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

24 April–1 May 2017

Copenhagen, Denmark

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

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Executive Summary

WGDEEP met at ICES Headquarters in Copenhagen, Denmark on 24th April to 1st of May 2017. 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.

WGDEEP gives advice according to an advice schedule where, in short, 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 ICES Division 5.a (Iceland) that 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 15 of the report.

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 16).

2 Introduction

The **Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources** (WGDEEP), chaired by Pascal Lorance from France and Gudmundur Thordarson, met at ICES Headquarters in Copenhagen, Denmark on 24th of April to 1st of May 2017.

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

2.1 Terms of Reference

2016/2/ACOM14 The Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP), chaired by Pascal Lorance, France, and Gudmundur Thordarson, Iceland, will meet at ICES Headquarters, 24 April–1 May 2017 to:

a) Address generic ToRs for Regional and Species Working Groups.

b) Complete the development of Stock Annexes for all the stocks assessed by WGDEEP, based on the most recent agreed assessment.

c) Update the description of deep-water fisheries in both the NEAFC Regulatory Area 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 Regulatory Area and describe and prepare a first Advice draft of any emerging deep-water fishery with the available data in the NEAFC Regulatory Area.

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

e) Evaluate the stock status of stocks in Icelandic waters for the provision of annual advice in 2017.

f) Evaluate the stock status of all stocks in non-EU waters for the provision of biennial advice in 2017.

g) Prepare for an evaluation of the stock status for stocks in EU waters for the provision of biennial advice due in 2018.

h) Estimate MSY proxy reference points for the category 3 and 4 stocks in need of new advice in 2017 (see table below).

   i) Collate necessary data and information for the stocks listed below prior to the Expert Group meeting. An official ICES data call was made for length and select life-history parameters for each stock in the table below;

   ii) Propose appropriate MSY proxies for each of the stocks listed below by using methods provided in the ICES Technical Guidelines (i.e. peer-reviewed methods that were developed by WKLIFE V, WKLIFE VI, and WKProxy) along with available data and expert judgement.

Stock Code	2016_Description	EG	Data Category
aru.27.123a4	Greater silver smelt (*Argentina silus*) in Subareas 1, 2, and 4, and in Division 3.a (Northeast Arctic, North Sea, Skagerrak and Kattegat)	WGDEEP	3.2
aru.27.5b6a	Greater silver smelt (*Argentina silus*) in Divisions 5.b and 6.a (Faroes grounds and west of Scotland)	WGDEEP	3.2
aru.27.5a14	Greater silver smelt (*Argentina silus*) in Subarea 14 and Division 5.a (East Greenland and Iceland grounds)	WGDEEP	3.2
aru.27.nea	Greater silver smelt (*Argentina silus*) in Subareas 7–10 and 12, and in Division 6.b (other areas)	WGDEEP	3.2
bli.27.5a14	Blue ling (*Molva dypterygia*) in Subarea 14 and Division 5.a (East Greenland and Iceland grounds)	WGDEEP	3.3
lin.27.1–2	Ling (*Molva molva*) in Subareas 1 and 2 (Northeast Arctic)	WGDEEP	3.2
lin.27.5b	Ling (*Molva molva*) in Division 5.b (Faroes grounds)	WGDEEP	3.2
lin.27.3a4a6–91214	Ling (*Molva molva*) in Subareas 6–9, 12, and 14, and in Divisions 3.a and 4.a (other areas)	WGDEEP	3.2
usk.27.1–2	Tusk (*Brosme brosme*) in Subareas 1 and 2 (Northeast Arctic)	WGDEEP	3.2
usk.27.3a45b6a7–912b	Tusk (*Brosme brosme*) in Subareas 4 and 7–9, and in Divisions 3.a, 5.b, 6.a, and 12.b (Northeast Atlantic)	WGDEEP	3.2

The assessments will be carried out on the basis of the stock annex. The assessments must be available for audit on the first day of the meeting.

Material and data relevant for the meeting must be available to the group no later than 24 March 2017 according to the Data Call 2017.

WGDEEP will report by 8 May 2017 for the attention of ACOM.

To address these terms of reference, the activity by stock assessment unit of the expert group meeting was coordinated as indicated in the table below.

Fish Stock	Stock name	Stock Coord.	Assess. Coord.	Next Advice year	Advice frequency
alf.27.nea	Alfonsinos/Golden eye perch (*Beryx* spp.) in the Northeast Atlantic	Mário Rui Rilho de Pinho	Mário Rui Rilho de Pinho	2016	Biennial
aru.27.5a14	Greater silver smelt (*Argentina silus*) in Division 5.a	Magnús Thorlacius	Gudmundur Thordarso	2016	Annual
aru.27.123a4	Greater silver smelt (*Argentina silus*) in Subareas 1 and 2	Elvar Halldor Hallferdsson	Elvar Halldor Hallferdsson	2017	Biennial
aru.27.5b6a	Greater silver smelt (*Argentina silus*) in Divisions 5.b and 6.a	Lise Helen Ofstad	Lise Helen Ofstad	2017	Biennial
aru.27.nea	Greater silver smelt (*Argentina silus*) in Subareas 4, 6.b, 7, 8, 9, 10, 12, and 14, and Divisions 3.a (other areas)	Hege Overboe Hansen	Elvar Halldor Hallferdsson	2017	Biennial
bli.27.5a14	Blue ling (*Molva dypterygia*) in Division 5.a and Subarea 14 (Iceland and Reykjanes Ridge)	Magnús Thorlacius	Gudmundur Thordarson	2016	Annual
bli.27.5b67	Blue ling (*Molva dypterygia*) in Subdivision 5.b, and Subareas 6 and 7	Pascal Lorance	Pascal Lorance	2016	Biennial
bli.27.nea	Blue ling (*Molva dypterygia*) in Divisions 3.a, and 4.a and Subareas 1, 2, 8, 9, and 12	Hege Overboe Hansen	Hege Overboe Hansen	2017	Biennial
bsf.27.nea	Black scabbardfish (*Aphanopus carbo*) in the Northeast Atlantic	Ivone Figueiredo	Ivone Figueiredo	2016	Biennial
gfb.27.nea	Greater forkbeard (*Phycis blennoides*) in the Northeast Atlantic	Guzmán Diez	Guzmán Diez	2016	Biennial
lin.27.1–2	Ling (*Molva molva*) in Subareas 1 and 2	Kristin Helle	Kristin Helle	2017	Biennial
lin.27.5a	Ling (*Molva molva*) in Division 5.a	Gudmundur Thordarson	Gudmundur Thordarson	2016	Annual
lin.27.5b	Ling (*Molva molva*) in Division 5.b	Lise	Lise	2017	Biennial

Fish Stock	Stock name	Stock Coord.	Assess. Coord.	Next Advice year	Advice frequency
lin.27.3a4a6–91214	Ling in (*Molva molva*) Divisions 3.a and 4.a, and in Subareas 6, 7, 8, 9, 12, and 14 (other areas)	Kristin Helle	Kristin Helle	2017	Biennial
ory.27.nea	Orange roughy (*Hoplostethus atlanticus*) in the Notheast Atlantic	Pascal Lorance	Pascal Lorance	2016	Biennial
rng.27.5a10b12ac14b	Roundnose grenadier (*Coryphaenoides rupenstris*) in in Mid-Atlantic Ridge (10., 12.c, 5.a1, 12.a1, 14.b1)	Dmitriy Aleksandrov	Dmitriy Aleksandrov	2017	Biennial
rng.27.3a	Roundnose grenadier (*Coryphaenoides rupenstris*) in Division 3.a	Hege Overboe Hansen	Hege Overboe Hansen	2016	Biennial
rng.27.5b6712b	Roundnose grenadier (*Coryphaenoides rupenstris*) in Subareas 6 and 7, and Divisions 5.b and 12.b	Lionel Pawlowski	Lionel Pawlowski	2016	Biennial
rng.27.1245a8914ab	Roundnose grenadier (*Coryphaenoides rupenstris*) in all other areas (1, 2, 4, 5.a2, 8, 9, 14.a, and 14.b2)	Dmitriy Aleksandrov	Dmitriy Aleksandrov	2017	Biennial
sbr.27.6–8	Red (=blackspot) sea bream (*Pagellus bogaraveo*) in Subareas 6, 7 and 8	Guzmán Diez	Guzmán Diez	2016	Biennial
sbr.27.9	Red (=blackspot) sea bream (*Pagellus bogaraveo*) in Subarea 9	Juan Gil	Juan Gil	2016	Biennial
sbr.27.10	Red (=blackspot) sea bream (*Pagellus bogaraveo*) in Subarea 10 (Azores region)	Mário Rui Rilho de Pinho	Mário Rui Rilho de Pinho	2016	Biennial
usk.27.1–2	Tusk in Subareas 1 and 2 (Arctic)	Kristin Helle	Kristin Helle	2017	Biennial
usk.27.5a14	Tusk in Division 5.a and Subarea 14	Gudmundur Thordarson	Gudmundur Thordarson	2016	Annual

Fish Stock	Stock name	Stock Coord.	Assess. Coord.	Next Advice year	Advice frequency
usk.27.12a	Tusk in Subarea 12, excluding 12.b (Mid-Atlantic Ridge)	Kristin Helle	Kristin Helle	2017	Biennial
usk.27.3a45b6a7–912b	Tusk in Divisions 3.a, 5.b, 6.a, and 12.b, and Subareas 4, 7, 8, and 9 (other areas)	Kristin Helle	Kristin Helle	2016	Biennial
usk.27.6b	Tusk in Division 6.b (Rockall)	Kristin Helle	Kristin Helle	2016	Biennial
tsu.27.nea	Roundsnout grenadier (*Trachiryncus scabrus*) in the Northeast Atltantic	Pascal Lorance	Pascal Lorance	2019	One-off advice
rhg.27.nea	Roughhead grenadier (*Macrourus berglax*) in NEAFC and 5.a (North Atlantic)	Pascal Lorance	Pascal Lorance	2019	Biennial
oth-comb	Other deep-sea species combined	Pascal Lorance	Pascal Lorance	No advice 2015	Collated data

ToR a) Address the general ToRs

In regards to the general ToRs WGDEEP did address them for the stocks relevant.

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

Most stocks assessed by WGDEEP have stock annexes but some of them are old and have not gone through a benchmark procedure. The following stock annexes were updated before the meeting by WKICEMSE: ling 5.a and tusk in 5.a and 14.

ToR c) NEAFC request on description of deep-water fishery

WGDEEP dealt with this request and the answer can be found in Section 17.

ToR d) Exploratory assessments

Exploratory assessments were presented for the following stocks:

- Greater silver smelt in 5.b and 6.a an XSA and SAM run were presented.
- Ling in 5.b an XSA and SAM run were presented.
- Red sea bream in 9 a Gadget model was presented.

A more detailed description, diagnostic and results can be found in the corresponding stock sections.

ToR e), f) g) Assessment and advice of WGDEEP stocks

These ToRs were the main focus of WGDEEP-2017.

ToR h) Estimate MSY proxy reference points for the category 3 and 4 stocks in need of new advice in 2017

A considerable time was allocated for addressing this term of reference. In general the group made good progress using the LBI method but as for SPiCT, the model was in most cases only tested using the default settings. Other proposed MSY proxy methods were not tested at the meeting.

The main concern regarding the use of LBI in terms using it for estimating relative harvest rate is that it is very sensitive to the values used for L_{∞} and L_{50}, not to mention the constant recruitment assumption. It can then be said that the method is more of a measure of selection pattern used in the fishery than actual F_{MSY} indicator.

In regards to the SPiCT model it is fairly easy to get the scripts to run but fine tuning the model, testing various assumptions and priors is more involved and takes more time than was available at the meeting. Therefore the SPiCT results presented for the various stocks are very preliminary.

In general the EG thinks the MSY proxy approach needs much further work, both inside specialised EG such as WKLIFE and the relevant expert groups (such as WGDEEP) before it can be used to evaluate if stocks are being harvested at MSY. Much better way is to further develop assessment methods that can be used in the ICES category 1 (analytical assessment) for the stocks which are potential candidates. For stocks that analytical methods do not work on the advice should only be based on the precautionary approach.

Other issues

Some issues or requirements beyond the remit of WGDEEP were identified for a few stock as follows:

1) Two stocks assessed by WGDEEP went through a benchmark and HCR evaluations, i.e. ling in 5.a and tusk in 5.a and 14 (WKICEMSE 2017). Therefore the assessment for these stocks is updated and the advice is now based on harvest rates applied to reference biomass, rather than fishing mortality before.
2) Catches of tusk in 14 have historically been very small compared to 5.a. WKICEMSE 2017 noted: "*Catches of tusk in Greenland, within ICES Subarea 14, were discussed. Minor catches (representing <5% of the total catch of tusk in 5.a+14) have always occurred in the Greenland area and were never included in the stock assessment of tusk. However, these catches increased in 2015 and 2016, representing around 10%–15% of the total catches in those years. None of the work presented to WKICEMSE included these catches, which seem to occur well away from the area where the catches included in the stock assessment take place (i.e. in or around ICES Division 5.a). Information about these catches in the Greenland area is somewhat limited and no biological samples are available; doubts related to population structure, movement and connectivities were also noted during the discussion. It was then decided to conduct a stock assessment run incorporating those catches (just the tonnage), to gain understanding on their potential impact on stock assessment results. Their inclusion in the assessment re-*

sulted in minor revisions upwards of the estimated stock biomass (around 1%–4% revision, on average throughout the years in the stock assessment) and downwards of the estimated harvest rate (around 0%–3% revision, on average throughout the years in the stock assessment, although with an increase of the harvest rates estimated for 2015 and 2016); the results of this run are available at the end of Section 2.2. As there are some doubts in relation to these catch data and population structure of tusk in the area, WKICEMSE did not feel that a decision to include these catches in the stock assessment at this point was appropriate before conducting additional explorations and having a better understanding. It is recommended that appropriate stock experts in WGDEEP should explore this issue further."

3) This issue with catches of tusk in 14 was discussed at WGDEEP 2017 and the following points were raised:

- Stock structure is generally unclear when it comes to deep-water stocks and many of the stock units assessed by WGDEEP are defined based on very limited scientific knowledge.
- The current advice units of tusk are not based on genetic studies except for tusk in Rockall and on the Mid-Atlantic Ridge.
- The fishing areas for tusk in 5.a and 14 are widely separated (see Section 6.1). However survey data do show continuous distribution between Greenland, Iceland and the Faroe Islands.
- Genetic studies do not detect difference in tusk populations from the Barents Sea down to the Faroe Islands and over to Iceland and Greenland (Knutsen *et al*., 2009).
- Knutsen *et al*. (2009) proposed that the bathymetry over the NE-Atlantic could form a "bridge" between Norway and Greenland. However they point out that tusk is not believed make extensive migrations and actually to be a sedentary species. Larval dispersal could account for the lack of genetic difference in tusk.
- It is highly plausible that the increased abundance of tusk seen in the Walter Herwig survey is of Icelandic origin that might have been dispersed as larvae to Greenland, similar as has been reported for cod in 5.a. However unlike cod it is unlikely that tusk would migrate back to Iceland
- The tusk population in Greenland is likely to be a "sink" from the Icelandic population and as such should not affect the productivity of tusk in Iceland.

Based on this WGDEEP 2017 concludes that the catches in 14 should not be included in the assessment of tusk in 5.a. Additionally the EG concludes that the division of tusk into different advice units should be reviewed, not only in 5.a and 14 but for all the tusk stocks.

4) A need for a benchmark was identified greater silver smelt in 5.b and 6.a. An exploratory assessment using SAM was presented at the meeting.

3 Stocks and Fisheries of the Oceanic Northeast Atlantic

3.1 Area overviews

Stocks and fisheries of the Oceanic Northeast Atlantic (Mid-Atlantic Ridge and oceanic seamounts and the Azores archipelago). 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. The subareas with hard substrata are characterized by a rough bottom topography comprising summits and upper slopes of seamounts and seamount complexes, the central rift valley slopes, and several fracture zones with steep slopes. However, the MAR is mainly sediment-covered and has generally gentle sloping bathymetry, and only about 5% of the lower bathyal area is hard substratum (Niedzielski *et al.* 2013).

The oceanic Northeast Atlantic also has off-ridge seamounts and seamount complexes with summits reaching into fishable depths, e.g. the Altair and Antialtair, and the Josephine Seamount.

The Azorean archipelago of nine islands and many seamounts is a major geomorphological feature spanning the MAR in the southern end of the ICES area.

3.2 Fisheries overview

Two different types of deep-water fisheries occur in the area, i.e. 1) oceanic fisheries with large midwater and bottom trawlers and longliners fishing in the central region and northern parts of the MAR, and 2) longline and handline fisheries inside the Azorean EEZ where trawling is prohibited. The latter fishery is targeted at stocks which may extend south of the ICES area.

This section deals with fisheries on the MAR and in the Azores.

3.2.1 Azores EEZ

The Azores deep-water fishery is a multispecies and multigear fishery. The dynamics of the fishery appears primarily determined by the main target species *Pagellus bogaraveo*. However, others commercially important species are also caught and the target species change seasonally according abundance, species availability, and market demand.

The fishery is relatively small scale in which 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 and island slope type with fishing operations occurring in all available areas, from the islands coasts to the multiple 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.

3.2.2 Mid-Atlantic Ridge

The Northern MAR is a very extensive area located between Iceland and Azores, and comprises features such as the comparatively shallow Reykjanes Ridge extending from southern Iceland to the Charlie-Gibbs Fracture Zone, as well as prominent seamount complexes such as the Faraday Seamounts just south of that fracture zone. Trawl fisheries started on the MAR in 1973, and more than 40 seamounts have subsequently been explored, fished for shorter or longer periods, and regarded as commercially important in Soviet/Russian assessments (Table 3.7.1). Figure 3.7.1 illustrates subareas of the area beyond national jurisdiction (where the Northeast Atlantic Fisheries Commission regulates fisheries) with depths shallower than 2000 m. These are the subareas within the approximate maximum depth of deep-water fisheries in the ICES area (in reality few fisheries extend deeper than 1500 m).

The basis of the pioneer Soviet deep-water fishery was the discovery of concentrations of roundnose grenadier (*Coryphaenoides rupestris)* on multiple hills along the MAR. 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 during multi-nation exploratory and commercial operations in the 1970s–1990s. Trawl and longline fisheries were conducted in Subareas 10, 12, 14 and 5 (Figure 3.7.2) by Russian, Icelandic, Faroese, Polish, Latvian, Spanish and Norwegian vessels. However, few of these (often subsidized) efforts led to lasting regular fisheries. It has also been suspected that IUU fishing occurred by vessels from other areas, but the scale of such activity is unknown.

The fishing activity has declined substantially during the last decade and in recent years (i.e. after 2010) the fisheries on the MAR comprised primarily a minor Faroese fishery targeting orange roughy on a few seamounts, and a recently developed Spanish trawl fishery (with bentho-pelagic trawls) targeting grenadiers (*Macrouridae*). Both fisheries fished in very limited areas compared with historical operations.

The major fishery in waters on and adjacent to the MAR is, however, currently the midwater trawl fishery along the western slope of the Reykjanes Ridge and in the Irminger Sea targeting *Sebastes mentella.* Annual landings in international waters ranged between 23 and 41 thousand tonnes in 2012–2014 (ICES, 2015).

3.3 Details on the history and trends in fisheries

3.3.1 Azores EEZ

Since the mid-1990s the landings of deep-water species show a decreasing tendency (Figure 3.7.3 and Table 3.7.2), reflecting the change in the fleet behaviour towards targeting blackspot sea bream.

Since 2000, the use of bottom longlines in the coastal areas has been significantly reduced as a result of the interdiction by the local authorities of the use of longlines in the coastal areas on a range of 6 miles from the islands coast. Large vessels (>24 m) are restricted to seamount areas outside 30 miles from the islands. As a consequence, the smaller boats that operate in the islands coast 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 only 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 12–16 meters, a change from bottom longline to handlines has been observed during the last decade. 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 or target on specific handlines.

3.3.2 Mid-Atlantic Ridge

Grenadier (Macrouridae) fisheries: The greatest annual catch of roundnose grenadier (almost 30 000 t) on the MAR was taken by the Soviet Union in 1975, fluctuating in subsequent years between 2800 and 22 800 t. The fishery for grenadier declined after the dissolution of the Soviet Union in 1992. In the last 19 years, there has only been a sporadic fishery (Figure 3.7.2) 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). During the entire fishing period to 2009, the catch of roundnose grenadier from the northern MAR amounted to more than 236 000 t, mostly from ICES Subarea 12.

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 14.b) there has been a decline in interest.

A new Spanish fishery for grenadiers has developed in Division 14.b since 2010. Official Spanish landings of roundnose grenadier have ranged between 242 and 2075 t. In the same period annual catches of 4–2687 tonnes of roughhead grenadier as well as 3–448 tonnes of roughsnout grenadier were reported to the working group. During 2015 and 2016 Spain reported landings of roundnose grenadier from subdivision 14.b1 of 533 t (and 330 t from 12.a1) and 371 t (and 289 from 12.a1) respectively.

Blue ling fisheries: The deep-water fisheries off Iceland tend to be on the continental slopes although in 1979 a short-lived fishery on spawning blue ling (*Molva dypterygia*) was initiated on a "small steep hill" at the base of the slope near the Westman Islands. The fishery peaked at 8000 t in 1980 and subsequently declined rapidly. Later, in 1993, French trawlers found a small seamount in southerly areas of the Reykjanes Ridge at the border of the Icelandic EEZ and were fishing for blue ling there 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 3.7.2). A fishery on the seamount was resumed by Spanish trawlers in the 2000s with biggest catch about 1000 t, but this has ceased.

Orange roughy fisheries: In 1992 the Faroe Islands began a series of exploratory cruises for orange roughy beginning in their own waters and later extending into international waters. Exploitable concentrations were found in late 1994 and early 1995. Several vessels began a commercial fishery but only one vessel managed to maintain a viable fishery. Most of the fishery took place on five banks. In the northern area (ICES Subarea 12) catches peaked in 1995–1998 (570–802 t), and since then have generally been less than 300 t (Figure 3.7.2). Catches from 6 to 470 t per annum were also made in ICES Subarea 10 in 1996–1998, 2000–2001, 2004–2011, 2012, 2014, 2015 and 2016. The black scabbardfish was the main bycatch species and in recent years catches were 45–313 t for both Subareas (2009–2014).

Longline fisheries for redfish: 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 vertical longlines were used in the fishery in rugged terrain. The fishery continued in 1997, but experienced an 84% decrease in cpue. Norway carried out two exploratory longline surveys in 1996 and 1997. A Russian longline fishery was conducted in the same area in 2005–2007 and 2009.

Alfonsino fisheries: The first commercial catches of alfonsino in this area were taken by pelagic trawling on the Spectre seamount in 1977 and this and other seamounts were exploited in 1978 and 1979. No commercial fishing took place during the 1980s but nine exploratory and research cruises yielded about 1000 t of mixed deep-water species, mostly alfonsino, but also commercial catches of cardinal fish, orange roughy, black scabbardfish and silver roughy (*Hoplostethus mediterrraneus)*. A joint 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 potential commercial significance. Commercial fishing yielded more than 2800 t over the next seven years (Figure 3.7.2). In recent years there have been no indications of a target 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. Faroe Islands reported landings of 141 t of alfonsinos and 82 t of orange roughy from area 10 (and 1.7 t from area 12) during 2015. During 2016 Faroes reported landings, from area 10, of 48 t of alfonsinos, 86 t of orange roughy (and 7 t from area 12) and 50 t of black scabbardfish (and 0.2 t from area 12).

Current status*:* Deep-water fisheries in the MAR have declined to very low levels in the recent years in Subareas 10 and 12, due to many reasons, including the implementation of a range of management measures.

3.4 Technical interactions

3.4.1 Azores EEZs

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 2004–2010 shows that for some species, like deep-water sharks, the discards may be important. Actually, commercial value species like red blackspot sea bream and wreckfish, alfonsinos among others, are also discarded. These changes may be 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.

3.4.2 Mid-Atlantic Ridge

Seamount aggregating species such alfonsinos and orange roughy are sensitive to sequential local depletion. However, no data were available to assess such effects in these areas. Little is understood about the stock structure of these species and it is not known whether the trawler fleets that fished in international waters of the MAR fish the same stocks that are exploited inside the EEZ by the Azorean fishery.

3.5 Ecosystem considerations

3.5.1 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.

3.5.2 Mid-Atlantic Ridge

Most of Divisions 12.a, 12.c, 10.b, 14.b1 and 5.a are abyssal plain habitats with an average depth of around 4000 m which remains unexploited. The major topographic feature is the northern part of the MAR, located between Iceland and the Azores. The geomorphological characteristics of seamounts and ridges and the hydrographic conditions associated with them form the basis for densely populated filter-feeding epifaunal communities comprising sponges, bivalves, brittlestars, sea lilies and a variety of corals (gorgonians, scleractinians a.o.), including the cold-water coral *Lophelia pertusa* and *Solenosmilia* (Mortensen *et al.*, 2008). This benthic habitat, probably also benefitting from impinging biomass of mesopelagic organisms (fish, zooplankton) (Sutton *et al.*, 2008), supports elevated levels of biomass in the form of aggregations of fish such as roundnose grenadier, orange roughy, alfonsinos, etc. The sessile benthic communities on hard substrata (i.e. regarded as 'vulnerable marine ecosystems' *sensu* FAO (2009) are highly susceptible to damage by bottom fishing gear, and the fish stocks can be rapidly depleted due to the life-history traits and behaviour of the species. The demersal fish fauna of the MAR has been well described based on data from exploratory fishing and scientific investigations (e.g. Hareide and Garnes, 2001; Bergstad *et al.*, 2008; Fossen *et al.*, 2008). Several of the seamount fish have long lifespans, low production rates and form easily targeted aggregations.

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. There is a substantial literature on biogeography of seamounts and the MAR, and also some recent studies of population genetics. Demersal fish assemblages on the MAR resemble those on adjacent slope areas on either side (Bergstad *et al.*, 2012), and for some important commercial species, e.g. roundnose grenadier, genetic studies suggest homogeneity across wide areas across the ocean basin (Knutsen *et al.*, 2012).

3.6 Management of fisheries

3.6.1 Azores EEZ

In the Azorean EEZ 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 sea bream, 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, minimum lengths and closed seasons) and updated thereafter.

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

3.6.2 Mid-Atlantic Ridge

There is a NEAFC regulation of fishing effort in the fisheries for deep-sea species (species on the NEAFC Annex 1b) list of regulated resources). This generalized measure is intended to prevent expansion in fisheries, including by third parties. The use of gillnets is prohibited beyond 200 m depth.

Specific measures were introduced for grenadiers, orange roughy, blue ling and deep-water sharks (http://neafc.org/managing_fisheries/measures/current). In 2015, the fishery for orange roughy was closed, and directed fishery for deep-water sharks has been prohibited.

Current NEAFC measures also include regulations on bottom fishing aimed to protect VMEs. Regular fishing with bottom-touching fishing gear is only allowed in restricted subareas of the NEAFC Regulatory Area designated as 'existing fishing areas' (Figure 3.7.4). Other areas are either closed to bottom fishing or considered subareas only open to pre-assessed exploratory fisheries evaluated and accepted by the commission. In the event a possible VME is encountered in 'existing fishing areas' or during exploratory fishing, move-on rules apply and temporary closures established until it has been determined that a VME exists or not.

European Union TACs for deep-sea species apply to licensed EU vessels fishing on the MAR.

3.7 References

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3.8 Tables

Table 3.7.2. Overview of landings in Subareas 10 (a.1,a.2,b),12I (c, a.1) (does not include information from 12.b, Western Hatton Bank) and 14.b1).

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ALFONSINOS (*Beryx* spp.)	731	1510	384	229	725	484	199	243	172	139	161	192	211	252	312	245	232	222	168	131	292	156
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		0	
BLACK SCABBARDFISH (*Aphanopus carbo*)	304	455	203	253	224	357	134	1062	502	384	198	73		80	162	240	163	16	206	85	7	86
BLUEMOUTH (*Helicolenus dactylopterus*)	589	483	410	381	340	452	301	280	338	282	190	209	275	281	267	213	231	190	235	200	256	306
DEEP WATER CARDINAL FISH (*Epigonus telescopus*)						3		14	16	21	4	10	7	7	7	5	5	4	4	2	4	
GREATER FORKBEARD (*Phycis blennoides*)	75	47	32	39	41	100	91	63	56	46	22	134	201	18	26	14	11	6	8	9	10	10
LING (*Molva molva*)	50	2	9	2	2	7	59	8	19		2				1			0	0		1	
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		47	84	93
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	448		
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	2075	862	659,95
RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*)	1115	1052	1012	1119	1222	947	1034	1193	1068	1075	1383	958	1070	1089	1042	687	624	613	692	663	701	515
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	713	429	87
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			1	
WRECKFISH (*Polyprion americanus*)	244	243	177	140	133	268	232	283	270	189	279	497	664	513	382	238	266	226	209	121	116	101
TOTAL	7222	10113	17861	22323	20993	17578	16533	17272	10950	8161	10364	2666	2674	2489	2393	3715	5218	7441	4398	4493	2 764	2 014

Table 3.7.1. Summary data on seamount fisheries on the MAR.

Main species	Discovery		No. of commercial seamounts	Maximum catch/yr ('000 t)
	Year	Country		
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

3.9 Figures

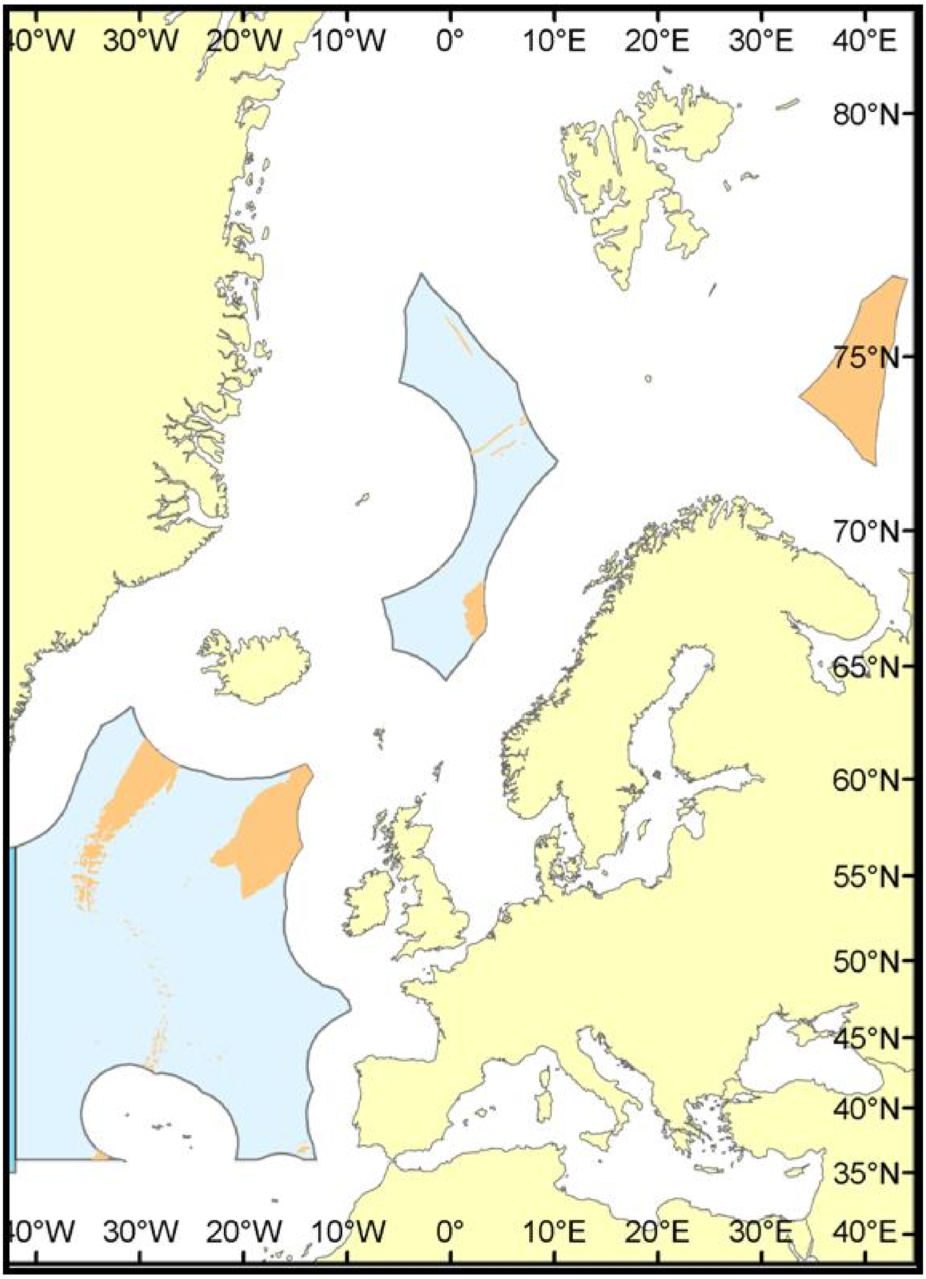


Figure 3.7.1. The NEAFC Regulatory Area (area beyond national jurisdiction) in the Northeast Atlantic (light blue polygons) with superimposed subareas shallower than 2000 m (light brown patches). Note that the NEAFC RA in the Barents Sea is entirely shallower than 2000 m, and that a high Arctic NEAFC RA (beyond 80◦N) is not shown on the map.

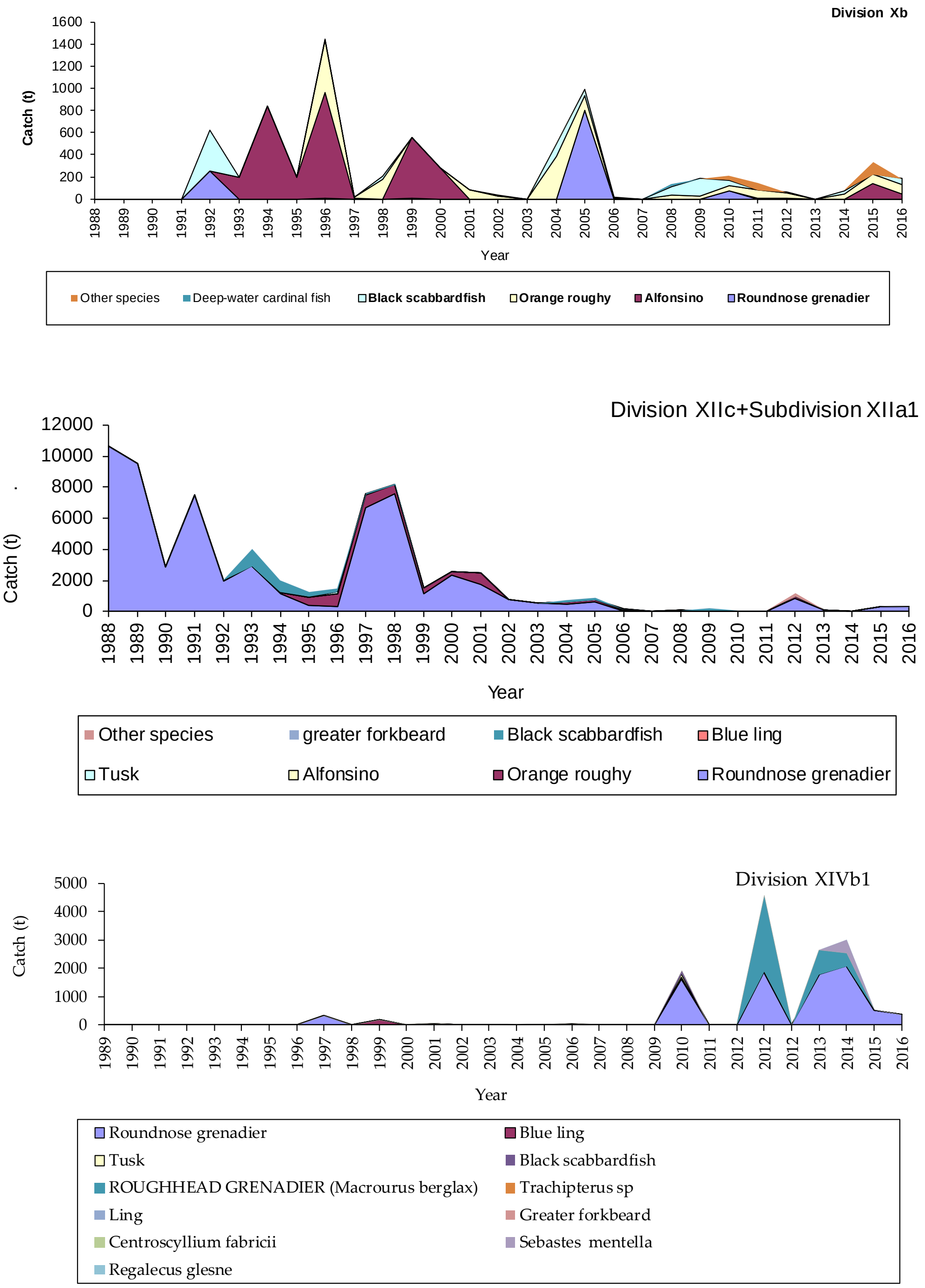


Figure 3.7.2. Annual catch of major deep-water species on MAR in 1988–2015.

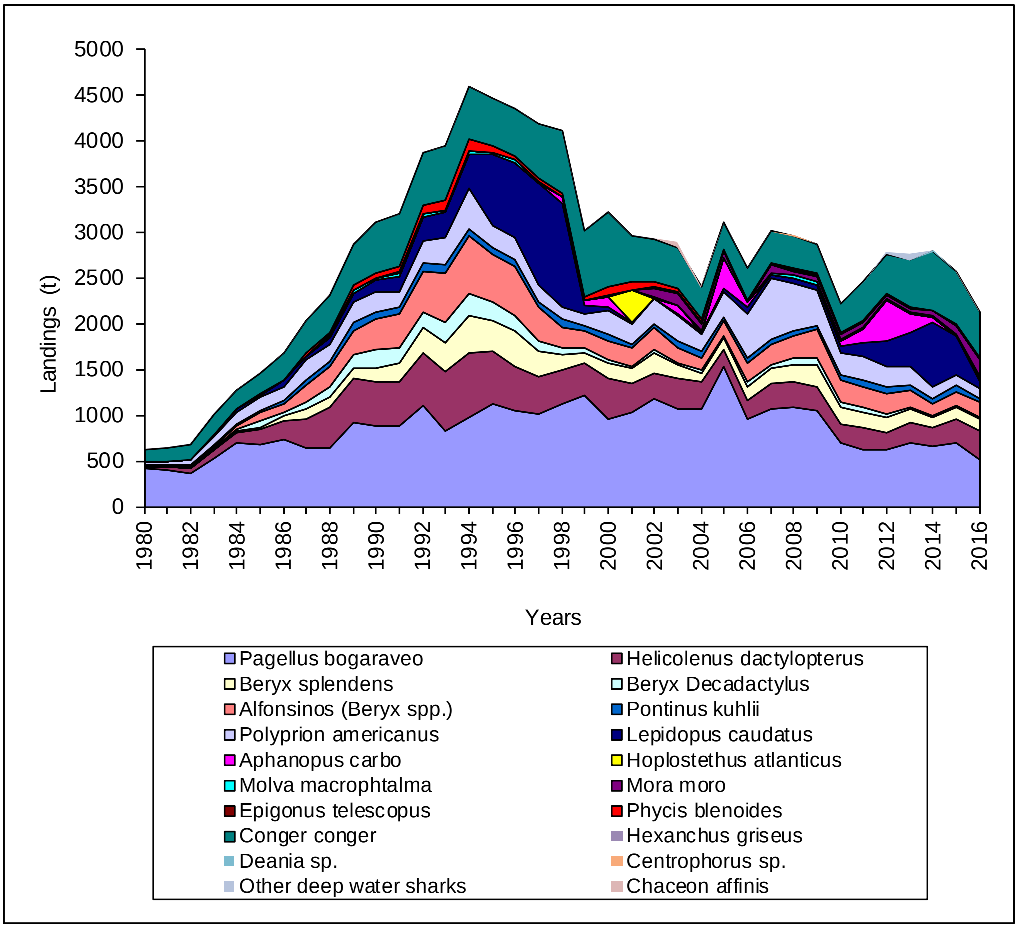


Figure 3.7.3. Annual landings of major deep-water species in Azores from hook and line fishery (1980–2016).

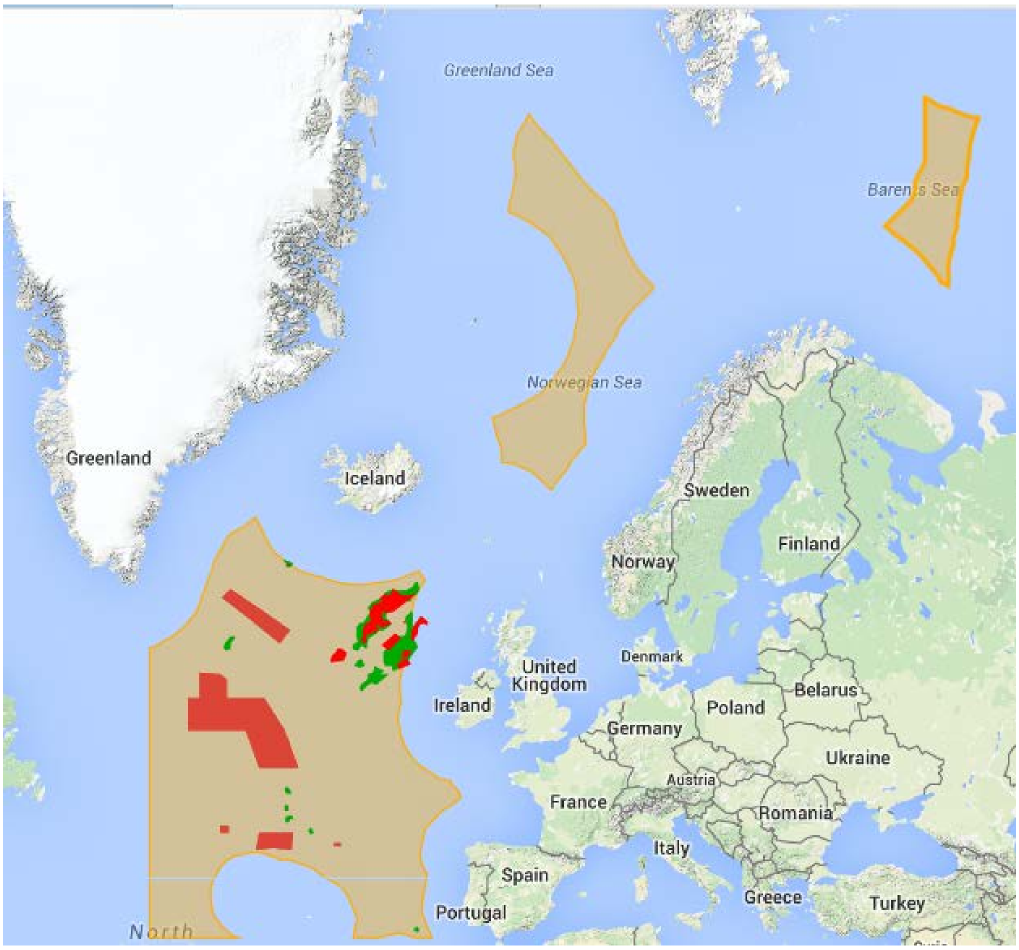


Figure 3.7.4. The regulatory area of NEAFC (light brown) and subareas of the Mid-Atlantic Ridge, seamounts and the Rockall-Hatton areas designated as bottom fishing closures (red), and 'existing fishing areas (green). Areas outside closures and 'existing fishing areas' are only open to pre-assessed exploratory bottom fishing. Source: www.neafc.org .

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

4.1 Stock description and management units

4.2 Ling (*Molva Molva*) in Division 5.b

4.2.1 The fishery

The longline fisheries in Faroese waters were mainly on the slope on the Faroe Plateau and a small amount of it was on the bank areas and Wyville-Thomson Ridge (Figure 4.2.1). Ling was also caught as bycatch by trawlers fishing saithe on the Faroe Plateau (Figure 4.2.2). In the latest years, foreign catches was mainly by the Norwegian longliners.

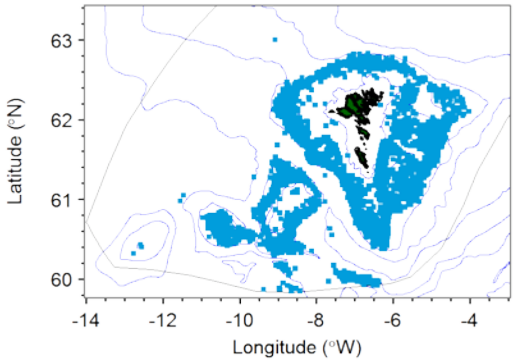


Figure 4.2.1. Ling in 5.b. Spatial distribution of the longline fishery 1985 to present, where ling was >30% of the total catches in the sets. These are the data behind the longliners cpue series of ling.

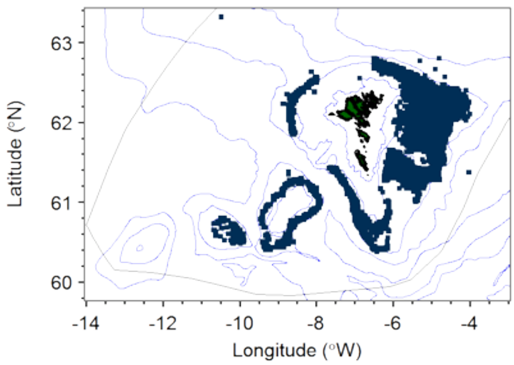


Figure 4.2.2. Ling in 5.b. Spatial distribution of pair trawler fishery 1994 to present, where ling was in the catch and saithe >60% of the total catch per haul. These are the data behind the pair trawler bycatch cpue series of ling.

4.2.2 Landings trends

Landings data for this stock are available from 1904 onwards (Figure 4.2.3). Landing statistics for ling by nation for the period 1988–2016 are given in Tables 4.2.1–4.2.3 and total landings data from 1904 onwards are shown in Figure 4.2.3. Total landings in Division 5.b 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 was fished in area 5.b2, and in the period 2006–2016 this has decreased to around 10%. The preliminary landings of ling in 2016 were 5886 tons, of which the Faroes caught 81%. The reason for the low foreign catches in 2011–2013 was because of no bilateral agreement on fishing rights between the Faroes, Norway and EU.

Around 50–70% of the ling in 5.b was caught by longliners and the rest mainly by trawlers (30–40%). Only a minor part of the landings were by other gear.

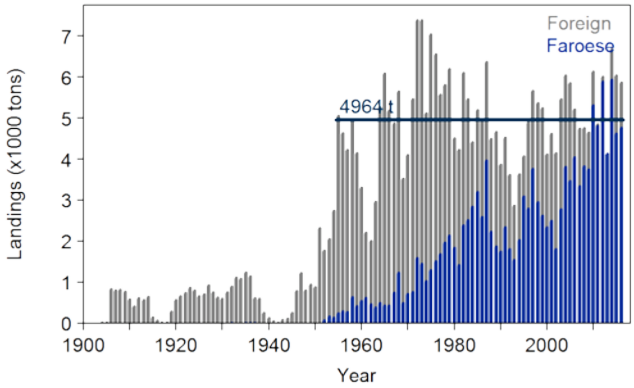


Figure 4.2.3. Ling in 5.b. Total international landings since 1904. The mean catches from 1955 to present were around 5000 tons.

4.2.3 ICES Advice

ICES advises that when the precautionary approach is applied, effort should be adjusted such that catches should be no more than 6730 tonnes in each of the years 2016 and 2017.

4.2.4 Management

For the Faroese fleets, there is no species-specific management of ling in 5.b, 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.

There is a bilateral agreed quota between Norway and Faroe Islands, but there was no such agreement in 2011–2013. In 2017, Norway can catch 2000 tons ling/blue ling, 1700 tons tusk, 567 tons saithe and 800 tons other species in Faroese waters.

In 2017, the Faroese Government will allow five Russian vessels to undertake experimental fishing in the Faroese Fishing Zone at depths deeper than 700 meters, provided that a Russian scientific observer is on board. No more than three vessels can be operating simultaneously. Two of these vessels can undertake experimental fishery in deep waters around Outer Bailey and Bill Baileys Banks, at depth between 500 and 700 meters, provided that catches in this area do not exceed 500 tonnes of deep-sea species.

Quotas of blue ling/ling* and other species for European Union vessels fishing in the Faroese zone in 2017 is 2000 tonnes and 800 tonnes, respectively. *Catches of maximum 665 tonnes of roundnose grenadier and black scabbardfish to be counted against this quota.

4.2.5 Data available

Data on length, gutted weight 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.

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 (mainly length and round weight, Table 4.2.4) 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.

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 Faroese EEZ, 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 longliners, the trawler fleet that captures ling as bycatch and two groundfish surveys (Figures 4.2.4–4.2.7).

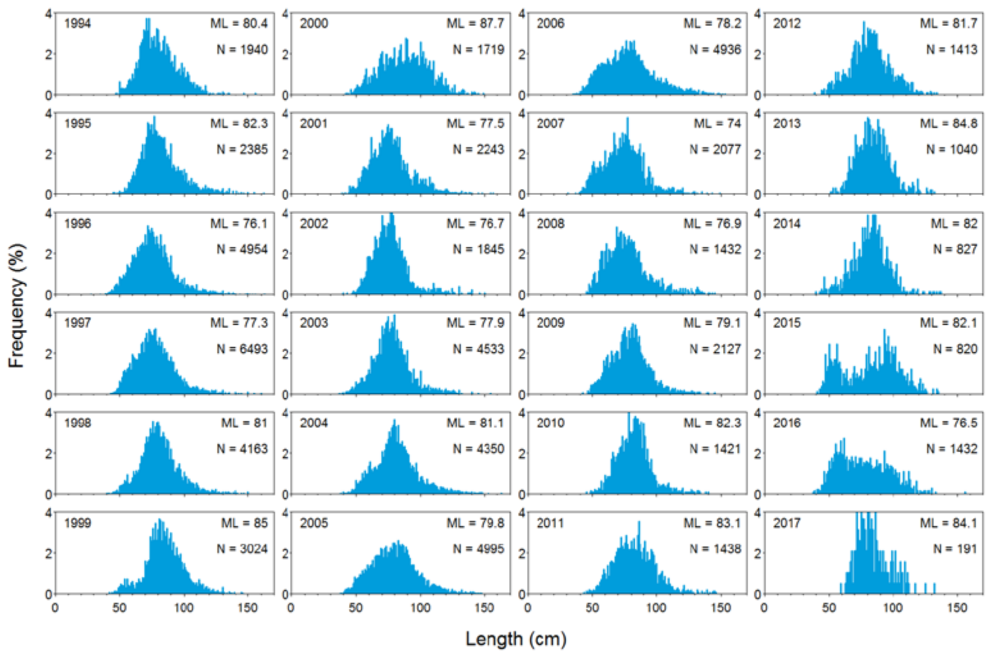


Figure 4.2.4. Ling in 5.b. Length distribution in the landings of ling from Faroese longliners (>110 GRT). ML-mean length and N-number of length measures.

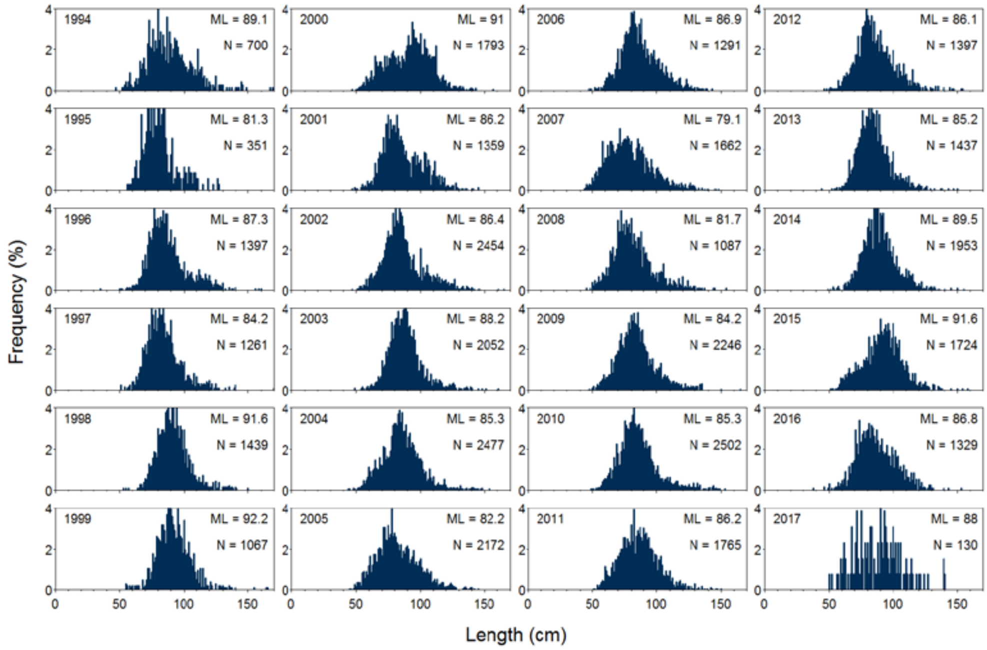


Figure 4.2.5. Ling in 5.b. Length distribution in the landings of ling from Faroese trawlers (>1000 HP). ML-mean length and N-number of length measures.

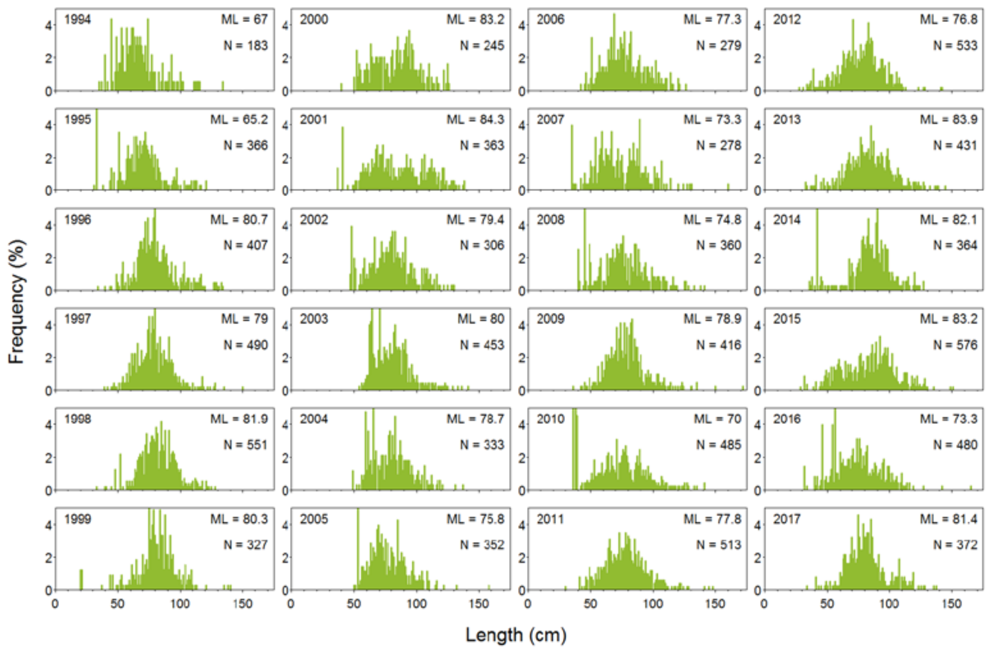


Figure 4.2.6. Ling in 5.b. Length distribution from the spring groundfish survey. ML- mean length, N- number of calculated length measures. The small ling are often sampled from a sub-sample of the total catch, so the values are multiplied to total catch.

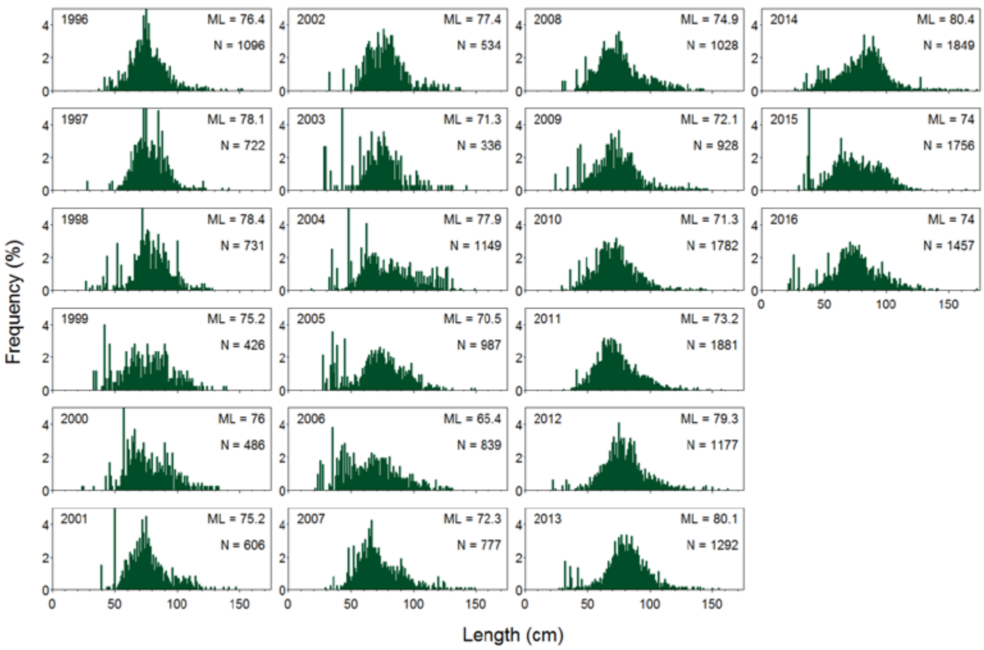


Figure 4.2.7. Ling in 5.b. Length distribution from the summer groundfish survey. ML- mean length, N- number of calculated length measures. The small ling are often sampled from a sub-sample of the total catch, so the values are multiplied to total catch.

4.2.5.3 Catch-at-age

Catch-at-age data were provided for Faroese landings in 5.b for the period 1996 to present. Due to few age data in the recent period were all ages from 1996 to present combined (the same age–length key for all these years in the exploratory assessment). Thereafter were the age–length data distributed on the lengths for the distinct years and fleets (longliners and trawlers) (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.

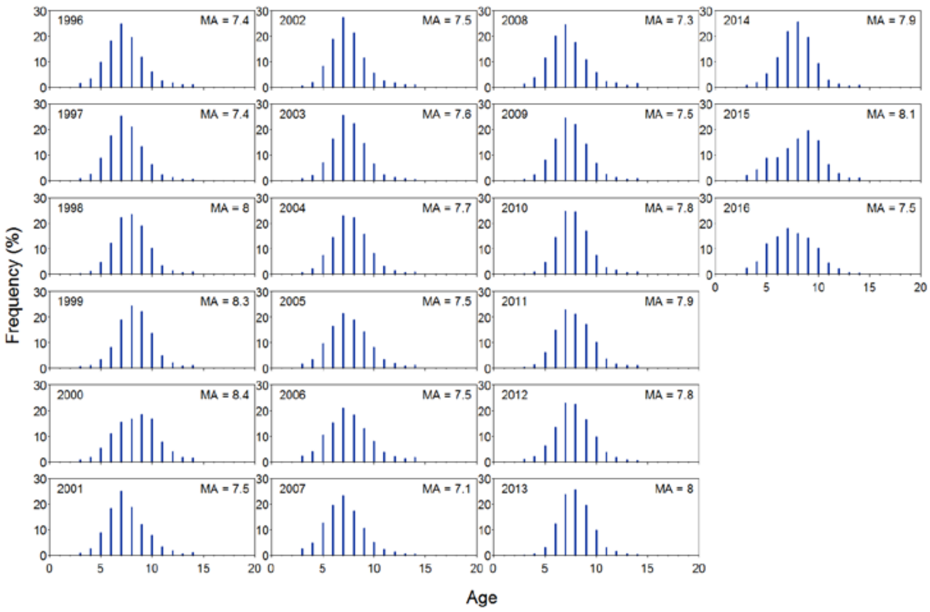


Figure 4.2.8. Ling 5.b. Catch-at-age composition used in the exploratory assessment. MA- mean age.

4.2.5.4 Weight-at-age

Mean weight-at-age data from the landings in 5.b were modelled by using all the age samples from landings (1996 to present) combined before they were distributed on the length distribution for the distinct year and fleet (longliners and trawlers). There is no particular decreasing trend in the mean weights over the period (Figure 4.2.9).

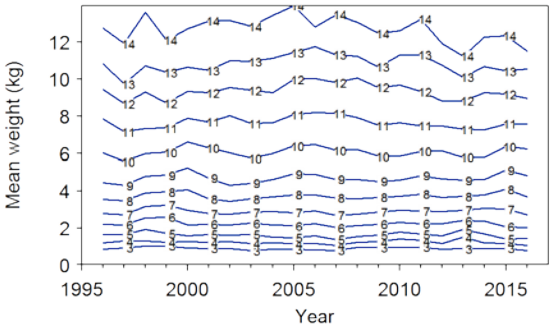


Figure 4.2.9. Ling in 5.b. Mean weight-at-age in the catches.

4.2.5.5 Maturity and natural mortality

Maturity ogives of ling are presented in Table below. The results 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).

Maturity parameters:

Area	Sex	A_{50}	N	L_{50}	N	RW_{50}	N	GW_{50}	N
Faroese waters	Combined	5.89	1677	68.86	1737	2069.5	1308	1435.2	295
Faroese waters	Female	6.21	846	71.81	871				
Faroese waters	Male	5.60	831	66.54	865				

The same calculated maturity-at-age of all data was used for all years in the assessment for sexes combined.

No information is available on natural mortality of ling in 5.b. Natural mortality of 0.15 was assumed for all ages in the assessment.

4.2.5.6 Catch, effort and research vessel data

Commercial cpue series

There are catch per unit of effort (cpue) data available from three commercial series, the Faroese longliners, the Faroese pair trawlers (bycatch) and Norwegian longliners fishing in Division 5.b. The Faroese cpue data are from five longliners (GRT>110) and 6–10 pair trawlers (HP>1000). The effort obtained from the logbooks was 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 selection of data and standardization are described in the stock annex for ling in 5.b. The data selected in the longliner series was only from sets where ling was more than 30% of the total catch to be able to compare with the Norwegian longliner series.

The standardized cpue data from Norwegian longliners fishing in Division 5.b are described in the stock annex for ling in 2.a (Section ling in 1 and 2) and in Helle *et al.*, 2017. The sets where ling >30% of the total catch were used. The Norwegian and Faroese longliners are comparable and both have ling (and tusk) as target species.

Fisheries-independent cpue series

Cpue estimates (kg/hour) for ling are available from two annual groundfish trawl surveys on the Faroe Plateau designed for cod, haddock and saithe. The annual survey on the Faroe Plateau covers the main fishing areas and mainly the larger part of the spatial distribution area (Ofstad, WD WGDEEP 2017). The summer survey series were used as tuning series for ling in 5.b in the exploratory assessment. Ages from 1242 otoliths were used in the combined age–length key, and then distributed out on length distribution of each distinct year (1996 to present). Information on the surveys and standardization of the data are described in the stock annex.

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 on the Faroe Plateau.

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 74–79 cm in 2007 to mainly around 83–86 cm since 2010 (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 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 on the Faroe Plateau showed high interannual 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 abundance

Information on abundance trends can be derived from the cpue data from the Faroese longliners (Figure 4.2.10), Norwegian longliners fishing in 5.b (Figure 4.2.11), bycatch from the Faroese pair trawlers fishing saithe (Figure 4.2.10) and from the Faroese groundfish surveys (Figure 4.2.12). Data from these series are presented in Table 4.2.5–4.2.6.

The Faroese longline cpue series and the Faroese trawl bycatch cpue series show an increasing trend since around 2001. The Norwegian longline series show an increase since 2004. It has to be noted that there are less than 100 fishing days from Norwegian longliners in Faroese waters in 2009–2014 (Table 4.2.6).

The two survey cpue series indicate a stable situation since the late 1990s and an increase in recent years. There were a small decrease in latest years, but the values were still well above the mean value.

A potential recruitment index was calculated from the two surveys as the number of ling smaller than 40 cm (Figure 4.2.13). This shows indications of increasing recruitment in recent years. In addition, a potential recruitment index was calculated of ling (2–3 cm in length) from the annual 0-group survey on the Faroe Plateau 1983 to present, which also showed indications of high recruitment (Figure 4.2.14). These recruitment indices support an indication of increasing recruitment in recent years.

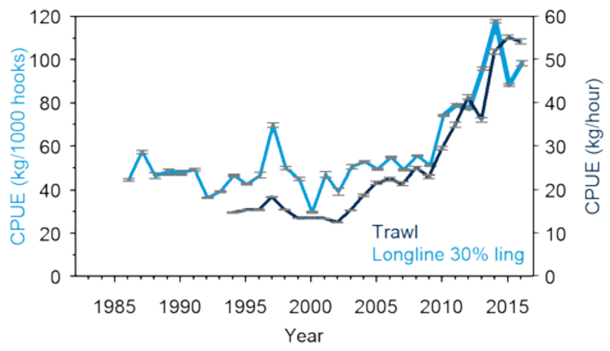


Figure 4.2.10. Ling in 5.b. Standardized cpue from Faroese longliners (turquoise line) and pair trawlers (bycatch, dark blue line) fishing in Faroese waters. Data from longliners (>110 GRT) are from sets where ling >30% of the total catch. Data from trawlers are from hauls where ling was caught and saithe >60% of the total catch. The error bars are SE.

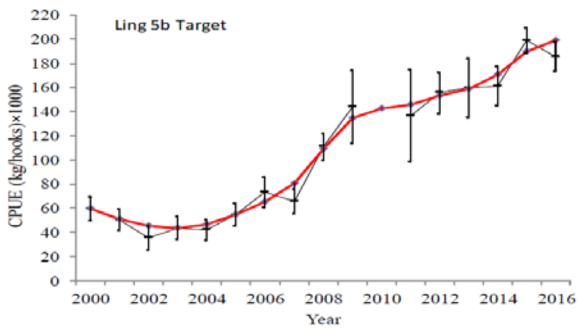


Figure 4.2.11. Ling in 5.b. Standardized cpue (kg/ 1000 hooks) of ling from Norwegian longliners fishing in 5.b. The bars denote the 95% confidence intervals. The smoothed cpue series is in red. Note that there are very few data since 2006 (WD Helle and Pennington, WGDEEP 2017).

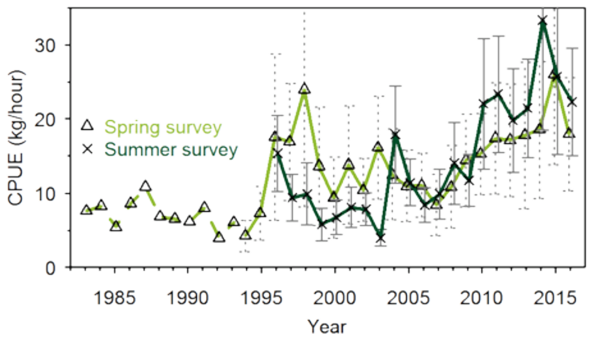


Figure 4.2.12. Ling in 5.b. Standardized cpue (kg/h) from the two annual Faroese groundfish surveys on the Faroe Plateau. The error bars are SE. The data for 1983–1993 were not standardized.

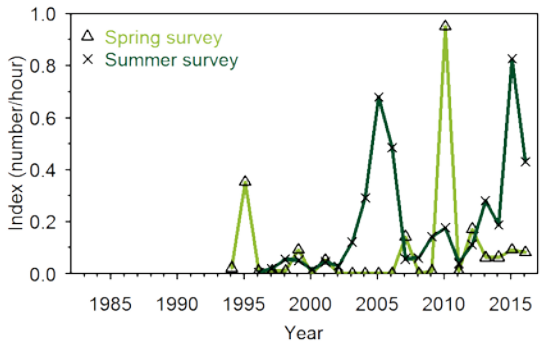


Figure 4.2.13. Ling in 5.b. Index (number/hour) of ling smaller than 40 cm from the spring- and summer survey on the Faroe Plateau.

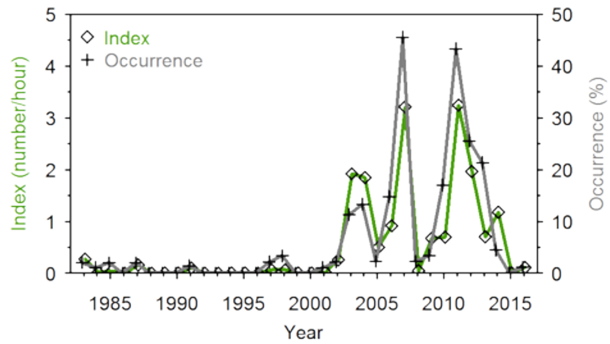


Figure 4.2.14. Ling in 5.b. Index (number/hour) and occurrence (%) of ling (2–3 cm in length) caught in the annual 0-group survey on the Faroe Plateau.

Analytical assessment

An exploratory assessment of ling in Division 5.b was done by using an age-based extended survivor analysis model (XSA) and SAM (Ofstad, WD15, 2017). The summer survey series was used as tuning series. The summer surveys on the Faroe Plateau cover most of the spatial distribution area and the fishery areas. In addition, the surveys also had the same trend as the commercial series.

The SAM model fitted the cpue-data well, but the log q residuals showed some seasonal problems in following the cohorts.

The results from the SAM model supported 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 (Figure 4.2.15, Table 4.2.7). The recruitment was quite stable, i.e. between 2 and 6 million, until 2013, where the recruitment increased to 13 million in 2015. The total biomass ranged between 21 and 30 thousand tons with an increase to around 55 thousand in 2015. The spawning–stock biomass varied between 12 and 28 thousand tons. The fishing mortality varied between 0.25 and 0.40 and the natural mortality was set to 0.15 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.

Comparison with the summary output from XSA (Figure 4.2.15) showed that SAM gave more stable results and in addition SAM gave variation as high and low values in the results.

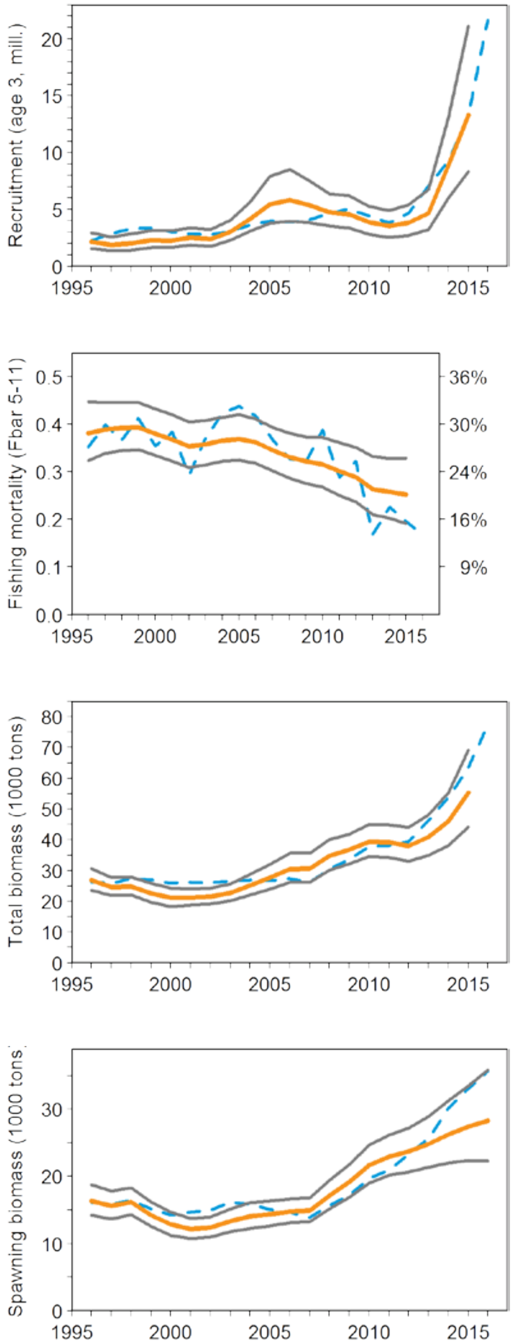


Figure 4.2.15. Ling in 5.b. Output from the age based assessment using SAM (orange) and XSA (stippled blue line).

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 $B_{trigger}$.

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 (1996 to present). The F_{MAX} was well-defined (F-factor of 0.9 giving an absolute F of 0.35). Fishing of F_{MAX} gave a catch of around 4400 tons and a biomass of 29 000 tons. The estimate of $F_{0.1}$ (F-factor of 0.45 giving an absolute F of 0.18) gave a catch of around 4200 tons and biomass of around 39 000 tons. The estimate of $F_{0.1}$ could be used as a conservative F_{MSY} proxy.

4.2.7 Comments on assessment

All signs from commercial catches and surveys indicate that ling in Division 5.b is at present in a good state. This is confirmed in the exploratory assessment using the summer survey as tuning series.

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 in recruitment, stock biomass and spawning–stock biomass during the last year's period.

Ling in 5.b is a category 3 stock according to the ICES DLS approach proposed by the ADG in 2012. There are possibilities to increase ling in 5.b to a category 1 stock with the excising data.

In the advice a 3.2 rule was used on the summer survey.

4.2.8 Management consideration

Stability in landings and trends in abundance indices suggest that ling in Division 5.b has been stable since the middle of the 1980s, with an increasing trend in the last seven years. The available dataseries does not cover the entire period of the fishery (back to the early 1900s; see Figure 4.2.3) and no information is available on stock levels prior to 1986. There is evidence of increased recruitment in the last seven years compared to earlier levels.

The only species-specific management for Faroese fisheries of ling in Division 5.b 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 of ling is influenced by regulations aimed at other groundfish species, e.g. cod, haddock, and saithe such as closed areas. The fisheries by other nations are regulated by TACs.

4.2.9 Application of MSY proxy reference points

<u>Length-based indicator method (LBI)</u>

The input parameters and the catch length composition for the period 1995–2016 are presented in the table below and in Figure 4.2.16. The length data used in the LBI model are data from the Faroese longliner and trawler fleets. The length data are not raised to total catch.

Input parameters for LBI.

Data type	Years/Value	Source	Notes
length–frequency distribution	1995–2016	Faroese long-liners and trawlers	
Length–weight relation	$0.0033 * \text{length}^{3.1311}$	Faroese survey data	combined sex
L_{MAT}	69 cm	Faroese survey data	
L_{inf}	198 cm	Faroese survey data	

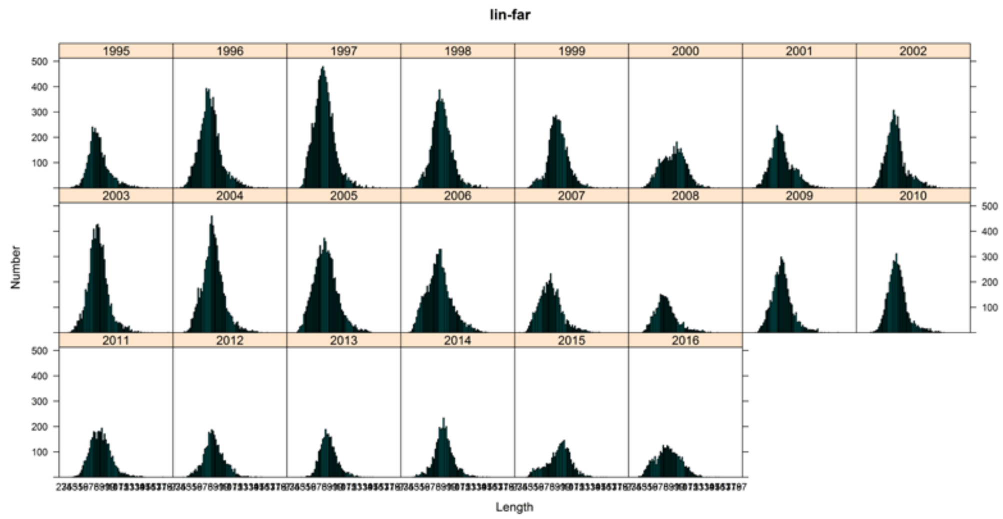


Figure 4.2.16. Ling in Faroese waters (5.b). Catch length distributions for the period 2001–2016 with 2 cm length bins (sex combined).

Output from the screening of length indicator ratios for combined sexes was conducted under three scenarios: (a) Conservation; (b) Optimal yield, and (c) maximum sustainable yield (Figure 4.2.17).

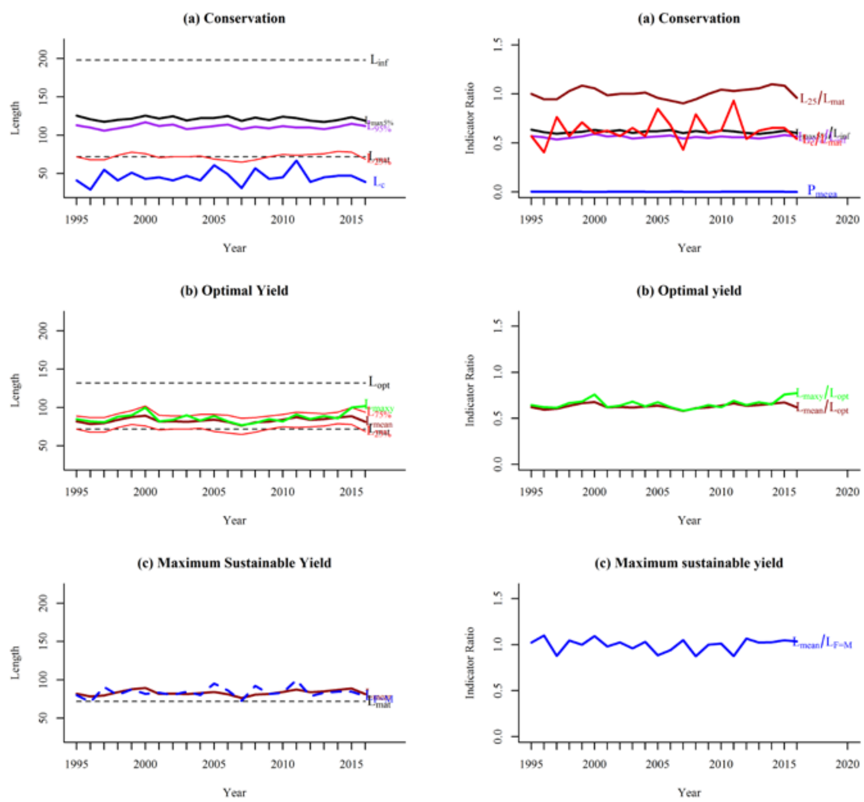


Figure 4.2.17. Ling in Faroese waters (5.b). Screening of length indicators ratios for sex combined under three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

Analysing the results showed that the conservation of immature ling indicator, L_c/L_{mat}, was usually less than one, while $L_{25\%}/L_{mat}$ was usually around 1 (Figure 4.2.17). In 2014-2016, $L_{25\%}/L_{mat}$, has been greater than 0.96 (Table below).

The conservation of large ling indicator, $L_{max5\%}/L_{inf}$, was around 0.6 for the entire period (Figure 4.2.17), and between 0.60 and 0.62 in 2014-2016 (Table below). The indicator was less than 0.8, which suggests that there were few mega-spawners in the catch. Since the VBF produced an unusually high L_{inf}, the value used in the model was L_{max}. This could be the reason that the indicator ratio was less than 0.8. If we would have used a lower L_{inf} value, the indicator ratio would have been higher! The catch was lower than the length of optimal yield.

The MSY indicator ($L_{mean}/L_{F=M}$) was greater than 1 for almost the whole period (Figure 4.2.17), which indicates that ling in Faroese waters are fished sustainably.

Conclusion: The overall perception of the stock during the period 2014–2016 is that ling in Faroese waters seems to be fished sustainably (Table below). However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

The final results from the LBI method.

	Conservation				Optimizing Yield	MSY
Ling 5.b	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2014	0.65	1.10	0.61	0%	0.66	1.03
2015	0.65	1.08	0.62	0%	0.67	1.05
2016	0.54	0.96	0.60	0%	0.62	1.04

<u>SPiCT</u>

The SPiCT model was tried with the landing data (1988–2016) and the index of ling from the summer survey (1996–2016). The model did not converge, so there are no results to show.

Table 4.2.1. Ling in 5.b1. Nominal landings (1988–present).

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	3734	7		0		0		3744
2014		5653	10		308		7	13	5990
2015		4375	15		993	1	3	6	5392
2016*		4214	4		855	0	114		5187

***Preliminary.**

(1) Includes 5.b2.

(2) Greenland 2006–2013.

Table 4.2.2. Ling in 5.b2. Nominal landings (1988–present).

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	387	1	0	388
2014	276		389	665
2015	244	1	337	582
2016*	569	4	126	699

***Preliminary.**

Table 4.2.3. Ling in 5.b. Nominal landings (1988–present).

Year	5.b1	5.b2	5.b
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	3744	388	4132
2014	5990	665	6655
2015	5392	582	5974
2016	5187	699	5886

***Preliminary.**

Table 4.2.4. Ling in 5.b. Overview of the sampling from commercial landings since 1996.

	Commercial sampling			Survey sampling		
Year	Length	Gutted Weight	Age	Length	Round weight	Age
1996	6399	410	1084	1687	366	11
1997	7900	541	1526	1478	326	0
1998	5912	538	1081	1572	820	0
1999	4536	360	480	795	665	0
2000	3512	360	360	864	684	14
2001	3805	420	420	1166	889	0
2002	4299	180	300	1049	817	0
2003	6585	360	661	1090	887	0
2004	6827	1169	659	1566	1131	0
2005	7167	3217	540	1406	1050	0
2006	6503	4038	276	1180	937	0
2007	4031	1713	120	1127	969	0
2008	2521	1945	60	1454	1052	10
2009	4373	4348	232	1407	1039	0
2010	4345	4279	180	2360	1395	0
2011	3405	2828	0	2533	1949	0
2012	2810	2447	50	1855	1771	0
2013	2477	2076	0	1873	1652	274
2014	2985	2274	20	2923	2268	556
2015	2544	2171	210	3453	2502	418
2016	2761	2360	360	4350	2227	435

Table 4.2.5. Ling in 5.b. Data on the cpue series from Faroese commercial fleets and groundfish surveys. Only the spring survey data from 1983–1993 was not standardized. N- number of sets/hauls behind the commercial cpues.

	Longline			Trawl (bycatch)			Spring survey		Summer survey	
Year	Mean	se	N	Mean	se	N	Mean	se	Mean	se
1983							7.7			
1984							8.3			
1985							5.5			
1986	44.6	0.6	47				8.6			
1987	57.2	0.8	91				10.9			
1988	46.4	1.1	26				6.9			
1989	48.0	1.2	28				6.6			
1990	47.6	1.1	39				6.2			
1991	48.9	0.6	110				8.0			
1992	36.3	0.4	139				4.0			
1993	39.2	0.5	130				6.1			
1994	46.6	0.4	182	14.8	0.2	69	4.3	2.1		
1995	42.6	0.4	150	15.3	0.1	244	7.3	3.6		
1996	46.7	1.3	22	15.3	0.1	216	17.5	11.2	15.3	5.1
1997	69.7	1.0	91	18.4	0.1	586	16.9	7.9	9.4	3.2
1998	49.7	0.7	77	15.4	0.1	597	23.9	15.8	9.9	4.1
1999	45.1	0.6	80	13.4	0.0	926	13.6	8.0	5.8	2.2
2000	29.6	0.5	68	13.3	0.0	851	9.4	5.4	6.8	2.3
2001	47.1	1.2	31	13.4	0.0	905	13.8	8.0	8.1	2.7
2002	39.2	1.8	9	12.5	0.0	792	10.4	4.2	7.9	2.2
2003	50.5	1.0	26	15.3	0.1	701	16.1	6.9	4.0	1.1
2004	52.6	0.7	73	18.9	0.3	591	12.5	6.1	17.9	6.5
2005	49.3	0.4	120	21.8	0.4	783	11.0	4.8	11.4	3.1
2006	54.8	0.5	135	22.6	0.5	666	11.1	4.3	8.4	2.4
2007	48.9	0.5	72	21.6	0.4	692	8.4	4.2	9.9	3.4
2008	55.6	0.4	175	25.1	0.5	612	10.8	5.6	14.0	5.5
2009	50.8	0.4	181	23.1	0.4	759	14.4	6.2	11.7	3.4
2010	74.3	0.4	823	29.7	0.4	968	15.2	5.4	22.1	8.8
2011	78.6	0.5	796	35.2	0.6	714	17.4	7.5	23.3	7.9
2012	77.5	0.5	679	41.7	0.6	1118	17.1	7.6	19.8	7.0
2013	96.1	0.8	368	36.3	0.5	928	17.8	9.9	21.4	6.7
2014	118.6	1.0	649	52.3	0.6	1275	18.5	9.2	33.4	14.9
2015	88.8	0.7	447	55.7	0.6	1614	26.0	12.3	25.7	10.5
2016	98.4	1.1	341	54.2	0.6	1257	17.9	7.6	22.3	7.3

Table 4.2.6. Ling in 5.b. Data from the Norwegian longliners cpue series. Mean cpue is from longliners with more than 30% ling in the sets. SE- standard error, N- number of days that the Norwegian longliners operated in an ICES subarea/division (WD 2017, Helle and Pennington).

Year	Mean cpue	SE	N
2000	59.3	5.1	288
2001	50.4	4.7	371
2002	35.4	5.1	355
2003	43.6	4.9	391
2004	42.1	4.3	571
2005	54.6	4.7	335
2006	73.1	6.4	125
2007	65.7	5.0	294
2008	110.8	5.8	167
2009	143.7	15.6	39
2010			
2011	136.4	19.5	11
2012	155.3	8.7	50
2013	159.7	12.5	24
2014	161.1	8.2	83
2015	199.0	5.3	205
2016	185.5	6.3	163

Table 4.2.7. Ling in 5.b. Summary output table from the exploratory assessment using SAM.

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F5-11	Low	High
1996	2160	1579	2954	26849	23582	30570	16349	14238	18772	0.381	0.324	0.448
1997	1872	1356	2586	24612	21873	27695	15614	13694	17802	0.389	0.339	0.446
1998	2011	1420	2849	24860	22113	27948	16181	14278	18338	0.392	0.345	0.446
1999	2282	1653	3152	22539	19680	25813	14246	12561	16156	0.393	0.347	0.446
2000	2276	1659	3122	21112	18325	24323	12854	11259	14674	0.38	0.335	0.432
2001	2526	1899	3360	21182	18757	23920	12154	10769	13716	0.368	0.323	0.42
2002	2384	1761	3228	21511	19094	24234	12418	11008	14009	0.354	0.309	0.405
2003	3055	2307	4045	22743	20208	25595	13337	11746	15144	0.358	0.315	0.408
2004	4173	3082	5649	25160	22083	28666	14038	12239	16100	0.366	0.322	0.415
2005	5475	3782	7927	27667	23925	31994	14392	12660	16360	0.369	0.325	0.42
2006	5809	3954	8534	30516	26162	35594	14783	13138	16633	0.362	0.318	0.411
2007	5376	3846	7515	30546	26219	35587	14936	13256	16828	0.346	0.303	0.394
2008	4755	3541	6386	34752	30172	40028	17134	15117	19420	0.331	0.287	0.381
2009	4571	3378	6185	36717	32208	41858	19178	16900	21762	0.322	0.276	0.374
2010	3864	2829	5277	39419	34507	45030	21647	19011	24648	0.316	0.268	0.372
2011	3538	2551	4907	39222	34243	44925	22971	20170	26162	0.301	0.25	0.361
2012	3834	2724	5397	38063	32950	43969	23695	20638	27204	0.289	0.237	0.351
2013	4661	3210	6768	40946	34885	48060	24860	21388	28895	0.264	0.21	0.332
2014	8883	6026	13095	45982	38234	55300	26239	22013	31277	0.258	0.203	0.328
2015	13278	8333	21159	55326	44239	69192	27392	22393	33507	0.252	0.192	0.329
2016							28311	22340	35878			

4.3 Ling (*Molva Molva*) in Subareas 1 and 2

4.3.1 The fishery

Ling has been fished in Subareas 1 and 2 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 caused by a series of technical advances, is well documented. Currently the major fisheries in Subareas 1 and 2 are the Norwegian longline and gillnet fisheries, but bycatches of ling are taken by other gears, such as trawls and handlines. Around 50% of the Norwegian landings are taken by longlines and 45% by gillnets, partly in the directed ling fisheries and in part as bycatch in fisheries for other ground fish. Other nations catch ling as bycatch in their trawl fisheries. Figure 4.3.1 shows the spatial distributions of the total catches for the Norwegian longline fishery in 2013 to 2016.

The Norwegian longline fleet (vessels larger than 21 m) increased from 36 in 1977 to a peak of 72 in 2000, and afterwards the number decreased to 25 in 2015 and 2016. The number of vessels declined mainly because of changes in the law concerning the quotas for cod. The average number of days that the longliners operated in ICES Subareas 1 and 2 has declined since its peak in 2011. During the period 2000 to 2014 the main technological change in Subareas 1 and 2 was that the average number of hooks per day increased from 31 000 hooks to 35 000 hooks. During the period 1974 to 2014 the total number of hooks per year has varied considerably, but with a downward trend since 2002 (for more information see Helle and Pennington, WD 2017).

Since the total number of hooks per year takes into account; the number of vessels, the number of hooks per day, and the number of days each vessel participated in the fishery, it follows that it may be a suitable measure of changes in applied effort. Based on this gauge, it appears that the average effort for the years 2011–2016 is 43% less than the average effort during the years 2000–2003.

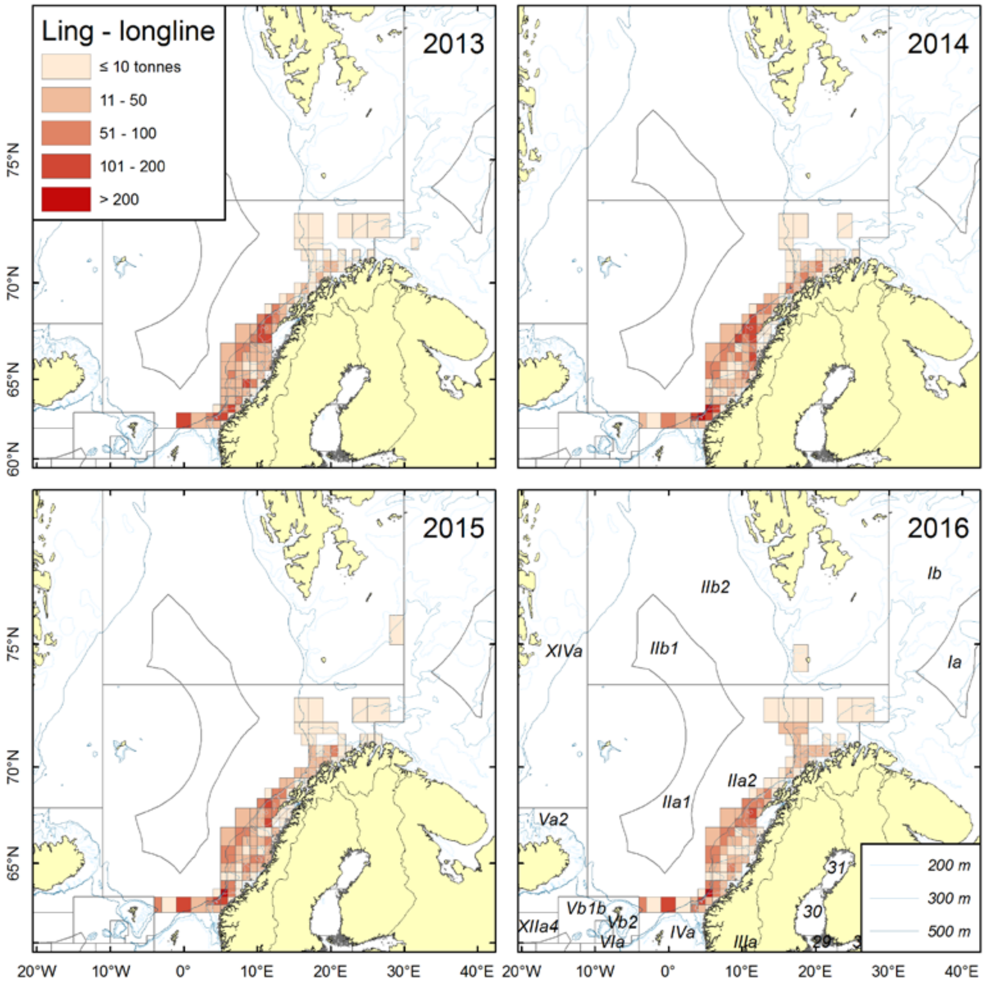


Figure 4.3.1. Distribution of the total catches in Subareas 1 and 2 taken by the Norwegian longline fishery in 2013–2016.

