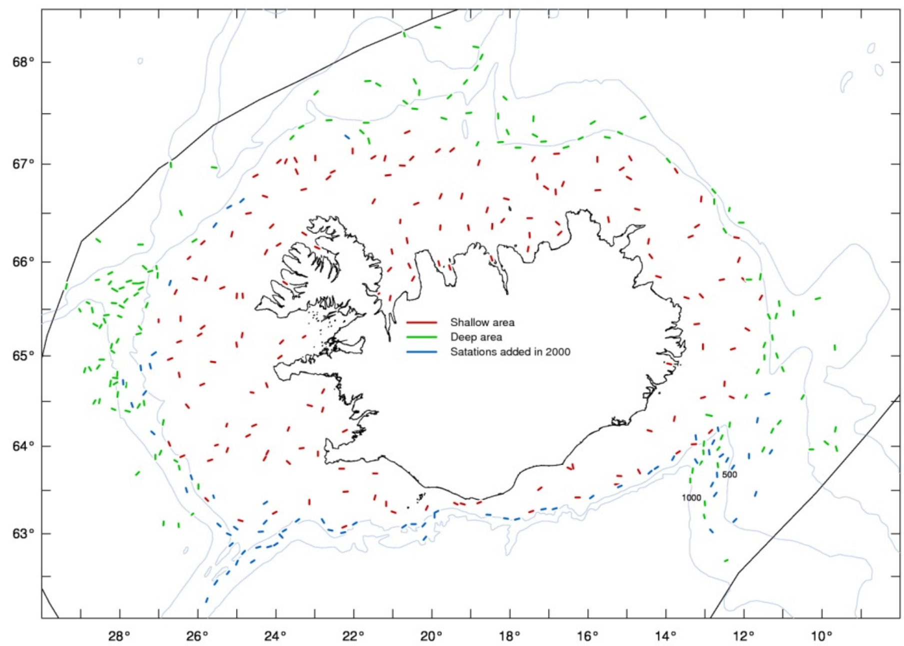

Figure 3. Stations in the Autumn Groundfish Survey (AGS). RV "Bjarni Sæmundsson" takes stations in the shallow-water area (red lines) and RV "Árni Friðriksson" takes stations in the deep-water areas (green lines), the blue lines are stations added in 2000.

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 66.6 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.

“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 66.6 m” 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 un-gutted 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 are 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 un-gutted 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 co-operation 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, Wind speed, 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 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.

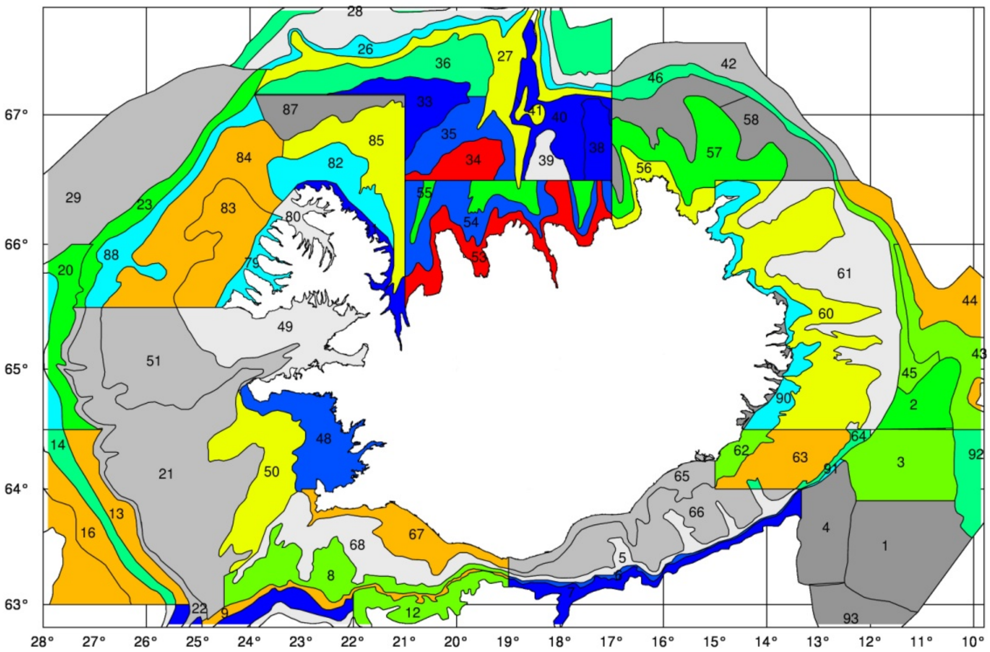

Figure 3. Subareas or strata used for calculation of survey indices in Icelandic waters.

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 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 optimisation 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-species, 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 optimisation 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. Optimisation 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 β, 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 discretisation 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 predator) is modelled so that either the total catch in each area and time interval is specified, or this 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.

Optimisation

The model has two alternative optimising algorithms linked to it, a wide area search simulated annealing Corona *et al*. (1987) and a local search Hooke and Jeeves algorithm 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 algorithm. The model is able to use both in a single-run optimisation, 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 algorithms returns estimates of the Hessian.

Likelihood weighting

The total objective function to be minimised 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 parameterisation. 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 datapoints.

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) * df*).

The effective number of datapoints (df*) 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 problems 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, ε_{lt}, is independent normal with variance σ_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 two 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
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 - 2 params.
- Icelandic Spring survey - 1 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 optimisation is started with simulated anneling to make the results less sensitive to the initial (starting) values and then the optimisation 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	Optimise
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
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 optimisation 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 analise convergence and problematic parameters.
- Plot comparing observed and modelled proportions in fleets (catches). To analise how estimated population abundance and exploration 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 affect 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 million fishes 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 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 as the mean weight in the stock.

G. Biological reference points

There are no reference points defined for this stock.

H. Other issues

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Stock Annex 7.2: Greater Silver Smelt in Division 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. In 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 (approximately 430 m). Between W19°30 and W14°30 taking of greater silver smelt is allowed south of given line (Figure 1 and Table 1).

3) It is mandatory to keep logbooks where 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.

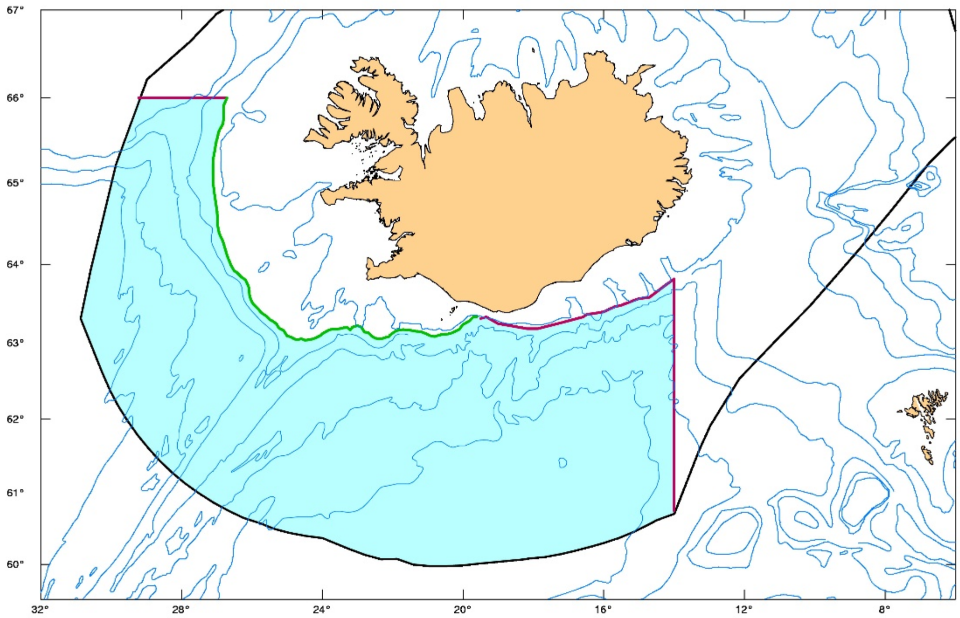

Figure 1. Area open to commercial fishing of Greater Silver Smelt in Va according to regulation nr 717, 6th of October 2000 with amendments 1138/2005 from the Ministry of Fisheries (the shaded blue area). The red line off the south coast drawn according to Table 1 and the green line is an approximation of the 400 m depth contour.

A.3. Ecosystem aspects

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 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 un-gutted weight (to the nearest gram). 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. 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. 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 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".