4.3.2 Landings trends

Landing statistics by nation in the period 1988–2016 are in Tables 4.3.1a–d. During the period 2000–2005 the landings varied between 5000 and 7000 t, which were slightly lower than the landings in the preceding decade. In 2007, 2008 and 2010 the landings increased to over 10 000 t. The preliminary amount of landings for 2016 is 8822 t. Total international landings in Areas 1 and 2 are given in Figure 4.3.2.

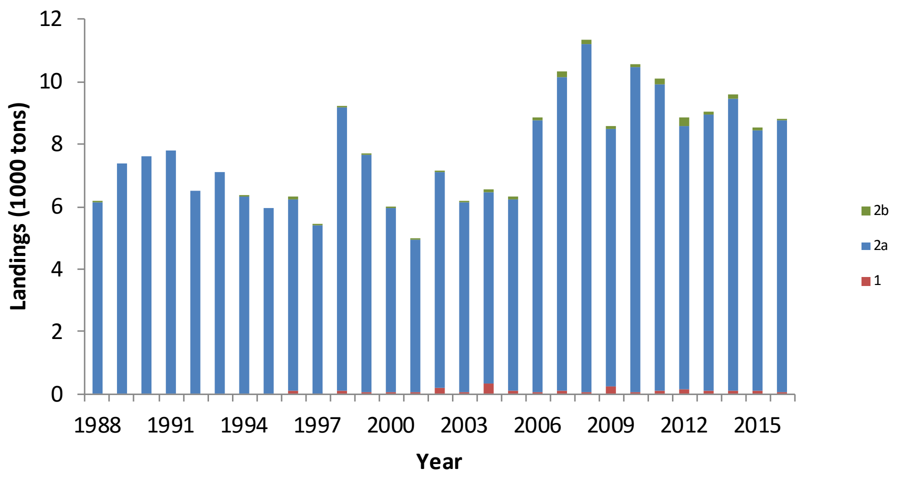


Figure 4.3.2. Total international landings of ling in Subareas 1 and 2.

4.3.3 ICES Advice

Advice for 2016 to 2017: ICES advises that, based on the precautionary approach, the yearly total catch should be no more than 11 300 tonnes in 2016 and 2017. All catches are assumed to be landed.

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 1 and 2 are required to have a specific licence. There is no minimum landing size in the Norwegian EEZ.

The quota for ling in EU and international waters was set at 36 t for 2017.

4.3.5 Data available

4.3.5.1 Landings and discards

Amounts landed were available for all 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.

4.3.5.2 Length compositions

Length composition data are available for the longliners and gillnetters from the Norwegian Reference fleet. Figures 4.3.3 and 4.3.4 show the length distribution of ling in Areas 1 and 2 for the period 2001 to 2016. The mean length in Area 1 has varied slightly, while the mean length in Area 2a has been very stable. The weight–length graphs are in Figure 4.3.5.

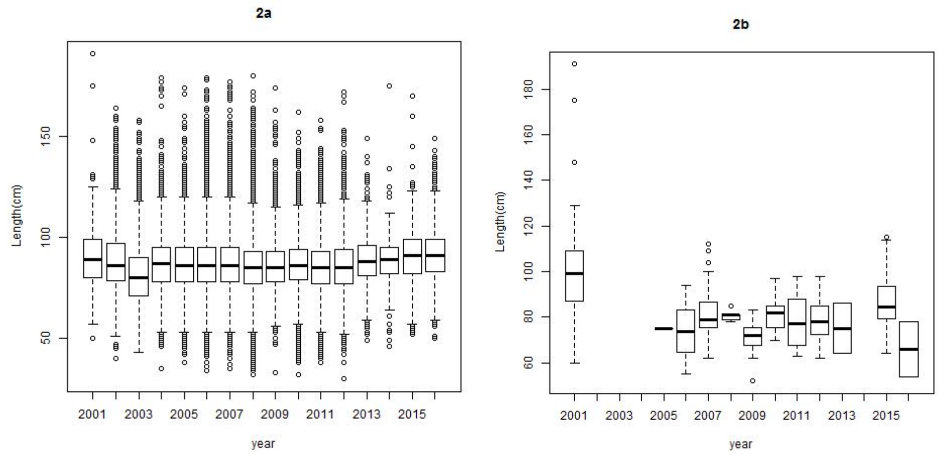


Figure 4.3.3. Box and whiskers plots for the length of ling in Areas 1, 2a and 2b for the period 2001 to 2016.

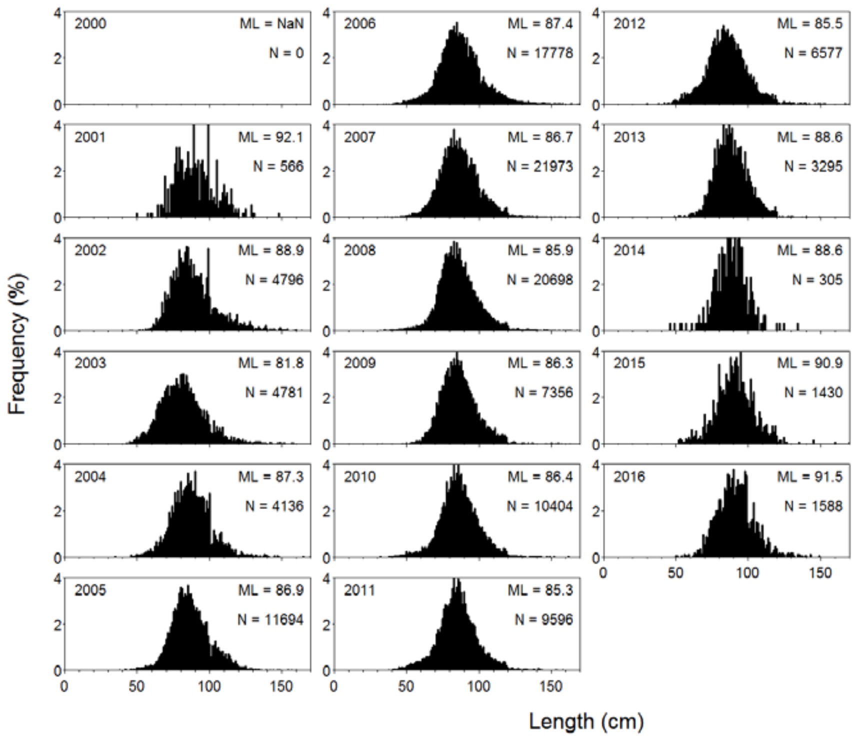


Figure 4.3.4. Plots of the length distributions of ling in Subareas 1 and 2 combined for the period 2001 to 2016.

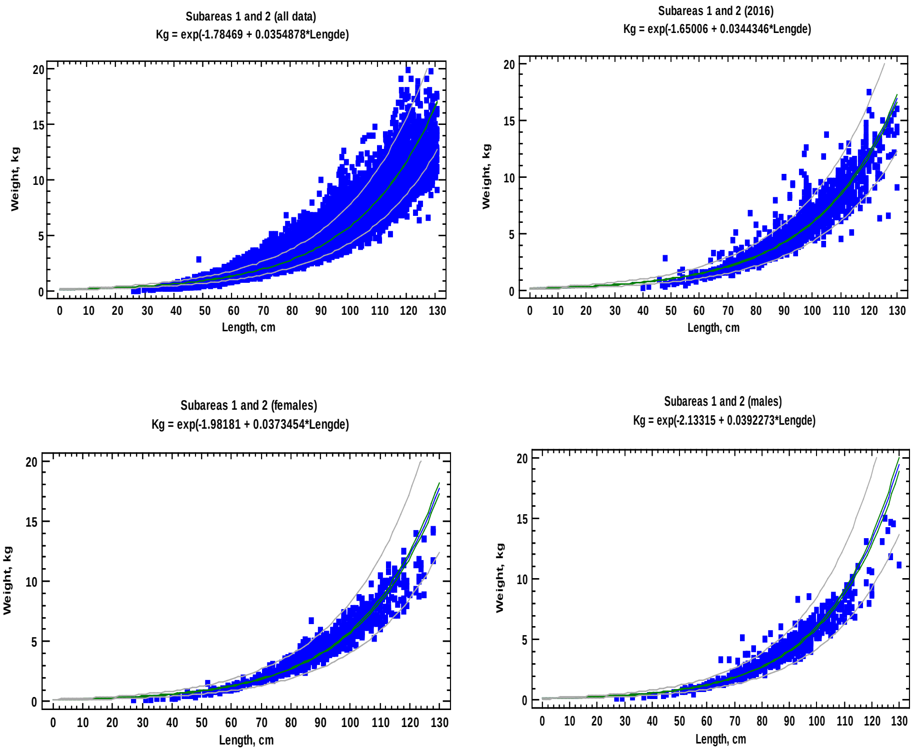


Figure 4.3.5. Weight–length relationship for the period 2008–2016, and only for 201 (upper panel) and for females and for males, separately (lower panel). Data were collected by the Norwegian Reference Fleet.

4.3.5.3 Age compositions

The Catch-at-age composition estimates are in figure 4.3.6, and box and whiskers plots for the estimated age distribution of the catch for: the total catch; and separately for the longline fishery and for the gillnet fishery for 2010–2016, are shown in Figure 4.3.7.

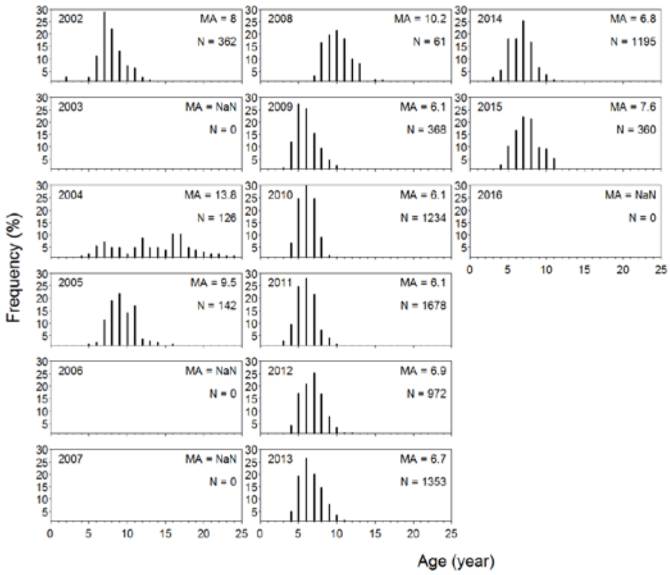


Figure 4.3.6. Ling in areas 1 and 2, Catch-at-age composition. MA denotes mean age.

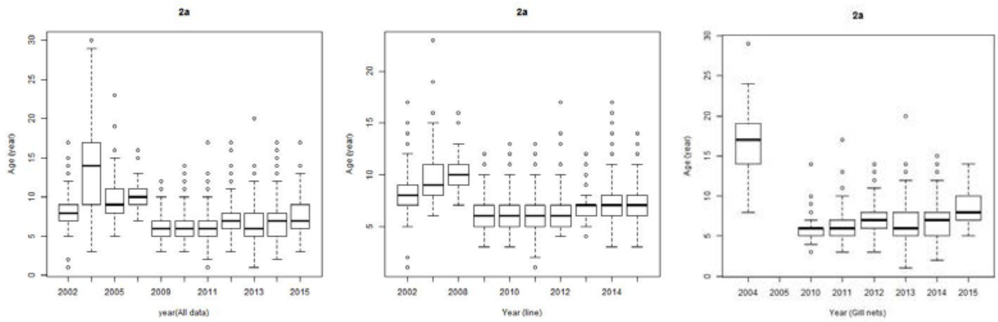


Figure 4.3.7. Age composition of the fish taken by longliners and gillnetters during the period 2002–2016.

4.3.5.4 Length and weight-at-age

Figure 4.3.8 shows the average mean length and mean weight-at-age for the years 2009–2016.

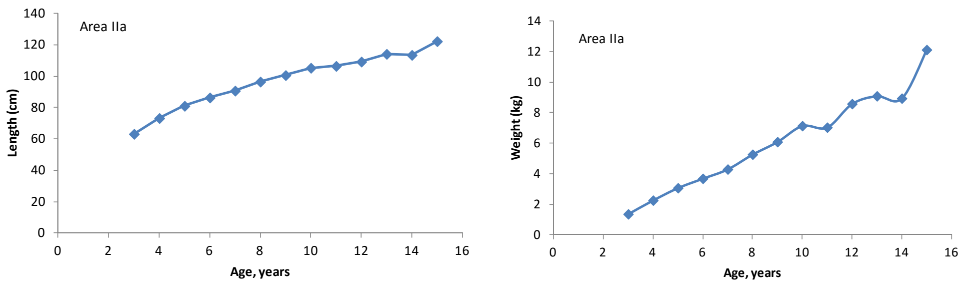


Figure. 4.3.8. Average mean length and mean weight-at-age for the period 2009–2016.

4.3.5.5 Maturity and natural mortality

Maturity ogives for ling are in Figure 4.3.9 and in the following table. The results fit well with previous observations that ling reach maturity-at-ages 5–7 (60–75 cm lengths) in most areas, while males reach maturity at a slightly younger age than females (Magnusson *et al.*, 1997).

Maturity parameters:

Stock	L_{50}	N	A_{50}	N	Source
Lin-arct	73.0	1540	7.0	769	Norwegian long liners (Reference fleet) and survey data

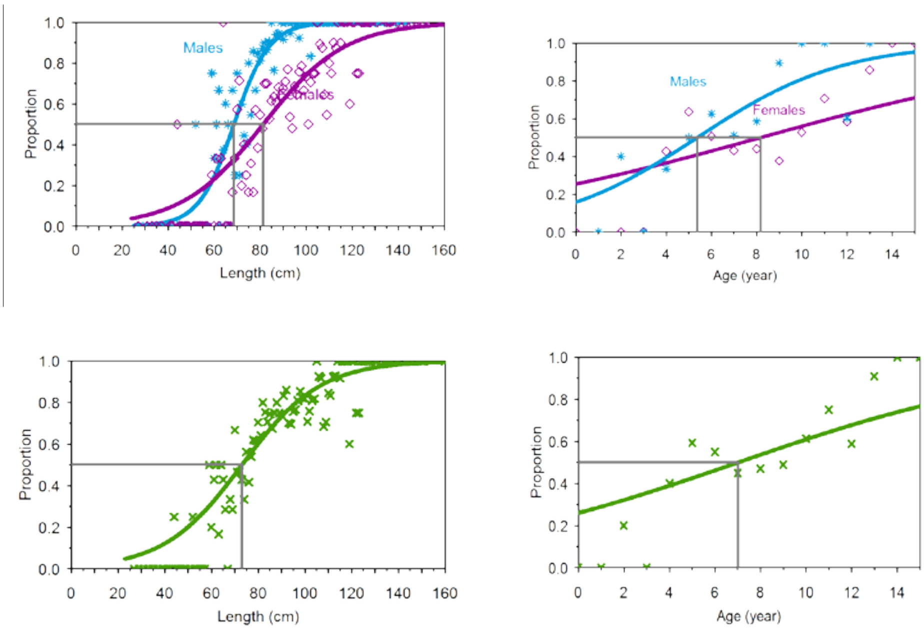


Figure 4.3.9. Maturity ogives for ling in areas 1 and 2 for age and length: males and females (upper panel) and for males and females combined (lower panel).

4.3.5.6 Catch and effort data

A standardized cpue series for 2000–2016 for Norwegian longliners is in Figure 4.3.10. 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 by weight). No research vessel data are available.

4.3.6 Data analyses

Length distribution

Figures 4.3.3 and 4.3.5 show plots of the length distributions in Areas 2 and 3 for the period 2001 to 2016. It appears that the mean length in Area 1 has varied slightly, while the mean length in Area 2a and 2b has been very stable. The average length is slightly higher in the gillnet fishery than in the longline fishery.

Cpue

No analytical assessments were done.

Graphs of two standardized GLM-based cpue series estimated based on all the data and based on data for which ling made up more than 30% of the catch are shown in Figure 4.3.8. The cpue series starting in 2000 shows an upward trend for the entire period. The method is described in Helle *et al.*, 2015.

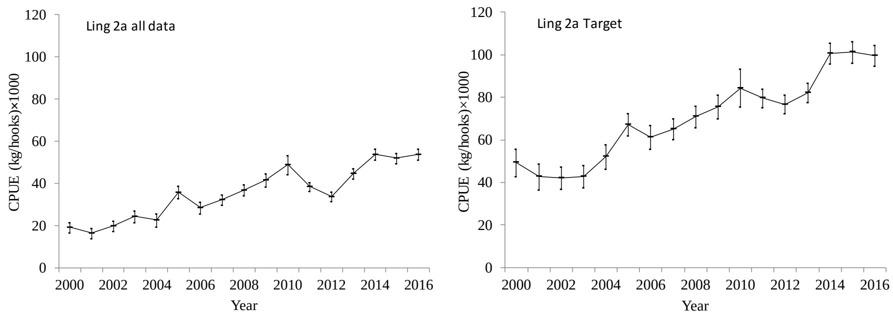


Figure4.3.8. Ling in 2a. Estimates of cpue (kg/1000 hooks) based on all available data and on catches when ling was considered the target species 2000–2016. The bars denote the 95% confidence intervals. The data are from skipper's logbooks.

4.3.7 Comments on the assessment data analyses

The two new standardized cpue series based on all data and when ling were 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.

4.3.8 Management considerations

Catch levels since 2006 do not appear to have had a detrimental effect on the stock given that the cpue continued to increase steadily, and therefore, the current catch levels are considered appropriate. The size of the longline fleet fishing for ling has decreased over time because of the fleets' greater access to quotas for Arcto-Norwegian cod. Since the catches have been stable and the indicator series show an increasing trend it is suggested that a 20% buffer should not be applied.

As always, it should be emphasized that commercial catch data are typically observational data; that is, there were no scientific controls on how or from where the data were collected. Therefore, it is not known with certainty if the ling cpue series tracks the population and/or how accurate the measures of uncertainty associated with the series are (see, for example, Rosenbaum, 2002). Consequently, one must usually hope and pray that a cpue series, which is based only on commercial catch data, truly tracks abundance.

An infamous example of a misleading cpue series based on commercial data was a cpue series for Newfoundland cod that incorrectly indicated that the abundance of the cod stock was increasing greatly. Advice based on this cpue series ultimately caused the collapse of the stock (see, e.g., Pennington and Strømme, 1998).

In general, any assessment method based only on commercial catch data needs to be applied with caution. The reason that assessments using only commercial data are problematic is because the relation between the commercial catch and the actual population is normally unknown and probably varies from year to year.

4.3.9 Application of MSY proxy reference points

Two different methods were tested for ling in areas 1 and 2: the Length-based indicator method (LBI) and SPiCT. When all landings data were used 1988–2016 the SPiCT model did not converge. For a shorter period 2000–2016, the model converged, but the retrospective plot showed that this method was not robust. Therefore, the LBI appears to be the best method. Both models indicate that ling in areas 1 and 2 are fished sustainably.

A summary of the methods applied:

Length-based indicator method (LBI)

The input parameters and the length distributions of the catches for the period 2001–2016 are in the following tables and figures. The length data used in the LBI model are from the Norwegian longliner fleet. The length data were not weighted to represent the total catch.

Table 1.1. Ling in arctic waters (1, 2.a, 2.b). Input parameters for LBI.

Data type	Years/Value	Source	Notes
Length–frequency distribution	2001–2016	Norwegian long-liners (Reference fleet) fishing in divisions 1,2a,2b	
Length–weight relation	0.0055* length $^{3.0175}$	Norwegian Reference fleet and survey data	
L_{MAT}	73 cm	Norwegian Reference fleet and survey data	Sexes combined
L_{inf}	172 cm (L_{max})	Norwegian Reference fleet and survey data	

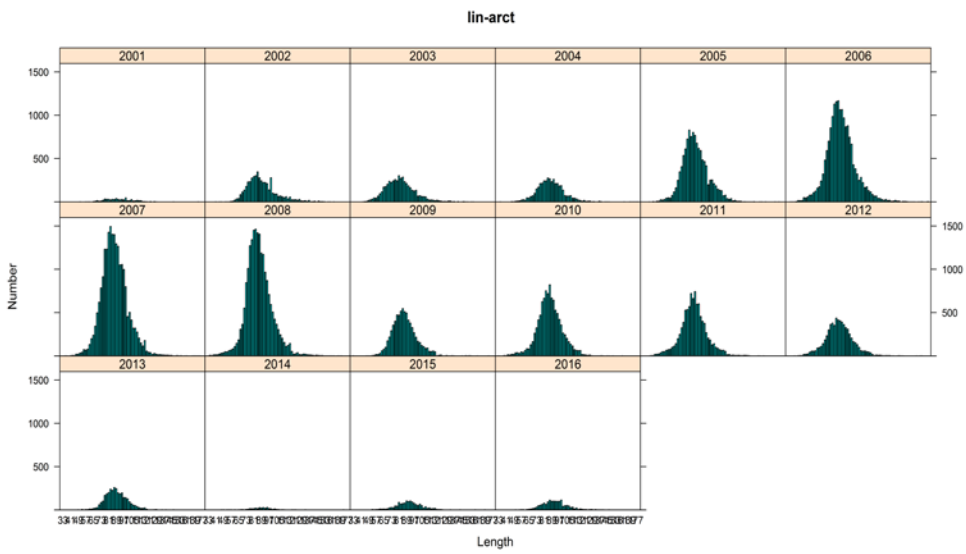


Figure 1.1. Ling in arctic waters (1, 2.a, 2.b). Catch length distributions, 2 cm length classes, for the period 2001–2016 (sex combined).

Outputs from the screening of length indicator ratios for combined sexes under three scenarios: (a) Conservation; (b) Optimal yield; and (c) maximum sustainable yield, are presented in the following figures.

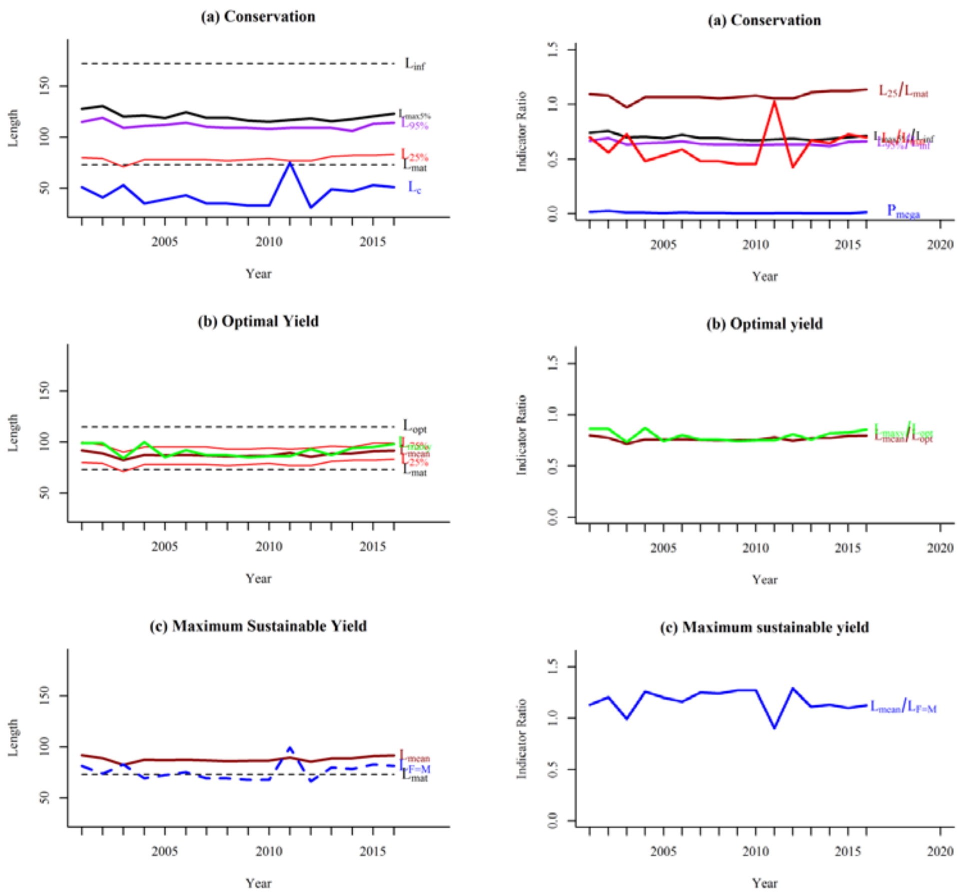


Figure 1.2. Ling in arctic waters (1, 2.a, 2.b). Screening of the length indicator ratios for sex combined under three scenarios: (a) Conservation; (b) Optimal yield; and (c) maximum sustainable yield.

Analysis of results

The model for the conservation of immature ling shows that L_c/L_{mat} is usually less than one, but $L_{25\%}/L_{mat}$ is usually greater than 1 (Figure 1.2). In 2014–2016, $L_{25\%}/L_{mat}$ was also greater than 1 (Table 1.2), therefore there is no indication that immature ling are being overfished.

For the status for large ling, the model shows that the indicator ratio of $L_{max5\%}/L_{inf}$ is around 0.7 for the whole period (Figure 1.2), and between 0.68 and 0.71 in 2014–2016 (Table 1.2), which is less than the limit of.0.8 suggesting that there is a lack of mega-spawners in the catch, which indicates that there is a truncation point in the length distribution. The mean length of ling in the catch is lower than the mean length for optimizing yield.

The MSY indicator ($L_{mean}/L_{F=M}$) is greater than 1 for almost the whole period (Figure 1.2), which indicates that ling in arctic waters are fished sustainably. Regarding model sensitivity, the MSY value was always greater than 0.90.

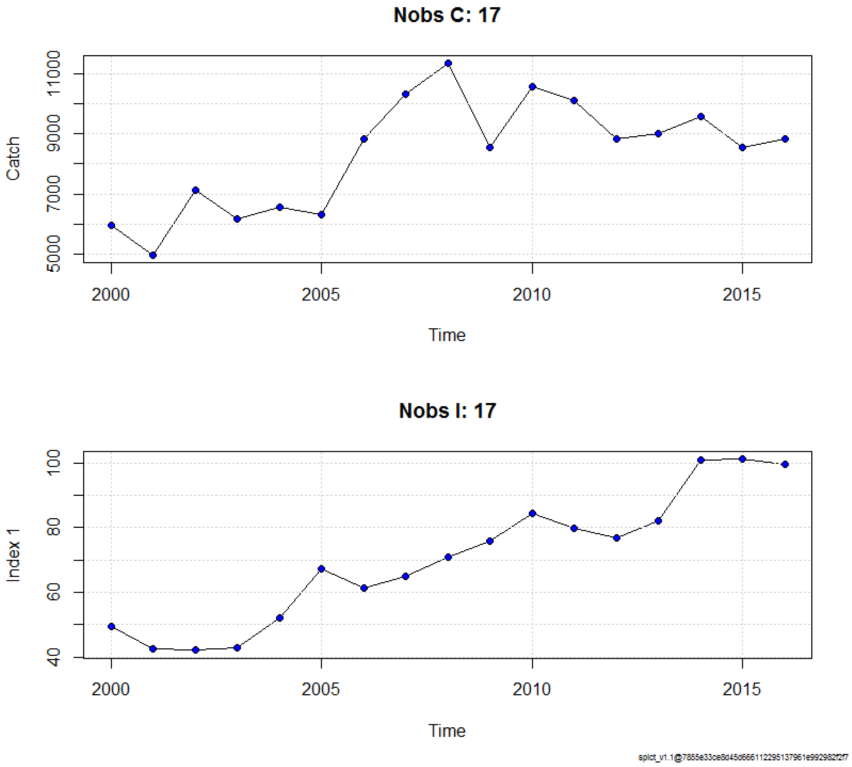
Conclusion: The overall perception of the stock during the period 2014–2016 is that ling in arctic waters seems to be fished sustainably (Table 1.3). However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

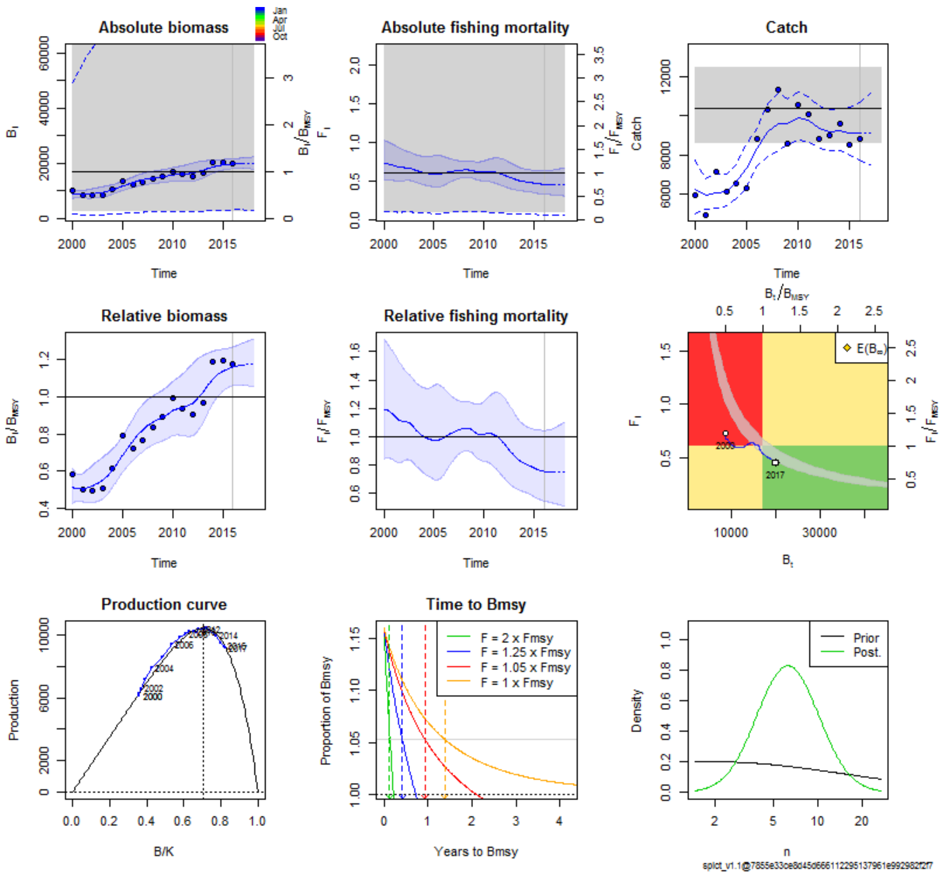
Table 1.2. Ling in arctic waters (1, 2.a, 2.b). The final results from the LBI method.

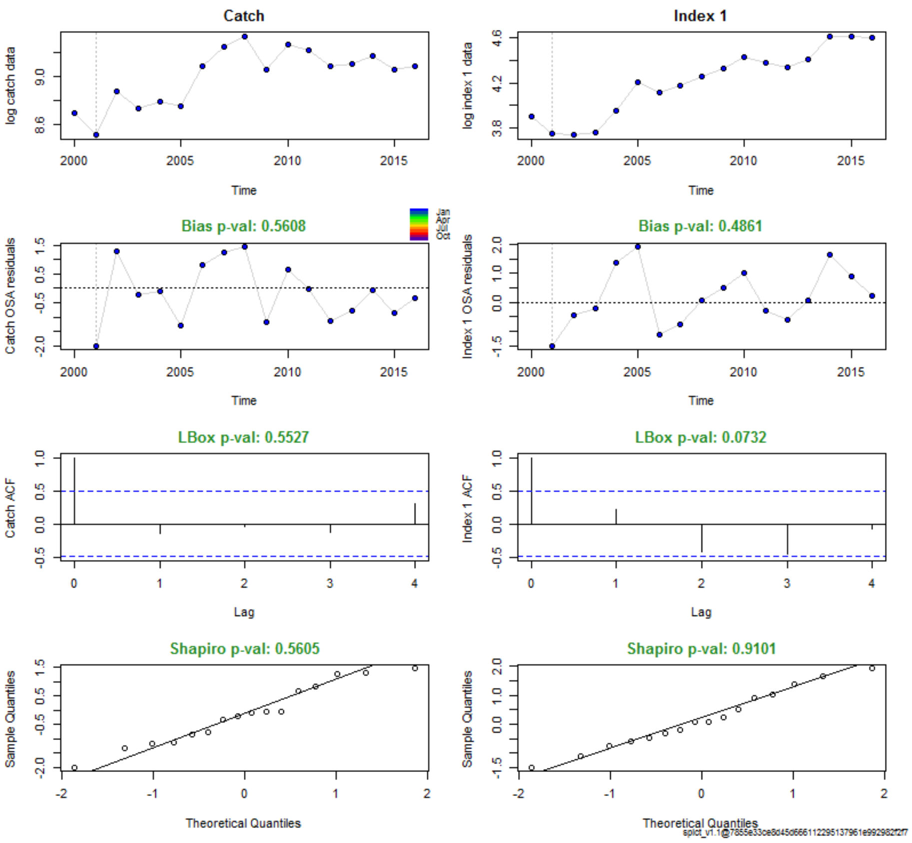
	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2014	0.64	1.12	0.68	1%	0.77	1.13
2015	0.73	1.12	0.70	0%	0.79	1.10
2016	0.70	1.14	0.71	2%	0.80	1.13

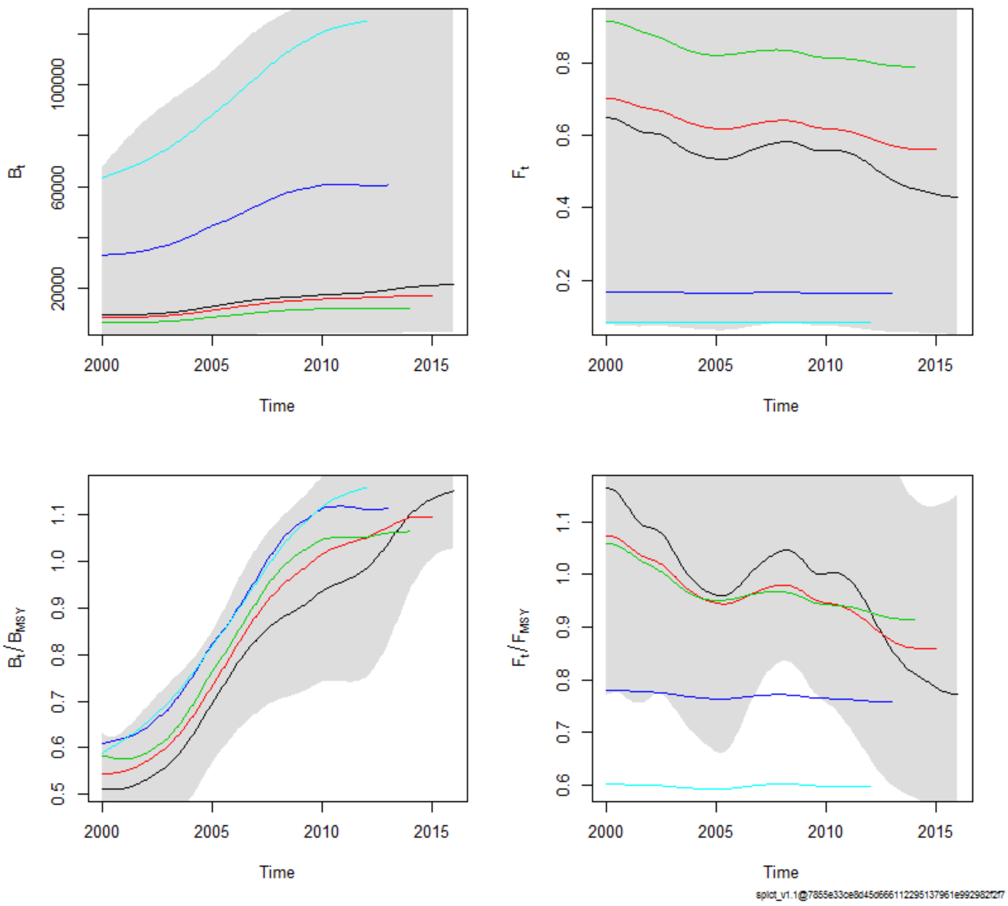
Plots for the SPiCT model:

The input data was landings 2000–2016, and the cpue index for the targeted fishery from 2000–2016.


Nobs C: 17
Catch
Time
Nobs I: 17
Index 1
Time


Absolute biomass
Absolute fishing mortality
Catch
Relative biomass
Relative fishing mortality
Production curve
Time to Bmsy
F = 2 x Fmsy
F = 1.25 x Fmsy
F = 1.05 x Fmsy
F = 1 x Fmsy
Years to Bmsy
Proportion of Bmsy
Production
B/K
Prior
Post.
Density
n
Time


Catch
log catch data
Time
Index 1
log index 1 data
Time
Bias p-val: 0.5608
Catch OSA residuals
Time
Bias p-val: 0.4861
Index 1 OSA residuals
Time
LBox p-val: 0.5527
Catch ACF
Lag
LBox p-val: 0.0732
Index 1 ACF
Lag
Shapiro p-val: 0.5605
Sample Quantiles
Theoretical Quantiles
Shapiro p-val: 0.9101
Sample Quantiles
Theoretical Quantiles


B_t
Time
F_t
Time
B_t/B_{MSY}
Time
F_t/F_{MSY}
Time

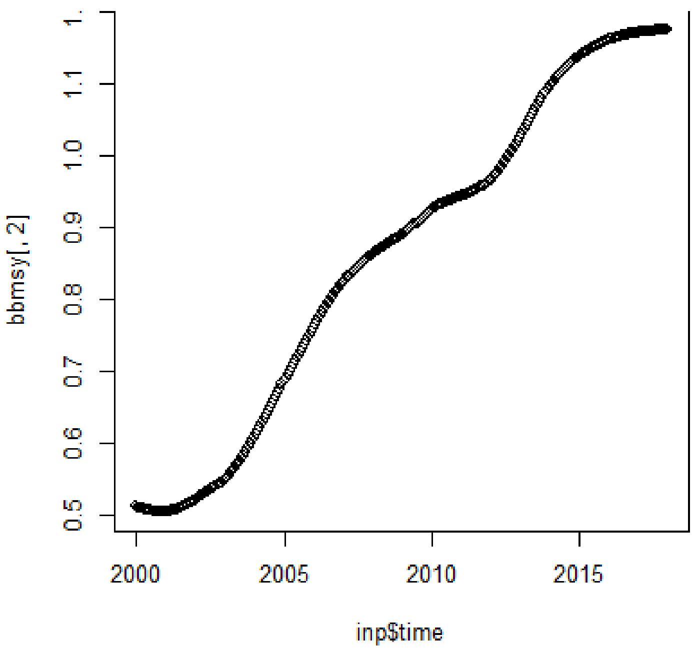

bbmsy[, 2]
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.
2000
2005
2010
2015
inp$time

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

Year	Norway	Iceland	Scotland	Faroes	France	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
2014	122				1	123
2015	93					93
2016*	65					65

***Preliminary.**

Table 4.3.1b. Ling 2a. WG estimates of landings.

Year	Faroes	France	Germany	Norway	E & W	Scotland	Russia	Ireland	Iceland	Spain	Greenland	Poland	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	1	2	7	8189	0	19	17						8244

Year	Faroes	France	Germany	Norway	E & W	Scotland	Russia	Ireland	Iceland	Spain	Greenland	Poland	Total
2010	10	0	18	10 318	0	2	47						10 395
2011	4	6	6	9763			19						9798
2012	21	6	9	8334		7	45		3				8425
2013	7	9	7	8677		1	114		4				8819
2014	3	13	3	9245			73						9337
2015	10	5	4	8220		3	115		5				8362
2016*	18	6	9	8526	2	3	112		8	2	9	6	8703

***Preliminary.**

Table 4.3.1c. Ling 2b. 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
2014	85	52			137
2015	95				95
2016	53			1	54

***Preliminary.**

Table 4.3.1d. Ling 1 and 2. Total landings by subarea or division.

Year	1	2.a	2.b	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	10395	128	10580
2011	129	9798	171	10098
2012	158	8425	266	8849
2013	126	8819	76	9021
2014	123	9337	137	9606
2015	93	8362	95	8550
2016*	65	8703	54	8822

***Preliminary.**

4.4 Ling (*Molva Molva*) in Division 5.a

4.4.1 The fishery

The fishery for ling in 5.a 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 5.a is caught on longlines and the proportion caught by that gear has increased since 2000 to around 65% in 2009–2016. At the same time the proportion caught by gillnets has decreased from 20–30% in 2000–2007 but the proportions have been going down since then to around 4% in 2016. Catches in trawls have varied less and have been at around 20% of Icelandic catches of ling in 5.a (Table 4.4.1).

Table 4.4.1. Ling in 5.a. Number of Icelandic boats and catches by fleet segment participating in the ling fishery in 5.a.

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
2014	128	30	60	10 342	673	2722	228	13 965
2015	159	44	58	7765	655	1913	1218	11 551
2016	137	46	60	5672	343	1339	369	8581

Most of the ling caught in 5.a 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 5.a 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 5.a 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). In recent years the main fishing pressure has shifted towards shallower waters (Figure 4.4.1).

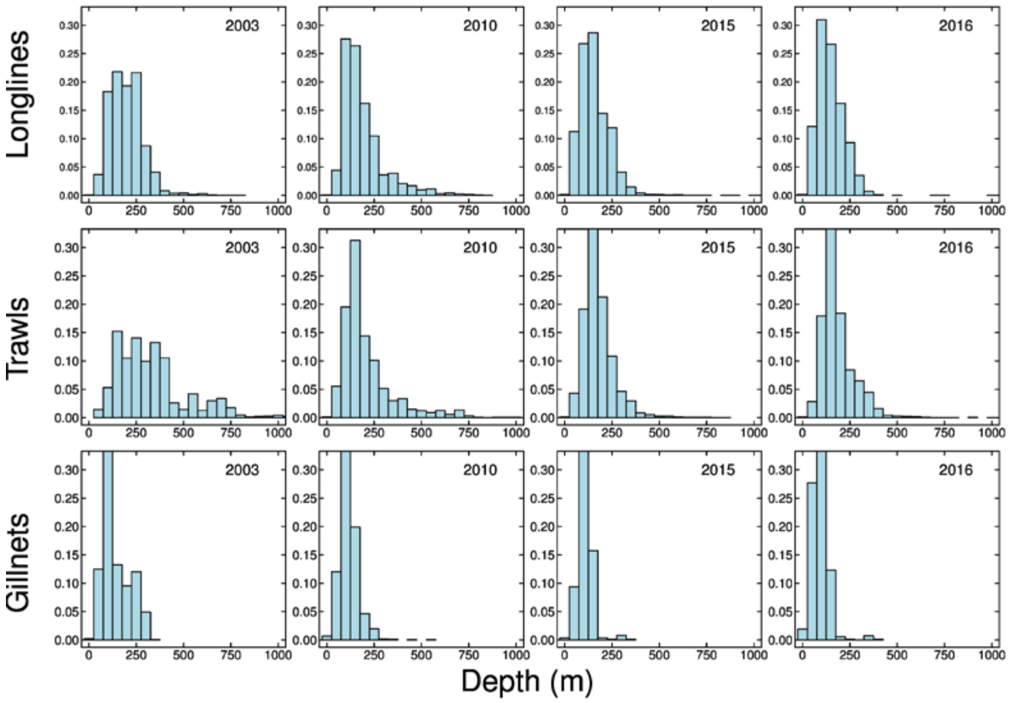


Figure 4.4.1. Ling in 5.a. Depth distribution of ling catches from longlines, trawls and gillnets from Icelandic logbooks.

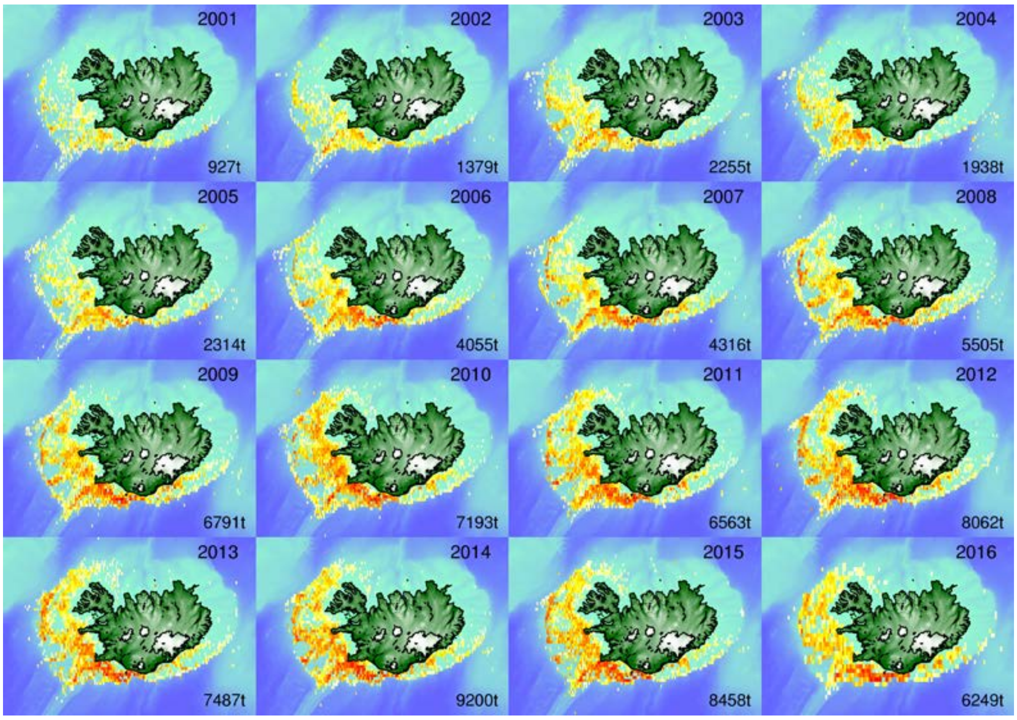


Figure 4.4.2. Ling in 5.a. Geographical distribution (tonnes/square mile) of the Icelandic longline ling fishery since 1998 as reported in logbooks by the Icelandic fleet.

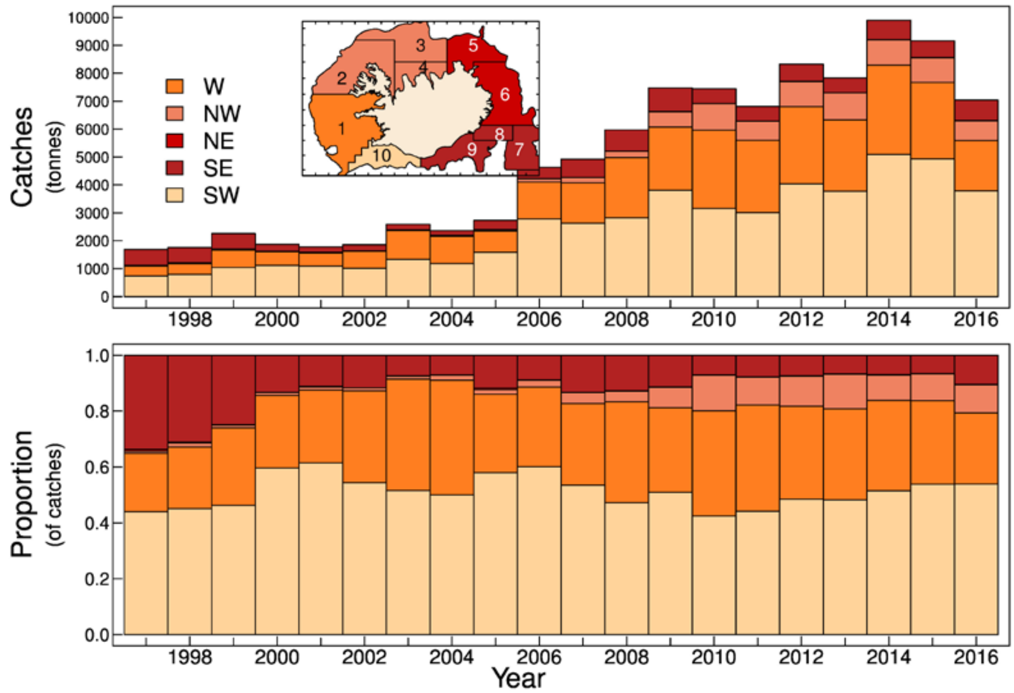


Figure 4.4.3. Ling in 5.a. Changes in spatial distribution of ling catches as recorded in Icelandic logbooks.

4.4.2 Landings trends

In 1950 to 1971 landings of ling in 5.a 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 kt in 2010 and remained at that level until 2014, apart from 2011 catches of 9.6 kt, when the catches increased to 16 kt. This catch level 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 2017 states: ICES advises on the basis of an MSY approach that catches should be no more than 9 343 t. All catches are assumed to be landed.

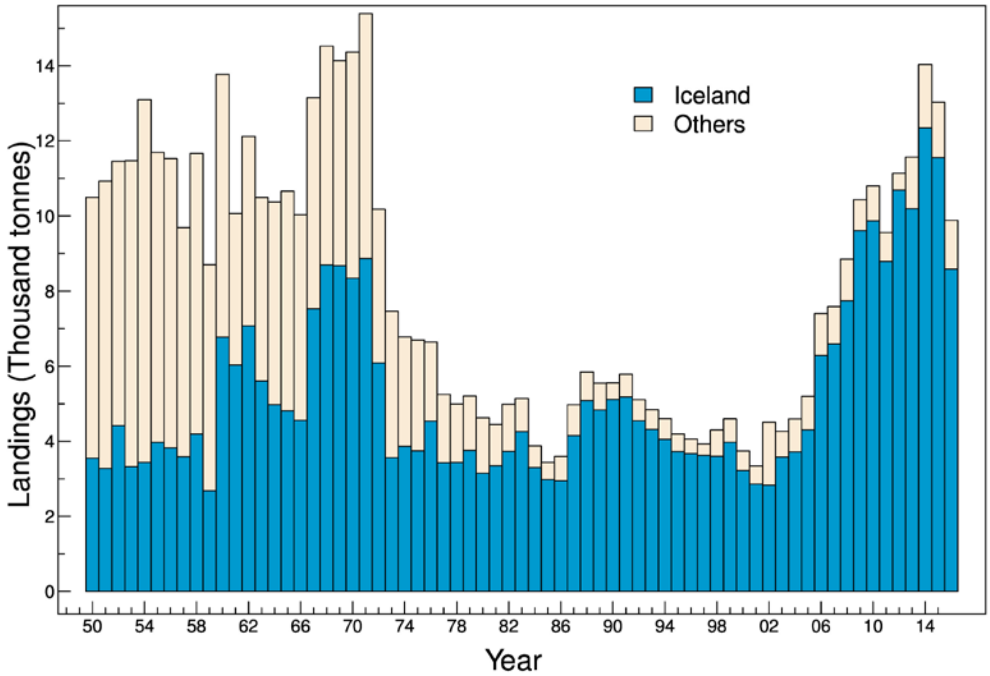


Figure 4.4.4. Ling in 5.a. Nominal landings.

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 5.a has been managed by TAC since the 2001/2002 fishing year.

Landings have exceeded both the advice given by MRI and the set TAC from 2002/2003 to 2012/2013 but amounted to less than two thirds in 2015/2016 (Table 4.4.2). Overshoot in landings in relation to advice/TAC has been decreasing steadily since the 2009/2010 fishing year, with an overshoot of 53% to 35% in 2010/2011, 24% in 2011/2012 and 4% in 2012/2013. 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 5.a.

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–31st of August).

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	13 500	14 983
2014/2015	14 300	13 800	13 166
2015/2016	16 200	15 000	9769
2016/2017	9343	8143	

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 5.a. 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
2014	6448	1286	120	5053	13 610
2015	3315	1563	0	5667	10 545
2016	2483	2039	0	3673	8195

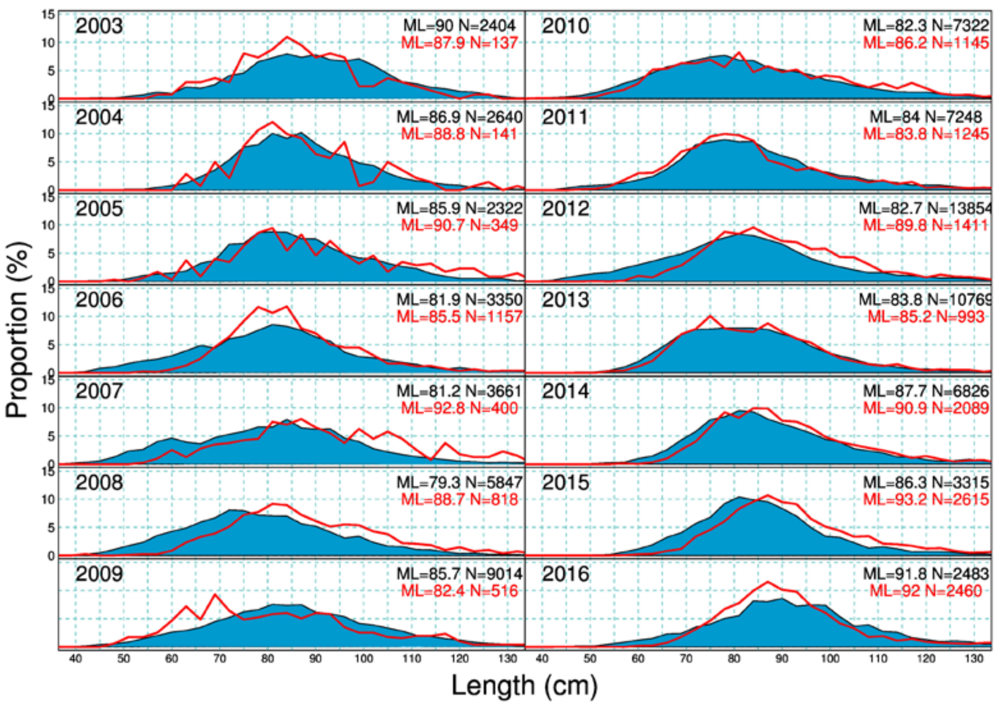


Figure 4.4.5. Ling in 5.a. Length distributions from the Icelandic longline fleet (blue area) and trawls (red lines).

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). Substantial progress has been made since 2010. Now aged otoliths are available from the 2000 onwards (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 and 9.

Table. 4.4.5. Ling in 5.a. Number of available aged otoliths from the commercial catches.

YEAR	LONGLINES	GILLNETS	D. SEINE	TRAWLS	TOTAL
2000	650	200	0	150	1000
2001	550	193	0	37	780
2002	519	166	0	150	835
2003	900	100	0	150	1150
2004	750	100	46	100	996
2005	750	0	0	231	981
2006	1137	288	0	550	1975
2007	1300	0	50	100	1450
2008	1950	150	0	365	2465
2009	2550	150	0	400	3100
2010	2498	50	0	850	3398
2011	2546	0	50	700	3296
2012	4031	50	50	941	5072
2013	2863	100	50	800	3813
2014	743	225	20	913	1901
2015	595	300	0	1003	1898
2016	440	345	0	680	1465

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 5.a, 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

The cpue estimates of ling in 5.a have not been considered representative of stock abundance.

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 groundfish surveys is given in the stock annex.

Figure 4.4.5 shows both a recruitment index and the trends in biomass from both surveys. Length distributions from the spring survey are shown in Figure 4.4.6 (abundance) and changes in spatial distribution the spring survey are presented in Figure 4.4.7.

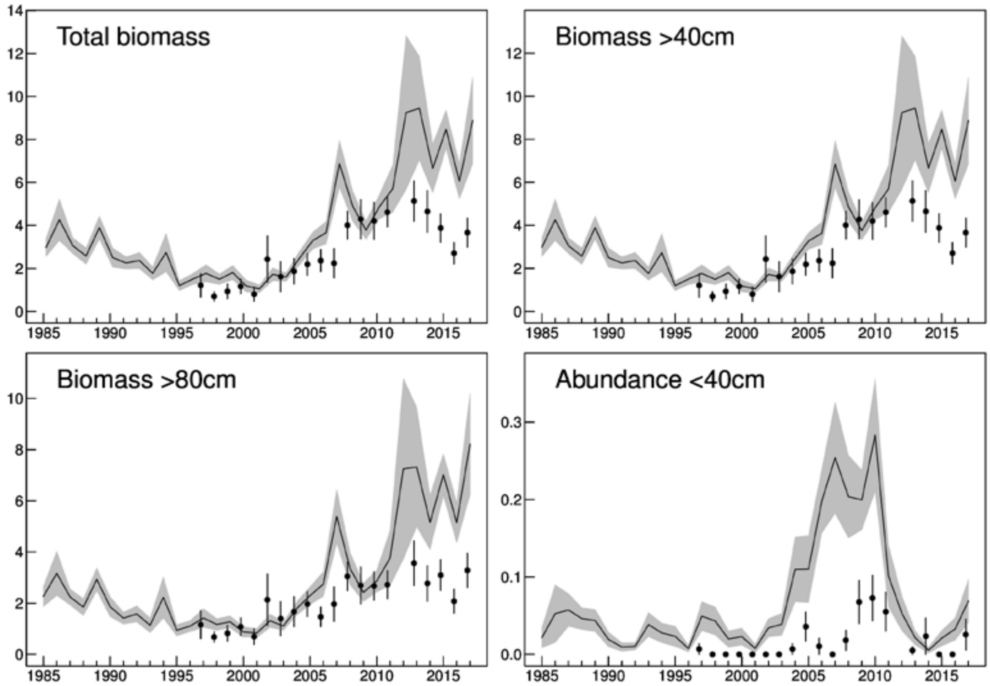


Figure 4.4.5. Ling in 5.a. Shown are a) Total biomass indices, b) biomass indices larger than 40 cm, c) biomass indices larger than 80 cm and d) abundance indices smaller than 40 cm. The lines with shades show the spring survey index from 1985 and the points with the vertical lines show the autumn survey from 1997. The shades and vertical lines indicate +/- standard error.

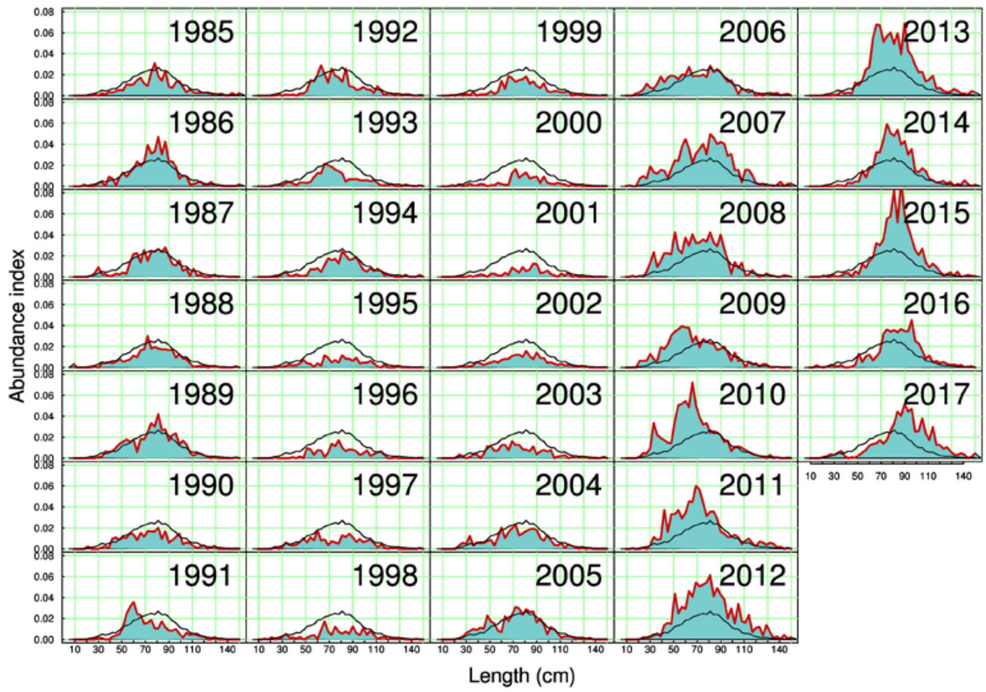


Figure 4.4.6. Ling in 5.a. Abundance indices by length (3 cm grouping) from the spring survey since 1985. Black line is the average over the whole period.

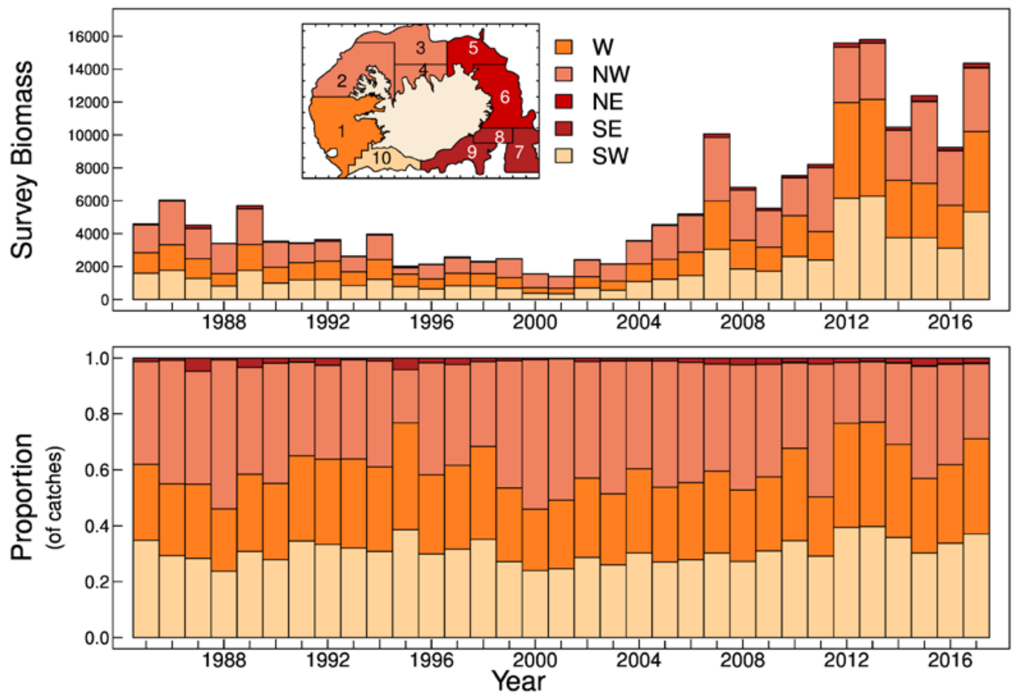


Figure 4.4.7. Ling in 5.a. Estimated survey biomass in the spring survey by year from different parts of the continental shelf (upper figure) and as proportions of the total (lower figure).

4.4.6 Data analyses

There have been no marked changes in the number of boats participating in the ling fishery in 5.a. Most of ling catches are taken at depths less than 250 meters (Figure 4.4.1). 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. Mean length has varied in the period 2009 to 2016 between 82 to 92 cm with no clear trend. 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 9; but from longlines the age is between the ages of 6 to 10.

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 4.4.5). In the years 1995 to 2003 these indices were half of the mean from 1985–1989. In 2003 to 2007, the indices increased and have been for the last five years the highest in the time-series. The index of the large ling (80 cm and larger) shows similar trend as the total biomass index (Figure 4.4.5). 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. Then the juvenile index fell to a very low level in 2014 but has since then started showing signs of an upward trend (Figure 4.4.5). However the increase in the juvenile index is very uncertain as it is simply some variation in the length distribution of the survey but not a distinct peak (Figure 4.4.6).

The shorter autumn survey shows that biomass indices were low from 1996 to 2000, but have increased since then (Figures 4.4.5). There is a consistency between the two survey series; the autumn survey biomass indices are however derived from substantially fewer 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 4.4.5). This discrepancy is likely a result of much lower catchability of small ling (due to different gears) in the autumn survey, where ling less than 40 cm has rarely been caught.

Changes in spatial distribution as observed in surveys: According to the spring survey most of the increase in recent years in ling abundance is in the western area, but an increase can be seen in most areas. However most of the index in terms of biomass comes from the southwestern area or around 40% 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 5.a developed in the Gadget framework (see http://www.hafro.is/gadget for further details) was benchmarked for the use in assessment. As part of a Harvest Control Evaluation requested by Iceland this stock was benchmarked in 2017 (WKICEMSE 2017). Several changes were made to the model setup and settings which are described in the Stock Annex.

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 5.a are described in more detail in the stock annex.

Diagnostics

Observed and predicted proportions by fleet

Overall fit to the predicted proportional length and age–length distributions is close to the observed distributions. (Figures 4.4.7 to 4.4.12). 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 gillnet, the overall noise is greater than for those gears with greater number of samples.

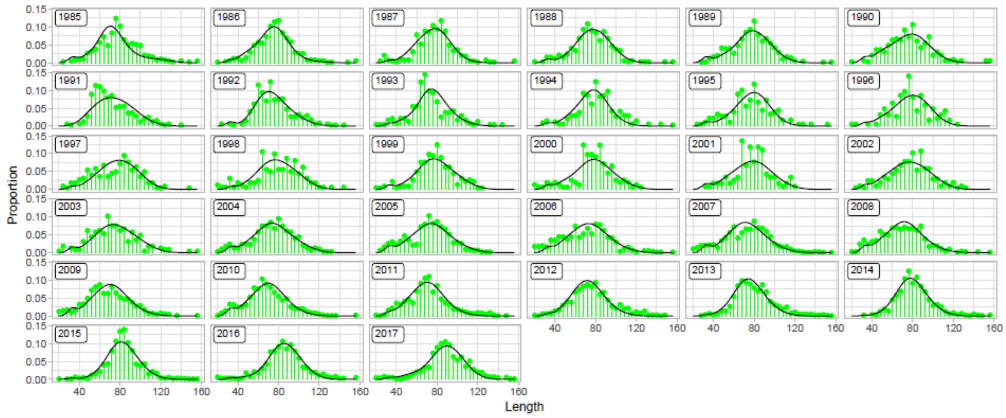


Figure 4.4.7. Ling in 5.a. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions in the spring survey (green lines and points).

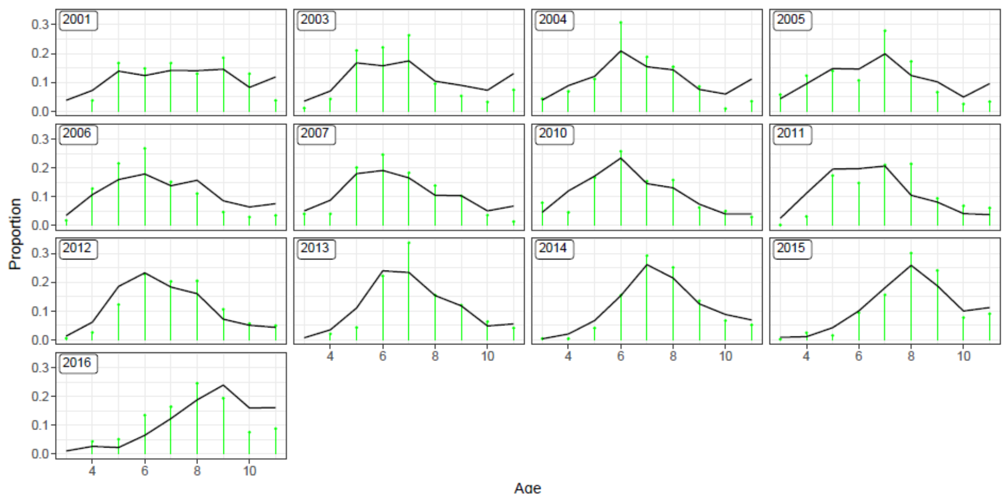


Figure 4.4.8. Ling in 5.a. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions in the spring survey catches (green lines and points).

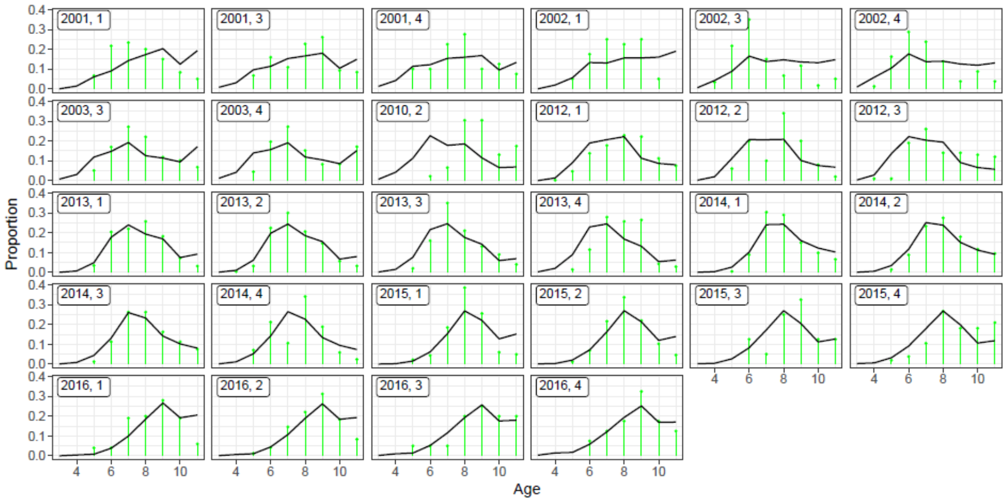


Figure 4.4.9. Ling in 5.a. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions in longlines catches (blue lines and points).

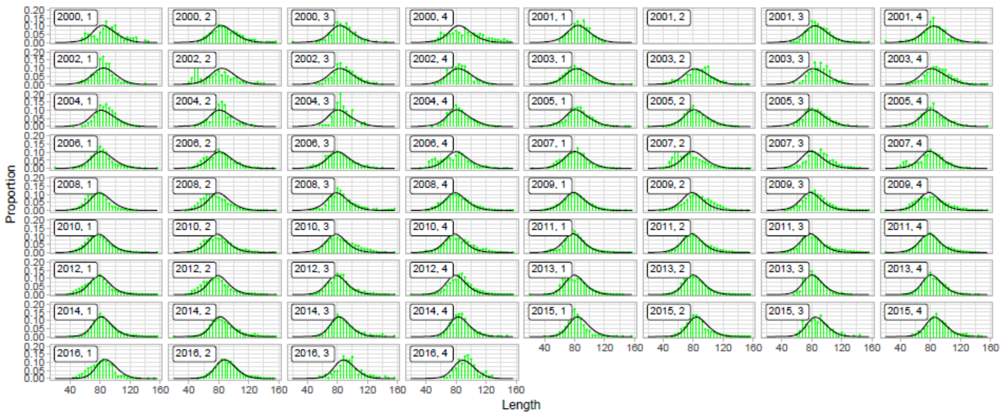


Figure 4.4.10. Ling in 5.a. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions from longline catches (green lines and dots).

Model fit

Figure 4.4.13 shows the overall fit to the survey indices described in the stock annex. In general the model appears to follow the stock trends historically. Furthermore the terminal estimate is not seen to deviate substantially from the observed value for most length groups, with model overestimating the abundance in the two largest length groups. 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. Summed up over survey biomass the model overestimates the biomass in the terminal years.

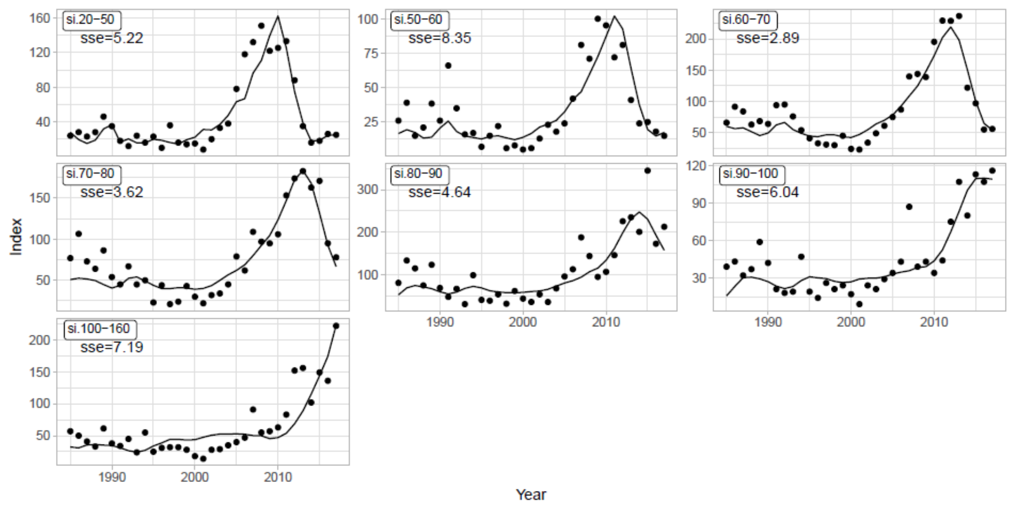


Figure 4.4.13. Fitted spring survey index by length group from the Gadget model (black line) and the observed number of ling caught in the survey (dotted line). The green line indicates the difference between the terminal fit and the observations.

Results

The results are presented in Table 4.4.7 and Figures 4.4.14 and 4.4.16. Recruitment peaked in 2009 to 2010 but has decreased and is estimated in 2013 to 2015 to be at low level. Spawning–stock biomass has increased since 2000 and is now estimated 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 0.66 in 2009 to 0.25 in 2015.

This year's assessment shows a downward revision of SSB and an upward revision of fishing mortality compared to the 2014 and 2015 assessments (Figure 4.4.15). The reason for this revision is the 'one-way trip' in the data and as the model is now getting closer to the terminal total survey index there is a downward revision of biomass. Therefore when running an analytical retrospective analysis a very similar pattern is observed (Figure 4.4.16). Nevertheless some slight inconsistencies were found in input data and catches used in the model. The catches in the model have been updated with official ICES catches as presented in Table 4.4.6.

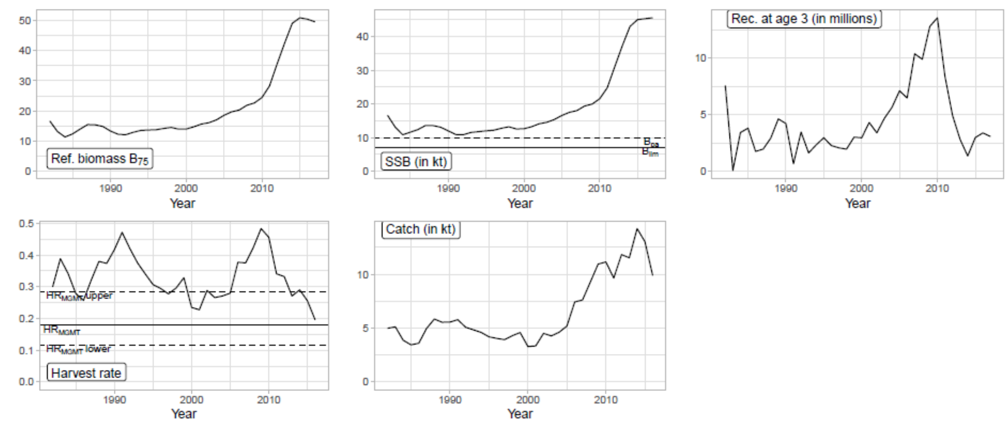


Figure 4.4.14. Ling in 5.a. Estimated recruitment, biomass, fishing mortality and total catches.

Reference points

At the WKDEEP-2014 benchmark meeting for ling in 5.a the following reference points were adopted.

REFERENCE POINT	VALUE	TECHNICAL BASIS
MSY $B_{trigger}$	9.5	Based on B_{pa}
F_{MSY}	0.24	Based on stochastic simulations
B_{lim}	8.6	Median of the lowest SSB
B_{pa}	9.5	Based on the 97.5% quantile of the lowest SSB

As part of the WKICEMSE 2017 HCR evaluations the following reference points were defined for the stock.

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	9.93 kt	B_{pa}
	H_{msy}	0.24	The harvest rate that maximises the median long-term catch in stochastic simulations with recruitment drawn from a block bootstrap of historical recruitment scaled according to a hockey stick recruitment function with B_{loss} as defined below.
	F_{msy}	0.284	The median fishing mortality when an harvest rate of H_{msy} is applied.
	$H_{p.05}$	0.497	The harvest rate that has an annual probability of 5% of SSB $< B_lim$.
	$F_{p.05}$	0.516	The median fishing mortality when an harvest rate of $H_{p.05}$ is applied.
Precautionary approach	B_{lim}	7.09 kt	$B_{pa}/e^{1.645\sigma}$ where $\sigma = 0.2$
	B_{pa}	9.93 kt	SSB(1992), corresponding to B_{loss}
	H_{lim}	0.56	H corresponding to 50% long-term probability of SSB $> B_{lim}$
	F_{lim}	0.70	F corresponding to H_{lim}
	F_{pa}	0.41	$F_{lim}/e^{1.645\sigma}$ where $\sigma = 0.33$
	H_{pa}	0.35	H corresponding to F_{pa}
Management plan	H_{mp}	0.18	

The management plan proposed by Iceland is:

> The spawning–stock biomass trigger (MGT $B_{trigger}$) is defined as 9.93 kt, the reference biomass is defined as the biomass of ling 70+ cm and the target harvest rate (HR_{MGT}) is set to 0.18. In the assessment year (Y) the TAC for the next fishing year (September 1 of year Y to August 31 of year Y+1) is calculated as follows:
>
> When SSB_Y is equal or above MGT $B_{trigger}$:
> $TAC_{Y/y+1} = HR_{MGT}*B_{Ref,y}$
>
> When SSB_Y is below MGT $B_{trigger}$:
> $TAC_{Y/y+1} = HR_{MGT}*(SSB_y/MGT\ B_{trigger})*B_{ref,y}$

WKICEMSE 2017 concluded that the HCR was precautionary and in conformity with the ICES MSY approach.

4.4.7 Comments on the assessment

At WKICEMSE 2017 the assessment was benchmarked. Various settings were changed from the previous assessment. Therefore the assessment in 2017 is not directly comparable to previous assessments of this stock.

4.4.7.1 Management considerations

All the signs from commercial catch data and surveys indicate that ling in 5.a 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 in the near future.

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 fleet is substantially different from other fleets.

Table 4.4.6. Ling in 5.a. Catches by country (Source STATLANT).

Year	Belgium	Faroe	Germany	Iceland	Norway	UK	Total
1980	445	607	0	3149	423	0	4624
1981	196	489	0	3348	415	0	4448
1982	116	524	0	3733	612	0	4985
1983	128	644	0	4256	115	0	5143
1984	103	450	0	3304	21	0	3878
1985	59	384	0	2980	17	0	3440
1986	88	556	0	2946	4	0	3594
1987	157	657	0	4161	6	0	4981
1988	134	619	0	5098	10	0	5861
1989	95	614	0	4896	5	0	5610
1990	42	399	0	5153	0	0	5594
1991	69	530	0	5206	0	0	5805
1992	34	526	0	4556	0	0	5116
1993	20	501	0	4333	0	0	4854
1994	3	548	0	4049	0	0	4600
1995	0	463	0	3729	0	0	4192
1996	0	358	0	3670	20	0	4048
1997	0	299	0	3634	0	0	3933
1998	0	699	0	3603	0	0	4302
1999	0	500	0	3973	120	1	4594
2000	0	0	0	3196	67	3	3266
2001	0	362	2	2852	116	1	3333
2002	0	1629	0	2779	45	0	4453
2003	0	565	2	3855	108	5	4535
2004	0	739	1	3721	139	0	4600
2005	0	682	1	4311	180	20	5194
2006	0	960	1	6283	158	0	7402
2007	0	807	0	6592	185	0	7584
2008	0	1366	0	7736	176	0	9278
2009	0	1157	0	9610	172	0	10939
2010	0	1095	0	9867	168	0	11130
2011	0	588	0	8743	249	0	9580
2012	0	875	0	10586	248	0	11709
2013	0	1030	0	10121	294	0	11445
2014	0	1524	0	12248	158	0	13930
2015*	0	1095	0	11551	216	0	12862

***Preliminary.**

Table 4.4.7. Ling in 5.a. Results from the Gadget assessment.

Year	Biomass	B40	SSB	Rec3	Catch	HR	F
1982	20.02	16.22	17.38	7.59	4.99	0.32	0.34
1983	19.26	12.60	14.07	0.07	5.12	0.42	0.44
1984	17.60	10.39	10.75	3.43	3.88	0.38	0.41
1985	18.20	10.93	11.12	3.81	3.45	0.32	0.37
1986	19.87	12.48	11.87	1.75	3.60	0.29	0.39
1987	21.16	14.02	13.03	1.96	4.97	0.36	0.50
1988	20.90	13.96	13.48	2.93	5.85	0.43	0.63
1989	19.76	13.55	12.84	4.63	5.55	0.43	0.68
1990	19.52	12.18	12.21	4.22	5.56	0.46	0.66
1991	19.63	11.05	11.01	0.66	5.79	0.53	0.70
1992	18.64	10.61	10.57	3.47	5.09	0.48	0.68
1993	18.72	11.33	11.28	1.62	4.84	0.44	0.70
1994	18.46	12.12	11.34	2.33	4.60	0.39	0.61
1995	18.35	12.42	11.72	2.96	4.20	0.34	0.47
1996	18.71	12.62	12.10	2.27	4.05	0.32	0.42
1997	19.04	13.05	12.45	2.07	3.93	0.30	0.37
1998	19.36	13.34	12.98	1.95	4.30	0.33	0.41
1999	19.13	12.82	12.87	3.02	4.59	0.36	0.44
2000	18.80	12.89	12.58	2.96	3.29	0.26	0.33
2001	19.97	13.62	13.12	4.31	3.35	0.25	0.33
2002	21.85	14.43	13.96	3.40	4.51	0.32	0.38
2003	22.84	14.71	14.18	4.68	4.28	0.29	0.34
2004	24.81	15.47	15.24	5.65	4.62	0.30	0.35
2005	27.36	16.80	16.34	7.12	5.20	0.31	0.37
2006	30.65	17.74	17.59	6.49	7.43	0.42	0.50
2007	32.51	18.03	17.86	10.40	7.62	0.42	0.51
2008	36.32	19.22	19.13	9.92	9.28	0.48	0.56
2009	39.94	19.65	19.97	12.83	10.95	0.56	0.67
2010	44.16	20.94	21.09	13.59	11.15	0.52	0.60
2011	50.31	24.17	23.66	8.38	9.65	0.39	0.43
2012	58.05	30.68	29.66	4.93	11.83	0.38	0.42
2013	62.46	37.27	36.24	2.80	11.54	0.31	0.35
2014	64.98	44.16	42.80	1.35	14.25	0.32	0.39
2015	61.98	47.07	45.25	2.98	13.04	0.28	0.33
2016	58.16	47.78	45.53	3.39	9.88	0.21	0.24
2017	56.01	47.77	45.63	3.07	9.23		

4.5 Ling (*Molva Molva*) in Areas (3.a, 4, 6, 7, 8, 9, 10, 12, 14)

4.5.1 The fishery

Significant fisheries for ling have been conducted in Subareas 3 and 4 at least since the 1870s, pioneered by Swedish longliners. Since the mid-1900s the major targeted ling fishery in 4.a is by Norwegian longliners conducted around Shetland and in the Norwegian Deep. There is little activity in 3.a. Of the total Norwegian 2016 landings in Subareas 3 and 4, 83% were taken by longlines, 9% by gillnets, and the remainder by trawls. The bulk of the landings from other countries were taken by trawls as bycatches, and the landings from the UK (Scotland) are the most substantial. The comparatively low landings from the central and southern North Sea (4.b,c) are bycatches from various other fisheries.

The major directed ling fishery in Area 6 is the Norwegian longline fishery. Catches by trawl fisheries from the UK (Scotland) and from France are primarily bycatches.

When Areas 3–4 and 6–14 are pooled over the period 1988–2016, 42% of the total landings were in Area 4, 31% in Area 6.a, and 26% in Area 6.b.

In Subarea 7, the Divisions b, c, and g–k providese most of the landings of ling. Norwegian landings, and some Irish and Spanish landings are from targeted longline fisheries, whereas other landings are primarily bycatches in trawl fisheries. Data split by gear type were not available for all countries, but the bulk of the total landings (at least 60–70%) were taken by trawls in these areas.

In Subareas 8 and 9, 12 and 14 all landings are bycatches from various fisheries.

The Norwegian fishery

The Norwegian longline fleet increased from 36 in 1977 to a peak of 72 in 2000, and afterwards the number decreased to 25 in 2015 and 2016. The number of vessels declined mainly because of changes in the law concerning the quotas for cod. The average number of days that each Norwegian longliner operated in an ICES division was highly variable for 4.a, stable for 6.b and declining for 6.a. The average number of hooks has remained relatively stable in 4.a and 6.a. During the period 1974 to 2016 the total number of hooks per year has varied considerably, but with a downward trend since 2002 (For more information see Helle and Pennington, WD 2017).

Since the total number of hooks per year takes into account; the number of vessels, the number of hooks per day, and the number of days each vessel participated in the fishery, it follows that it may be a suitable measure of changes in applied effort. Based on this gauge, it appears that the average effort for the years 2011–2016 is 43% less than the average effort during the years 2000–2003.

The French fishery

French fleets operating in 6, 7.bck are mainly otter trawlers, gillnetters and longliners, which accounts for around 1000 t of ling in 2016, mainly from otter trawlers (600 t). Gillnetters landed 40 t and longliners around 400 t.

The number of otter trawlers operating in the region has decreased from around 70 in the beginning of the 2000s to 26 in 2016. Gillnetters have had a relatively stable number of boats involved, between 12 and 20 during the period 2000 to 2014, but was reduced to five in 2016. The number of longliners has increased from one in 2000 to 12 in 2016 (Table 4.5.3).

Since 2000, otter trawlers have exhibited a nearly continuous decrease in effort by a factor of 2. Gillnetters had a peak in effort in the mid 2000 followed by a steep decrease by a factor of 5 since 2010. The recorded fishing efforts by longliners has been imprecise due to lack of information in the first part of the year 2000s. The activity seems to have peaked in 2007 followed by a sharp decrease to 2009. Since 2009, the effort has been steadily increasing.

Landings of ling by otter trawlers has been increasing since 2004. For gillnetters and longliners, landings are closely related to changes in efforts. Since 2011 landings have been stable for gillnetters and increasing for longliners.

The Spanish fishery

The Spanish fleet fishes for ling in ICES Subarea 7, for the most part in divisions b, c and g–k, and the catch is mainly taken by longliners. However, there are also important bycatches of ling by trawlers operating in the area. Porcupine Bank important fishing area for the trawlers, therefore the results from the Porcupine Bank Spanish groundfish survey could be useful as an indicator of the abundance and status of ling in the area.

4.5.2 Landings trends

Landing statistics by nation in the period 1988–2016 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 then the amount landed has been stable. When Areas 3–14 are pooled, the total landings averaged around 32 000 t in the period 1988–1998 and afterwards the average catch varied between 16 000 and 17 000 tons per year. The preliminary landings for 2016 is 19 269 t.

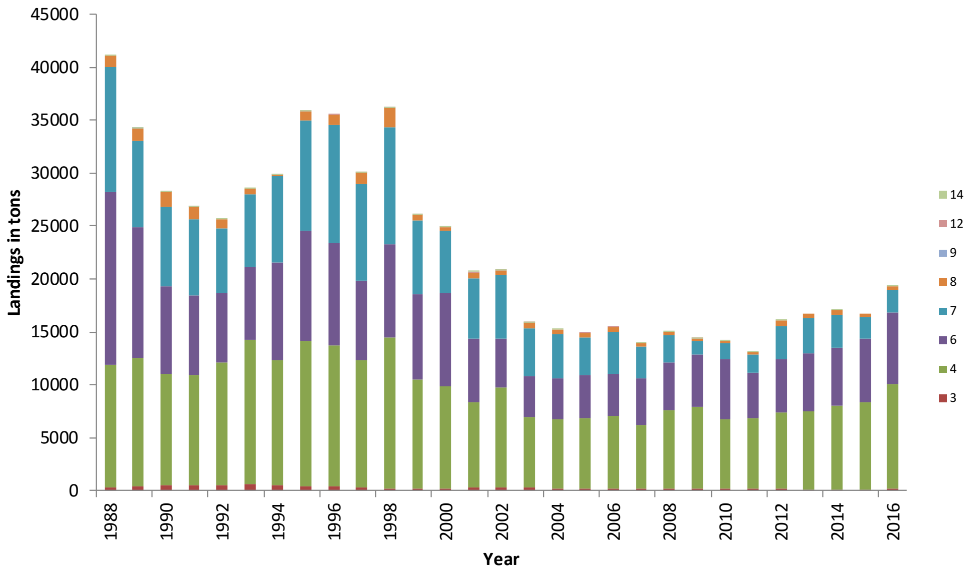


Figure 4.5.1. International landings. Ling in other areas.

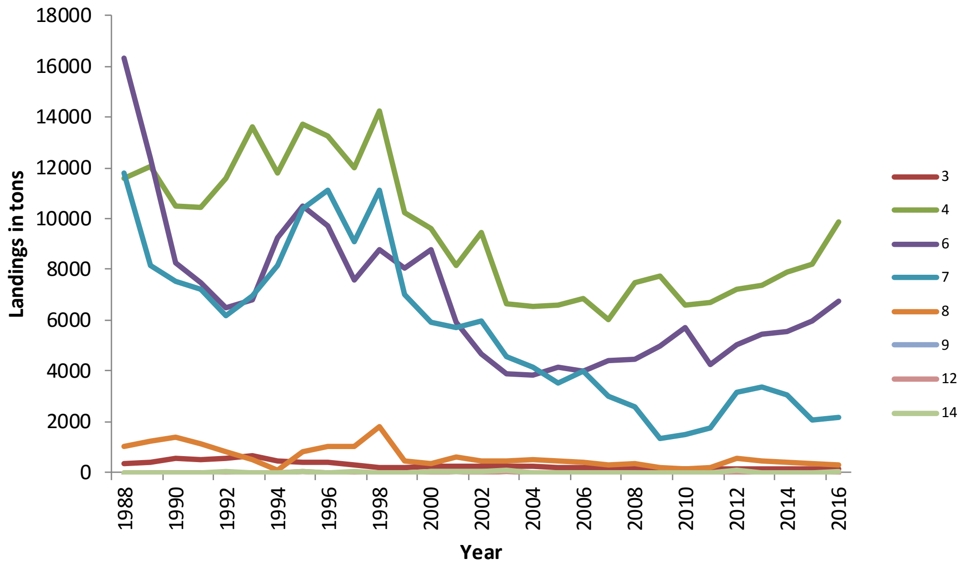


Figure 4.5.2. International landings. Ling in other areas.

4.5.3 ICES Advice

Advice for 2016 to 2017: "ICES advises that when the precautionary approach is applied, catches should be no more than 14 746 tonnes for each of the years 2016 and 2017. Discarding is considered to be negligible".

4.5.4 Management

Norway has a licensing scheme in EU waters, and in 2017 the Norwegian quota in the EC zone is 6500 t. The Faroe Islands has a quota of 200t in 6.a and 6.b. The quota for the EU in the Norwegian zone (Area 4) is set at 1 350 t.

EU TACs for areas partially covered in this section are in 2016 and 2017:

	2016	2017
Subarea 3	87 t	87
Subarea 4	2912 t	3494
Subarea 6, 7 (EU and international waters)	10 297 t.	13 696

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 from 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 there is no information on discarding. Discards by Spain, Ireland, France, Sweden, England and Scotland are given below for the years 2012 to 2016, and by area and countries for

2016. Discarding has been increasing over this period, and in 2016, 1598 tons of ling were discarded.

Total discards by country for the years 2013 to 2016.

	2012	2013	2014	2015	2016
Spain	46	101	54	0	1
Ireland	176	160	435	0	220
France		29	15	131	72
Sweden				4	
UK (Scotland)				704	1302
UK (England)					22
Total	222	290	504	839	1598

Reported discards by area and country:

Area	Country	Discards
4.a	UK(Scotland)	1179
4.b	UK (England)	2
6.a	Ireland	85
6.a	UK(Scotland)	92
6.b	Ireland	67
6.b.5	UK(Scotland)	31
7.e	UK (England)	7
7.f	UK (England)	11
7.g	Ireland	38
7.h	UK (England)	2
7.j	Ireland	2
7.k	Ireland	10
8.c	Spain	1
4.a	France	15
6.a	France	6
7.e	France	5
7.f	France	4
7.g–k	France	33
8.a	France	8
Total		1598

4.5.5.2 Length composition

Data from the Norwegian reference fleet

Average fish length, weight–length relationships and the length distribution for the Norwegian longline and gillnet fishery in Areas 4a, 6a, 6b are shown in Figures 4.5.3–4-5.7. Data are from the Norwegian longline reference fleet. Weight as a function of length for ling in Areas 6 and 7 are based on Spanish data (Figure 4.5.8).

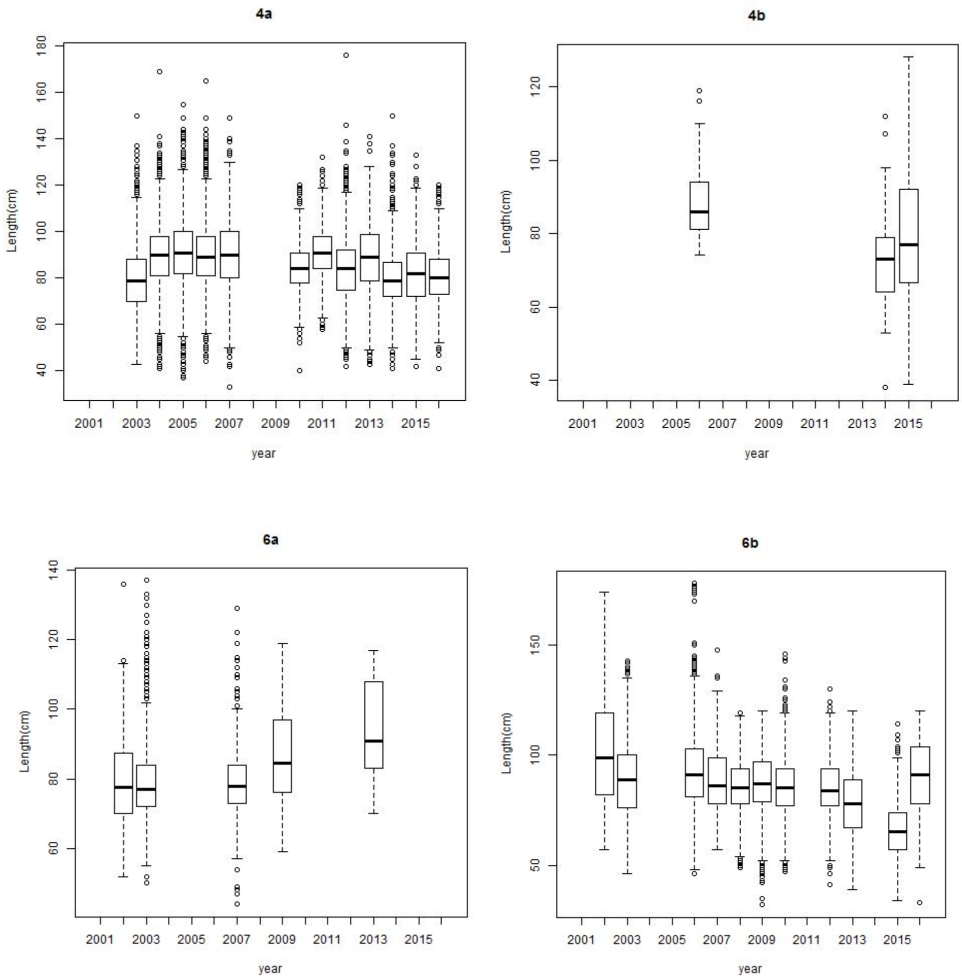


Figure 4.5.3. Box and whisker plots of length distributions for the Norwegian longline reference fleet in 4.a, 4.b, 6.a and 6.b.

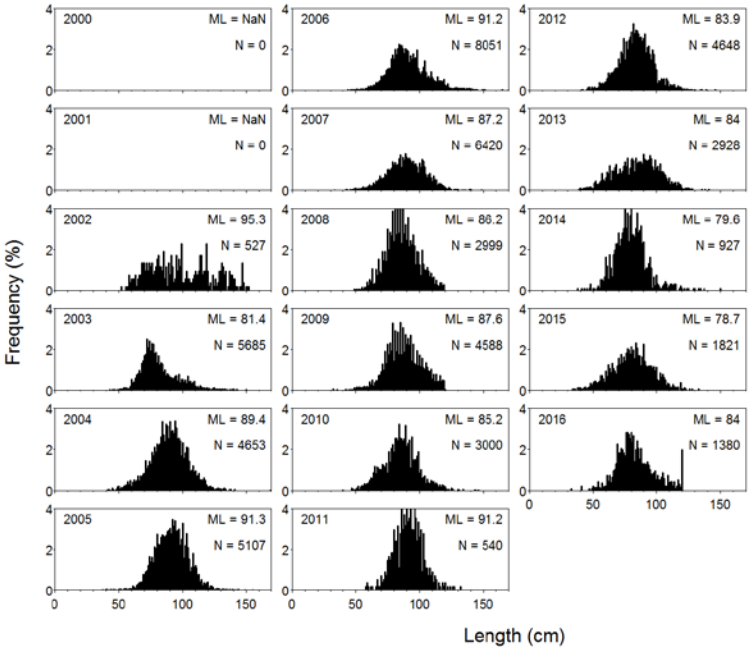


Figure 5.4.4. .Length distributions of ling in areas 4.a, 6.a and 6.b for the Norwegian reference fleet.

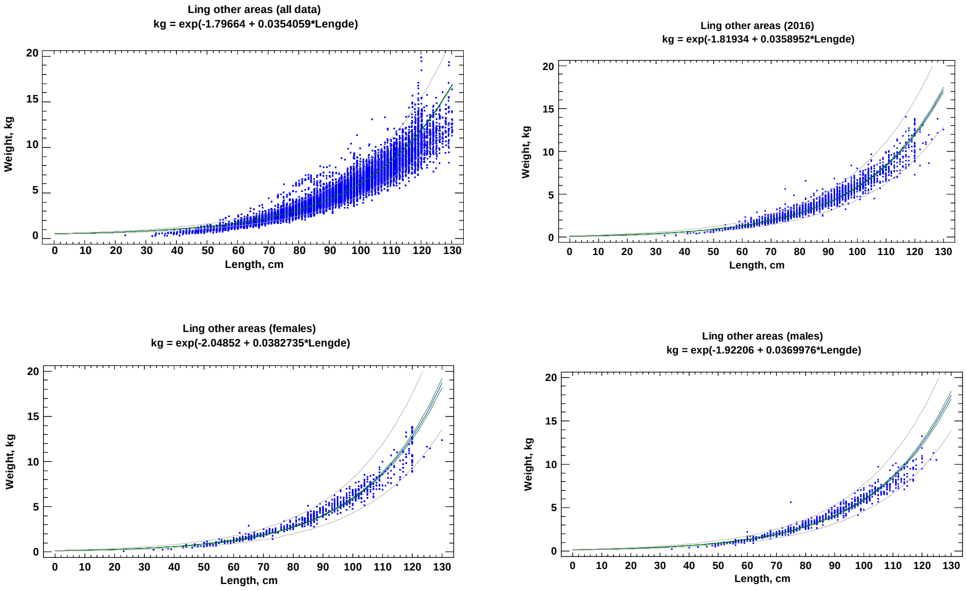


Figure 4.5.5. Weight versus length for ling and for ling other areas based on all available Norwegian data.

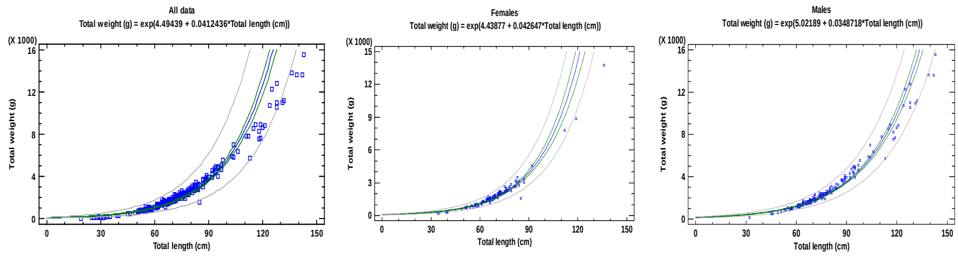


Figure 4.5.9. Weight as a function of length for ling in Areas 6 and 7 based on Spanish data 2014 to 2016.

Estimated Length distributions based on the Spanish Porcupine Bank (NE Atlantic) surveys

In Figure 4.5.10 are the estimated length distributions of ling for the years 2001–2016. (For more information see Fernández-Zapico *et al.*, WD 2017).

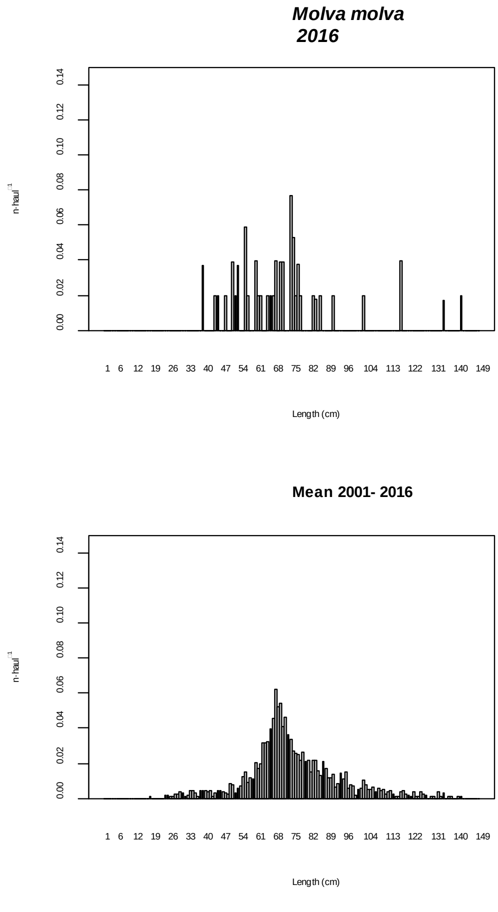


Figure 4.5.10. Estimated length distributions of ling (*M. molva*) based on the Porcupine Bank Spanish survey in 2016 and the period 2001–2016.

4.5.5.3 Age compositions

Estimated age distributions for the years 2009–2015 based on data from the Norwegian Reference fleet for all areas combined (Figures 4.5.12) and box and whisker plots for the age composition of the fish taken by longliners and gillnetters in area 4.a (Figure 4.5.13).

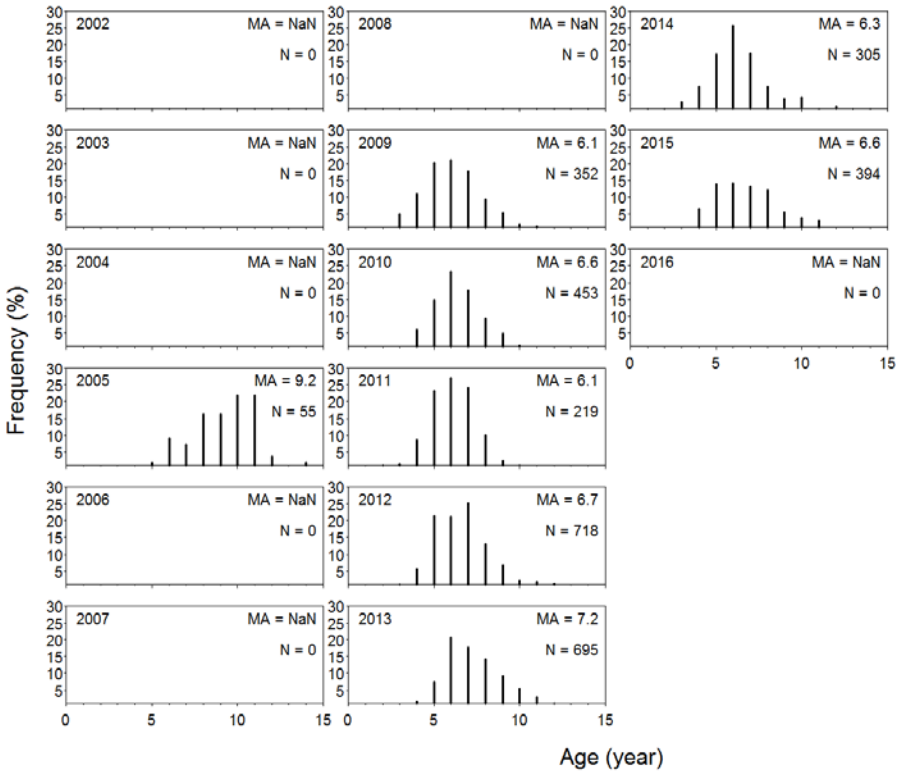


Figure 4.5.12. Age distributions for ling other areas for all catches taken by longliners.

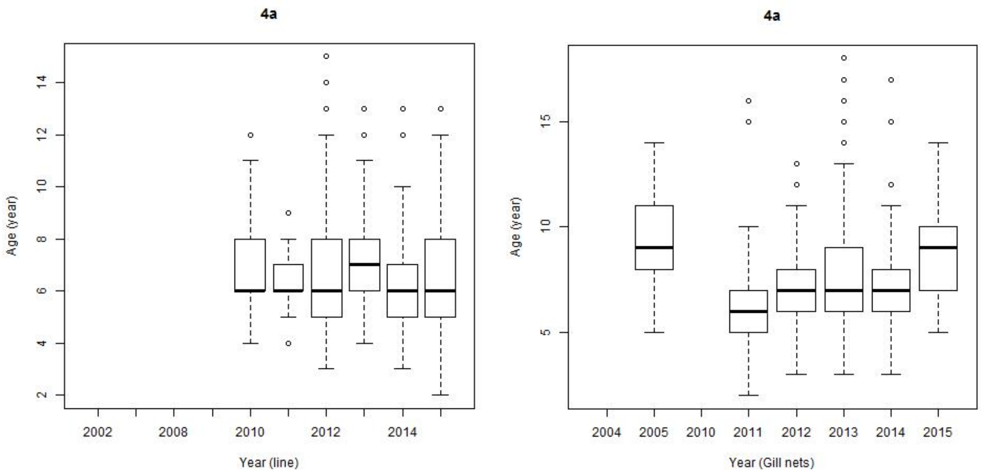


Figure 4.5.13. Age composition of the fish taken by longliners and gillnetters.

4.5.5.4 Weight-at-age

Average weight- and length-at-age for 2009 to 2015 were available for areas 4.a and 6.a based on data from the Norwegian reference fleet Figure 4.5.13. and the average length-at-age and average weight-at-age for the Spanish ling fishery (2014–2016) on Porcupine Bank (Figures 4.5.14 and 4.5.15).

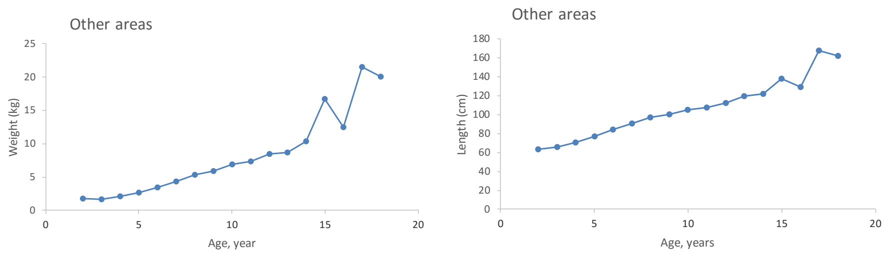


Figure 4.5.13. Average weight- and length-at-age for 2009 to 2015 for Areas 4.a and 6.a.

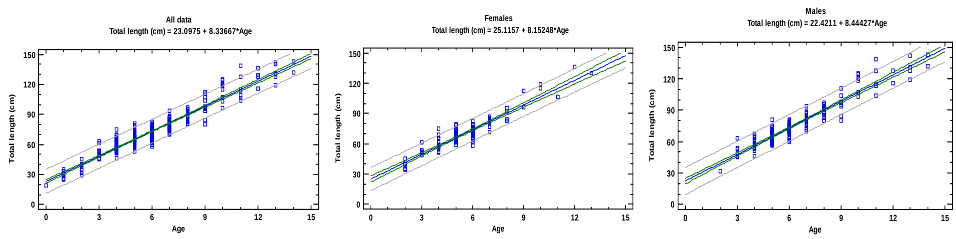


Figure 4.5.14. Average length-at-age based on Spanish data for areas 6 and 7 from 2014 to 2016.

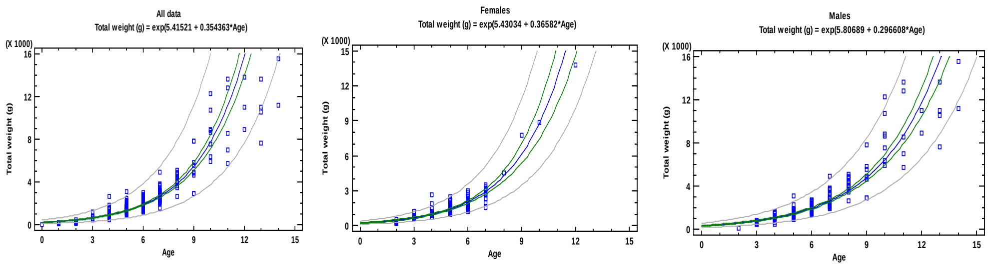


Figure 4.5.15. Average weight-at-age based on Spanish data for areas 6 and 7 from 2014 to 2016.

4.5.5.5 Maturity and natural mortality

Maturity ogives for ling are in Figure 4.5.16 and in the table below. The results 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).

Maturity parameters:

Stock	L_{50}	N	A_{50}	N	Source
Lin-lin.27.3.a4.a6-91214	63.6	1472	4.8	336	Norwegian long liners (Reference fleet) and survey data

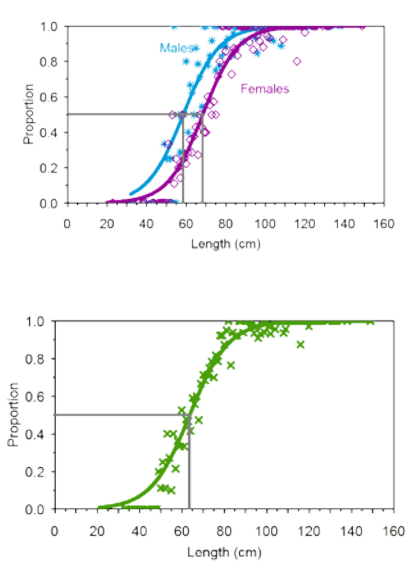


Figure 4.5.16. Ling lin.27.3a4a6-91214, Maturity ogives for age and length for males and females (top panel) and sexes combined (lower panel).

4.5.5.6 Catch, effort and research vessel data

Spanish ling 2014 Porcupine Bank (NE Atlantic) survey

The Spanish bottom trawl survey on the Porcupine Bank (ICES divisions 7.c and 7.k) has been carried out annually since 2001 to study the distribution, relative abundance and biological parameters of commercial fish in the area (ICES, 2010a; 2010b). The survey provides estimated biomass and abundance indices. Area covered by the survey in given in Figure 4.5.17.

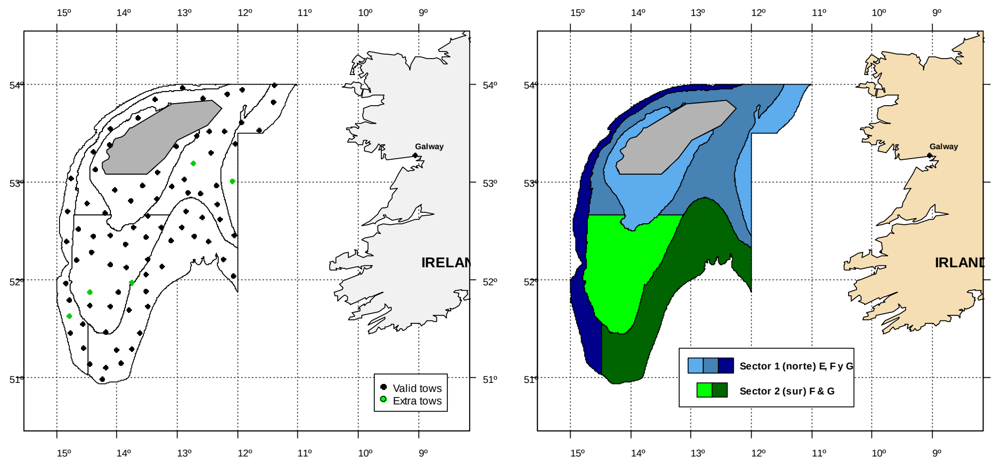


Figure 4.5.17. Left: distribution of hauls performed during 2016 Porcupine Bank survey. Right: Stratification design used in Porcupine surveys from 2003, previous data were re-stratified. Depth strata are: E) shallower than 300 m, F) 301–450 m and G) 451–800 m. Grey area in the middle of Porcupine bank corresponds to a large non-trawleable area, not considered for area measurements and stratification.

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, mean length and 95 percentiles for length) for the Bay and Biscay and Celtic Sea (ICES divisions 7.g,h,j,k and 8.a,b,d) combined were provided for years 1997–2016 (Figure 4.5.18). The 95 percentiles for length aims at representing changes in the proportion of large individuals, when this index increases, there is a larger proportion of large fish in the population. The survey covers depths from 30 to 600 m and is stratified by depth and latitude. Only a small number of ling are caught in the survey area, indices show no recent changes. Indices values were slightly higher at the start of the 20 years' time-series.

Commercial cpues

French lpue

Landings, effort measured in hours at sea and landings per unit of effort (lpue) are provided by the French otter trawl, longline and gillnet fishery for areas 6 and 7.bck for the years 2000 to 2016.

Norwegian longline cpue

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2016. 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 data quality has improved considerably and data from the entire fleet were available.

For the standardised Norwegian cpue series, data were available from official logbooks from 2000 onwards. All catch data, and a subset where ling appeared to have been targeted (>30 percent of total catch), were used to estimate a standardized cpue series.

A standardised commercial cpue series using data from the Norwegian longline reference fleet was presented based on methods described in Helle *et al*., 2015.

4.5.6 Data analyses

Length data analysis

Mean length of the commercial catches by the Norwegian longlining reference fleet fluctuate and are around 90 cm for Areas 4 and 6.b and around 80 cm for Area 6.a. The series does not indicate any apparent time trends.

On Porcupine Bank the estimated length distributions appear to be quite stable with a length range from approximately 30–130 cm. The mode of the distributions tends to be around 70 cm, and there are no clear recruitment signals, which imply that Porcupine Bank is not a recruitment area for ling (Figure 4.5.10). For more information see Fernández-Zapico *et al*., WD 2017.

The French IBTS survey (EVHOE)

Total abundance of ling varies but with no apparent trends. The biomass may have been higher in the early years of the time-series, and mean length may be decreasing. However, the number of ling caught by the survey is small and variable so that the confidence intervals are wide.

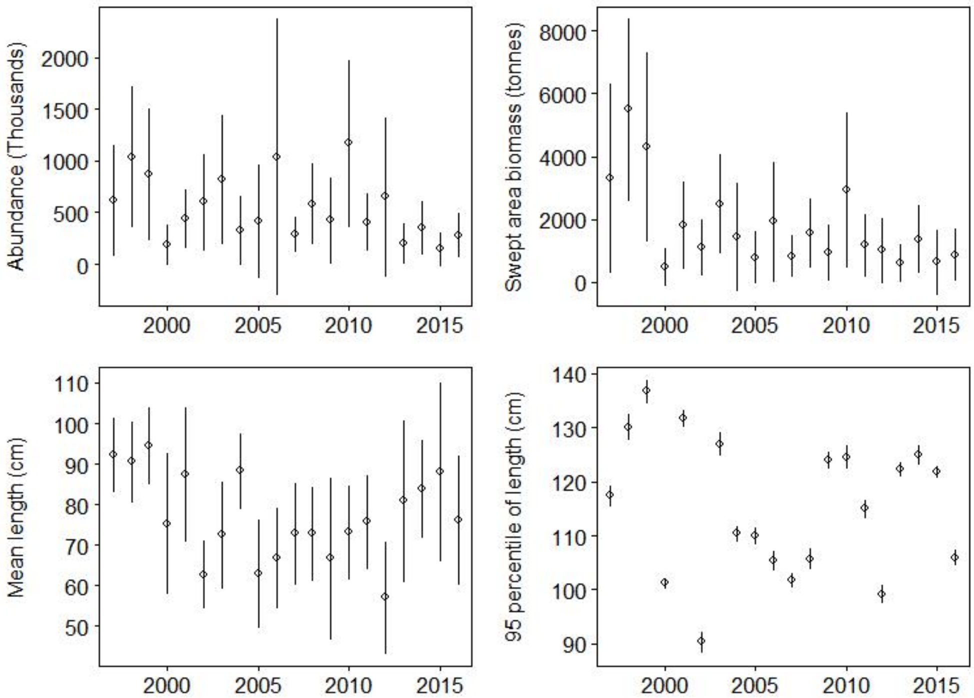


Figure 4.5.18. Population indices (swept area raised abundance and biomass as well as mean length) for the Bay and Biscay and Celtic Sea (ICES divisions 7.g,hjk and 8a,b,d) for the years 1997–2016.

French lpue

The landings of ling by otter trawlers increased from 2004 to 2016. During the last two years there has been a decrease in landings. For gillnetters and longliners, landings are closely related to changes in effort (Figure 4.5.19).

Overall, while total fishing effort has decreased in the area fished by the three major French fleets, there is a clear increasing trend in lpue for otter trawlers, a decrease since 2014 for the gillnetters. The lpue seems to be low but stable for longliners.

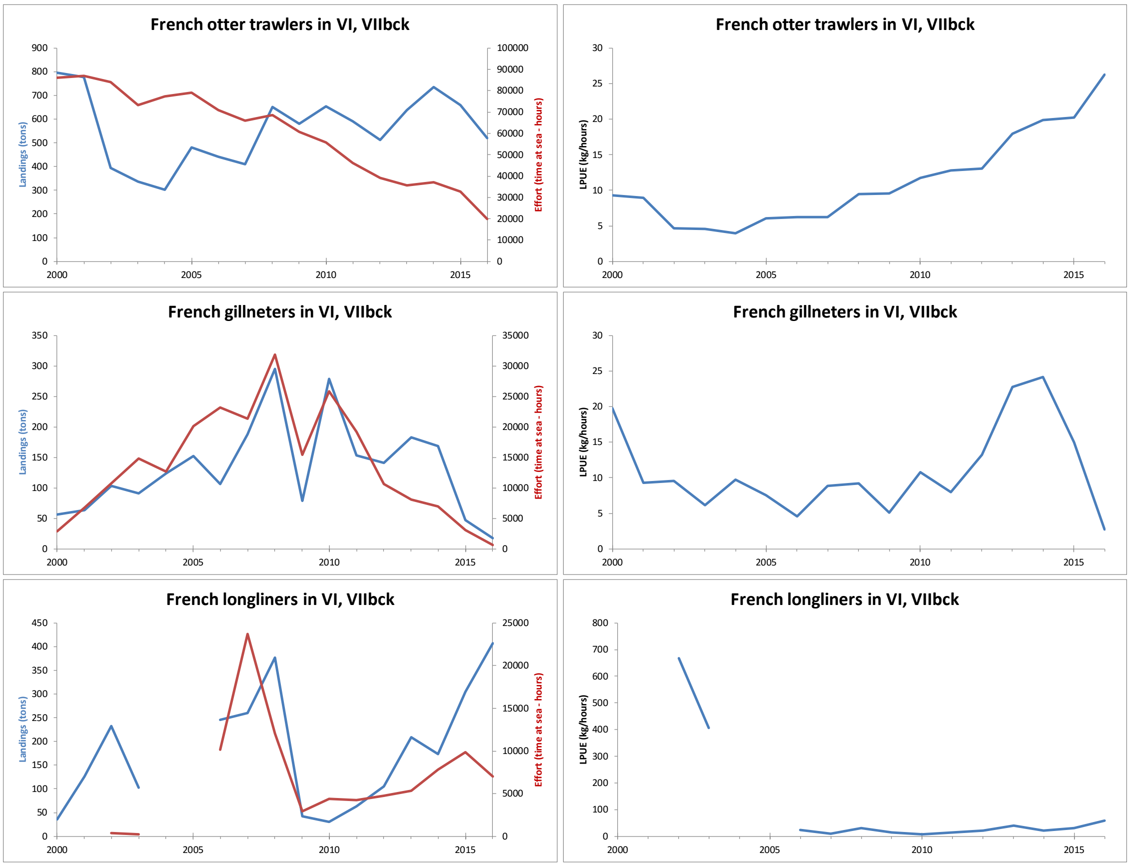


Figure 4.5.19. Lpue series for the main French fleet operating in 6, 7.b, c and k.

Spanish ling 2016 Porcupine Bank (NE Atlantic) survey

Estimated biomass and abundance indices based on data from the Porcupine Survey for the years 2001–2016 are in Figure 4.5.20. The abundance indices for ling based on the survey have been quite stable from 2001 up to 2012. Taking into account the 80% confidence limits, except for the peak in 2013, the abundance indices for ling have been quite stable, for the years 2001 to 2016, however there is a downward trend after the peak in 2013.

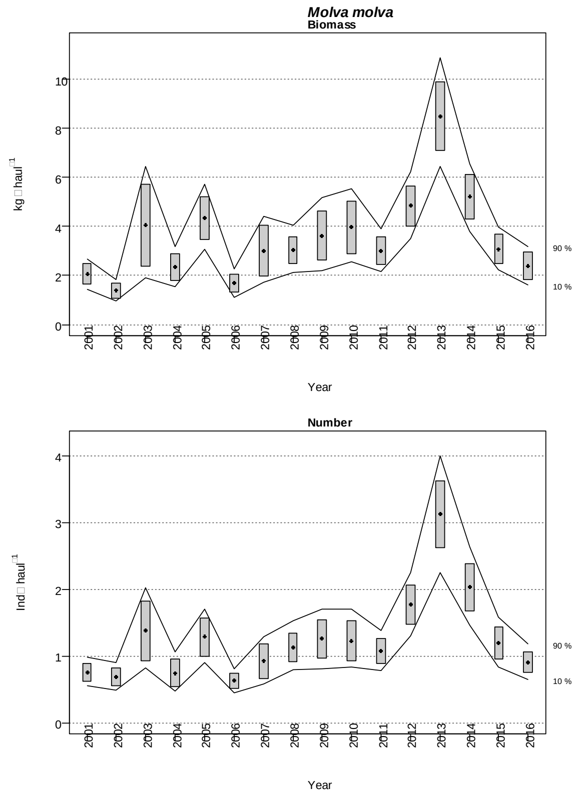


Figure 4.5.20. Estimated biomass and abundance indices based on the Porcupine Survey for the years 2001–2016. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

Cpue series based on the Norwegian longline fleet

For ling, there is a positive development in cpue for all areas. A large part of Rockall (area 6.b) was closed for fishing in the beginning of 2007. After 2007, the cpue for ling has increased considerably.

When all data for "ling other areas" are combined, the cpue series indicates a steady increase since 2003 to 2016.

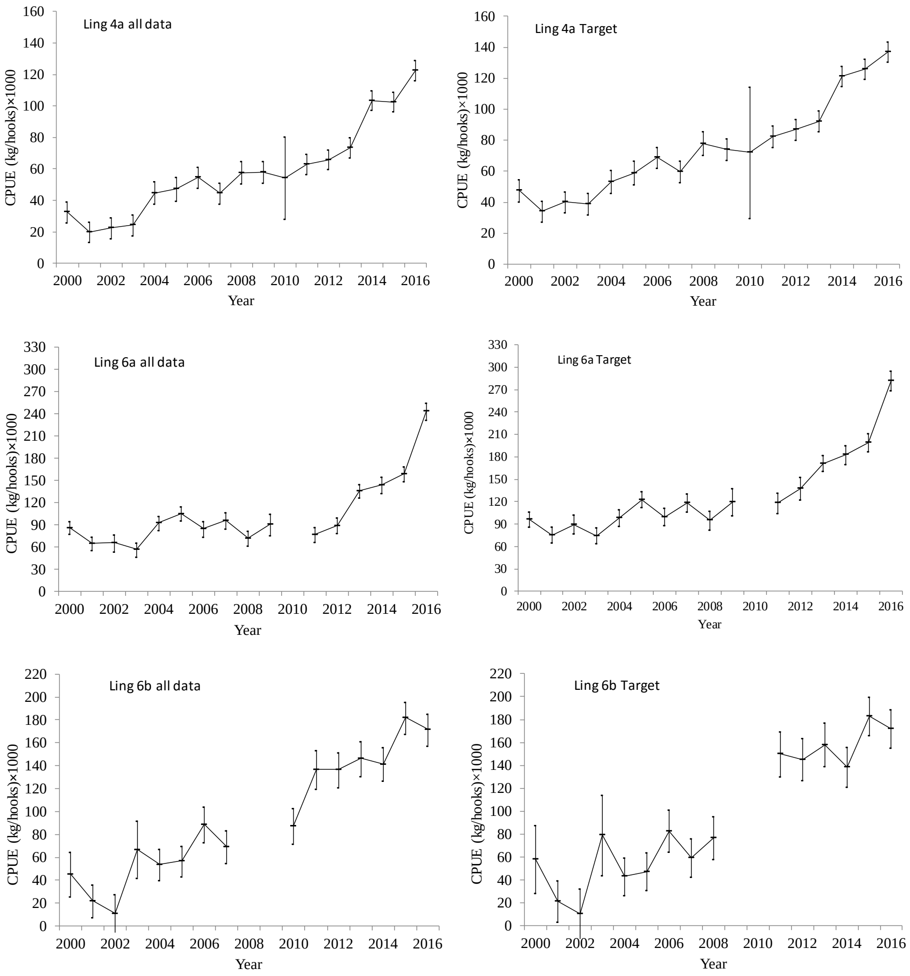


Figure 4.5.20. Cpue series for ling for the period 2000–2016 based on all available data and when ling appeared to have been targeted. The bars denote the 95% confidence intervals.

The ling stocks in Areas (3.a, 4, 6, 7, 8, 9, 10, 12, 14) are best covered by the Norwegian longline fleet. It was therefore decided in plenary that a combined cpue series should be made in order to give advice for the entire area, and that the data from the targeted fishery should be used. The combined series is shown in Figure 4.5.21.

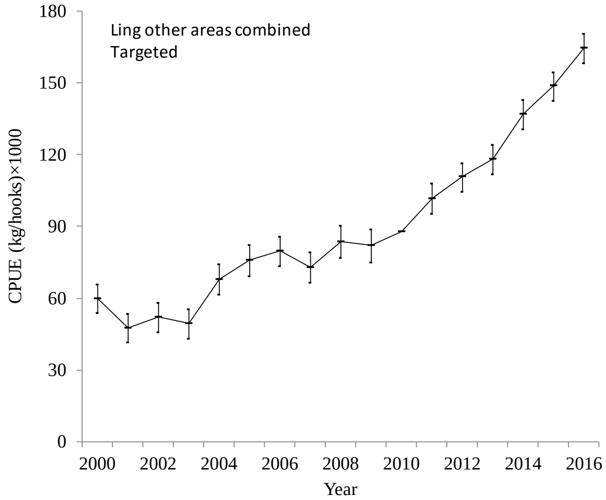


Figure 4.5.21. Cpue series for ling, areas combined, for the period 2000–2015 based on data when ling appeared to have been targeted. The bars denote the 95% confidence intervals.

Biological reference points

See Section 4.5.9.

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 presented in 2011. The trend is either stable (4.a and 6.a) or increasing (6.b) during the last decade (Figure 4.5.21).

All data in areas 4.a, 6.a and 6.b were combined to make one index for the entire area. These series show the same positive trend as for each area separately. This positive trend is also reflected in the French lpue series based on the otter trawlers but not in the Spanish biomass and abundance indices.

4.5.8 Management considerations

The cpues series based on commercial data either indicate a stable or an increasing trend. Since the catches have been stable and the indicator series has been showing an increasing trend. There has been an increase in discrrding of ling, in 2016 around 8% was discarded. On average the last three years 5.1% was discarded.

As always, it should be emphasized that commercial catch data are typically observational data; that is, there were no scientific controls on how or from where the data were collected. Therefore, it is not known with certainty if the ling cpue series tracks the population and/or how accurate the measures of uncertainty associated with the series are (see, for example, Rosenbaum, 2002). Consequently, one must usually hope and pray that a cpue series, which is based only on commercial catch data, truly tracks abundance.

An infamous example of a misleading cpue series based on commercial data was a cpue series for Newfoundland cod that incorrectly indicated that the abundance of the cod stock was increasing greatly. Advice based on this cpue series ultimately caused the collapse of the stock (see, e.g. Pennington and Strømme, 1998).

In general, any assessment method based only on commercial catch data needs to be applied with caution. The reason that assessments using only commercial data are problematic is because the relation between the commercial catch and the actual population is normally unknown and probably varies from year to year.

4.5.9 Application of MSY proxy reference points

Two different methods were tested for Ling, the Length based indicator method (LBI) and SPiCT. When all landings data were used 1988–2016 the SPiCT model did not converge. For a shorter period 2000–2016, the model converged, but the retrospective plot showed that this method was not robust enough. Therefore, the LBI appears to be the best method. Both models indicate that ling in 1 and 2 is fished sustainably. A summary of the methods are given under:

Length-based indicator method (LBI)

The input parameters and the catch length composition for the period 2002–2016 are in the following tables and figures. The length data used in the LBI model are data from the Norwegian longline fleet. The length data are not weighted and therefore do not represent the length distribution of the entire catch.

Input parameters for LBI.

DATA TYPE	SOURCE	YEARS/VALUE	NOTES
Length–frequency distribution	Norwegian longliners (Reference fleet)	2002–2016	
Length–weight relation	Norwegian Reference fleet and survey data	0.0055* length $^{3.0120}$	
L_{MAT}	Norwegian Reference fleet and survey data	64 cm	Combined sexes
L_{inf}	Norwegian Reference fleet and survey data	183 cm	

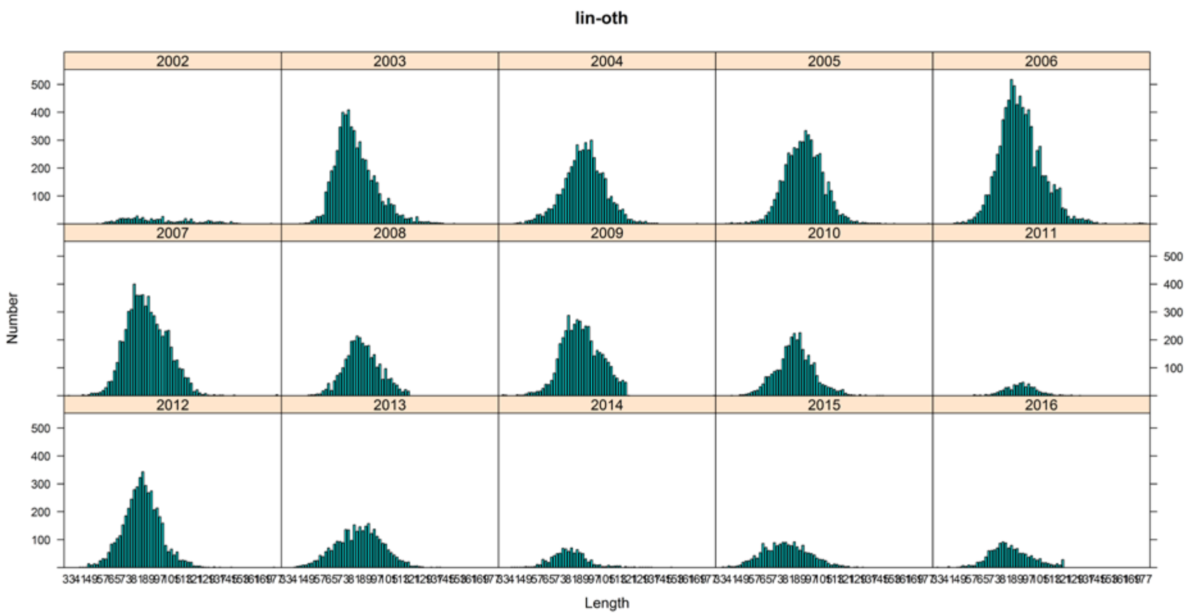


Figure 4.5.22. Ling in other areas (3.a, 4.a, 4.b, 6.a, 6.b, 7). Catch length composition for the period 2001–2016 at 2 cm length classes (sex combined).

Outputs

The screening of length indicator ratios for combined sexes was conducted under three scenarios: (a) Conservation. (b) Optimal yield, and (c) maximum sustainable yield. The results are presented in the following figures.

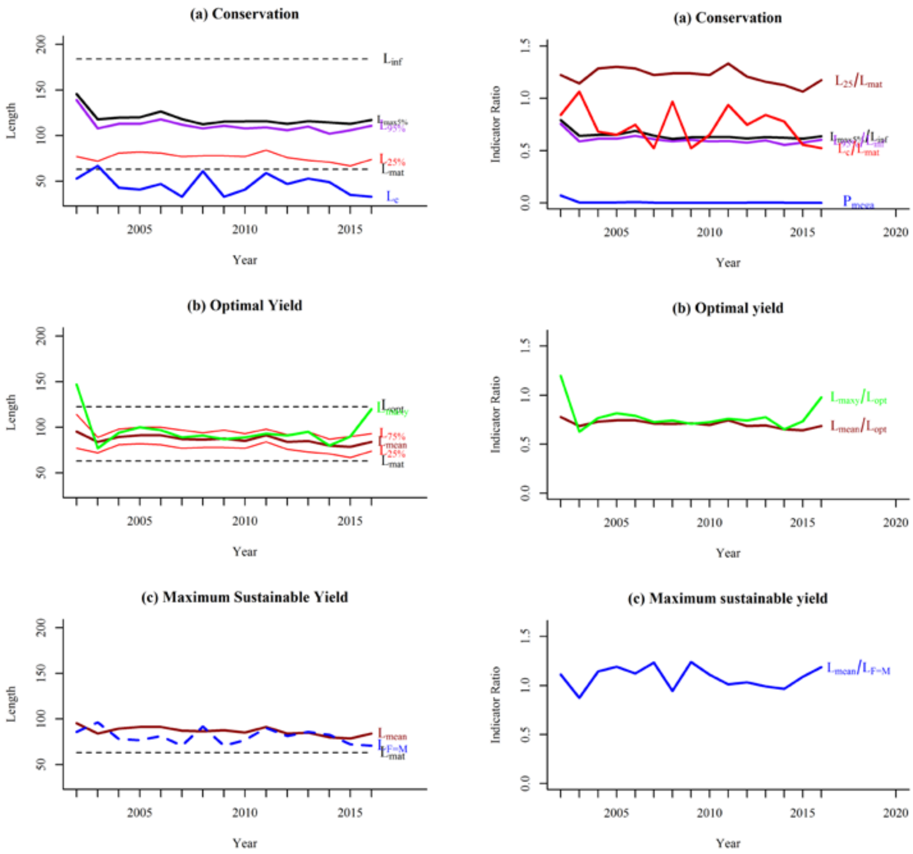


Figure 4.5.23. Ling in other areas (3.a, 4.a, 4.b, 6.a, 6.b, 7). Screening of length indicators ratios for sex combined under three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

Analysis of results

For the conservation of immature ling the model shows that L_c/L_{mat} is usually less than one, but $L_{25\%}/L_{mat}$ is usually greater than 1 (Figure 4.5.23). In 2014–2016, $L_{25\%}/L_{mat}$ has been greater than 1. The sensitivity measure, L_{mat}, suggests that there is no overfishing of immature ling.

The conservation measure for large ling shows that the indicator ratio of $L_{max5\%}/L_{inf}$ is around 0.6 for the whole period (Figure 4.5.23) and between 0.61 and 0.64 in 2014–2016 (table under). Therefore, since the conservation indicator is less than 0.8, this implies that there are few of mega-spawners in the catch which indicates that there is a truncation point in the length distribution of the catch, i.e. the present catch levels are not optimal.

The MSY indicator ($L_{mean}/L_{F=M}$) is greater than 1 for almost the whole period which indicates that ling in other areas were fished sustainably. The sensitivity measure, L_{inf}, indicates that MSY is always higher than 0.94.

Conclusions

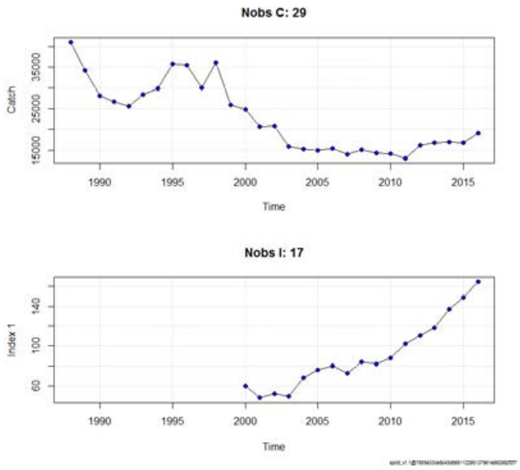
The overall perception of the stock during the period 2014–2016 is that ling in other areas seems to be fished sustainably (table under). However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

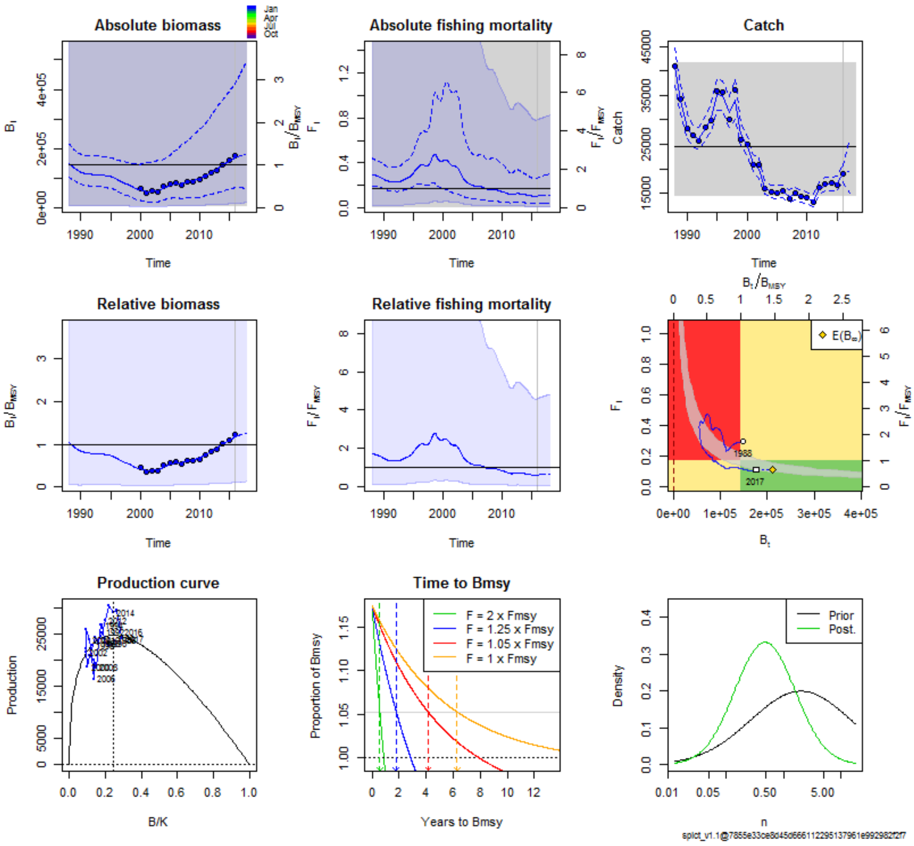
The final results from the LBI method.

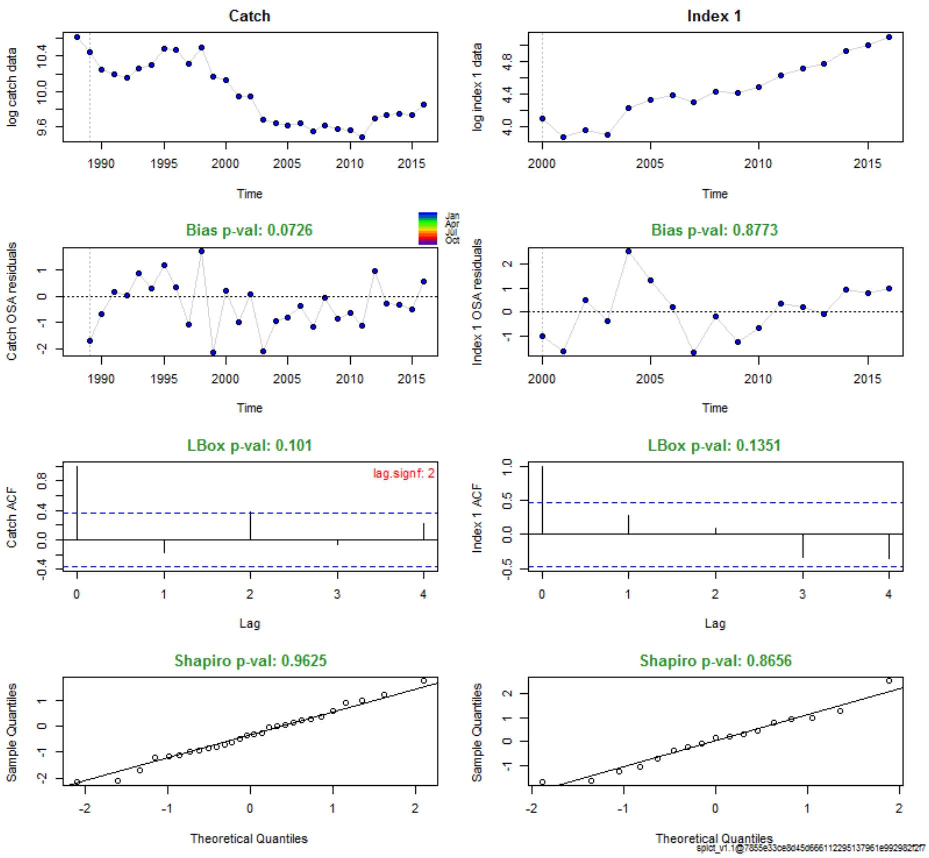
	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2014	0.78	1.13	0.62	0%	0.65	0.97
2015	0.56	1.06	0.61	0%	0.64	1.09
2016	0.52	1.17	0.64	0%	0.68	1.19

<u>Plots for the SPiCT model:</u>

The input data were landings 1988–2016, and the cpue index for the targeted fishery from 2000–2016.


Nobs C: 29
Catch
Time
Nobs I: 17
Index 1
Time


Absolute biomass
Absolute fishing mortality
Catch
Relative biomass
Relative fishing mortality
Production curve
Time to Bmsy
Time
Production
B/K
Proportion of Bmsy
Years to Bmsy
F = 2 x Fmsy
F = 1.25 x Fmsy
F = 1.05 x Fmsy
F = 1 x Fmsy
Density
Prior
Post.
n


Catch
Index 1
log catch data
log index 1 data
Time
Bias p-val: 0.0726
Bias p-val: 0.8773
Jan
Apr
Jul
Oct
Catch OSA residuals
Index 1 OSA residuals
LBox p-val: 0.101
LBox p-val: 0.1351
lag.signf: 2
Catch ACF
Index 1 ACF
Lag
Shapiro p-val: 0.9625
Shapiro p-val: 0.8656
Sample Quantiles
Theoretical Quantiles

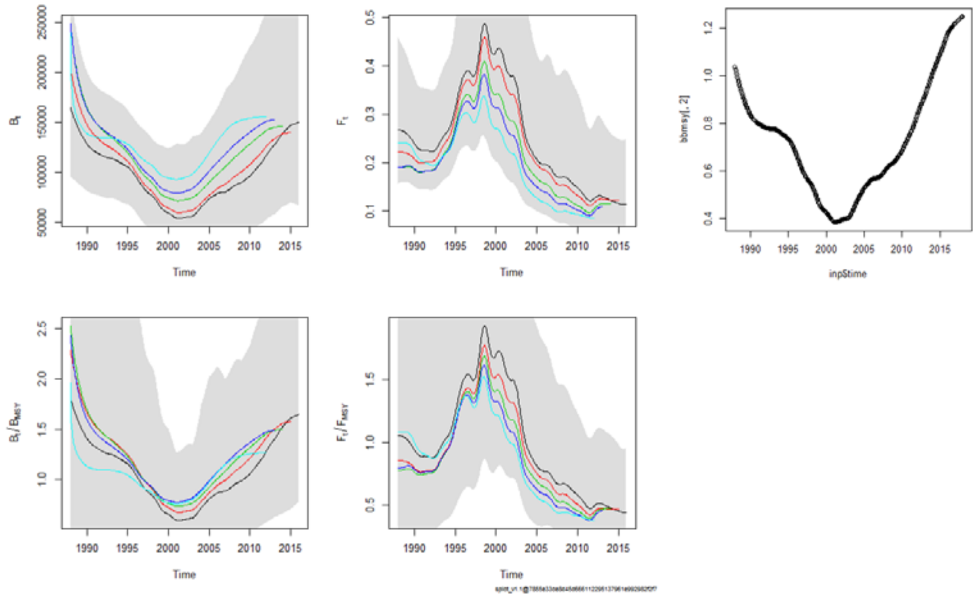

Time
inp$time

Table 4.5.1. Ling 3a, 4a, 6, 7, 8, 9, 12 and 14. WG estimates of landings.

Ling 3

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
2014		51	1	54	14		120
2015		58	1	50	16		125
2016*		77	1	57	17		152

***Preliminary.**

Table 4.5.1. (continued).

Ling 4.a

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	7408
2010		433		62	40		3914		28		1921	6398
2011		541		90	62		3790	8	18		1999	6508
2012		419		105	47		4591	6	28		1822	7018
2013		548		104	83		4273	5	15		2169	7197
2014		404		182	53		5038	3	23		2046	7749
2015		424		127	53		5369	6	90		2018	8069
2016*		797		304	71		6020	5	65		2477	9739

***Preliminary.**

(1) Includes 4b 1988–1993.

Table 4.5.1. (continued).

Ling 4.bc.

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	1	10	84	25	7	8		192
2013	15	47	1	5	71	0	21	12	4	176
2014	16	46	0	6	34	7	14	15	3	141
2015	11	36		6	54	10	16	14		147
2016*	14	42		6	50	7	9	21	1	150

***Preliminary.**

Table 4.5.1. (continued).

Ling 6.a 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
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

Year	Belgium	Denmark	Faroes	France (1)	Germany	Ireland	Norway	Spain(2)	E&W	IOM	N.I.	Scot.	Total
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	718		54	1429	899	10			1500	4660
2014			0	937		39	1006	1005	6			1768	4761
2015				891		65	1214	961	4			1629	4764
2016*			92	1005		154	1313	1109	9			1975	5659

***Preliminary. (1) Includes 6.b until 1996 (2) Includes minor landings from 6.b.**

Table 4.5.1. (continued).

Ling 6.b.

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	7		13	1089	3			218		1390
2013		19		8	532	6			229	1	795
2014	60	7		10	435	2			258	2	774
2015	5	10	1	16	952	11	6		211	3	1215
2016*	56			35	821	2	4		170		1088

***Preliminary. (1) Includes XII. (2) Until 1966 included in 6.a. (3) Included in Ling 6.a.**

Ling 7

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 7.a.

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
2014	2	0	11				16	29
2015	1		8				10	19
2016*	1		10				13	24

Preliminary. (1) French catches in 7 not split into divisions, see Ling 7. (2) Included with UK (EW).

Table 4.5.1. (continued).

Ling 7.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	126	1	39	230	370	1		246	1013
2013	267	2	46		379	136		180	1010
2014	118		57		279	19		59	532
2015	101		53		184	144		78	560
2016*	93		46	6	172	46		207	570

***Preliminary. (1) See Ling 7. (2) Included with UK (EW). (3) Included with 7.g–k until 2011.**

Table 4.5.1. (continued).

Ling 7.d, 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		255	1	164	2			7	436
2013	5		259		218					482
2014	4		338	1	262					605
2015	5		204		137			1		347
2016*	3		141		149					293

***Preliminary.**

Table 4.5.1. (continued).

Ling 7.f.

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	80	<1	59	<1	167
2013	22	68	1	93	40	224
2014	61	182	0	91		334
2015	15	54	2	17		88
2016*	25	51	1	34	3	114

***Preliminary. (1) See Ling 7.**

Table 4.5.1. (continued).

Ling 7.g–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		584	2	516		201	138			56	1520
2013	24		622		495		190	74			203	1608
2014	13		535		445		177	185			202	1557
2015	11		391		366		153	131			13	1065
2016*	10		383		549		107	114			9	1172

***Preliminary. (1) See Ling 7. (2) Includes 7.b, c until 2011. (3) Included in UK (EW).**

Table 4.5.1. (continued).

Ling 8.

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		349		201	2		552
2013		281		139	35	4	459
2014		280		110	4	1	395
2015*		269		63	5		337
2016		207		77	3		287

Ling 9.

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 12.

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
2014								0
2015								0
2016*								0

Table 4.5.1. (continued).

Ling 14.

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
2014	1	1	6	1	1			9
2015								0
2016*	9	1		10			1	21

***Preliminary.**

Table 4.5.2 Ling. Total landings by subarea or division.

Year	3	4.a	4.bc	6.a	6.b	7	7.a	7.bc	7.de	7.f	7.g–k	8	9	12	14	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	7408	314	2324	2635		48	131	363	106	673	186		1	3	14 341

Year	3	4.a	4.bc	6.a	6.b	7	7.a	7.bc	7.de	7.f	7.g–k	8	9	12	14	All areas
2010	142	6398	201	3031	2687		44	253	294	69	848	134		0	3	14 104
2011	140	6508	211	2999	1259		28	208	425	155	936	201		0	3	13 073
2012	145	7018	192	3655	1390		14	1013	436	167	1520	552		0	106	16 208
2013	130	7197	176	4660	795		30	1010	482	224	1608	459		0	0	16 771
2014	120	7749	141	4761	774		29	532	605	334	1557	395		0	9	17 075
2015	125	8069	147	4764	1215		19	560	347	88	1065	337		0	0	16 736
2016*	152	9739	150	5659	1088		24	570	293	114	1172	287			21	19269

***Preliminary.**

Table 4.5.3. Number of French fishing vessels (otter trawlers, gillnetters and longliners) during the period 2000–2016.

NUMBERS OF SHIPS	OTTER TRAWLERS	GILLNETTERS	LONGLINERS
2000	65	12	1
2001	77	13	2
2002	66	15	3
2003	61	19	2
2004	52	22	0
2005	46	24	1
2006	44	20	6
2007	42	20	7
2008	37	20	7
2009	38	20	6
2010	29	21	2
2011	32	18	3
2012	36	15	4
2013	33	14	8
2014	33	13	9
2015	31	9	11
2016	26	5	12

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 14 and Division 5.a with a small component in 5.b, and a southern stock in Subarea 6 and adjacent waters in Division 5.b. 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 5.b and Subareas 6 and 7 and one in Division 5.a and 14. All remaining areas are grouped together as “other areas". This latter unit includes Subareas 1 and 2 and Division 4.a and 3.a were historical landing have been significant and subareas, 8 and 9, where the species does not occur. Landings reported in 8 and 9 are ascribed to the related Spanish ling (*Molva macrophtalma*). The situation in 12 is different as this subarea includes part of the Mid-Atlantic Ridge (12.a1, 12.a2, 12.a4 and 12.c) and the western slope of the Hatton Bank (12.c). 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 (6.b). Therefore, including ICES Division 12.b in the assessment unit 5.b, 6 and 7 could be considered. Because of the much lesser abundance of blue ling on the Hatton Bank, this should not impact on stock modelling.

Historical total international landings show that blue ling have been exploited for long. Before the start of the time-series used by WGDEEP, Norway landed 1000–2000 t per year in the 1950s and 1960s. These landings might have been mainly from Subareas1 and 2. German landings starting in the 1950s were mainly reported in Statlant from ICES Division 5.a and 5.b. Since 1966, the main fishing country have been the Faroe Islands, France, Germany, Iceland and Norway (Figure 5.1.1). Except in a few recent years where large amount where caught in Division 5.a, the stock unit of Division 5.b and Subareas 6 and 7I have had the main contribution to total landings (Figure 5.1.2).

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 5.1.3. In Iceland, the depletion of the spawning aggregation in a few years was documented (Magnússon, 1995) and blue ling is an aggregating species at spawning time. To prevent depletion of adult populations temporal closures have been set in the Icelandic and EU EEZs as well as in the NEAFC RA.

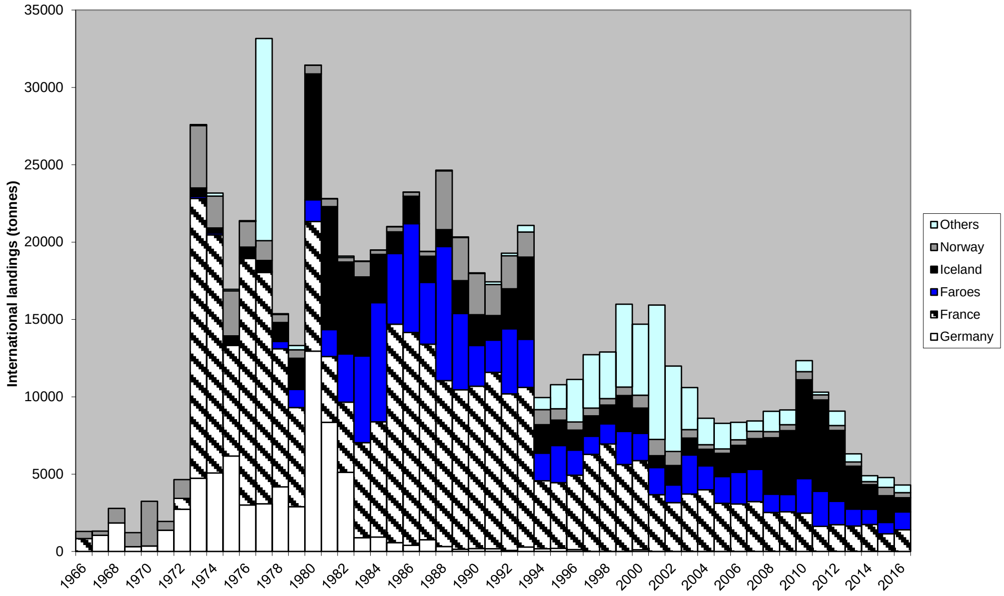


Figure 5.1.1. Total international landings of blue ling in the Northeast Atlantic, by country, 1966–2015.

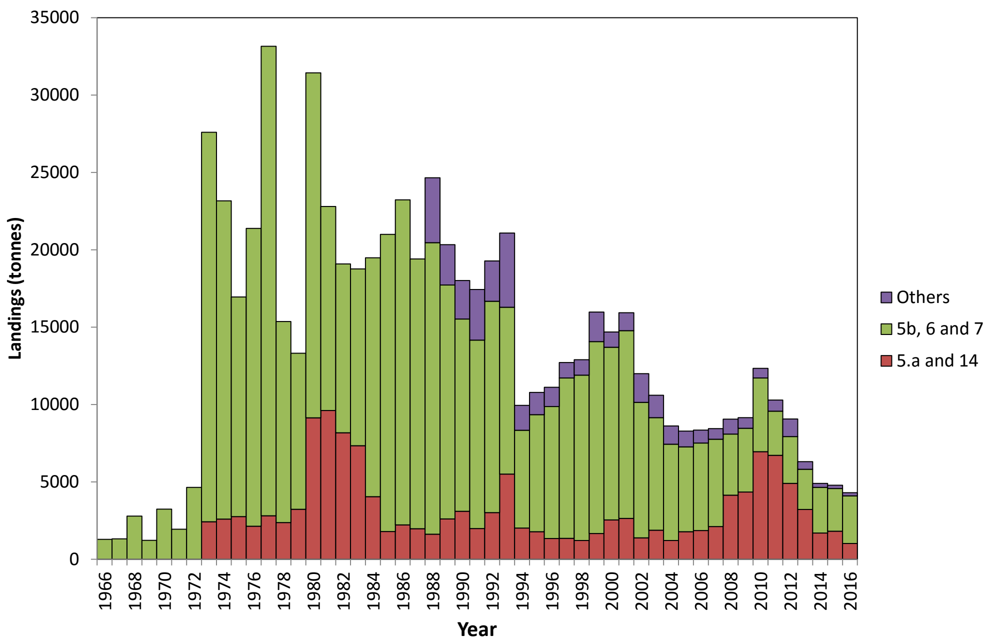


Figure 5.1.2. Total international landings of blue ling in the Northeast Atlantic, by stock unit, 1966–2015.

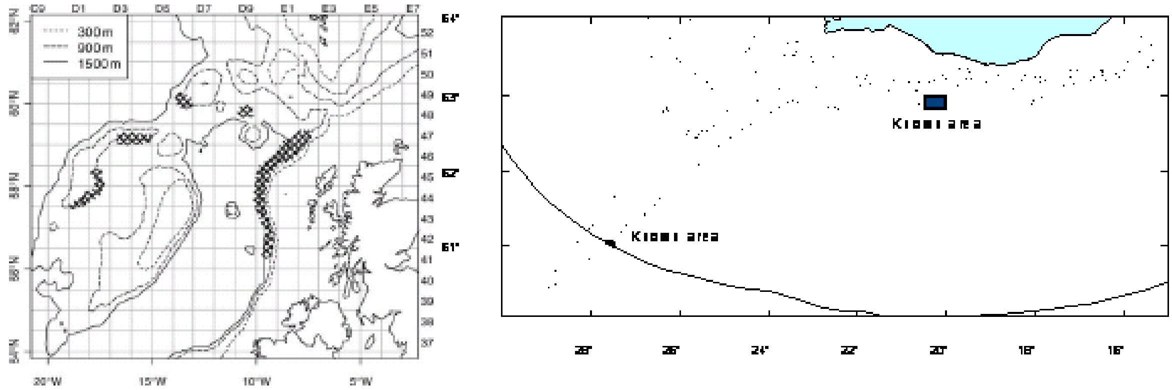


Figure 5.1.3. Known spawning areas of blue ling in Icelandic water (a) and to the West of Scotland (b, from Large *et al.*, 2010).

5.2 Blue Ling (*Molva dypterygia*) In Division 5.a and Subarea 14

5.2.1 The fishery

The change in geographical distribution of the Icelandic blue ling fisheries from 1999, to 2016 (Figures 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 northwestern area.

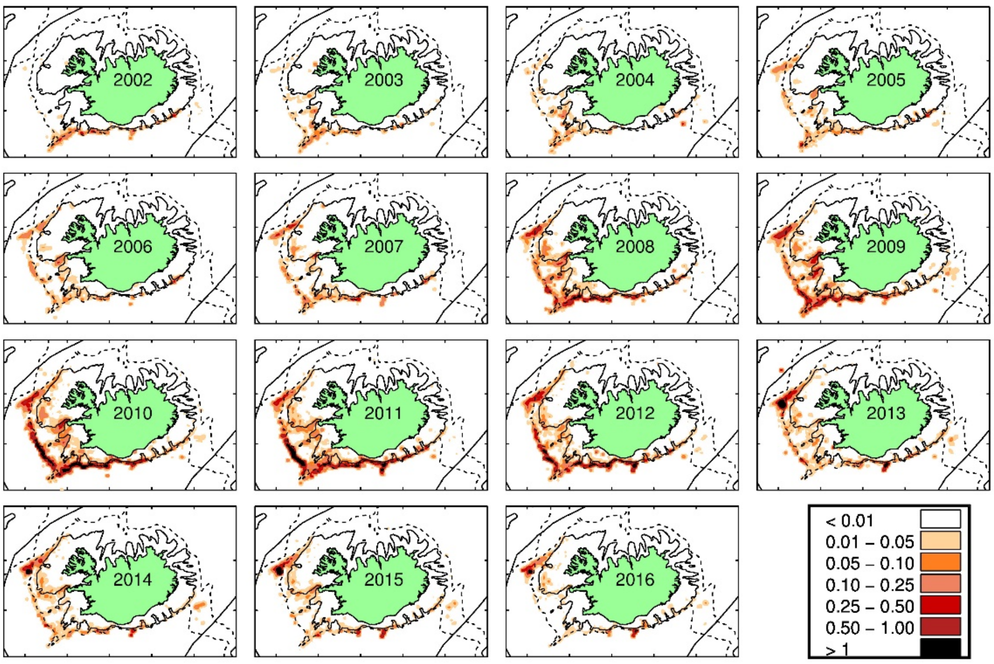


Figure 5.2.1. Blue ling in 5.a and 14. Geographical distribution of the Icelandic blue line fishery since 2002 as reported in logbooks. All gear types combined.

Before 2008 the majority of the catches of blue ling in 5.a 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 5.a (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 2015–2016 the proportion of longline catches decreased to 20–30%. At the same time longliners have started fishing in deeper waters than before 2008 and 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 14 have been relatively small but highly variable.

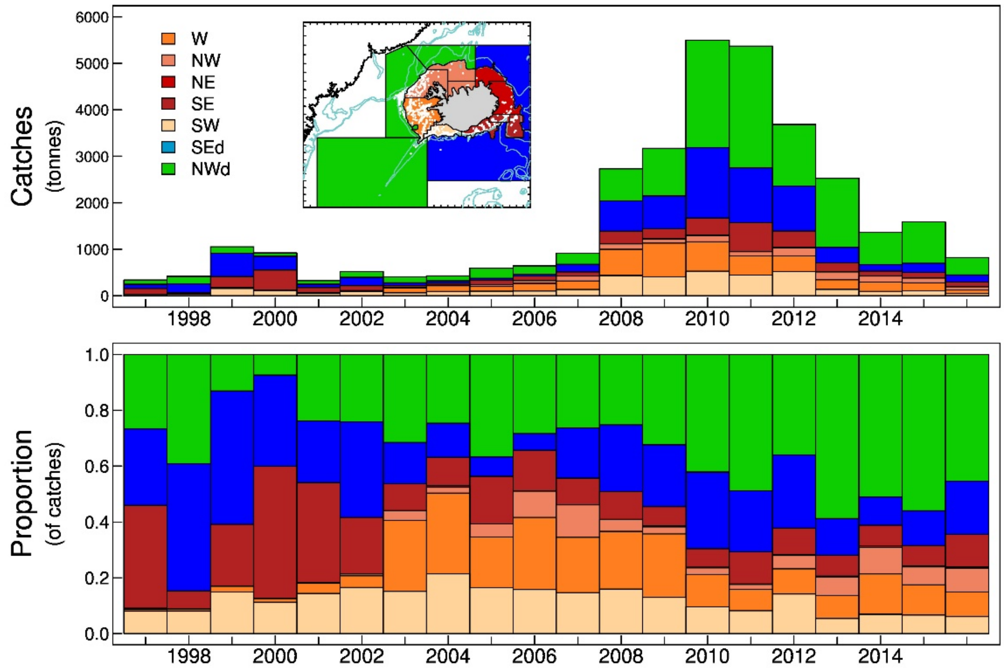


Figure 5.2.2. Blue ling in 5.a and 14. Spatial distribution of reported catches in 5.a in tonnes (upper) and as annual proportions (lower). The inserted map shows the area division and location of operations in 2013 (hauls and lines) as white points.

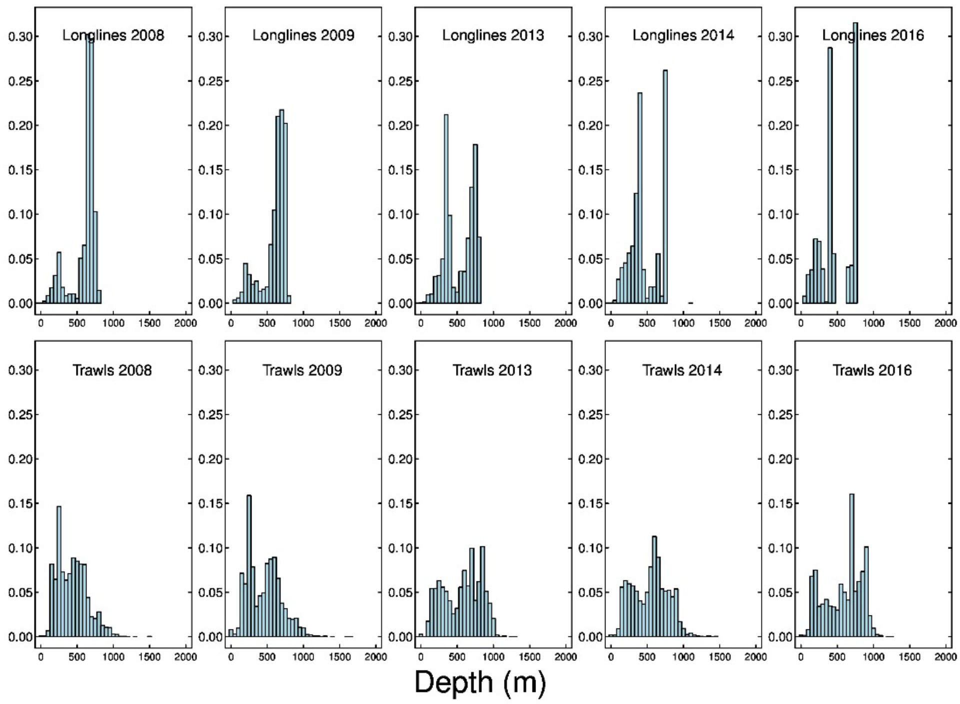


Figure 5.2.3. Blue ling in 5.a and 14. Depth distribution of longlines (upper row) and trawls (lower row) catches in 5.a according to logbook entries.

5.2.2 Landings trends

The preliminary total landings in 5.a 2016 were 925 t of which the Icelandic fleet caught 928 t. (Table 5.2.2 and Figure 5.2.4). Catches of blue ling in 5.a 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 5.a decreased compared to 2010 or by around 4600 tonnes (Table 5.2.3).

Total international landings from 14 (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 2016 were 7 t.

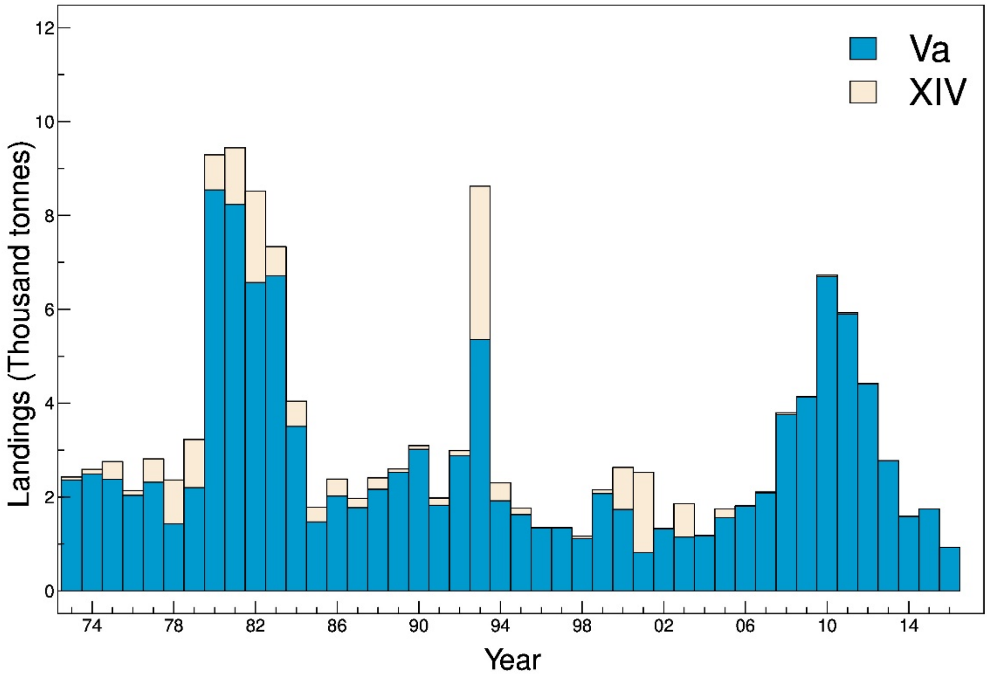


Figure 5.2.4. Blue ling in 5.a and 14. Nominal landings.

5.2.3 ICES Advice

The ICES advice for 2016 is: Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 2032 tonnes. Area closures to protect spawning aggregations should be maintained and expanded as appropriate.

The basis for the advice was the following: The ICES framework for category 3 stocks was applied (ICES, 2012). The Icelandic autumn trawl survey was used together with the catch to calculate a harvest rate index. Based on this an F_{proxy} has been chosen from a reference period, 2002–2009, when the fishing pressure was relatively constant and the SSB increased steadily, which implies that the harvest was considered sustainable.

The advice is based first on a comparison of the latest index value (index A) with the preceding value (index B), combined with the F_{proxy} target (catch/survey biomass). The index is estimated to have decreased by less than 20% which means that the uncertainty cap was not applied. So, in estimating the catch advice the F_{proxy} is used directly with the survey observation (index A).

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 2015/2016 fishing year was set at 2550 based on the recommendations of MRI using the same advisory procedure as in 5.2.3.

Table 5.2.5. Blue ling in 5.a and 14. TAC recommended for tusk in 5.a by the Marine Research Institute, national TAC and total landings from the quota year 2013/2014.

FISHING YEAR	ICES/MRI ADVICE	NATIONAL TAC	ICELAND	OTHERS	LANDINGS
2013/2014	2400	2400	1653	101	1754
2014/2015	3100	3100	1898	41	1939
2015/2016	2550	2550	1734	90	1824
2016/2017	2032	2032			

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 5.a and 14. 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 5.a.

5.2.5.2 Length compositions

Length distributions from the Icelandic trawl and longline catches for the period 2001–2016 are shown in Figure 5.2.5. Mean length from trawls has increased from 86 cm in 2012 to 94 cm in 2016. On average mean length from longlines is higher than from trawls.

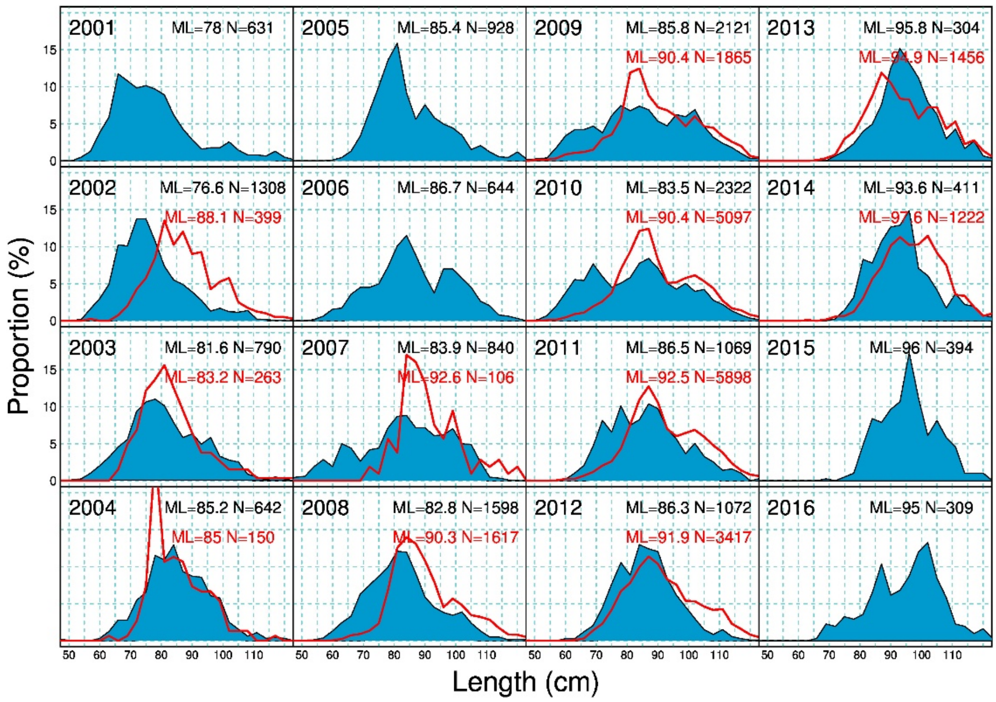


Figure 5.2.5. Blue ling in 5.a and 14. Length distribution of blue ling from trawls (blue area) and longlines (red lines) of the Icelandic fleet in 5.a since 2001. The number of measured fish (N) and mean length (ML) is also given.

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 in 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 65–90 cm.

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 5.a 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.

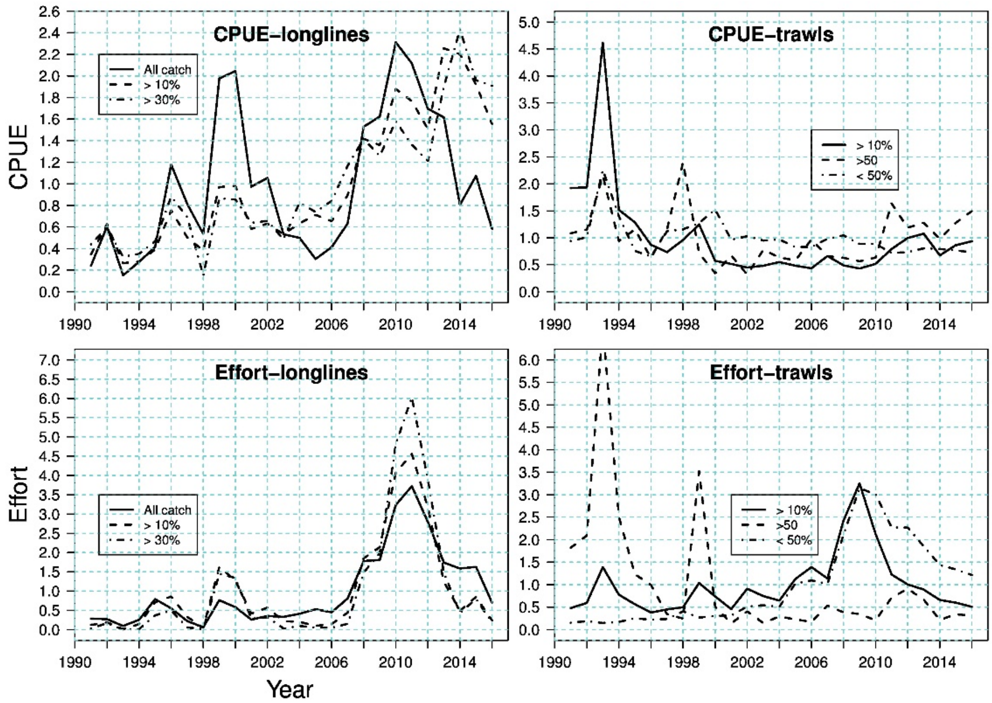


Figure 5.2.6. Blue ling in 5.a and 14. Nominal cpue and effort from longlines and trawls in 5.a based on logbook data where blue ling was either recorded in catches or above certain level.

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.

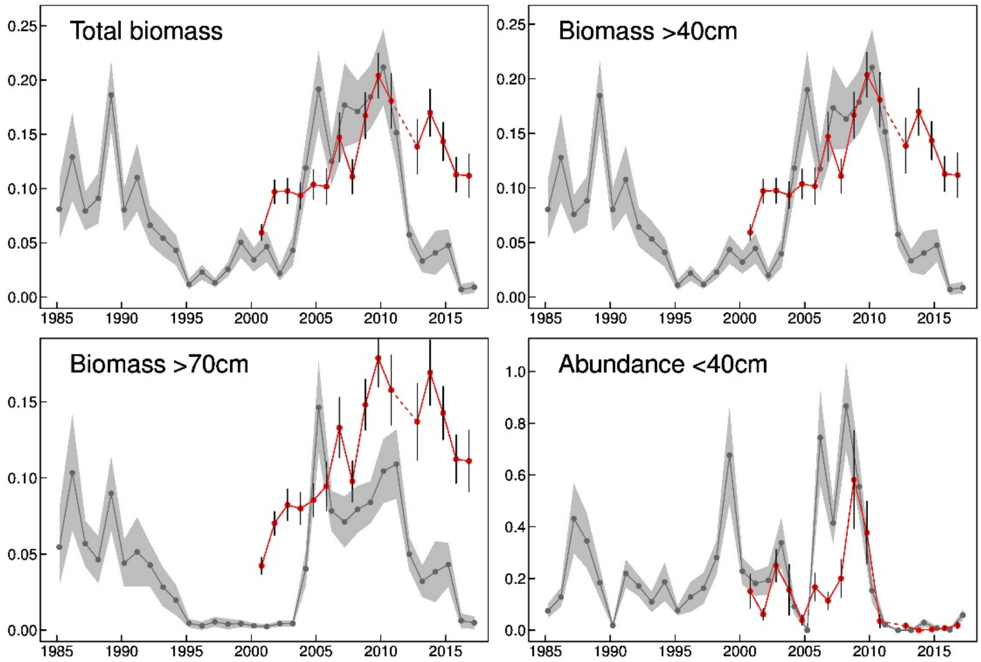


Figure 5.2.7. Blue ling in 5.a and 14. Abundance indices for blue ling in the Icelandic spring survey since 1985 (line and shaded area) and the autumn survey since 2000 (red points and vertical lines). A) total biomass index, b) biomass of 40 cm and larger c) biomass of 70 cm and larger, d) abundance index of <40 cm. The shaded area and the vertical bar show +/- standard error of the estimate.

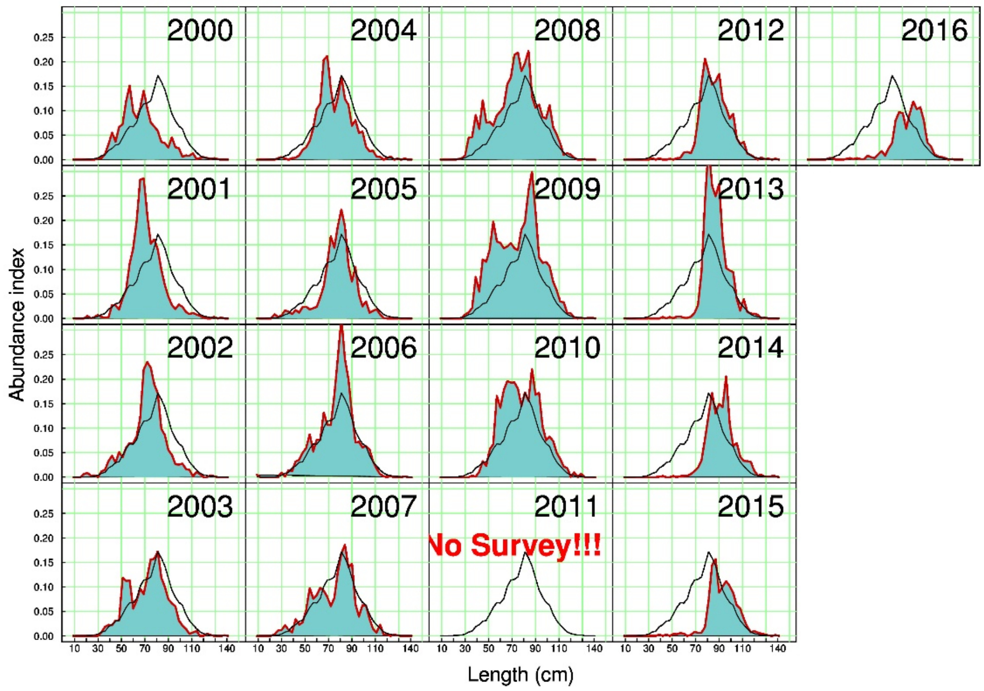


Figure 5.2.8. Blue ling in 5.a and 14. Length distributions from the Icelandic autumn survey since 2000. Black line is the average by length over the whole survey period.

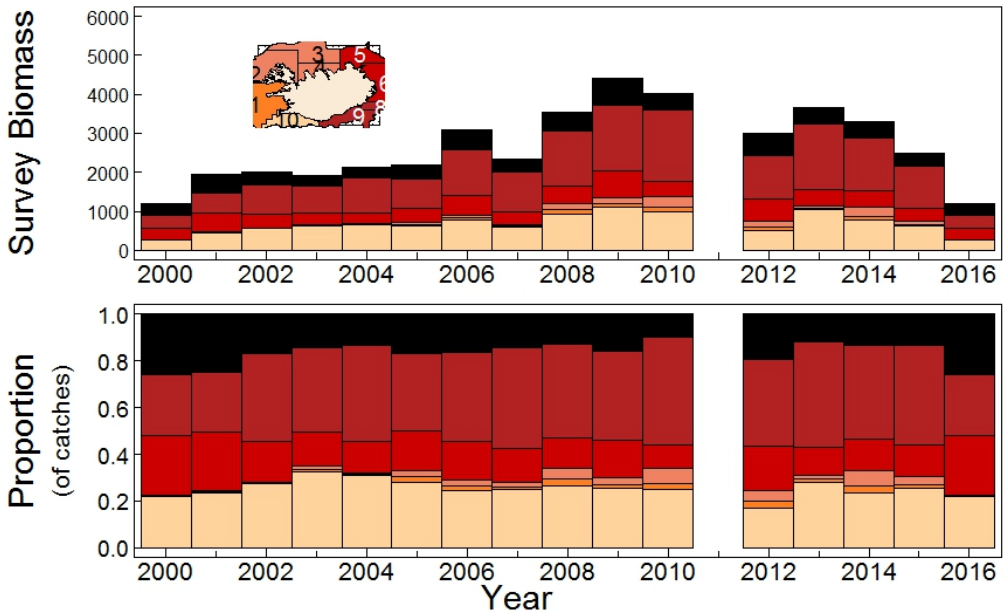


Figure 5.2.9. Blue ling in 5.a and 14. Spatial distribution from the Icelandic autumn survey.

5.2.6 Data analyses

Landings and sampling

Catches from the Icelandic longline fleet increased rapidly from 2007–2010 resulting in a rapid expansion of the fishing area and change in the selectivity of the fishery although there are now strong indications since 2012 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 or 27%, but longliners 4138 tonnes or 70%. Since then the proportion taken by longliners has decreased and in 2016 longliners caught 29% of the catches, trawls 67% and other gear 4%.

As longliners take on average larger blue ling (Figure 5.2.5) this will have resulted in an overall change in the selection pattern in 2006–2015. 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.

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 increased until about 2009 after which it has decreased (Figure 5.2.6).

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 it 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). Since 2010 the biomass index has decreased to similar levels as observed in 2002–2005. A large increase of more than 200% in the recruitment index was observed in 2008 but in the 2010 it had decreased again to its lowest observed value and has not increased again (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 5.a and 14 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 has decreased by similar percentage between 2012 and 2014, to the same levels as observed in 2002 and 2009 but has decreased even further between 2015 and 2016. The reason for the decrease is because of proportionally greater decrease in landings than in the survey index.

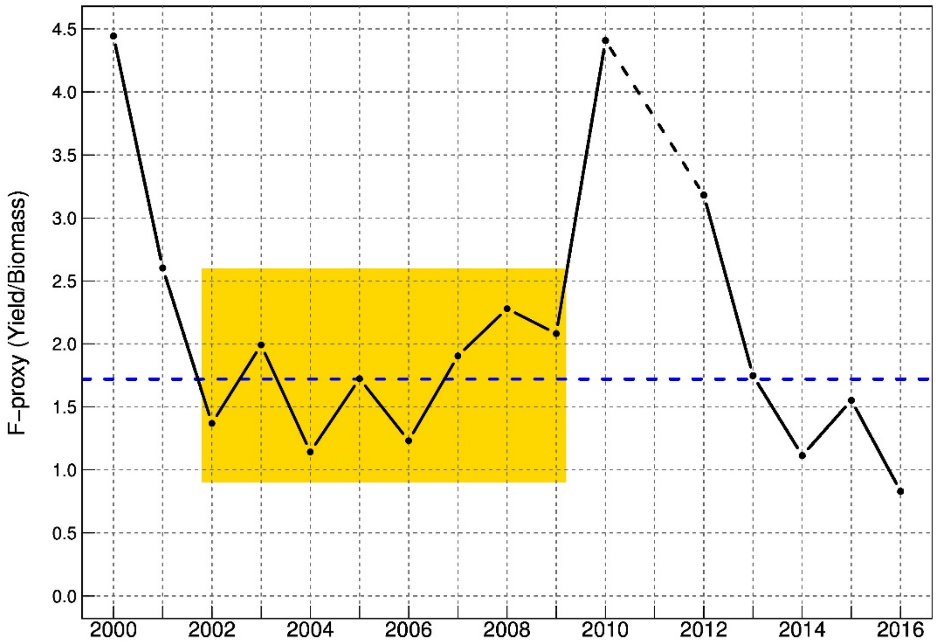


Figure 5.2.10. Blue ling in 5.a and 14. Changes in relative fishing mortality (Yield/Survey biomass >39 cm). The yellow box highlights the reference period used by ICES as basis for the 2012 advice and the blue dotted line is the target F_{proxy} of 1.75 (Mean of 2002–2009).

Analytical assessment

Exploratory stock assessment on Blue ling in 5.a and 14.b using Gadget

An exploratory stock assessment of blue ling in 5.a using the Gadget model was presented at WGDEEP 2012. Updated results of the model were not presented at WGDEEP 2016.

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 2002–2009, however the landings from 14 were not correct and using the revised landings the target should be 1.75.

The autumn survey index in 2016 was 1118.0. Using the same procedure as last year would result in the advice for 2017 to set the TAC at 1956 t (1118.0 * 1.75).