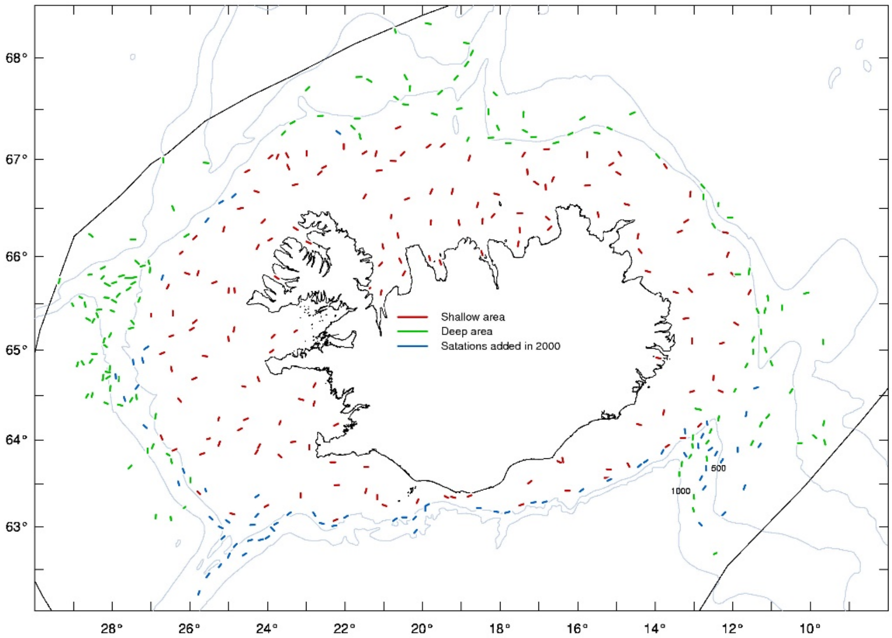

Figure 2. Stations in the Autumn Groundfish Survey (AGS). RV "Bjarni Sæmundsson" takes stations in the shallow-water area (red lines) and RV "Árni Friðriksson" takes stations in the deep-water areas (green lines), the blue lines are stations added in 2000.

B.3.2.1. Data collection (biological sampling)

B.3.2.1.1. Length measurement, counting (sub-sampling)

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 are 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 have 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 co-operation 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, Wind speed, 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" (Figures 6–9). 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 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.

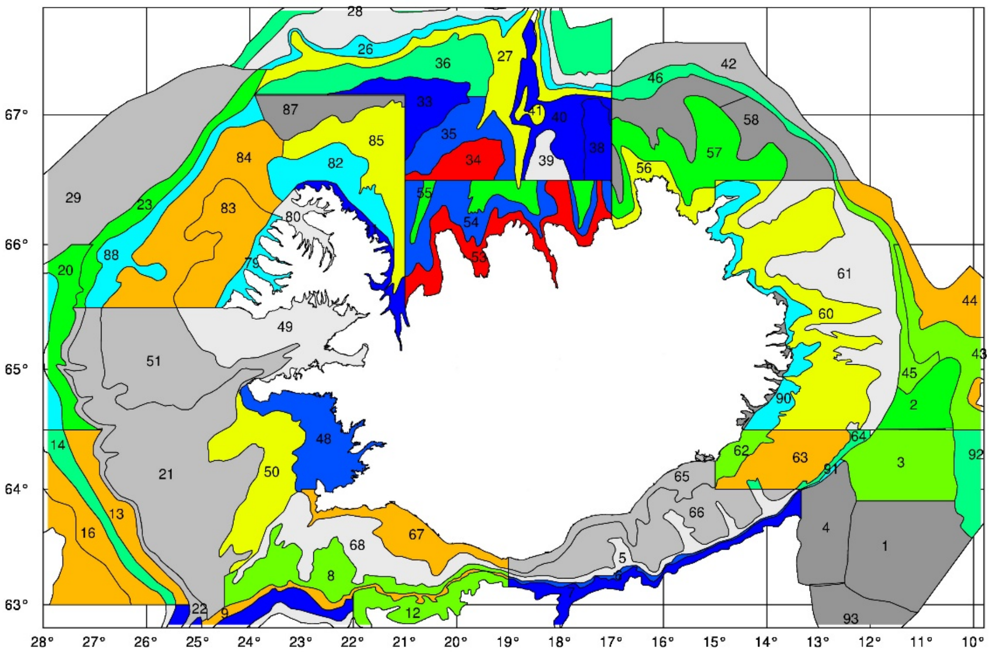

Figure 3. Subareas or strata used for calculation of survey indices in Icelandic waters.

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 1 and Figure 4).

Table 1. Survey regions used for calculation of various Autumn Groundfish Survey indices for greater silver smelt in Va.

Region	No. strata	Area (km^2)	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

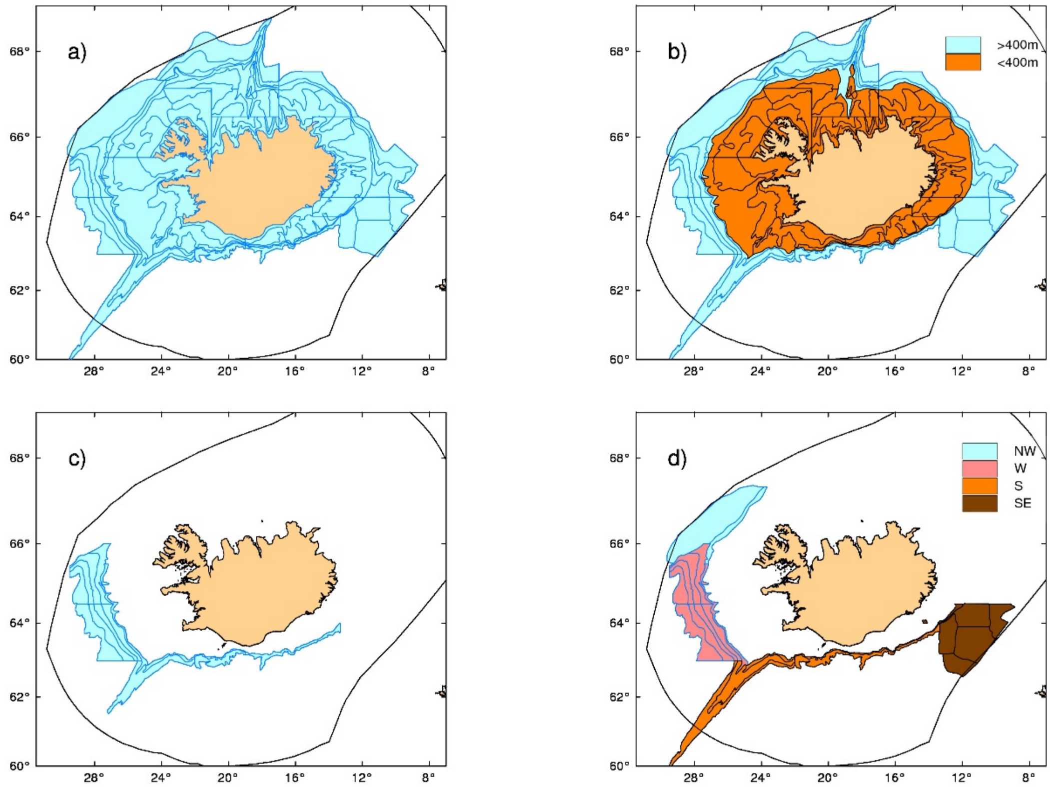

Figure 4. Divisions used in calculation of indices for greater silver smelt in Va. a) Total area. b) Division at 400 m depth contour. c) Greater silver smelt fishing area. d) Subdivisions of the main distributional area of greater silver smelt.

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 number 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 form 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.

Stock Annex 9.2: 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	9th Avril 2014
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 1):

Skagerrak (IIIa) The Faroe-Hatton area;

Celtic sea (Divisions Vb and XIIb, Subareas VI, VII);

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.

Some studies have allowed observing fish in all maturity stages in all the distribution area (Allain, 2001; Kelly *et al*., 1996, 1997; Shibanov, 1997; Vinnichenko *et al*., 2004), therefore allowing for several populations to exist.

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.

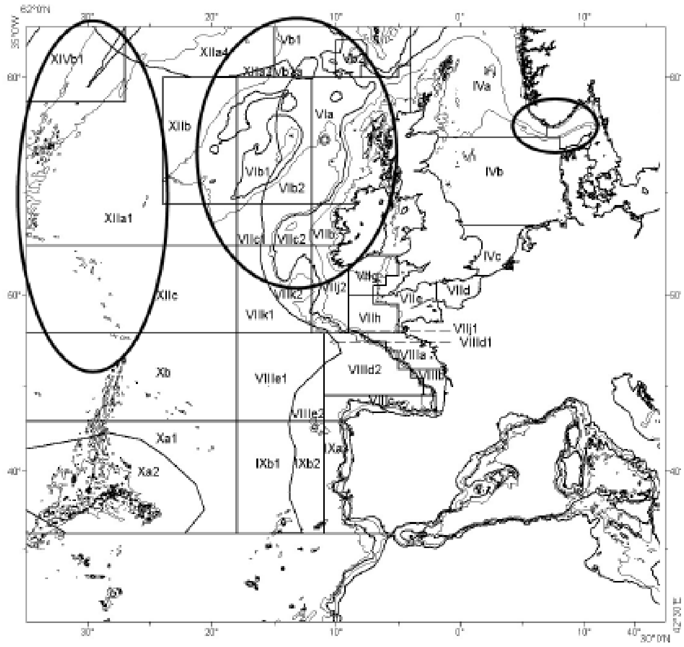

Figure 1. Areas of the main fisheries for roundnose grenadier, Skagerrak, west of the British Isles and Mid-Atlantic Ridge. The isobaths displayed are 100, 200, 1000 and 2000 m (from Lorance *et al.*, 2008).

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. Historic length–frequency series from sampling on board French trawlers by French and Scottish observer is presented in Figures 2 and 3.