5.2.8 Management considerations

Landings have decreased considerably in the last year and as blue ling in 5.a is now part of the ITQ system such a rapid increase in landings as observed between 2006 and 2011 is unlikely. Blue ling is caught in mixed fisheries by the trawler fleet, mainly targeting redfish and Greenland halibut. After the inclusion of blue ling in the ITQ system the longliners have shifted from a directed fishery to a more mixed fishery for the species. Because of the restrictions of the TAC the implications of low blue ling TAC for the trawlers can be considerable, although the species is a low percentage in their catches.

Recruitment index from the autumn survey indicates very little recruitment to the stock since 2010, resulting in a truncated length distribution from both the survey and commercial catches.

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

5.2.9 Application of MSY_{proxy} reference points (ToR h)

In the ICES response to the: EU request to provide a framework for the classification of stock status relative to MSY proxies for selected category 3 and category 4 stocks in ICES Subareas 5 to 10. ICES set the F_{MSY} proxy for greater silver smelt in 5.a as 0.171 but did not set a B_{MSY} trigger proxy for the stock.

This year WGDEEP re-ran the length-based indicator model used to answer the request and also tried the SPiCT model on the index used for the assessment.

Length-Based Indicator (LBI)

Data and settings

In the LBI-model model run presented here length-at-maturity (L_{mat}) was set at 76 cm. This value was obtained from data collected in the Icelandic autumn survey. Linf was at 128 cm taken as the 99% quantile of all blue ling measurements in the MFRI database. This value is in line with values reported for blue ling in other areas. The length distributions came from commercial catches from 2004 to 2016. Mean weight-at-length was estimated from a length–weight relationship from the Icelandic autumn survey (Figure 5.2.11). The length-bin used was 4 cm.

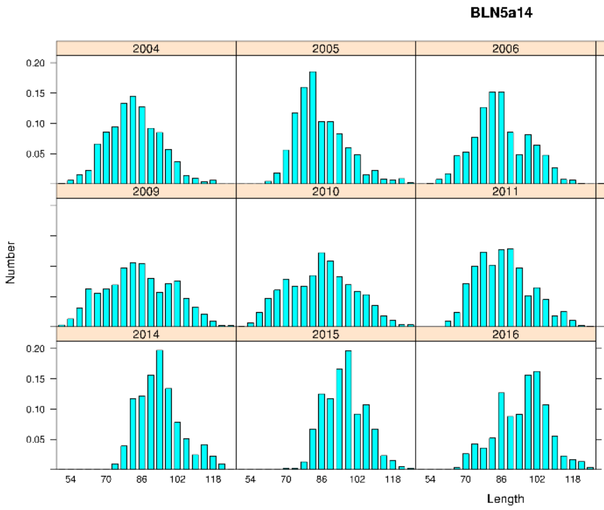


Figure 5.2.11. Length distributions used for estimating LBI.

Results

According to the results, blue ling in 5.a is being harvested at a sustainable level in the period as $L_{mean}/L_{F=M}$ is always larger than 1 (Table 5.2.5 and Figure 5.2.12).

Table 5.2.5. LBI results for 2014 to 2016.

	Traffic light indicators					
	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2014	1.08	1.13	0.92	46%	1.11	1.02
2015	1.08	1.17	0.90	61%	1.13	1.03
2016	0.92	1.14	0.92	58%	1.12	1.13

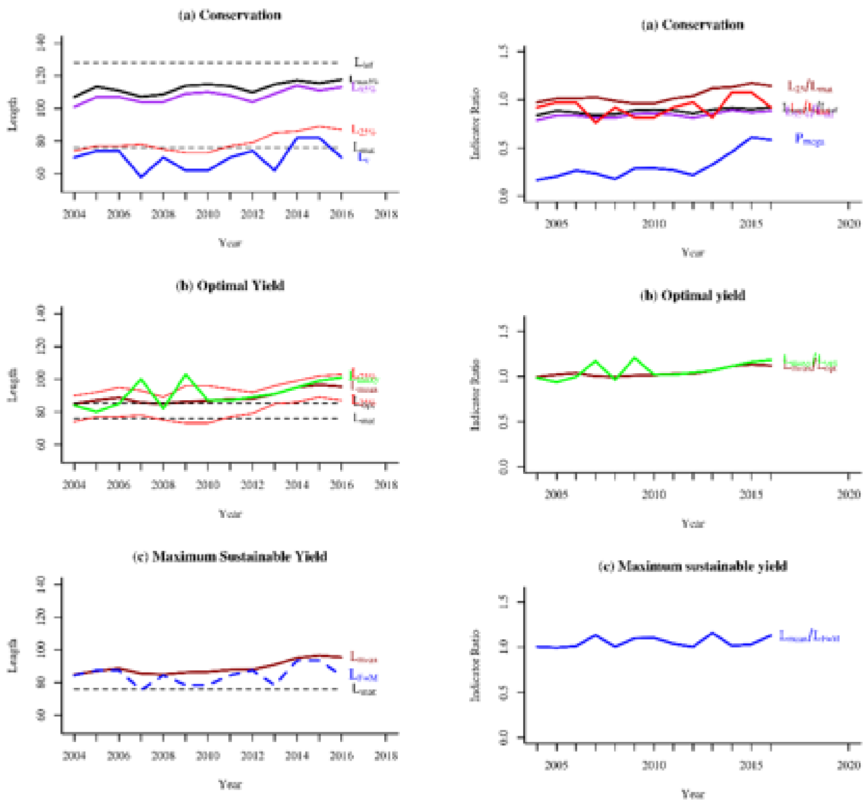


Figure 5.2.12. Results of LBI to commercial length distributions from 5.a.

SPiCT

Settings and data

The model could not converge using the catch history back to 1973 therefore the input data in the model was the catch history from 1998 and the index from the Icelandic Autumn survey used for the assessment that goes back to 2000 (Figure 5.2.13). The model run presented here deviates from the default settings in two ways. The uncertainty in the survey was taken into account in the model. The model was very sensitive to the prior for the K/B0 ratio and the only way fishing at any effect in the model was by setting it at 0.035 which indicates a seriously depleted stock in 1998 which is not in conformity with the perception of the stock status in that period.

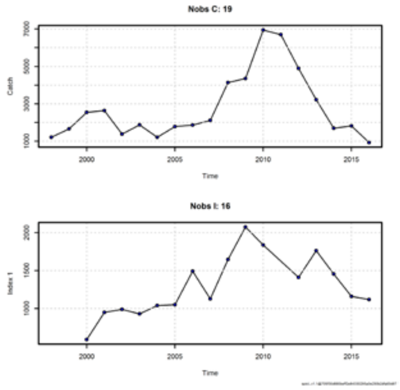


Figure 5.2.13. Input data to the SPiCT model.

Results

The output from the model is shown below. The estimates of r and K do seem plausible for a long-lived species like blue ling. It would be expected that r would be somewhere in the range of 0.05–0.15 and is estimated at 0.05. K is estimated at 143 kt. BMSY is estimated at 20 kt, which is quite low. The diagnostic plots are shown in Figure 5.2.14, the results in Figure 5.2.15 and finally the analytical retrospective analysis in Figure 5.2.16.

```
> summary(res)
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 16.6138966
Euler time step (years):  1/16 or 0.0625
Nobs C: 19,  Nobs I1: 16

Priors
      logn  ~  dnorm[log(2), 2^2]
  logalpha  ~  dnorm[log(1), 2^2]
   logbeta  ~  dnorm[log(1), 2^2]
 logbkfrac  ~  dnorm[log(0.035), 0.02^2]

Model parameter estimates w 95% CI
           estimate        cilow        ciupp    log.est
 alpha   2.074363e-01 5.228120e-02 8.230457e-01 -1.572931
 beta    5.235551e-01 1.897500e-01 1.444584e+00 -0.647113
 r       4.790960e-02 5.544800e-03 4.139637e-01 -3.038439
 rc      4.477635e-01 1.923150e-02 1.042518e+01 -0.803490
 rold    6.095330e-02 6.747900e-03 5.505893e-01 -2.797647
 m       4.499699e+03 1.945602e+03 1.040670e+04  8.411766
 K       1.429101e+05 1.099765e+04 1.857060e+06 11.869971
 q       5.600650e-02 1.166820e-02 2.688273e-01 -2.882288
 n       2.139951e-01 2.453220e-02 1.866682e+00 -1.541802
 sdb     1.817885e-01 1.034885e-01 3.193309e-01 -1.704911
 sdf     3.216214e-01 1.892796e-01 5.464948e-01 -1.134380
 sdi     3.770950e-02 1.359410e-02 1.046046e-01 -3.277842
 sdc     1.683865e-01 8.221480e-02 3.448773e-01 -1.781493

Deterministic reference points (Drp)
          estimate        cilow        ciupp    log.est
 Bmsyd 2.009855e+04  689.9555361 5.854751e+05  9.908403
 Fmsyd 2.238818e-01    0.0096158 5.212588e+00 -1.496637
 MSYd  4.499699e+03 1945.6015632 1.040670e+04  8.411766
Stochastic reference points (Srp)
          estimate        cilow        ciupp    log.est rel.diff.Drp
 Bmsys 1.934612e+04  741.3574353 5.048476e+05  9.870247 -0.038892946
 Fmsys 2.302724e-01    0.0106193 4.993289e+00 -1.468492  0.027752523
 MSYs  4.459686e+03 1933.0580606 1.028878e+04  8.402834 -0.008972123

States w 95% CI (inp$msytype: s)
                   estimate        cilow        ciupp    log.est
 B_2016.00      2.061112e+04 4240.3644153 1.001843e+05  9.9335858
 F_2016.00      6.003570e-02    0.0118204 3.049207e-01 -2.8128153
 B_2016.00/Bmsy 1.065387e+00    0.0850237 1.334980e+01  0.0633384
 F_2016.00/Fmsy 2.607162e-01    0.0166645 4.078905e+00 -1.3443228

Predictions w 95% CI (inp$msytype: s)
                 prediction        cilow        ciupp    log.est
 B_2017.00      2.213200e+04 4704.5319533 1.041178e+05 10.0047798
 F_2017.00      4.696210e-02    0.0086593 2.546902e-01 -3.0584152
 B_2017.00/Bmsy 1.144002e+00    0.0857674 1.525918e+01  0.1345324
 F_2017.00/Fmsy 2.039414e-01    0.0121534 3.422265e+00 -1.5899228
 Catch_2017.00  1.106301e+03  547.1400163 2.236909e+03  7.0087775
 E(B_inf)       6.729053e+04           NA           NA 11.1167747

>
```

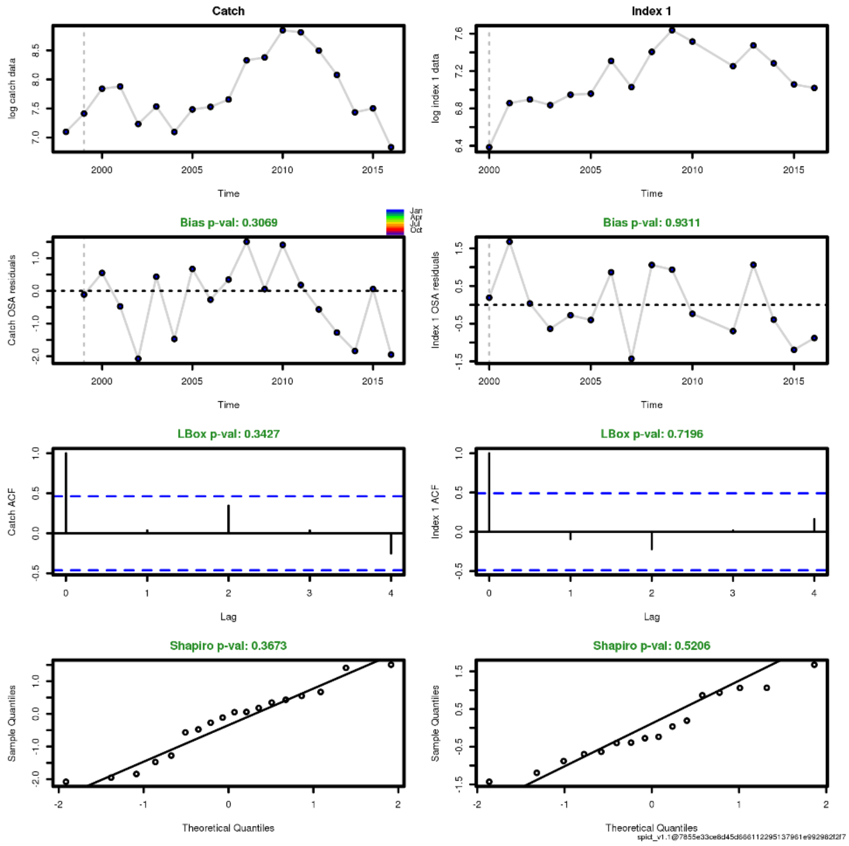


Figure 5.2.14. Diagnostics from the SPiCT-model.

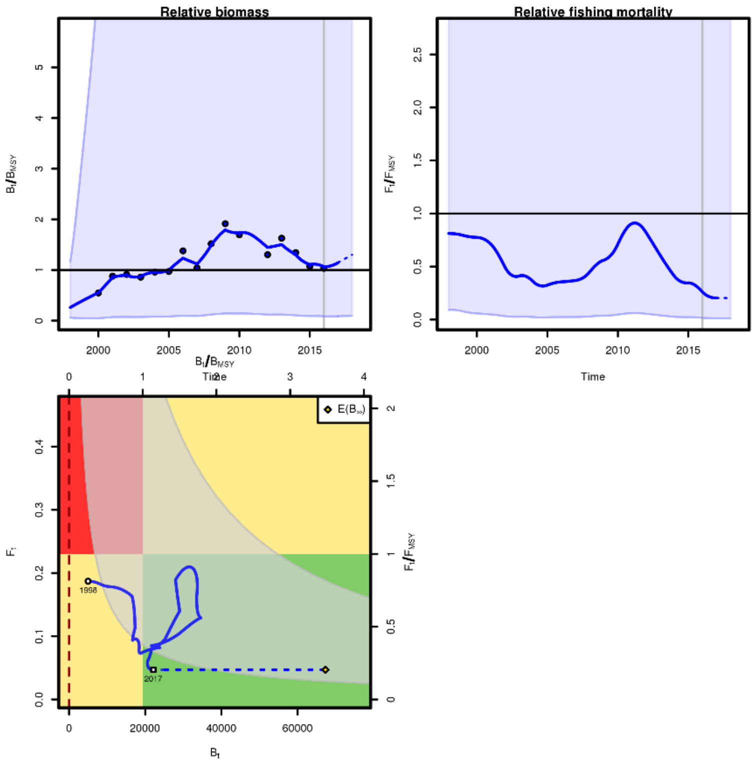


Figure 5.2.15. Results from the SPiCT-model.

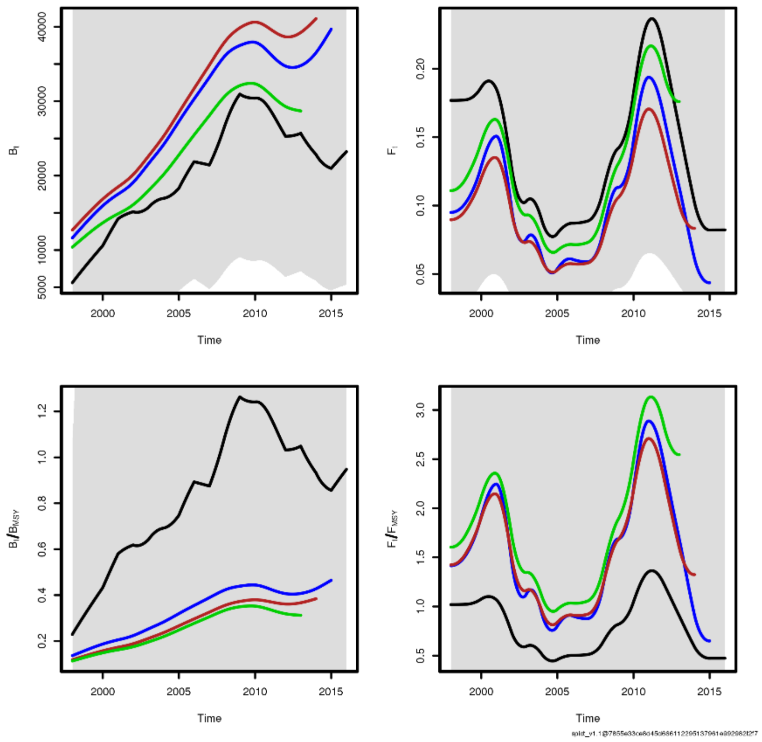


Figure 5.2.16. Analytical retrospective analysis from the SPiCT-model.

Conclusions

The analysis presented above indicates that the fishing pressure is below F_{MSY} and the stock biomass is above possible MSY $B_{trigger,proxy}$. This does not sound unlikely given that the biomass index is still rather high compared to its lowest values. The selection pattern from the fishery is good as only large blue ling are being caught but that is most likely because there is no recruitment coming into the stock at present.

The findings presented here support the general view of WGDEEP that the stock is at a sustainable level and that the selection pattern is good. However there is a question whether LBI and SPiCT are the correct tools to state that.

Table 5.2.1. Blue ling: Landing in ICES Division 5.a.

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	88	0	3653	21	0	3763
2009	178	0	4132	5	0	4315
2010	515	0	6377	13	0	6905
2011	797	0	5903	2	0	6702
2012	312	0	4207	2	0	4521
2013	435	0	2769	2	0	3204
2014	71	0	1588	30	0	1689
2015	10	0	1734	4	0	1748
2016[1)]	6	0	925	84	0	1015

[1)] **Provisional figures.**

Table 5.2.2. Blue ling: Landing in ICES Division 14. Source: STATLANT database.

Year	Faroe	Germany	Greenland	Iceland	Norway	Russia	Spain	UK	Denmark	Total
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	1	385
2009	1	0	0	0	3	0	111	4	0	119
2010	1	0	0	0	9	0	34	0	3	47
2011	0	0	0	0	2	0	0	1	6	9
2012	0	0	0	367	9	0	0	0	3	379
2013	0	0	4	0	0	0	0	3	9	16
2014	0	0	0	0	3	0	0	0	0	3
2015	0,3	0	59	0	0,9	0	0	0	5	65
2016[1)]	0	0	0	0	0	0	0	0	7,2	7,2

[1)] Provisional figures.

Table 5.2.3. Blue ling. Catches by gear type and numbers of boats participating in the blue ling fishery in 5.a.

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	53	2767	28	6.6	49	4.0
2014	622	911	54	1588	23	4.4	47	3.8
2015	868	841	25	1734	29	4.9	46	2.9
2016	293	681	30	1015	16	1.5	50	2.6

Table 5.2.4. Blue ling in 5.a and 14. Catches in 5.a and 14 along with survey biomass index (larger than 40 cm) from the Icelandic Autumn survey and the calculated F_{proxy} (($C_{5.a}$ + C_{14})/I).

Year	5.a	14	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	385	1645.2	2.52
2009	4233	119	2073.8	2.10
2010	6905	47	1836.8	3.78
2011	6702	9	*No survey*	
2012	4521	379	1411.5	3.47
2013	3082	16	1762.3	1.76
2014	1588	3	1455.8	1.09
2015	1734	65	1161.1	1.55
2016	1015	7	1118.0	0.92

5.3 Blue Ling (*Molva dypterygia*) in Division 5.b and Subareas 6 and 7

5.3.1 The fishery

The main fisheries are those by Faroese trawlers in 5.b and French trawlers in 6.a and, to a lesser extent, 5.b. Total international landings from Subarea 7 are small and are mostly bycatches in other fisheries, except in in ICES Division 7.b–c where there are more fishing hauls directed to deep-water fish.

Landings by Faroese trawlers are mostly taken in the spawning season. Historically, this was also the case for French trawlers fishing in 5.b and 6.a. However, during the last decade blue ling has been taken round the year together with roundnose grenadier and black scabbardfish as well as deep-water sharks until 2009.

5.3.2 Landings trends

Total international landings from Division 5.b (Tables 5.3.1a–f and Figure 5.3.1) peaked in the late 1970s at around 21 000 t and then decline until the 2010s, where landings stabilized around 1500 t per year.

The landings from Subarea 27.6 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. In the 2000s reducing EU TACs have been the main driver of the catch level. In the last five years, landings have been stable at 1300–1500 tonnes in 6.a and minor in 27.6.b.

Landings from Subarea 7 are comparatively small, mostly less than 500 t per annum in the whole time-series and less than 100 t during the last ten years.

Landings data by country and ICES Division considered for 2016 were extracted from InterCatch, ICES preliminary landings are national data supplied to WGDEEP, whichever was the larger.

5.3.3 ICES Advice

The ICES advices for 2017 and 2018 is "when the MSY approach is applied, catches should be no more than 11 314 tonnes in 2017 and no more than 10 763 tonnes in 2018. All catches are assumed to be landed".

Following reference points development carried out in 2015 for stocks of ICES category 1, F_{MSY} for the stock was set to 0.12 in 2016, and this was the reason for the higher ICES catch Advice for 2017 and 2018. The previous advice, delivered in 2014, was based on an F_{proxy} defined as $F_{50\%SPR}$=0.07.

5.3.4 Management

Prior to 2009, EU deep-water TACs were set on a biennial basis; however from 2009 onwards, annual TACs were applied for the components of this stock in EU waters of 5.b, 6 and 7. TACs are fixed according to bilateral agreements between EU and Faroe Islands and EU and Norway. The EU TAC includes quota for Norway and the Faroe Islands and the Faroe Islands attribute quotas of ling and blue ling to French and UK vessels. The latter include an allowance for bycatch of roundnose grenadier and black scabbardfish (see EU council regulation 2015/104 and Faroese regulation). There was no such agreement between the Faroe Island and the EU in 2011–2013 but these were resumed in 2014.

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 FAROESE WATERS OF 5.B(1)	INTERNATIONAL
Year	Area	ICES advice	EU TAC	EU	Norway	Faroe		landings
2006	67	Biennial		3037	200	400	3065	5650
2007	67	No direct fisheries		2510	160	200	3065	5648
2008	67	Biennial		2009	150	200	3065	3940
2009	5b67	No direct fisheries	2309	2009	150	150	3065	4121
2010	5b67	Biennial	2032	1732	150	150	2700	4759
2011	5b67	No direct fisheries	2032	1717	150	0	0	2861
2012	5b67	Same as 2011	2031	1882	150	0	0	3031
2013	5b67	3900	2540	23905	150	0	0	2588
2014	5b67	3900	2540	2210	150(2)	150(3)	1500	2949
2015	5b67	5046	5046	4746	150(2)	150(3)	1500(4)	2712
2016	5b67	5046	5046	4746	150(2)	150(3)	2100	3071
2017	5b67	11 314	11 314	11 014	150(2)	150(3)	2000	
2018	5b67	10 763						

(1) TAC for ling and blue ling, against which a bycatch roundnose grenadier and black scabbard fish may be counted. Up to a limit of 500 t.

(2) To be fished in Union waters of 27.2.a and 27.4-7 (BLI/*24X7C).

(3) Including bycatch of roundnose grenadier and black scabbardfish.

(4) including a quota of 419 t to Germany, which was caught as ling without blue ling landings

In Faroese waters, Faroese vessels are encouraged to land all fish, which is thought to be done for blue ling, owing to the species value and the absence of fish of unmarketable size. Faroese vessels in Faroese waters are regulated by licences and fishing days but no quota.

Like in 2015 and 2016, the EU TAC for 2017 in EU and international waters amounts was set to the level of catch advice. Therefore international catch from the stock, which include catch in EU, international and Faroese waters, are legally allowed to exceed the ICES catch advice.

In 2009, the EU introduced protection areas of spawning aggregations of blue ling on the edge of the Scottish continental shelf and at the edge of Rosemary Bank (6.a). 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. In 2013, NEAFC introduced a protection of the spawning area located near the southwest boundary of the Icelandic EEZ, this area was banned to bottom fishing gears from 15 February to 15 April from 2013 to 2016 (rec 5:2013, http://www.neafc.org/managing_fisheries/measures/current).

In ICES Division 27.6.b, areas closed to bottom fishing gears have been extended and these include some of the spawning areas identified by Large *et al*. (2009), see Figure 5.1.3b.

5.3.5 Data availability

5.3.5.1 Landings and discards

Landings data were updated. International landings in 2016 amounted to 3071 t at 10% increased from 2016 but well below the TAC. Some EU fleet, in particular the French fleet of large trawlers, appear to be in a situation of under capacity. Although higher fishing opportunities for blue ling became available in 2015, vessels kept fishing mostly for saithe. This under capacity is the results of the reduction of the number of French trawlers >=30 m, based in harbours where deep-waters species are landed from 35 in 2005 to 16 in 2016 (Common Fleet Register data). Further the restriction of fishing at spawning time no longer allows for major target catch at the spawning season as in the 1980s and 1990s.

Based upon data provided to ICES through InterCatch, international discards in 2016 were less than 1% of landings for country reporting through InterCatch. Faroese data were provided separately and Faroese vessels are considered making no discards. The proportion of blue ling discarded by year in the French deep-water trawl fishery in 2010–2015 based upon French on-board observations carried out under the DCF was estimated to 0.01–0.3%, well below the maximum 5% level where discards are considered negligible in ICES advice. This low discarding proportion comes from the absence of catch of small fish.

Similarly, Spanish observer on board trawlers fishing in 6.b reported that discards for this species are negligible, in the range of 0–0.5% of the catch.

Some blue ling discards were reported 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 latitudinal range of this fishery, this discard is likely to comprise a large proportion of the Spanish ling (*Molva macrophthalma*), 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.

5.3.5.2 Length compositions

Length distribution of blue ling landings from Faroese trawlers was available from 1981 to 2016 (Figure 5.3.2).

Length distribution of blue ling in Faroese spring and summer groundfish surveys are shown in Figures 5.3.3 and 5.3.4. A deep-water survey was initiated in 2014 in Faroese water, the length of blue ling in this deeper survey is larger than in the two other surveys (Figure 5.3.5).

Time-series of number and occurrence (percent of haul) of blue ling smaller than 80 cm in Faroese surveys was provided (Figure 5.3.6).

The length distribution of French landings shows a decreasing trend up to the early 2000s followed by an increase (Figure 5.3.7) to levels of the late 1980s. (Figure 5.3.7). This is considered to reflect the overexploitation in the 1990s, followed by a rebuilding.

5.3.5.3 Age compositions

Age estimation of blue ling sampled in 2014 and 2015 was available from France. In application of the DCF regulation about 250 age estimations have been carried out for every quarter since 2009.

5.3.5.4 Weight-at-age

Blue ling is landed gutted in France, the only EU country where age estimation of this species is carried out. 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 parameters 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 standardized cpue time-series from the Faroese trawler fleet was updated (Ofstad, 2016 WD). This time-series was not used in assessment.

The standardized cpue from haul-by-haul data provided by the French industry skipper tally books (see stock annex) was not updated in 2017.

The Scottish deep-water research survey has been set to be biennial, there was no survey in 2016; the available time-series is presented in Figure 5.3.8).

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

The standardized time-series from the Faroese spring and summer surveys were updated (Table 5.3.2).

The standardized abundance index from the Norwegian longliner fleet operating in 6.a was updated (Table 5.3.3). The standardization method was the same as that developed for ling (Helle *et al.*, 2015) and is also used for stocks of ling and tusk (see chapters 4 and 6). This index shows large year-to-year variation probably in relation to the small size of the fleet and the small fishing effort and catch.

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 5.3.2). Recruitment inputs are visible in survey catches in some years, e.g. 2007–2009.

Mean length in French trawl landings (Figure 5.3.7) declined until the mid-1990s and has been increasing since the mid-2000s, with some low levels in some years probably reflecting recruitment pulses, in particular in 2007 and higher mean length in 2014–2015 (Figure 5.3.7).

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 and are stratified indices.

Multiyear catch curve (MYCC) model

The Multiyear catch curve (MYCC, see stock annex) model was not run in 2017, results from 2016 are presented in Figures 5.3.9 and 5.3.10. The total mortality was estimated to 0.14 in 2015 and 0.15 one year earlier, corresponding to fishing mortalities of 0.03 and 0.04 respectively. The fishing mortality has been smaller than 0.07 (MSY F_{lower}) since 2008. The total number of individuals of age 9 and over was estimated to 23 million at the start of 2016.

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

SRA estimates were made using the natural mortality *M=0.11*, which, was chosen in 2014, because it resulted in the smallest difference in number-at-age estimated from the MYCC and SRA. This value is also similar to F=0.1 used for blue ling in 5.a and 14.b.

The cpue index from the Norwegian longline fleet was updated. This index shows large year-to-year variation probably in relation to the small size of the fleet and the small fishing effort and catch. It is reminded that the Irish index from the Irish deepwater survey 2006–2009 was no longer used in this model since 2015. These changes had however only minor impact on the estimated biomass and exploitation rate over the whole time-series. The fit of each time-series of index to the estimated stock biomass trajectory is shown in Figure 5.3.11.

At *M*=0.11, trials without the Norwegian fleet index (either fitting only to the Scottish and Faroese surveys or adding the former Irish survey) led to similar biomass estimates with a slightly higher B2015/B0 ratio. The initial (1966) biomass was estimated to about 275 000 t. The time-series of the biomass and fishing mortality is given in Figure 5.3.12 for *M*=0.11and in Table 5.3.5.

SRA estimated that fishing mortality in recent years were low. The estimated F in the past was five to ten times above the current level for 20 years from 1984 to 2003. The exploitable biomass in 2015 was estimated to 95 000 tonnes, corresponding to 37% of the exploitable biomass at the start of the time-series (1966), before the development of the main fisheries. The exploitable biomass was at its lowest historical level, 54 000 tonnes, in 2002–2003. It was then less than 20% of the initial biomass, i.e. close or below the precautionary approach B_{lim} level as expected, at the time, in assessment comments, although without quantification, at the time (ICES, 2002). For this stock the exploitable biomass and the spawning biomass (SSB) are equal because the fish recruit to the fishery and to the adult stock at the same time.

Reference points

Reference points the stock were defined by WKMSYref 4 as F_{MSY}=0.12, MSY F_{lower}=0.08 and MSY F_{upper}=0.17. MSY B Trigger was set as B_{pa}=1.4*B_{lim} (table below), because the variability of the stock dynamics was not fully captured by the WKMSYref4 analysis. This is because the only input available to WKMSYref4 was SRA as the MYCC does not cover a sufficient time-series to estimate a stock–recruitment relationship. SRA does not allow for significant variability of recruitment. In these circumstances a MSY $B_{trigger}$ based on 5% of B_{MSY} is not meaningful and was not recommended by WKMSYref4. B_{lim} was set as B_{loss}, the lowest biomass estimate in the time-series (here the time-series of biomass from SRA).

Reference points for bli-5b67 estimated by WKMSYref4.

MSY F_{lower}	F_{MSY}	MSY Fupper with AR	MSY $B_{trigger}$ (tonnes)	MSY Fupper with no AR
0.08	0.12	0.17	75 000	0.14

Further, F_{lim} was estimated to 0.17 by WKMSYref4 Based on simulated fishing mortality to B_{lim} and F_{pa} was estimated to 0.12 as F_{lim}*exp(-1.645*0.2). Therefore, F_{pa} is estimated to be equal to F_{MSY} and F_{lim} to MSY F_{upper}. This comes from setting B_{lim} at B_{loss}≈20% of the unexploited biomass, which is in all circumstances much more than 5% B_{MSY}, again, a level not used here because the long-term of mean of B_{MSY} could not be projected in a projection taking account of recruitment variability.

5.3.7 Comments on assessment

The assessment of blue ling in ICES Division 5.b and Subareas 6 and 7 is based on two models. 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. Although F_{MSY}=0.12 was estimated for the stock, WKMSYref4 reported that *"it seems most appropriate to use ' F_{MSY} lower with $B_{trigger}$* [=0.08] *as an interim F_{MSY} reference point for management purpose. This would allow increasing the catch and continuing the rebuilding of the stock biomass, while getting more years in the assessment"*. The advice delivered in 2016 was however based on F_{MSY}=0.12.

No short-term projection was carried out in 2017.

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 as far as a TAC management regime is effective in limiting fishing mortalities as intended and if highly aggregated fisheries in these areas do not cause local depletion. In Faroese waters, from which one third to half the catch has been taken in recent years, the catch is mainly taken in the spawning season.

5.3.9 References

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Table 5.3.1a. Landings of blue ling in Subdivision 5.b.1.

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
2007	1220	1166		212	8		36	2642
2008	642	865		35			110	1652

YEAR	FAROES	FRANCE(1)	GERMANY(1)	NORWAY(2)	E & W(1)	IRELAND	RUSSIA(1)	TOTAL
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	440	423		0		0	3	866
2014	730	609		29				1368
2015	621	139	0	140	0	0	0	900
2016	1100	555	0	74	0	0	0	1729

(1) Includes 5.b.2; (2) includes 5.b.2 up to 1974.

Table 5.3.1b. Landings of Blue ling in Subdivision 5.b.2.

YEAR	FAROES	NORWAY	SCOTLAND	FRANCE	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	FRANCE	TOTAL
2009	444	8	161		613
2010	656	10	225		891
2011	319	0	0		319
2012	211	0			211
2013	133	0	2		135
2014	150	6	2		158
2015	82	97		46	225
2016	13	0	7		20

(1) **Includes 5.b.1.**

Table 5.3.1c. Landings of blue ling in Division 6.a.

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

YEAR	FAROES	FRANCE	GERMANY	IRELAND	NORWAY	SPAIN(1)	E & W	SCOTLAND	LITHUANIA(2)	TOTAL
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
2010	43	1937			86	223		134		2423

YEAR	FAROES	FRANCE	GERMANY	IRELAND	NORWAY	SPAIN(1)	E & W	SCOTLAND	LITHUANIA(2)	TOTAL
2011	10	1136			93	10		74		1323
2012	5	1178			86	6		47		1322
2013	2	1168			132	11		203		1516
2014		1094			18			278		1390
2015	0	933	0	0	127	83	8	371	0	1522
2016	0	827			37	127	0	273	0	1264

. (1) Includes 5.b; (2) Includes 6.b for all countries up to (and including) 1974.

Table 5.3.1d. Landings of blue ling in Division 6.b.

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

YEAR	POLAND	RUSSIA	FAROES	FRANCE	GERMANY	NORWAY	E & W	SCOTLAND	ICELAND	IRELAND	ESTONIA	SPAIN	TOTAL
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(2)
2013				5				0				3	39(2)
2014								3					4(2)
2015	0	0	0	0	0	2	0	0	0	0	0	31	33
2016	0	0	0	0	0	0	0	0	0	0	0	18	18

(1) **Included in 6.a. (2) includes unallocated catch.**

Table 5.3.1e. Landings of blue ling in Subarea 7.

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
2014	24				3	2		29
2015	11	0	63	0	3	1	0	78
2016	13	0	25	0	0	1	1	40

Table 5.3.1f. Blue ling landings in Division 5.b and Subareas 6 and 7.

YEAR	5.B	6	7	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

YEAR	5.B	6	7	TOTAL
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	1001	1555	32	2588
2014	1526	1394	29	2949
2015	1125	1555	78	2758
2016	1749	1282	40	3071

Table 5.3.2. Standardized biomass indices (kg/h) of blue ling in the annual demersal trawl spring and summer survey on the Faroe Plateau.

YEAR	SPRING SURVEY		SUMMER SURVEY	
	Index	SE	Index	SE
1994	1.66	0.98		
1995	1.38	0.95		
1996	1.39	0.78	4.93	2.03
1997	3.46	2.10	1.31	0.67
1998	1.60	0.97	3.26	1.34
1999	0.10	0.06	1.85	0.81
2000	0.63	0.58	1.28	0.57
2001	1.38	0.83	1.87	0.96
2002	0.68	0.58	0.80	0.40
2003	2.31	1.76	0.90	0.57
2004	1.51	1.12	5.46	2.47
2005	1.13	0.90	4.87	1.84
2006	2.18	1.68	2.06	0.80
2007	2.30	1.74	1.64	0.76
2008	0.90	0.55	1.11	0.48
2009	4.39	2.35	3.04	1.48
2010	4.27	2.58	4.01	1.80
2011	2.92	1.79	3.41	1.55
2012	4.52	3.05	4.04	1.41
2013	2.99	2.04	3.84	1.61
2014	1.36	1.01	3.63	1.97
2015	1.63	1.38	5.00	2.14
2016	1.28	1.1	6.78	4.50

Table 5.3.3. Standardized cpue index (kg/1000 hooks) from the Norwegian longliners in ICES Division 6.a.

YEAR	LOWER LIMIT	MEAN INDEX	UPPER LIMIT
2000	5.555	8.832	12.11
2001	1.361	5.25	9.139
2002	5.703	10.28	14.86
2003	0.7733	3.954	7.134
2004	-1.763	1.826	5.414
2005	0.7071	3.801	6.895
2006	6.867	9.824	12.78
2007	3.361	6.839	10.32
2008	11.31	15.06	18.82
2009	8.333	12.68	17.03
2010			
2011	10.7	13.27	15.83
2012	14.73	17.54	20.35
2013	16.82	19.29	21.76
2014	6.574	9.662	12.75
2015	18.24	21.07	23.89

Table 5.3.4. Total and fishing mortality, stock number and recruitment estimates from the MYCC model under the assumption M=0.1. (2014 assessment).

YEAR	Z	Z STANDARD DEV.	RECRUITMENT NUMBER (MILLIONS)	RECRUIT. STANDARD DEV.	TOTAL NUMBERS AGES 9+ (MILLIONS)	NUMBER AGE 9+ SD	F
1995	0.22	0.01	3.62	0.41	17.63	1.94	0.11
1996	0.22	0.01	3.66	0.42	17.83	1.76	0.11
1997	0.26	0.01	3.74	0.43	18.02	1.59	0.15
1998	0.26	0.01	3.64	0.41	17.55	1.47	0.15
1999	0.30	0.02	3.77	0.43	17.30	1.36	0.19
2000	0.30	0.02	3.63	0.39	16.45	1.30	0.19
2001	0.32	0.02	3.68	0.38	15.85	1.25	0.21
2002	0.26	0.01	3.47	0.40	15.03	1.27	0.15
2003	0.24	0.01	3.53	0.38	15.08	1.31	0.13
2004	0.21	0.01	3.92	0.39	15.76	1.31	0.10
2005	0.20	0.01	4.14	0.44	16.92	1.34	0.09
2006	0.20	0.01	4.05	0.40	17.92	1.42	0.09
2007	0.19	0.01	3.90	0.37	18.56	1.51	0.08
2008	0.17	0.01	3.86	0.37	19.15	1.60	0.06
2009	0.17	0.01	3.63	0.35	19.79	1.68	0.06
2010	0.18	0.01	3.49	0.36	20.21	1.75	0.07
2011	0.15	0.00	3.66	0.37	20.62	1.84	0.04
2012	0.15	0.00	3.40	0.38	21.17	1.92	0.04
2013	0.15	0.00	3.38	0.41	21.56	2.00	0.04
2014	0.15	0.00	3.27	0.47	21.92	2.10	0.04
2015	0.14	0.00	3.68	0.42	22.59	2.14	0.03
2016			3.62	0.44	23.18	2.17	

Table 5.3.5. Time-series 1966–20116 of exploitable biomass (thousand tonnes), fishing mortality (*F*, year^{-1}) and Spawning–Stock Biomass relative to the Spawning–Stock Biomass in the first year (*SSB/SBB0*) from the stock reduction analysis (SRA), with *M*=0.11.

YEAR	EXPLOITABLE BIOMASS	F	SSB/(SSB0)	YEAR	EXPLOITABLE BIOMASS	F	SSB/(SSB0)
1966	273.1	0	1	1992	64.7	0.25	0.237
1967	271.8	0.01	0.995	1993	60.8	0.21	0.223
1968	270.5	0.01	0.991	1994	59.7	0.12	0.219
1969	267.9	0	0.981	1995	63.1	0.14	0.231
1970	266.9	0.01	0.977	1996	64.8	0.15	0.237
1971	264	0.01	0.967	1997	65.2	0.18	0.239
1972	262.5	0.02	0.961	1998	63.5	0.2	0.233
1973	258.5	0.11	0.946	1999	61.3	0.24	0.224
1974	233.9	0.1	0.856	2000	57.1	0.23	0.209
1975	215.2	0.07	0.788	2001	54.1	0.27	0.198
1976	204	0.1	0.747	2002	50.4	0.2	0.184
1977	188.3	0.19	0.69	2003	50.4	0.17	0.184
1978	162.3	0.09	0.594	2004	52	0.13	0.191
1979	155.3	0.07	0.569	2005	54.8	0.11	0.201
1980	151.8	0.17	0.556	2006	58.2	0.11	0.213
1981	136.2	0.11	0.499	2007	61.1	0.1	0.224
1982	130.5	0.09	0.478	2008	63.8	0.07	0.234
1983	127.6	0.1	0.467	2009	67.9	0.07	0.249
1984	124.3	0.14	0.455	2010	71.7	0.07	0.262
1985	116.9	0.19	0.428	2011	74.7	0.04	0.274
1986	105.9	0.23	0.388	2012	79.8	0.04	0.292
1987	93.4	0.22	0.342	2013	84.7	0.03	0.31
1988	84.9	0.27	0.311	2014	90.2	0.04	0.33
1989	75.2	0.24	0.275	2015	95.2	0.03	0.348
1990	69.6	0.21	0.255	2016	100.4	0.03	0.368
1991	67	0.21	0.245				

Table 5.3.6. Estimated SSB and yield in the long term (after stabilization) of the stock bli-5b67 under a range of fishing mortality. Projection initiated from the stock number-at-age in 2014 and run for 200 years, with a range of F value from the current F to ten times more.

F	SSB (TONNES)	YIELD (TONNES)
0.031	188 088	5414
0.046	158 906	6810
0.062	135 982	7712
0.077	117 597	8274
0.093	102 593	8598
0.108	90 163	8750
0.111	87 932	8764
0.114	85 777	8774
0.123	79 731	8778
0.139	70 875	8713
0.154	63 280	8580
0.17	56 710	8396
0.185	50 979	8174
0.201	45 945	7922
0.216	41 493	7649
0.231	37 534	7359
0.247	33 992	7058
0.262	30 810	6748
0.278	27 936	6432
0.293	25 331	6112
0.309	22 960	5789

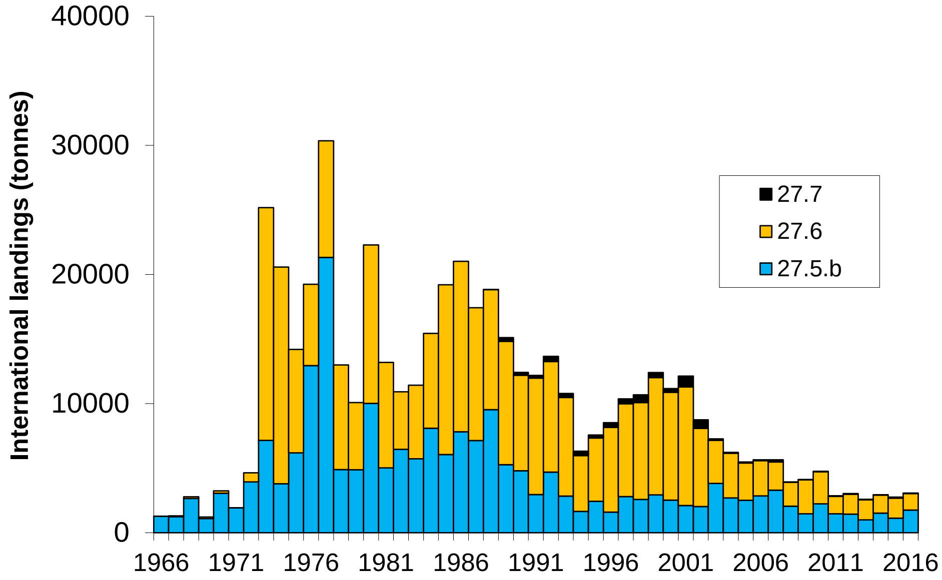


Figure 5.3.1. Trends in total international landings for bli-5b67.

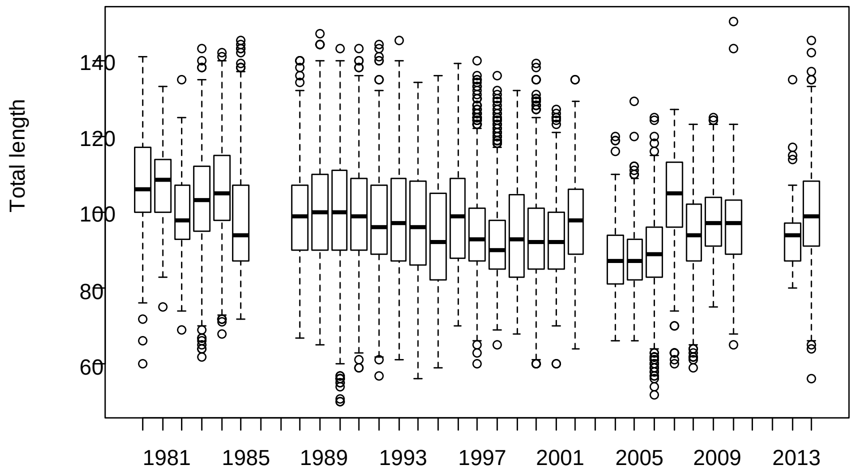


Figure 5.3.2. Boxplot of length distribution of blue ling landings from Faroese otter-board trawlers >1000 HP in ICES 5.b.

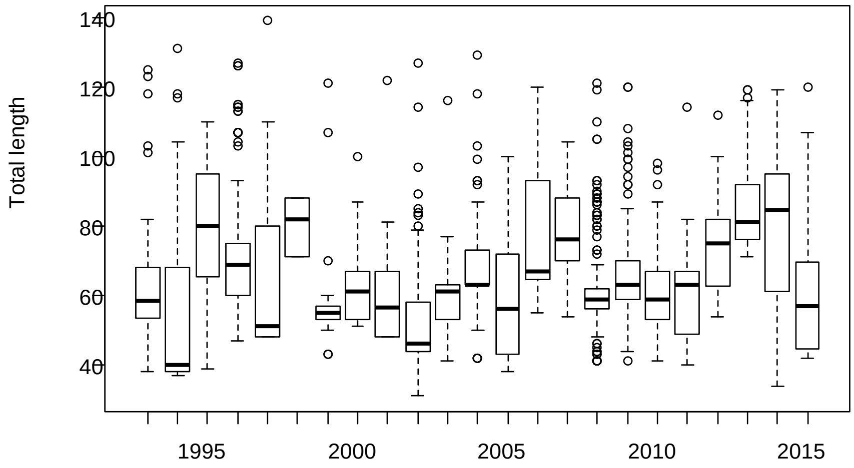


Figure 5.3.3. Boxplot of length distribution of blue ling in the spring groundfish Faroese survey on the Faroe Plateau.

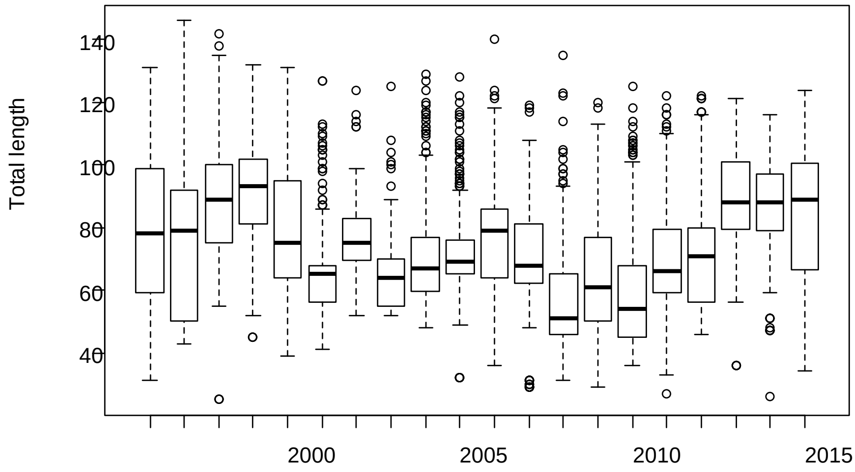


Figure 5.3.4. Length distribution of blue ling in the summer groundfish Faroese survey on the Faroe Plateau.

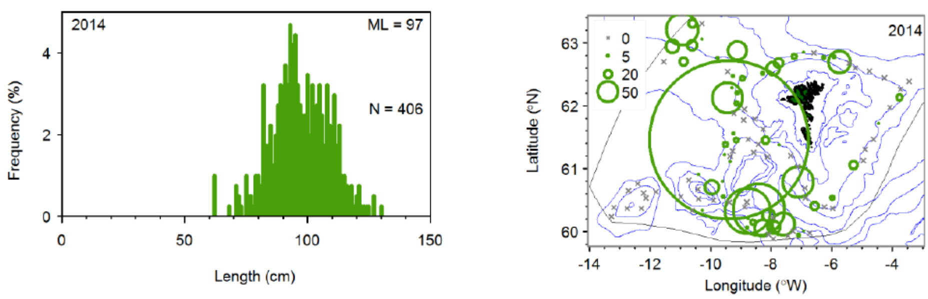


Figure 5.3.5. Length distribution of blue ling in the 2014 deep-water survey in Faroese waters and spatial distribution of catches of blue ling in the survey.

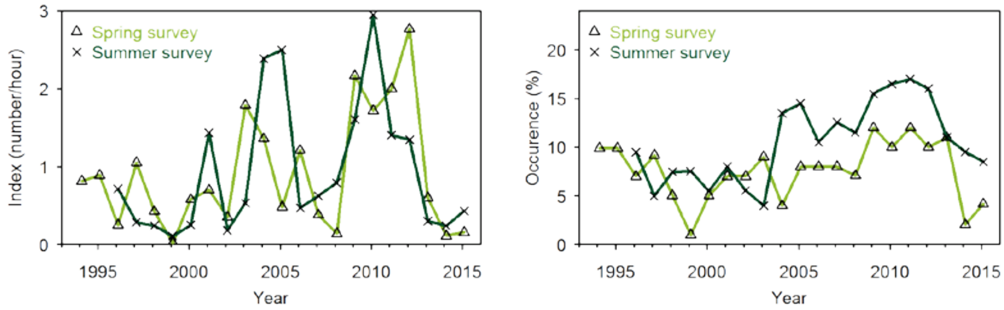


Figure 5.3.6. Juvenile (<80 cm) blue ling caught in groundfish surveys on the Faroe Plateau (left) number per hour and (right) occurrence.

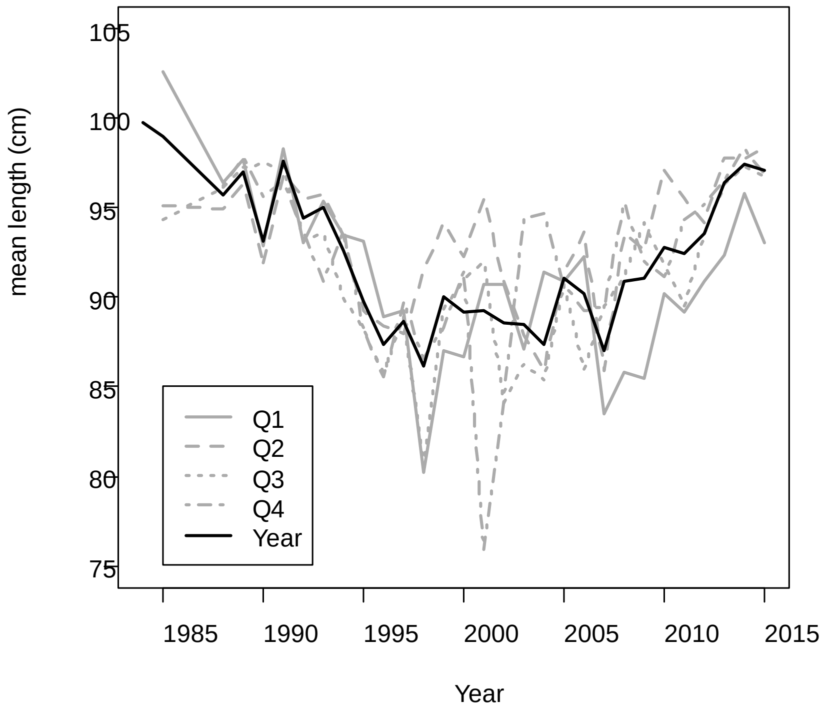


Figure 5.3.7. Quarterly mean length in French trawl landings, 1984–2016.

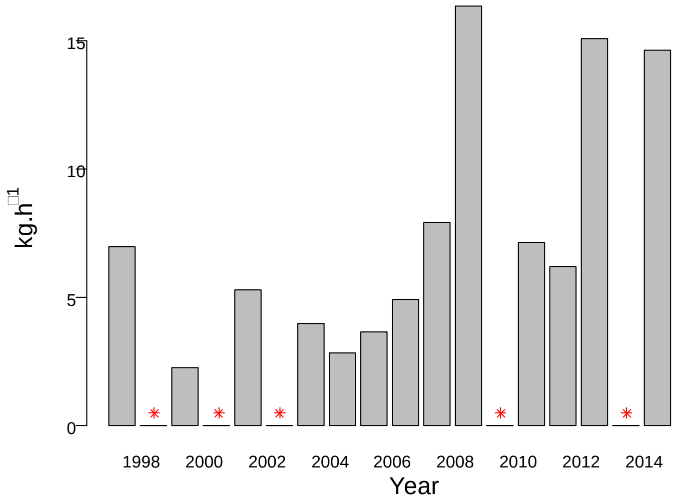


Figure 5. 3.8. Biomass index in the Scottish deep-water survey, based on haul carried out from 400 to 1600 m along the Scottish slope. Red stars depict years without surveys.

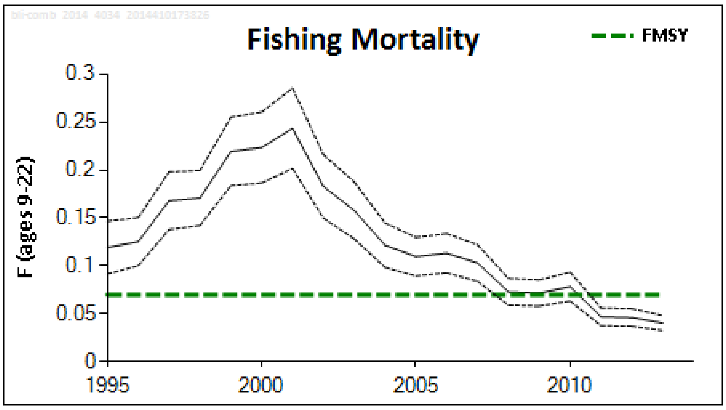
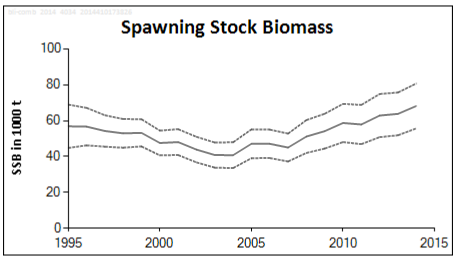


Figure 5.3.9. Estimated fishing mortality from the MYCC, the green dotted line depicts F lower MSY.



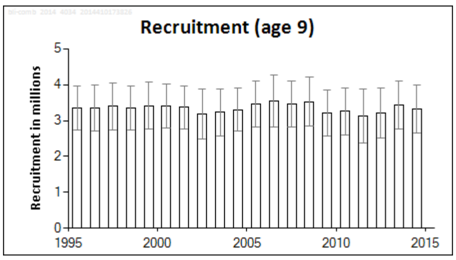


Figure 5.3.10. Estimated biomass of age 9+ and recruitment numbers-(at-age 9) from the MYCC.

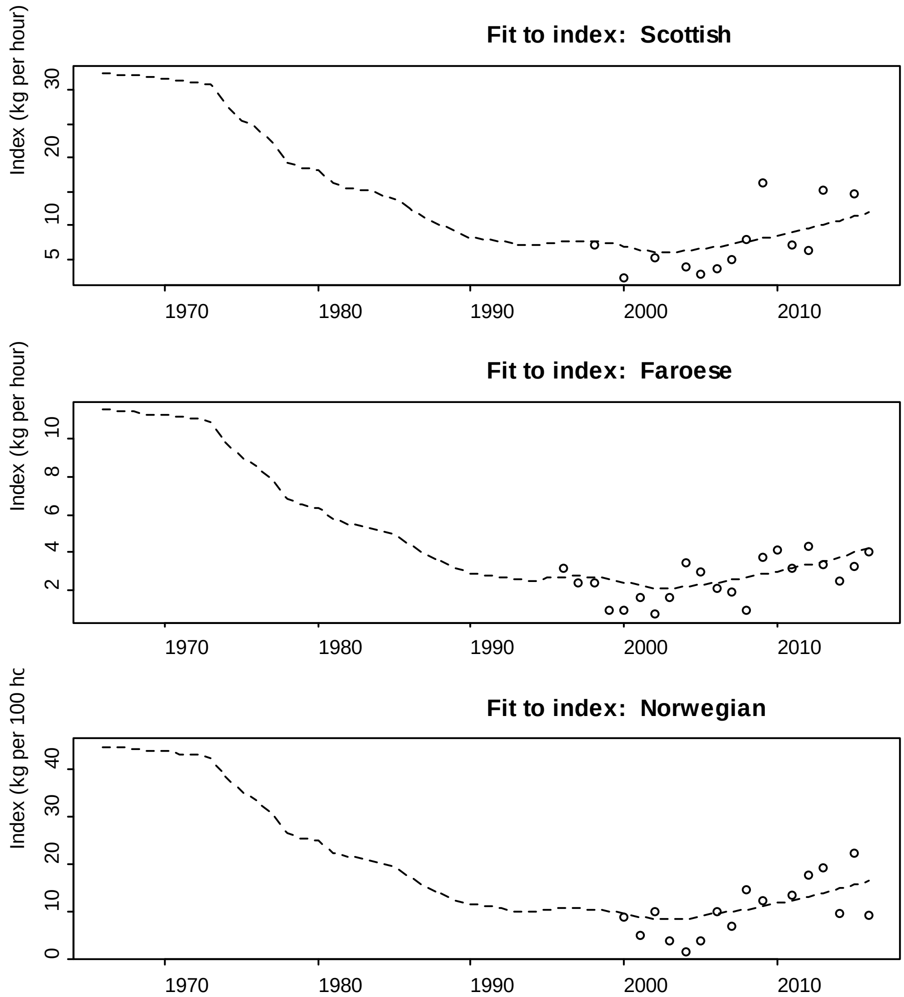


Figure 5.3.11. SRA model: fit of biomass indices to the estimated stock biomass: (top) Marine Scotland deep-water research survey, (centre) combined Faroese surveys, (bottom) Norwegian longliner fleet cpue.

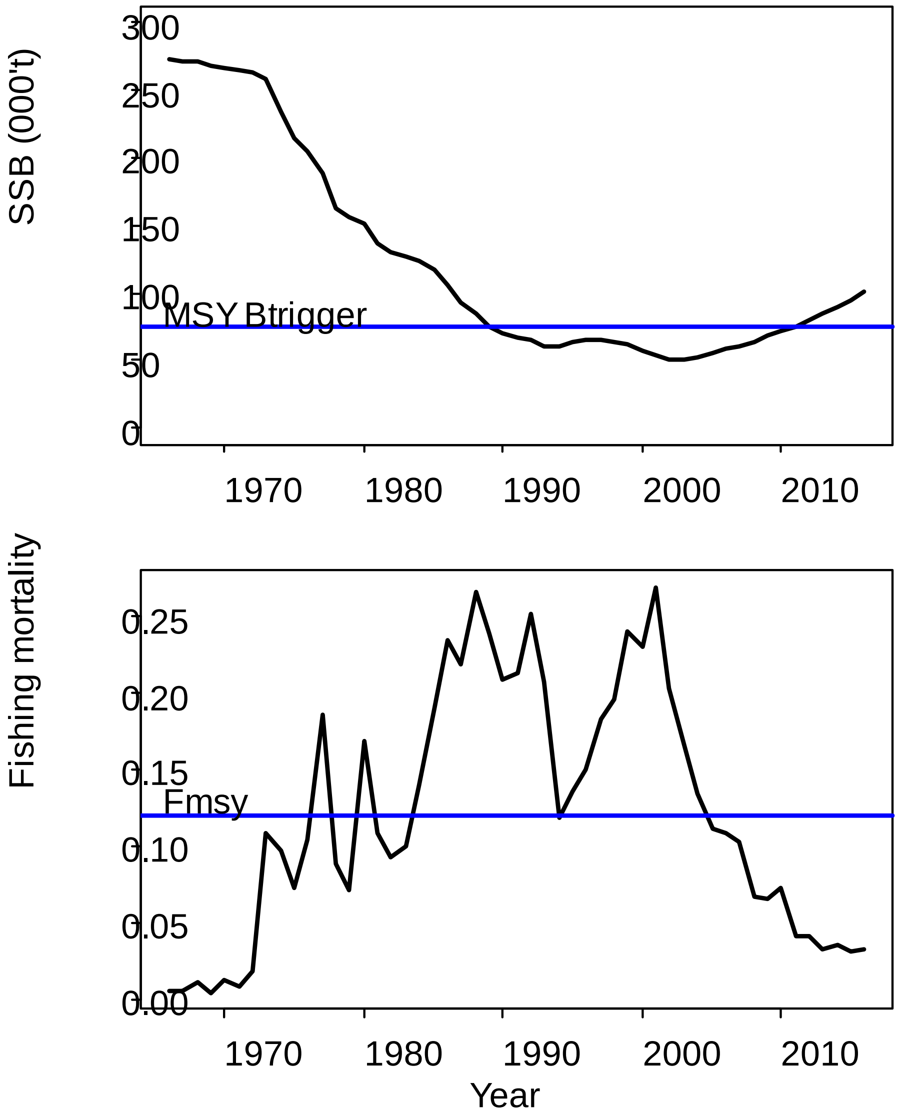


Figure 5.3.12. Spawning–stock biomass (SSB, thousand tonnes, top panel) and fishing mortality (bottom panel) from 1966 (onset of the fishery) to 2016.

5.4 Blue ling (*Molva dypterygia*) in 1, 2, 3.a, 4, and 12

5.4.1 The fishery

The directed fisheries on spawning aggregations for blue ling on Hatton Bank (Division 12.b) and Division 2.a (Storegga) are no longer conducted. Blue ling is now only taken as bycatch of other fisheries taking place in these areas.

In Hatton Bank (Division 12.b) blue ling represents a significant bycatch of trawl fisheries for mixed deep-water species. In Division 2.a there is also a bycatch from the longline and gillnet fisheries.

In other ICES subareas blue ling is taken in minor quantities. Small reported landings in Subareas 8, 9 and 10 are now ascribed to the closely related Spanish ling (*Molva* *macropthalma*) since the species is not known to occur in any significant numbers in these subareas.

5.4.2 Landings trends

Landing data are presented in Tables 5.4.0a–f. There are also historical landings from the Norwegian fishery, mainly from Division 2.a, back from 1896 (Figure 5.4.1). During the whole time-series, around 90% or more of the total landings were taken in Subareas 2, 4 and 12 combined. Landings from other areas are currently at a low level. In 2016, 85% of the landings came from Subarea 2 and 4.

For all areas, a continuous decline on landings has been observed after the higher landing levels in the 1988–1993 period. Landings from individual subareas and divisions have since the three last year been below 200 tonnes but apparently still declining.

5.4.3 ICES Advice

The ICES advice for 2016 and 2017 was:

"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 2017 precautionary TAC for EU vessels in international waters of 12 was set to 357 tonnes and value for bycatches only. TACs for vessels in EU waters and international waters of 5.b, 6 and 7 were set to 11 314 tons, an increase from 5046 tons in 2016; of this a quota for Norwegian vessels was set to 150 tonnes to be fished in Union waters of 2.a, 4, 5.b, 6 and 7. In Union and international waters of 2 and 4, a precautionary TAC for EU vessels was set to 53 tonnes.

5.4.5 Data availability

5.4.5.1 Landings and discards

Landings data are presented in Table 5.4.0a–f. 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

For the Norwegian catches there was presented a cpue from Subarea 1, 2, 3.a and 4 combined (Figure 5.4.5.). The cpue series is calculated from 2000–2016 and is based on longline data from the Norwegian fishery. The cpue show a low and stable level in this period.

5.4.6 Data analyses

The assessment for this stock is based on landing trends. The landings have declined and for all areas except for Subarea 4, the mean landings are now less than 5% of the mean landings from the years 1988–1993 (the period with stable landings). The increase in landings seen for Subarea 4 in 2015 has stabilized at the same level in 2016. The 2015 increase was a result of increased Norwegian landings (Figures 5.4.2–5.4.4).

The historical Norwegian landings, mainly in 2.a show that landings reached almost 6000 tonnes in 1980. Since then landings have decreased. In 2010, there was an increase in landings from Subarea 2 as a result of an increase in Faroese landings. From 2013 onwards, landings are at the same low levels as seen in the early 2000s.

In Subarea 12 and after relative high levels for the period 2001–2005 landings have declined. This decline is likely to be due to reductions in Spanish fishing activity in this area.

In Subarea 4 an increase on French and Norwegian landings were registered in 2010 and 2011. The landings for 2016 are at the same level as in 2015 and landing levels are still at the low levels seen in mid-2000s.

The increase of landings in Division 3.a in 2005 (2.5 times increase from 2004–2005) is likely to be associated to the increase of Danish roundnose grenadier fishery. This fishery stopped in 2006 and the landings of blue ling have since been insignificant.

The Norwegian cpue series show a low and stable level for the years 2000–2016 and although there is no directed fishery from this area there seems to be no recovery for this part of the stock.

5.4.6.1 Biological reference points

There are not yet suggested methods to estimate biological reference points for category 5 and 6 stocks. Therefore, no attempt was made to run SPiCT or LBI-method for this stock.

5.4.7 Comments on assessment

Not applicable.

5.4.1 Management considerations

Trends in landings suggest serious depletion in Subarea 2. Landings have also declined strongly in Subarea 12 from 2002 onwards. Landings in other subareas and divisions are minor but there is some evidence of a persistent decline.

The advice given in 2015 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.

Blue ling specimens caught in Subarea 12.b probably belong to the same stock that is exploited in Subarea 6. Management of Subarea 12.b should be consistent with the Advice for ICES Subarea 5.b and for Divisions 6 and 7.

The bulk of current bycatches of blue ling from subareas and divisions treated in this section are taken within EEZs. The exception is the 12.b catches from the Hatton Bank within the NEAFC Regulatory Area. In accordance with the interim guidelines from NEAFC established in 2014, the blue ling for this subarea would fall into Category 2. The only measure NEAFC can contribute, i.e. complementing measures within EEZs, is to further reduce bycatches in 12.b.

Table 5.4.0a. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Sub-area 1. (* preliminary).

YEAR	ICELAND	NORWAY	FRANCE	FAROES	TOTAL
1988		10			10
1989		8			8
1990		4			4
1991		3			3
1992		5			5
1993		1			1
1994		3			3
1995		5			5
1996		2			2
1997		1			1
1998		1			1
1999		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
2014				4	4
2015					0
2016*		0.84			1

Table 5.4.0b. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Divisions 2.a, 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			333
2009	56	1			219		9			285
2010	183	1			234		4			422
2011	312	7			167					486
2012	188	7			142		1			338
2013	79	16			107					202
2014	29	16			73		9			127
2015	16	6			91					113
2016*	22	7	0.059		57		1			87

Table 5.4.0c. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Subarea 3. (* preliminary).

Year	Denmark	Norway	Sweden	FRANCE	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
2014		+	+		0
2015	+	+			0
2016*	0.154	0.64	0.005	0.307	1

Table 5.4.0d. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Division 4.a. (* 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		46		1		176
2012			96		70				166
2013			5		38				43
2014			4		34		12		50
2015	+		6		74	+	3		83
2016*	0,48		6	0,041	74		6		87

Table 5.4.0e. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Subarea 12. (* preliminary).

Year	Faroes	France	Germany	Spain	E & W	Scotland	Norway	Iceland	Poland	Lithuania	Russia	unallocated	Total
1988		263											263
1989		70											70
1990		5					547						552
1991		1147											1147
1992		971											971
1993	654	2591	90			1							3336
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	48	9						1318
2003		7		1096			40		12	37			1192
2004		27		861		10					7		905
2005		10		657		35				8			710
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	632
2013				178								76	254
2014				80									80
2015				12									12
2016*				29									29

Table 5.4.0f. Blue ling (*Molva dypterygia*). Total landings by Subarea/Division (From 2010 landings from Areas 8, 9 and 10 given in previous reports are now considered to represent *Molva macropthalma*). (* preliminary data).

YEAR	1	2	3	4	12	TOTAL
1988	10	3537	22	363	263	4195
1989	8	2058	23	457	70	2616
1990	4	1412	21	495	552	2484
1991	3	1479	21	620	1147	3270
1992	5	1039	38	553	971	2606
1993	1	1020	23	412	3336	4792
1994	3	419	18	421	752	1613
1995	5	359	20	477	573	1434
1996	2	267	12	179	788	1248
1997	1	291	21	269	417	999
1998	1	278	6	280	438	1003
1999	1	291	6	264	1353	1915
2000	3	249	14	129	594	989
2001	1	208	24	252	675	1160
2002	1	149	9	376	1318	1853
2003	0	147	19	92	1192	1450
2004	1	174	19	83	905	1182
2005	1	197	49	66	710	1023
2006	0	202	42	94	501	839
2007	0	262	0	62	354	678
2008	0	333	2	74	564	973
2009	1	285	0	89	312	687
2010	1	422	0	155	50	628
2011	3	486	0	176	55	720
2012	1	338	0	166	632	1137
2013	0	202	1	43	254	500
2014	4	127	0	50	80	261
2015	0	113	0	83	12	208
2016*	0,84	87	1	87	29	205

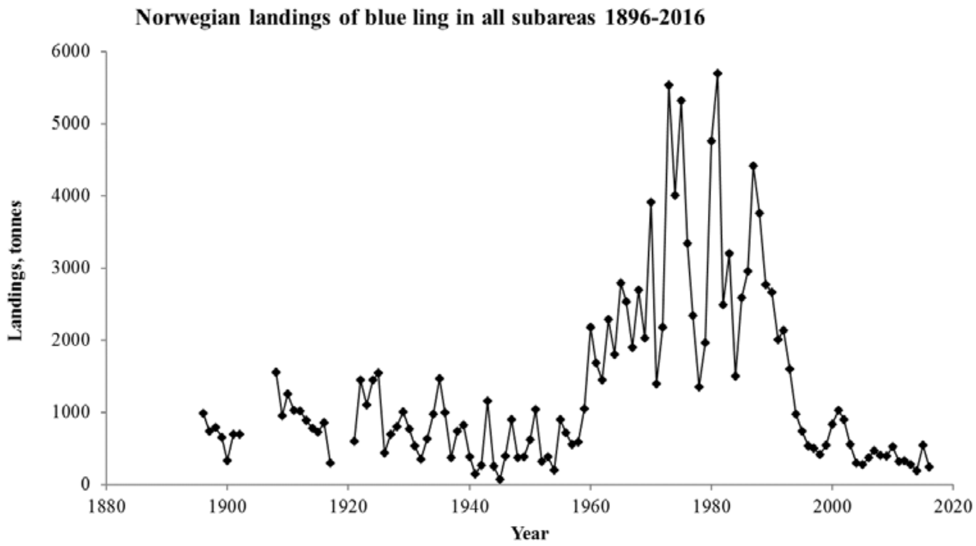


Figure 5.4.1. Reported Norwegian landings on blue ling from 1896–2016.

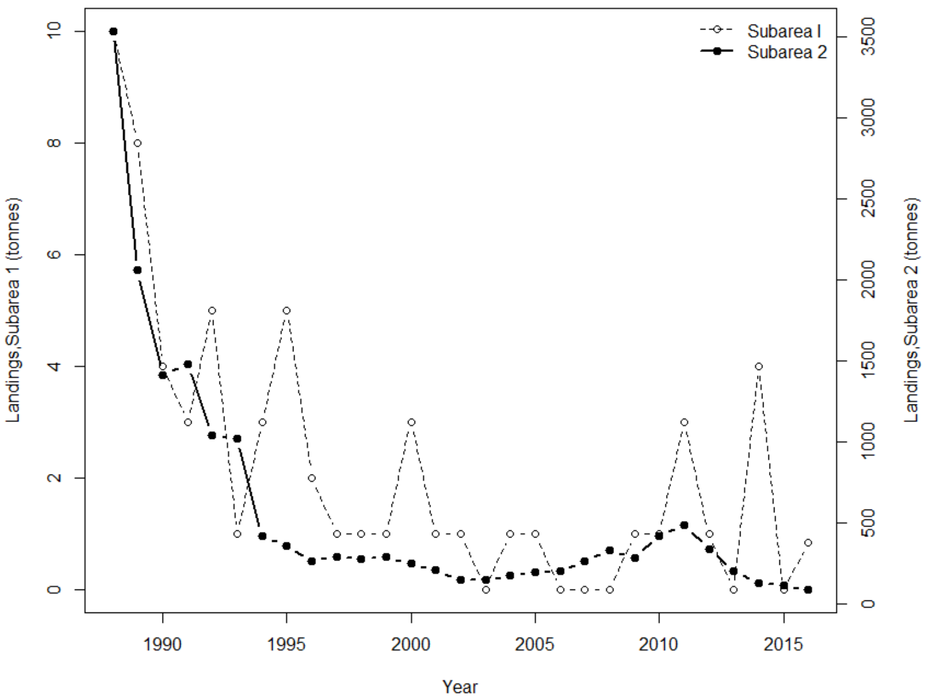


Figure 5.4.2. Landings of blue ling in Subareas 1 and 2.

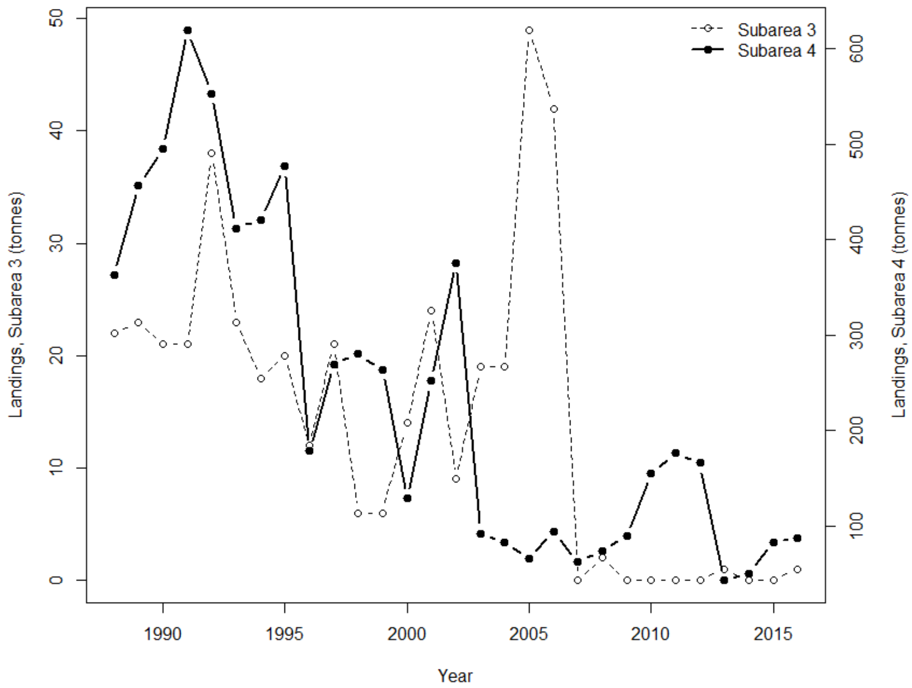


Figure 5.4.3. Landings of blue ling in Subareas 3 and 4.

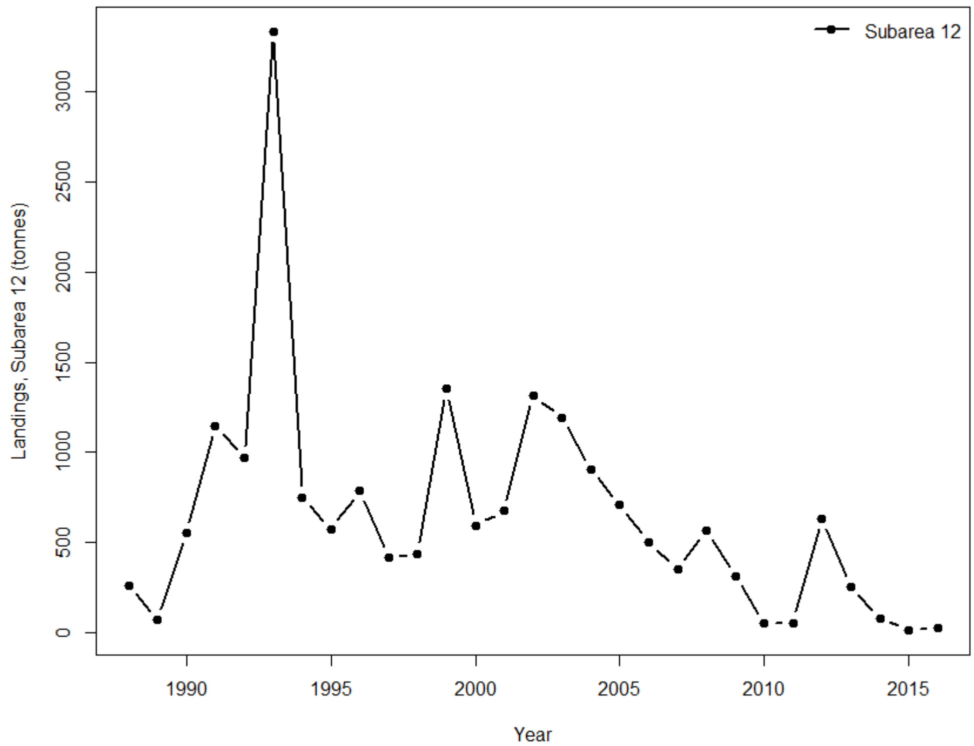


Figure 5.4.4. Landings of blue ling in Subarea 12.

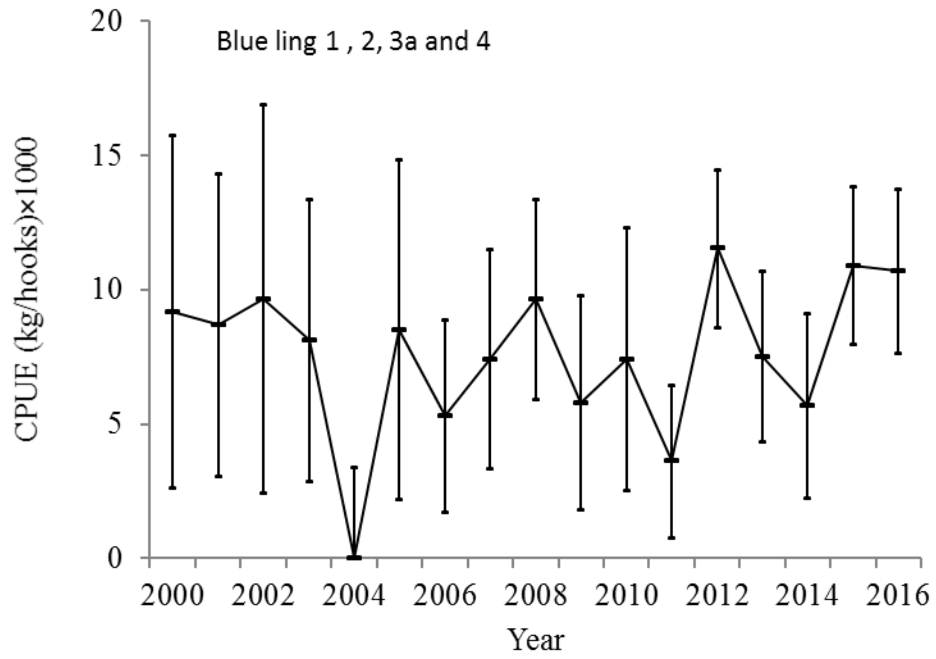


Figure 5.4.5. Norwegian cpue (kg/1000 hooks) from longlines catches in areas 1, 2, 3.a and 4 from 2000–2015.

6 Tusk

6.1 Stock description and management units

In 2007, WGDEEP examined the available evidence of any stock discrimination for tusk. Based on genetic investigations (references), the group suggested the following stock units for tusk:

- Area5.a and 14;
- Mid-Atlantic Ridge;
- Rockall (6.b);
- Areas 1, 2.

All other areas (4.a,5.b, 6.a, 7,…) be assessed as one combined stock, until further evidence of multiple stocks become available in these areas purposes.

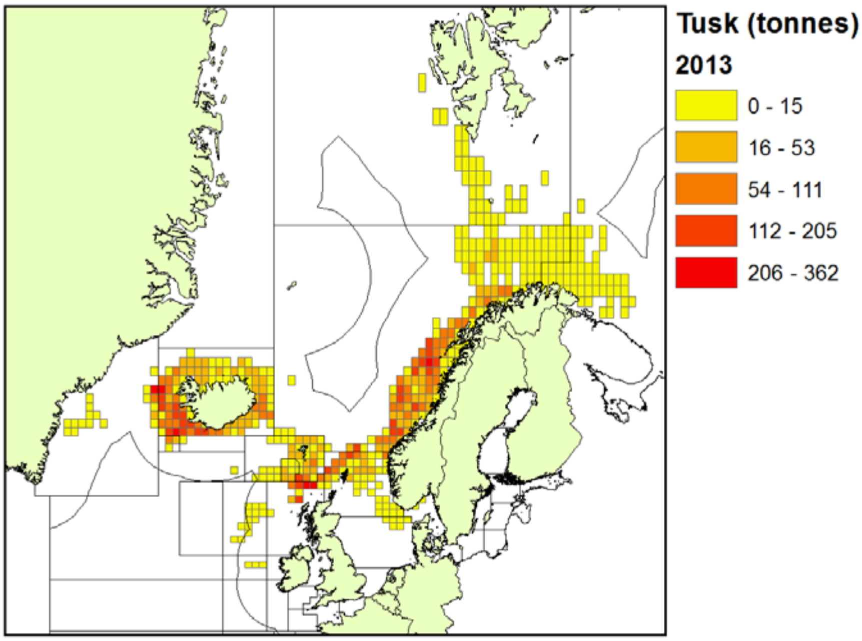


Figure 6.1. Reported landings of tusk in the ICES area by statistical rectangle, 2013. Data from Norway, Faroes, Iceland, France, UK (England and Wales) and Spain. Landings shown in this figure account for 99% of all reported landings in the ICES area.

6.2 Tusk (*Brosme Brosme*) in Division 5.a and Subarea 14

6.2.1 The fishery

Tusk in 5.a is caught in a mixed longline fishery, conducted in order of importance by Icelandic, Faroese and Norwegian boats. Between 150 and 240 Icelandic longliners report catches of tusk, but much fewer gillnetters and trawlers. The number of longliners reporting tusk catches in 2016 decreased to 138 from 163 the previous year (Table 6.2.1). Most of tusk in 5.a 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 5.a. Number of Icelandic boats reporting catches and their landings from logbooks.

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	177	16	36	4873	73	27	4973
2014	181	19	37	4878	88	28	4994
2015	163	13	39	3913	67	20	4000
2016	138	15	37	2207	22	2	2231

Most of the tusk caught in 5.a by Icelandic longliners is caught at depths less than 300 meters (Figure 6.2.1). The main fishing grounds for tusk in 5.a 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 5.a 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 50–60% of tusk is caught on the south and western part of the shelf (Figure 6.2.3).

Tusk in 14 is caught mainly as a bycatch by longliners and trawlers. The main area where tusk is caught in 14 is 63°–66°N and 32°–40°W, well away from the Icelandic EEZ.

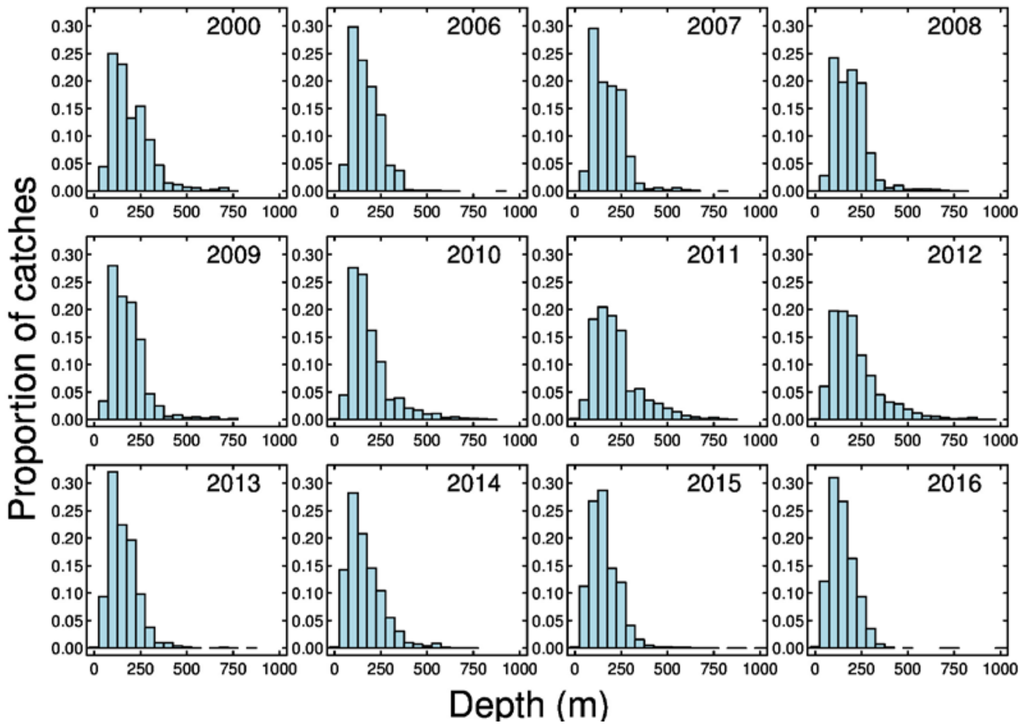


Figure 6.2.1. Tusk in 5.a and 14. Depth distribution of longline catches in 5.a according to logbooks.

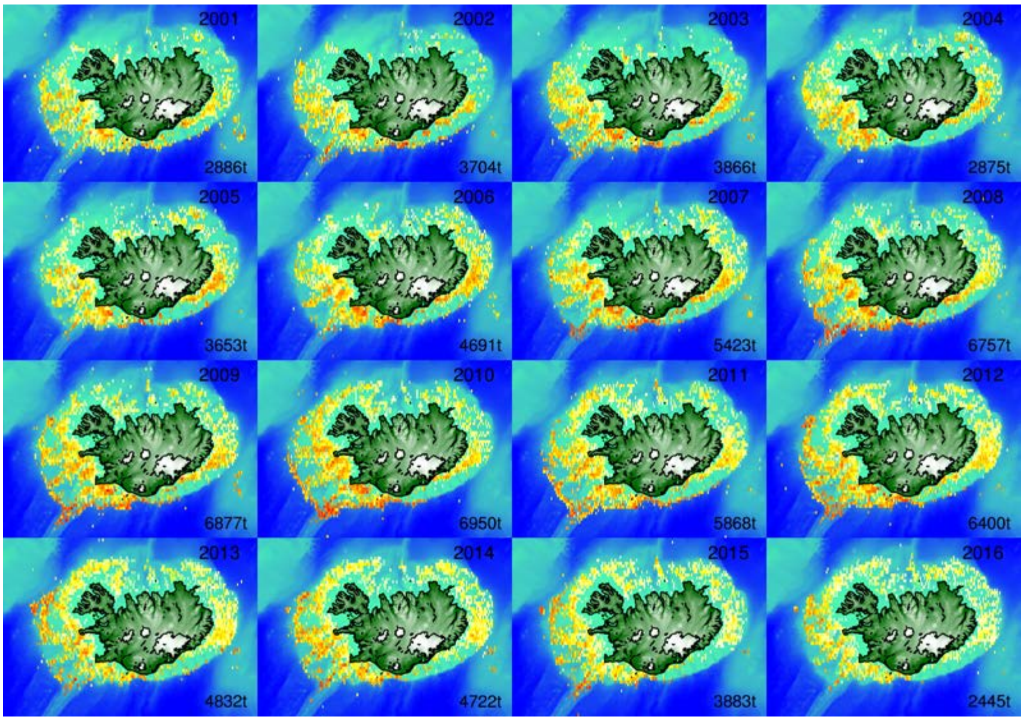


Figure 6.2.2. Tusk in 5.a and 14. Geographical distribution of the Icelandic fishery since 1999 as reported in logbooks. All gears combined.

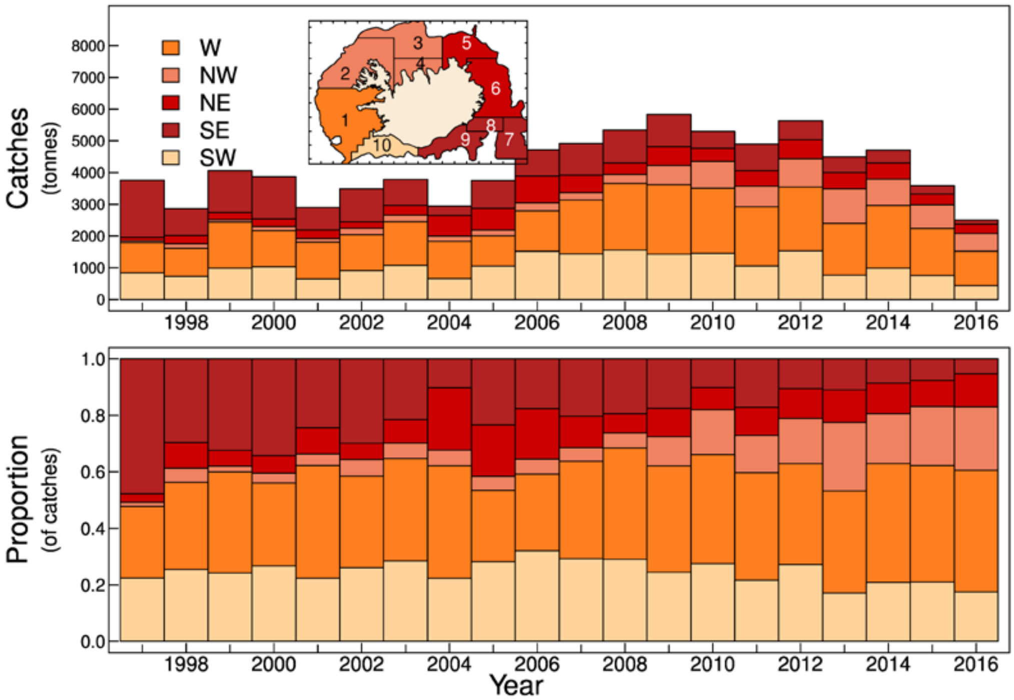


Figure 6.2.3. Tusk in 5.a and 14. Changes in spatial distribution of the Icelandic fishery from 1996 as reported in logbooks. All gears combined.

6.2.1.1 Landings trends

The total annual landings from ICES Division 5.a were around 3500 tonnes in 2016 (Table 6.2.7). This is contrary to the trend in landings from 2000 in which the annual landings gradually increased in 5.a 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 5.a was caught by foreign vessels but has since then been between 15–25%, mainly from the Faroe Islands (Table 6.2.7).

Landings in 14.b have always been low compared to 5.a, rarely exceeding 100 t. However around 900 tonnes in 2015 and around 500 tonnes in 2016 were caught in the 14.b mainly by Faroe and Greenlandic vessels (Table 6.2.8). The spatial distribution of longline operations in 14.b in 2015 is shown in Figure 6.2.3b.

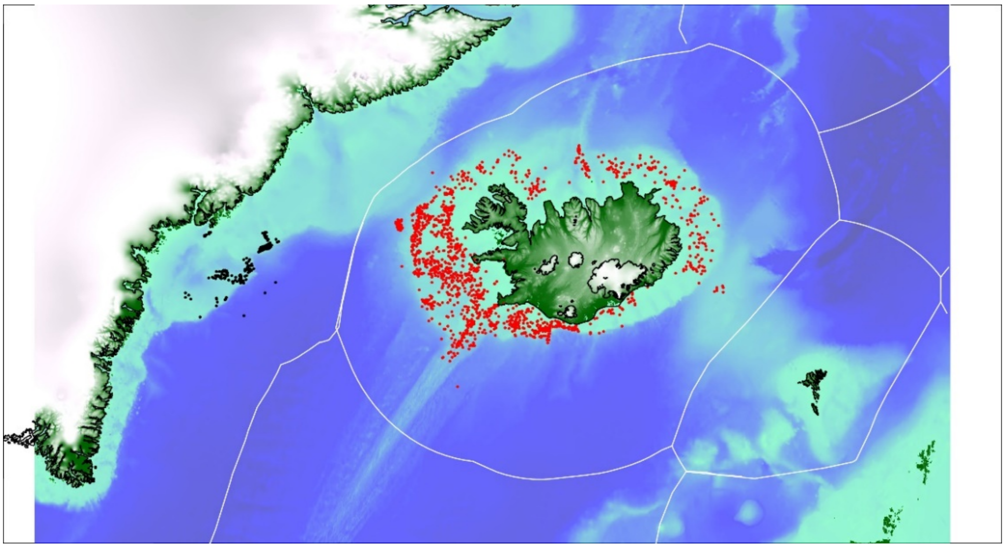


Figure 6.2.3b. Position of longline operations in 14.b and 5.a where tusk was recorded in 2015.

6.2.1.2 ICES Advice

The latest Advice from ICES in May 2016 states: ICES advises that, based on the MSY approach, catches should be no more than 3780 t.

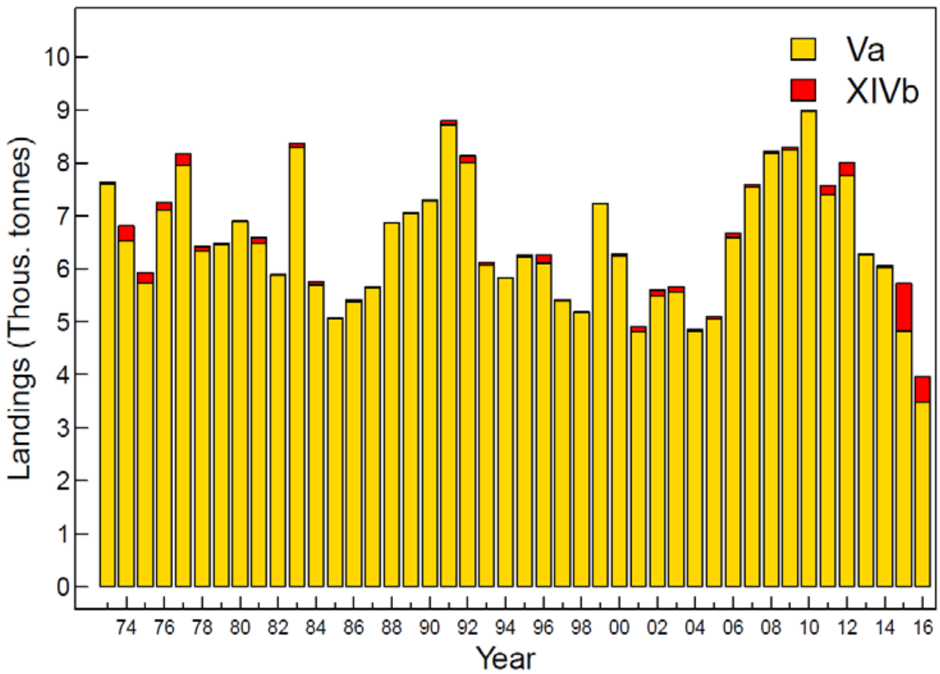


Figure 6.2.4. Tusk in 5.a and 14. Landings in 5.a and 14 (source STATLANT).

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. At 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%. However since the 2011/2012 fishing year the overshoot in landings has decreased to 6–16% apart from 2014/2015 when it was 34% (Table 6.2.2).

The reasons for the large difference between annual landings and both advised and set TACs are threefold:

1) It is possible to transfer unfished quota between fishing years;

2) It is possible to convert quota shares in one species to another;

3) The national TAC is only allocated to Icelandic vessels. All foreign catches are therefore outside the quota system.

However for the last three 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. Figure 6.2.5 shows the net transfers in the Icelandic ITQ-system. During the 2005/2006 to 2010/2011 fishing years there was a net transfer of other species quota being converted to tusk quota, this however reversed during the following three fishing years. In the 2014/2015 and 2015/2016 fishing years there was again net transfer of other species being changed to tusk quota.

Table 6.2.2. Tusk in 5.a and 14. TAC recommended for tusk in 5.a 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	5881
2014/15	4000	3700	4958
2015/16	3440	3000	3494

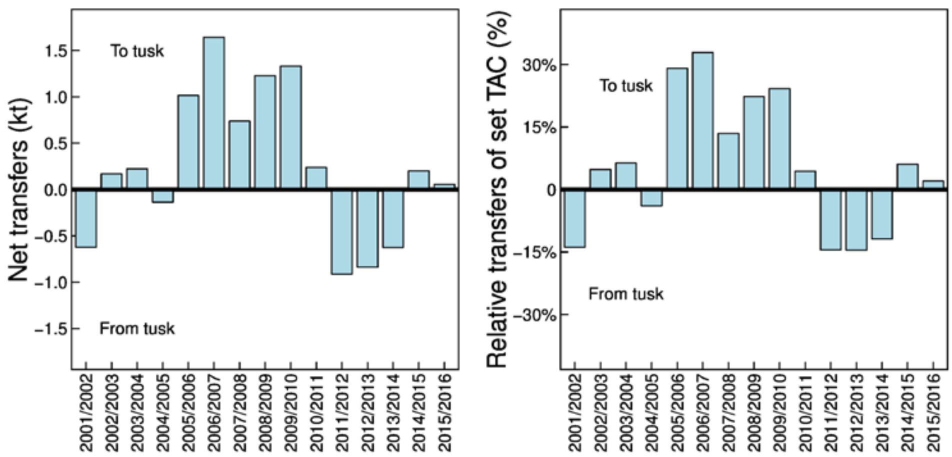


Figure 6.2.5. Tusk in 5.a and 14. Net transfers of tusk quota to other species in the Icelandic ITQ system by fishing year. Positive values indicate that other species are being changed to tusk but negative mean that tusk quota is being converted to other species.

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.

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 5.a and 14.

Landings for tusk in 14 are obtained from the STATLANT database. No information is available on discards in 14.

6.2.2.2 Length compositions

An overview of available length measurements from 5.a is given in Table 6.2.3. Most of the measurements are from longlines, number of available length measurements increased in 2007 from around 2500 to around 4000 and were close to that until 2016 when they decreased to around 1700.

Length distributions from the longline fishery are shown in Figures 6.2.6 (abundance) and 6.2.7 (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 14 are available.

Table 6.2.3. Tusk in 5.a and 14. Number of available length measurements from Icelandic (5.a) commercial catches.

Year	Longline		Gillnets		Trawls	
	Samples	Measured	Samples	Measured	Samples	Measured
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
2014	28	3384	0	0	0	0
2015	26	3115	0	0	0	0
2016	14	1671	0	0	0	0

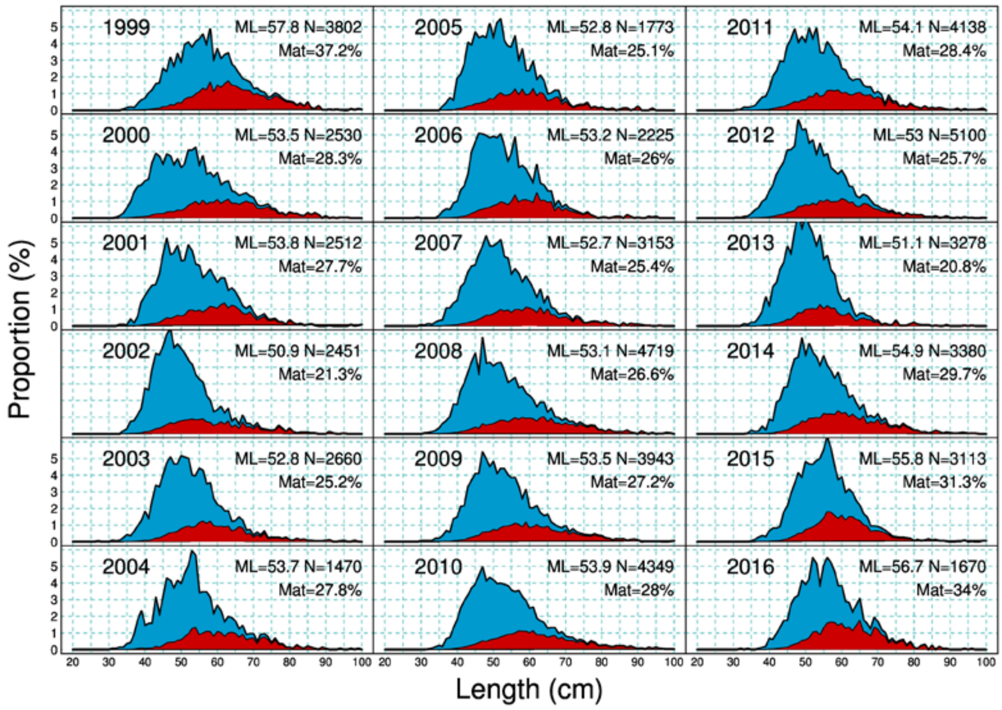


Figure 6.2.6. Tusk in 5.a and 14. Length distributions from Icelandic commercial longline catches in abundance. Blue areas are immature tusk and red represent mature tusk. Small numbers to the right refer to mean length (ML), number of samples (N) and percentage of mature individuals (Mat).

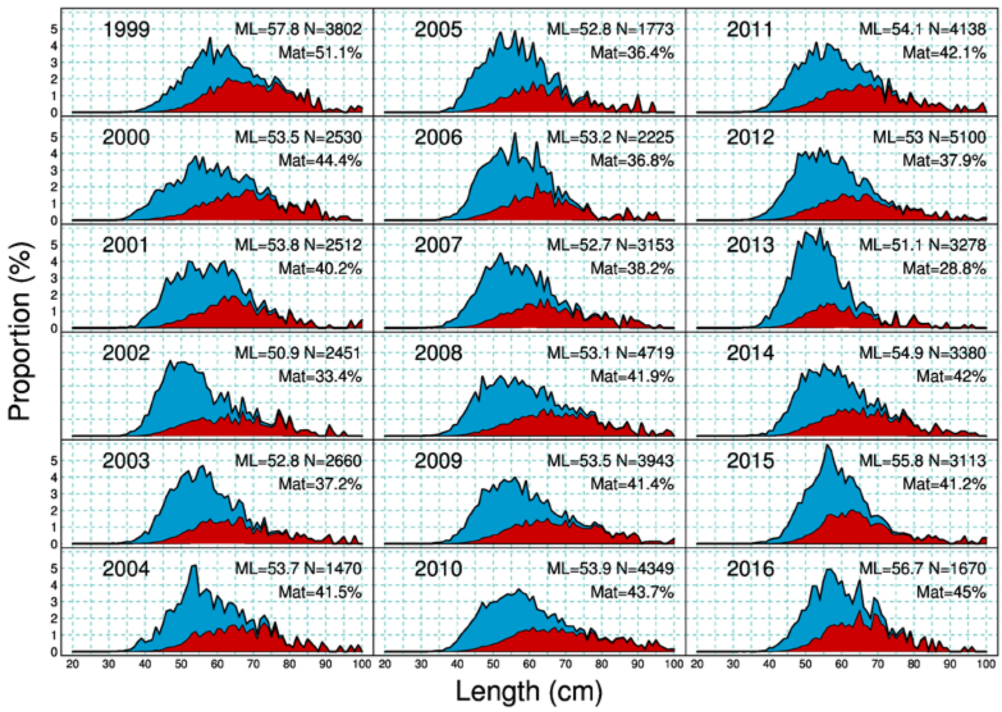


Figure 6.2.7. Tusk in 5.a and 14. Length distributions from Icelandic commercial longline catches in biomass. Blue areas are immature tusk and red represent mature tusk. Small numbers to the right refer to mean length (ML), number of samples (N) and percentage of mature individuals (Mat).

6.2.2.3 Age compositions

Table 6.2.4 gives an overview of otolith sampling intensity by gear types from 2000 to 2016 in 5.a. Since 2010 considerable effort has been put into ageing tusk otoliths, so now aged otoliths are available from 1984, 1995, 2008–2016. The ageing are used as input data for the Gadget assessment (Figure 6.2.8). It is expected that the effort in ageing of tusk will continue.

No data are available from 14.

Table 6.2.4. Tusk in 5.a and 14. Number of available otoliths from Icelandic (5.a) 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	1112	285	771	750
2013	22	1100	490	275	744	517
2014	28	620	587	241	585	560
2015	26	555	505	260	614	573
2016	14	290	290	259	689	676

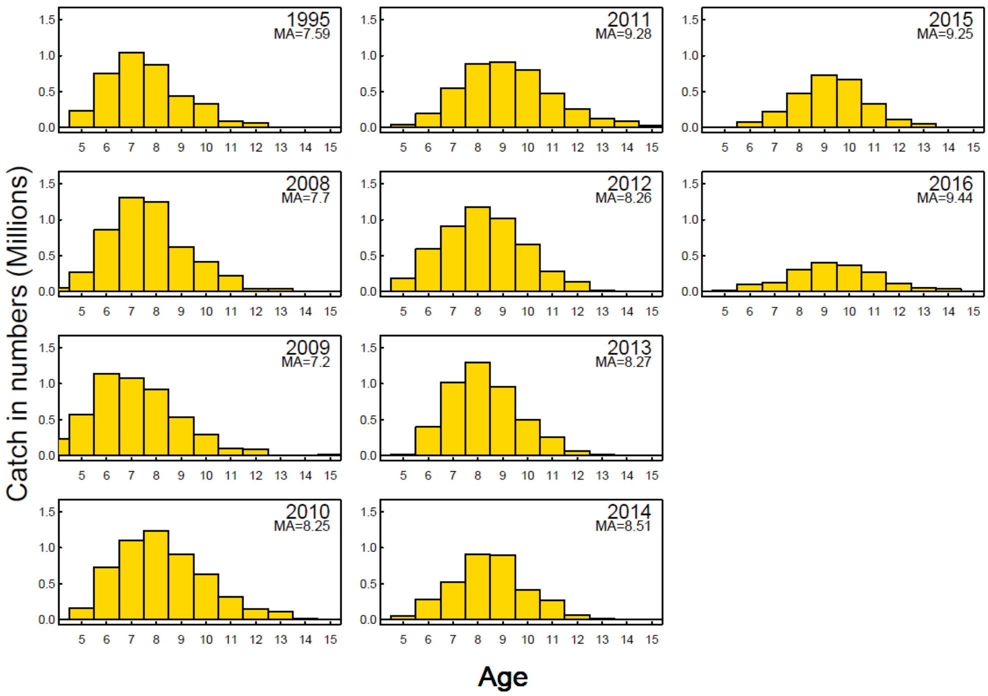


Figure 6.2.8. Tusk in 5.a and 14. Catch in numbers in 5.a (From longlines).

6.2.2.4 Weight-at-age

Weight-at-age data from 5.a are limited to 2008–2016.

No data are available from 14.

6.2.2.5 Maturity and natural mortality

At 54 cm around 25% of tusk in 5.a 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 5.a.

No data are available for 14.

6.2.2.6 Catch, effort and research vessel data

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

The cpue estimates of tusk in 5.a are not considered representative of stock abundance.

Cpue estimations have not been attempted on available data from 14.

Icelandic survey data (5.a)

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 5.a. In 2011 the 'Faroe Ridge' survey area was included into the estimation of survey indices.

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 groundfish surveys is given in the Stock Annex. Figure 6.2.9 shows both a recruitment index and the trends in various biomass indices. Survey length distributions are shown in Figure 6.2.10 (abundance) and changes in spatial distribution in Figures 6.2.11 and 6.2.12.

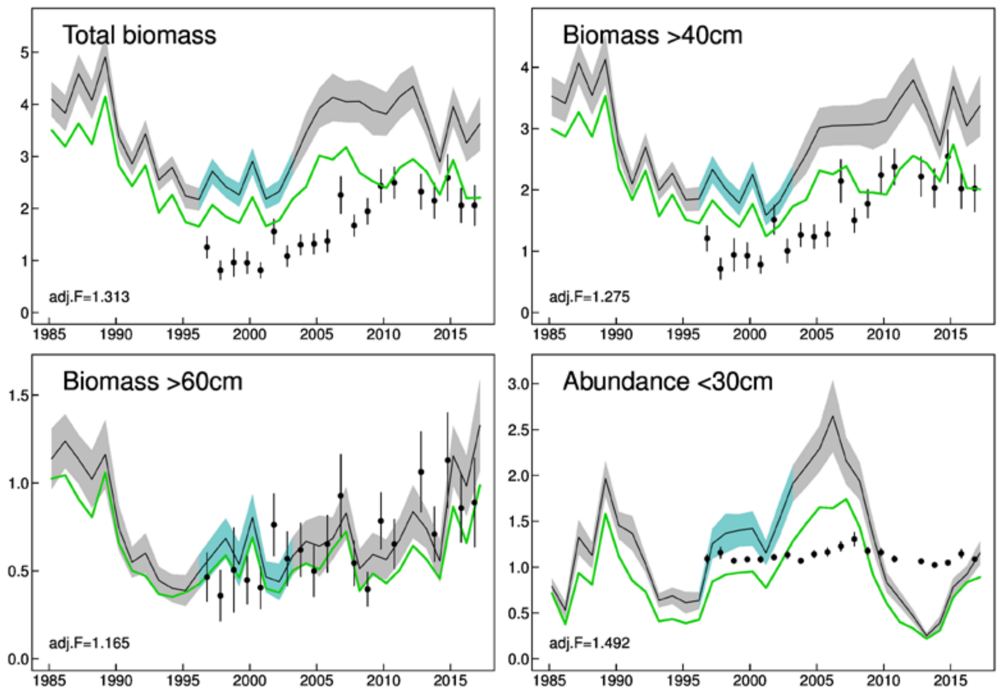


Figure 6.2.9. Tusk in 5.a and 14. Indices in the Spring Survey (March) 1985 and onwards (line shaded area) and the autumn survey (October) 1996 and onwards (No autumn survey in 2011). Green line is the index excluding the Faroe-Iceland Ridge.

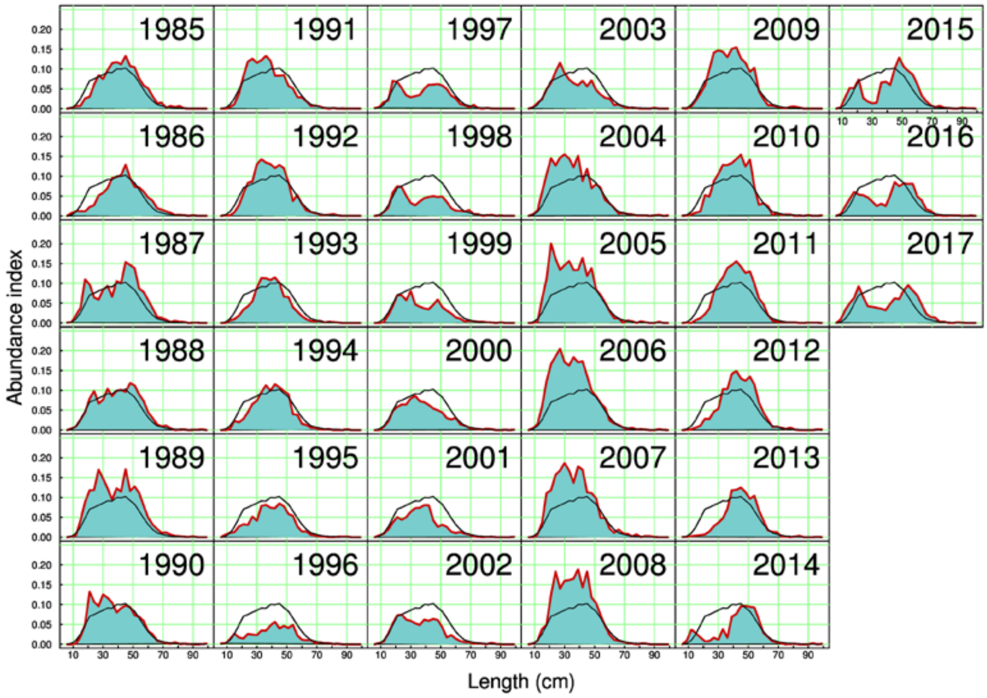


Figure 6.2.10. Tusk in 5.a and 14. Length disaggregated abundance indices from the spring survey (March) 1985 and onwards. Black line is the average over the whole period.

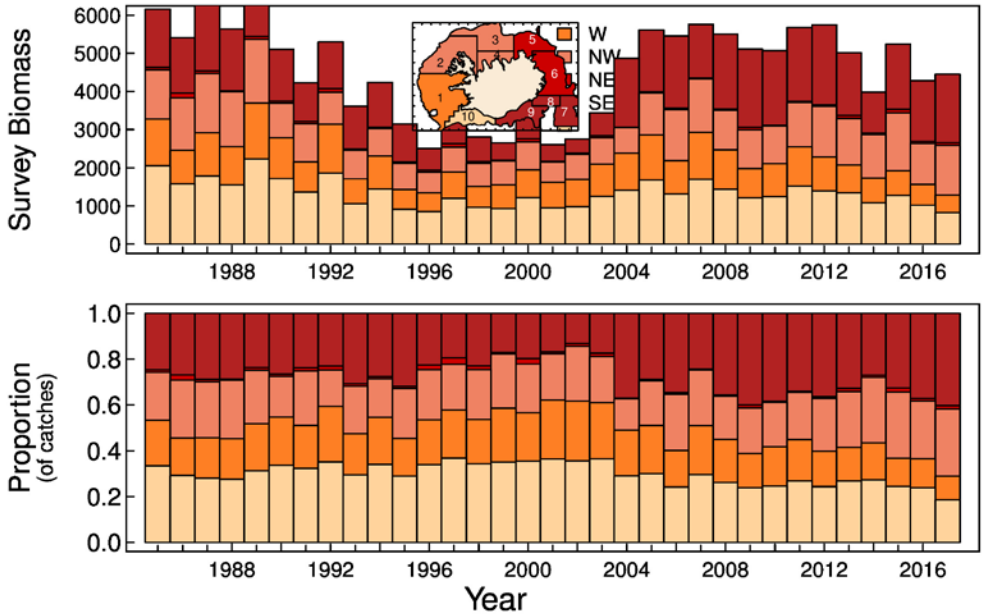


Figure 6.2.11. Tusk in 5.a and 14. Estimated survey biomass in the spring survey (March) by year from different parts of the continental shelf (upper panel) and as a proportion of the total (lower panel).

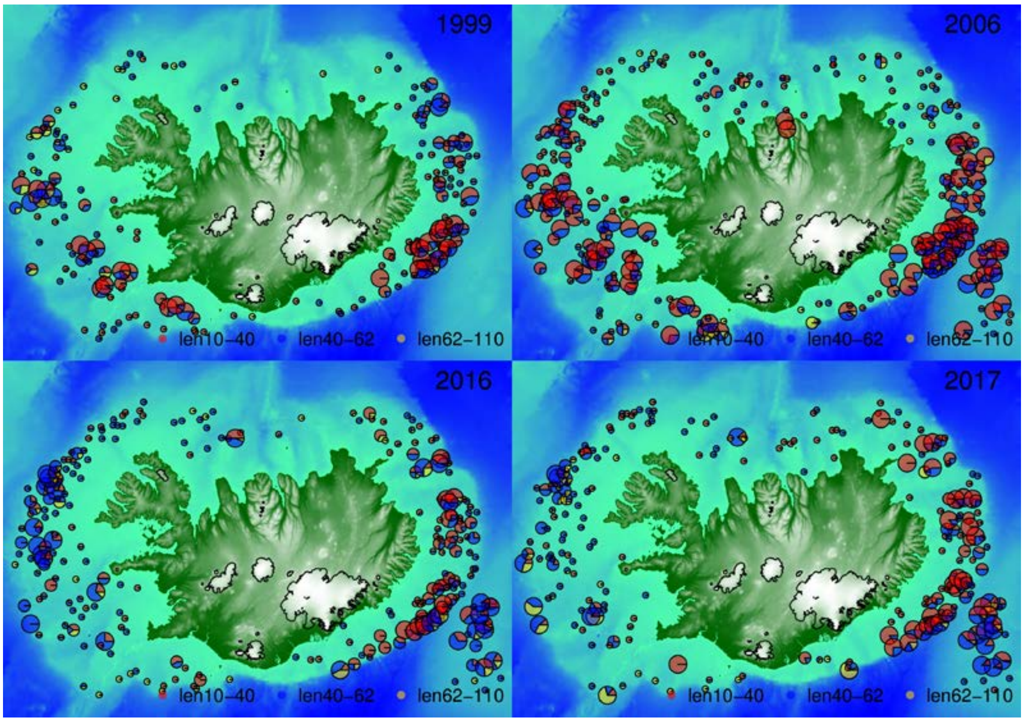


Figure 6.2.12. Tusk in 5.a and 14. Changes in spatial distribution divided by size. Size of pie is indicative of numbers of specimens caught at the tow-station.

German survey data (14)

Indices: The German groundfish survey was started in 1982 and is conducted in 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 minutes at 4.5 kn. (Ratz, 1999).

Data from the German survey in 14 were available at the meeting up to 2015. The trend in the German survey catches is similar to those observed in surveys in 5.a. It should however be noted that the data presented in Figure 6.2.12b is based on total number caught each year so it can't be used directly as an index from East Greenland. Length distributions from the survey in recent years are shown in Figure 6.2.12c.

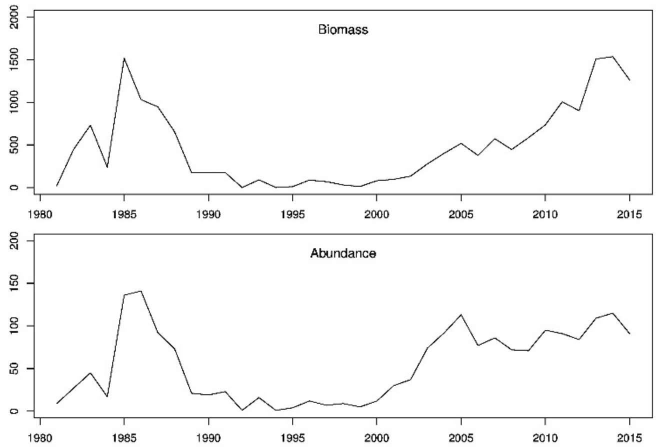


Figure 6.2.12b. Biomass and abundance estimates from the Walter Herwig survey in 14. The data are just the total number caught and then converted to weight.

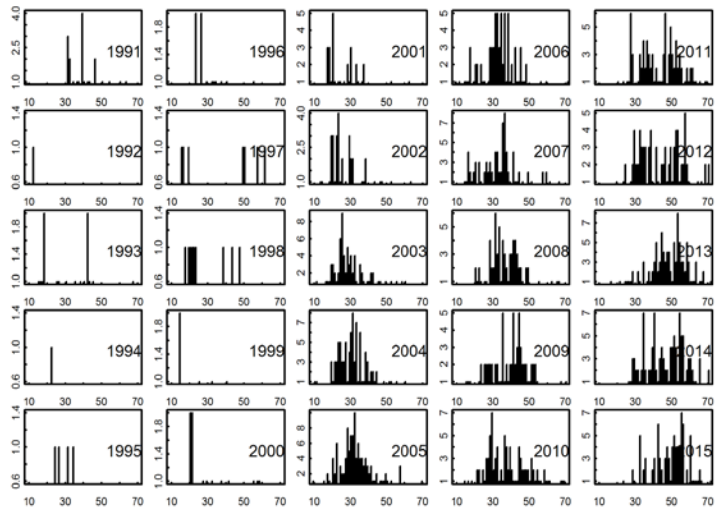


Figure 6.2.12c. Length distributions from the Walter Herwig survey in 14.

6.2.3 Data analyses

There have been no marked changes in the number of boats nor the composition of the fleet participating in the tusk fishery in 5.a (Table 6.2.1). Catches decreased from around 9000 tonnes in 2010 to 4800 tonnes in 2015. This decrease is mainly because of reductions in landings by the Icelandic longline fleet and to a lesser extend Faroese and Norwegian landings (Table 6.2.6). This has resulted in less overshoot of landings relative to set TAC (Table 6.2.2) but species conversions in the ITQ system show that other species were converted to tusk last year compared to tusk being converted to other species 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 6.2.6). According to the available length distributions and information on maturity only around 29% of catches in abundance and 44% in biomass are mature (Figures 6.2.6 and 6.2.7). 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 2015 appear similar as observed in 2010 (Figure 6.2.8). 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.

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 5.a. 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) has remained at similar level as in since 2011 at a relatively high level (Figure 6.2.9). 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) decreased by a factor of six between the 2005 survey when it peaked and the 2013 survey when it was at its lowest observed value. Since 2013 juvenile index has increased year on year in the 2014–2016 surveys. 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 6.2.11). 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 2015 can be clearly seen in Figures 6.2.11 and 6.2.12 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 5.a 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 5.a (See stock annex for details). As part of a Harvest Control Evaluation requested by Iceland this stock was benchmarked in 2017 (WKICEMSE 2017). Several changes were made to the model setup and settings which are described in the stock annex.

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 5.a are described in more detail in the stock annex.

Diagnostics

Observed and predicted proportions by fleets: Overall the fit of the predicted proportional length distributions is close to the observed distributions (Figures 6.2.12 and 6.2.13). In general for the commercial catch distributions the fit is better at the end of the time-series (Figure 6.2.12). The reason for this is there are few data at the beginning of the time-series and the model may be constrained by the initial values.

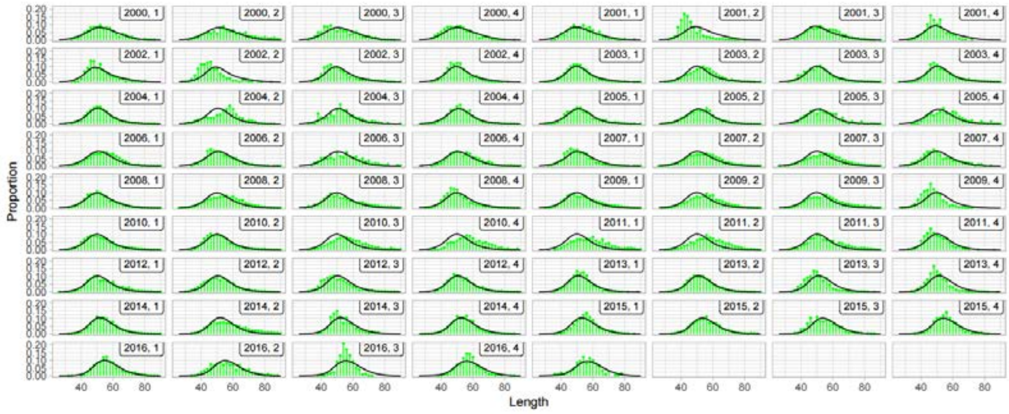


Figure 6.2.12. Tusk in 5.a and 14. Proportional fit (red line) to observed length distributions (points and blue bars) from commercial catches (longlines) by year and quarter from Gadget.

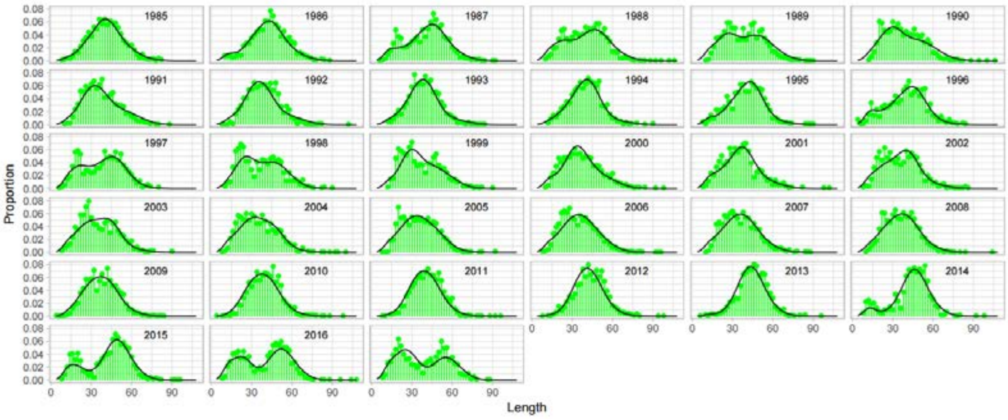


Figure 6.2.13. Tusk in 5.a and 14 Fit (red line) to observed length distributions (points and blue bars) from the Icelandic spring survey by year from Gadget.

Model fit: In Figure 6.2.14 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 (10–19, 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, however the model is predicting lower biomass than the survey indicates in the terminal year (Figure 6.2.14).

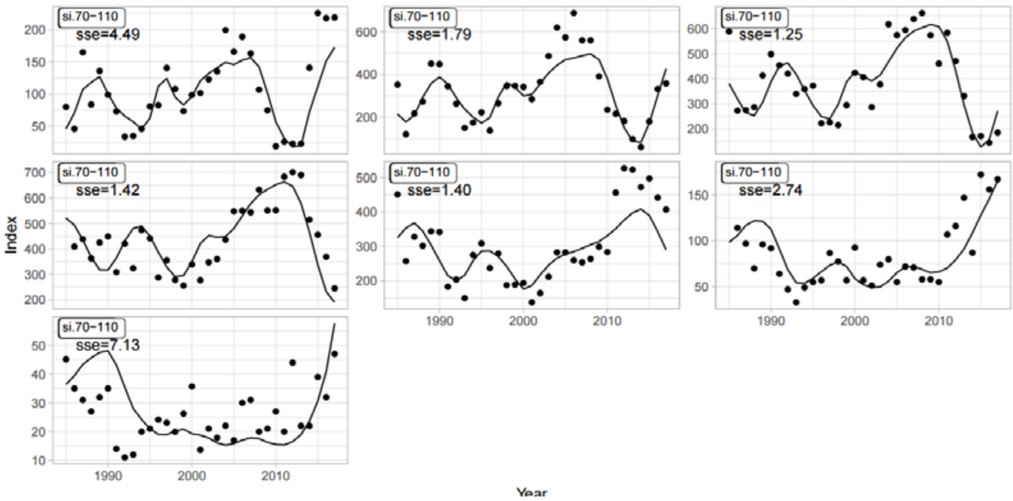


Figure 6.2.14. Tusk in 5.a and 14. Gadget fit to indices from disaggregated abundance by length indices from the spring survey.

Results

The results are presented in Table 6.2.8 and Figure 6.2.16. Recruitment peaked in 2005 to 2006 but has decreased and is estimated in 2013 to have been the lowest observed. Recruitment in 2014–2016 is estimated to be considerably higher than in 2013. 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. Harvest rate has decreased from 0.29 in 2008 to 0.12 in 2016. Estimates reference biomass (B40+) have been stable for the last three years.

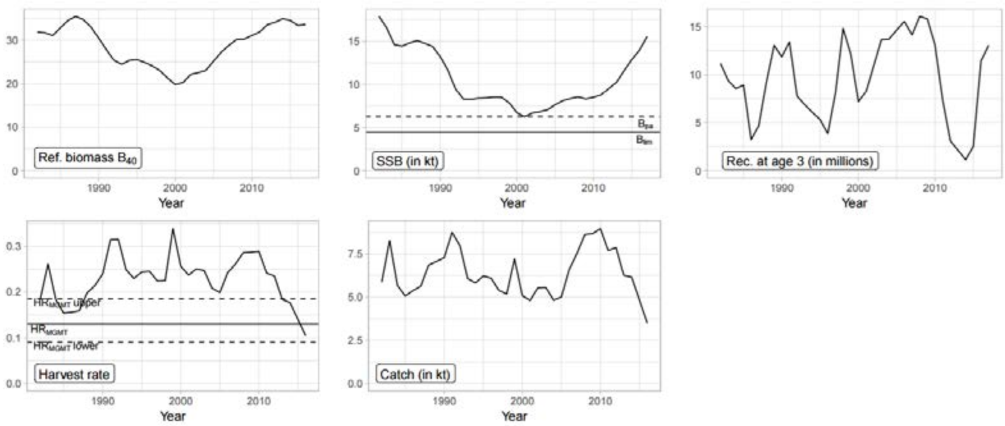


Figure 6.2.16. Tusk in 5.a and 14. Estimates of recruitment, biomass, harvestable biomass and fishing mortality for tusk for the age groups most important in the fishery i.e. ages 7 to 10 (solid line).

Reference points

In the past Yield-per-recruit based reference points estimated as described in the stock annex were used as proxies for F_{MSY}. F_{MAX} from a Y/R analysis is 0.24 and $F_{0.1}$ is 0.15.

WGDEEP 2014 recommended using F_{MSY}=0.2 as the target fishing mortality rather than F_{max}. This was subsequently used as the basis for the advice in 2014 by ICES. (See stock annex for details).

As part of the WKICEMSE 2017, HCR evaluations requested by Iceland the following reference points were defined for the stock.

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	6.24 kt	B_{pa}
	H_{msy}	0.17	The harvest rate that maximises the median long-term catch in stochastic simulations with recruitment drawn from a block bootstrap of historical recruitment scaled according to a hockey stick recruitment function with B_{lim} as defined below.
	F_{msy}	0.226	The median fishing mortality when an harvest rate of H_{msy} is applied.
	$H_{p.05}$	0.371	The harvest rate that has an annual probability of 5% of SSB $<$ B_lim.
	$F_{p.05}$	0.356	The median fishing mortality when an harvest rate of $H_{p.05}$ is applied.
Precautionary approach	B_{lim}	4.46 kt	$B_{pa}/e^{1.645\sigma}$ where $\sigma = 0.2$
	B_{pa}	6.24 kt	SSB(2001), corresponding to B_{loss}
	H_{lim}	0.27	H corresponding to 50% long-term probability of SSB $>$ B_{lim}
	F_{lim}	0.41	F corresponding to H_{lim}
	F_{pa}	0.27	$F_{lim}/e^{1.645\sigma}$ where $\sigma = 0.25$
	H_{pa}	0.20	H corresponding to F_{pa}
Management plan	H_{mp}	0.13	

The management plan proposed by Iceland is:

> The spawning–stock biomass trigger (MGT $B_{trigger}$) is defined as 6.24 kt, the reference biomass is defined as the biomass of tusk 40+ cm and the target harvest rate (HR_{MGT}) is set to 0.13. In the assessment year (Y) the TAC for the next fishing year (September 1 of year Y to August 31 of year Y+1) is calculated as follows:
>
> When SSB_Y is equal or above MGT $B_{trigger}$:
>
> $TAC_{Y/y+1} = HR_{MGT} * B_{Ref,y}$
>
> When SSB_Y is below MGT $B_{trigger}$:
>
> $TAC_{Y/y+1} = HR_{MGT} * (SSB_y / MGT\ B_{trigger}) * B_{ref,y}$

WKICEMSE 2017 concluded that the HCR was precautionary and in conformity with the ICES MSY approach.

6.2.4 Comments on the assessment

This assessment is conducted in a different manner than last year as the stock was benchmarked in 2017 as part of Harvest Control Rule evaluation request to ICES from Iceland.

WKICEMSE 2017 noted:

> "Catches of tusk in Greenland, within ICES Subarea 14, were discussed. Minor catches (representing <5% of the total catch of tusk in 5.a+14) have always occurred in the Greenland area and were never included in the stock assessment of tusk. However, these catches increased in 2015 and 2016, represent-

ing around 10%–15% of the total catches in those years. None of the work presented to WKICEMSE included these catches, which seem to occur well away from the area where the catches included in the stock assessment take place (i.e. in or around ICES Division 5.a). Information about these catches in the Greenland area is somewhat limited and no biological samples are available; doubts related to population structure, movement and connectivities were also noted during the discussion. It was then decided to conduct a stock assessment run incorporating those catches (just the tonnage), to gain understanding on their potential impact on stock assessment results. Their inclusion in the assessment resulted in minor revisions upwards of the estimated stock biomass (around 1%–4% revision, on average throughout the years in the stock assessment) and downwards of the estimated harvest rate (around 0%–3% revision, on average throughout the years in the stock assessment, although with an increase of the harvest rates estimated for 2015 and 2016); the results of this run are available at the end of Section 2.2. As there are some doubts in relation to these catch data and population structure of tusk in the area, WKICEMSE did not feel that a decision to include these catches in the stock assessment at this point was appropriate before conducting additional explorations and having a better understanding. It is recommended that appropriate stock experts in WGDEEP should explore this issue further."

This was discussed at WGDEEP-2017 and the following points were raised:

- Stock structure is generally unclear when it comes to deep-water stocks and many of the stock units assessed by WGDEEP are defined based on very limited scientific knowledge.
- The current advice units of tusk are not based on genetic studies except for tusk in Rockall and on the Mid Atlantic Ridge.
- The fishing areas for tusk in 5.a and 14 are widely separated (see Section 6.1). However survey data do show continuous distribution between Greenland, Iceland and the Faroe Islands.
- Genetic studies do not detect difference in tusk populations from the Barents Sea down to the Faroe Islands and over to Iceland and Greenland (Knutsen *et al*., 2009).
- Knutsen *et al*. (2009) proposed that the bathymetry over the NE-Atlantic could form a "bridge" between Norway and Greenland. However they point out that tusk are not believed make extensive migrations and actually to be a sedentary species. Larval dispersal could account for the lack of genetic difference in tusk.
- It is highly plausible that the increased abundance of tusk seen in the Walter Herwig survey is of Icelandic origin that might have been dispersed as larvae to Greenland, similar as has been reported for cod in 5.a. However unlike cod it is unlikely that tusk would migrate back to Iceland.
- The tusk population in Greenland is likely to be a "sink" from the Icelandic population and as such should not affect the productivity of tusk in Iceland.

Based on this WGDEEP 2017 concludes that the catches in 14 should not be included in the assessment of tusk in 5.a. Additionally the EG concludes that the division of tusk into different advice units should be reviewed, not only in 5.a and 14 but for all the tusk stocks.

6.2.5 Management considerations

Increased catches in 14.b from less than 100 tonnes in previous year to 980 tonnes in 2015, and about 500 tonnes in 2016 are of concern (See Section 6.2.4).

The signs from commercial catch data and surveys indicate that the total biomass of tusk in 5.a is stable. This is confirmed in the Gadget assessment. Recruitment in 5.a is on the increase again after a low in 2013. However due to reduction in fishing mortality harvestable biomass and SSB seem to be either stable or slowly increasing.

Due to the selectivity of the longline fleet catching tusk in 5.a 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 5.a as observed in the Icelandic spring survey may result in decreased catch rates and local depletions of tusk in the main fishing areas.

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.

Table 6.2.6. Tusk in 5.a and 14. Nominal landings by nations in 5.a.

Year	Faroe	Denmark	Germany	Iceland	Norway	UK	Total
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
2014	728	0	0	4995	306	0	6029
2015	625	0	0	4000	198	0	4823
2016	543	0	0	2649	302	0	3494

Table 6.2.7. Tusk in 5.a and 14. Nominal landings by nations in 14.

YEAR	FAROE	DENMARK	GREENLAND	GERMANY	ICELAND	NORWAY	RUSSIA	SPAIN	UK	TOTAL
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

Year	Faroe	Denmark	Greenland	Germany	Iceland	Norway	Russia	Spain	UK	Total
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
2014	2	0	0	0	0	26	0	0	0	28
2015	670	0,1	166	0	0	62	0	0	0	898
2016	111	0	182	0	0	178	0	0	0	471

Table 6.2.8. Tusk in 5.a and 14. Estimates of biomass, biomass 40+ cm, spawning–stock biomass (SSB) in thousands of tonnes and recruitment (millions), harvest rate (HR) and fishing mortality from Gadget.

Year	Biomass	B40+	SSB	Rec3	Catch	HR	F
1982	40.44	31.71	18.06	11.54	5.88	0.18	0.25
1983	41.38	32.45	17.38	12.07	8.29	0.26	0.37
1984	39.78	31.14	15.01	4.34	5.69	0.18	0.26
1985	40.32	32.74	14.67	6.31	5.06	0.15	0.21
1986	41.08	34.72	15.09	12.50	5.38	0.15	0.21
1987	41.27	35.71	15.25	17.63	5.64	0.16	0.21
1988	41.15	35.65	15.15	16.04	6.86	0.20	0.26
1989	39.83	33.58	14.63	18.12	7.08	0.22	0.28
1990	38.59	31.00	13.56	10.45	7.30	0.24	0.31
1991	37.23	28.64	12.25	9.23	8.76	0.32	0.43
1992	34.45	25.66	9.85	8.14	8.00	0.31	0.46
1993	32.34	24.18	8.39	7.16	6.07	0.25	0.38
1994	31.93	24.86	8.13	5.17	5.83	0.23	0.35
1995	31.39	25.48	8.35	10.86	6.23	0.24	0.37
1996	30.18	25.02	8.41	20.00	6.10	0.25	0.36
1997	29.19	23.92	8.35	16.41	5.40	0.23	0.32
1998	29.07	22.91	8.38	9.69	5.17	0.23	0.31
1999	29.28	21.97	8.15	11.11	7.23	0.34	0.49
2000	27.58	19.53	6.73	14.77	5.08	0.26	0.38
2001	28.28	20.15	6.30	18.43	4.81	0.23	0.36
2002	29.69	21.60	6.50	18.51	5.55	0.25	0.40
2003	30.76	22.33	6.74	19.81	5.57	0.25	0.39
2004	32.27	22.99	7.02	20.99	4.82	0.20	0.31
2005	35.08	24.79	7.52	19.11	5.01	0.20	0.30
2006	38.21	27.13	8.10	21.71	6.60	0.24	0.37
2007	40.25	28.60	8.33	21.34	7.54	0.26	0.41
2008	41.73	29.70	8.40	17.69	8.63	0.29	0.47
2009	42.28	30.13	8.27	9.89	8.68	0.29	0.47
2010	42.49	30.74	8.37	4.17	8.98	0.29	0.48
2011	41.76	31.26	8.54	2.87	7.70	0.24	0.39
2012	41.44	32.98	9.24	1.50	7.87	0.24	0.37
2013	39.89	33.83	9.96	3.42	6.26	0.18	0.28
2014	38.90	34.89	11.31	15.44	6.16	0.18	0.25
2015	37.53	34.37	12.49	17.63	4.84	0.14	0.19
2016	37.33	33.63	13.77	23.91	3.49	0.10	0.13
2017	38.90	33.28	15.16	24.58	4.44		

6.3 Tusk (*Brosme brosme*) on the Mid-Atlantic Ridge (Subdivisions 12.a1 and 14.b1)

6.3.1 The fishery

Tusk is a bycatch species in the gillnet and longline fisheries in Subdivisions 12.a1 and 14.b1. 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 1988–2016 are shown in Table 6.3.1.

The reported landings are generally very low in these areas. Russia reported some 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 14.b1 and the Faroe Islands, 1 tonne No landings have been reported in 2013, 2014 and 2016, while in 2015 Greenland reported 2 tonnes.

6.3.3 ICES Advice

Advice for 2016 to 2017: ICES advises on the basis of the precautionary approach that catches should not be increased unless there is evidence that it 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 percent of the highest effort 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.

6.3.6.1 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.

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 6.3.1. Tusk 12. WG estimate of landings.

Tusk 12

Year	Faroes	France	Iceland	Norway	Scotland	Russia	Total
1988		1					1
1989		1					1
1990		0					0
1991							0
1992							0
1993	29	1	+				30
1994	27	1	+				28
1995	12	-	10				18
1996	7	-	9	142			158
1997	11	-	+	19			30
1998				-			1
1999				+	1		1
2000				5	+		5
2001		1		51	+		52
2002				27			27
2003				83			83
2004		2		7		5	14
2005	2	1					3
2006						64	64
2007						19	19
2008						0	0
2009						2	2
2010							0
2011							0
2012	1						1
2013							0
2014							0
2015							0
2016*							0

***Preliminary.**

TUSK 14.b1

Year	Faroes	Iceland	Norway	E & W	Russia	GREENLAND	Total
2012			17				**17**
2013							**0**
2014							**0**
2015						**2**	**2**
2016*							**0**

Table 6.3.1. (Continued).Tusk, total landings by subareas or division.

Year	12	14.b1	All areas
1988	1		1
1989	1		1
1990	0		0
1991	0		0
1992	0		0
1993	30		30
1994	28		28
1995	18		18
1996	158		158
1997	30		30
1998	1		1
1999	1		1
2000	5		5
2001	52		52
2002	27		27
2003	83		83
2004	14		14
2005	3		3
2006	64		64
2007	19		19
2008	0		0
2009	2		2
2010	0		0
2011	0		0
2012	1	17	18
2013	0		0
2014	0		0
2015	0	2	2
2016*	0		0

***Preliminary.**

6.4 Tusk (*Brosme brosme*) in 6.b

6.4.1 The fishery

Tusk is a bycatch species in the trawl, gillnet and longline fisheries in Subarea 6.b. 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. The areas closed are traditional areas fished by the Norwegian longline fleet.

During the period 1988 to 2014 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 6.b by trawlers in the haddock fishery.

6.4.2 Landings trends

Landing statistics by nation in the period 1988–2016 are in Table 6.4.1.

Landings varied considerably between 1988 and 2000 and peaked at 2344 t in 2000, and since then have been low with a declining trend. In 2014 the catch was 38 tons, an all-time low during this time period, while in 2015 the total catch increased to 226 tons but in 2016 the landings decreased to 90 tons (Figure 6.4.1).

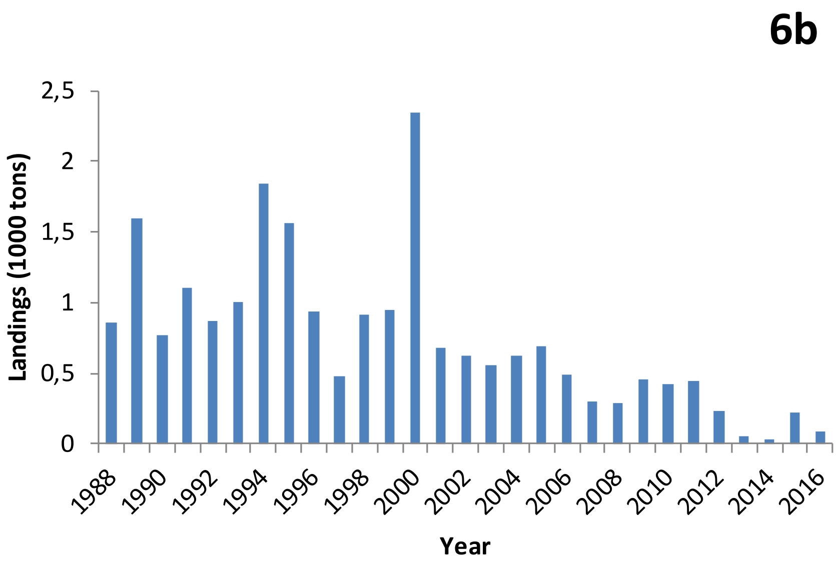


Figure 6.4.1.The international total landings of tusk from Subarea 6.b.

6.4.3 ICES Advice

Advice for 2017 to 2018: ICES advises that when the precautionary approach is applied, catches should be no more than 350 tonnes in each of the years 2017 and 2018. All catches are assumed to be landed.

6.4.4 Management

Apart from the closed areas, there are no management measures that apply exclusively to 6.b.

Norway, which also has a licensing scheme, had a catch allocation in EU waters (Subareas 5, 6 and 8). In 2017 the Norwegian quota in the EU zone is 2923 t (up to 2000 t are interchangeable with ling quota).

EU TACs cover Subarea 5, 6, 7 (EU and international waters) and in 2017 is set at 937 t.

NEAFC recommended in 2009 that the effort in the NEAFC regulatory area shall not exceed 65 percent of the highest effort level of the deep fishing in previous years.

6.4.5 Data available

6.4.5.1 Landings and discards

Landings were available for all relevant countries. UK (Scotland) reported 7 tons discarded tusk.

6.4.5.2 Length compositions

The length distributions of tusk based on data provided by the Norwegian reference fleet for the period 2002–2016 are presented in Figures 6.4.2 and 6.4.3. The average length during this period fluctuated without any obvious trends (no data were available for 2004, 2011 and 2014).

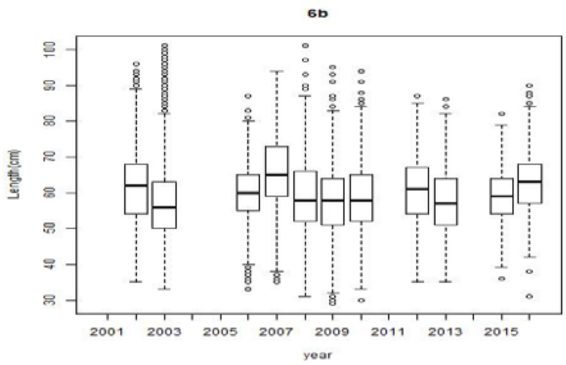


Figure 6.4.2. The length distribution of tusk based on data provided by the Norwegian reference fleet for the period 2002–2016 (no data were available for 2004, 2011 and 2014).

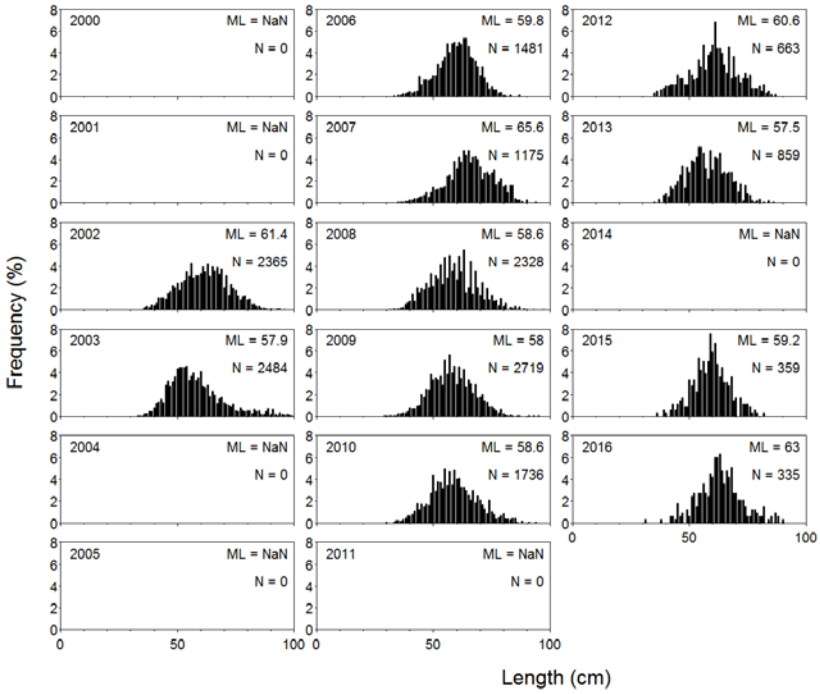


Figure 6.4.3. The length distribution of tusk based on data provided by the Norwegian reference fleet for the period 2002–2016 (no data were available for 2004, 2005, 2011 and 2014).

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 collecting and entering data from official logbooks into an electronic database, and data are now available for the period 2000–2016. 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 longliner data (see Helle and Pennington, WD 2016). The number of long-liners has declined from 72 to 25 during the period 2000–2016. The number of fishing days with a tusk catch in Division 6.b has remained very stable in the period 2000–2008 with an average between five and eight days per vessel, (Helle and Pennington, WD 2017).

Table 6.4.2. Average number of days that each Norwegian longliner fished in an ICES subarea/division.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Days	4	6	8	5	5	8	7	6	5	2	4	4	4	3	3	5	5

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 6.b (Figure 6.5.4) 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 has increased slightly compared to the period 2000–2008 (Figure 6.4.4).

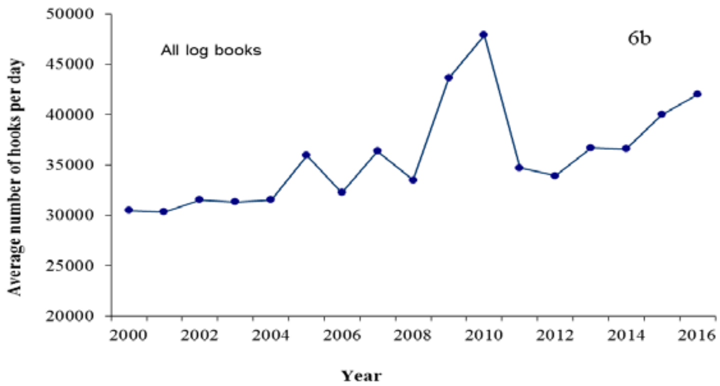
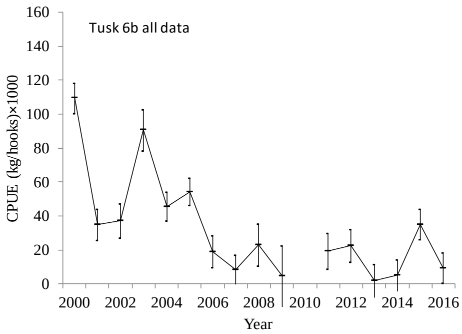


Figure 6.4.4. Average number of hooks the Norwegian longliner fleet used per day in each of the ICES Subarea 6.b for the years 2000–2016 in the fishery for tusk, ling and blue ling.

When using all available data thee standardized cpue series shows a declining trend during the period 2000–2007, after 2007 cpue has been at a stable but low level. When only data from the targeted fishery are, used the cpue appears to be stable, atlthough there were no new data in 2016 (Figure 6.4.5).



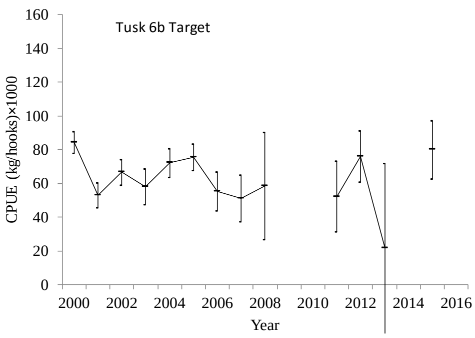


Figure 6.4.5. Estimated cpue (kg/1000 hooks) series for tusk in Subarea 6.b based on skipper's logbooks (during the period 2000–2016). The bars denote the 95% confidence intervals.

6.4.6.1 Biological reference points

See Section 6.4.9.

6.4.7 Management considerations

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 since 2001 have been low with a decreasing trend. The landings were especially low in 2013 and 2014. During these two years the fishing activities were also very low with an average fishing activity of two days per longliner. In 2015 the average number of fishing days increased to five and the total landings increased considerable compared to the previous two years. When all available data are combined, the cpue also show a decreasing trend until 2007 after this it has been at a stable but low level. The cpue series for the targeted fishery for tusk shows a stable level.

The main fishing grounds traditionally exploited by the Norwegian fleet in 6.b were closed to bottom contacting gears in 2007 and this may have influenced recent estimates of cpue.

As always, it should be emphasized that commercial catch data are typically observational data; that is, there were no scientific controls on how or from where the data were collected. Therefore, it is not known with certainty if the tusk cpue series tracks the population and/or how accurate the measures of uncertainty associated with the series are (see, for example, Rosenbaum, 2002). Consequently, one must usually hope and pray that a cpue series, which is based only on commercial catch data, truly tracks abundance.

An infamous example of a misleading cpue series based on commercial data was a cpue series for Newfoundland cod that incorrectly indicated that the abundance of the cod stock was increasing greatly. Advice based on this cpue series ultimately caused the collapse of the stock (see, e.g. Pennington and Strømme, 1998).

In general, any assessment method based only on commercial catch data needs to be applied with caution. The reason that assessments using only commercial data are problematic is because the relation between the commercial catch and the actual population is normally unknown and probably varies from year to year.

6.4.9 Application of MSY proxy reference points

Length-based indicator method (LBI)

The input parameters and the length distribution of the catch for some years in the period 2002–2016 are presented in the following tables and figures. The length data used in the LBI model are from the Norwegian longline fleet. The length data are not raised to total catch.

Input parameters for theLBI model

Data type	Source	Years/Value	Notes
Length–frequency distribution	Norwegian long-liners (Reference fleet)	2002–2003, 2006–2010, 2012–2013, 2015–2016	
Length–weight relation	Norwegian longliners (Reference fleet) and survey data.	0.0212* length 2.8515	
L_{MAT}	Faroese survey data	50 cm	Combined sexes
L_{inf}	Norwegian longliners (Reference fleet).	101 cm (L_{max})	

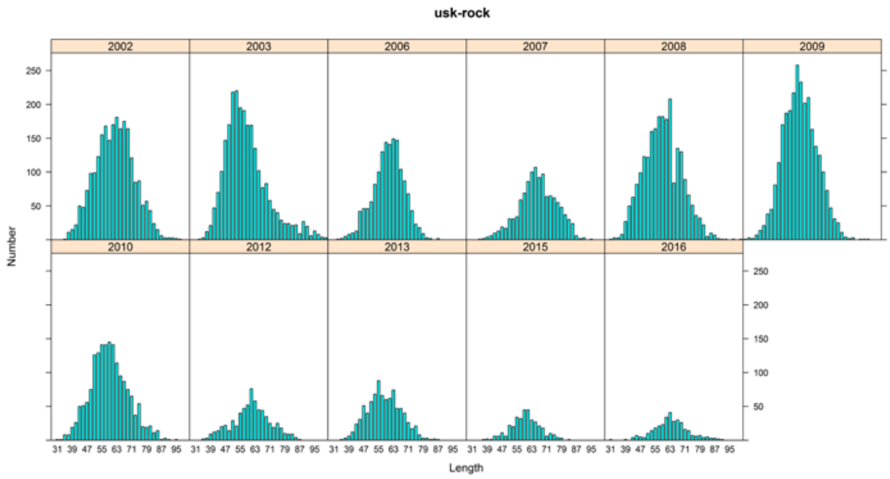
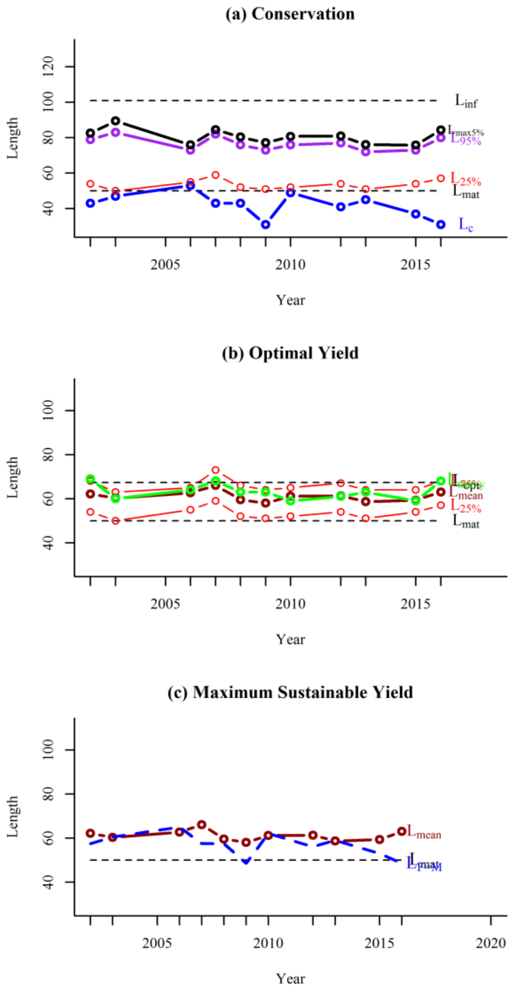


Figure 6.4.6. Tusk on Rockall (6.b). Length distributions of the catches for the period 2001–2016 using 2 cm length bins (sexes combined).

Outputs

Screening of length indicators ratios for combined sexes under three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield are presented in the figures below.


(a) Conservation
Length
Year
Linf
Lmax5%
L95%
L25%
Lmat
Lc
(b) Optimal Yield
Length
Year
Lopt
Lmean
L25%
Lmat
(c) Maximum Sustainable Yield
Length
Year
Lmean
Lmat
LF=M

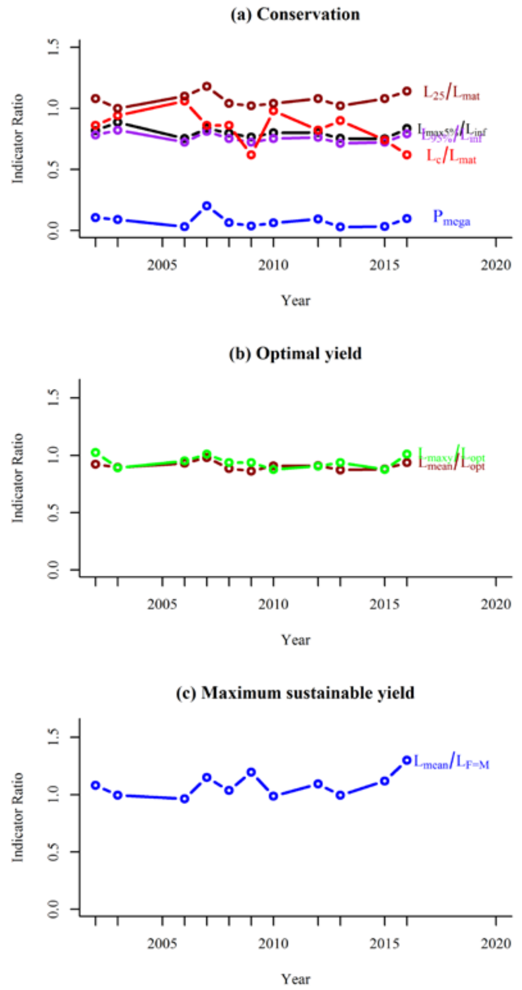


Figure 6.4.7. Tusk on Rockall (6.b). Screening of length indicators ratios for sexes combined under three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

Analysis of results

The conservation model for immature tusk shows that L_c/L_{mat} is usually less than 1 and $L_{25\%}/L_{mat}$ is greater than 1 (Figure 6.2). During the period 2014–2016, $L_{25\%}/L_{mat}$ was greater than 1 (Table 6.2). Therefore, it seems as if there was no overfishing of immature tusk. The data used to calculate L_{mat} are from Division 5.b, and therefore it may not be appropriate for Rockall.

The conservation model for large tusk shows that the indicator ratio of $L_{max5\%}/L_{inf}$ is around 0.75 for the entire period (Figure 5.2), and between 0.75 and 0.84 in 2014–2016 (Table 6.2). Since the VBF results produced an unusual small L_{inf}, the value used in the model was L_{MAX}. This could be the reason that the indicator ratio was less than 0.8 in some years. If we would have used a smaller Linf value, then the indicator ratio would be larger. Since tusk is a deep-water and a slow growing species, the P_{mega} and L_{mean}/L_{opt} values are not realistic.

The MSY indicator ($L_{mean}/L_{F=M}$) is around 1 for almost the entire period (Figure 6.2), which indicates that tusk on Rockall are fished sustainably. It should be noted that L_{inf}.is set equal to L_{MAX} in the model, which may be the reason that the MSY.is usually varying around 1, but is higher than 1 in 2015 and 2016.

The final results from the LBI method.

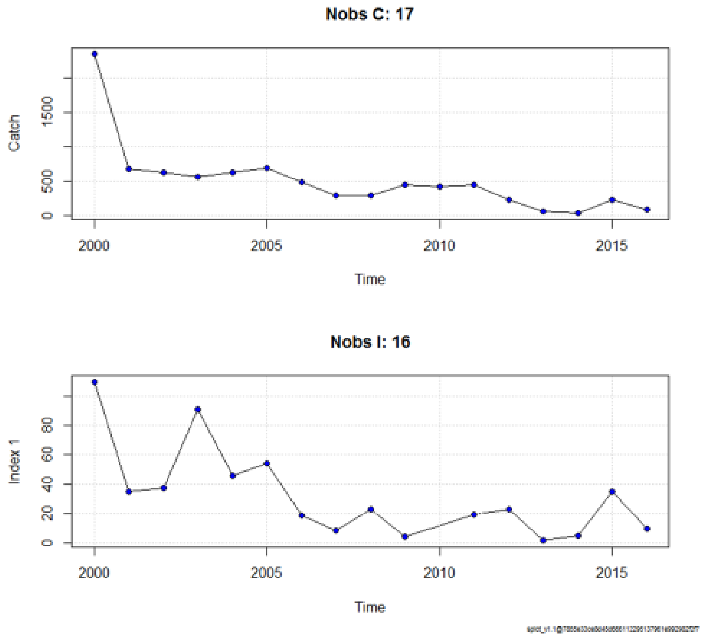
	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2013	0.90	1.02	0.75	3%	0.87	0.99
2015	0.74	1.08	0.75	3%	0.88	1.12
2016	0.62	1.14	0.84	10%	0.94	1.30

Conclusions

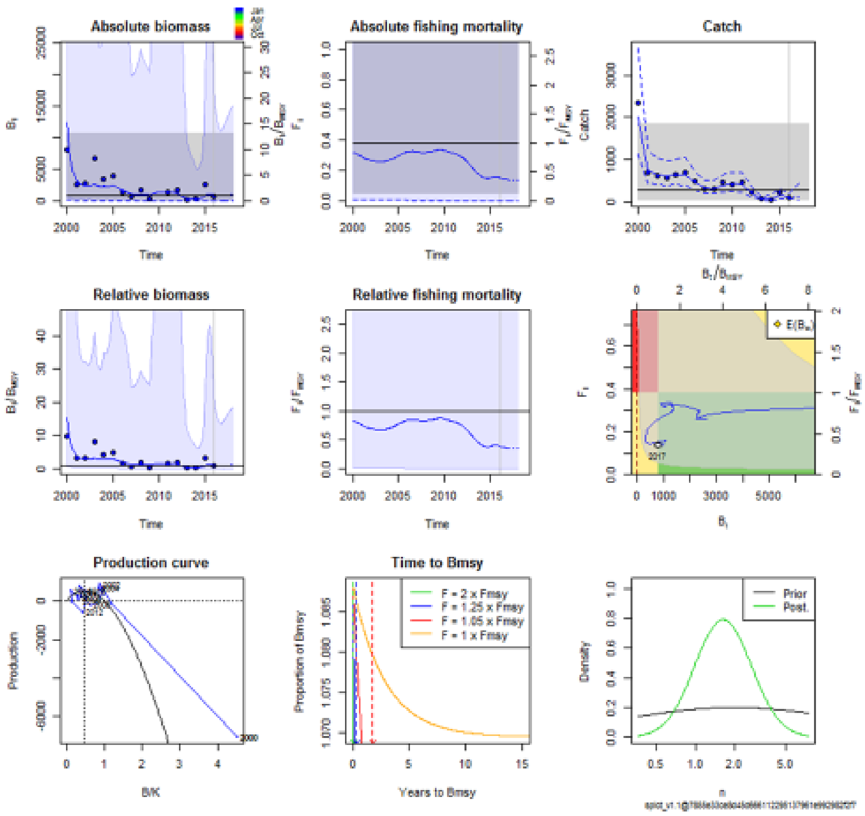
The overall perception of the stock during the period 2015–2016 is that tusk on Rockall seem to be in good shape, specifically the tusk stock is fished sustainably and the stock is not fished greater than the length-based indicator of MSY. However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

SPiCT

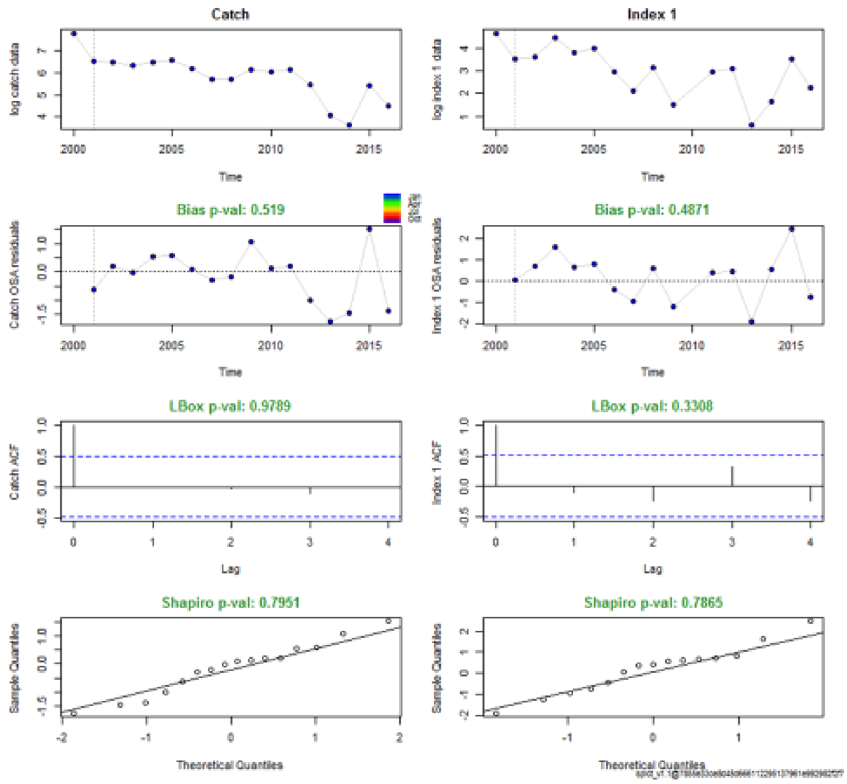
The SPiCT model was run on the cpue and catch data for tusk in 6.b using the default settings. Due to time constrains various model settings were not tested and further work is needed before it can be concluded whether or not SPiCT is appropriate method for this stock.

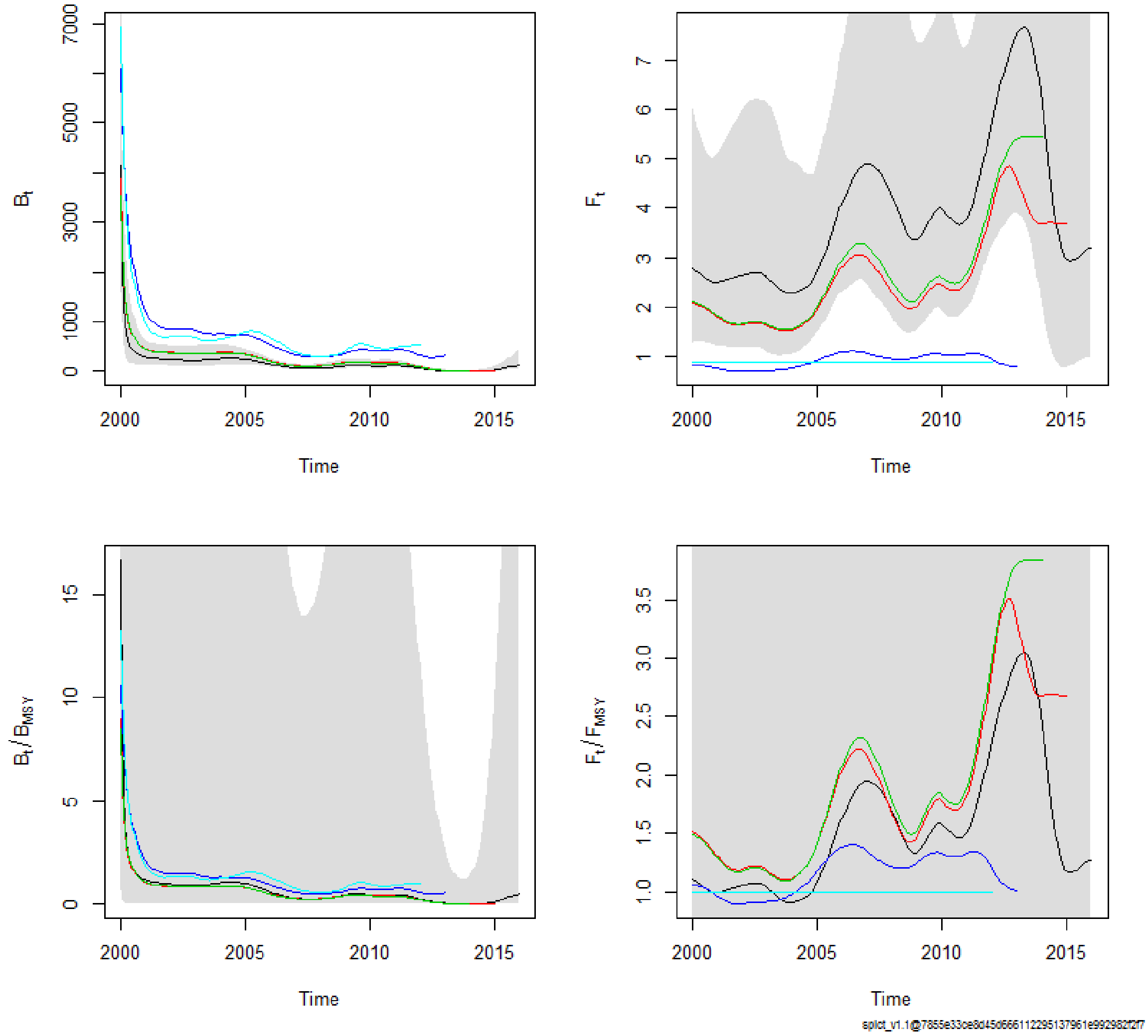


Nobs C: 17
Catch
Time
Nobs I: 16
Index 1
Time

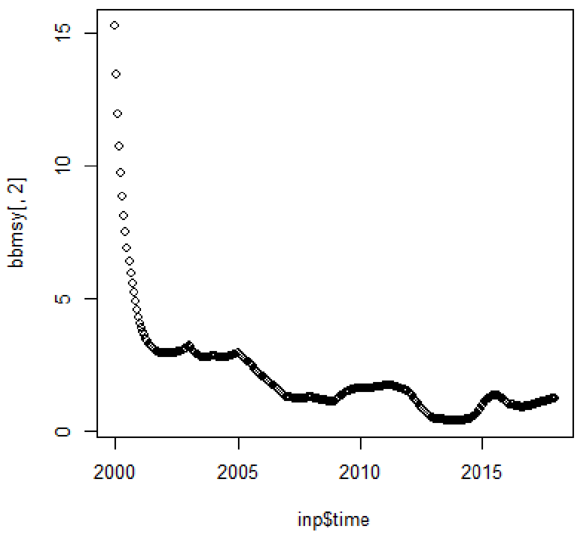


Absolute biomass
Absolute fishing mortality
Catch
Relative biomass
Relative fishing mortality
Production curve
Time to Bmsy
F = 2 x Fmsy
F = 1.25 x Fmsy
F = 1.05 x Fmsy
F = 1 x Fmsy
Years to Bmsy
Proportion of Bmsy
Production
B/K
Density
Prior
Post.
Time


Catch
Index 1
log catch data
log index 1 data
Time
Bias p-val: 0.519
Bias p-val: 0.4871
Catch OSA residuals
Index 1 OSA residuals
LBox p-val: 0.9789
LBox p-val: 0.3308
Catch ACF
Index 1 ACF
Lag
Shapiro p-val: 0.7951
Shapiro p-val: 0.7865
Sample Quantiles
Theoretical Quantiles



B_t
F_t
B_t/B_MSY
F_t/F_MSY
Time



bbmsy[, 2]
inp$time

Table 6.4.1. Tusk 6.b. 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				46			11		57
2014	6					26			6		38
2015	1					218	7		7		226
2016*				1		80			9		90

***Preliminary.**

Table 6.4.1. (Continued).

Tusk, total landings in Subarea 6.b.

Year	6.b	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
2014	38	38
2015	226	226
2016	90	90

***Preliminary.**

6.5 Tusk (*Brosme brosme*) in Subareas 1 and 2

6.5.1 The fishery

Tusk is caught primarily as a bycatch in the ling and cod fisheries in Subareas 1 and 2. Currently the major fisheries in Subareas 1 and 2 are the Norwegian longline and gillnet fisheries, but there are also bycatches by other gears, e.g. trawls and handlines. The total Norwegian landings are composed of usually around 85% from longlines, 10% from gillnets and the remainder by a variety of other gears. Other nations catch tusk as a bycatch in trawl and longline fisheries. Figure 6.5.1 shows the spatial distribution of the total catch by the Norwegian longline fishery in 2013 to 2016. The

Norwegian longline fleet (vessels larger than 21 m) increased from 36 in 1977 to a peak of 72 in 2000, and afterwards the number decreased to 25 in 2015 and 2016. The number of vessels declined mainly because of changes in the law concerning the quotas for cod. The average number of days that the longliners operated in ICES Subareas I and II has declined since the peak in 2011. During the period 1974 to 2016 the total number of hooks per year has varied considerably, but with a downward trend since 2002 (For more information see Helle and Pennington, WD 2017).

Since the total number of hooks per year takes into account; the number of vessels, the number of hooks per day, and the number of days each vessel participated in the fishery, it follows that it may be a suitable measure of changes in applied effort. Based on this gauge, it appears that the average effort for the years 2011–2016 is 43% less than the average effort during the years 2000–2003.

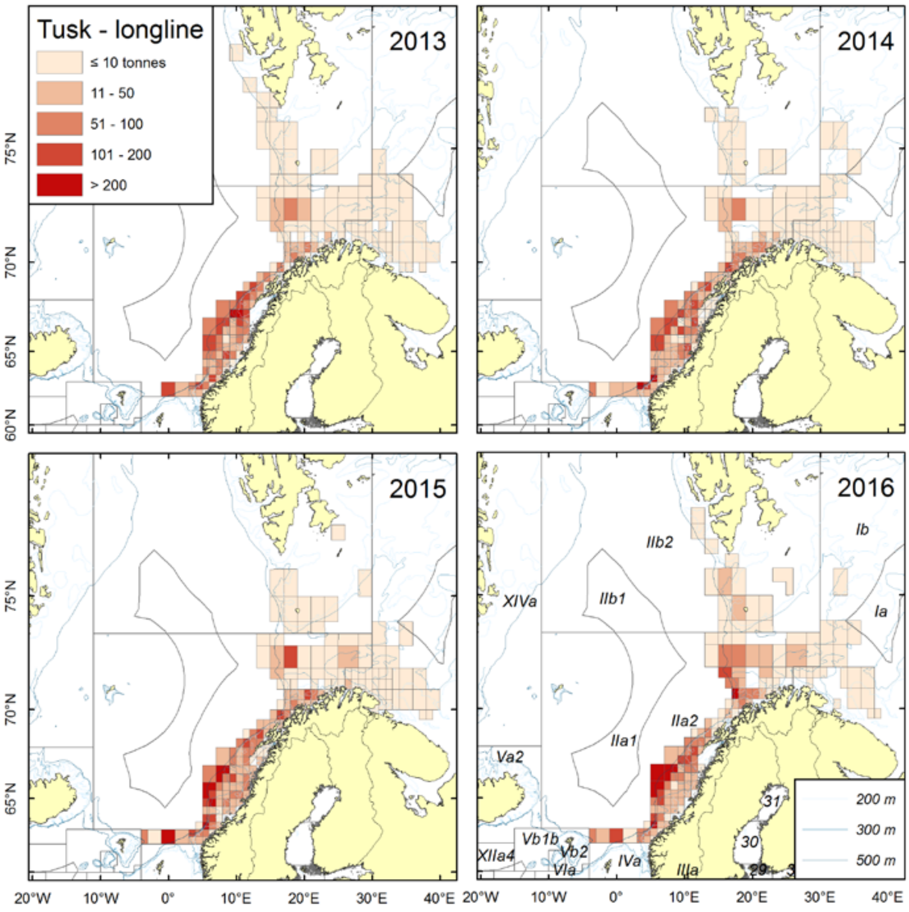


Figure 6. 5.1. Distribution of catches for the Norwegian longline fishery in 2013 to 2016.

6.5.2 Landings trends

Landing statistics by nation in the period 1988–2016 are given in Table 6.5.1a–d. Landings declined from 1989 to 2005, afterwards the landings increased (Figures 6.5.2 and 6.5.3). The preliminary landings for 2016are 11 659 t.

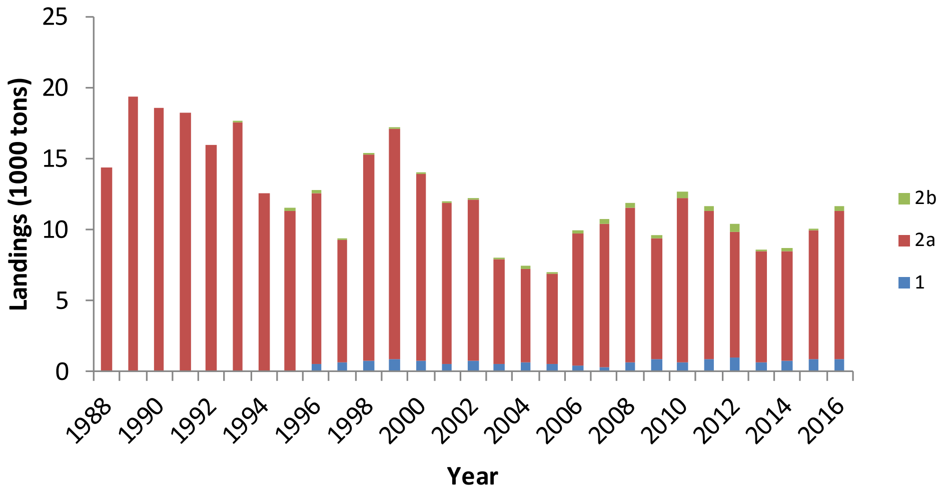


Figure 6.5.2. Total yearly landings of tusk in Areas 1 and 2 for the period 1988–2016.

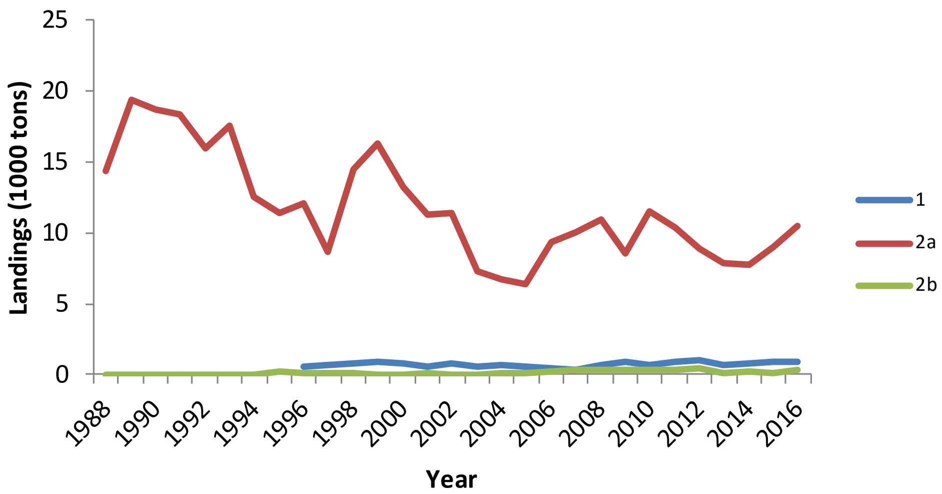


Figure 6.5.3. Total yearly landings of tusk in Areas 1 and 2 in each area for the period 1988–2016.

6.5.3 ICES Advice

Advice for 2016 to 2017: ICES advises that when the precautionary approach is applied, catches should be no more than 9492 tonnes in each of the years 2016 and 2017. All catches are assumed to be landed.

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 1 and 2 are required to have a licence for tusk. 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 1, 2 and 14) was set to 21 t in 2017.

6.5.5 Data available

6.5.5.1 Landings and discards

The amounts landed were available for all the relevant fleets. 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. Germany reported 2 tons of discarded tusk. The landings statistics are regarded as being adequate for assessment purposes.

6.5.5.2 Length compositions

Figures 6.5.4 and 6.5.5 show the length distribution and Figure 6.5.6 shows the length–weight relationship for tusk based on data provided by the Norwegian reference fleet for the period 2001–2016.

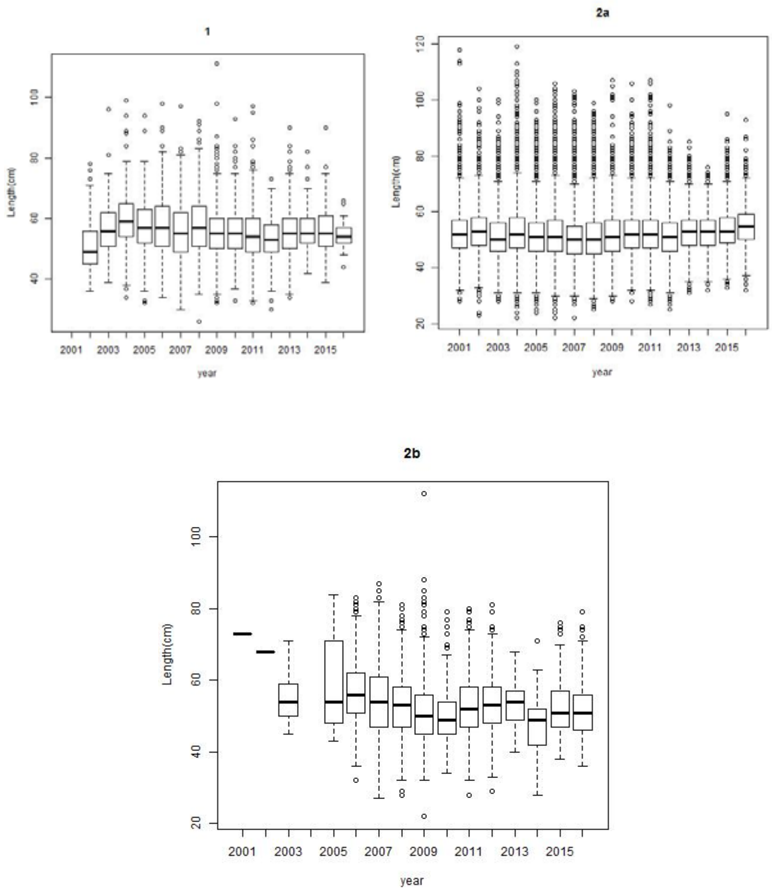


Figure 6.5.4. Box and whisker plots showing the length distribution of tusk. The data were provided by the Norwegian reference fleet for the period 2001–2016.

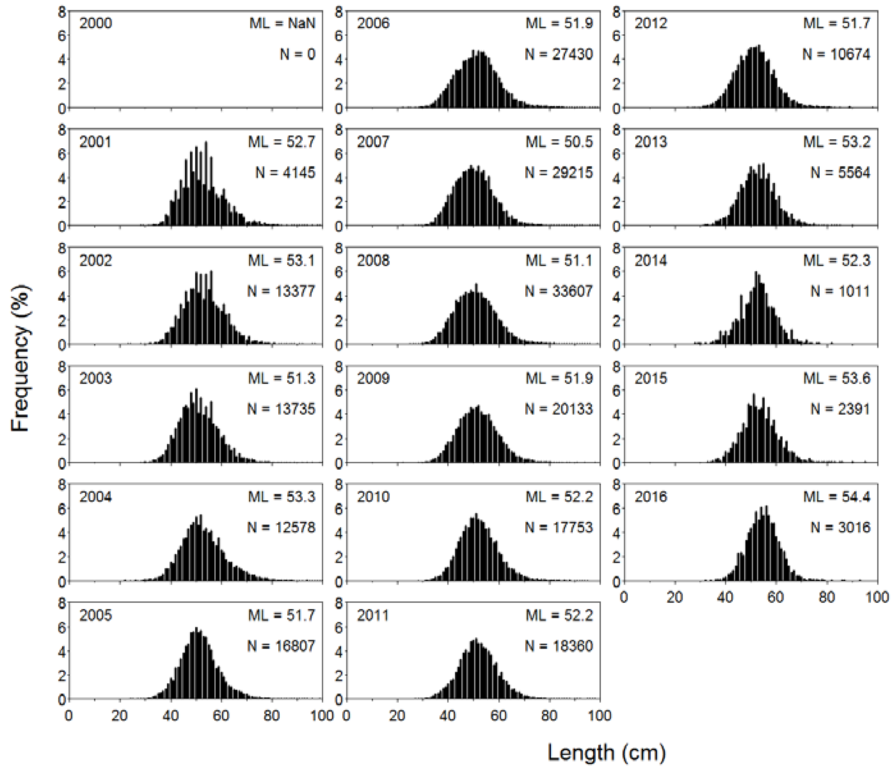


Figure 6.5.5. The estimated length distributions of the catch of tusk by Norwegian longliners combined for the areas 1, 2.a and 2.b.

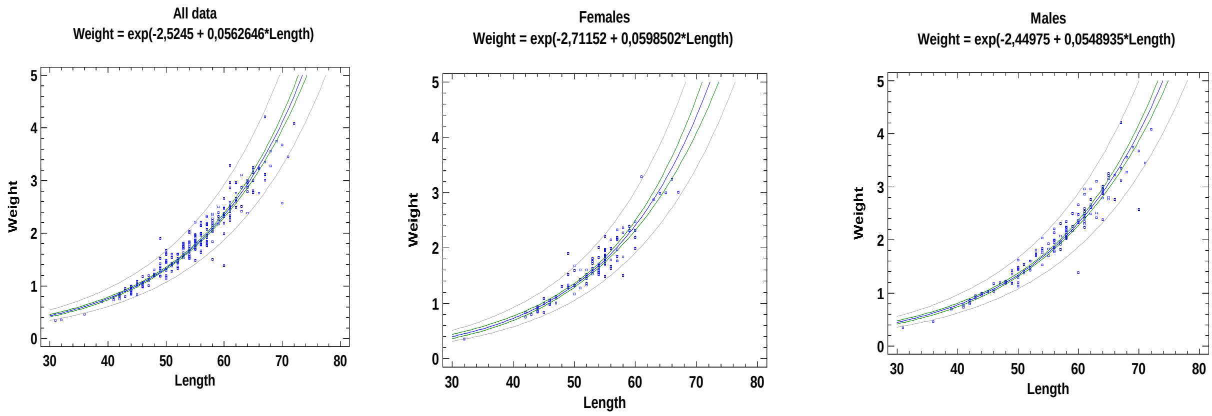


Figure 6.5.6. Length–weight relationship for tusk.