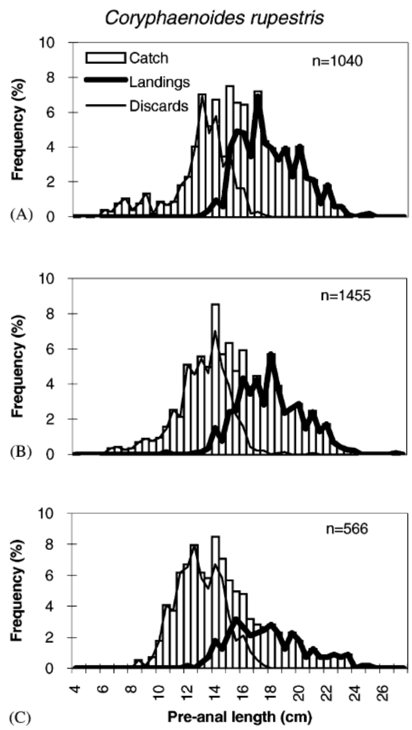

Figure 2. Length distribution of the discards and landings of roundnose grenadier in 1996–1997 by depth, A) 800–1000 m, B) 1000–1200 m, C) 1200–1400 m, sampled on board French vessels, (redrawn from Allain, 2003).

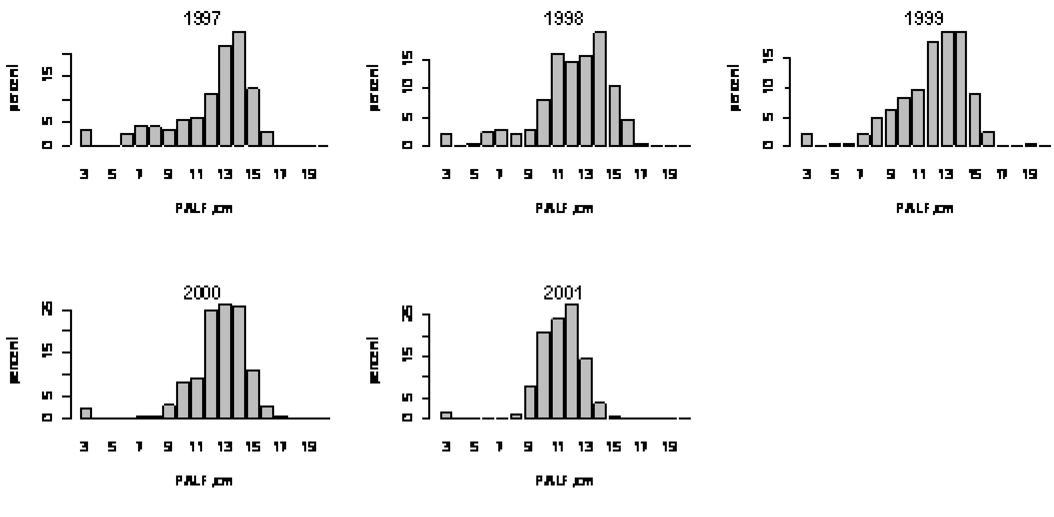

Figure 3. Length distribution of the discards of the French fleet, sampled on board French vessels by Scottish observers, 1997–2001.

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 hve 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 data based upon French tallybooks are available from 2000 based upon a voluntary participation of fishermen. 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 Divisions 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 Multiyear 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 recruitment (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 data based 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.

Lpues from Spanish data in XIIb from 2002.

D. Short-term projection

Short-term projections are done using the surplus production model for set catch levels and various management scenarios.

E. Medium-term projections

No projections are performed.

F. Long-term projections

No projections are performed.

G. Biological reference points

B_{MSY} and H_{MSY} are outputs from the model.

MSY $B_{trigger}$ is equals to B_{loss} (2006 biomass estimate).

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 is dependent on the length of the time-series, separate exploratory runs may be performed to evaluate the effects of new datasets or datapoints.

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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Stock Annex 10.2: Black scabbardfish in Subareas Vb and XIIb and Divisions VI and VII

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Black scabbardfish in Subareas Vb and XIIb and Divisions VI and VII
Working Group	WGDEEP
Date	
Revised by	

A. General

A.1. Distribution

Black scabbardfish *Aphanopus carbo* Lowe, 1839 is a widely distributed species. In the North Atlantic, the species occurs between 30°N and 70°N, from the strait of Denmark to Western Sahara, with greatest abundance to the South of the Faroe Islands, in the Rockall Trough, to the west of mainland Portugal, and around Madeira and the Canary archipelagos. It occurs only sporadically north of the Scotland-Iceland-Greenland Ridges.

Black scabbardfish is a bathypelagic species which can be found at depths from 200 m, in the northern section of the NE Atlantic (Nakamura and Parin, 1993; Kelly *et al*., 1998), to 2300 m around the Canary Islands (Pajuelo *et al*., 2008). Despite this wide bathymetric range, it is more frequent between 800 and 1800 m in mainland Portugal (Martins *et al*., 1987), 800 and 1300 m in Madeira (Morales-Nin and Sena-Carvalho 1996), and 400 and 1400 m of the West of the British Isles (Ehrich, 1983; Allain *et al*., 2003).

A.1.1. Species dynamics

Mean length and maximum length of black scabbardfish caught west of the British Isles are smaller than those caught off mainland Portugal, which in turn are smaller than those caught in Madeira. Mature or spawning individuals have never been recorded west of the British Isles or Mainland Portugal and the only known spawning locations are around Madeira, the Canary Islands the NW coast of Africa (Figueiredo *et al*., 2003; Pajuelo *et al*., 2008; Perera, 2008; Neves *et al*., 2009). Evidence from otolith microchemistry and stable isotope analysis are consistent with the fish caught west of the British Isles and Portugal having been spawned at latitudes similar to Madeira.

This leads to the hypothesis of migratory behaviour mostly driven by feeding and reproduction processes (Zilanov and Shepel, 1975; Anon., 2000; Figueiredo *et al*., 2003). According to this, spawning apparently occurs around Madeira, the Canary Islands and possibly in a few other southern areas, such as the NW coast of Africa (Figueiredo *et al*., 2003; Pajuelo *et al*., 2008; Perera, 2008; Neves *et al*., 2009). Juveniles migrate from those areas to the northernmost ones, namely Iceland, the Faroes Islands, and the west of the British Isles, where small fish of about two years old have been caught by fisheries or by surveys. This northward migration also includes non-recruited stages up to a length of 70 cm. After having grown in northern areas for a few years, fish move southwards, namely to mainland Portugal (International Council for the Exploration of the Seas Division IXa) where they remain a few years before migrating further south to the spawning areas.

A.1.2. Stock definition

Although the stock structure is uncertain, in the absence of clear scientific evidence to suggest structuring it is hypothesised that a single stock exists in the NE Atlantic. Results from several studies are in agreement with this hypothesis. However, due to the differing nature of fisheries in the northern and southern areas, ICES has historically given separate advice for three assessment units. These assessment units are generally consistent with the management units used by the EU:

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).

These management units reflect the main fisheries to which the species is subjected. The northern component comprises fish exploited mainly by trawl fisheries while the southern component by a longline fishery. In other areas the species is exploited by both longliners and trawlers, but the overall landings are very small in comparison to the other two management units.

In 2012, ICES Stock Identification Methods Working Group (SIMWG) recommended that the management units of Northern and Southern divisions may need revision and should be considered as one assessment unit (ICES 2012). Consequently, a single assessment unit is now considered for this stock.

A.2. Fisheries

The Faroese fisheries take mostly place in Subarea Vb with 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. 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 in 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 since 1995. This fishery has decreased to low levels since the introduction of TACs in 2003.

Following the decline of target orange roughy Irish trawl fishery, landings of black scabbardfish derived from ICES Subareas VI and VII reached about 1000 t in 2002. In recent years (since 2008) Irish landings have been zero.

The French deep-water fishery operates mainly in Subareas VI and VII targeting roundnose grenadier, black scabbardfish, and blue ling. Over recent years, the landings of black scabbardfish have declined but to a lesser extent than landings of other deep-water species (roundnose grenadier, blue ling, orange roughy and deep-water sharks).

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. A total of 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.

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 and then there was a decrease mainly due continuous decreases of landings from ICES Divisions VI and VII.

In Subarea IXa the main fishery taking place 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 place at grounds around Sesimbra (south of Lisboa; latitude 38º20'N), following a series of exploratory surveys conducted by the Portuguese Institute of the Sea and Atmosphere (former IPIMAR) in close collaboration with professionals from the fisheries sector some of them from Madeira. These surveys were oriented towards the search for new fishing grounds for the species, the environmental characterization of the ocean layer where black scabbardfish occurs, the experimentation of longline fishing gears and preliminary studies on the biology of the species. Fishermen from Madeira with extensive experience in deep-sea longline fishing have greatly contributed.

The fishing method and gear used by the black scabbardfish longline fleet were developed soon after the initial fishing trials off the Sesimbra coast by fishermen 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 with 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 of small artisanal vessels with an average LOA around 11 m and an average tonnage of ca. 16 GRT. In 1988, 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 again underwent technological improvements, including an increase in engine power, tonnage and average LOA average. Such improvements were experienced by a limited number of vessels (four), which is reflected by the increase in standard deviation estimates.

The number of vessels in the fleet 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.

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 h) 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 fishermen as these marine mammals are attracted by the catch when it reaches the surface and feed on the fish captured.

In ICES Division IXa2 (Azorean EEZ), black scabbardfish fisheries have 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. 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.

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 scabbardfish, 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 by one trawler (M/S Ran TG0752) which had 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 1.