6.5.5.3 Age compositions

The age–length-weight relation is based on data from a small area off Lofoten. The data collected for the project CoralFish are shown in Figure 6.5.7. 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.

Average length and weight-at-age based on all available data for the years 2000–2002, 2004, 2005, 2010 and 2011 (Figure 6.5.8).

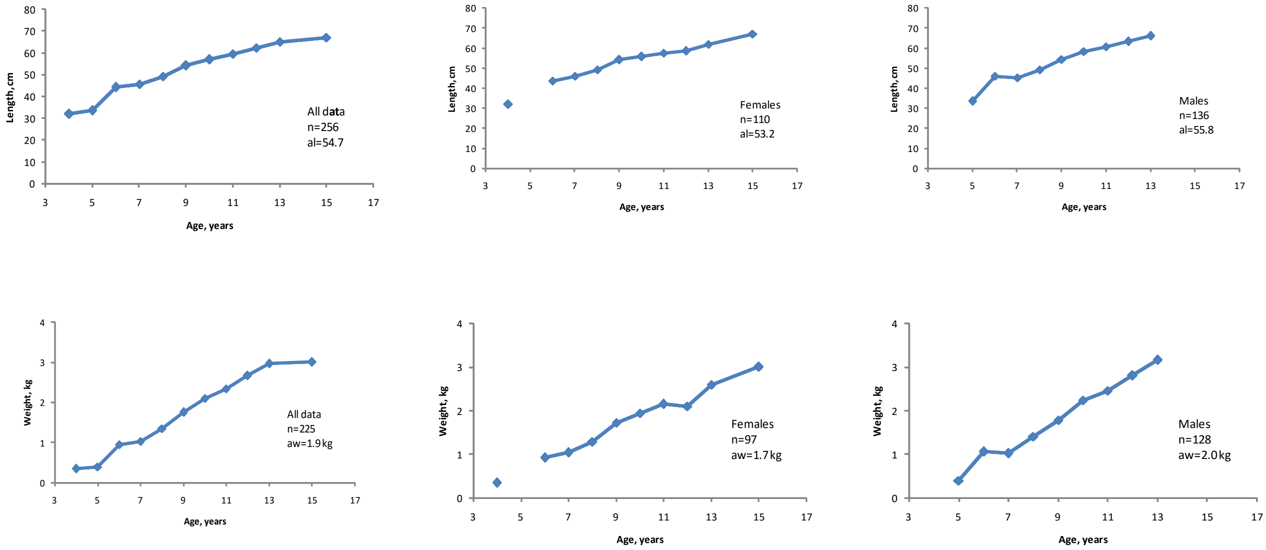


Figure 6.5.7. Weight and length-at-age for females and males combined.

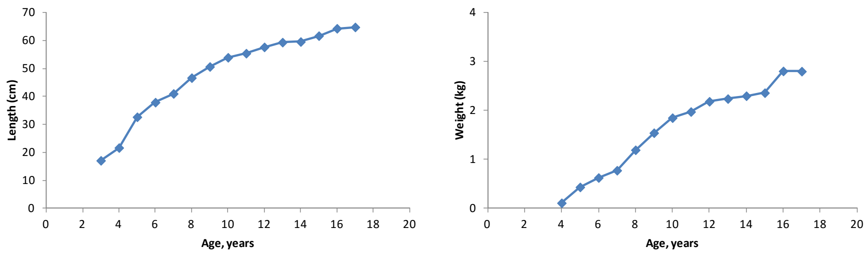


Figure 6.5.8. Average length and weight-at-age for all available data for the years 2000–2002, 2004, 2005, 2010 and 2011.

6.5.5.4 Maturity and natural mortality

Maturity ogives of tusk are presented in Figure 6.5.9 and in the Table below. There were insufficient age data to determine A_{50}.

Maturity parameters:

Stock	L_{50}	N	A_{50}	N	Source
Usk-arct	56.3	2616			Norwegian long liners (Reference fleet) and survey data

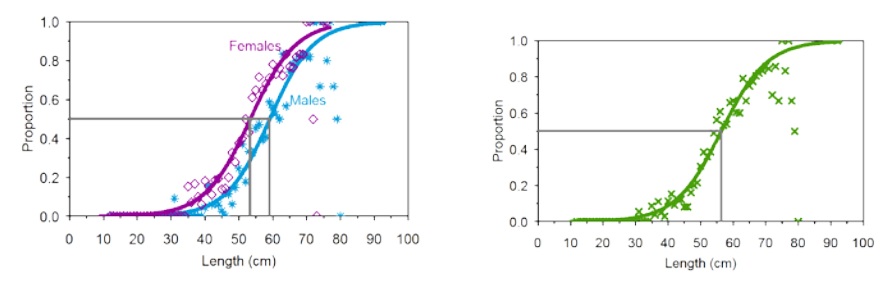


Figure 6.5.9. Tusk 1 and 2, Maturity ogive on length for males and females, and all data combined.

6.5.5.5 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 2000–2015. 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 method for estimating cpue for tusk is given in Helle *et al.*, 2015. An analysis based on these data is in the WD Helle and Pennington, 2017. Two cpue series, one based on all data and one when tusk was targeted were presented (Figure 6.5.9). No research vessel data were available.

6.5.6 Data analyses

Length distribution

The mean length fluctuated without any obvious trends.

Cpue

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

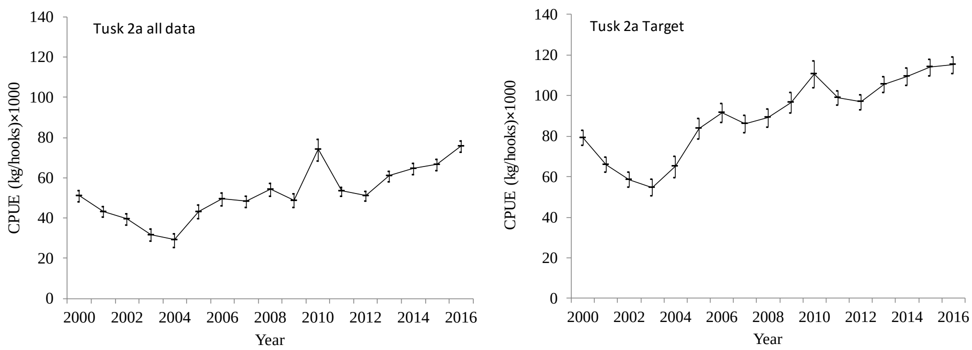


Figure 6.5.9. Estimates of cpue (kg/1000 hooks) of tusk based on skipper's logbook data for 2000–2016. The bars denote the 95% confidence interval.

Graphs of two standardized GLM-based cpue series estimated from all data and from a subset of the data for which tusk made up more than 30% of the catches are shown in Figure 6.5.9. 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.

Biological reference points

See Section 6.5.9.

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 the cpue continues to increase steadily. Current catch levels are considered to be appropriate. The fishing pressure on tusk has decreased considerable because the size of the longline fleet fishing for tusk has decreased by about 65 percent since 2000 and because of greater access to quotas for Arcto-Norwegian cod. Since the catches have been stable and the indicator series has been showing an increasing trend it, is suggested not to apply the 20% buffer.

As always, it should be emphasized that commercial catch data are typically observational data; that is, there were no scientific controls on how or from where the data were collected. Therefore, it is not known with certainty if the tusk cpue series tracks the population and/or how accurate the measures of uncertainty associated with the series are (see, for example, Rosenbaum, 2002). Consequently, one must usually hope and pray that a cpue series, which is based only on commercial catch data, truly tracks abundance.

An infamous example of a misleading cpue series based on commercial data was a cpue series for Newfoundland cod that incorrectly indicated that the abundance of the cod stock was increasing greatly. Advice based on this cpue series ultimately caused the collapse of the stock (see, e.g. Pennington and Strømme, 1998).

In general, any assessment method based only on commercial catch data needs to be applied with caution. The reason that assessments using only commercial data are problematic is because the relation between the commercial catch and the actual population is normally unknown and probably varies from year to year.

6.5.9 Application of MSY proxy reference points

Two different methods were tested for tusk in 1 and 2, the Length-based indicator method (LBI) and SPiCT.

The results for the LBI are very sensitive to the assumed values of L_{inf} and L_{mat}. The backround data for Linf and Lmat limited and may in future be recalculated to estimate both A_{50} and L_{50}.

The ageing of tusk is very difficult and A_{50} was not estimated. Tusk is a deep-water species, so P_{mega} and L_{mean}/L_{opt} are not used for tusk.

In the SPiCT model landings data from 1988–2016 and the cpue based on data from the Norwegian reference fleet was used. The model converged and the retrospective plot showed that the test is robust.

A summary of the methods are given under:

Length-based indicator method (LBI)

The input parameters and the catch length distribution for the period 2001–2016 are in the following tables and figures. The length data used in the LBI model are from the Norwegian longliner fleet. The length data are not raised to total catch.

Input parameters for LBI

Data type	Years/Value	Source	Notes
Length–frequency distribution	2001–2016	Norwegian longliners (Reference fleet)	
Length–weight relationship	0.0106* length $^{3.0168}$	Norwegian longliners (Reference fleet) and survey data.	combined sex
L_{MAT}	56 cm	Norwegian longliners (Reference fleet) and survey data.	
L_{inf}	119 cm (L_{max})	Norwegian longliners (Reference fleet) and survey data.	

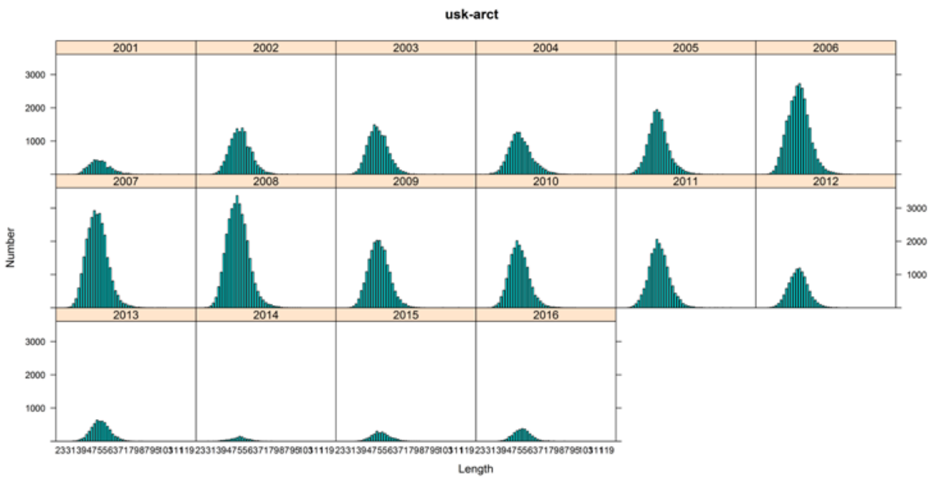
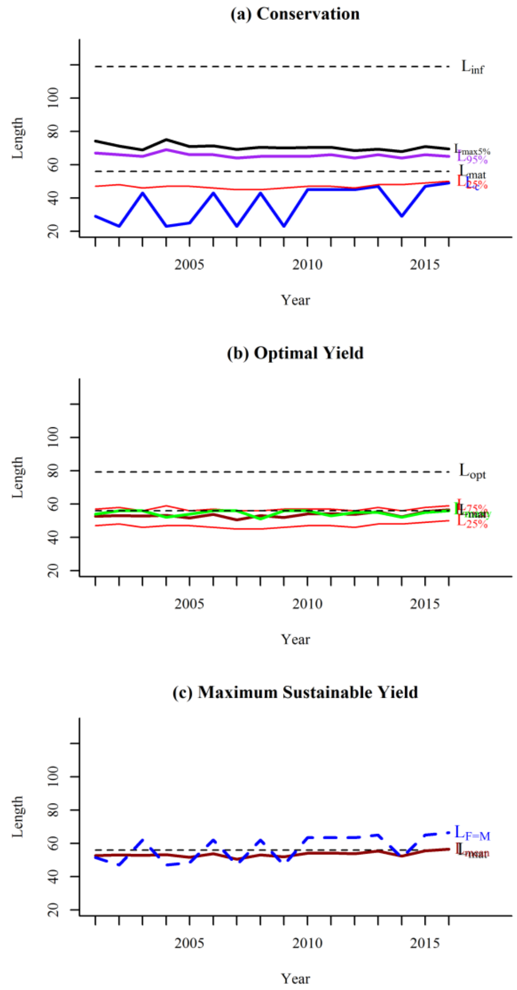


Figure 6.5.10. Tusk in arctic waters (1, 2.a, 2.b). The length distribution (2 cm length bins) based on data from the Norwegian longline fleet for the period 2001–2016 (sex combined).

Outputs

The length indicator ratios for combined sexes were examined for three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield are presented in the following figures.


(a) Conservation
Length
Year
2005
2010
2015
20
40
60
80
100
L_inf
L_max5%
L_95%
L_mat
L_25%
L_c
(b) Optimal Yield
L_opt
L_75%
L_mean
L_25%
(c) Maximum Sustainable Yield
L_F=M
L_mean

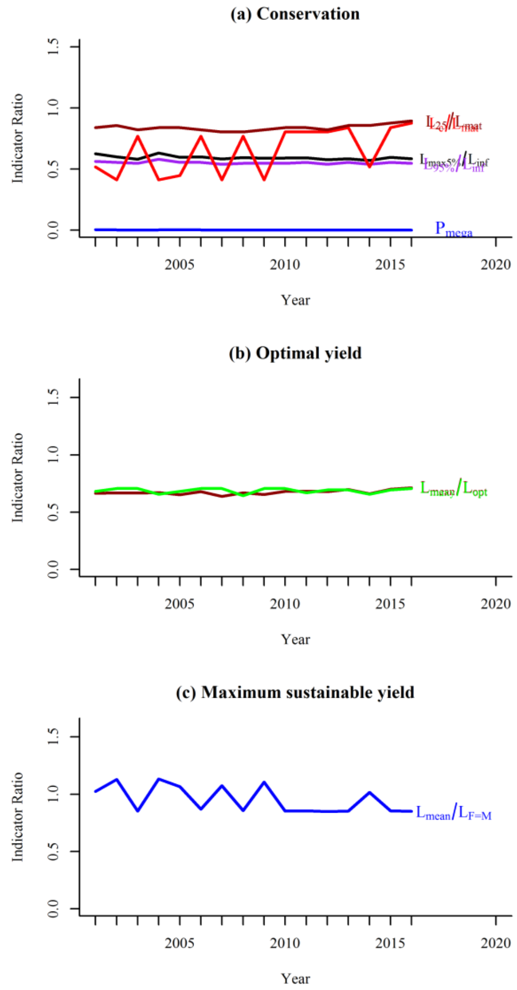


Figure 6.5.11 Tusk in arctic waters (1, 2.a, 2.b).Using length indicators ratios for sex combined to examine three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

Analysis of results

The conservation model for immature tusk shows that both L_c/L_{mat} and $L_{25\%}/L_{mat}$ are less than one, but $L_{25\%}/L_{mat}$ is still usually greater than 0.8 (Figure 4.2, Table 4.2). Regarding the sensitivity of L_{mat}, there appears to be little or no overfishing of immature individuals.

The conservation model for large individuals estimates that the indicator ratio, $L_{max5\%}/L_{inf}$ is, around 0.58 for the whole period (Figure 4.2), and between 0.57 and 0.60 in 2014–2016 (Table 4.2), which is less than the cut-off point.0.8. Since the VBF results gave an unusual low L_{inf}, the value used in the model was L_{max}. This could be the reason that the indicator ratio is less than 0.8. If we had used a smaller L_{inf}, the indicator ratio would be higher! Since tusk is a slow growing, deep-water species, the P_{mega} and L_{mean}/L_{opt} values are unreliably.

The MSY indicator ($L_{mean}/L_{F=M}$) varies between 0.85 and 1.13 (Figure 4.2). The values were less than one in 2015 and 2016 which indicates that tusk in areas 1, 2.a and 2.b are being fished unsustainably. In regards to the sensitivity of the value of L_{inf} used in the model: If L_{inf} is set equal to L_{max}, then MSY is always higher than 0.85.

Conclusions

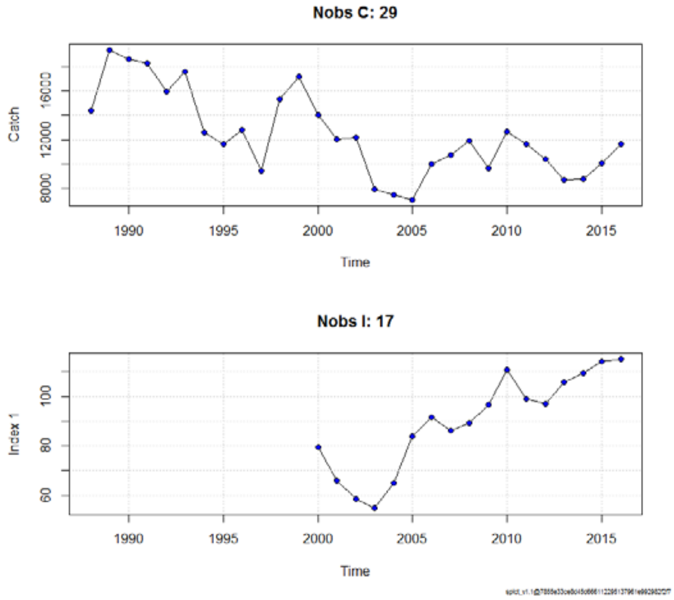
The overall perception of the stock during the period 2014–2016 based on LBI results is that tusk in Division 1, 2.a and 2.b seem to be overexploited and therefore fished unsustainably (Table 4.3). However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

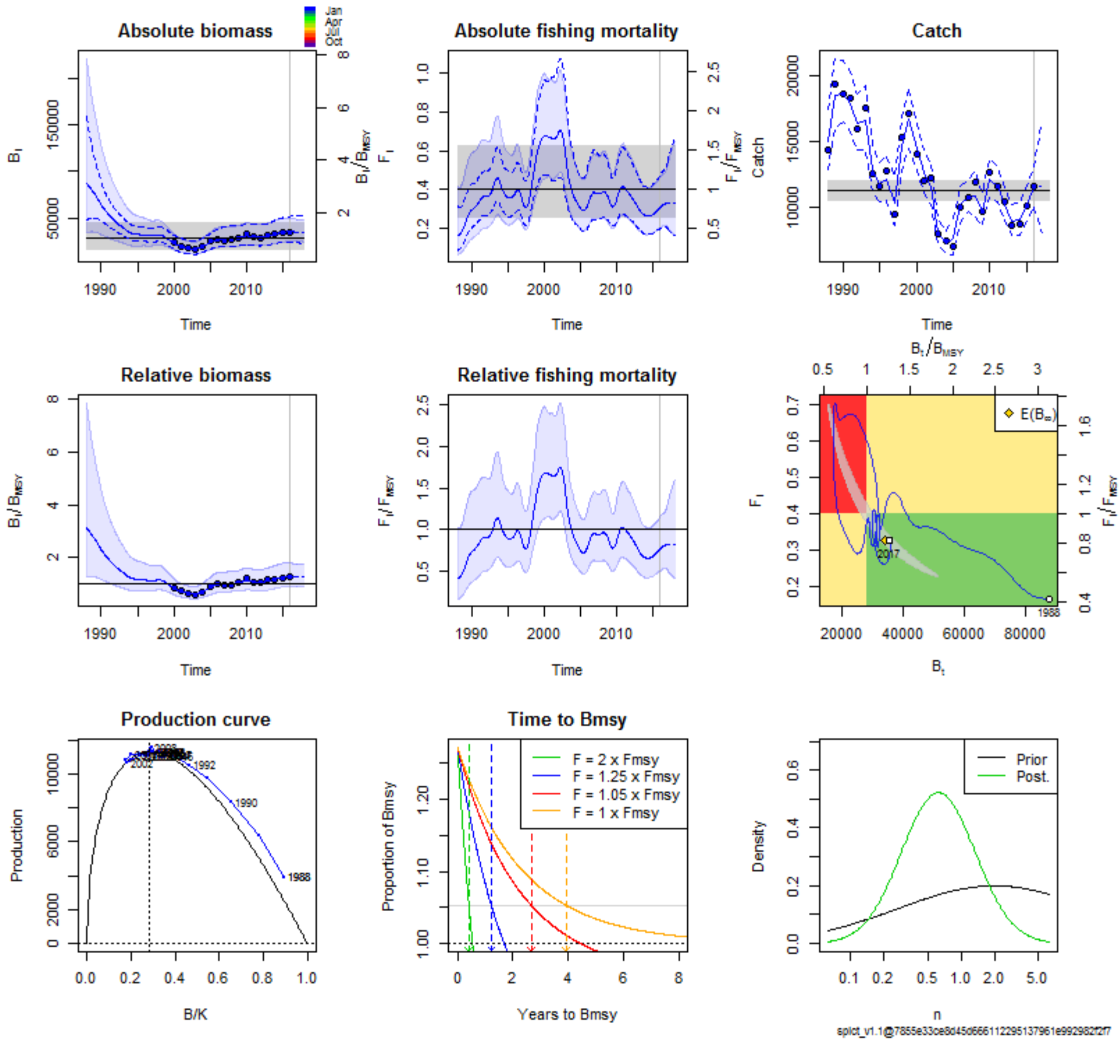
The results from the LBI method

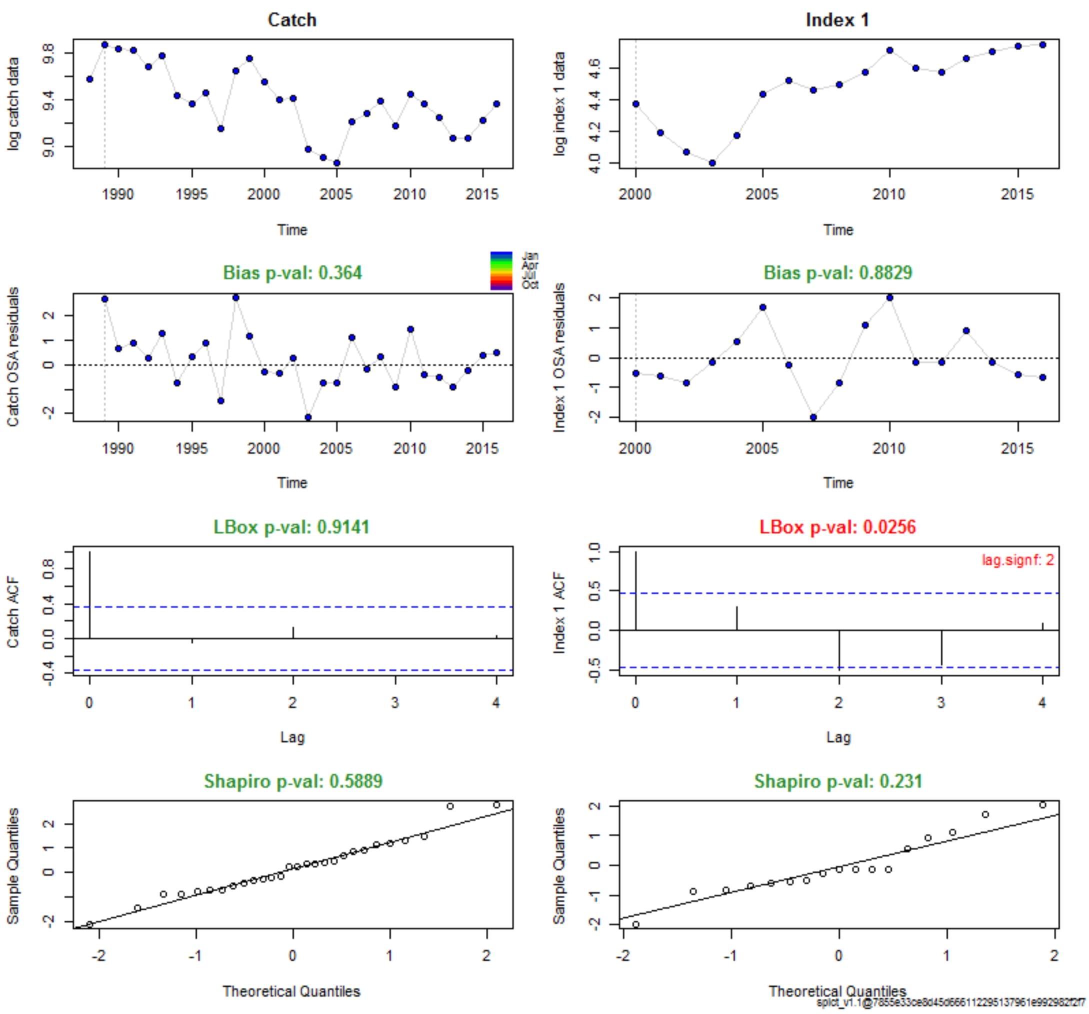
	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2014	0.52	0.86	0.57	0%	0.66	1.02
2015	0.84	0.88	0.60	0%	0.70	0.85
2016	0.88	0.89	0.58	0%	0.71	0.85

SPiCT

The SPiCT model was run on the cpue and catch data for tusk in arctic waters (1, 2.a, 2.b) using the default settings. Due to time constrains various model settings were not tested and further work is needed before it can be concluded whether or not SPiCT is appropriate method for this stock.


Nobs C: 29
Catch
Time
Nobs I: 17
Index 1
Time


Absolute biomass
Jan
Apr
Jul
Oct
Time
Absolute fishing mortality
Time
Catch
Time
Relative biomass
Time
Relative fishing mortality
Time
E(B∞)
2017
1988
Production curve
Production
B/K
1988
1990
1992
2002
Time to Bmsy
F = 2 x Fmsy
F = 1.25 x Fmsy
F = 1.05 x Fmsy
F = 1 x Fmsy
Proportion of Bmsy
Years to Bmsy
Prior
Post.
Density
n


Catch
log catch data
Time
Index 1
log index 1 data
Time
Bias p-val: 0.364
Catch OSA residuals
Jan
Apr
Jul
Oct
Bias p-val: 0.8829
Index 1 OSA residuals
LBox p-val: 0.9141
Catch ACF
Lag
LBox p-val: 0.0256
lag.signf: 2
Index 1 ACF
Shapiro p-val: 0.5889
Sample Quantiles
Theoretical Quantiles
Shapiro p-val: 0.231
spict_v1.1@7855e33ce8d45d6661122951379 61e992982f2f7

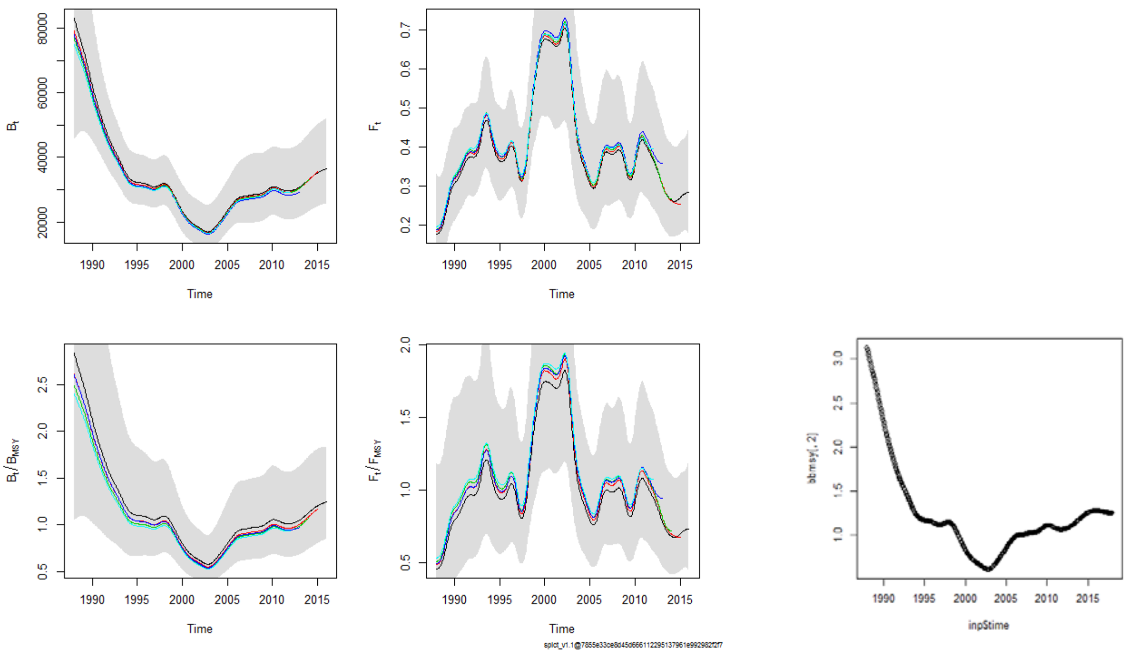

Time
inp$time

Table 6.5.1a. Tusk 1. 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	692						692
2014	766	5					771
2015	904						904
2016	890	2					892

***Preliminary.**

Table 6.5.1b. Tusk 2.a. 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	24	13	3		7729		7	52		2	7830
2014	10	9	1		7682		7	38			7743
2015	19	5			8906	1		90			9021
2016*	61	2	1	2	10 331		1	57		3	10 458

***Preliminary.**

(1)Includes 2.b.

Table 6.5.1c. Tusk 2.b. 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	3	16			140
2014	185		41			226
2015	97		69			166
2016	165		144			309

Table 6.5.1d. Tusk 1 and 2. WG estimates of total landings by subareas or divisions.

Year	1	2a	2b	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	692	7830	140	8662
2014	771	7745	226	8742
2015	904	9021	166	10 091
2016*	892	10 458	309	11 659

***Preliminary.**

6.6 Tusk (*Brosme brosme*) in areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9 and other areas of 12

6.6.1 The fishery

General descriptions of the fisheries in these areas are in the overview 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 major proportion of the total landings. Around 90% of the Norwegian and Faroese landings are taken by longliners.

When landings from Areas 3–4 and 6.a–12 are pooled over the period 1988–2016, 36% of the landings have been in Area 4, 46% in Area 5.b, and 16% in Area 6.a.

In Area 5.b, tusk was mainly fished by longliners (about 90% of the catch), 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. Since 2014 Norwegian longliners have been given quotas in 5.b.

6.6.2 Landings trends

Landing statistics by nation during the period 1988–2016 are in Table 6.6.1 and are shown by year in Figure 6.6.1.

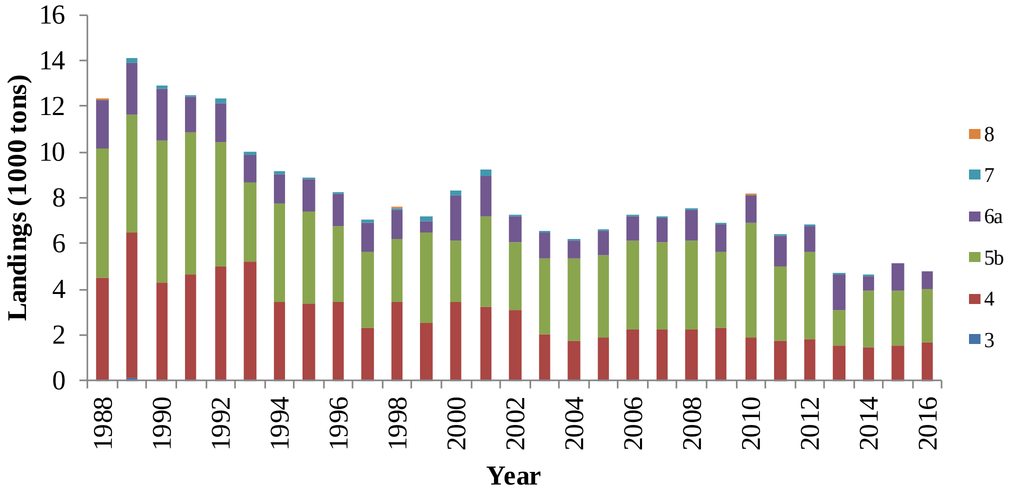


Figure 6.6.1. Landings of tusk per year for the period 1988–2016.

For all subareas/divisions, the catches were relatively stable during the period 2002 to 2012, afterwards there was a decline in catches, especially in Area 5.b. The total catch was 4820 in 2016 (Figures 6.6.1 and 6.6.2).

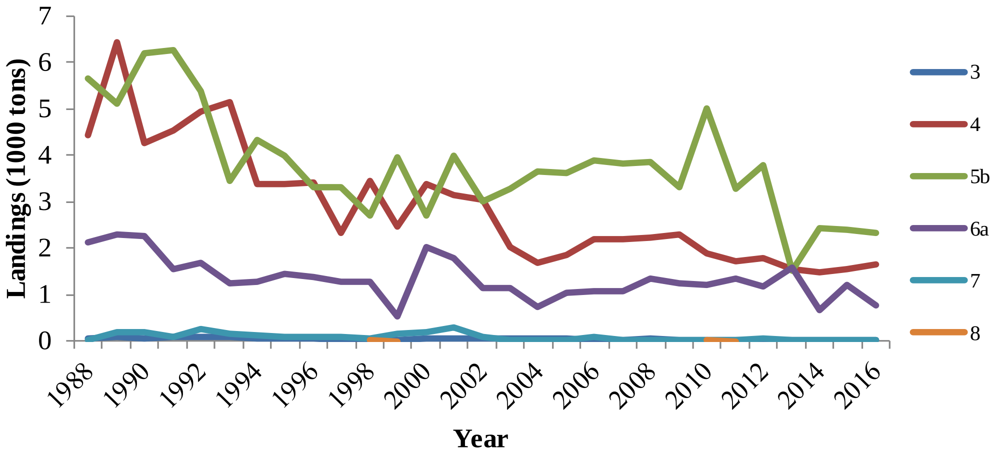


Figure 6.6.2. Landings of tusk in each area for the period 1988–2016.

6.6.3 ICES Advice

Advice for 2016 to 2017: ICES advises that when the precautionary approach is applied, catches should be no more than 8415 tonnes in each of the years 2016 and 2017. Discards are considered to be negligible.

6.6.4 Management

There is a licensing scheme and effort limitation in area 5.b. The minimum landing length for tusk in Division 5.b is 40 cm. Norway has a bilaterally agreed quota with the Faeroes in 5.b, and the quota for 2017 is 1700 t. Norway also has a licensing scheme in EU waters, and in 2016 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.

In 2017, The Faroese Government will allow five Russian vessels to undertake experimental fishing in the Faroese Fishing Zone at depths deeper than 700 meters, provided that a Russian scientific observer is on board. No more than three vessels can be operating simultaneously. Two of these vessels can undertake experimental fishery in deep waters around Outer Bailey and Bill Baileys Banks, at depth between 500 and 700 meters, provided that catches in this area do not exceed 500 tonnes of deep-sea species.

EU TACs for areas partially covered in this section are in 2017:

Subarea 3:	29 t;
Subarea 4:	235 t;
Subarea 5, 6, 7 (EU and international waters):	937 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 the relevant fleets. No estimates of the quantity of discards for tusk were available. The Norwegian and Faroese fleet are not allowed to discard tusk, and incentives for illegal discarding are believed to be low. The landings statistics and logbooks are therefore regarded as being adequate for assessment purposes.

Discards by Spain, Ireland, France and Scotland are given under for the years 2013 to 2016, and by area and countries for 2016.

Total discards by country for the years 2013 to 2016.

	2013	2014	2015	2016
Spain	40	0		
Ireland	12	0		
France			6	1
UK (Scotland)			12	152
Total	52	0	18	153

Discards in 2016 by area on country.

Area	Country	Discards
4	UK(Scotland)	143
4.a	France	1
5.b.1.b	UK(Scotland)	1
6.a	UK(Scotland)	8
Total		153

6.6.5.2 Length compositions

Figure 6.6.3 show the estimated length distributions of tusk in Areas 4.b, 5.b and 6.a based on data provided by the Norwegian reference fleet for the period 2001–2016, and Figure 6.6.4 shows the estimated length distributions of the catch of tusk by Norwegian longliners combined for areas 4.a, 5.b and 6.a.

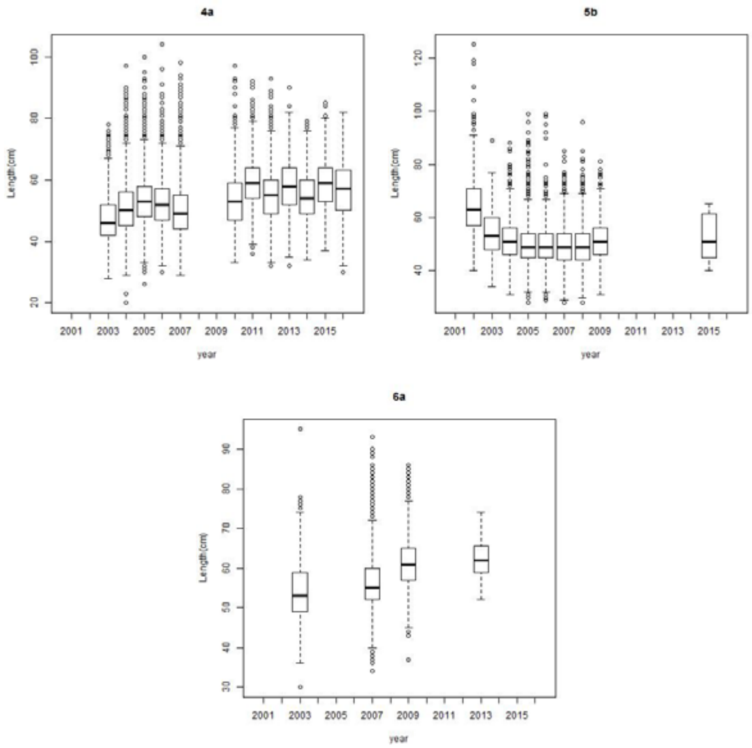


Figure 6.6.3.Plots of the length distribution in Areas 4.a, 5.b and 6.a for the period 2001 to 2016. The graphs are based on length data from the Norwegian reference fleet.

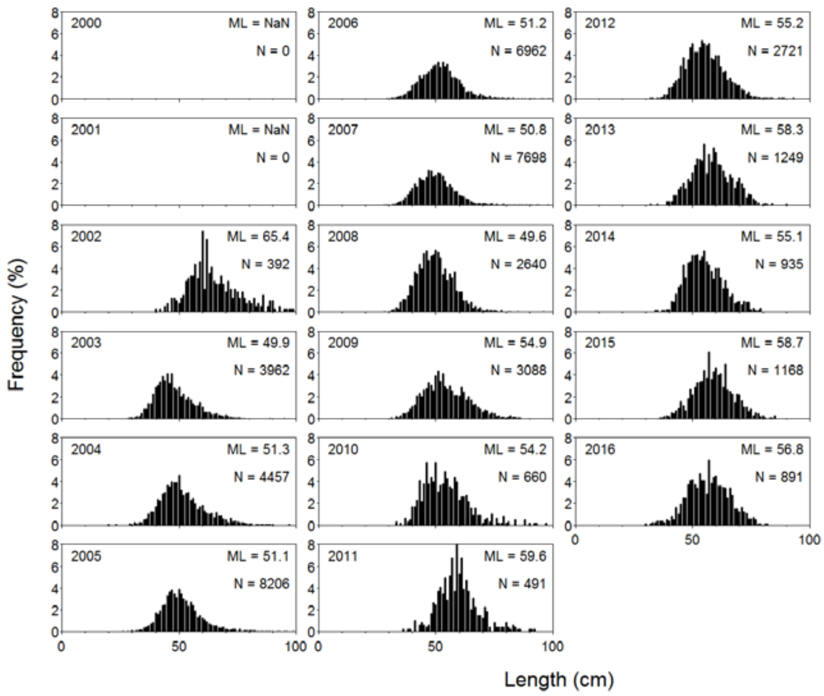


Figure 6.6.4. The estimated length distributions of the catch of tusk by Norwegian longliners combined for areas 4.a, 5.b and 6.a.

Length distribution from the commercial catches by Faroese longliners were presented for the period 1994–present (Figure 6.6.5). The estimated mean lengths from the longliners varied from 46 to 56 cm, and there was no downward trend in mean lengths with year. The main landing size was between 40 and 60 cm (Figure 6.6.5).

Length distributions of tusk from different trawl surveys conducted in Faroese waters are presented: the annual Faroese spring (1994–present, Figure 6.6.6) and summer surveys (1996–present, Figure 6.6.7), deep-water surveys (2014–2016, Figure 6.6.8), the annual Greenland halibut surveys (1995–present, Figure 6.6.9), redfish trawl surveys (2003–2011, Figure 6.6.10) and the blue ling surveys (2000–2003, Figure 6.6.11).

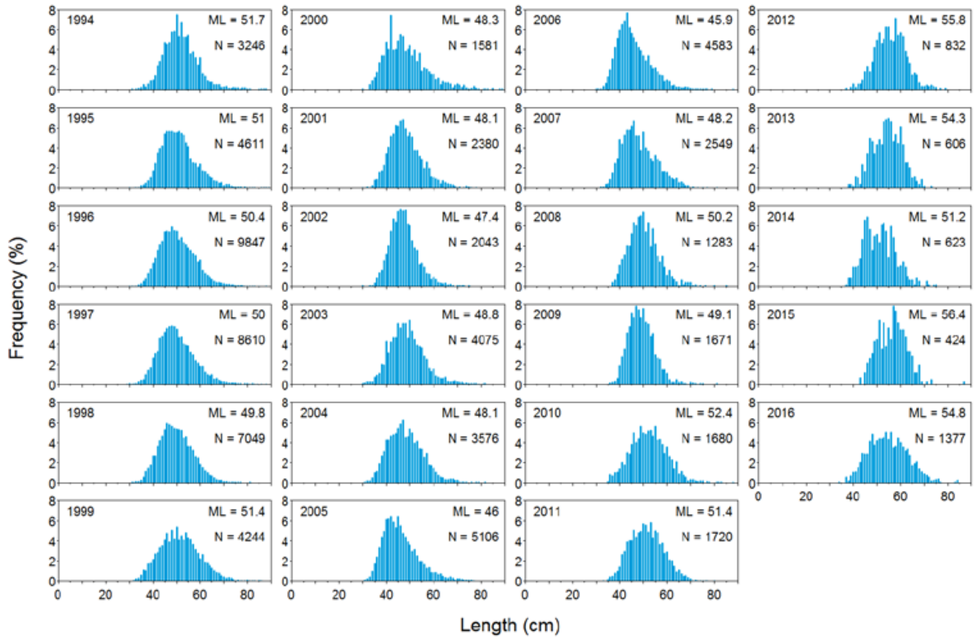


Figure 6.6.5. The estimated length distributions of the catch of tusk by Faroese longliners (>100 BRT) in Area 5.b.

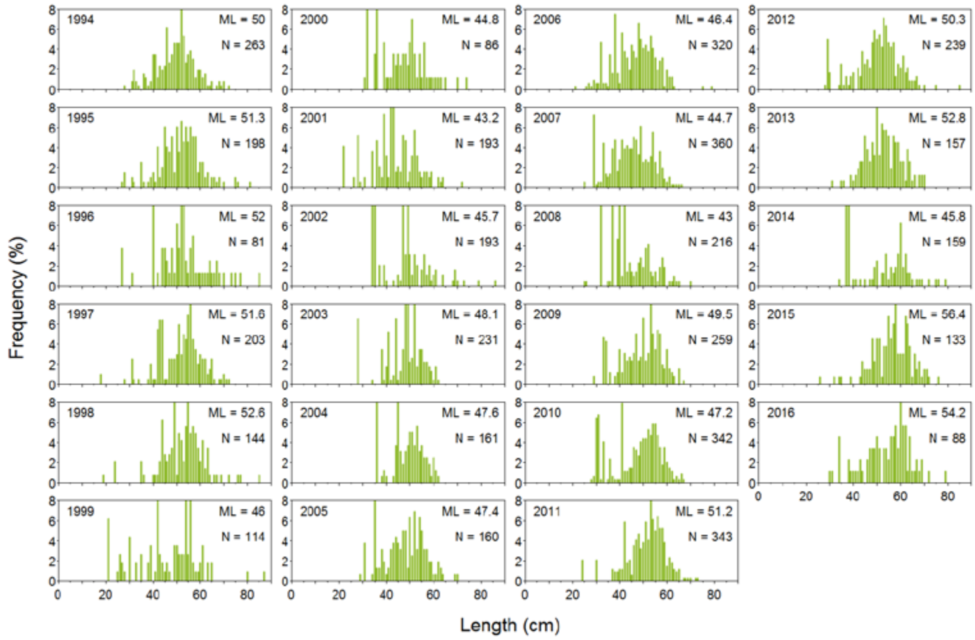


Figure 6.6.6. Estimated length distributions of tusk in Area 5.b based on data from the Faroese spring groundfish surveys.

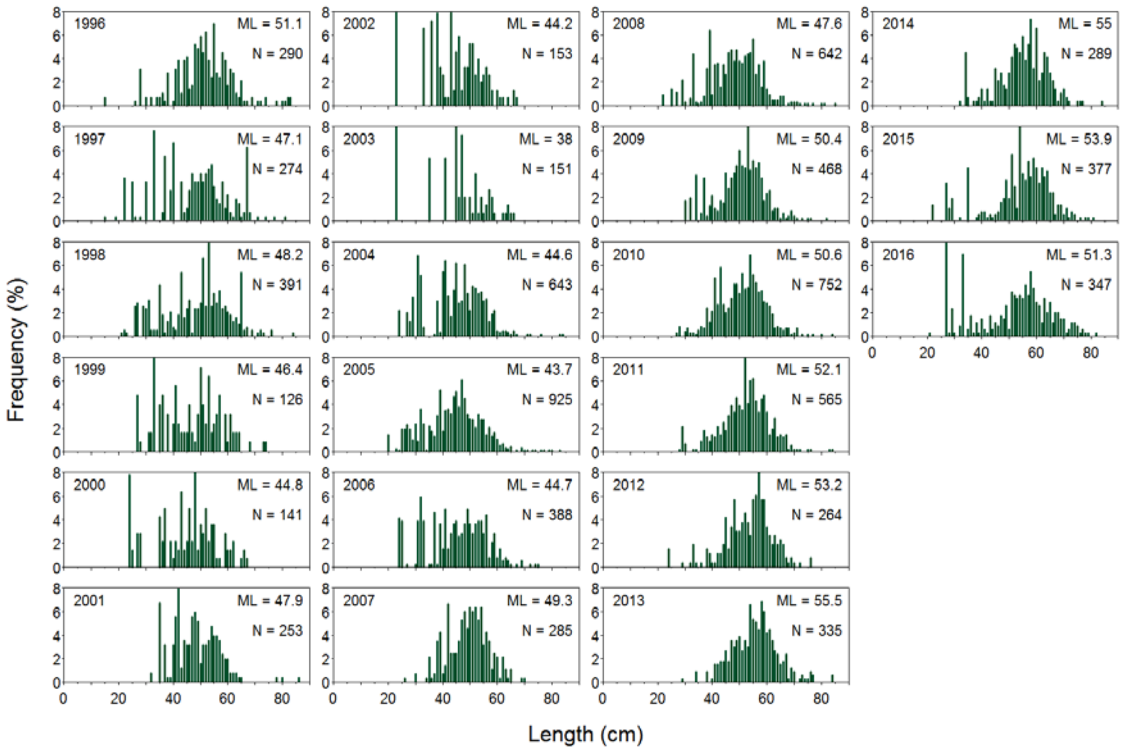


Figure 6.6.7. Estimated length distributions of tusk in Area 5.b based on data from the Faroese summer groundfish surveys.

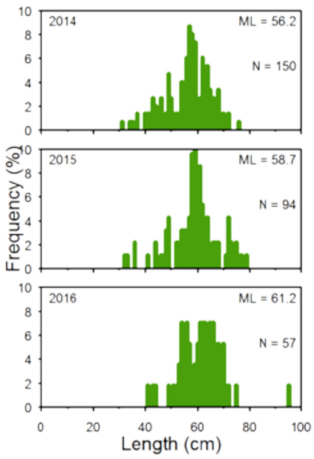


Figure 6.6.8. Tusk 5.b. Length distribution in the deep-water survey in 2014–2016.

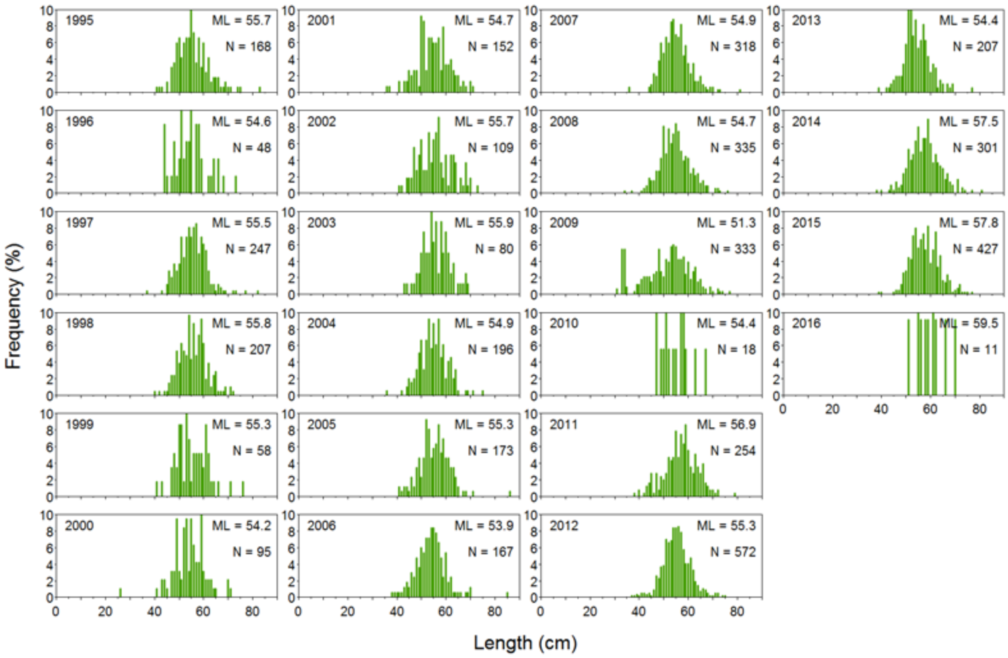


Figure 6.6.9. Tusk 5.b. Length distributions from the annual Faroese Greenland halibut trawl survey.

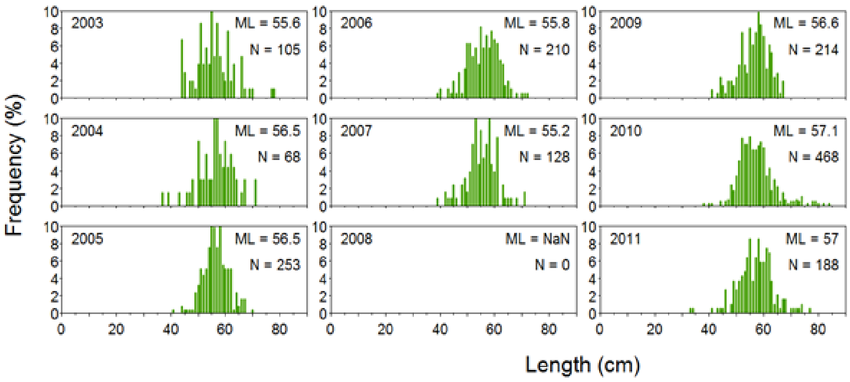


Figure 6.6.10. Tusk 5.b. Length distribution from the redfish trawl survey 2003–2007, 2009–2011.

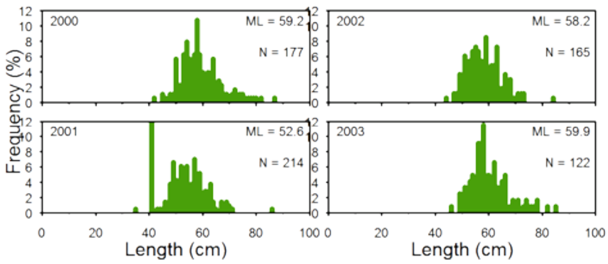


Figure 6.6.11. Tusk 5.b. Length distribution in the blue ling survey in 2000–2003.

6.6.5.3 Age and growth compositions

Growth, as mean length-at-age, mean gutted weight-at-length and mean round weight-at-age, of tusk in Faroese waters are presented in Tables 3–4 and Figures 6.6.12–6.6.14. Tusk has slow growth because the mean growth was only 2.5–3 cm per year. One year old tusk was around 9–15 cm in length, five years old around 43 cm and ten year old fish was around 59 cm in length. The mean gutted weight of a 40 cm and 60 cm long tusk was around 0.7 kg and 2.2 kg, respectively (Figure 6.6.13). There is almost no difference in female and male growth (Figures 6.6.12 and 6.6.14). The gutted-round weight relation is showed in Figure 6.6.15.

An age–length key using all data from the last three years was used as background to do a catch-at-age (age composition) from the longline fishery (Figure 6.6.16). These preliminary results show that the longline landings are largely of six to ten year old fish and the mean age in the catch was around eight to nine years.

Table 3. Tusk 5.b. Growth parameters.

Area	Sex	L_∞ (cm)	SE	K (year^{-1})	SE	T_0	SE	N	Age range	Max observed size (cm)
Faroese waters	Combined	109.632	15.410	0.060	0.018	-3.414	1.129	1287	2–18	
Faroese waters	Female	84.430	3.230	0.109	0.012	-1.434	0.444	667	2–17	
Faroese waters	Male	76.207	2.555	0.144	0.017	-0.675	0.463	618	3–18	

Table 4. Tusk 5.b. Weight–length relation. Coefficient a and b of Weight = a * Length^b.

Area	Sex	a	b	N	Length range (cm)	Weight range (g)	Weight	Source
Faroese waters	Combined	0.0098	3.023	15160			Round	Surveys
Faroese waters	Female	0.0150	2.9185				Round	Surveys
Faroese waters	Male	0.0085	3.0582				Round	Surveys
Faroese waters	Combined	0.0126	2.952	6657			Gutted	Landings

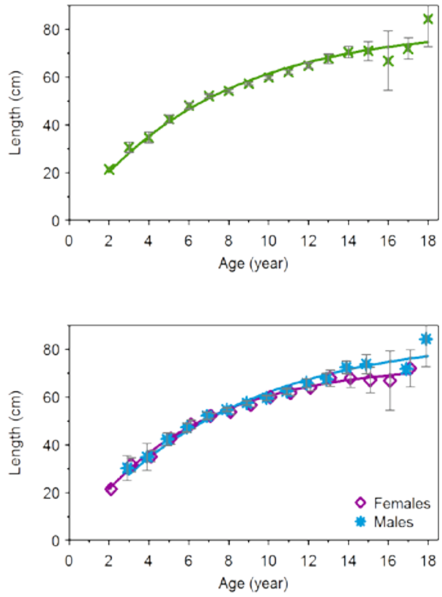


Figure 6.6.12. Tusk 5.b. Growth of tusk as mean length-at-age of all data (left figure) and females/males (right figure). Grey bars are standard error.

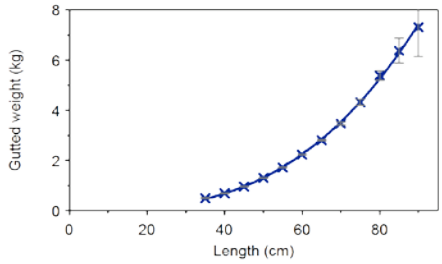


Figure 6.6.13. Tusk 5.b. Growth of tusk as mean gutted weight-at-length. Grey bars are standard error.

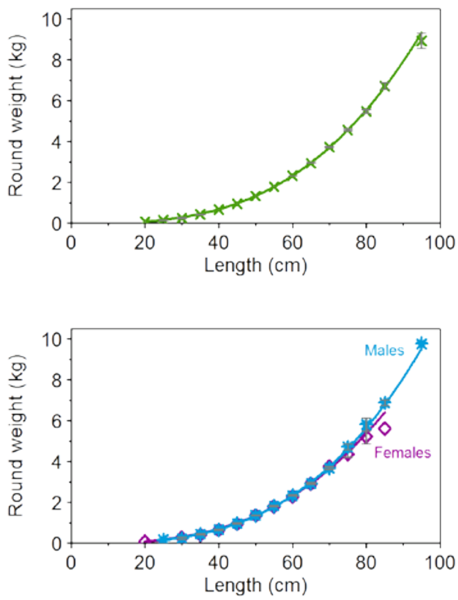


Figure 6.6.14. Tusk 5.b. Growth of tusk as mean round weight at length. Grey bars are standard error.

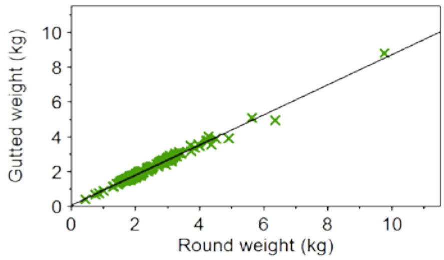


Figure 6.6.15. Tusk5.b. Gutted-round weight relation. Gutted weight = 0.8666* round weight + 0.0657, R^2 = 0.9869, N=148.

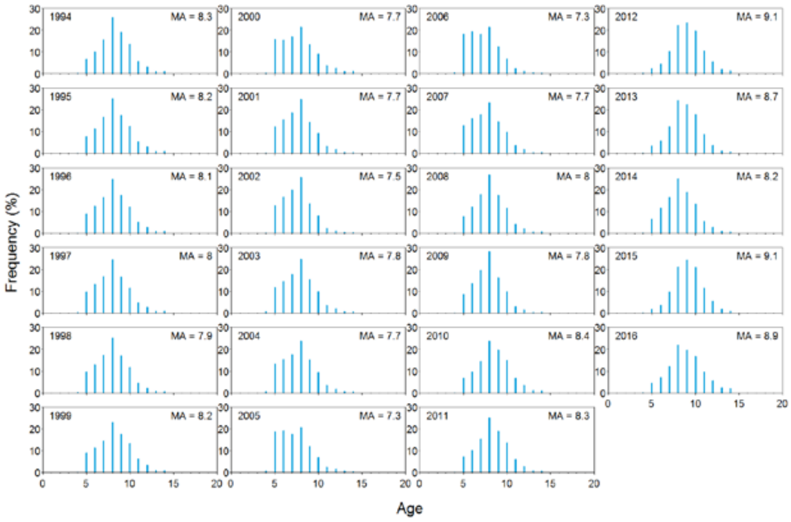


Figure 6.6.16. Tusk 5.b. Age distributions in the Faroese longline fishery catch number-at-age. Age 14 is a plus group.

6.6.5.4 Weight-at-age

Mean weight-at-age of tusk in the commercial catches in Faroese waters are presented in Figure 6.6.17. The mean weight-at-age was relative stable during the period from 1994 to 2016. There were very few samples of four year old tusk.

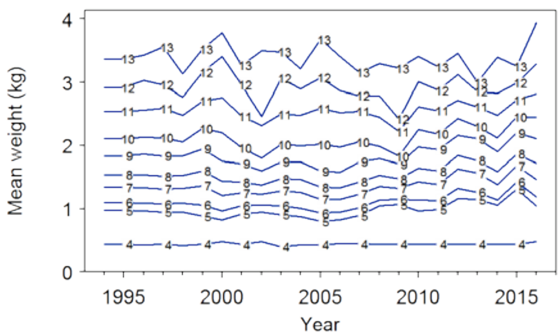


Figure 6.6.17. Tusk 5.b. Mean weight-at-age in the landings.

6.6.5.5 Maturity and natural mortality

There was a difference in maturity ogive for females and males, where females had a lower value than males (Table 5, Figure 6.6.8). Most of the maturity samples are collected outside the spawning season, so it is a bit difficult to see if the individuals are immature or resting. Proportion females showed that females and males seems to be equal distributed by length (Figure 6.6.19).

No information is available on natural mortality of tusk in 5.b.

Table 5. Tusk 5.b. Maturity parameters.

Area	Sex	A_{50}	N	L_{50}	N
Faroese waters	Combined	6.75	1267	50.50	1292
Faroese waters	Female	6.01	653	48.35	665
Faroese waters	Male	7.77	614	53.33	627

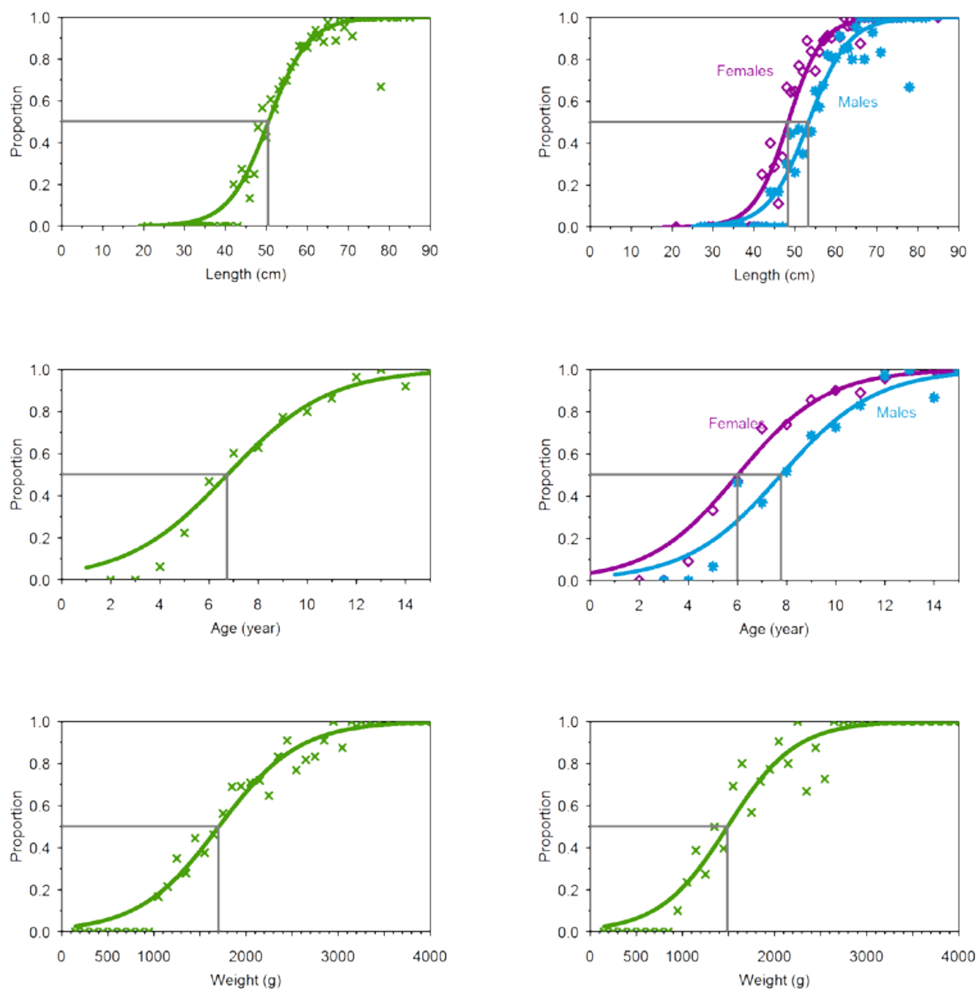


Figure 6.6.18. Tusk 5.b. Maturity ogive on length (upper left), age (upper right), round weight (bottom left) and gutted weight (bottom right).

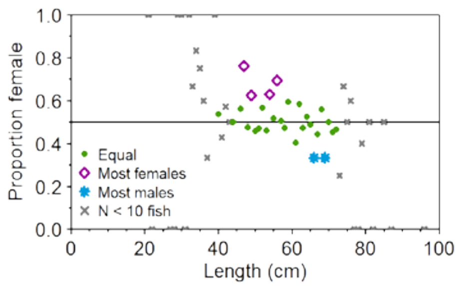


Figure 6.6.19. Tusk 5.b. Proportion female.

6.6.5.6 Catch, effort and research vessel data

Commercial cpue series

There are catch per unit of effort (cpue) data available from three commercial series, the Faroese longliners, the Faroese pair trawlers (bycatch) and Norwegian longliners fishing in Division 5.b. The Faroese cpue data are from five longliners (GRT >110) and 6–10 pair trawlers (HP >1000). The effort obtained from the logbooks was 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 selection of data and standardization are described in the stock annex for tusk in "other areas". The data selected in the longliner series were only from sets where ling was more than 30% of the total catch to be able to compare with the Norwegian longliner series.

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2016. 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 data quality has improved considerably and data from the entire fleet were available.

The standardized cpue data from Norwegian longliners fishing in Division 5.b are described in the stock annex for tusk in 2.a (Section tusk in 1 and 2) and in Helle *et al.*, 2015. The sets where tusk >30% of the total catch were used. The Norwegian and Faroese longliners are comparable and both have ling (and tusk) as target species.

Fisheries independent cpue series

Cpue estimates (kg/hour) for tusk are available from two annual groundfish trawl surveys on the Faroe Plateau designed for cod, haddock and saithe. The annual survey on the Faroe Plateau covers the main fishing areas and mainly the larger part of the spatial distribution area (Ofstad, WD WGDEEP 2017). Information on the surveys and standardization of the data are described in the stock annex.

6.6.6 Data analyses

Length distributions

Norwegian length distributions, based on data provided by the longline reference fleet from Areas 4.a, 5.b and 6.a, have varied slightly with no obvious trends (Figures 6.6.3 and 6.6.4). The average length of the catch of tusk by Norwegian longliners combined for areas 4.a, 5.b and 6.a was in 2016 56.8 cm.

The mean length in the spring and summer groundfish surveys varied between 43 and 55 cm (Figures 6.6.6 and 6.6.7). The length distributions from these surveys are noisy and some lengths seem to be overestimated (especially small fish). The reason behind the overestimation is probably that small tusk, below commercial landing size, are sampled as a subsample from the catch and thereafter multiplied up to the total catch weight. Few tusk smaller than 30 cm is caught in these surveys. The mean length of tusk caught in the deep-water survey was around 56–58 cm (Figure 6.6.8). The mean length of tusk in the Greenland halibut-, redfish- and blue ling surveys, which used commercial trawl, varied around 55 cm (Figure 6.6.9–6.6.11).

Cpue trends

4.a

Two cpue series for tusk in Area 4.a based on Norwegian longline data were presented; one based on all the 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 6.6.20).

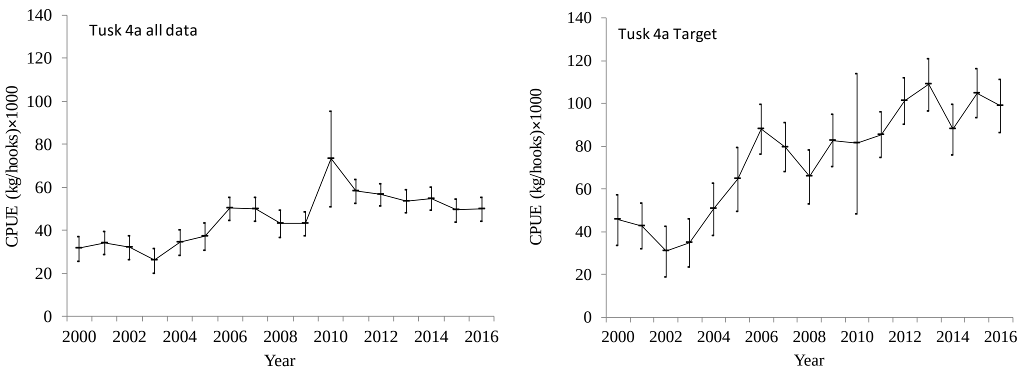


Figure 6.6.20. Tusk cpue series in 4.a for the period 2000–2016 based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

5.b

A standardized commercial cpue from longliners fishing in Faroese waters was presented (Table 6, Figure 21). The background data were based mainly on data from the logbooks of five longliners. The data selected were only from sets where tusk was more than 30% of the total catch. This new series was suggested on WGDEEP 2015 to be able to compare with the Norwegian series. Mean cpue in the period from 2008 to 2016 was 83 kg/1000 hooks and the cpue of 100 kg/1000 hooks in 2016 was above average.

Abundance indices as a standardized cpue from the annual Faroese groundfish surveys in spring (1994–present) and summer (1996–present) were presented in Figure 22. Also, cpue from the spring survey 1983–1993 were presented, and these data are not stratified (Figure 22). The cpue from the annual groundfish surveys are quite stable during the last five years. These surveys are only conducted down to maximal 530 m, so these estimates are not covering the whole distribution area of tusk.

Abundance indices of tusk caught in the Faroese 0-group survey on the Plateau show a very low level in the period 1983–2011, whereas the level has increased in 2012–

2013, but decreased again in 2014–2016 (Figure 23). In the 2015 and 2016 0-group survey no tusk was caught on the Faroe Plateau.

Abundance indices of tusk <40 cm caught in the Faroese groundfish surveys on the Plateau do also have a low level in 2015, with a slight increase in 2016 (Figure 23).

Table 6. Tusk 5.b. Standardized cpue of Faroese longliners in Faroese waters.

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cpue	**83.6**	**84.8**	65.2	60.7	**70.4**	**59.1**	**48.5**	**48.0**	**53.0**	**52.3**	46.1	79.6	55.6	48.8	40.4	56.8	49.6	70.8	47.2	61.4	**69.3**	61.9	**67.3**	**68.8**	**90.9**	**93.0**	**94.8**	**78.6**	**81.1**	**73.5**	**100.6**
SE	0.27	0.26	0.43	0.30	0.22	0.18	0.13	0.16	0.13	0.16	0.38	0.23	0.25	0.18	0.26	0.24	0.59	0.47	0.98	0.73	0.51	0.87	0.80	0.82	0.51	0.64	0.66	0.84	0.61	0.79	2.27
N	112	125	58	67	147	274	301	246	305	214	26	54	57	77	71	77	22	23	26	53	103	76	145	135	651	634	509	169	194	119	119

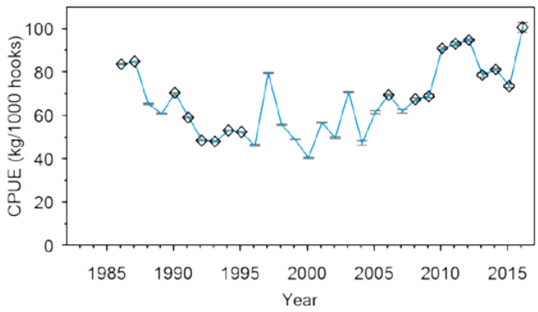


Figure 6.6.21. Tusk 5.b. Standardized cpue for longliners (<110 GRT) fishing in Faroese waters. The points show where more than 100 setting are behind the cpue.

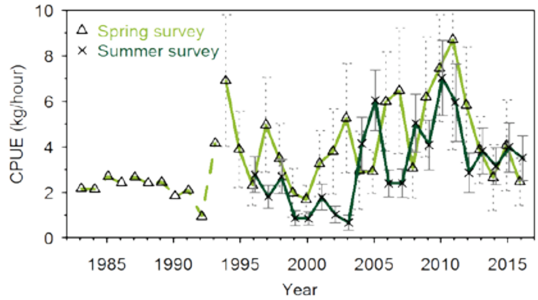


Figure 6.6.22. Tusk 5.b. Standardized cpue from the annual trawl groundfish surveys. The spring survey data from 1983–1993 is not stratified.

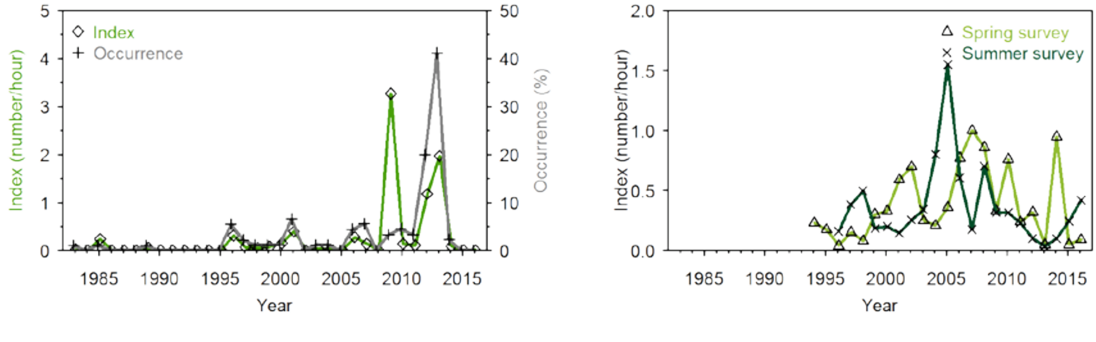


Figure 6.6.23. Tusk 5.b. Abundance index of tusk (2–3 cm in length) (number/hour) on the Faroe Plateau from the 0-group survey (left figure) and abundance index of tusk <40 cm in the annual spring- and summer trawl survey on the Faroe Plateau (right figure).

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 with an upward trend in 2015 and 2016 (Figure 6.6.24).

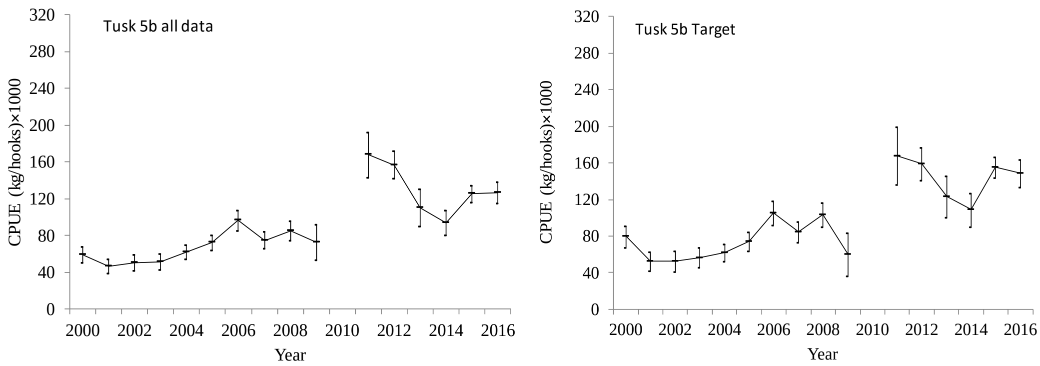


Figure 6.6.24. Tusk cpue series in 5.b for the period 2000–2016 based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

6.a

In **6.a** a cpue series based on the Norwegian longline data shows a decrease in cpue from 2004 to 2008, after this it has remained at a high but slightly declining level (Figure 6.6.25).

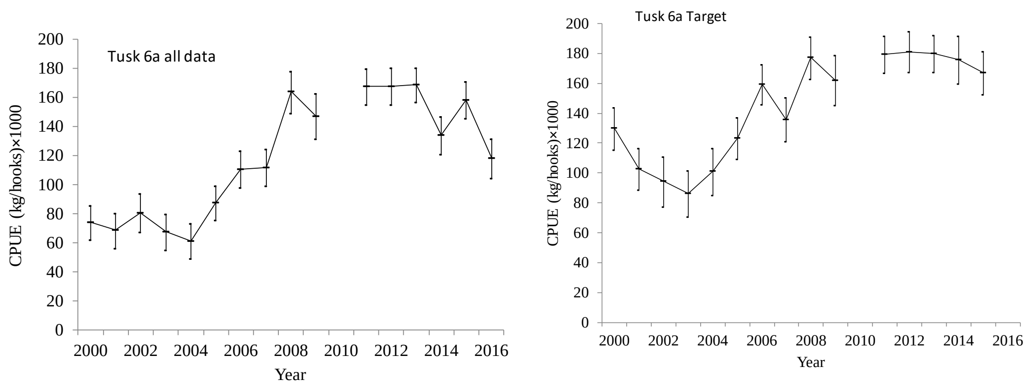


Figure 6.6.25. Tusk in area 6.b cpue series for the period 2000–2016 based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

Combined cpue series for "Tusk other areas"

In order to produce one cpue series for all areas, all the data from the Norwegian longline fleet was combined (Areas 4.a, 4.b, 5.b and 6.a). Data from the targeted fishery were used (daily catches when tusk made up more than 30% of the total catch) (Figure 6.6.26).

The combined Norwegian longline cpue series shows an increasing trend from 2000 to 2010, after this the cpue has remained at a high and stable level (Figure 6.6.22).

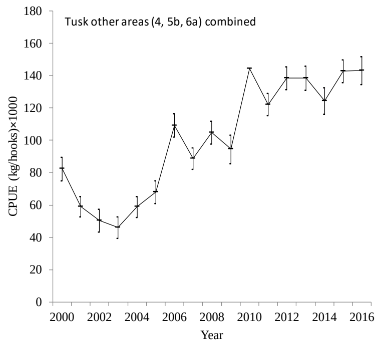


Figure 6.6.26. A combined cpue series for all "other tusk" areas for the period 2000–2016 based on data from the Norwegian longline fleet when tusk was targeted (>30% of total catch). The bars denote the 95% confidence intervals.

6.6.6.1 Biological reference points

See Section 6.6.9.

6.6.7 Comments on the assessment

The Norwegian longline cpue series based on the logbooks has now been 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, for the Faroes longline fishery in 5.b and for the Norwegian longline fisheries show a stable or positive trend since 2003 with a decrease during the last few years. In 4.a and 6.b the cpue series indicate a positive development of the stocks. Since the catches have been stable and the indicator series have been showing an increasing trend it is suggested not to apply the 20% buffer.

As always, it should be emphasized that commercial catch data are typically observational data; that is, there were no scientific controls on how or from where the data were collected. Therefore, it is not known with certainty if the tusk cpue series tracks the population and/or how accurate the measures of uncertainty associated with the series are (see, for example, Rosenbaum, 2002). Consequently, one must usually hope and pray that a cpue series, which is based only on commercial catch data, truly tracks abundance.

An infamous example of a misleading cpue series based on commercial data was a cpue series for Newfoundland cod that incorrectly indicated that the abundance of the cod stock was increasing greatly. Advice based on this cpue series ultimately caused the collapse of the stock (see, e.g. Pennington and Strømme, 1998).

In general, any assessment method based only on commercial catch data needs to be applied with caution. The reason that assessments using only commercial data are problematic is because the relation between the commercial catch and the actual population is normally unknown and probably varies from year to year.

6.6.9 Application of MSY proxy reference points

Two different methods were tested for tusk in other areas, the Length-based indicator method (LBI) and SPiCT.

The results for the LBI are very sensitive to the assumed values of L_{inf} and L_{mat}. In the combined areas, such as tusk other areas, the values used for L_{inf} and L_{mat} are sometimes based on data from only one of the subareas and not from the entire area combined. In this working document, the source of L_{inf} and L_{mat} has been identified and may in the future be recalculated to cover the entire area.

The value of L_{max} is often used for L_{inf}. For tusk, it is because the ageing of tusk is very difficult so the background values are not very reliable. Tusk is a deep-water species, so P_{mega} and L_{mean}/L_{opt} are not used for tusk.

In the SPiCT model landings data from 1988–2016 and the cpue based on data from the Norwegian reference fleet were used. The model converged and the retrospective plot showed that the test is robust.

A summary of the methods are given under:

Length-based indicator method (LBI)

The input parameters and the catch length composition for the period 2002–2016 are presented in the following tables and figures. The length data used in the LBI model are data from the Faroese and Norwegian longliners. The length data are not raised to total catch.

Input parameters for LBI.

DATA TYPE	YEARS/VALUE	SOURCE	NOTES
Length–frequency distribution	2002–2016	Faroese longliners fishing in Division 5.b	Data combined from both sources
	2002–2016	Norwegian longliners fishing in Divisions 4.a, 4.b, 5.b, 6.a	Lengths grouped into 2 cm bins
Length–weight relationship	$0.0161 * length^{2.9101}$	Norwegian longliners (Reference fleet) and survey data.	combined sexes
L_{MAT}	51 cm	Faroese survey data	
L_{inf}	125 cm (L_{max})	Norwegian longliners (Reference fleet)	

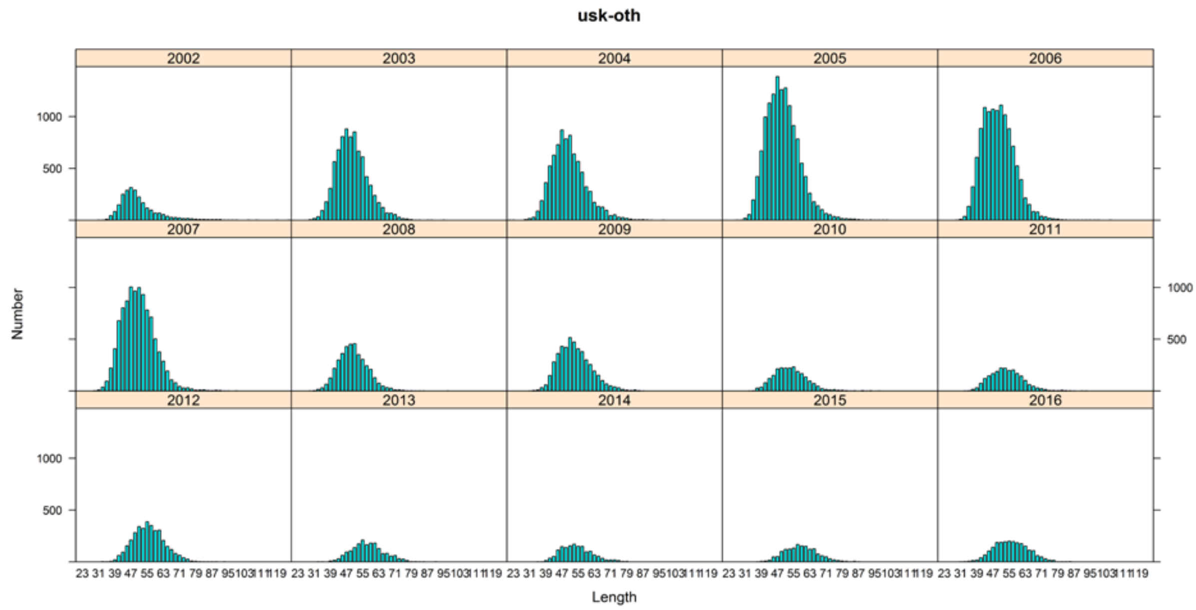
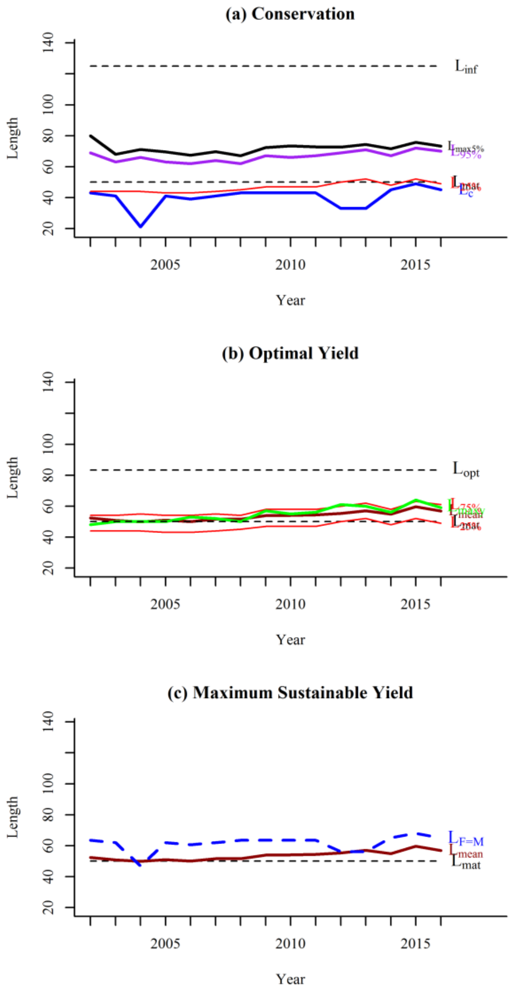


Figure 6.6.27. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Catch length distributions (2 cm bins) have not been raised to total catch for the period 2002–2016 (combined sexes).

Outputs

The length indicator ratios for combined sexes were examined for three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield are presented in the following figures.


(a) Conservation
Length
Year
L_{inf}
L_c
(b) Optimal Yield
Length
Year
L_{opt}
L_{mat}
(c) Maximum Sustainable Yield
Length
Year
$L_{F=M}$
L_{mean}
L_{mat}

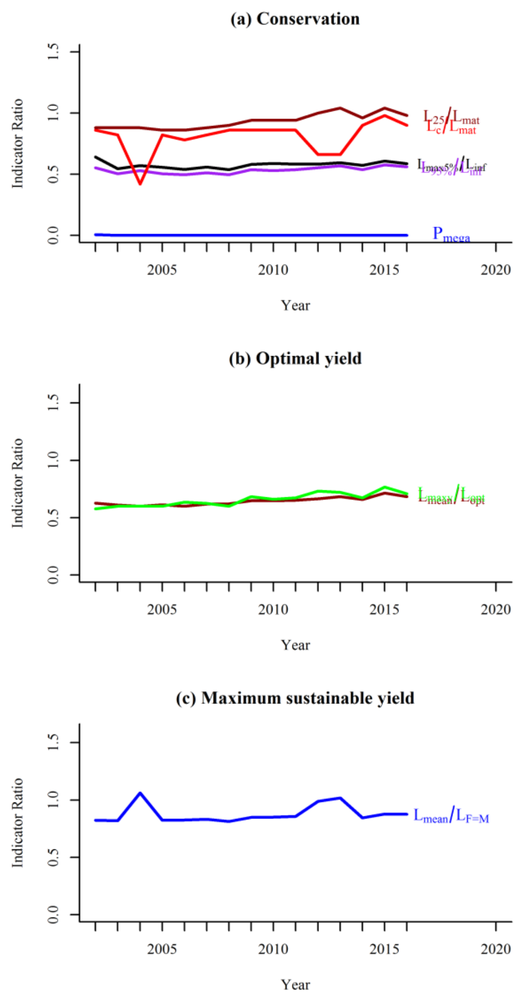


Figure 6.6.28. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Screening of length indicators ratios for sexes combined under three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

Analysis of results

The conservation model for immature tusk shows that both L_c/L_{mat} and $L_{25\%}/L_{mat}$ are usually less than 1, but usually greater than 0.8 (Figure 5.2). In 2014–2016, the ratios were greater than 0.9 (Table 5.2). Regarding the sensitivity of L_{mat}, there appears to be little or no overfishing of immature individuals. The estimate of L_{mat} is based on data from Division 5.b, so L_{mat} may differ in the other areas.

The conservation model for large individuals shows that the indicator ratio of $L_{max5\%}/L_{inf}$ was around 0.58 for the whole period (Figure 5.2), and between 0.57 and 0.61 during the period 2014–2016 (Table 5.2), which is less than the baseline, 0.8. The reason that the VBF results gave unusually low values of L_{inf}, was because the value used in the model was L_{max}. If we had used a smaller value of L_{inf}, then the indicator ratio would be higher. Since tusk is a deep-water and slow-growing species, the P_{mega} and L_{mean}/L_{opt} values used were probably incorrect.

The MSY indicator, $L_{mean}/L_{F=M}$, was less than 1 for almost the entire period (Figure 5.2), which indicates that tusk in other areas were fished unsustainably. It should be noted that if L_{inf} were set equal to L_{max}, then MSY would always have been greater than 0.8.

Table 5.2. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). The final results based on the LBI method.

	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	$L_{mean}/L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2014	0.90	0.96	0.57	0%	0.66	0.84
2015	0.98	1.04	0.61	0%	0.72	0.88
2016	0.90	0.98	0.59	0%	0.68	0.88

Conclusions

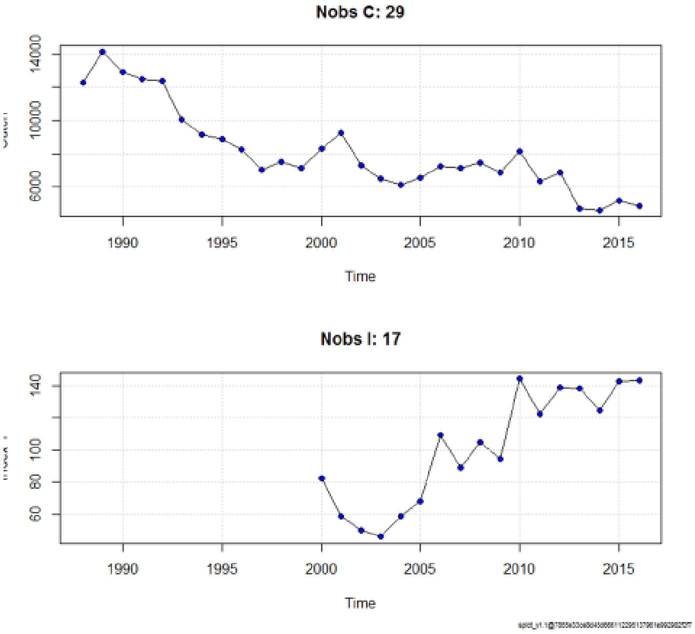
The overall perception of the tusk stock in these areas during the period 2014–2016, based on the LBI results, is that tusk seems to be overexploited and fished unsustainably (Table 5.3). However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

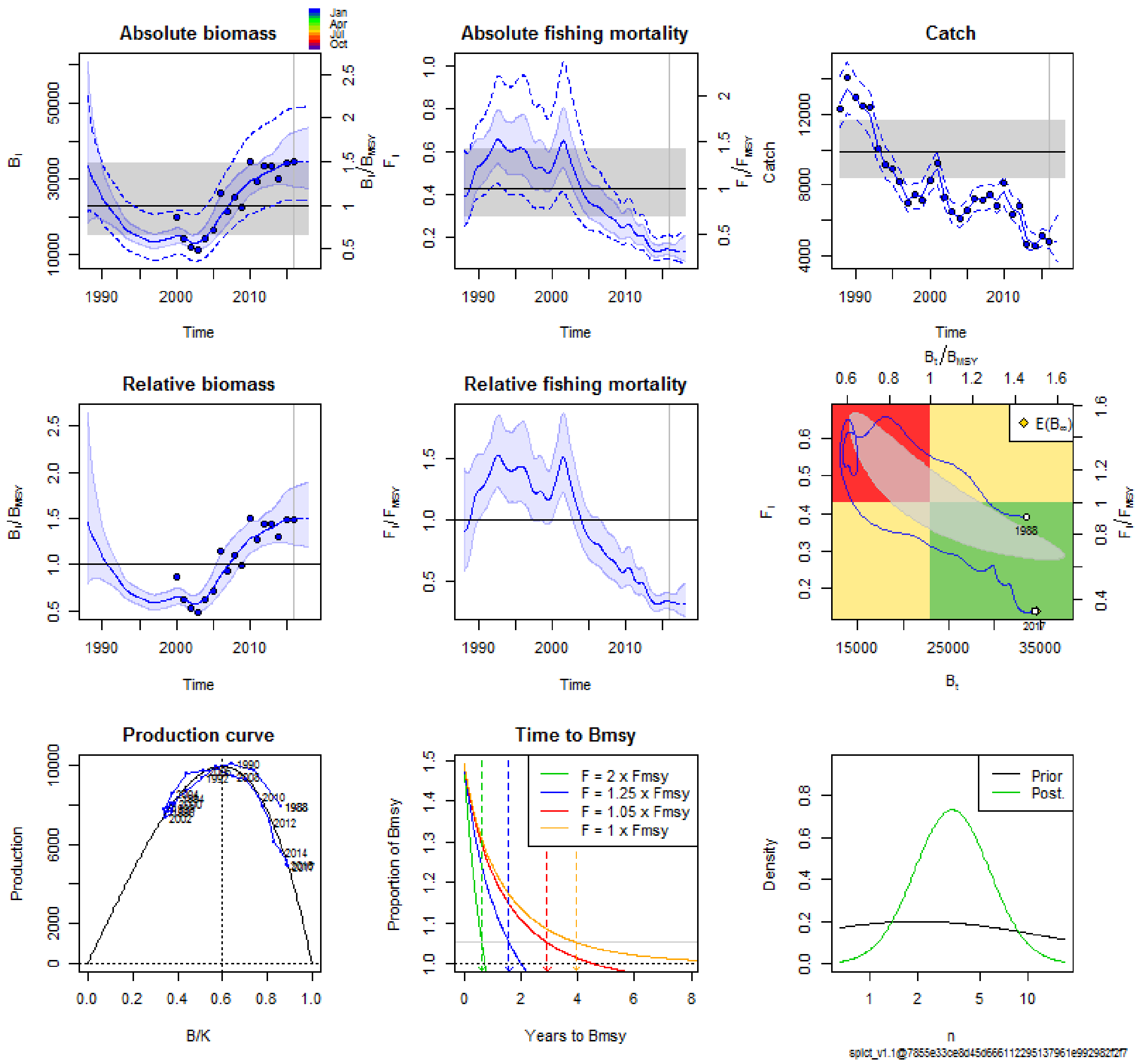
Table 5.3. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Stock status inferred from LBI for MSY. Red tick marks for MSY are provided because the $L_{mean}/L_{F=M}$ < 1 in each year. The MSY ($L_{mean}/L_{F=M}$) = 0.88 for year 2015 and 2016. Stock size is unknown as this method only provides the exploitation status.

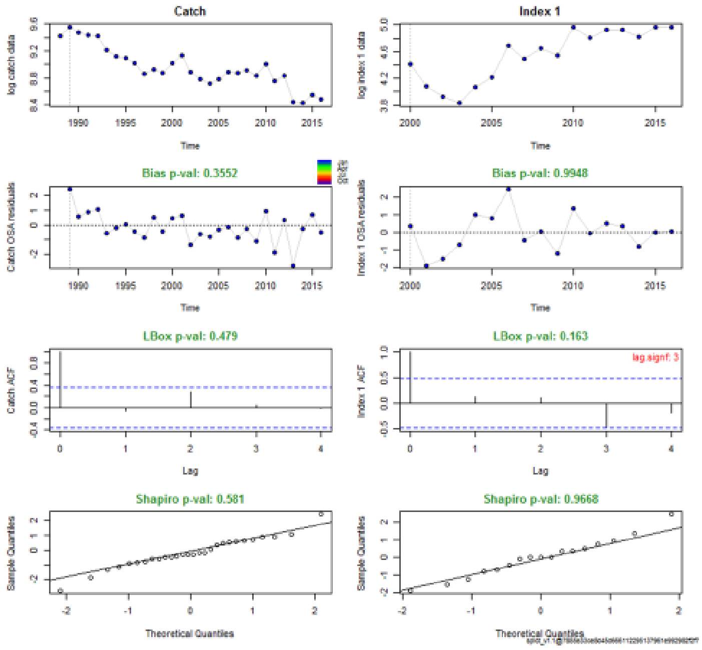
	Fishing pressure			
	2014	2015	**2016**	
MSY (F/F_{MSY})	✗	✗	✗	Fished unsustainably
	Stock size			
	2015	2016	**2017**	
MSY $B_{trigger}$ (B/B_{MSY})	?	?	?	Unknown

SPiCT

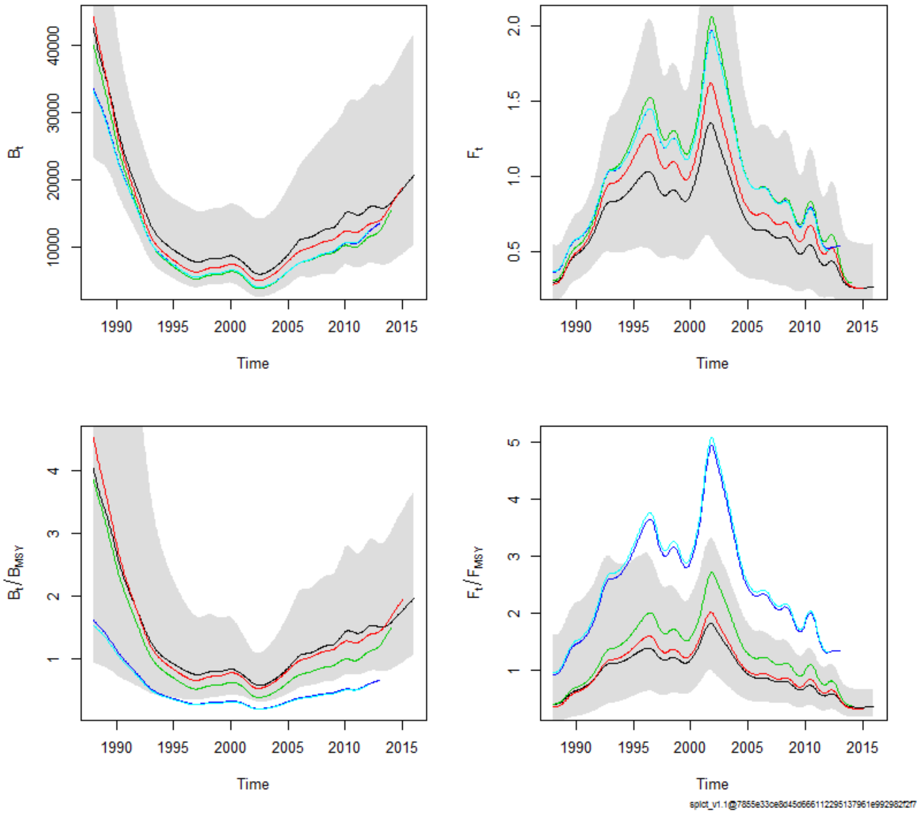
The SPiCT model was run on the cpue and catch data for tusk in other areas using the default settings. Due to time constrains various model settings were not tested and further work is needed before it can be concluded whether or not SPiCT is appropriate method for this stock. However the current results look promising.


Nobs C: 29
Time
Nobs I: 17
Time


Absolute biomass
Absolute fishing mortality
Catch
Relative biomass
Relative fishing mortality
Production curve
Time to Bmsy
F = 2 x Fmsy
F = 1.25 x Fmsy
F = 1.05 x Fmsy
F = 1 x Fmsy
Years to Bmsy
Proportion of Bmsy
Prior
Post.
Density
B/K
Production
Time



Catch
Index 1
log catch data
log index 1 data
Time
Bias p-val: 0.3552
Bias p-val: 0.9948
Catch OSA residuals
Index 1 OSA residuals
LBox p-val: 0.479
LBox p-val: 0.163
lag.signf: 3
Catch ACF
Index 1 ACF
Lag
Shapiro p-val: 0.581
Shapiro p-val: 0.9668
Sample Quantiles
Theoretical Quantiles



B_t
F_t
B_t/B_{MSY}
F_t/F_{MSY}
Time

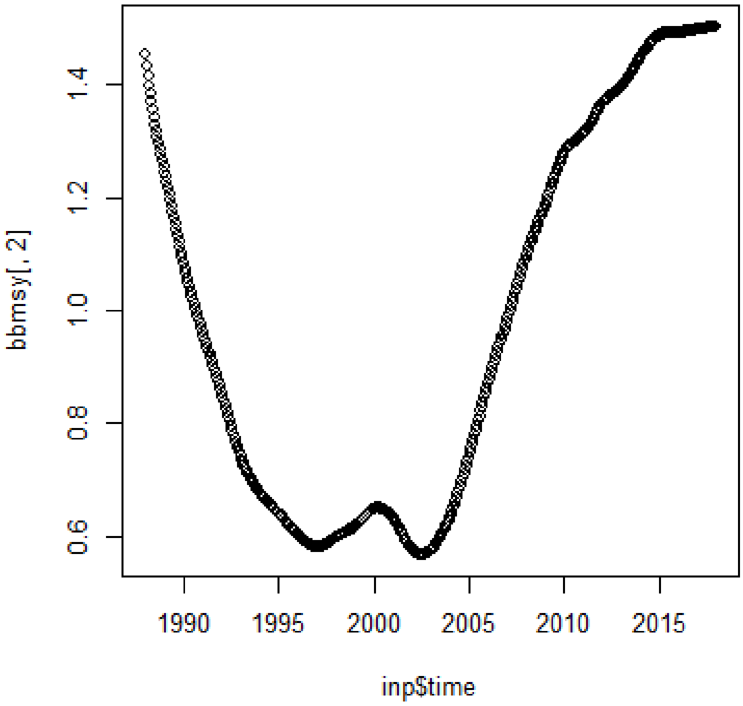

bbmsy[, 2]
0.6
0.8
1.0
1.2
1.4
1990
1995
2000
2005
2010
2015
inp$time

Table 6.6.1. Tusk 3.a, 4, 5.b, 6, 7, 8, 9. WG estimates of amount landed.

TUSK 3.a

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
2014	1	7	1	9
2015	1	7	1	9
2016*	1	12	1	14

***Preliminary.**

TUSK 4.a

Year	Denmark	Faroes	France	Germany	Norway	Sweden[1]	E & W	N.I.	Scotland	Ireland	Total
1988	83	1	201	62	3998	-	12	-	72		4429
1989	86	1	148	53	6050	+	18	+	62		6418
1990	136	1	144	48	3838	1	29	-	57		4254
1991	142	12	212	47	4008	1	26	-	89		4537
1992	169	-	119	42	4435	2	34	-	131		4932
1993	102	4	82	29	4768	+	9	-	147		5141
1994	82	4	86	27	3001	+	24	-	151		3375
1995	81	6	68	24	2988		10		171		3348
1996	120	8	49	47	2970		11		164		3369
1997	189	0	47	19	1763	+	16		238	-	2272
1998	114	3	38	12	2943		11		266	-	3387
1999	165	7	44	10	1983		12		213	1	2435
2000	208	+	32	10	2651	2	12		343	1	3259
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		11	3	1375		3		76		1510
2014	21		13	3	1365		3		58		1463
2015	24		6	2	1448	1	5		44		1530
2016	33		5	3	1565	1	4		39		1650

[1]) Includes 4.b 1988–1993.

***Preliminary.**

Table 6.6.1. (Continued).

Tusk 4.b

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		28						31
2014	2		9						11
2015	3		14	1					18
2016*	2		5		2				9

(1) Includes 4.c.

***Preliminary.**

TUSK 5.b1

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		1464	36		0				1500
2014		1764	32		511		3		2310
2015		1338	26		717				2081
2016*		1494	17		747		3		2261

1) Included in 5.b2 until 1996.

(2) Includes 5.b2.

(3) Reported as 5.b.

(4) 2000–2003 5.b1 and 5.b2 combined.

*** Preliminary.**

Table 6.6.1. (Continued).

TUSK 5.b2

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
2014		123			6	129
2015		323			1	324
2016*		42				42

[(1)]Includes 5.b1.

[(2)]See 5.b1.

[(3)]Included in 5.b1.

***Preliminary.**

TUSK 6a

Year	Denmark	Faroes	France (1)	Germany	Ireland	Norway	E & W	N.I.	Scot.	Spain	netherlands	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	191		1	1204			66	86		1594
2014		0	193			393			60	16		662
2015			200			866	1		63	62	1	1193
2016*		41	178		1	499			42	82	1	844

Not allocated by divisions before 1993.

*** Preliminary.**

Table 6.6.1. (Continued).

TUSK 7.a

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				
2013				
2014				
2015				
2016*				

***Preliminary.**

TUSK 7.b,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
2014		1					1
2015							0
2016*							0

***Preliminary.**

Table 6.6.1. (Continued).

TUSK 7.g–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
2014								0
2015								0
2016								0

***Preliminary.**

TUSK 8.a

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
2014			0
2015			0
2016*			0

***Preliminary.**

Table 6.6.1. (Continued).

Tusk, total landings by subareas or division.

Year	3	4.a	4.b	5.b1	5.b2	6.a	7.a	7.b,c	7.g–k	8.a	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	1510	31	1500	12	1594		4	0		4673
2014	9	1463	11	2310	129	662		1			4585
2015	9	1530	18	2081	324	1193		0			5155
2016	14	1650	9	2261	42	844		0			4820

***Preliminary.**

7 Greater silver smelt

7.1 Stock description and management units

At the WGDEEP 2014 it was suggested that unit arg-oth was split further into advisory units as fishing grounds are sufficiently isolated (WD, 2014). It was also suggested that further division may be adequate. This change was implemented at the WGDEEP meeting in 2015.

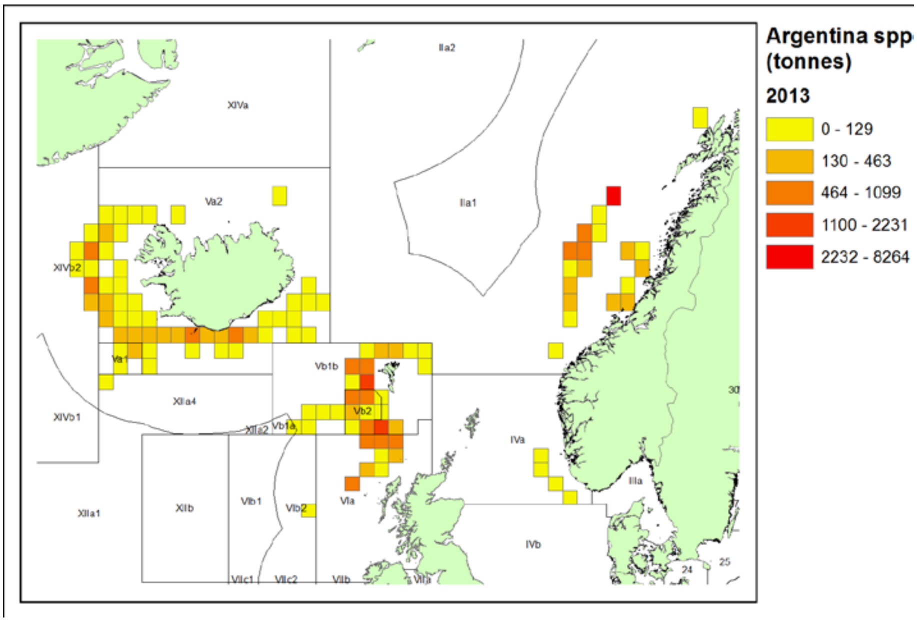


Figure 7.1.1. Catches of greater silver smelt by Iceland, Norway, Faroes and the Netherlands in 2013. Some catches of *A. Sphyraena* and *Argentina* unidentified may be included in the Norwegian and Dutch landings.

7.2 Greater silver smelt (*Argentina silus*) in 1, 2, 3.a and 4

7.2.1 The fishery

The targeted fishery is primarily conducted by Norwegian midwater and bottom trawlers in Division 2.a, and the fishery was initiated in the early 1980s. From the 1970s until the mid-1990s a smaller target fishery existed in Division 3.a (Skagerrak), but landings from that area have since been only minor bycatch.

In addition to the target fisheries in 2.a, trawl fisheries for other species along the Norwegian Deep in Division 4.a (northern North Sea) result in variable but sometimes significant landed bycatch of greater silver smelt. These landings can also contain, presumably minor, quantities of the lesser silver smelt (*Argentina sphyraena*) which has a more southern and shallower distribution then greater silver smelt.

7.2.2 Landing trends

International landings are summarised in Tables 7.2.1–72.4. The variation through the time-series primarily reflects the developments in the Norwegian target fisheries in Subarea 2. The landings from 4.a were estimated based on sampling of mixed-species catches at the fishmeal factories, and the quality of the process may have varied somewhat through the time-series.

From peak levels of 10 000 t to 11 000 t in the 1980s when the targeted fishery developed, the landings (primarily by Norway) from Subareas (1 and) 2 declined in the 1990s. Except for in 2001, when landings were 14 369 t, the landings remained relatively stable at 6–8000 t until 2003. In 2004 to 2006 landings increased sharply to reach 21 685 t in 2006. The monitoring of abundance was not satisfactory in that period, but the increase in landings did probably not reflect increased abundance. Since the fishery was not restricted by a TAC, it is thought that temporal variation in landings primarily reflected variation in the market demand. In 2007–2015 the Norwegian catches in targeted fisheries were around 12 000 t per year in accordance with annual TAC regulations reintroduced in 2007. In 2016 they increased to 13 115 t.

Since 2014 marked increase is observed in catches in area 3 and 4, and these have in 2016 risen to substantial 5669. Mostly they are bycatch taken at the southern slope of Norwegian trench, and the bulk of them are reported as lesser silver smelt. There are uncertainties on how well these landings are estimated and about species identification, and this should be addressed with better sampling in cooperation with the industry. In this report, all registered landings are assumed to be greater silver smelt.

In 2016 total landings were 18 893 t (Table 7.2.1–7.2.3). Landings from Subarea 2 were 13 122 t and the remainder was reported from 4 and 3.a.

7.2.3 ICES Advice

In 2015 ICES advised that, when the precautionary approach is applied, landings should be no more than 13 047 tonnes in each of the years 2016 and 2017. All catches are assumed to be landed.

7.2.4 Management

For a period after 1983 a Norwegian precautionary unilateral annual TAC applied in 2.a which was always the main fishing area. The landings never exceeded the quota and this regulation was abandoned in 1992. As landings increased substantially in the mid-2000s, a 12 000 t unilateral Norwegian TAC was introduced in 2007 and this TAC was maintained until 2015 when for 2016 it was increased to 13 047 t, which also was the TAC for 2016. The Norwegian target fishery is further regulated by a licensing system that limits the number of trawlers that can take part and specifies gear restrictions, bycatch restrictions, and an area- and time restriction. In 2016 there are 31 licences, but in recent years 21–26 actually took part in the fishery.

There is no Norwegian TAC for fisheries in 4.a and 3.a where targeted fisheries are prohibited, but bycatch restrictions apply. The EU introduced TAC management in 2003 applying to EU vessels fishing in the EU EEZ and international waters. For 2017 the EU TAC for 1+2 =90 t, and for 4.a + 3.a the TAC was 1028 t.

This management unit is not distributed in international waters, hence the 2016 TACs described above totalling 13 047 t (Norway) and 90 (EU;area 1 and 2) +1028 t (EU; 3 and 4) apply to Norwegian and EU waters, respectively.

7.2.5 Data available

7.2.5.1 Landings and discards

Landings data are presented by ICES Subareas and Divisions and countries (Tables 7.2.1–7.2.4, Figure 7.2.1–7.2.4). (Data from 2014–2016 were obtained from national official statistics (Norway) and InterCatch. From earlier years data are WG estimates based on national submissions to ICES which are not fully included in InterCatch.)

Discarding is banned in Norway and all catches are assumed to be landed. There is no information in InterCatch nor from other sources on discards from non-Norwegian fisheries on this management unit, but bycatches are assumed generally to be landed.

7.2.5.2 Length compositions

Length distributions are presented for target fishery catches from 2.a for the period 2009–2016 and for bycatches by Norwegian vessels in 4.a for the years 2011, 2013, 2014 and 2016 (Figure 7.2.4–7.2.7) For each year these distributions are derived by pooling multiple samples from landing sites and samples provided by commercial vessels (WD by Hallfredsson *et al.*, 2016).

Length information is available from the Norwegian slope survey in 2.a in March biennially 2009–2016 (Figure 7.2.8) (WD by Hallfredsson *et al.*, 2017).

Length information is available from the annual Norwegian shrimp survey in 3.a–4.a, 1984–2016 (Figure 7.2.9).

7.2.5.3 Age compositions

Age compositions from Norwegian catches in 2015 are presented in Figures 7.2.10.

Age distributions by depth from the Norwegian slope survey in 2 in March 2016 are shown in Figure 7.2.11.

7.2.5.4 Weight-at-age

No new data on weight-at-age were presented.

7.2.5.5 Maturity and natural mortality

No new data on maturity and natural mortality were presented.

7.2.5.6 Catch, effort and research vessel data

A trawl acoustic survey was conducted in 2016 along the continental slope in Norwegian EEZ from 62–74°N (WD16 Hallfredsson *et al.*, 2017). This survey was the fourth in a biennial series. Highest densities of greater silver smelt in 2016 were found in similar areas as in previous surveys, i.e. on the shelf break and in shelf troughs off central Norway (Figure 7.2.12). Additionally, trawl surveys were conducted in 2.a in 2003–2005. Biomass estimates based on the acoustic observations and trawl swept area estimates show increasing trend since 2012 (Table 7.2.5, Figure 7.2.13). Greater silver smelt has been distributed rather evenly from 300–500 m depth in the surveys according to acoustics, which is in contrast to the catches that are mostly conducted at depths around 300–400 m (Figure 7.2.14).

Incidence and abundance indices for greater silver smelt from the annual Norwegian shrimp survey in 3.a and southeastern parts of 4.a are shown in Figure 7.2.15.

7.2.6 Data analyses

Length and age distributions

In Division 2.a size and age distributions from target fisheries (Figures 7.2.5 and 7.2.10) continue to consist of rather smaller and younger fish than catches in the 1980s during the initial years of the target fisheries (Bergstad, 1993; Monstad and Johannessen, 2003; Johannessen and Monstad, 2003). There are, however, no changes in the size and age composition in the recent seven years when the target fishery has been regulated with TACs and other measures. Length and age distributions in the Norwegian survey sampling the entire geographical and depth range show higher length and age ranges, however, with deeper than 400 m samples having proportion of old fish closer to those observed in the 1980s (Figure 7.2.11). The fishery is mainly conducted shallower than 400 m (Figure 7.2.14).

In Division 3.a there has been a declining trend in the length distributions throughout the 1984–2016 shrimp survey time-series, but with some reappearance of large fish in the most recent years (Figure 7.2.9).

In Division 4.a size distributions from the bycatch (Figures 7.2.6 and 7.2.7) suggest that the catches comprise rather variable but smaller fish than those in the target fishery landings in 2.a. This probably reflects that the slope of the Norwegian Deep in 4.a is comparatively shallow and is mainly a juvenile area and feeding area for dispersed large fish out with the winter-spring aggregatory phase (Bergstad, 1993).

Commercial and survey cpue series

For Division 2.a fisheries, both acoustic and trawl indices show similar upward trend in recent years (Table 7.2.5, Figure 7.2.13). The geographical distribution and pattern of aggregations in 2016 appeared similar to those observed in earlier surveys (Figure 7.2.12). There is a rather high CV in the trawl estimates, and the acoustic biomass estimates are considerably higher than the trawl indices. It is possible that this reflects that the trawl indices don't show the more pelagic part of the vertical distribution of this bento-pelagic fish. One should however be careful in the interpretation of absolute biomass values from different methods, and the comparison might thus not be fully appropriate. It is reassuring that both methods show similar trends.

The catch rates in terms of numbers and weight from the Norwegian shrimp survey (1984–2016) in 3.a and 4.a suggest pronounced variation and trends (Figure 7.2.15). The survey catch rates first declined steadily and then rather abruptly to unprecedented low levels in 2005. Since 2005, indices have increased steadily and they are now at similar levels to the start of the series in 1985. The decline in abundance until 2005 was also reflected in a decrease in incidence and size.

Exploratory assessment

An exploratory assessment was conducted and presented at the meeting, using the SPiCT model. The model was run with different input data, but only the option of catch data from 2002–2016 data combined with the trawl index did perform. The model estimated a relatively realistic MSY, but the B_{MSY} was unrealistically low and F_{MSY} was high (Table 7.2.6, Figures 7.2.16 and 7.2.17). The approach might prove promising, but needs further development for this stock.

Existing abundance, length and age dataseries for this stock are rather short in time. However, if the time-series are maintained they may support more analytical assessment in near future.

7.2.7 Comments on the assessment

The ICES framework for category 3 stocks was applied (ICES, 2012). For draft advice, the Norwegian acoustic survey in Subarea 2 was applied as an index for the stock development. The advice is based on a comparison of the two latest index values with the three preceding values, combined with average catches in recent years. For years where index values are not available the values are obtained by interpolation).

The index is estimated to have increased by more than 20% which means that the uncertainty cap was applied to calculate the catch advice. The stock status relative to candidate reference points is unknown. The precautionary buffer was applied in 2015 therefore it is not applied again. Discarding is considered negligible.

7.2.8 Management considerations

Advice is given every second year for this stock and the 2017 advice applies for 2018 and 2019.

The size and age distributions of landings in the major fishery, i.e. the target fishery in the Norwegian EEZ, remains stable, suggesting that the prior decline in the proportions of large fish in the catches observed during the first decades of the fishery has halted. Furthermore, corresponding data from Norwegian surveys show that larger and older fish occur in adjacent and deeper areas than the areas being used by the fishery. The fishing areas (both for the target fishery and bycatch fisheries) have remained the same since the early 1980s. The exception is the 3.a where a target fishery was conducted until the mid-1990s but not since.

Acoustical biomass estimates for Division 2.a in 2012 showed some reduction compared to 2009, but a marked upward trend again since then, as does the trawl index.

The Norwegian shrimp survey data from Division 3.a suggest that the abundance in that area has increased in recent years after an abrupt decline in 2004–2005. The apparently rather rapid increase in the abundance index in recent years may suggest that immigration from northern areas (in 4.a or 2.a) may have happened. The abrupt decline in 2005 may partly have resulted from high incidental mortality due to greater silver smelt being a bycatch in the roundnose grenadier fishery which peaked in 2003–2005.

The bycatch in area 4 has increased rapidly since 2012, and was 5669 tonnes in 2016. This is an alarming level. There are uncertainties in how this bycatch is estimated in this, as it is an industry fishery for reduction. Additionally, most of these catches are registered as lesser silver smelt, but there are strong reasons to assume that these for the most are greater silver smelt catches. These matters need to be more thoroughly investigated.

Table 7.2.1. Greater Silver Smelt in 1, 2, 3.a and 4 by countries. WG estimates of landings in tonnes. ICES official statistics.

YEAR	DENMARK	SWEDEN	IRELAND	GERMANY	NETHERLANDS	NORWAY	POLAND	RUSSIA/USSR	SCOTLAND	FRANCE	FAROES	ICELAND	SUM
1966	0	0		0		156							156
1967	0	0		0		3							3
1968	0	0		0		0							0
1969	0	0		0		0							0
1970	0	0	0	0	0	339			0	0			339
1971	0	0	0	0	0	116			0	0			116
1972	0	0	0	0	0	77			0	0			77
1973	0	0	0	21	0	110			0	0			131
1974	0	0	0	0	0	0			0	0			0
1975	0	0	0	0	0	500			0	0			500
1976	0	0	0	0	0	1034			0	0			1034
1977	0	0	0	0	0	478			0	0			478
1978	0	0	0	428	0	1500			0	0			1928
1979	0	0	0	64	0	640			0	0			704
1980	0	0	0	22	0	156			0	0			178
1981	0	0	0	18	0	183			0	0			201
1982	4654	0	0	0	0	610			0	0			5264
1983	8539	0	0	0	0	671			0	0			9210
1984	6293	0	0	0	0	442			0	0			6735
1985	996	0	0	0	0	1070			0	0			2066
1986	0	0	0	0	0	762			0	0			762
1987	190	0	0	2	0	1141			0	0			1333
1988	1062	0	0	1	0	13014	5	14	0	0	0	0	14096
1989	1322	0	0	0	335	10495	0	23	1	0	0	0	12176
1990	737	0	0	13	5	10686	0	0	0	0	0	0	11441
1991	1421	0	0	0	3	8864	0	0	6	1	0	0	10295
1992	3564	0	0	1	70	8932	0	0	101	0	0	0	12668
1993	2353	0	0	0	298	8481	0	0	56	0	0	0	11188

YEAR	DENMARK	SWEDEN	IRELAND	GERMANY	NETHERLANDS	NORWAY	POLAND	RUSSIA/USSR	SCOTLAND	FRANCE	FAROES	ICELAND	SUM
1994	1118	0	0	0	0	6221	0	0	614	0	0	0	7953
1995	1061	0	0	357	0	6419	0	0	20	0	0	0	7857
1996	1446	0	0	0	0	6817	0	0	0	0	0	0	8263
1997	1455	542	0	1	0	5167	0	0	0	0	0	0	7165
1998	748	428	0	169	277	8655	0	0	0	0	0	0	10277
1999	1420	0	0	0	7	7151	0	0	18	0	0	0	8596
2000	1039	273	10	0	3	6107	0	195	18	9	0	0	7654
2001	907	1011	3	0	0	14360	0	7	233	28	0	0	16549
2002	614	484	4	0	0	7406	0	0	164	0	0	0	8672
2003	918	42	0	4	617	8351	0	7	22	4	4	0	9969
2004	910	0	36	4	4277	11574	0	4	12	0	0	0	16817
2005	470	0	0	1	28	17066	0	16	0	0	14	0	17595
2006	335	0	0	6	0	25149	0	4	2	0	0	0	25496
2007	0	0	0	0	0	16373	0	1	0	0	0	0	16374
2008	0	0	0	0	0	13424	0	0	0	0	0	0	13424
2009	0	0	0	0	0	13495	0	0	0	0	0	0	13495
2010	0	0	0	0	0	12865	0	0	33	0	0	0	12898
2011	0	0	0	0	0	12060	0	0	0.4	4	0	0	12064.4
2012	0	0	0	0	0	12352	0	0	0	1.2	114	18	12485.2
2013	0	0	0	0	0	13227	0	0	0	2.3	0	0	13229.3
2014	40	1	0	204	345	14471	0	0	0	1	0	0	15062
2015	0	1	0	0	0	15235	0	0	0	0	0	0	15236
2016	0	1	0	38	11	18835	0	7	0	1.4	0	0	18893.4

Table 7.2.2. Greater Silver Smelt in 1 and 2. WG estimates of landings in tonnes.

Year	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Iceland	TOTAL
1988			11332	5	14					11351
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			14357		7	5				14369
2002			7405			2				7407
2003		575	8345		7	2	4	4		8937
2004		4235	11557		4					15796
2005			17063		16			14		17093
2006			21681		4					21685
2007			13272		1					13273
2008			11876							11876

Year	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Iceland	TOTAL
2009			11929							11929
2010			11831			23				11854
2011			11476			0.4				11476
2012			12002				0.2	114	18	12134
2013			11978				0.3			11979
2014			11752							11752
2015			12049							12049
2016			13115		7		0.4			13122

Table 7.2.3. Greater Silver Smelt in 3. WG estimates of landings in tonnes. Figures in parentheses are discards as recorded in InterCatch.

Year	Denmark	Germany	Norway	Sweden	TOTAL
1966			156		156
1967			3		3
1968					
1969					
1970			106		106
1971			26		26
1972					
1973		20			20
1974					
1975			496		496
1976			1034		1034
1977			273		273
1978		25	1435		1460
1979			640		640
1980			156		156
1981			173		173
1982	4376		140		4516
1983	7733		221		7954
1984	5588		317		5905
1985	10		281		291
1986			676		676
1987	190		768		958
1988	1062		27		1089
1989	938		236		1174
1990	732		1150		1882
1991	1421		800		2221
1992	3564		634		4198
1993	2343		487		2830
1994	1108				1108
1995	1061				1061
1996	1389		159		1548
1997	1455		703	542	2700
1998	748		413	428	1589
1999	1420		2		1422
2000	1039		4	273	1316
2001	907			1011	1918
2002	614			484	1098
2003	918			42	960
2004	910		1		911
2005	470				470
2006	324				324
2007					0

Year	Denmark	Germany	Norway	Sweden	TOTAL
2008					0
2009					0
2010					0
2011					0
2012					0
2013					0
2014			2	1	3
2015			22	1	23
2016			101	1	102

Table 7.2.4. Greater Silver Smelt in 4. WG estimates of landings in tonnes. Figures in parentheses are discards as recorded in InterCatch.

Year	Denmark	France	Germany	Netherlands	Norway	Scotland	Ireland	TOTAL
1970					233			233
1971					90			90
1972					77			77
1973			1		110			111
1974								
1975					4			4
1976								
1977					205			343
1978			403		65			493
1979			64					64
1980			22					22
1981			18		10			28
1982	278				470			748
1983	806				450			1256
1984	705				125			830
1985	986				789			1775
1986					86			86
1987			2		373			375
1988			1		1655			1656
1989	384			335	1892	1		2612
1990	5		13		421			439
1991		1		3	323	6		333
1992			1	70	64	101		236
1993	10			298	81	56		445
1994	10				4	24		38
1995					1	20		21
1996	57				54			111
1997			1		1			2
1998			129	277	21			427
1999				7	4			11
2000		7			28		10	45
2001		28			3	228	3	262
2002					1	162	4	167
2003			4	42	6	20		72
2004			4	42	16	12	36	110
2005			1	28	3			32
2006	11		6		3468	2		3487
2007					3101			3101
2008					1548			1548
2009					1566			1566
2010					1034	10		1044
2011		4			584			588

Year	Denmark	France	Germany	Netherlands	Norway	Scotland	Ireland	TOTAL
2012		1			350			351
2013		2			1249			1251
2014	40 (7)	1	204	345	2717			3307(7)
2015*					3164			3164
2016		1	38	11	5619			5669

Table 7.2.5. GSS in 2.a. Biomass estimates (t) for greater silver smelt in Norwegian slope surveys conducted in March 2009, 2012 and 2014. For acousic methods see Harbitz, WD ICES, WKDEEP 2010.

	Swetp-area, bottom trawl							Acoustics				
Area	**SW**	**SE**	**NW**	**NE**	**Total**	**std**	**CV**	**SW**	**SE**	**NW**	**NE**	**Total**
2004					43978	20366	0.46					
2005					114644	39648	0.35					
2009	24171	44961	484	997	70613	18952	0.27	122026	91901	1069	1787	216783
2012	4505	28778	1053	155	34491	12996	0.38	66961	96643	10941	3352	177897
2014*	104726	18818	2769	0	126313	98011	0.78	209771	111156	7216		328143
2016	53868	118059	4256	47	176230	81894	0.46	113942	456046		1573	571561

SW = Latitude < 70°N, depth 500–750 m.

SE = Latitude < 70°N, depth 300–500 m.

NW = Latitude > 70°N, depth 500–750 m.

NE = Latitude > 70°N, depth 300–500.

***In 2014 the survey was conducted without the use of a midwater trawl. This might reduce accuracy and precision of the estimates because the allocation of backscattering strength to species categories in the pelagic zone could not be supported by catch information from targeted trawl tows.**

Table 7.2.6. Results from the experimental SPiCT assessment.

Determinitic	reference	points	(Drp)			
		estimate	cilow	ciupp	log.est	
	Bmsyd	19029	4420	81918	10	
	Fmsyd	0.88	0.22	3.48	-0.13	
	MSYd	16726	12850	21771	10	
Stochastic	reference	points	(Srp)			
		estimate	cilow	ciupp	log.est	rel.diff.Drp
	Bmsys	18272	4027	82904	10	-0.041
	Fmsys	0.88	0.22	3.47	-0.13	0.000
	MSYs	16062	12140	21252	10	-0.041

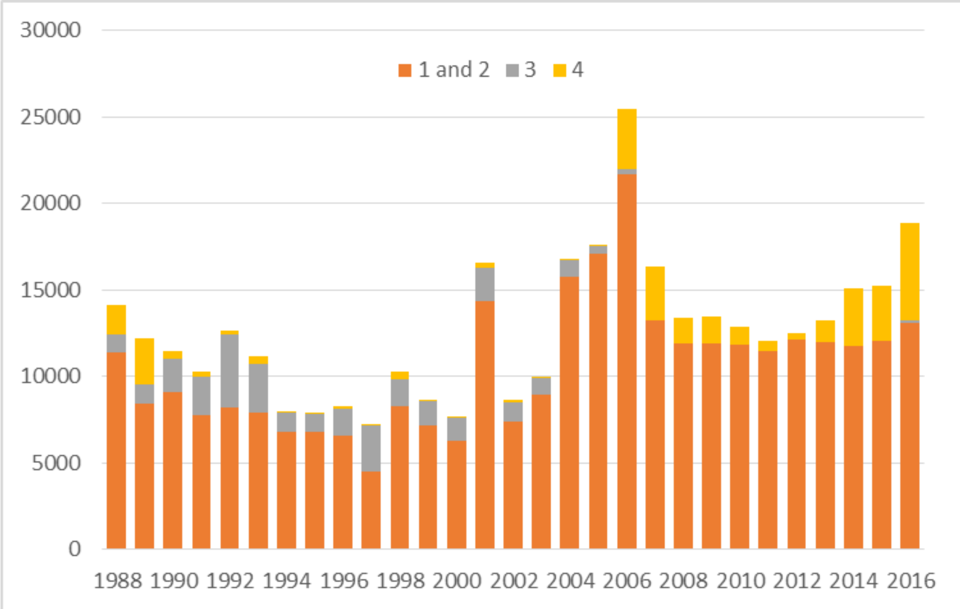


Figure 7.2.1. Total landings of greater silver smelt in Subareas 1, 2, 3 and 4.

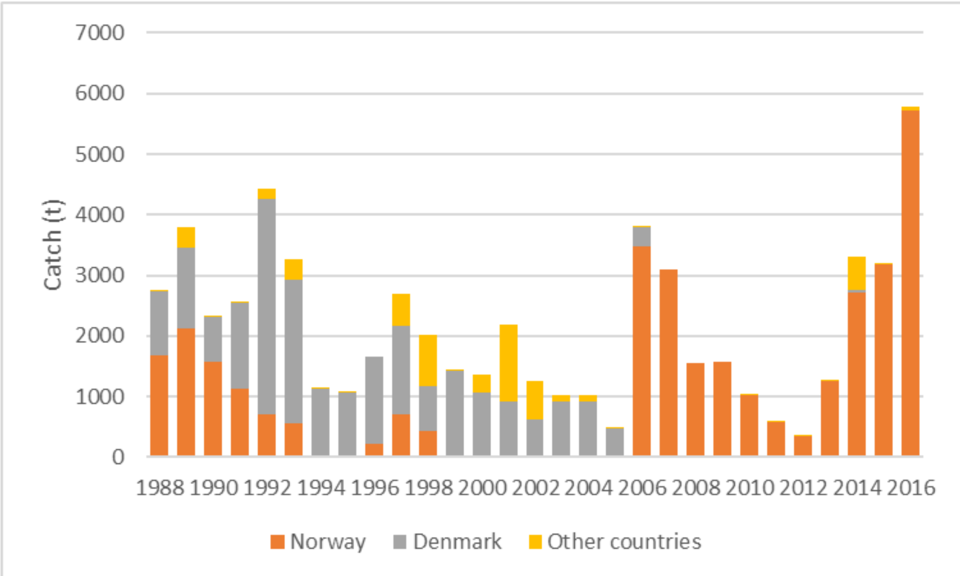


Figure 7.2.2. Total landings of greater silver smelt in Subareas 3 and 4, by countries.

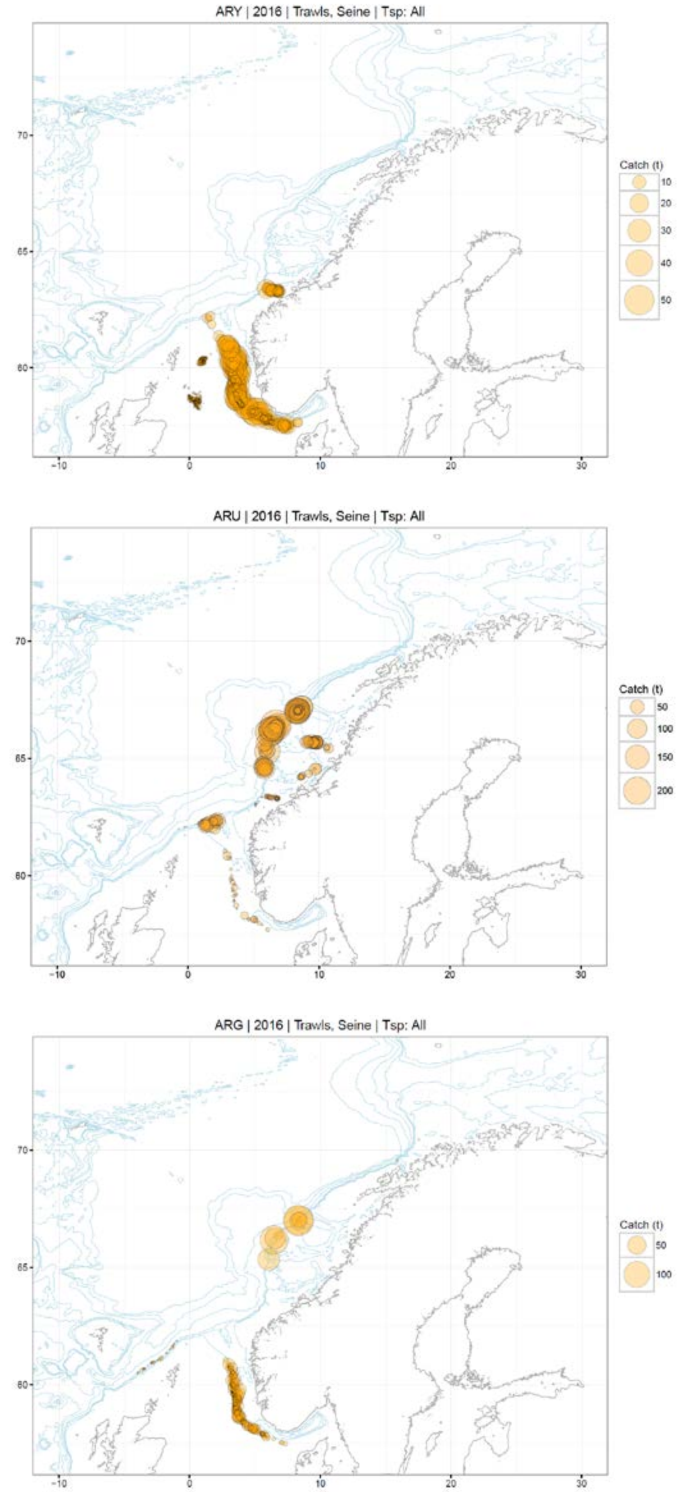
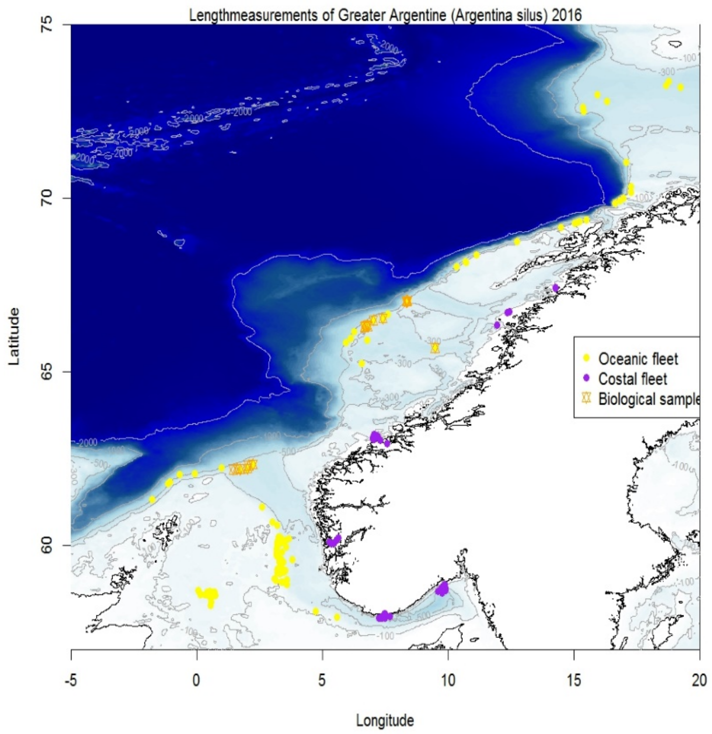


Figure 7.2.3. Norwegian catches in 2016 based on logbooks, included bycatch. Uppermost, middle and lowermost panels show catches registered as lesser silver smelt, greater silver smelt and mix of both species, respectively. Bubble sizes reflect sizes of single catches. NB: Catch representing max bubble size varies between panels.



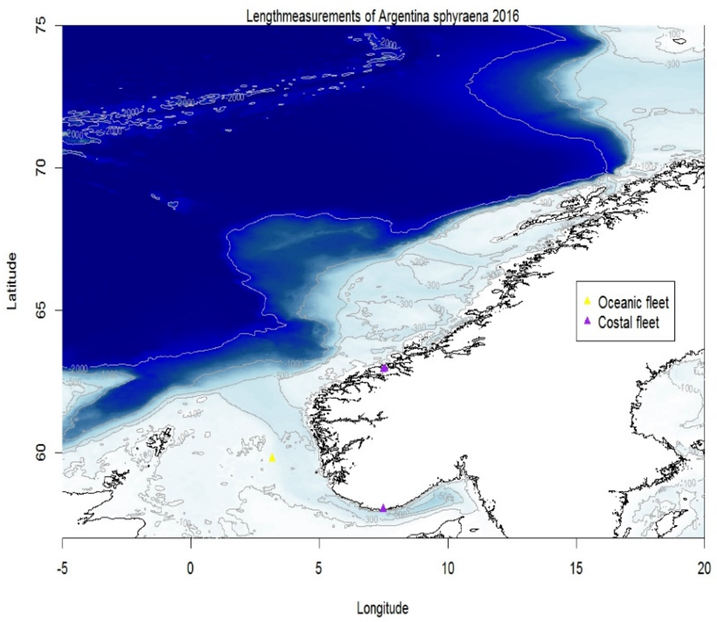


Figure 7.2.4. Positions for the greater silver smelt (upper panel) and lesser silver smelt (lower panel) catches that samples were taken from in 2016.

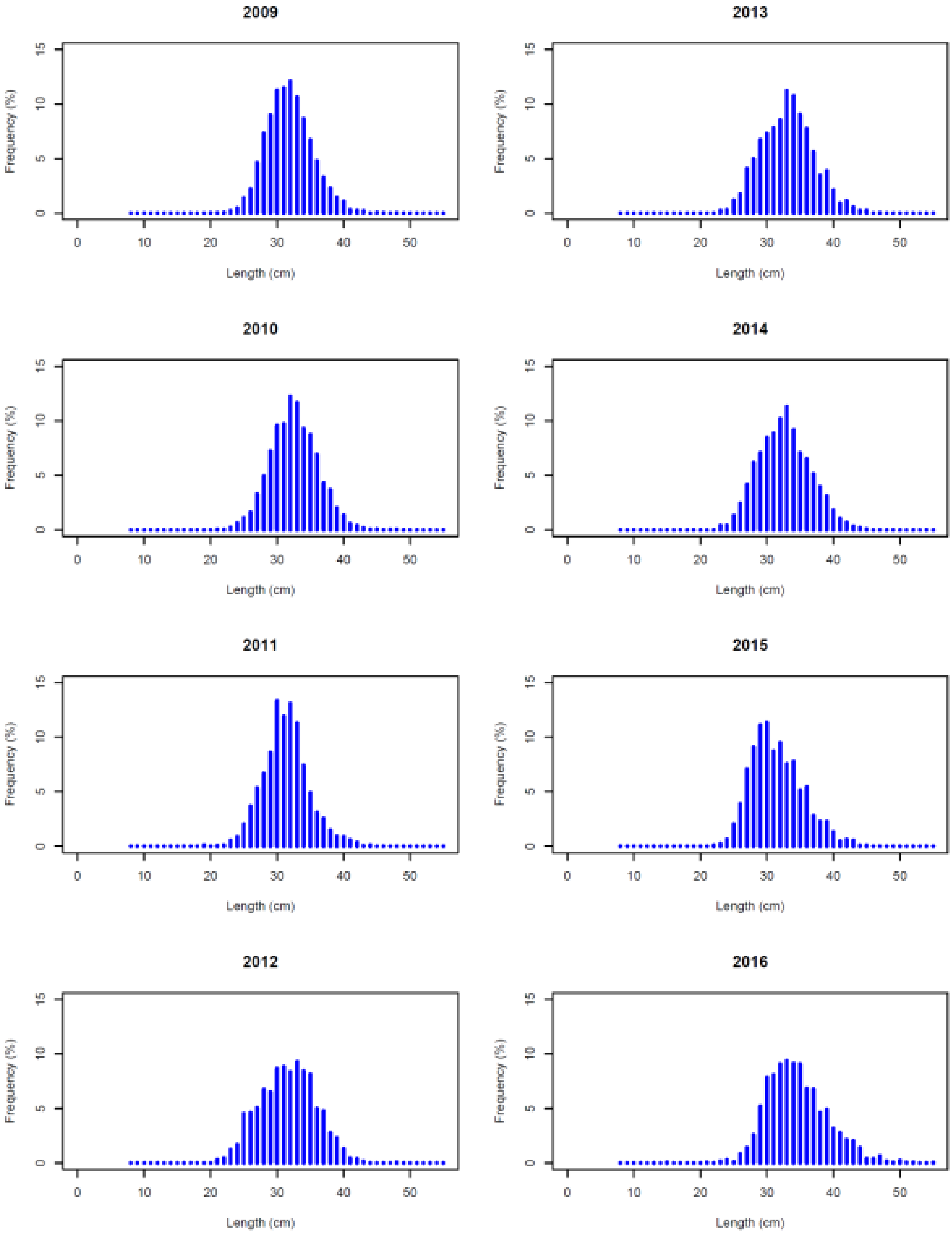


Figure 7.2.5. Greater silver smelt in 1, 2, 4 and 3.a. Length distributions from the target fisheries in 2009–2016 north of 62°N (approximately area 1 and 2). For each year, the distributions were derived by pooling samples from all fishing grounds in (WD Hallfredsson *et al.*, 2017).

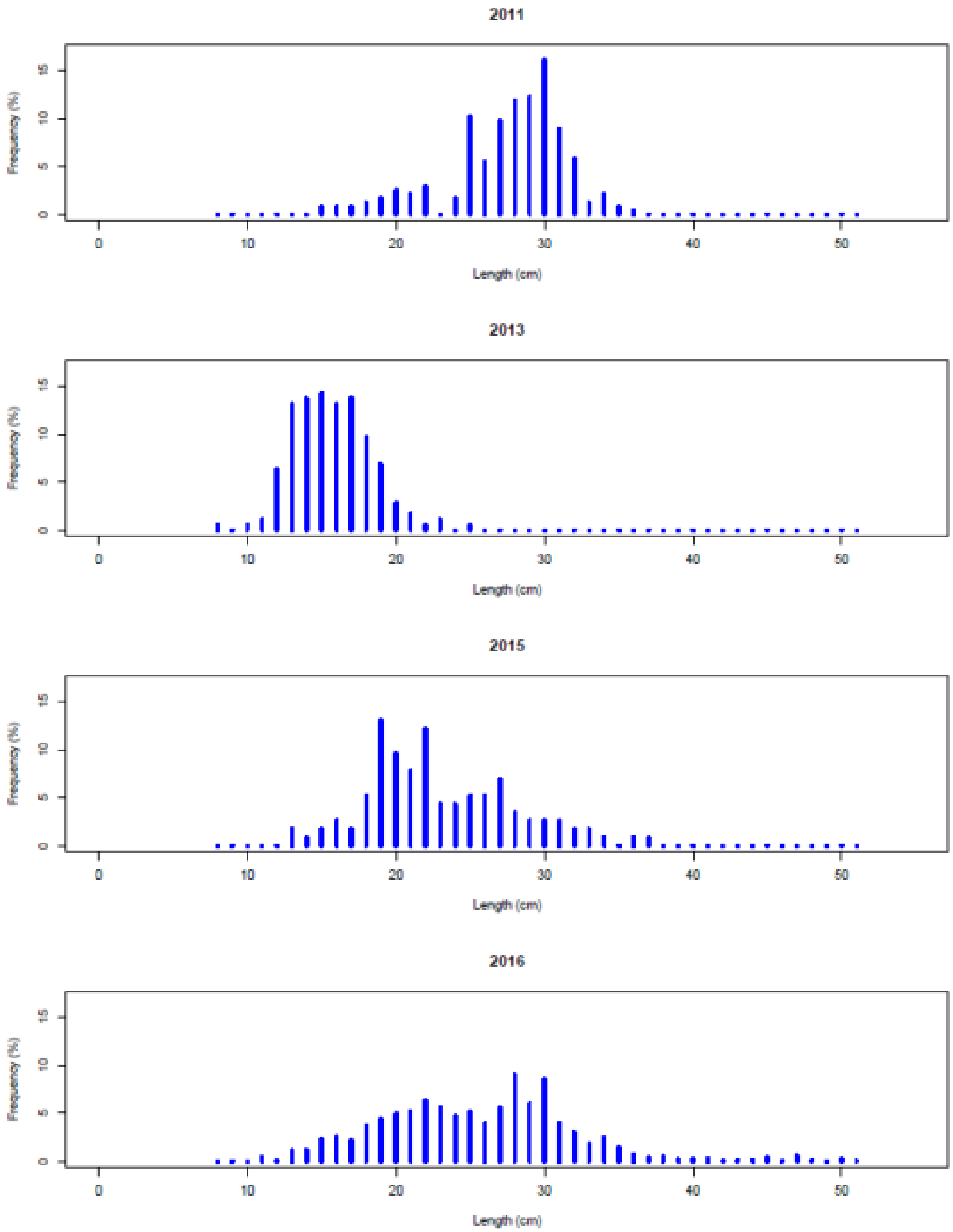


Figure 7.2.6. Greater silver smelt in 1, 2, 3.a and 4. Length distributions in annual samples from Norwegian bycatches south of 62°N (approximately area 3 and 4.). For each year, the distributions were derived by pooling samples from all fishing grounds in (WD Hallfredsson *et al.*, 2017).

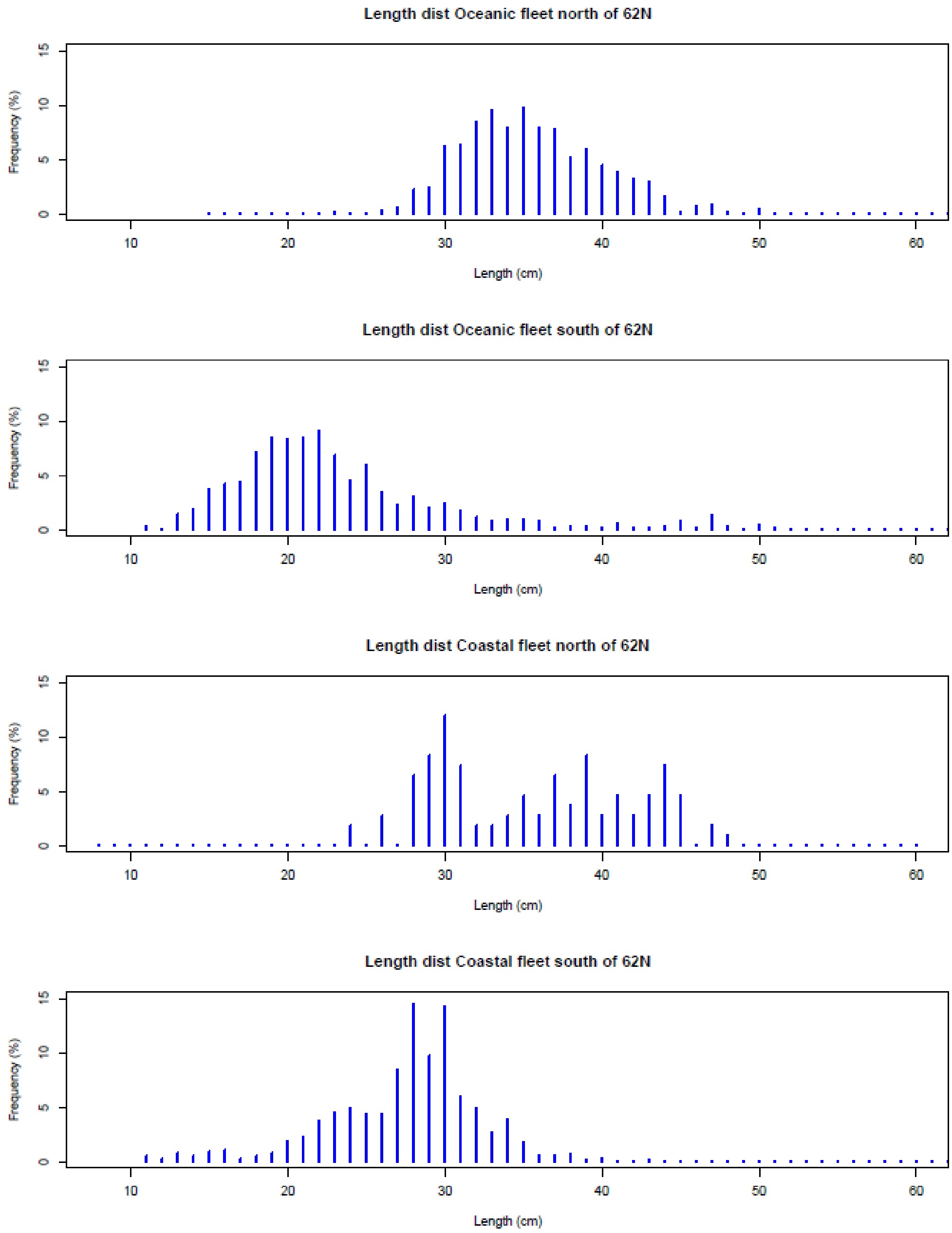


Figure 7.2.7. Length distributions from the fisheries north and south of 62°N, devided by if samples came from ocanic vs. coastal fleeds. The distribution were derived by pooling all samples from all fishing areas. The distributions were derived by pooling samples from all fishing grounds in (WD Hallfredsson *et al.*, 2017).

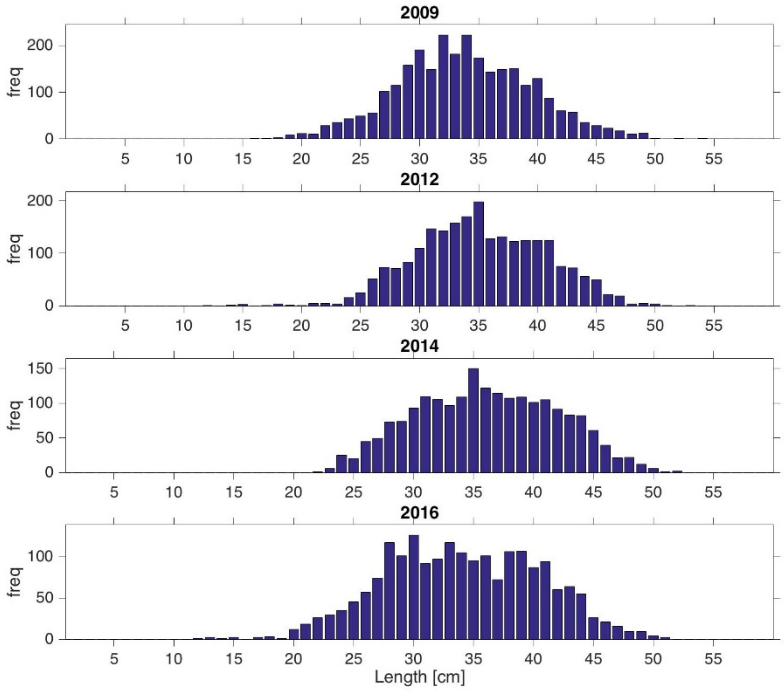


Figure 7.2.8. Length frequencies for Argentine in Norwegian slope survey in 2009, 2012, 2014 and 2016. No apparent substantial difference between years is seen, and few individuals have lengths outside the range 20–50 cm.

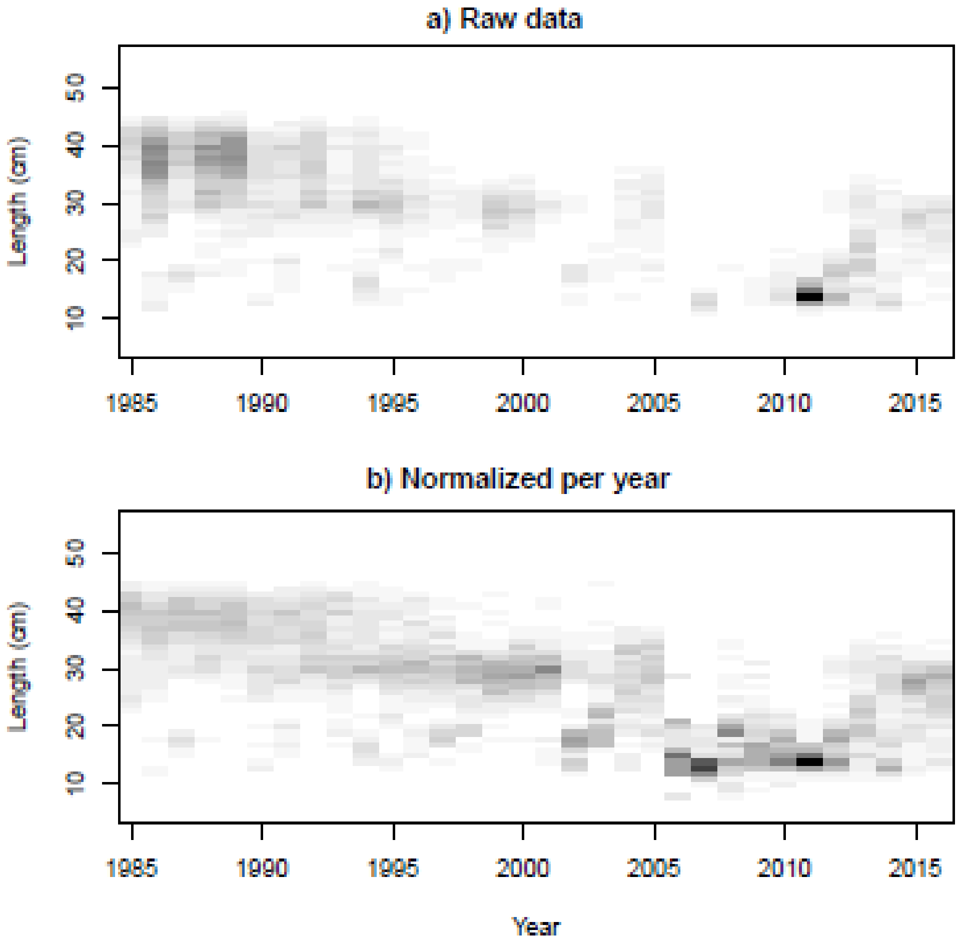


Figure 7.2.9. Greater silver smelt in 1, 2, 3, and 4. Length distributions from the annual Norwegian shrimp survey in 3.a and eastern parts of 4.a, 1985–2016 (from Hallfredsson *et al.*, 2016, WD for WGDEEP).

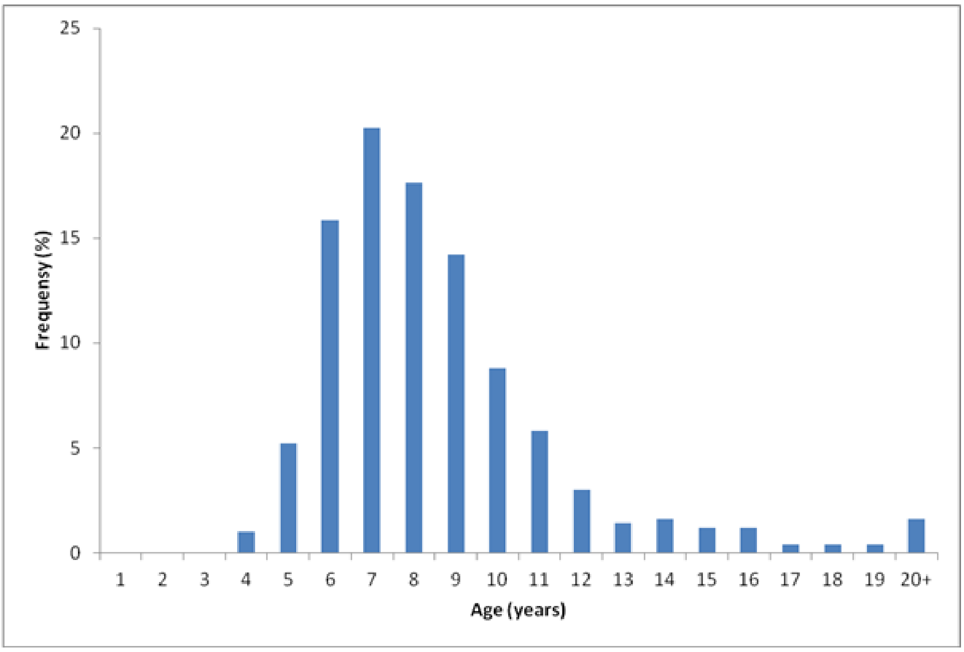


Figure 7.2.10. Greater silver smelt in 1, 2, 3, and 4. Age composition of pooled Norwegian landings samples, 2015. (Hallfredsson *et al.*, 2016, WD to WGDEEP).

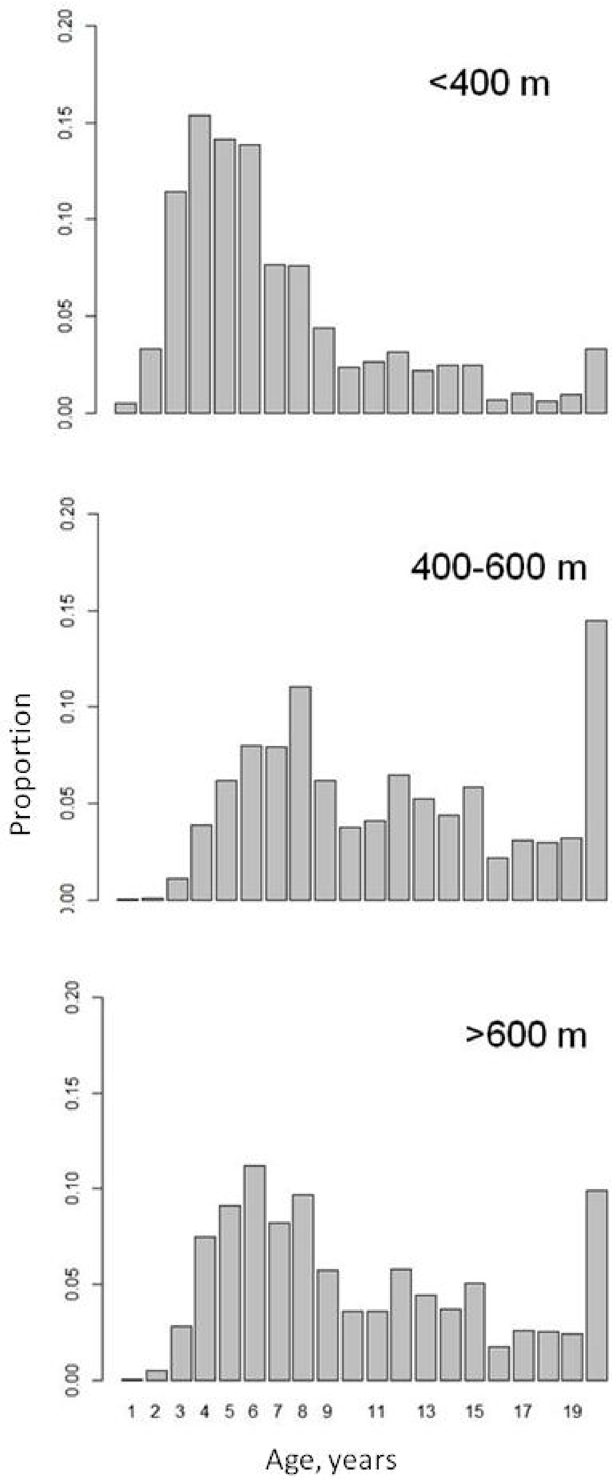


Figure 7.2.11. Greater silver smelt in 1, 2, 3, and 4. Age compositions by depth zones in the Norwegian slope survey in March–April 2016.

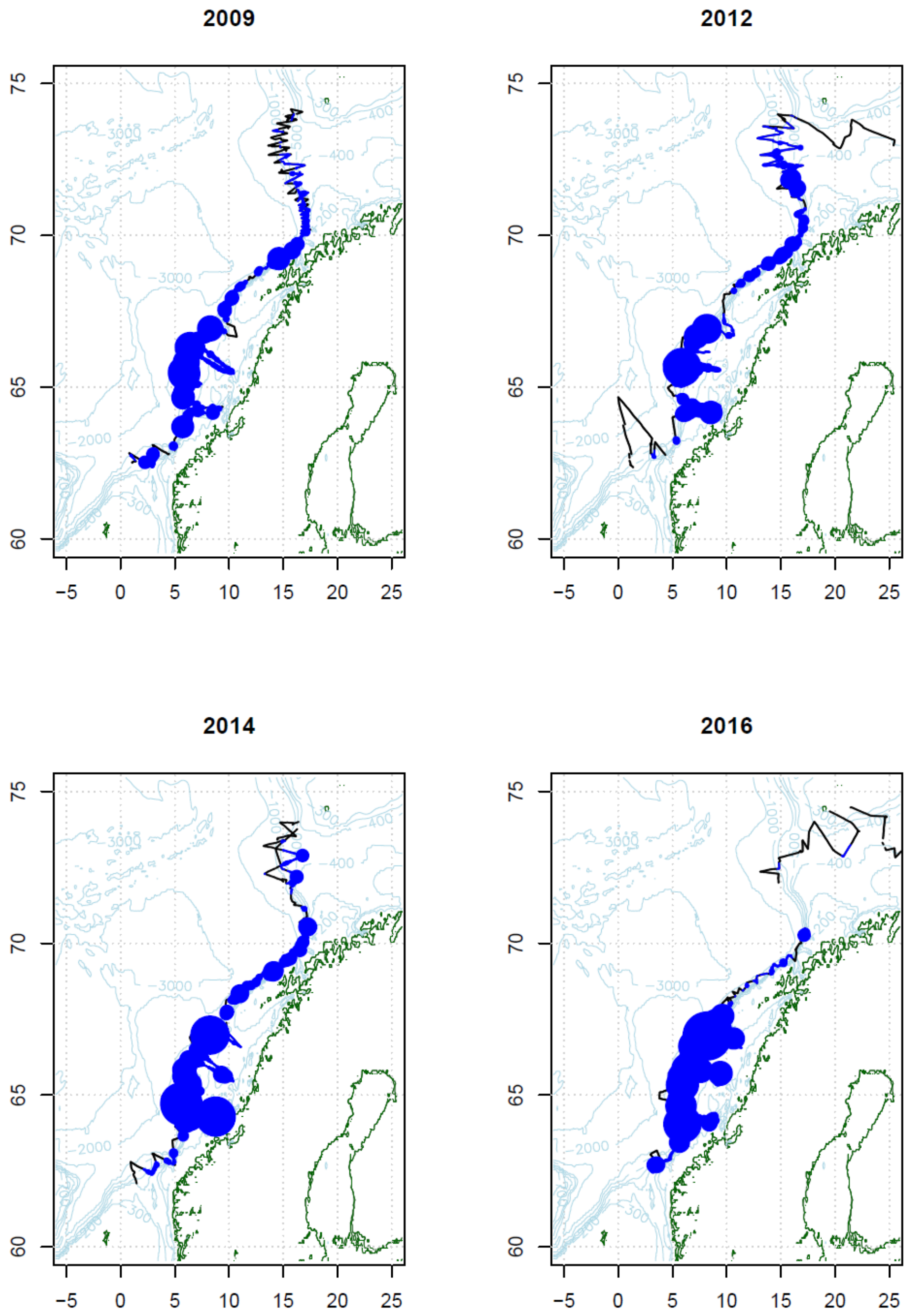


Figure 7.2.12. Greater silver smelt in 2.a. Acoustic backscattering strength estimates SA-values) in Norwegian continental shelf and slope surveys March–April 2009, 2012, 2014, and 2016.

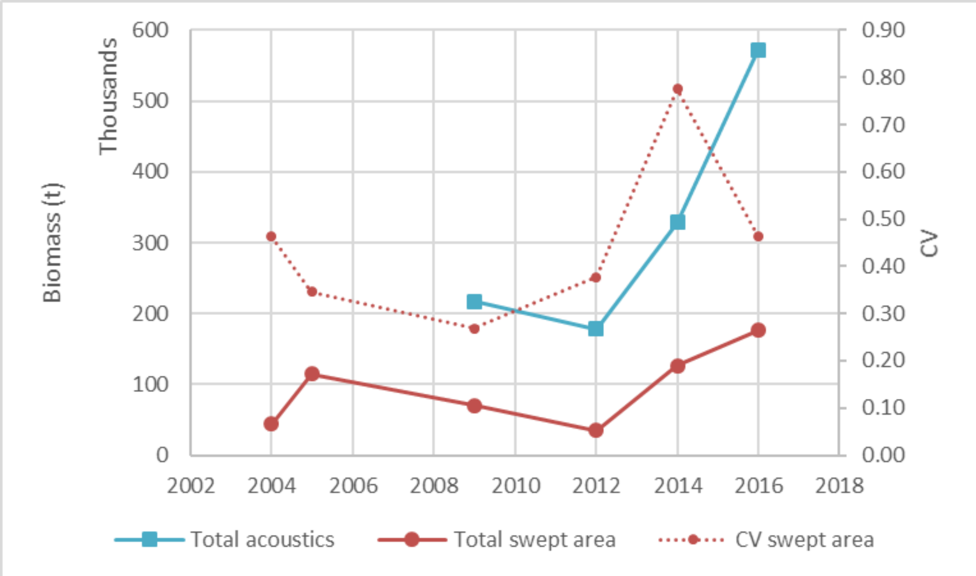


Figure 7.2.13. Estimated biomass for greater silver smelt for acoustic surveys in March–April 2009, 2012, 2014 and 2016 (for method see Harbitz, 2010), and bottom trawl swept area estimates from the same surveys and 2004 and 2005 in addition. Also shown is CV for the trawl estimates.

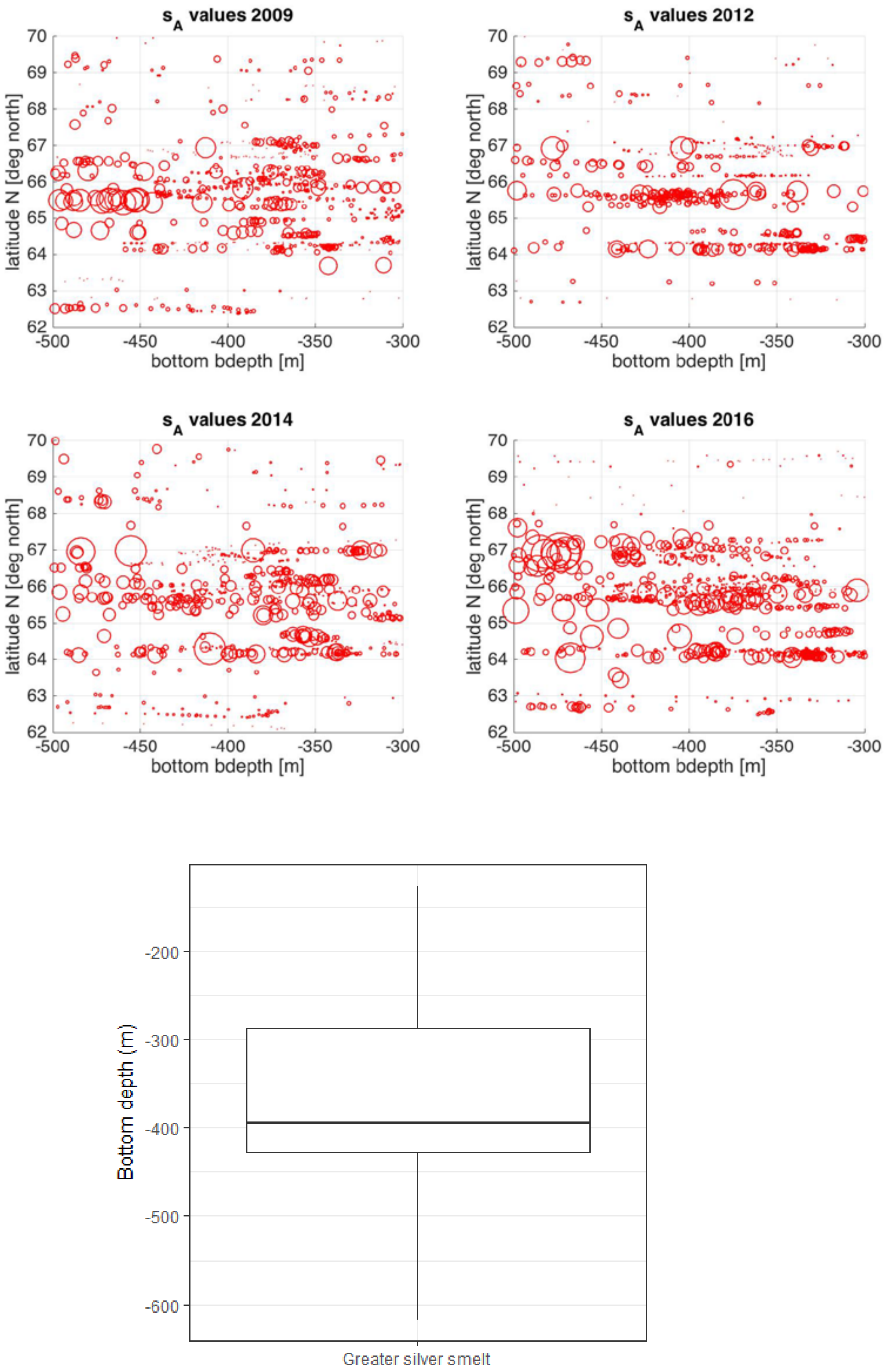


Figure 7.2.14. Upper panels: sA (1 nm. resolution) plots of acoustic Argentine registrations from the most abundant stratum in Egga South (southeast) during the scientific IMR cruises in 2009, 2012, 2014 and 2016. All circles are scaled equally with area proportional to the square root of sA-value. A considerably larger mean sA-value (180) was found in 2016 compared to 2009, 2012 and 2014 (107, 104 and 118, respectively). Lower panel: Boxplot showing depth at stations where catches were registered in 2016 according to logbooks.

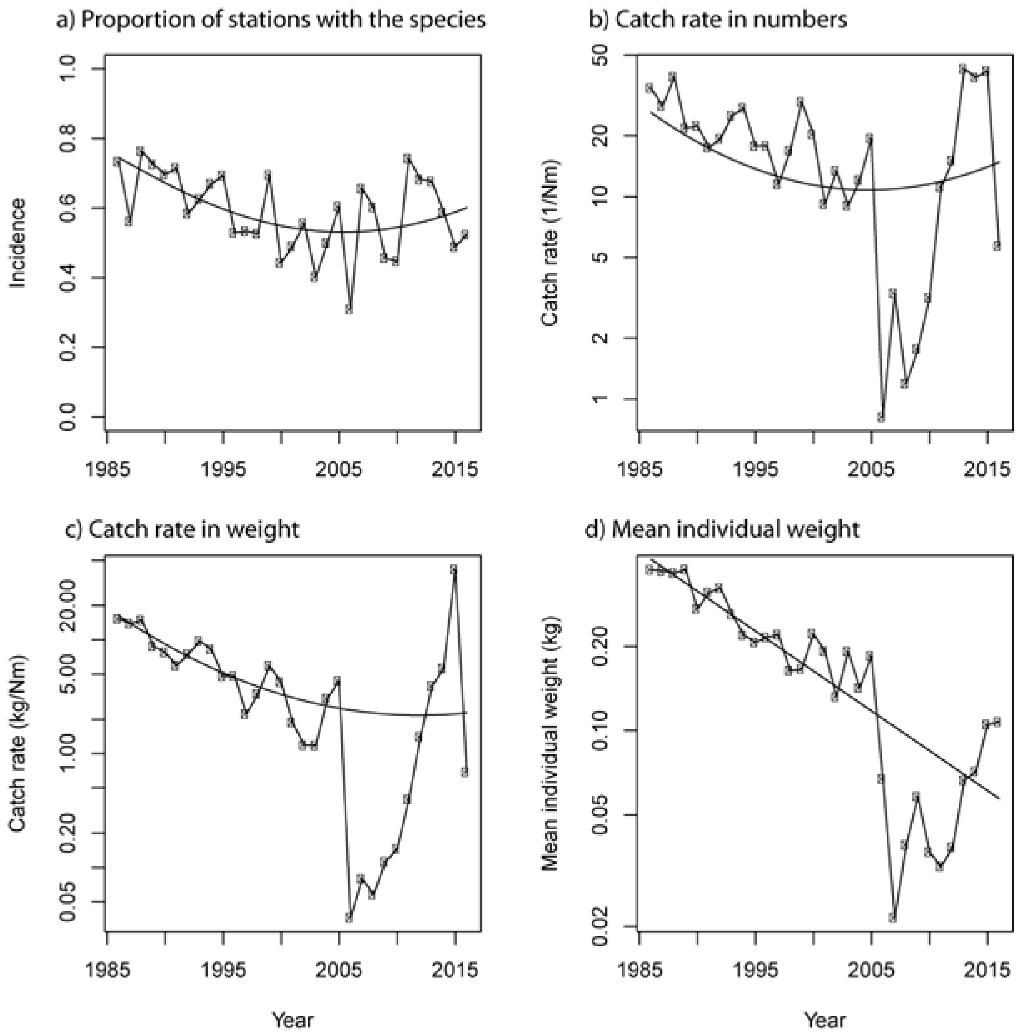


Figure 7.2.15. Greater silver smelt in 1, 2, 3 and 4. Annual estimates of incidence, mean catches in numbers and weight, and mean lengths derived from the annual Norwegian shrimp survey in 3.a and eastern parts of 4.a, 1985–2016 (note logarithmic scales). Superimposed on the means are fitted trend lines, allowing for linear and quadratic effects, using quasi-Poisson regression. (from Hallfredsson *et al.*, 2017, WD16 WGDEEP).

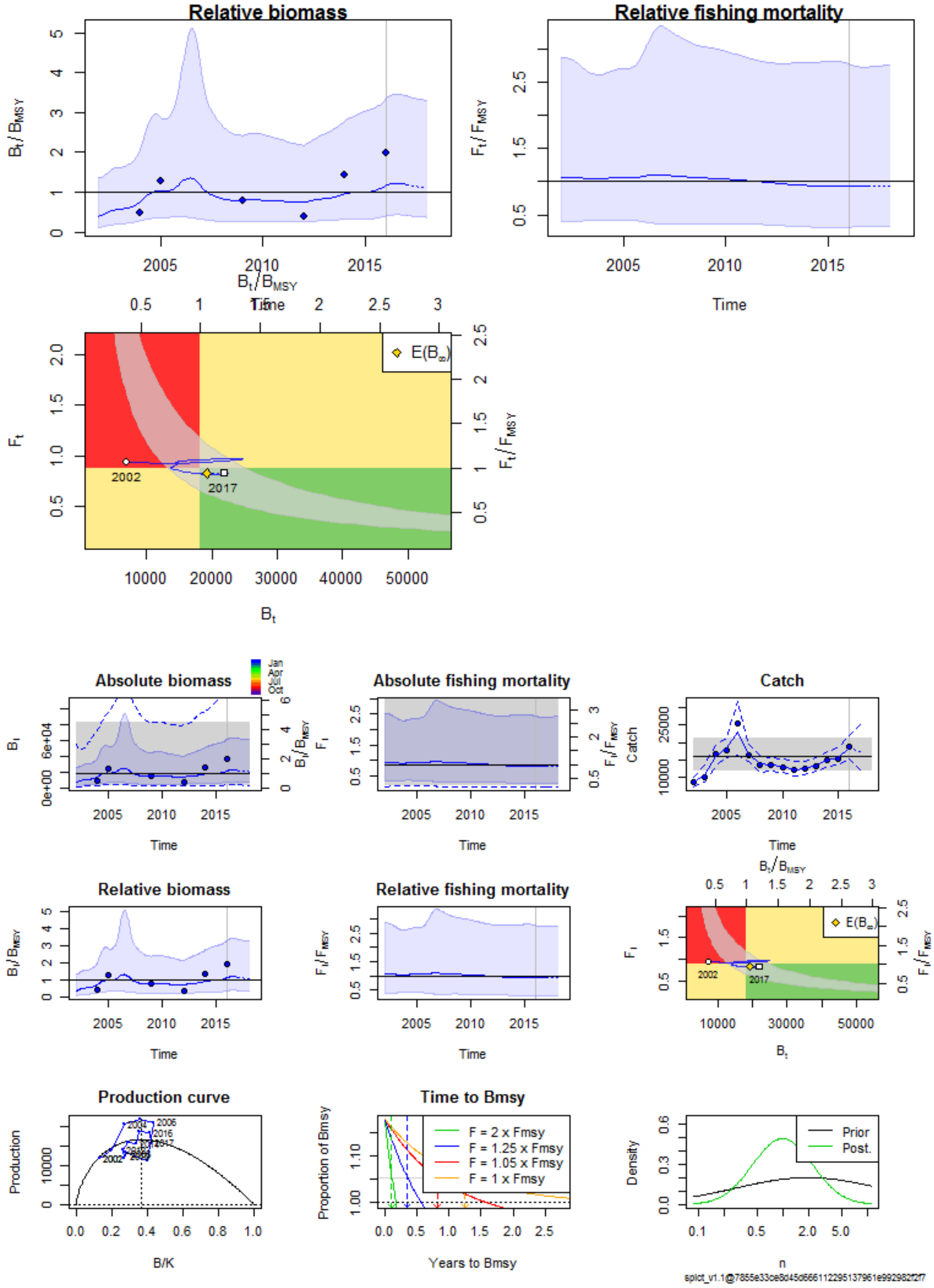


Figure 7.2.16. Results from the SPiCT analysis.

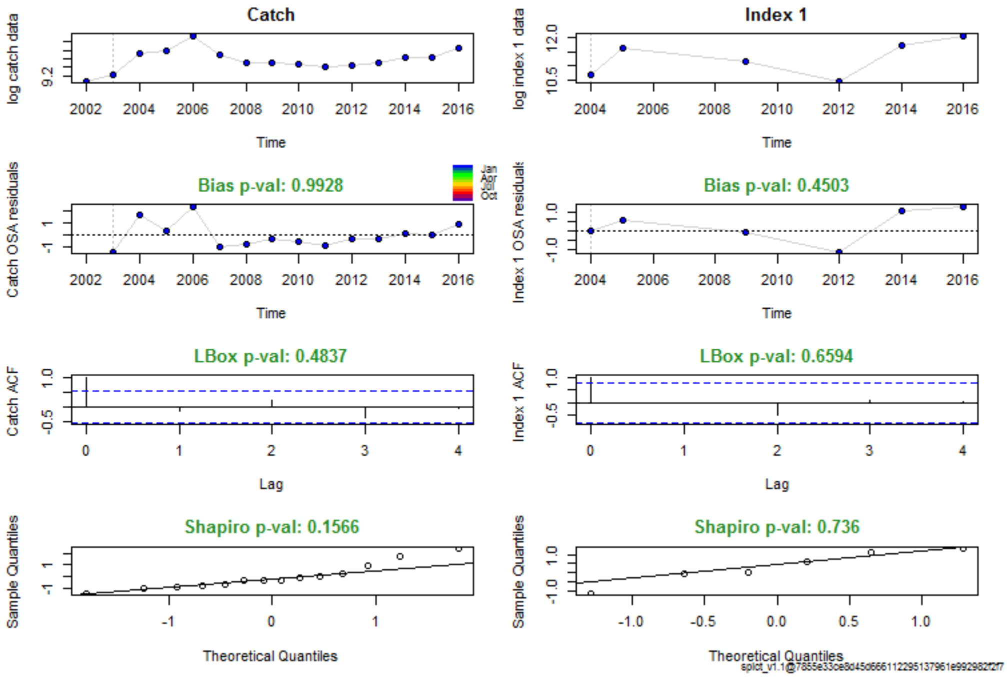


Figure 7.2.17. Diagnostics from the SPiCT analysis.

7.3 Greater silver smelt (*Argentina silus*) in Division 5.a

7.3.1 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 significant because of the relatively large mesh size used in the redfish fishery. Since 1997, a directed fishery for greater silver smelt has been ongoing and the landings have increased significantly (Table. 7.3.1).

7.3.1.1 Fleets

Since 1996 between 20 and39 trawlers have annually reported catches of greater silver smelt in 5.a (Table 7.3.1). 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.

Number of hauls peaked in 2010, but the number of hauls have decreased since then in line with lower total catches. 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 7.3.2).

Table 7.3.1. Greater silver smelt in 5.a. 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
2014	24	2336	6157	487	0,614
2015	24	1836	5312	334	0,600
2016	26	2090	5708	387	0,596

7.3.1.2 Targeting and mixed fisheries issues in the Greater Silver Smelt fishery in 5.a

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 5.a (Table 7.3.2).

Table 7.3.2. Greater silver smelt in 5.a. 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
2014	2,4	78,3	2,8	0,3	5,5	10,7
2015	13,8	67,1	3,1	0,3	4,2	11,7
2016	10,9	73,5	5,5	0,2	2,8	7,1

Spatial distribution of catches through time

Spatial distribution of catches in 1996–2016 is presented in Figures 7.3.1 and 7.3.2. 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 7.3.1 and 7.3.2).

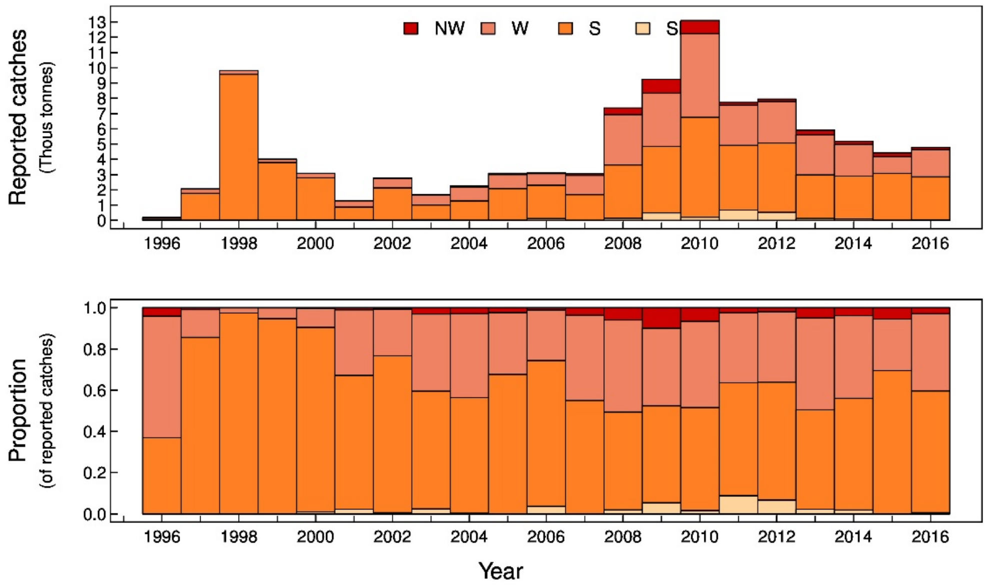


Figure 7.3.1. Greater silver smelt in 5.a. Catches defined by survey regions deeper than 400 m by year (See stock annex for details). Above are the catches on absolute scale and below in proportions.

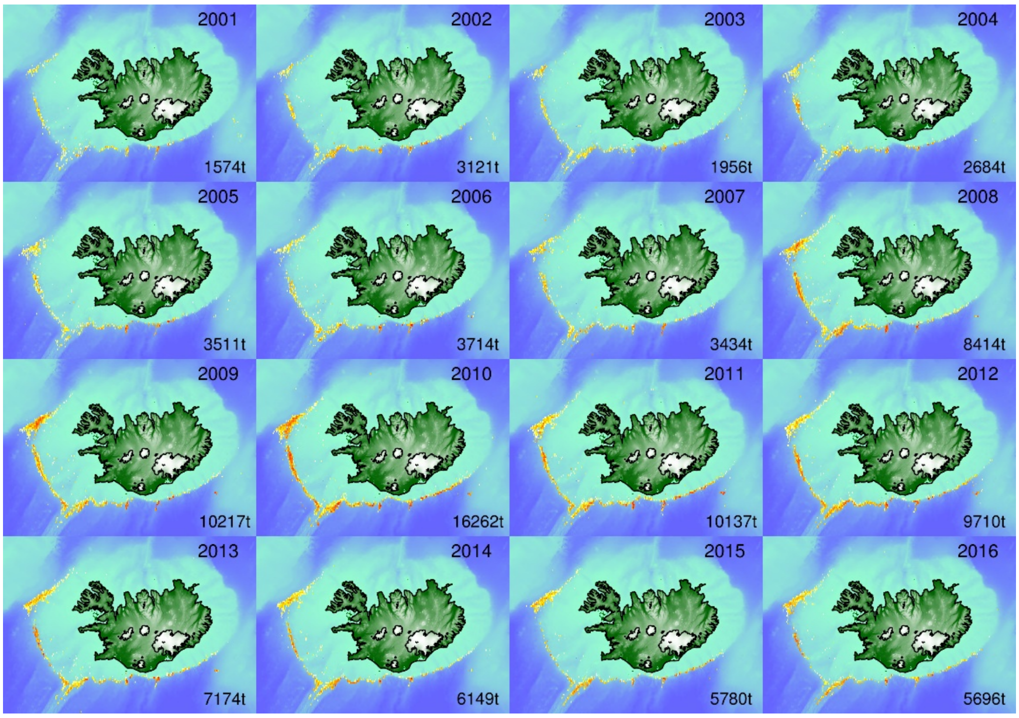


Figure 7.3.2. Greater silver smelt in 5.a. Spatial distribution of catches as reported in logbooks.

7.3.2 Landings trends

Landings of Greater Silver Smelt are presented in Table 7.3.1 and Figure 7.3.3. 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 landings started to decrease due increased management actions, and landings in 2016 amounted to approximately 5500 tonnes.