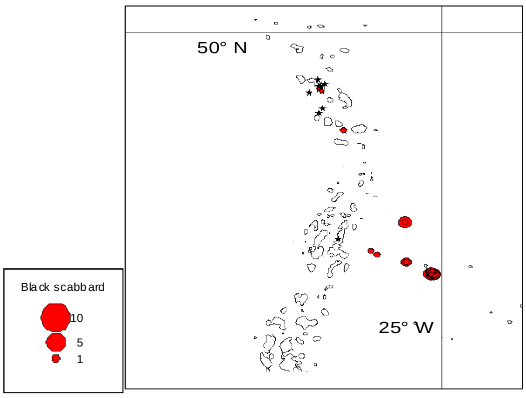

Figure 1. Faroese exploratory survey total catches of black scabbardfish (tonnes).

Outside the ICES area, black scabbardfish is being exploited in Madeira and the Canaries. In Madeira, the drifting deep-water longline targeting black scabbardfish is the main fishery activity. It probably started in the early 1800s when local fisherman were targeting "oil fish". This fishery was kept almost unaltered for over one century, when in 1982 hemp was replaced by monofilament drifting longline and the number of hooks per line increased (Martins and Ferreira, 1995). This change in fishing gear, along with better equipped boats that helped local fisherman searching for new fishing grounds such as seamounts, significantly improving their yields (Martins and Ferreira, 1995). The fleet now exploits new areas, especially located SE of Madeira, as far as 150–200 nautical miles from the fishing port. The fishery is mostly developed inside the Madeira Exclusive Economic Zone, included in the CECAF 34.1.2 area, all year round. Sporadically fishing sets are made, by the vessels with higher autonomy in the vicinity of the Madeira EEZ.

In 1800s, the fleet was composed by about 30 small artisanal vessels (<6 m length) with low engine power. The number of vessels dedicated to this fishery peaked in 1988 with a total of 95 vessels. After that period the fleet suffer a considerable reduction, mainly between 1990 and 1995, when the number of vessels dropped from 84 to 44 (Bordalo-Machado *et al.*, 2009). Between 1998 and 2000, the fleet comprised ca. 40 vessels (on average 13 m LOA, 19 GT and 150 Hp) (Reis *et al.*, 2001). Fleet size continued to decrease to around 15 vessels in the most recent years (2009–2010), with no significant changes in their technical characteristics. Landings of black scabbardfish reached a peak pf 4.2 thousand tonnes in 1998 and have been steadily declining since then to 1.7 thousand tonnes in 2012.

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). Baird's smoothhead (*Alepocephalus bairdii*) is the main discarded species of the trawl fishery but a large number of other non-marketable bentho-pelagic species are also discarded. The survival of these discards although unknown, it is believed to be virtually zero because of fragility of these species and the effects of pressure changes during retrieval (Gordon, 2001). Therefore such fisheries have the potential to deplete the whole fish community biomass. 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).

Catch, bycatch and discards of sharks in deep-sea fisheries have been an issue of concern (Stevens *et al.*, 2000). Deep-sea sharks are frequent bycatch of black scabbardfish longline and trawl fisheries (Clarke *et al.*, 2005; Bordalo-Machado, 2009; Muñoz *et al.*, 2011; Piñeiro *et al.*, 2001) and their commercial exploitation has recently increased. It is recognized that trawls and longlines catch varied quantities of different deep-sea shark species and size frequencies in different locations (Clarke *et al.*, 2005; Coelho *et al.*, 2003). However, the global magnitude of the problem is still unknown. It has been recognized that the bycatch of deep-sea sharks in trawls is lower than for longlines in many locations (Piñeiro *et al.*, 2001; Hareide and Garnes, 2001; Clarke *et al.*, 2005) but post catch survival is likely to be higher in longlining (Coelho and Erzini, 2008). Some solutions may exist to reduce deep-sea shark bycatch in longlines such as increasing the distance of the hooks from the seabed (Coelho *et al.*, 2003) or use artificial baits; but still need to be tested.

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 in the past (Hall-Spencer, 2002; Grehan *et al.*, 2003) but all are now closed to bottom contacting fishing gears.

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 historic records of impacts on deep-water ecosystems, in particular corals (Joubin, 1922). In Division IXa 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 VMEs.

B. Data

B.1. Commercial catch

In ICES Divisions VIb1 and XIIb the landings from Spanish trawling fleet operating on the northern and western Hatton Bank are available since 2004.

Landings from other fleets in the northern area are available from 1989 onwards, which is believed to correspond to the entire history of the fisheries.

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. Data are available from 1989 which is believed to correspond to the entire history of the fishery.

Data are not currently available for fisheries outside the ICES area including Madeira and the Canaries.

Discards

Discard data from Spanish bottom otter trawl métiers operating Hatton Bank (ICES Divisions VIb1 and XIIb) 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 fishing effort as auxiliary variable.

Discarding information from the French fisheries west of the British Isles is collected by French observers. Discards of this species are very low comprising only individuals that are damaged.

In Division IXa the artisanal segment of the commercial fishing fleet 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

Since 2003, French length data of back scabbardfish by depth are available based on data from on-board observations of French trawlers.

Length on data from Russian 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).

In Division IXa length–frequency and biological samples from Portuguese landing port at Sesimbra have been collected on a monthly basis since 2000.

LHC	Best estimate	Derived from	Other estimates
Maximum observed length	1510 mm	Figueiredo *et al.* 2003	
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)	

Ageing

Studies on age and growth of the black scabbardfish have been carried out at different areas (Table 3).

Table 3. Von Bertalanffy growth parameter estimates from different studies carried out in the NE Atlantic, including otolith age-reading method and clearing solution. F: female, M: male, SD: standard deviation.

Area	Method	Clearing	Sex	*N*	Total length range (cm)	Age range (year)	L_{inf} ± SD (cm)	*k* (year^{-1})	t_0 (year)	Source
W. British Isles	Thin sections in epoxy resin	Alcohol	both	230	75–120	4–32	*NA*	0.1	*NA*	Kelly et al. 1998
Mainland Portugal	Thin sections in epoxy resin	1:1 glycerin-alcohol	F	248	64–131	5–13	135 ± 4	0.2	–2.0	Vieira et al. 2009
			M	206		4–10	124 ± 3	0.2	–1.7	
Madeira	Surface	Glycerol	F	334	58–151	0–8	142	0.3	–2.1	Morales-Nin and Sena-Carvalho 1996
			M	357	58–132		155	0.2	–3.3	
			both	649	58–151		139	0.3	–2.3	
	Thin sections in epoxy resin	1:1 glycerin-alcohol	F	200	125–148	8–15	159 ± 4	0.1	–2.3	Vieira et al. 2009
			M	163		8–14	146 ± 1	0.1	–1.4	
	Surface	1:1 glycerin-alcohol	F	554	100–140	6–14	136 ± 5	0.2	–4.2	Delgado et al. 2013
			M				132 ± 5	0.2	–3.1	
Canary Islands	Surface, burned	50% glycerol	F	196	100–148	2–12	149 ± 2	0.2	–4.7	Pajuelo et al. 2008
			M	102	104–134	2–8	141 ± 4	0.3	–3.5	
			both	298	100–148	2–12	148 ± 2	0.2	–4.6	

NA: not available.

The maximum age estimated by Morales-Nin and Sena-Carvalho (1996) corresponded to a male of 130 cm and a female of 150 cm total length. These ages were probably underestimated because, when using whole otoliths in larger specimens from this species, the growth increments closer to the border are very difficult to identify (Vieira *et al.*, 2009). On the contrary, the maximum age assigned by Kelly *et al.* (1998) using thin otolith sections was most likely overestimated since, with this preparation technique, the number of visible rings is very high and the authors reported problems in their interpretation. Regarding age estimations in Madeira and the Canary Islands in studies prior to 2008, when caught specimens started being routinely separated by species, the possible mixing of black scabbardfish and intermediate scabbardfish (*A. intermedius*) specimens could also explain the differences found between regions and should be taken into consideration (Farias *et al.*, 2013).

Excluding Kelly *et al.* (1998) the growth parameters estimated based on the von Bertalanffy growth equation showed a relatively rapid growth rate for the black scabbardfish (Table 3). The low estimate of growth rate obtained by Kelly *et al.* (1998) for the west of the British Isles is not in agreement with the predominance of young immature specimens in this area, commonly characterized by fast growth rates.

Ribeiro Santos (2013) compared two alternative methods for the interpretation of growth increments in sectioned otoliths. The more conservative interpretation, which was preferred, gave ages in the range of 0 to 15 years and 0 to 13 years respectively, for females and males from the west of the British Isles. In Madeira, the age ranged between eight and 19 for females and six and 24 years (only one fish over 18 years) for males. Growth parameters for the west of the British Isles were: males, L_{inf} = 117 (SE = 4), k = 0.238, t_0 = 3.65; female, L_{inf} = 140 (SE = 8), k = 0.248, t_0 = 3.65 and for Madeira: males L_{inf} = 124 (SE = 6), k = 0.131, t_0 = 3.35; female, L_{inf} = 149 (SE = 6), k = 0.081, t_0 = 3.35.

Females, particularly those from Madeiran waters, had 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 optimisation 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 the Canary Islands (Pajuelo *et al.*, 2008) and the northwest coast of Africa although it is possible that two species may occur in these areas.

The black scabbardfish is an iteroparous species, since it can spawn multiple times throughout its life, and is also a total spawner, as it spawns in one single event (Pajuelo *et al.*, 2008; Ribeiro Santos *et al.*, 2013).

Mature and spawning adults have only been observed in the last quarter of the year in Madeira (Figueiredo *et al.*, 2003; Neves *et al.*, 2009; Ribeiro Santos *et al.*, 2013), the Canaries (Pajuelo *et al.*, 2008), and the northwest coast of Africa (Perera, 2008).

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 fishes 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 - Estimated female length at first maturity (L50) was 103 cm around Madeira (Figueiredo *et al*., 2003) and 114 cm around the Canary Islands (Pajuelo *et al*., 2008). Once again, the possible mixture of black and intermediate scabbardfish specimens in the samples may have biased these results. In a more recent work, female L50 was estimated to be 111 cm for Madeira and 116 cm when also including specimens from the west of the British Isles (Ribeiro Santos *et al*., 2013). The latter values are probably overestimated because the estimation did not include specimens from Madeira smaller than 92 cm in total length (Farias *et al*., 2013).

Fecundity - Black scabbardfish has a determinate fecundity strategy the relative fecundity estimates ranged from 73 to 373 oocytes/female weights (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

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 between 2006 and 2009. Sampling methodology and trawl gear were standardised in accordance with the Scottish deep-water survey with trawling at fixed stations around 500 m, 1000 m, 1500 m and 1800 m. This survey has been discontinued.

No fisheries-independent survey is available for the Portuguese mainland fishery.

B.4. Commercial cpue

An lpue dataseries for black scabbardfish is estimated for the French deep-water fleet based upon the French tallybooks (Pawlowski *et al*., WD 2009). The tally book (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).

A GAM model is adjusted where landing is the response variable and fishing time, depth, month, vessel identity (vessel.id), rectangle, year and area are the explanatory variables:

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). The haul duration is used as an explanatory variable to avoid non-proportional relationship between landings and fishing time.

The fit is done assuming a Tweedie distribution with a log-link function using the mgcv package in R (Wood, 2006; Lorance *et al*., 2010). All hauls in areas edge6 and other6 in the depth range 500–1500 m of duration between 30 minutes and 5 hours were selected. In the case, all fishing hauls in a given depth range can be selected as the depth factor and the rectangle factor implies that the targeting is handled (i.e. in given rectangle, fishing at a given depth implies fishing for one or some species). In the case of logbooks it was necessary to select fishing subtrips with a threshold proportion of black scabbardfish in the landings in order to exclude hauls targeting other (and possibly shelf) species. Taking a 10% threshold implies that in a substrip where black scabbardfish is below this threshold most of the fishing effort of the subtrip (i.e. the majority of the hauls) was directed to other species or that black scabbardfish was a minor bycatch.

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 2 cpue estimates were presented for Subdivisions VIb1 and XIIb separately, as well as, for the two combined.

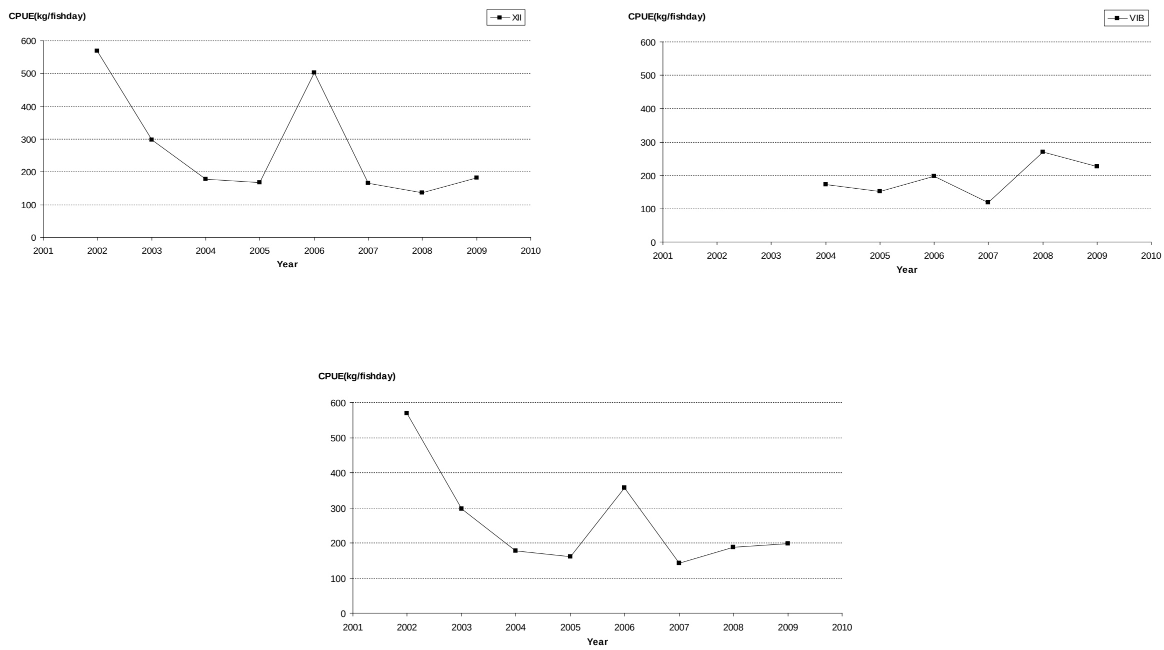

Figure 2. Black scabbard fish cpue (kg/fishing days) in VIb (upper left). XIb (upper right) and the two subareas combined (center) from Spanish trawlers.

An lpue dataseries for black scabbardfish is estimated for the Portuguese longline fishery operating in Portugal mainland (ICES Subarea IXa). The commercial daily landings from Portuguese longline vessels are 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 fishermen that each vessel uses the same number of hooks on each trip (Bordalo-Machado and Figueiredo, 2009). 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 lpue is 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 α_i (i = 1995,…, lastyear), β_j (j = 1,…,12) and λ_k (k = 1,…,33) are coefficients to be determined. The most appropriate distribution the expected or a function of the expected response variable is chosen among the exponential family group of distributions. The quality of the model adjustment is evaluated by quantile residuals analysis.

B.5. Other relevant data

Information from the fishery, particularly the abundance index, cpue, indicates the existence of a seasonal trend in abundance, both in BI and in P: lower abundance is usually registered from March to August of any year (here referred as the 1st semester) and higher abundances are mostly registered from September to December of an year and January and February of the following year (here referred as the 2nd semester). These fluctuations in abundance are considered to be associated with the migratory processes and as a consequence, the time unit adopted to analyse the dynamics of the population is the semester defined as before and denoted by s.

C. Assessment: data and method

Data

The input data for the model are

- the number of specimens landed in each semester (defined as mentioned above) by the French trawlers and the Portuguese longliners partitioned into two length groups $70 \leq C2 < 103$ cm and $C3 \geq 103$ cm. The time-series covered is from 1999 to 2012;
- Standardized total fishing effort for each of the two fleet for the time period from 1999–2012.

The input data for the model are in turn dependent on data availability on:

- Length–frequency distributions from on-board observers from the French trawlers;
- Monthly landings of the Portuguese longline fishery by commercial longline category;
- Length–frequency distributions from landing sampling programme;
- Weight–length relationship;
- Standardized cpue for each of the two fleets.

Model used

The model used consists of two state–space models, one for part of the population in the BI and the other for part of the population in P. In both cases the state vectors are partitioned into four groups defined according to criteria to length size (C2 or C3) and the fishing status (fished, F, or not fished, $\overline{F}$).

In each semester s, the population abundance in BI and in P is given, respectively, by the state vectors $n_{BI;s}$ and $n_{P;s}$, with the following components:

$$\begin{aligned} \boldsymbol{n}'_{BI,s} &= \left(n_{BI,C2,s}(\overline{F}),\ n_{BI,C3,s}(\overline{F}),\ n_{BI,C2,s}(F),\ n_{BI,C3,s}(F)\right) \\ \boldsymbol{n}'_{P,s} &= \left(n_{P,C2,s}(\overline{F}),\ n_{P,C3,s}(\overline{F}),\ n_{P,C2,s}(F),\ n_{P,C3,s}(F)\right), \end{aligned}$$

where ($\overline{F}$) represents those components including only specimens that have survived fishing while (F) refers to those that were fished, $n_{BI;C2;s}$ and $nB_{I;C3;}s$ are the number of individuals belonging, respectively, to C2 and C3 inhabiting BI and $n_{P;C2;s}$ and $n_{P;C3;s}$ are the number of individuals be belonging, respectively, to C2 and C3 inhabiting P.

Two state–space models are considered, one for BI and one for P, these models run separately but not independently since the one for BI is linked to that of P through a migration subprocess.

In each model, the state process is subdivided into subprocesses which translate the main features of the species' life cycle and migration pattern. The state process is assumed to be a first order Markov process. It is also assumed that all the individuals in the population act identically and independently (IID hypothesis) of each other and that the parameters of the distribution functions depending on the subprocesses remain constant over time.

The Markovian assumption assures that, at each time point s, the process is totally defined if the distribution of the process conditional on the process state in the previous time point is known, $\mathbf{n}_s \overset{d}{=} H_s[\mathbf{n}_{s-1}]$.

State-space model for BI

The temporal evolution of the population in BI area is divided into four stochastic subprocesses:

M_s - Survival to natural mortality

T_s - Class transition

D_s - Displacement by migration - entrances and departures

F_s - Survival to fishing:

The model assumes that the subprocesses are discrete and succeed in time always in the same order, each of which depending exclusively on the subprocess that occurred immediately before

$$M_s \to T_s \to D_s \to F_s$$

For the first subprocess, survival to natural mortality, a binomial distribution is assumed for the number of survivors in BI, with probability of survival $p_{M;BI}$, common to both length groups,

$$\boldsymbol{u}^M_{BI,s} \sim \boldsymbol{H}^M_{BI,s}(\boldsymbol{n}_{BI,s-1}) : \begin{cases} u^M_{BI,C2,s} & \sim & \text{Bi}\left(n_{BI,C2,s-1}(\overline{F}), p_{M,BI}\right) \\ u^M_{BI,C3,s} & \sim & \text{Bi}\left(n_{BI,C3,s-1}(\overline{F}), p_{M,BI}\right) \end{cases}$$

In the subprocess class transition, the distribution of the number of C2 elements that evolve to length group C3 is binomial with parameter $p_{23;BI}$,

$$\boldsymbol{u}^T_{BI,s} \sim \boldsymbol{H}^T_{BI,s}(\boldsymbol{u}^M_{BI,s}) : \begin{cases} u^T_{BI,C2,s} & = & u^M_{BI,C2,s} - X[u^M_{BI,C2,s}], \\ & & \text{with } X[u^M_{BI,C2,s}] \sim \text{Bi}\left(u^M_{BI,C2,s}, p_{23,BI}\right) \\ u^T_{BI,C3,s} & = & u^M_{BI,C3,s} + X[u^M_{BI,C2,s}] \end{cases}$$

The subprocess displacement by migration, Ds, differs according to whether s corresponds to a first or second semester. In the second semester, a contingent of new recruits is admitted to be added to the C2 length group of BI, part of which have just arrived from their migration from south and the others, being already present in BI, only then attained the recruitment size and enter into C2 length group. It is further assumed that the number of entries in BI is binomial distributed over the number of C2 fishes existing there with probability $p_{r;BI}$.

$$\boldsymbol{u}^D_{BI,s} \sim \boldsymbol{H}^D_{BI,s}(\boldsymbol{u}^T_{BI,s}) \quad : \quad \begin{cases} u^D_{BI,C2,s} & = & u^T_{BI,C2,s} + E_{C2,s} \\ & & \text{with } E_{C2,s} \sim \text{Bi}\left(u^T_{BI,C2,s}, p_{r,BI}\right) \\ u^D_{BI,C3,s} & = & u^T_{BI,C3,s} \end{cases} ,$$
$$\text{if } s \text{ corresponds to a second semester.}$$

Emigration from BI is admitted to occur during the first semester and the specimens exiting belong either to C2 or C3. The number of exits in the two length groups are considered to have independent binomial distributions with the same parameter $p_{E;BI}$.

$$\boldsymbol{u}^D_{BI,s} \sim \boldsymbol{H}^D_{BI,s}(\boldsymbol{u}^T_{BI,s}) \quad : \quad \begin{cases} u^D_{BI,C2,s} & = & u^T_{BI,C2,s} - I_{C2,s} \\ & & \text{with } I_{C2,s} \sim \text{Bi}\left(u^T_{BI,C2,s}, p_{E,BI}\right) \\ u^D_{BI,C3,s} & = & u^T_{BI,C3,s} - I_{C3,s} \\ & & \text{with } I_{C3,s} \sim \text{Bi}\left(u^T_{BI,C3,s}, p_{E,BI}\right) \end{cases}$$
$$\text{if } s \text{ corresponds to a first semester.}$$

The subprocess of survival to fishing, denoting by ϕ_{BI} the probability of one element in BI being fished, the distributions of the number of survivors to fishing in each length group are considered to be independent binomials with probability complementary to the one mentioned

$$\boldsymbol{n}_{BI,s} = \boldsymbol{u}^F_{BI,s} \sim \boldsymbol{H}^F_{BI,s}(\boldsymbol{u}^D_{BI,s}) : \begin{cases} n_{BI,C2,s}(\overline{F}) & \sim & \mathrm{Bi}(u^D_{BI,C2,s}, 1-\phi_{BI,s}) \\ n_{BI,C3,s}(\overline{F}) & \sim & \mathrm{Bi}(u^D_{BI,C3,s}, 1-\phi_{BI,s}) \\ n_{BI,C2,s}(F) & = & u^D_{BI,C2,s} - n_{BI,C2,s}(\overline{F}) \\ n_{BI,C3,s}(F) & = & u^D_{BI,C3,s} - n_{BI,C3,s}(\overline{F}) \end{cases}$$

State-space model for P

Five subprocesses are considered, the first of which is deterministic, while the others are stochastic, is

I_s - Immigration from BI

M_s - Survival to natural mortality

T_s - Class transition

E_s - Emigration

F_s - Survival to fishing.

As for the BI model it is also admitted that the subprocesses succeed in time always in the following order,

$$I_s \rightarrow M_s \rightarrow T_s \rightarrow E_s \rightarrow F_s.$$

The first subprocess to be considered is immigration from BI. The entrance in P of immigrants from BI, is admitted to occur at the beginning of the second semester. It is assumed that specimens arrive at P with a constant delay from their departure from BI estimated to be around three semesters. This time interval roughly corresponds to the age difference of specimens with modal length caught in the northern and southern areas, respectively, 94 cm and 106 cm. It is also considered that during the migration time period, both natural mortality and class transition occur. So, when s corresponds to a second semester, the number of immigrants to the group C2 of P, iC2;s, is given by the following product,

$$i_{C2,s} = E[I_{C2,s-3}]\ p^2_{M,BI}\ (1-p_{23,BI})^2.$$

where $E[I_{C2;s-3}]$ is the estimated mean number of those that have left the group C_2 of BI at the end of semester s-3, and $p^2_{M;BI}$ and $(1-p_{23;BI})^2$ are, the posterior estimates of the probability of surviving, and the probability of remaining in group C2, during two semesters of migration. The third semester of migration is supposed to occur already in the P area.

Similarly, the number of immigrants to the group C3 of P, $i_{C3;s}$ is given by,

$$i_{C3,s} = E[I_{C2,s-4}]\ p^2_{M,BI}\ (1-(1-p_{23,BI})^2) + E[I_{C3,s-3}]\ p^2_{M,BI}$$

where E[IC3;s⊚3291] represents the survivors of the estimated mean number of elements leaving the group C3 of BI. The corresponding expressions are

$$\boldsymbol{u}^I_{P,s} \sim \boldsymbol{H}^I_{P,s}(\boldsymbol{n}_{P,s-1}) : \begin{cases} u^I_{P,C2,s} = n_{P,C2,s-1}(\overline{F}) + (1-p_{23,BI})^2 p^2_{M,BI} i_{C2,s-3} \\ u^I_{P,C3,s} = n_{P,C3,s-1}(\overline{F}) + p^2_{M,BI} i_{C3,s-3} \\ \quad + (1-(1-p_{23,BI})^2) p^2_{M,BI} i_{C2,s-3} \end{cases}$$
$$\text{if } s \text{ corresponds to a second semester.}$$

The next state processes (Survival to natural mortality, Class transition, Emigration, Survival to fishing) are defined similarly to the corresponding BI subprocess but with parameters assigned to P area.

The prior distributions for the parameters in the model were selected in a way that each of them incorporates as much information as available for the species. Non-informative gamma were chosen for the prior distributions of the dispersion of the observation errors as this is the common choice for dispersion parameters.

The quality of the fitting is evaluated for each model separately. For the BI model, the catch estimates for the C2 and C3 length groups, in semester s, i.e. the components of $\hat{Y}_{BI,s}$ are the median of the distributions of the state process vector components corresponding to the two shed subpopulations, in that semester. For the P model, the catch estimates in semester s were obtained, in the same way and are denoted by $\hat{Y}_{PI,s}$. The evaluation of the model's adequacy is based on the expected deviance and also on visual inspection of the credible intervals. Contrarily to the confidence intervals, the latter are intervals in the domain of the posterior probability distributions.

Software used

The estimation of these models, both parameters and states, is done via the Bayesian paradigm, implying non-trivial integration of these several probability density functions, which is accomplished through sequential Monte Carlo. Two state models were considered in order to estimate the BI and P abundances, being estimated by sequential importance sampling according to Liu and West (2010) algorithm. The necessary computations were run in R.

Model options chosen

The prior distributions for the parameters in the models were selected in a way that each of them incorporates as much information as available for the species (Table 4). Non-informative gamma were chosen for the prior distributions of the dispersion of the observation errors as this is the common choice for dispersion parameters.

Table 4. Priors distributions adopted for the parameters in each model defined based on the mean and standard deviation shown in two right columns.

Parameter	Prior Distribution	Mean	Standard Deviation
$p_{M,BI}$	Beta(16.56,1.11)	0.937	0.06
p_{23BI}	Beta(1.15,5.92)	0.16	0.1
p_{rBI}	Beta(1,1)	0.5	0.29
$p_{E,BI}$	Beta(3.91,10.41)	0.27	0.11
q_{BI}	Log-normal($-5.44, 0.83$)	0.006	0.006
ψ_{BI}	Gamma(0.4,0.25)	0.10	0.16
$p_{M,P}$	Beta(16.56,1.11)	0.937	0.06
p_{23P}	Beta(1.09,1.35)	0.45	0.27
$p_{E,P}$	Beta(4.39,18.48)	0.19	0.08
q_P	Log-normal($-3.59, 0.83$)	0.039	0.039
ψ_P	Gamma(0.4,0.25)	0.10	0.16

Input data types and characteristics

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes			
Canum	Catch-at-age in numbers			
Weca	Weight-at-age in the commercial catch			
West	Weight-at-age of the spawning stock at spawning time.			
Mprop	Proportion of natural mortality before spawning			
Fprop	Proportion of fishing mortality before spawning			
Matprop	Proportion mature at age			
Natmor	Natural mortality			

G. Biological reference points

In view of the probable linkage between the Portuguese and British Isles fishery components, it is considered essential that the status of the stock as a whole should be considered when giving management advice for either fishery component. However, given the presumed sequential nature of the exploitation pattern, management should also take into consideration trends occurring in the separate areas.

The harvest control rule proposed by WKDEEP 2104 is therefore to adjust catches in both areas according to recent trends in total abundance for the two areas combined as estimated by the state space model (estimated by a regression fitted to the posterior median estimates of abundance of the most recent five years). This will be applied in combination with a simple harvest control rule that specifies that catch advice should only increase when the abundance trends for both fishery components are increasing. If either is stable or decreasing, the advised catch for both areas should be adjusted according to the rate of change in the area showing the decrease.

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 TYPE3	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

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Stock Annex 13.3: Red seabream in ICES Subarea IX

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Red seabream in ICES Subarea IX.
Working Group	WGDEEP
Date	April 2014
Revised by	WGDEEP / Juan Gil Herrera

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 seabream, but it offers a better way of recording the available information" (ICES, 2007). The inter-relationships of the red seabream 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 seabream also inhabit in Morocco waters. In fact recaptures of tagged fishes were also notified by Morocco fishermen.

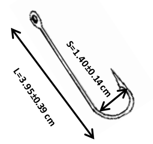
A.2. Fishery

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 seabream landings reflect a seasonal activity probably related with a larger availability of the species or market demands that lead fishermen to spend some time targeting this species (I. Figueiredo, *pers. com.*).

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 to the 2014 WGDEEP), that complete the information offered in the previous WGs (Gil *et al*., 2000; 2003; 2005; 2006; 2007; 2008; 2009; 2010; 2011; 2012 and 2013; Gil and Sobrino, 2001; 2002 and 2004). This artisanal longline fishery targeted red seabream has been developed along the Strait of Gibraltar area. In recent years 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 mechanised hook and line baited with sardine, is the gear used by the fleet (Table 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 60 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 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 1. Red seabream Spanish fishery of the Strait of Gibraltar: Fleet and gear summary descriptive.

FLEET ID	GEAR TYPE	N° BOATS	NUMBER OF LINES	HOOK TYPE AND SIZE	MEAN SOAKTIME	EFFORT (DAYS AT SEA)
LHM_DEF	Vertical mechanized handline ("voracera")	±60	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 begun 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.

In addition, Moroccan longliners have been fishing in the Strait of Gibraltar area since 2001. Around 102 boats are mainly based in Tangier and their average technical characteristics are: 20 GRT, 160 CV and about ten years old. Moreover, 435 artisanal boats (±15 CV, ≤2 GRT and 4–6 m length) also target this species in the Strait of Gibraltar area (S. Benchoucha, *pers.com.*). The WG considers the account of Moroccan data appropriate as the fishery operates in the same area as the Spanish fishery and obviously targets the same stock. Unfortunately, no updated information was available in 2014 and no new information from the Moroccan fishery has been received in the last two years.

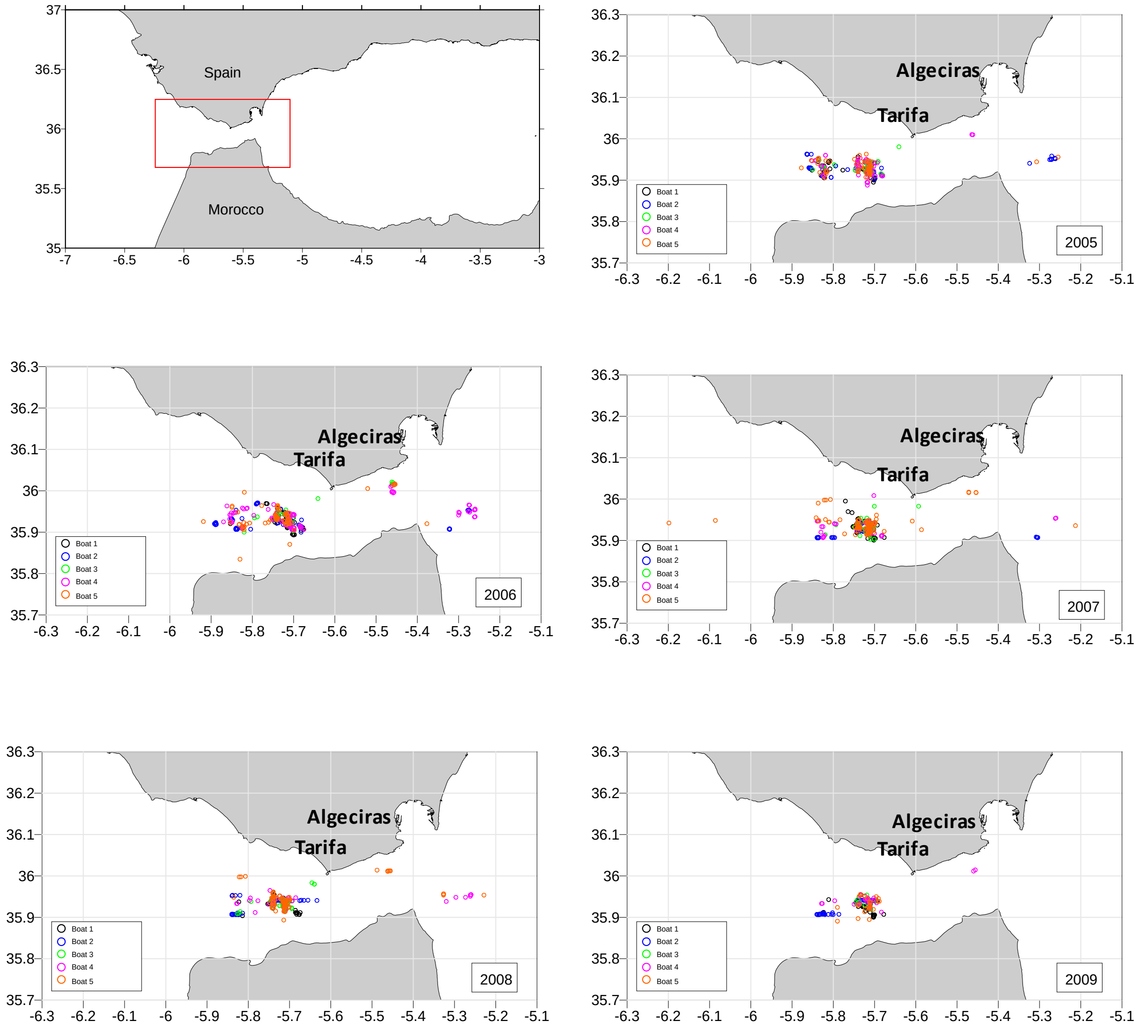


Figure 1. Red seabream Spanish fishery of the Strait of Gibraltar: Yearly soaking positions footprints from observers' on-board programme (from Gil *et al.*, WD 19 to the 2011 ICES WGDEEP).

A.3. Ecosystem aspects

Red seabream is a benthopelagic 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. A total of 1106 red seabream stomachs contents were analysed: 725 stomachs were empty and 381 were full. 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 seabream in the Strait of Gibraltar has only a main prey, *Sergia robusta* (J. Gil, *pers.com.*).

Main red seabream 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 hotspots. 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 2 shows the deep-water coral occurrences in the Strait of Gibraltar.

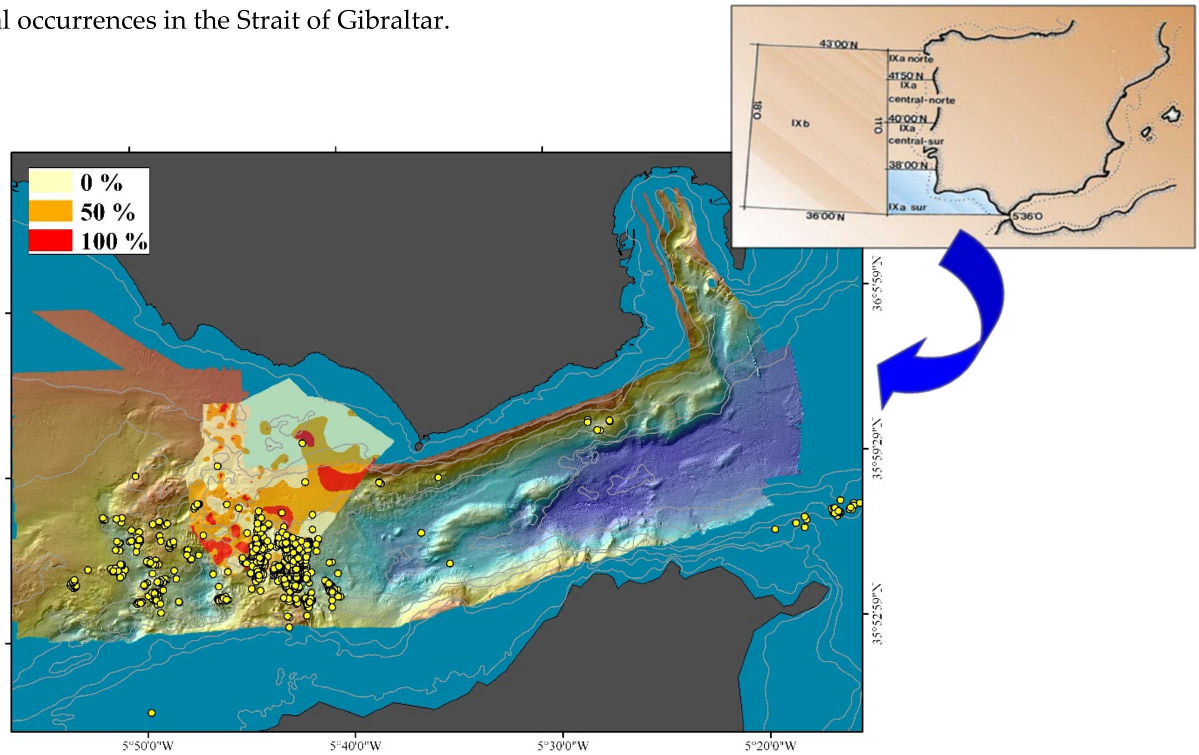


Figure 2. Coral distribution in the Strait of Gibraltar (adapted from Álvarez-Pérez *et al.* in Freiwald and Roberts eds, 2005). Yellow points correspond with "*voracera*" fleet fishing grounds from observers' on-board programme. Legend refers to percentage cover of coral.

B. Data

B.1. Commercial catch

In Subarea IX, catches -most of them taken by lines- correspond to Spain and Portugal. 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). Catches in 2009 amount to 718 t, but decreases again (484 t) over the last years (180 t in 2013, the minimum of the available time-series). Morocco information shows a continuous increasing trend in landings from 2001 to 2011.

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 2013 landings were 90 t.

Length frequencies of landings are only available for the Spanish red seabream fishery in the Strait of Gibraltar. There was a decrease of the mean size from 1995 to 1998. It is necessary to point out that the red seabream 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 increased 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 to the 2011 ICES WGDEEP) and also within Spain (Gil *et al.*, WD 19 to the 2011 ICES WGDEEP). 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 four 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 seabream is a protandric hermaphrodite species changing from male to female. Red seabream have a low productivity and they change sex as they age, starting as male and becoming female between ages four and six. 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 female, maturing at L_{50}=35.73 cm. Thus, from age 5 all individuals can be considered mature, whether they are males or females.

Red seabream 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 three and ten, 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. com.*). Table 2 presents different estimates of von Bertalanffy Growth Function (VBGF) parameters available from otoliths readings or tag–recapture data.

Table 2. Red seabream of the Strait of Gibraltar: VBGF parameter estimates.

Authors	Study Area	Methodology	T_0	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*. (WD17 to the 2011 WGDEEP) 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 seabream 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 are 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.

Age and growth based on otolith readings were revised along the ICES WKAMDEEP meeting (October, 2013): No more than ten years of age was estimated from otolith readings in the Strait of Gibraltar area but two recaptures from the tag–recapture programme have remained at sea for more than ten years (J. Gil, *pers. com*.). Moreover, growth estimates from tag–recapture experiments suggest that otolith readings may underestimate age and that some hyaline rings are uncounted and/or missing. The use of biased age estimates may have important consequences.

B.3. Surveys

Only tagging surveys were carried out in the Strait of Gibraltar area. Several tagging surveys (56 days at sea in 2001, 2002, 2004, 2006 and 2008) have been conducted in the Strait of Gibraltar area. 4500 fish were tagged and 404 recaptures have been reported. No significant movements have been observed, although local migrations were noted: feeding grounds are distributed along the entire Strait of Gibraltar and the species seems to remain within this area as a resident population (Gil, 2006). Recaptures of tagged fish have also been reported by the Moroccan fishery.

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 over-estimated.

Gil *et al*. (WD 19 to the 2011 WGDEEP) presents a short series of cpue (2005–2009) from the observers' on-board programme in the red seabream 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 seabream per ±70 hooks but the general trend seems to be slightly decreasing throughout the years.

Burgos *et al*. (2013) demonstrated that a VMS system in operation since 2009 provided a reliable estimate of actual fishing effort and derived a cpue time-series. This cpue series is now used as a biomass index of the stock.

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 not accepted and only several trends (landings and length distributions) were used for the scientific advice.

So according to the available information, DLS method 3.2 was selected to estimate C_{y+1} as a reduction of C_{y-1}, applying the 20% Uncertainty Cap and the 20% Precautionary Buffer because the steep declining the catch and in the biomass index occurred over the last years.

Software used: None

Model Options chosen: None

Input data types and characteristics:

D. Short-term projection

Model used: None

Software used: None

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: None

Software used: None

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: None

Software used: None

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 $B_{trigger}$**	**N/A**	
Approach	**F_{MSY}**	**$F_{0.1}$**	**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 assessed 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 seabream 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 seabream fishery data is described by González and Gil (WD 18 to the 2011 WGDEEP). Belcaid *et al.* (WD 20 to the 2011 WGDEEP) 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.

In 2012 new assessment attempts for the Strait of Gibraltar fishery were presented to the Group by González *et al.* (WD to the 2012 WGDEEP). Simple assessment methods that use historical catches and available trend or size-composition information could potentially be applied to many data-poor stocks. The exercise, which includes two different approaches, appears to be enough indicative because this quite small area comprises more than the 80% from the total of the species in the ICES Subarea IX:

- Depletion-Corrected Average Catch (DCAC) input parameters were: Sum of Catch along 29 years=12 723, Natural Mortality=0.2 (standard deviation of 0.5 and Lognormal distribution), F_{MSY} to M=0.8 (standard deviation of 0.2 and Lognormal distribution), Depletion Delta=0.47 (standard deviation of 0.3 and Lognormal distribution) and B_{MSY}/B0=0.4 (standard deviation of 0.1 and Beta distribution). The number of iterations chosen was 10 000.
- Besides, from 2009–2011 available information (Spain and Morocco landings and length distributions) Length Cohort (LCA) and Yield per Recruit (YpR) analysis were carried out. A plus group of 50 cm was established because the anomalous F values in larger length classes. After exploratory analysis using different F terminal random seed values (0.3–0.5–0.8) 0.5 was adopted as F terminal in the final run.

Besides, along the 2012 WGDEEP meeting several exercises were attempted:

- The Catch-MSY method (Martell and Froese) propose a new method for estimating maximum sustainable yield (MSY) from a time-series of catch data, resilience of the species, and estimations about depletion, i.e. relative stock abundances at the beginning and the end of the time-series by means of the Catch-MSY method. With the guidance and help from R. Froese a Catch MSY with the total landings in Subarea IX was carried out.
- Two new functions within FLR (FLAdvice package) allow us the simulation of a fish stock based on its life-history parameters. From a species complete set of parameters: ages 1 to 17, VBGF growth model (Linf= 62 and k=0.169) and the length–weight relationship (a= 0.014 and b=3.014) the functions derive in a set of biological reference points, including $F_{0.1}$ and $F_{30\%SPR}$.

- Another approach was considered along the WG to estimate BRPs using the Beverton and Holt function developed in R by Azevedo and Cadima (BHAC). As same as the previous, a set of life-history parameters and derives in a F vector (which includes F_{MAX}, $F_{0.1}$ and $F_{30\%SPR}$ for example).

And also several Biological Reference Points estimates from different approaches were available. Table below summarizes the methods adopted and its estimates:

METHOD/ESTIMATE	F_{MAX}	$F_{0.1}$	$F_{30\%SPR}$	$F_{40\%SPR}$	F_{SQ}
Gislason spreadsheet (WKLIFE) with AFC=3	0.61	0.26	0.36	0.24	-
Gislason spreadsheet (WKLIFE) with AFC=4	0.77	0.29	0.62	0.37	-
BHAC (WKLIFE)	0.39	0.17	0.20	0.14	-
FLAdvice (WKLIFE)		0.16	0.16		-
YpR Analysis (from LCA outputs)(1)	0.30	0.11		0.12	0.19

(1) Landings from the Strait of Gibraltar only.

WKLIFE Gislason spreadsheet was applied using an L_{MAX} of 62 cm and AFC = 3 and 4. The parameters estimated by the mode were unrealistic based on what is known about this stock and the F_{MAX} value was substantially higher than that estimated by YPR. This may be because the underpinning empirical relationships may not apply to a protandric hermaphrodite species.

In the 2014 meeting no analytical assessment was attempted. Results from gadget exploratory analysis that was presented should be considered preliminary as the model needs a better parameterization. However it was decided the use of the cpue as a biomass index rather than the use of recent landings (like two years before). Thus, the quantitative advice was given according to the DLS 3.2 method instead of the 6.2 that appears in the ICES DLS Guidance Report 2012.

In summary, recent trends are fairly clear; despite Moroccan landings from the Strait of Gibraltar are not available in the years 2012 and 2013. It is however assumed that these landings follow a decreasing trend. Landings have declined significantly over the last four years and may be considered as a substantial reduction in exploitable biomass. Mean length distribution and lpue decreasing trends may also be consistent with overexploited population signals.