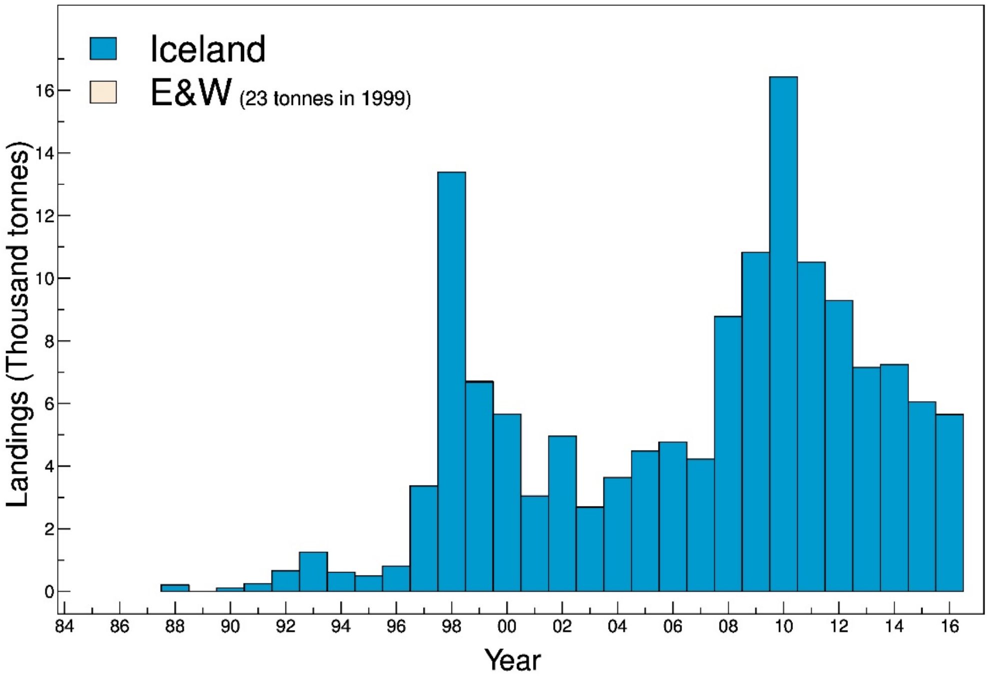


Figure 7.3.3. Greater silver smelt in 5.a. Nominal landings. 23 tonnes were landed by foreign vessels (England and Wales) in 1999, which is the only year of reported by foreign vessels.

7.3.3 ICES Advice

The ICES advice for 2017 is: Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 9310 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 0.171 is applied, with an additional uncertainty cap of 20%, as a factor to the 2016 biomass estimate, resulting in catch advice of no more than 9310 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.

7.3.4 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 5.a is given in the stock annex.

The TAC for the 2013/2014 fishing year was set at 8000 based on the recommendations of MRI using a preliminary Gadget model and the 2014/2015 fishing year the recommendation was to maintain the catches at 8000 t. For the fishing year 2015/2016 it was also maintained at 8000 t but 7885 t for 2016/2017.

7.3.5 Data available

7.3.5.1 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.

7.3.5.2 Length compositions

Table 7.3.3 gives the number of samples and measurements available for calculations of catch in numbers of Greater Silver Smelt in 5.a. Length distributions are presented in Figure 7.3.4.

7.3.5.3 Age compositions

Table 7.3.3 gives the number of samples and measurements available for calculations of catch in numbers of greater silver smelt in 5.a. Estimates of catch in numbers are given in Figure 7.3.5.

Table 7.3.3. Greater silver smelt in 5.a. 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
2014	32	4709	16	350	340
2015	11	1275	8	221	217
2016	45	5880	13	285	184

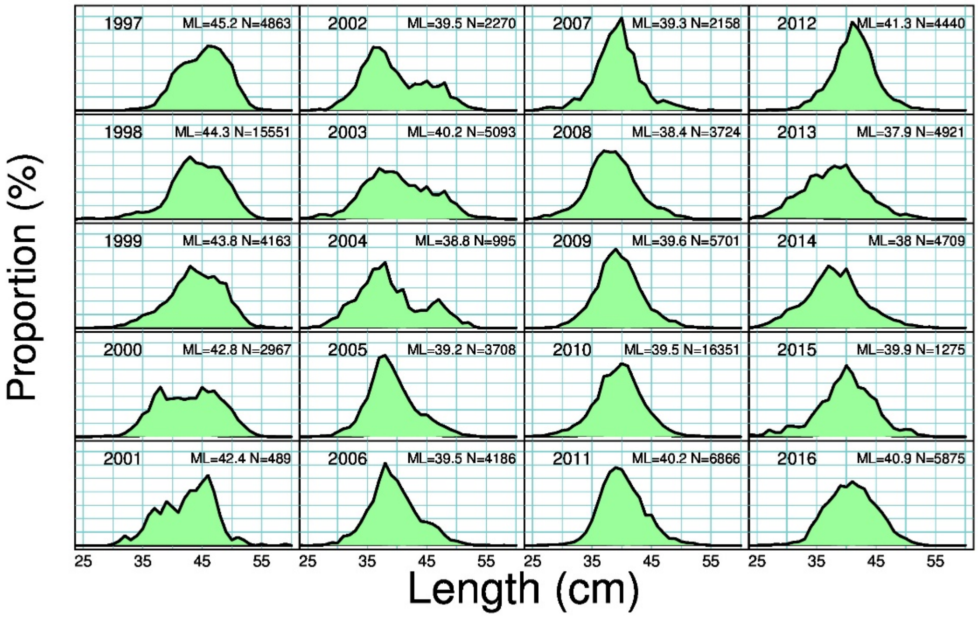


Figure 7.3.4. Greater silver smelt in 5.a. Length distributions from commercial catches.

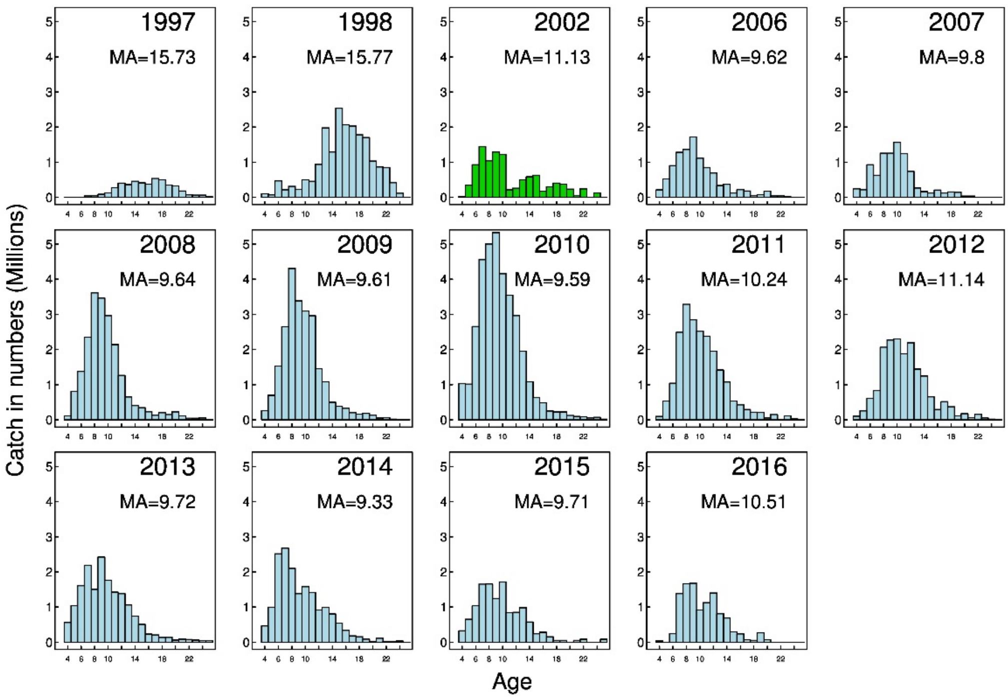


Figure. 7.3.5. Greater silver smelt in 5.a. Catch in numbers. Estimates for 2002 are based on limited number of aged otoliths (See Table 7.3.3).

7.3.5.4 Weight-at-age

No marked changes can be observed in mean weight-at-age from commercial catches between 1997–1998 and 2006–2013.

7.3.5.5 Maturity and natural mortality

Estimates of maturity ogives of greater silver smelt in 5.a 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 5.a are mature.

No information exists on natural mortality of greater silver smelt in 5.a.

7.3.5.6 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 groundfish 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 5.a 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 groundfish survey is given in the stock annex for greater silver smelt in 5.a. The survey is considered representative of stock biomass of greater silver smelt since it was expanded in 2000. Figure 7.3.6 gives trend in biomass and juvenile abundance for the spring survey in 1985 to 2017 and for the autumn survey in 2000 to 2016. 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 greater silver 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. Therefore the index is winsorized when used in the advisory procedure (See stock annex for details). A comparison of indices, with or without winsorization are shown in Figure 7.3.7.

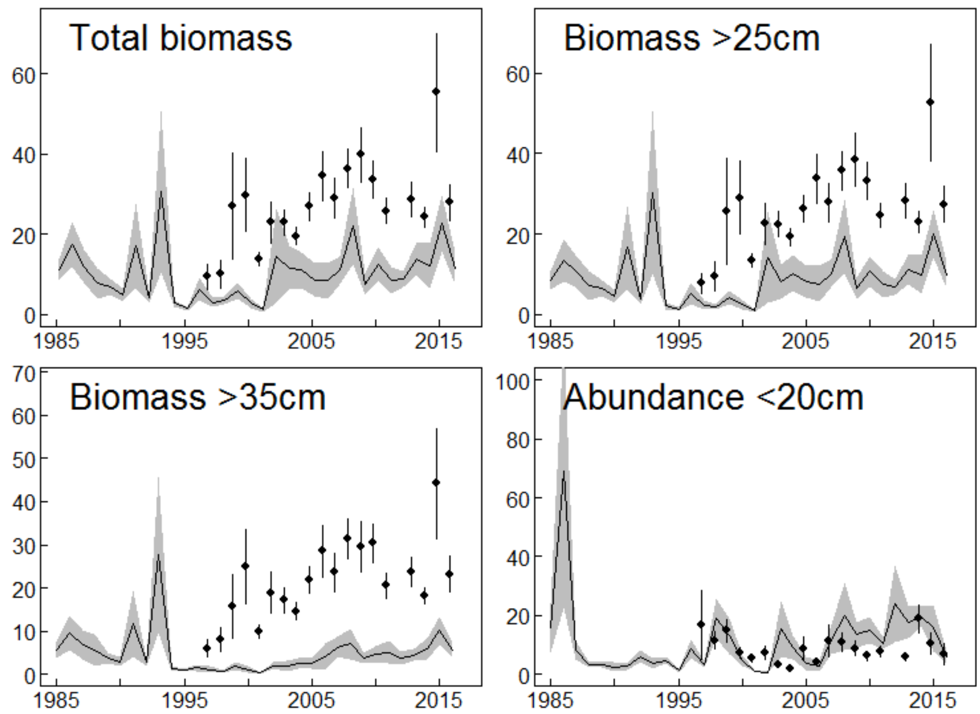


Figure 7.3.6. Greater silver smelt in 5.a. Indices from the Icelandic spring survey (black lines and shaded area) and from the autumn survey (dots and vertical lines). Vertical lines and shaded area represent +/- 1 standard error.

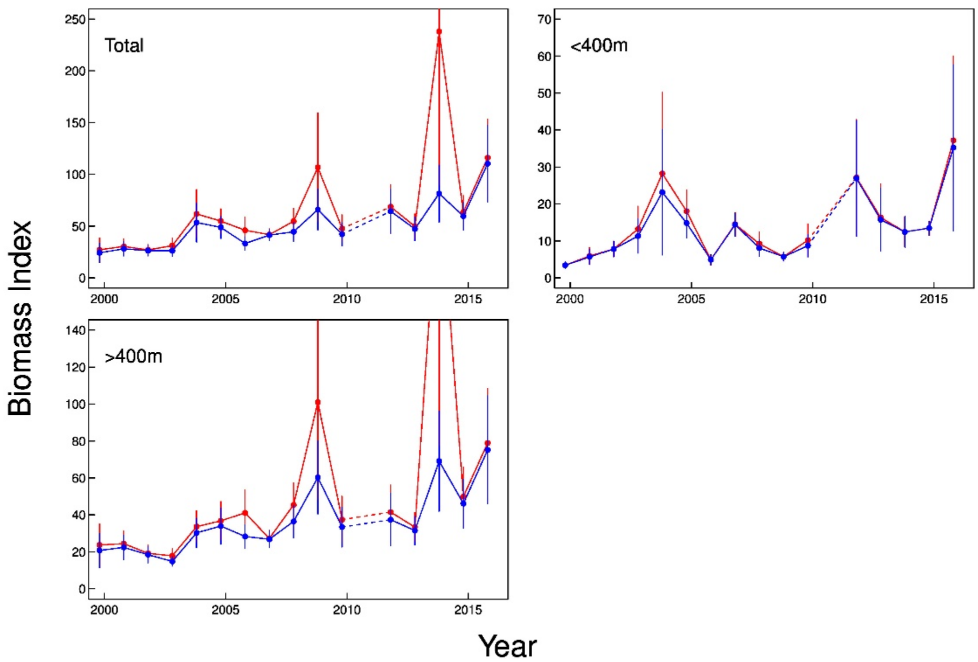


Figure 7.3.7. Greater silver smelt in 5.a. Index from the Icelandic autumn survey, divided by depth. The line colour indicates the biomass index used, either un-altered or Winsorized (see text for further details).

7.3.6 Data analyses

Landings and sampling

Spatial distribution of catches did not change markedly between 2015 and 2016 and fishing for greater silver smelt in the NW area seems to have stopped (Figures 7.3.1 and 7.3.2). 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 5646 tonnes in 2016 (Figure 7.3.3 and Table 7.3.4). The decrease in catches is the result of increased vigilance by the managers to constrain catches to those advised and also lesser interest by the fleet in the stock. 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 2016 (Figure 7.3.4). 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 7.3.5). 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 surveys have high CVs. Occasional spikes in the indices without any clear trend characterize the spring survey biomass indices. 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 2017 at a 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 with the 2015 estimate at the highest level since 1993 (Figure 7.3.6).

The observed trends in the biomass indices from the autumn survey have a considerably different trends than those observed in the spring survey (Figure 7.3.6). 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 showed slight variations until 2014 when the index increased to the highest value observed.

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 5.a is banned at depths less than 400 meters. The autumn survey index for depth greater than 400 meters is therefore considered the best indicator of available biomass to the fishery. As noted in the section above the Winsorized index appears to be less sensitive to the few large hauls in the 2009 and 2014 survey years (Figure 7.3.7).

F_{proxy}

Changes in relative fishing mortality (F_{proxy} = Yield / Survey biomass at depths greater than 400 m) are presented in Figure 7.3.8 and Table 7.3.5. 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 due to decrease in catches as the index was at similar levels between the two years (Figure 7.3.7).

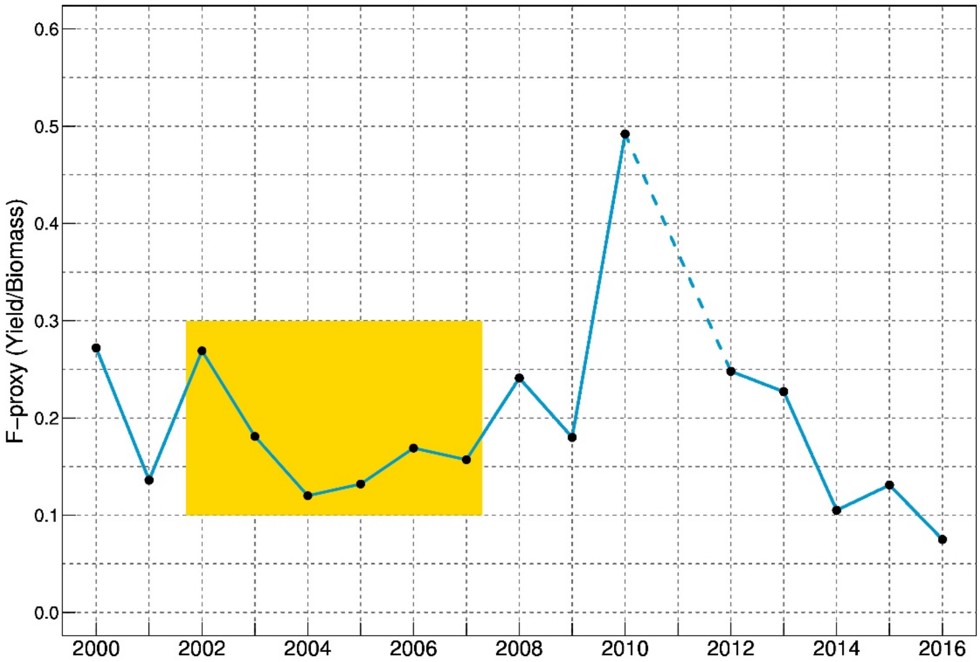


Figure 7.3.8. Greater silver smelt in 5.a. Changes in relative fishing mortality (F_{proxy}). The index used is the >400 m winsorized index from the Icelandic autumn survey (see text for further details).

Analytical assessment

No analytical assessment presented this year.

7.3.7 Comments on the assessment

The assessment was conducted according to the stock annex.

7.3.8 Management considerations

Exploitation of greater silver smelt has been reduced in recent years, coming down from a relatively high level in 2010, to levels lower than the average exploitation rate in the reference period.

7.3.9 Application of MSY proxy reference points (ToR h)

In the ICES response to the: EU request to provide a framework for the classification of stock status relative to MSY proxies for selected category 3 and category 4 stocks in ICES Subareas 5 to 10. ICES set the F_{MSY} proxy for greater silver smelt in 5.a as 0.171 but did not set a B_{MSY} trigger proxy for the stock.

This year WGDEEP re-ran the length-based indicator model used to answer the request and also tried the SPiCT model on the index used for the assessment.

Length-Based Indicator (LBI)

Data and settings

In the LBI-model model run presented here length-at-maturity (L_{mat}) was set at 35.95 cm and Linf at 48.77. These values were obtained from data collected in the Icelandic autumn survey. The length distributions came from commercial catches from 2004 to 2016. Mean weight at length was estimated from a length–weight relationship from the Icelandic autumn survey (Figure 7.3.9). The length bin used was 2 cm.

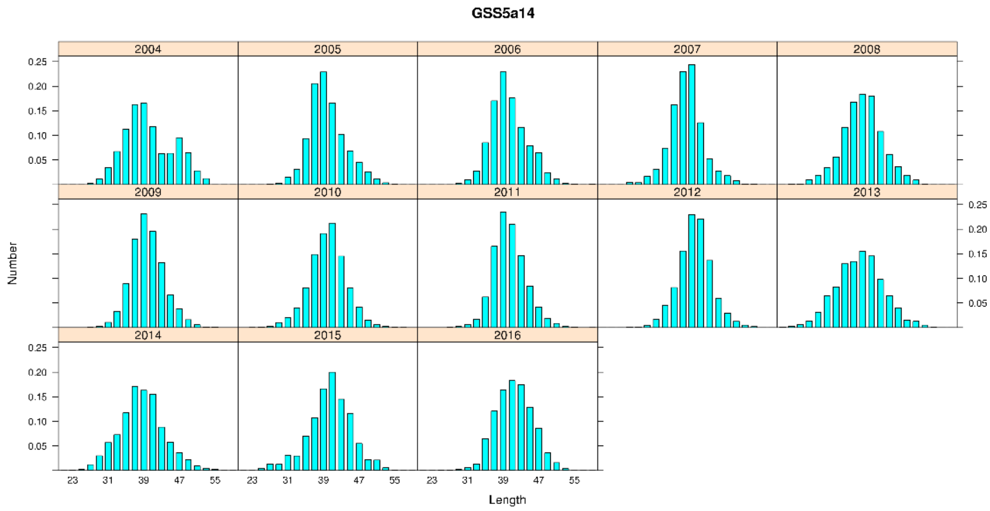


Figure 7.3.9. Length distributions used for estimating LBI.

Results

According to the results, greater silver smelt in 5.a is being harvested at a sustainable level in the period as $L_{mean}/L_{F=M}$ is always larger than 1 (Table 7.3.6 and Figure 7.3.10).

Table 7.3.6. LBI results for 2014 to 2016.

Traffic light indicators						
	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2014	0.97	0.97	1.00	71%	1.23	1.04
2015	0.75	1.03	1.02	84%	1.23	1.23
2016	1.03	1.06	1.01	91%	1.29	1.05

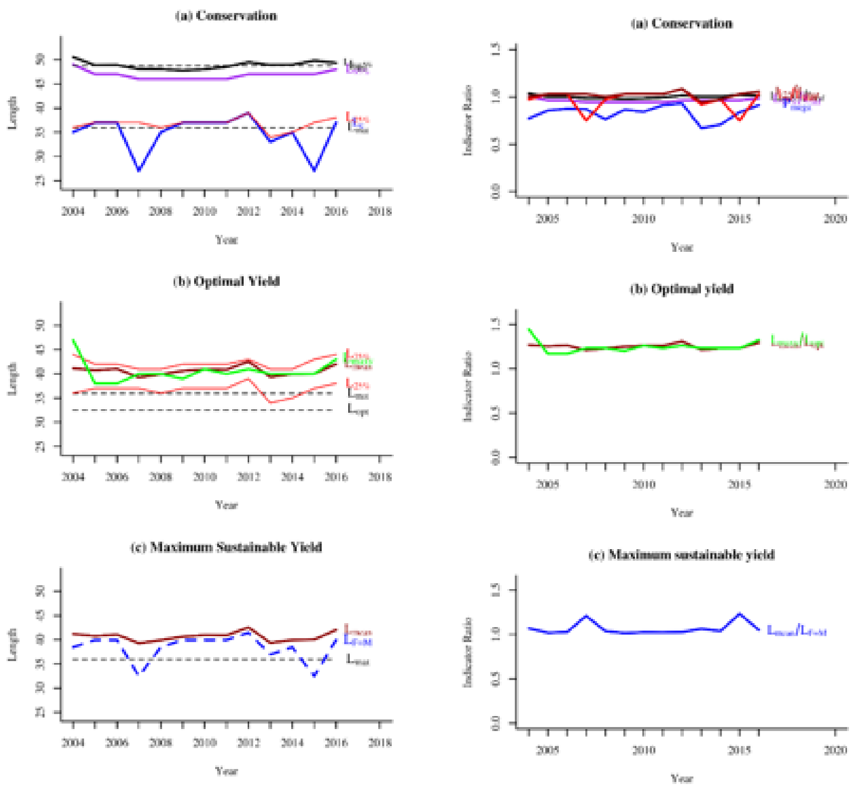


Figure 7.3.10. Results of LBI to commercial length distributions from 5.a.

SPiCT

Settings and data

The input data in the model were the entire catch history of greater silver smelt in 5.a and the winsorized index from the Icelandic Autumn survey used for the assessment that goes back to 2000 (Figure 7.3.11). The model run presented here deviates from the default settings in two ways. The uncertainty in the survey was taken into account in the model and also the prior for the K/B0 ratio was set at 0.95 as the stock was not exploited before the beginning of the assessment period.

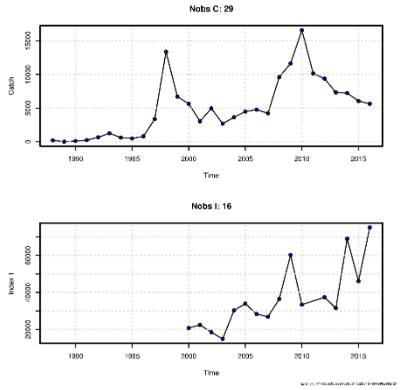


Figure 7.3.11. Input data to the SPiCT model.

Results

The output from the model is shown below. The estimates of r and K do not seem plausible for a long-lived species like greater silver smelt. It would be expected that r would be somewhere in the range of 0.1–0.3 but not at 0.9 and given that the *K* also seems rather low at 59 kt. B_{MSY} is estimated at 33 kt, which is very low. The diagnostic plots are shown in Figure 7.3.12, the results in Figure 7.3.12 and finally the analytical retrospective analysis in Figure 7.3.13.

```
> res <- fit.spict(inp)
> summary(res)
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 55.5678617
Euler time step (years):  1/16 or 0.0625
Nobs C: 29,  Nobs I1: 16

Priors
      logn  ~  dnorm[log(2), 2^2]
  logalpha  ~  dnorm[log(1), 2^2]
   logbeta  ~  dnorm[log(1), 2^2]
 logbkfrac  ~  dnorm[log(0.95), 0.2^2]

Model parameter estimates w 95% CI
             estimate        cilow        ciupp    log.est
 alpha  1.498083e-01    0.0507490 4.422262e-01 -1.8983985
 beta   5.554681e-01    0.1255107 2.458315e+00 -0.5879442
 r      9.355688e-01    0.0783691 1.116880e+01 -0.0666006
 rc     6.650060e-01    0.1063304 4.159046e+00 -0.4079591
 rold   5.158301e-01    0.0352641 7.545378e+00 -0.6619779
 m      1.113305e+04 2212.4107511 5.602250e+04  9.3176734
 K      5.922856e+04 3150.9782382 1.113312e+06 10.9891591
 q      7.306465e-01    0.0227969 2.341745e+01 -0.3138255
 n      2.813715e+00    0.2294246 3.450804e+01  1.0345057
 sdb    2.949027e-01    0.1576420 5.516778e-01 -1.2211098
 sdf    8.445967e-01    0.4052827 1.760114e+00 -0.1688960
 sdi    4.417890e-02    0.0205698 9.488520e-02 -3.1195083
 sdc    4.691465e-01    0.1989834 1.106114e+00 -0.7568402

Deterministic reference points (Drp)
           estimate        cilow        ciupp    log.est
 Bmsyd 33482.550796 1624.9764938 6.899061e+05 10.418780
 Fmsyd     0.332503    0.0531652 2.079523e+00 -1.101106
 MSYd  11133.049351 2212.4107511 5.602250e+04  9.317673
Stochastic reference points (Srp)
           estimate        cilow        ciupp  log.est rel.diff.Drp
 Bmsys 2.990691e+04 1598.213558 5.596394e+05 10.30584   -0.1195590
 Fmsys 2.946373e-01    0.030679 2.829659e+00 -1.22201   -0.1285164
 MSYs  8.676299e+03 1857.189077 4.053338e+04  9.06835   -0.2831566

States w 95% CI (inp$msytype: s)
                    estimate        cilow        ciupp    log.est
 B_2016.00       5.799578e+04 2042.3557930 1.646878e+06 10.9681255
 F_2016.00       1.030988e-01    0.0034385 3.091289e+00 -2.2720680
 B_2016.00/Bmsy 1.939210e+00    0.7115697 5.284845e+00  0.6622807
 F_2016.00/Fmsy 3.499175e-01    0.0304753 4.017756e+00 -1.0500580

Predictions w 95% CI (inp$msytype: s)
                  prediction        cilow        ciupp    log.est
 B_2017.00       5.314816e+04 1963.5644641 1.438571e+06 10.8808387
 F_2017.00       1.022868e-01    0.0028753 3.638761e+00 -2.2799747
 B_2017.00/Bmsy 1.777120e+00    0.7093039 4.452470e+00  0.5749939
 F_2017.00/Fmsy 3.471617e-01    0.0246214 4.894985e+00 -1.0579646
 Catch_2017.00   5.326821e+03 1080.7996160 2.625373e+04  8.5805100
 E(B_inf)        4.171460e+04           NA           NA 10.6386065
```

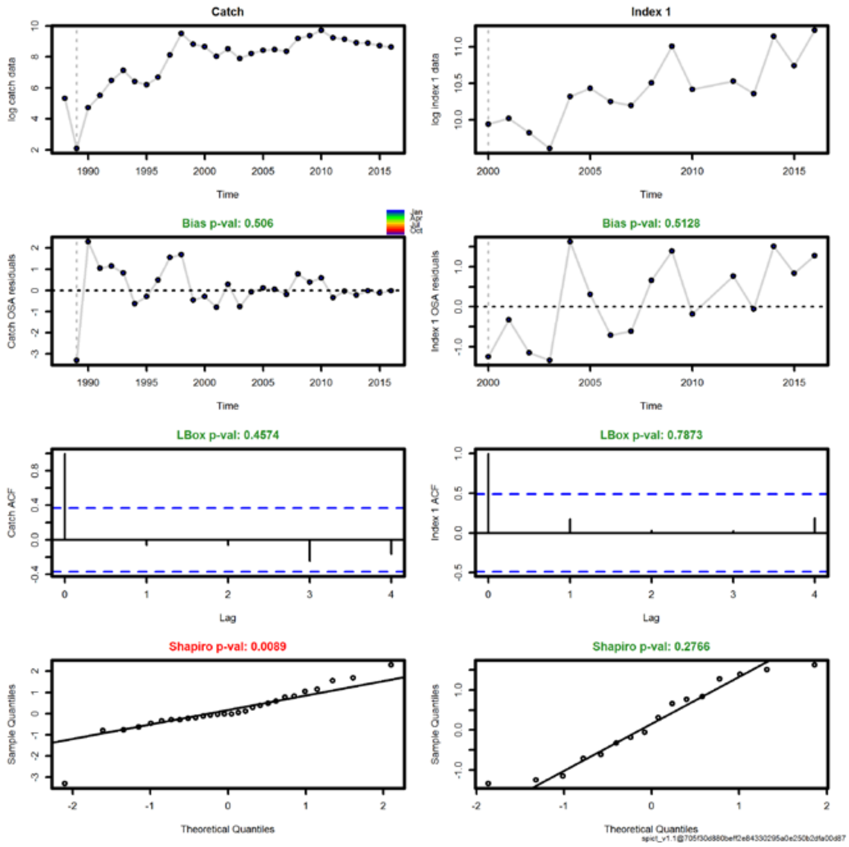


Figure 7.3.12. Diagnostics from the SPiCT-model.

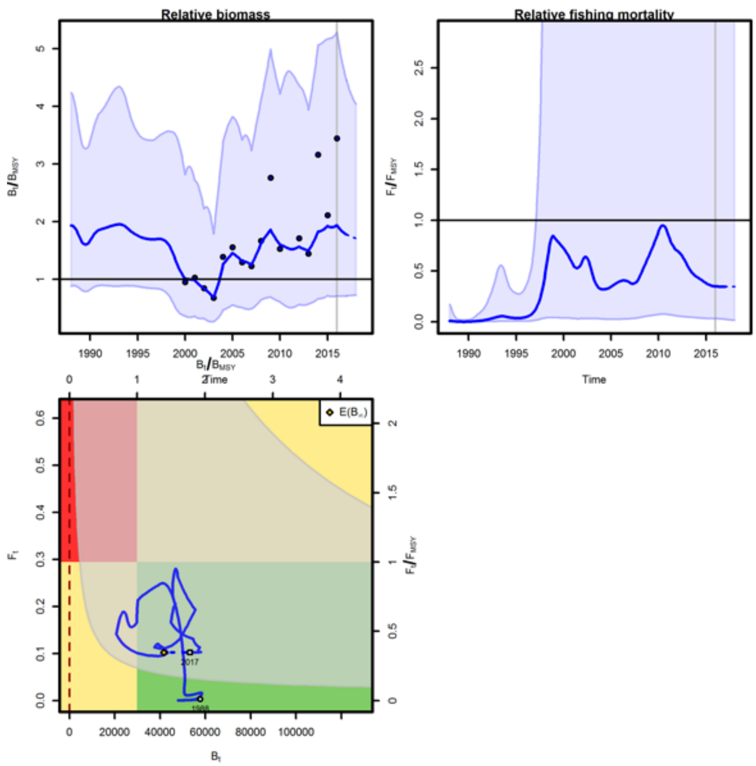


Figure 7.3.12. Results from the SPiCT-model.

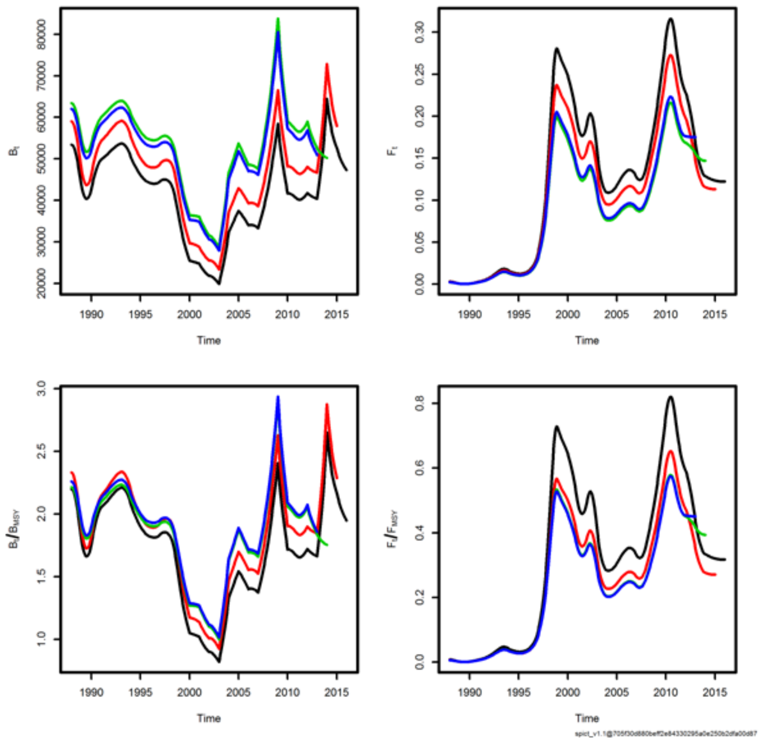


Figure 7.3.12. Analytical retrospective analysis from the SPiCT-model.

Conclusions

The analysis presented above indicates that the fishing pressure is below F_{MSY} and the stock biomass is above possible MSY $B_{trigger,proxy}$. This does not sound unlikely given that the stock has not been fished hard in the past. Catches of greater silver smelt have not been high in the past, normally below 10 kt, compared with catches in 5.b and 6.a. Additionally the distribution area in 5.a is much larger than in 5.b and 6.a. The selection pattern from the fishery is good as fishing for greater silver smelt is only allowed at depths greater than 400 meters, where juveniles are not found.

The findings presented here support the general view of WGDEEP that the stock is at a sustainable level and that the selection pattern is good. However there is a question whether LBI and SPiCT are the correct tools to state that.

Table 7.3.4. Greater silver smelt in 5.a. Nominal landings in 1988–2016.

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
2014	7.241
2015	6056
2016	5646

Table 7.3.5. Greater silver smelt in 5.a. Landings and survey biomass from the Icelandic autumn survey (greater than 400 m, winsorised) and F_{proxy} (Yield/Survey biomass). The mean of the F_{proxy} values in italic is used as an F_{proxy} target.

YEAR	LANDINGS	INDEX	CV INDEX	FPROXY
2000	5657	20764,4	0,443	0.272
2001	3043	22425,5	0,294	0.136
2002	4960	18464,8	0,24	*0.269*
2003	2686	14826,1	0,17	*0.181*
2004	3637	30289,1	0,26	*0.120*
2005	4481	33955,8	0,289	*0.132*
2006	4775	28317,1	0,224	*0.169*
2007	4226	26832,4	0,165	*0.157*
2008	8778	36458	0,242	0.241
2009	10 829	60277,8	0,328	0.180
2010	16 428	33383,1	0,322	0.492
2011	10 515	No survey		
2012	9290	37413	0,38	0.248
2013	7154	31504,4	0,243	0.227
2014	7241	69072,8	0,393	0.105
2015	6056	46114,0	0,285	0,131
2016	5646	75199,8	0,389	0,075

7.4 Greater silver smelt (*Argentina silus*) in 5.b and 6.a

7.4.1 The fishery

The target fisheries for the Divisions 5.b and 6.a management unit are mainly conducted by Faroese and Dutch trawlers. In 2016, the Faroese trawlers caught 98% of the catches in 5.b and 43% of the catches in 6.a (inside the Faroese EEZ), while the Dutch trawlers caught 52% of the catches in 6.a. Other nations landing significant quantities in 2014–2016 were Germany, Iceland, Russia and Denmark (Table 7.4.1).

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 greater silver smelt in Faroese waters did not develop until the mid-1990s. In 2016 the preliminary landings in Faroese waters, from mainly three pairs of pair trawlers deploying bentho-pelagic trawls, were 13 179 t (11 129 t in 5.b and 2050 t in 6.a) (Table 7.4.1 and Figure 7.4.1).

The greater silver smelt fishing grounds in Faroese waters from the mid-1990s to 2007 were located north and west on the Faroe Plateau and around Faroe Bank/Lousy Bank at depths between 300 and 700 meters. Since 2008, the Faroese fishery has extended the fishing grounds to include the area around the Wyville-Thomson Ridge south of the islands (Figure 7.4.2). Since 2012 around 50% of the Faroese catches were fished on the Wyville-Thomson Ridge (in Divisions 5.b and 6.a, inside the Faroese EEZ).

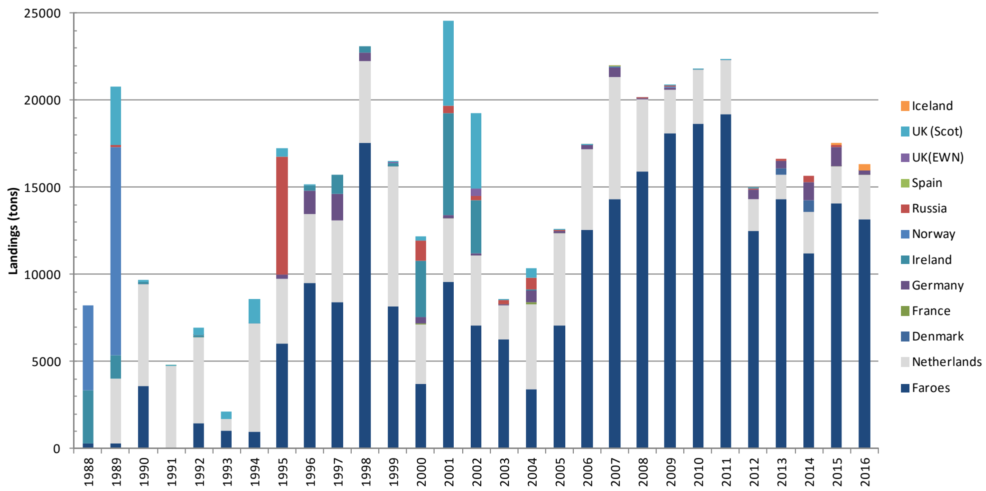


Figure 7.4.1. Greater silver smelt in 5.b and 6.a. Total landings of greater silver smelt in 5.b and 6.a by countries.

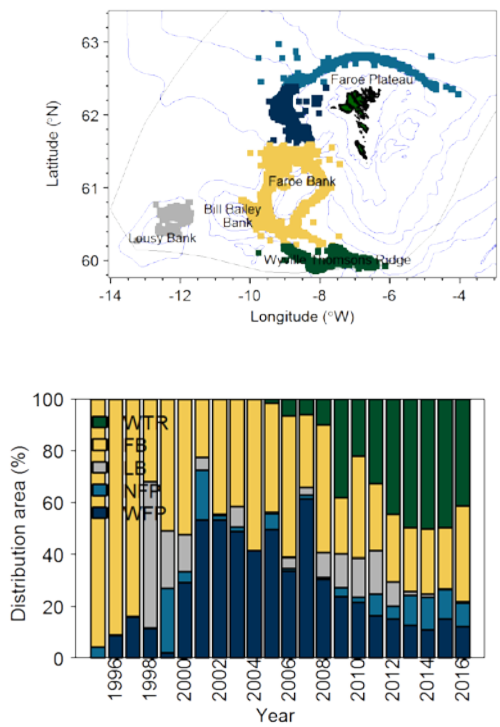


Figure7.4.2. Greater silver smelt in 5.b. Spatial distribution of the Faroese directed trawl fishery of greater silver smelt (upper Figure) and distribution of the greater silver smelt catch divided into five main areas in Faroese waters (lower Figure). WFP- west of the Faroe Plateau, NFP- north of the Faroe Plateau, LB- Lousy Bank, FB- Faroe Bank, WTR- Wyville Thomson Ridge.

7.4.2 Landing trends

Landings in Division 5.b increased rapidly from 2004 (5300 t) to 2006 (12 500 t) and further increased with landings in 2011 being 15 600 t (Table 7.4.2). Since then landings have been around 10–13 thousand tonnes, in 2016 the preliminary catch was 11 557 t. The recent reduction in greater silver smelt catches in 5.b is a combined effect of the vessels targeting mackerel rather than greater silver smelt, the introduction of

Faroese quotas, and a shift in fishing area to include areas in 6.a inside the Faroese EEZ.

The landings in 6.a increased and reached a maximum of 14 466 t in 2001; then decreased again and have been between 5000 and 7500 t since 2004. Preliminary landings in 2016 were 4773 t.

7.4.3 ICES Advice

ICES advises that when the precautionary approach is applied, landings should be no more than 10 030 tonnes in each of the years 2016 and 2017. Discarding is known to take place, but ICES cannot quantify the corresponding catches.

7.4.4 Management

The EU introduced TAC management in 2003 and sets quotas for fishery in areas 5, 6, 7. For 2015 and 2016 the EU TAC was set to the same as in previous years (5, 6, 7 = 4316 tons). In 2017, the TAC is 3884 tons in areas 5, 6 and 7.

In 2014, the Faroese authorities introduced species-specific TAC for greater silver smelt applicable for Faroese trawlers fishing inside the Faroese EEZ. Six trawlers had licences to target greater silver smelt, the technical measures continued to apply and the TAC are presented in the table below. The reason for this reduction in TAC was the decrease in the biomass index as estimated by the exploratory assessment of greater silver smelt in Faroese waters.

Year	TAC tons	Kunngerð
2014	16 000	Nr. 36 frá 5. mai 2014. Kunngerð um skipan av fiskiskapinum eftir gulllaksi á føroysku landleiðunum í 2014.
2015	14 400	Nr. 16 frá 23. mars 2015. Kunngerð um skipan av fiskiskapinum eftir gulllaksi á føroysku landleiðunum í 2015.
2016	13 000	Nr. 29 frá 29. mars 2016. Kunngerð um skipan av fiskiskapinum eftir gulllaksi á føroysku landleiðunum í 2016.
2017	11 500	Nr. 27 frá 28. mars 2017. Kunngerð um skipan av fiskiskapinum eftir gulllaksi á føroysku landleiðunum í 2017.

In the period from 2010–2013, the Faroese greater silver smelt fishery was managed by an agreement between the Faroese fleet that were licensed to conduct direct greater silver smelt fishery and the Faroese authorities, guided by the stock assessment and scientific advice of Faroe Marine Research Institute. The agreement was that total annual landings should not exceed 18 000 tonnes in the Faroese EEZ. There was no advice from ICES that was specific for the Faroese greater silver smelt component. Regulation was through a general regulation of fishing days for the trawler group. There were also limitations in e.g. minimum size, bycatch, mesh size and fishing area restrictions.

7.4.5 Data available

Data on length, round weight and age were available for greater silver smelt from the Faroese and Dutch landings. There were also catch and effort data from logbooks for the Faroese trawlers.

From the two annual Faroese groundfish surveys on the Faroe Plateau, especially designed for cod, haddock and saithe, biological data (mainly length and round weight) as well as catch and effort data were available for greater silver smelt.

7.4.5.1 Landings and discards

Landings data were presented by area and countries (Tables 7.4.1 and 7.4.2, Figure 7.4.1). Landings were available for all relevant fleets.

Discarding is banned inside the Faroese EEZ and all catches are assumed to be landed. There was information in InterCatch and from other sources on discards from non-Faroese fisheries on this management unit (Table below), but bycatches are assumed generally to be landed.

However, in Subareas 6 and 7 greater silver smelt can be a very significant discard of the trawl fisheries on the continental slope, particularly at depths 300–700 m (e.g. Girard and Biseau, WD 2004). New calculation of the estimates for 2012 and 2013 reduce strongly the discards reported by Spain, so in 2014–2015 there appears to have been no Spanish discards of this species in Subarea 6 (only in 7).

Based upon on-board observations from EU data collection framework (DCF) sampling, the catch composition of the French mixed trawl fisheries in 5.b, 6 and 7 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 estimate of 280 t of discarded greater silver smelt was estimated for 2011. Based upon similar level of the fishery in 2010–2012 this figure was considered to apply also to recent years. The discards in 2014–2016 were mainly in Division 6.a and it was from the French deep-water fishery (data from WGDEEP), from the German fishery (data from InterCatch) and from the Scottish fishery (data from InterCatch) (table below).

The landings statistics are regarded as being adequate for assessment purposes.

	Area 5.b		Area 6.a			5.b and 6.a	
Year	Germany	France	Germany	Scotland	France	Total	% landings
2014	28		92	653	808	1581	10.1
2015				109	161	270	1.5
2016		12		1451	200	1663	10.2

7.4.5.2 Length compositions

There are length distributions of commercial catches from Faroese commercial trawl catches in 5.b (Figure 7.4.3) and from the Russian commercial bottom trawl catches in the Faroese Fishing Zone (Figure 7.4.4). In addition, length measurements from the Netherlands fishery in 6.a were available (Figure 7.4.5).

Length distributions from the Faroese spring- and summer groundfish surveys on the Faroe Plateau in 5.b are presented in Figures 7.4.6 and 7.4.7.

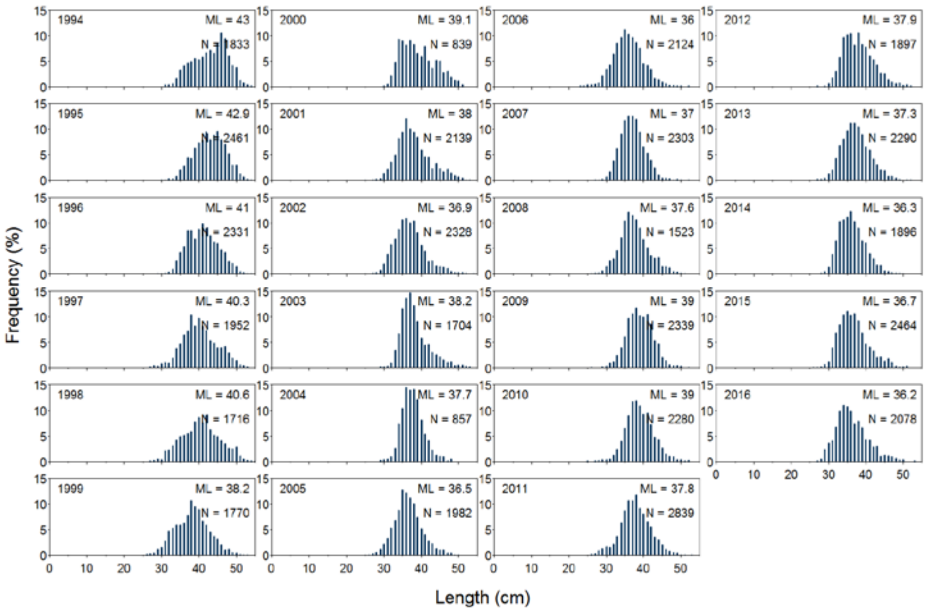


Figure 7.4.3. Grater silver smelt in 5.b. Length distributions of greater silver smelt in the Faroese landings.

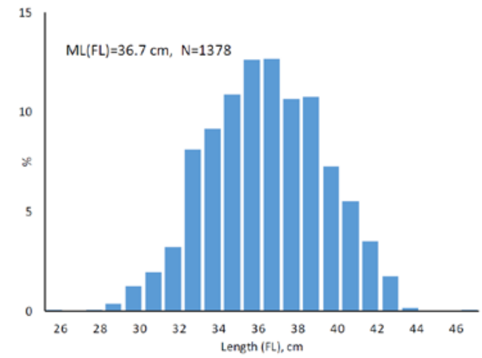


Figure 7.4.4. Greater silver smelt in 5.b. Length composition of greater silver smelt from Russian commercial bottom-trawl catches in the Faroese EEZ in March-May 2017 (Aleksandrov, WD WGDEEP 2017).

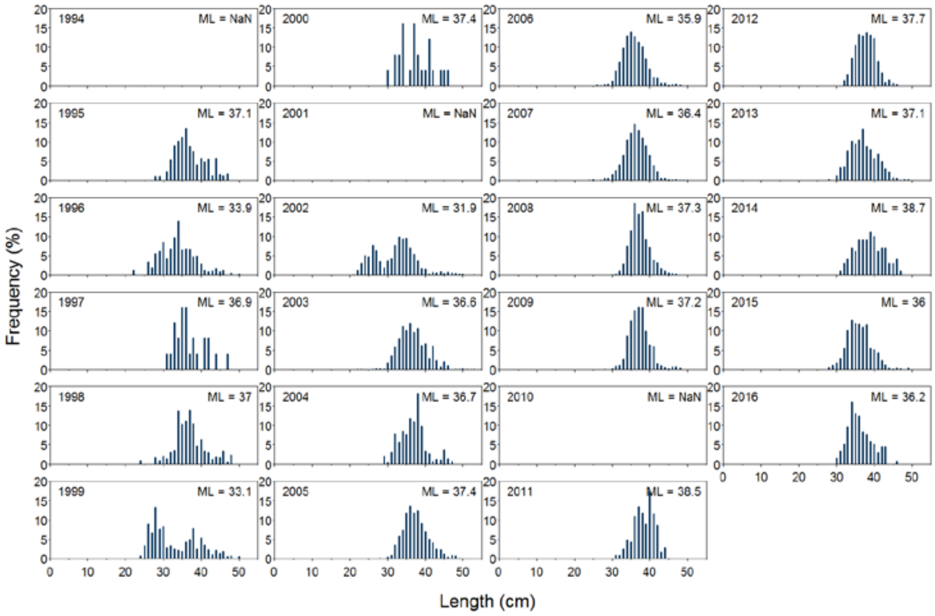


Figure 7.4.5. Greater silver smelt in 6.a. Length composition of greater silver smelt from the Dutch trawl catches in Division 6.a (data from InterCatch).

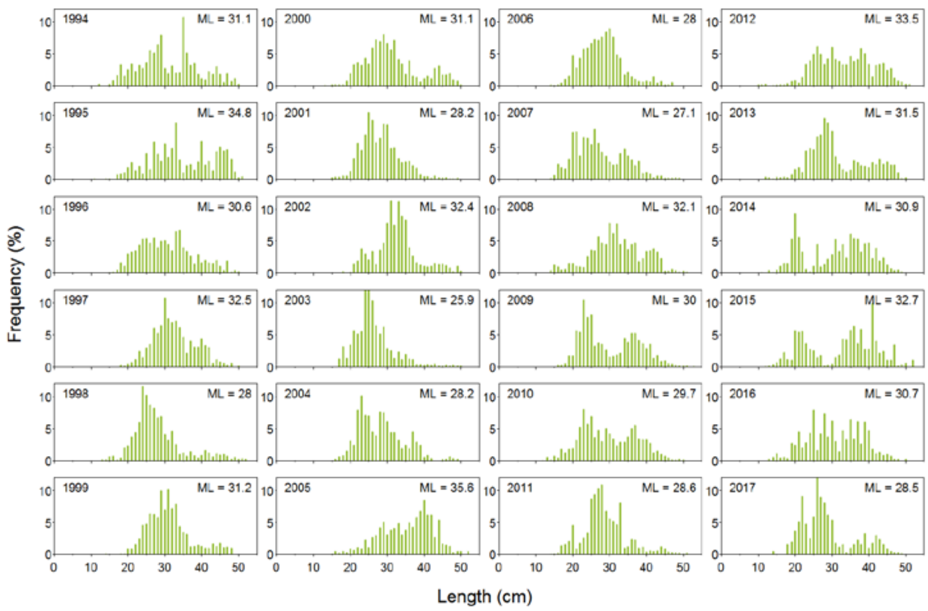


Figure 7.4.6. Greater silver smelt in 5.b. Length distribution from the Faroese spring survey with mean length (ML) and number of calculated length measures (N). Greater silver smelt is sampled from a subsample of the total catch, so the values are multiplied to total catch.

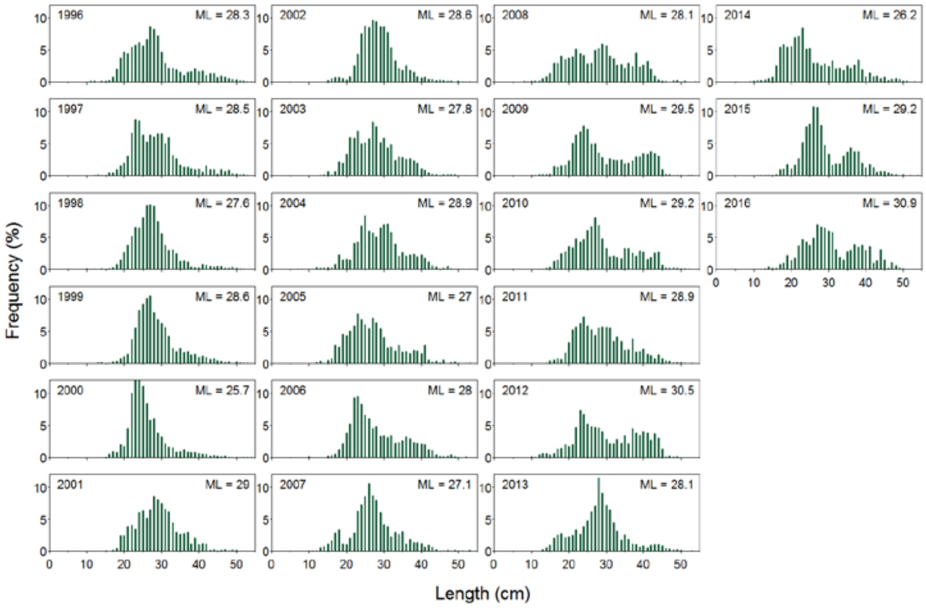


Figure 7.4.7. Greater silver smelt in 5.b. Length distribution from Faroese summer survey with mean length (ML) and number of calculated length measures (N). GSS is sampled from a sub-sample of the total catch, so the values are multiplied to total catch.

7.4.5.3 Age compositions

Age compositions from Faroese landings in Faroese waters are presented in Figure 7.4.8 and these were used in the exploratory assessment. In addition, age data are available from the Dutch fishery in Division 6.a in some years.

There are also age data of greater silver smelt from the Faroese groundfish surveys in Division 5.b.

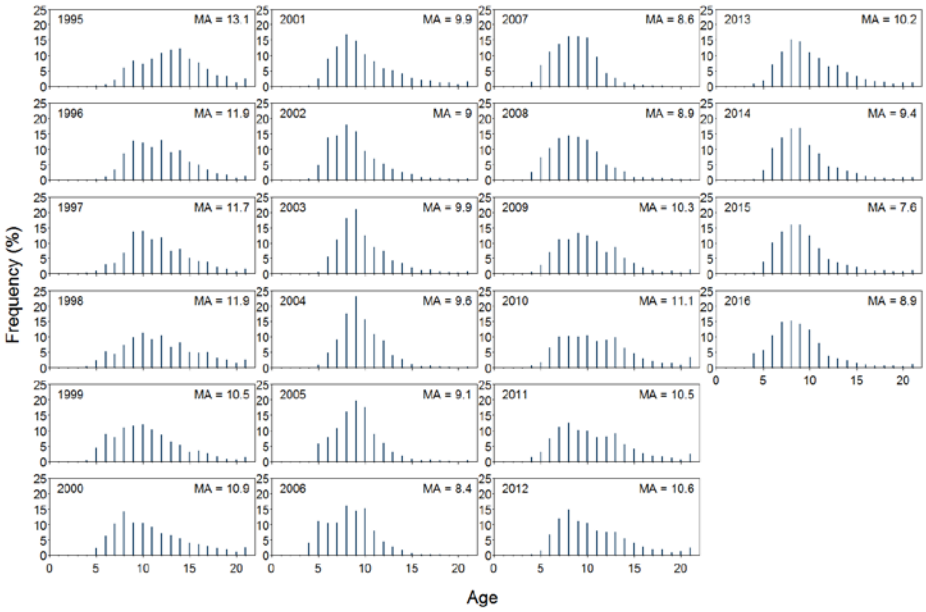


Figure 7.4.8. Greater silver smelt in 5.b. Age distribution used in the exploratory assessment in 5.b from commercial pair trawlers with mean age (MA) 1995–2016.

7.4.5.4 Weight-at-age

Weight-at-age data of greater silver smelt from the Faroese commercial trawl fisheries are presented in Figure 7.4.9 and these were used in the exploratory assessment. In addition, data were also available from the Dutch fishery in Division 6.a in some years (Figure 7.4.16).

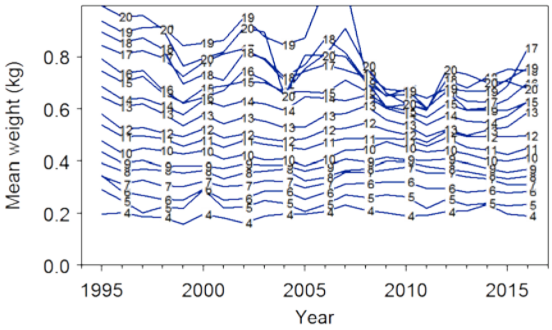


Figure 7.4.9. Greater silver smelt 5.b. Mean weight-at-ages 4–21+ of greater silver smelt in the commercial catch.

7.4.5.5 Maturity and natural mortality

Maturity of greater silver smelt from Russian commercial bottom-trawl catches in the Faroese Fishing Zone in May–June 2016 are shown in Figures 7.4.10. Most of the greater silver smelt caught in commercial catches in Division 5.b is mature (Ofstad, WD14 WGDEEP 2017).

No new data on natural mortality were presented. Natural mortality was set to 0.1 in the exploratory assessment.

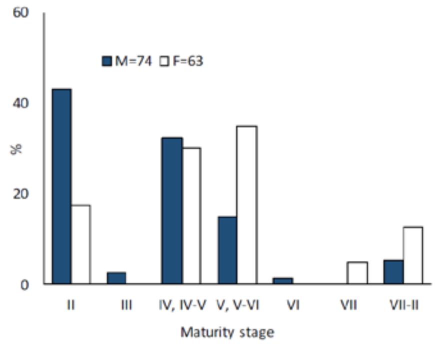


Figure 7.4.10. Greater silver smelt in 5.b. Maturity of Greater silver smelt from commercial bottom-trawl catches in the Faroese EEZ in March-May 2016 (Aleksandrov, WD WGDEEP 2017).

7.4.5.6 Catch, effort and research vessel data

A standardized cpue series from commercial trawlers targeting greater silver smelt in Faroese waters (Division 5.b) is shown in Figure 7.4.11. In addition, to investigate sequential depletion the cpue series for the five main fishing areas in Faroese EEZ are compared in Figure 7.4.11.

Cpue indices for greater silver smelt from the annual Faroese groundfish surveys for cod, haddock and saithe in Division 5.b are shown in Figure 7.4.12. Comparison of the cpue from the commercial fishery and the summer groundfish survey are shown in Figure 7.4.12. Density (mean kg/h for the whole survey period) and spatial distribution from the same survey is shown in Figure 7.4.13. It has to be noted that these surveys have very few stations (<5) deeper than 500 m and are therefore only likely to cover the juveniles adequately. The adult part of the population is not fully covered by these surveys and they may not necessarily reflect correctly the temporal variation of the biomass of the stock.

In 2014, a deep-water trawl survey was introduced and repeated in 2015 and 2016, covering the slope and banks around the Faroes. This deep-water survey covers the fishing area for greater silver smelt in Faroese EEZ (Figure 7.4.14).

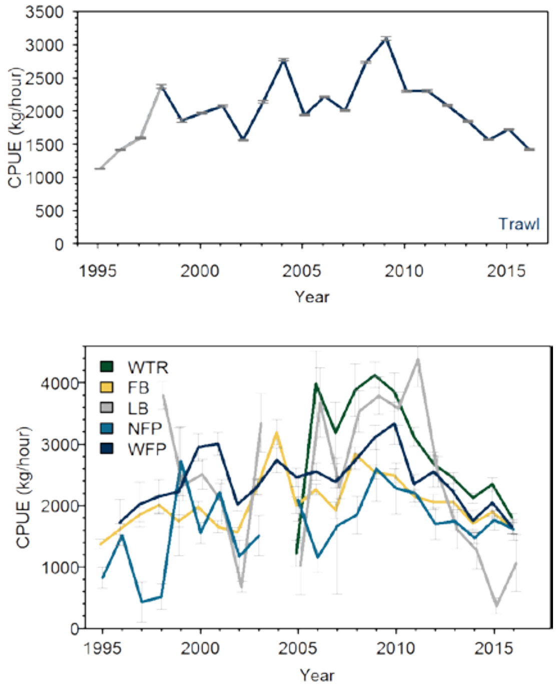


Figure 7.4.11. Greater silver smelt in 5.b. Standardized cpue from pair trawlers fishing greater silver smelt where catch of greater silver smelt is more than 50% of total catch in each haul (upper). Comparison of the commercial Faroese greater silver smelt cpue (kg/hour) from the five main fishing areas. WFP- west of the Faroe Plateau, NFP- north of the Faroe Plateau, LB- Lousy Bank, FB- Faroe Bank, WTR- Wyville-Thomson Ridge (lower).

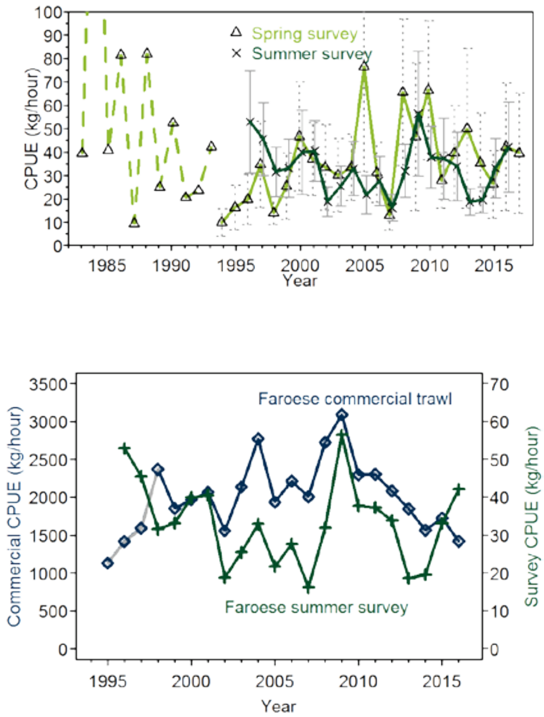


Figure 7.4.12. Greater silver smelt in 5.b. Standardized cpue from Faroese groundfish surveys on the Faroe Plateau (upper). Arrows +- SE and the data from 1983–1993 was not standardized. Comparisons between the cpue from the summer groundfish survey and the commercial trawler series (lower).

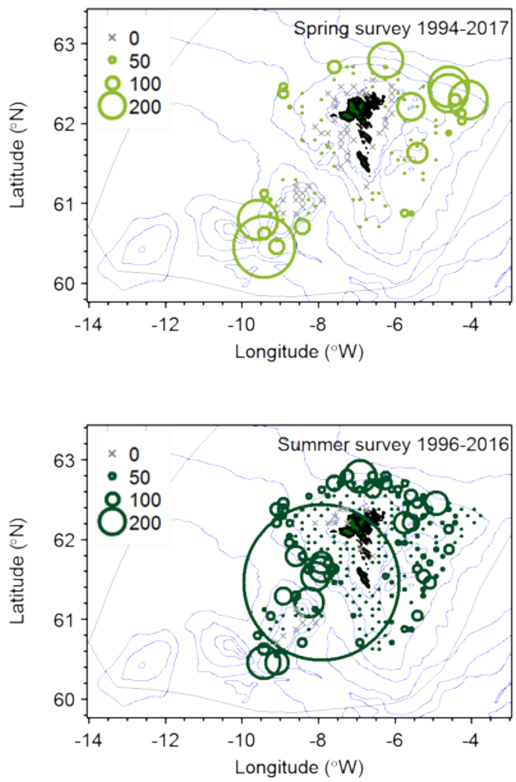


Figure 7.4.13. Greater silver smelt in 5.b. Density and spatial distribution of greater silver smelt in the annual spring (upper) - and summer (lower) groundfish surveys on the Faroe Plateau and the Faroe Bank as average (kg/hour, 1994-2016). Depth contour line is for 100, 200 and 500 m.

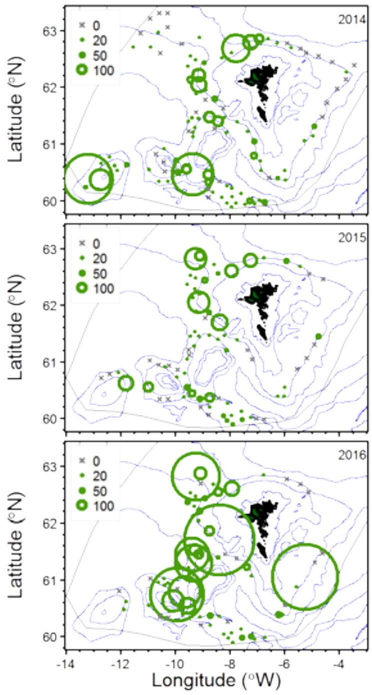


Figure 7.4.14. Greater silver smelt in 5.b. Density and spatial distribution of greater silver smelt in the deep-water surveys in 2014-2016 (kg/hour). Depth contour line is for 100, 200 and 500 m. (Ofstad, WD WGEEP 2016).

7.4.6 Data analyses

Landings have increased from the whole management unit since 1994 to 2007 (Figure 7.4.1). The landings have been stable at a level between 20 000 and 22 000 tonnes since 2007 to 2011 and decreased to a level around 15 000–17 000 in 2012–2016 in Divisions 5.b and 6.a (Table 7.4.2, Figure 7.4.1).

Length and age distributions

Mean length and age in the Faroese landings in Division 5.b decreased from 1994 to 2000 and have been stable since then (Figures 7.4.3, 7.4.8, 7.4.15), probably reflecting a gradual change during and following the first years of exploitation of a virgin stock (Ofstad, WD WKDEEP 2010). The variation in mean length during the latest years could be due to sampling from different depths in the various areas, as the size of greater silver smelt is increasing with increasing depth (Figure 7.4.15). Generally, the Faroese bottom surveys catch individuals less than 30 cm in length at depths shallower than 350 m whereas larger individuals (35–40 cm) were found deeper.

Mean lengths in the Dutch landings were mainly between 36 to 38 cm for the whole period 1995–2016 (Figure 7.4.5). The mean length of greater silver smelt in Faroese and Dutch trawlers was very similar, around 36–39 cm after 2003 (Figure 7.4.15). The low mean lengths observed in the Dutch fishery (1996, 1999, 2002) are probably caused by the catch being a mixture of *Argentina silus* and *Argentina spyraena* or that the Dutch trawlers in these years fished shallower waters than in other years. The Dutch data are from the ICES InterCatch database.

The mean lengths by age of greater silver smelt sampled in the Faroese and Dutch fishery were quite comparable (Figure 7.4.16), allowing the use of Faroese age–length data in an exploratory age-based assessment.

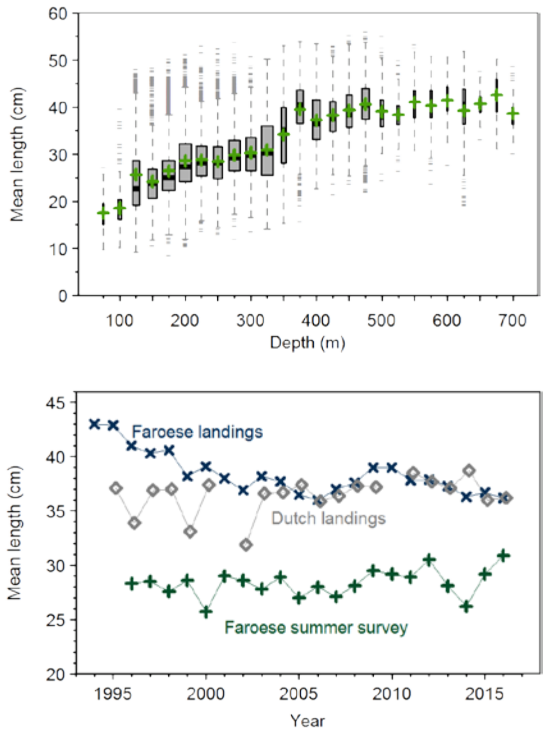


Figure 7.4.15. Grater silver smelt in 5.b and 6.a. Mean length at different depth interval (e.g. 100 is 100–124 m) from various surveys in Faroese area (upper). Comparison of mean length at year from Faroese- and Dutch landings and from the Faroese summer survey (lower).

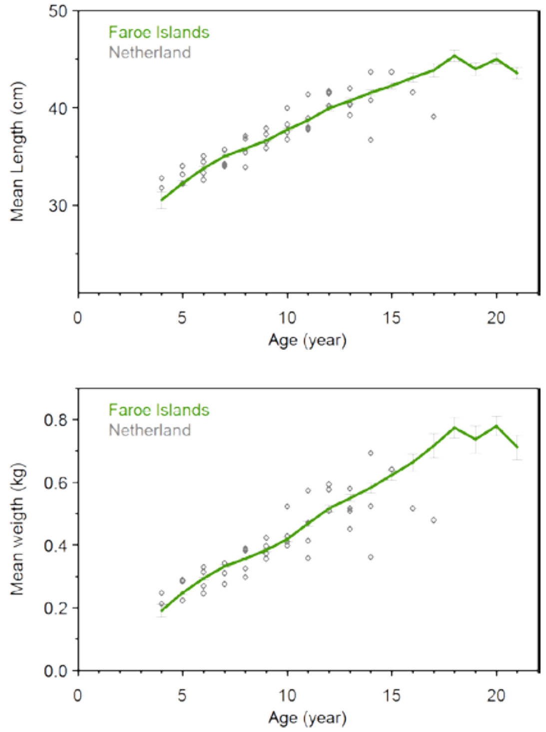


Figure 7.4.16. Grater silver smelt in 5.b and 6.a. Comparisons of greater silver smelt mean length-at-age (left) and mean weight-at-age (right) in the commercial Faroese fisheries (green line) and Dutch fisheries (grey symbols). Dutch data from InterCatch. Commercial and survey cpue series.

The Faroese commercial cpue (Division 5.b) increased until 2010 and has decreased slightly until 2014, with a slight increase in 2015 and a decrease in 2016 (Figure 7.4.11). The period from 1995 to 1997 is believed to be a “learning” period, i.e. the cpue is not believed to be proportional to abundance in those years.

There were concerns about that the commercial Faroese trawl cpue as the distribution of fishing amongst fishing grounds within the Faroes EEZ changed after 2008 (Figure 7.4.2). This has also been mentioned in an earlier WD (Ofstad, WD 2015). There was suspicion that the commercial cpue might be maintained by sequential fishing on different aggregations inhabiting different fishing ground. To investigate this a calculation of the cpue for each of the five different areas was conducted (Figure 7.4.11). The cpue for the “new” fishing area primarily used after 2008 were slightly higher for the period 2005–2011. Even so, the cpues still appear to show the same temporal pattern.

The Faroese summer survey biomass index showed actually the same main trends as in the Faroese commercial cpue, except in 2016 (Figure 7.4.12). Given the low turnover rate (high turnover time) in this species one would not expect to see large changes in abundance by year, indicating that short-term fluctuations may be caused by random events and inadequate sampling. The shallow depth range sampled by the survey (very few stations deeper than 500 m) covers the juveniles adequately but not necessarily the adults since large individuals are generally found at greater depths.

Exploratory assessment

An exploratory age-based stock assessment of greater silver smelt in Faroese waters was presented to the group. It was an update from last year’s XSA and in addition in 2017, a SAM model was also done on the same data and the results from XSA and SAM are compared (Ofstad, WD14 WGDEEP 2017).

The data basis for the age-based assessment was catch data for all countries fishing greater silver smelt particularly Faroe Islands and Netherlands, age compositions representing the Faroese fishery and growth data for both the Faroese fleet as well as the Dutch fleet. As showed earlier in this report, the Dutch length and age data were comparable with the Faroese data. There are two tuning series in the assessment 1) the Faroese summer survey used as a recruitment index (ages 4 to 6, as suggested by the WGDEEP group in 2016) and 2) the commercial cpue series from the Faroese commercial trawlers logbooks. Unfortunately, there is no corresponding commercial cpue series for the Dutch fishery. Such a series would have facilitated investigations of the patterns in 6.a and comparisons with the Faroese data.

The results of the assessment are summarised Figure 7.4.17. The results indicated that the SAM model gave much more stable values than the XSA and SAM also presented uncertainty limits as high and low values. The XSA values were overall inside the SAM uncertainty limits (Figure 7.4.17).

The spawning stock size fluctuated around 88 thousand tons (72–117 thousand tons) and mean recruitment around 80 mill 4-year old individuals (62–90 million). The average fishing mortality for individuals between six and 18 years old was on average 0.27. However, fishing mortality is found to be higher in the early part of the time-series than in more recent years. The fishing mortality has been around 0.23 since 2005. This is likely the combined effect of quota restrictions and in the last years the pair trawlers have shifted to fish for mackerel instead of greater silver smelt.

Although the exploratory age-based stock assessment has not been benchmarked, it seems to indicate the absolute level of stock size and fishing mortality and may provide a valid perception of the temporal variation of the stock. Greater silver smelt in 5.b and 6.a was suggested for benchmark.

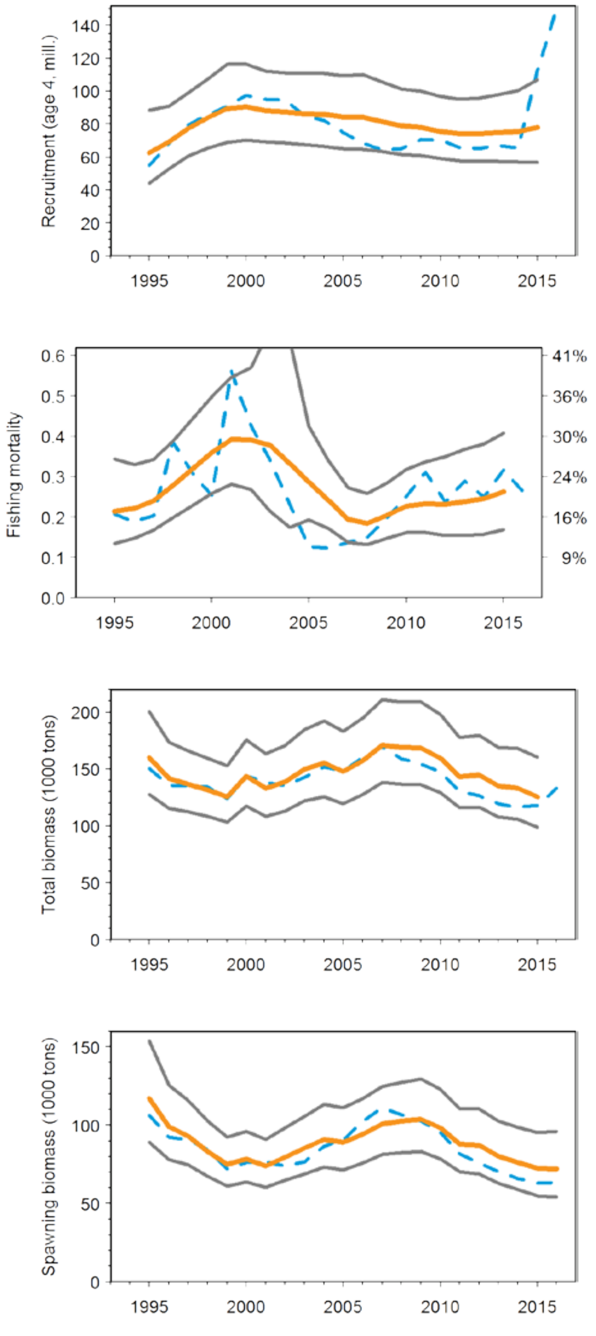


Figure 7.4.17. Grater silver smelt in 5.b and 6.a. Recruitment, fishing mortality, total biomass and spawning biomass of greater silver smelt in Division 5b and 6a, output from the age-based assessments done in SAM and XSA. Results from SAM are the orange line and the uncertainty limits is grey line. The results from XSA are the stippled blue line.

7.4.6.1 Reference points

There are no accepted reference points for this management unit.

Different methods were tried to come up with reference points (Ofstad, WD14 WGDEEP 2017) and a summary of the results are showed in the table below.

Method	FMSY proxy	Comment
Length method	Around current F	Length distribution from both Faroese and Dutch fishery
Eqsim	0.14–0.17 (new 0.28)	Background data from XSA assessment in year 2016
C_{MSY}	0.25–0.26	Background data from XSA assessment in year 2016
YPR $F_{0.1}$	0.08	Background data from SAM assessment in year 2017
F_{2016}	0.23	Result from SAM assessment in 2017

7.4.7 Comments on the assessment

Advice is given every second year for this stock, so the advice for 2018 also applies for 2019. The advice is based on trends in the cpue (kg/hour) from the Faroese summer survey on the Faroe Plateau (DLS method 3.2). The advice for 2016–2017 was, for the first time, given for the new advisory unit (Divisions 5.b and 6.a).

Unfortunately there is no corresponding cpue series for the Dutch fishery for comparison with the Faroese commercial cpue series. Such a series would have facilitated investigations of the patterns in 6.a and comparisons with the Faroese data.

7.4.8 Management considerations

The greater silver smelt fishery in Faroese waters is managed by Faroese authorities and the quota is set at the F_{01} catch from the age-based assessment. The quota of greater silver smelt in the Faroese EEZ has been reduced from 16 000 t (for 2014) to 14 400 t (for 2015) and to 13 000 t in 2016 and to 11 500 in 2017. The reason for this was the decrease in the spawning–stock biomass index from the exploratory assessment.

The possibility to find new fishing areas within Faroese waters seems to be limited. Developments during the next few years will have to be monitored closely in order to determine whether the stock can sustain the current TAC level.

7.4.9 Application of MSY proxy reference points

At the ICES WKPROXY meeting in November 2015 a screening method (Length-based indicators and reference points) was tried on greater silver smelt in Division 5.b and 6.a (ICES, WKPROXY 2015). These input data are updated with the latest values. The input data were the length distribution from Faroese commercial trawlers fishing in the Faroese EEZ 1994–2016 or length distribution from Dutch trawlers fishing in 6.a, mean weight-at-length per year was the same as used in the exploratory XSA assessment, L_{mat} = 34.8 cm, L_{inf} = 44.7 cm, combined sex.

The results show that greater silver smelt in Divisions 5.b and 6.a was fished sustainably at levels close to optimum yield and with exploitation at MSY levels based on the length-based indicator model (table below).

Area 5.b	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2012	1.01	1.01	1.05	95%	1.32	1.05
2013	1.01	1.01	1.02	92%	1.30	1.03
2014	0.95	0.98	0.99	88%	1.24	1.03
2015	0.95	0.98	1.04	87%	1.26	1.04
2016	0.95	0.95	1.04	83%	1.25	1.04

Area 6.a	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2013	1.01	0.98	1.00	92%	1.29	1.03
2014	1.01	1.03	1.03	96%	1.33	1.06
2015	0.95	0.98	0.97	89%	1.23	1.02
2016	1.01	0.98	0.97	90%	1.27	1.01

The conclusion of the screening method was that the results shows that the stock seems to be harvested in a suitable way as it was not exploited above the length-based indicator of MSY.

In addition, a SPiCT method was also tried on this advice unit (ICES, WKPROXY 2015). The data used for this stock were the total landings from Divisions 5.b and 6.a and the Faroese annual trawl summer survey, which is the same as the information provided in the 2015 advice for this stock (Tables 9.3.12.7 and 9.3.12.8 in advice 2015). The Faroese commercial trawl series was also tried as this series is more representative of the exploitable biomass. The conclusion was that the SPiCT model cannot be used for this assessment unit because the model did not give any reliable results (ICES, WKPROXY 2015). This model was also tried with updated input values at the WGDEEP 2017 meeting, and it still do not converge.

Table 7.4.1. Greater Silver Smelt 5.b and 6.a. WG estimates of landings in tonnes. *) landings in 2016 are preliminary.

Greater silver smelt (*Argentina silus*) 5.b

Year	Faroes	Russia/USSR	UK (Scot)	UK(EWN)	Iceland	Ireland	France	Netherlands	Norway	Germany	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

Year	Faroes	Russia/USSR	UK (Scot)	UK(EWN)	Iceland	Ireland	France	Netherlands	Norway	Germany	TOTAL
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	11 109	114									11 223
2014	9747	339								110	10 196
2015	13 025	115			132		0.3			40	13 312
2016*	11 129	13	0.2		345			31		38	11 557

Table 7.4.1. (Continued).

Greater silver smelt (*Argentina silus*) 6.a

Year	Denmark	Faroes	France	Germany	Ireland	Netherlands	Norway	E&W	Scotland	Russia	Spain	TOTAL
1988					3040		4884					7924
1989		188			1325	3715	11984		3369			20581
1990		689		14	110	5870			112			6795
1991			7			4709			10			4726
1992			1		100	4964			466			5531
1993						663			406			1069
1994				43		6217			1375			7635
1995		483		284		3706			465			4938
1996				1384	295	3953						5632
1997				1496	1089	4684						7269
1998				464	405	4687						5556
1999				24	168	8026		5				8223
2000			19	403	3178	3389						6989
2001			7	189	5838	3655			4777			14466
2002			1	150	3035	4020		424	4136			11766
2003				126	1	1932			80			2039
2004			147	652	46	3707			507			5059
2005		103	10	125	18	5317			61			5634
2006		53		213		4628			3		1	4897
2007		254		589		6969	3				2	7817

Year	Denmark	Faroes	France	Germany	Ireland	Netherlands	Norway	E&W	Scotland	Russia	Spain	TOTAL
2008		991		10		4156	3					5160
2009		3923		115	0.5	2488	83		6	36		6651
2010		3060				3143	7		20	11		6241
2011		3655			0.1	3050		2	2			6709
2012		2781	2	538	0.2	1785		5	5	1		5115
2013	125	3197		417	0.1	1430				13	0.2	5182
2014	711	1495		908		2332				21		5467
2015		1055		1027		2154	0					4236
2016*		2050	0	228		2495						4773

Table 7.4.2. Greater silver smelt (*Argentina silus*) (5.b and 6.a).

Year	5.b	6.a	Total
1988	287	7924	8211
1989	227	20581	20808
1990	2888	6795	9683
1991	60	4726	4786
1992	1443	5531	6974
1993	1063	1069	2132
1994	960	7635	8595
1995	12286	4938	17224
1996	9498	5632	15130
1997	8433	7269	15702
1998	17570	5556	23126
1999	8229	8223	16452
2000	5209	6989	12198
2001	10081	14466	24547
2002	7471	11766	19237
2003	6558	2039	8597
2004	5310	5059	10369
2005	7013	5634	12647
2006	12559	4897	17456
2007	14126	7817	21943
2008	14952	5160	20112
2009	14228	6651	20879
2010	15609	6241	21850
2011	15586	6709	22295
2012	9854	5115	14969
2013	11223	5182	16405
2014	10196	5462	15662
2015	13312	4236	17548
2016*	11557	4773	16330

7.5 Greater silver smelt (*Argentina silus*) in 6.b, 7, 8, 9,10 and 12

7.5.1 The fishery

The fisheries from this area is very minor and there are no directed fisheries.

7.5.2 Landing trends

Landings from this area are reported from 1966–2016. Landings increased until 2002 to 4662 tons then declined again to low levels of less than a ton in 2016. Landings from the five last years have been less than 50 tons. The main landings have been from Subareas 6b and 7 where Ireland were fishing for some years between 2000 and 2003.

7.5.3 ICES Advice

The 2015 advice was from area 6b, 7, 8, 9, 10 and 12, and stated "ICES advises that when the precautionary approach is applied, landings should be no more than 15 tons in each of the years 2016 and 2017. ICES cannot quantify the corresponding catches".

7.5.4 Management

The EU introduced TAC management in 2003. For 2017 the EU TAC in Subareas 5, 6 and 7 was 3884 tonnes.

7.5.5 Data available

7.5.5.1 Landings and discards

Landings data are presented by area and countries (Tables 7.5.1–7.5.5). Discards data from the two last years are presented in Table 7.5.6. Discards are mainly from the Spanish fishery and from Subarea 7. The discards are very high compared to the landings. However, the discards in 2016 were reduced compared to the years before 2011.

Argentina silus can be a very significant discard of the trawl fisheries of the continental slope of Subareas 6 and 7 particularly at depths 300–700 m (e.g. Girard and Biseau, WD 2004) (table 7.5.7). Information have been available on discards in 2009 and 2012 in Basque country and Spanish fisheries in Subareas 6–7, and Divisions 5.3.abcd and northern 9.a. 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. Same applies for discards registered by the Netherlands. Based upon on-board observations from DCF sampling, the catch composition of the French mixed trawl fisheries in 5.b, 6 and 7 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. It should be noted that after redefinition of stock structure in 2015 area 6.a is not included in this stock.

7.5.5.2 Length compositions

The size compositions of *Argentinas* spp. from Porcupine survey since 2001 is presented in Figure 7.5.2.

7.5.5.3 Age compositions

No new data on age composition were presented.

7.5.5.4 Weight-at-age

No new data on weight-at-age were presented.

7.5.5.1 Maturity and natural mortality

No new data on maturity and natural mortality were presented.

7.5.5.2 Catch, effort and research vessel data

Spanish bottom-trawl surveys have been carried out in Subarea 7 (Porcupine) since 2001. Recent investigations have revealed that survey catches from the Spanish Porcupine survey contain both *A. Silus* and *A. Sphyraena* (Figures 7.5.2, 7.5.3 and 7.5.4). Abundance and biomass indices from survey catches of mixed *A. silus* and *A. sphyraena* is presented in Figure 7.5.3. 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.

7.5.6 Data analyses

Length and age distributions

The size compositions from Porcupine Bank in Subarea 7 have no obvious trend towards smaller fish but these data may by disturbed by the relative species composition *A. silus* and *A. sphyreana* (Figure 7.5.2).

Commercial and survey cpue series

For Subarea 7, abundances and biomass indices from the Spanish porcupine survey have been showing a decreasing trend from 2002 until 2011 but have been rising since then (Figure 7.5.3). The index has increased in the last two years. However the survey is unlikely to cover all the exploitable biomass of the stock as it only goes down to 400 meters.

Exploratory assessment

No exploratory assessment was presented.

Biological reference points

SPiCT was run on the landings dataseries (1973–2016) and the biomass index series from Porcupine bank (2001–2016) but it did not converge.

7.5.7 Comments on the assessment

Advice is given every second year for this stock and this year's advice applies for 2018 and 2019.

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 7.5.2, 7.5.3 and 7.5.4). The proportion of lesser silver smelt in the fisheries is not believed to be large but further investigations should be undertaken.

The biomass index is only from the Porcupine bank and is therefore not covering the total stock area.

7.5.8 Management considerations

The trends for Porcupine bank survey biomass indices have increased in 2015 and 2016.

Table 7.5.1. Greater Silver Smelt in 6.b. WG estimates of landings in tonnes. * landings in 2016 are preliminary.

Year	Faroes	Germany	Ireland	Netherlands	Scotland	Russia	Spain	TOTAL
1979								
1980		13						13
1981		525						525
1982								
1983		4						4
1984								
1985								
1986								
1987								
1988								
1989								
1990			300					300
1991				5				5
1992			220		1			221
1993					3			3
1994					20			20
1995	1114							1114
1996								
1997								
1998								
1999			178					178
2000			1355			29		1384
2001					62	68		130
2002					1	29		30
2003					6	120		126
2004				11		12		23
2005						4		4
2006								
2007								
2008						1	8	9
2009								
2010								
2011								
2012								
2013								
2014						20.5		20.5
2015								0
2016*								0

Table 7.5.2. Greater Silver Smelt in 7. WG estimates of landings in tonnes. * landings in 2016 are preliminary.

YEAR	FRANCE	GERMANY	IRELAND	NETHERLANDS	SCOTLAND	NORWAY	POLAND	SPAIN	UK E/W	TOTAL
1972										
1973	40									103
1974							63			
1975										
1976										
1977			1							1
1978		404					5			409
1979		103								103
1980										
1981										
1982						666				666
1983						595				595
1984						163				163
1985										
1986						258				258
1987						50				50
1988						100				100
1989						200				200
1990		23		1						24
1991				9						9
1992				254						254
1993				505						505
1994				39						39
1995		73	6	431						510
1996		10								10
1997				12						12
1998										
1999			50							50
2000		79	166	244				34		523
2001	5		1592	2	2782			34		4415
2002			4433		2			2		4437
2003			95	19				5		119
2004				13	19			15		47
2005		26	1		14			17		58
2006								40		40
2007								35		35
2008										
2009	13		1					6		20
2010	10			8				2	3	23
2011		4			8					12
2012		2			1					3
2013				1						1
2014				1						1
2015				5						5
2016*	0			0				0		0

Table 7.5.3. Greater Silver Smelt in 8. WG estimates of landings in tonnes. *landings in 2016 are preliminary.

Year	Netherlands	Spain	TOTAL
2002	195		194.61
2003	43		42.525
2004	23		22.722
2005	202		202.29
2006			0
2007			0
2008		10	10
2009			0
2010			0
2011	1		1
2012			0
2013			0
2014	1.1		1.1
2015			0
2016*		0	0

Table 7.5.4. Greater Silver Smelt 9. WG estimates of landings in tonnes. *) landings in 2016 are preliminary.

Year	Netherlands	Portugal	TOTAL
2006			0
2007	1		1
2008		0.5	0.5
2009		1.9	1.9
2010		1.9	1.9
2011		0.9	0.9
2012		1.9	1.9
2013*			0
2014			0
2015			0
2016*			0

Table 7.5.5. Greater Silver Smelt 12. WG estimates of landings in tonnes. * landings in 2016 are preliminary.

Year	Faroes	Iceland	Russia	Netherlands	TOTAL
1988					0
1989					0
1990					0
1991					0
1992					0
1993	6				6
1994					0
1995					0
1996	1				1
1997					0
1998					0
1999					0
2000		2			2
2001					0
2002					0
2003					0
2004			4	625	629
2005				362	362
2006					0
2007					0
2008					0
2009					0
2010					0
2011					0
2012		31			31
2013					0
2014					0
2015					0
2016*					0

Table 7.5.6. Discard data from 2015 and 2016 from Subarea 6b, 7-1012.

	Spain				France
Year	6b	7	8	9	6b+7
2015	7	28	0		
2016		237	2	1	19

Table 7.5.7. Discards by Spain and Netherlands from before the redefinition of the stock area (Subarea 6,7 and 8) from 2003–2014.

Year	Spain	Netherland	Total
2003	2806	1246	4053
2004	3075	299	3374
2005	2437	0	2437
2006	1249	149	1398
2007	2037	44	2082
2008	3060	57	3118
2009	4108	73	4182
2010	2005	23	2029
2011	2050	5	2056
2012	177	25	202
2013	91	20	132
2014	159	111	1365

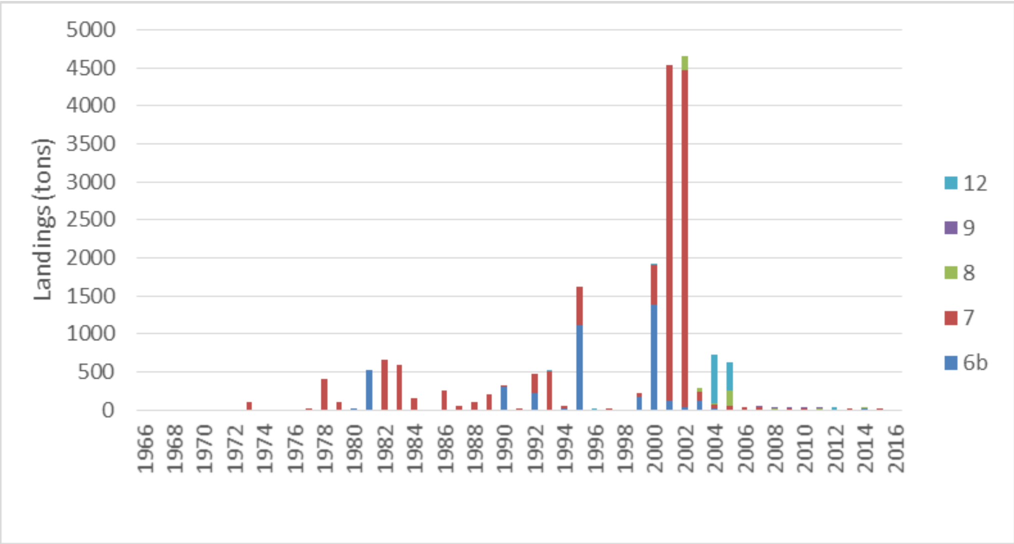


Figure 7.5.1. Total landings from 1966–2016 of greater silver smelt in 6.b, 7, 8, 9, 10 and 12.

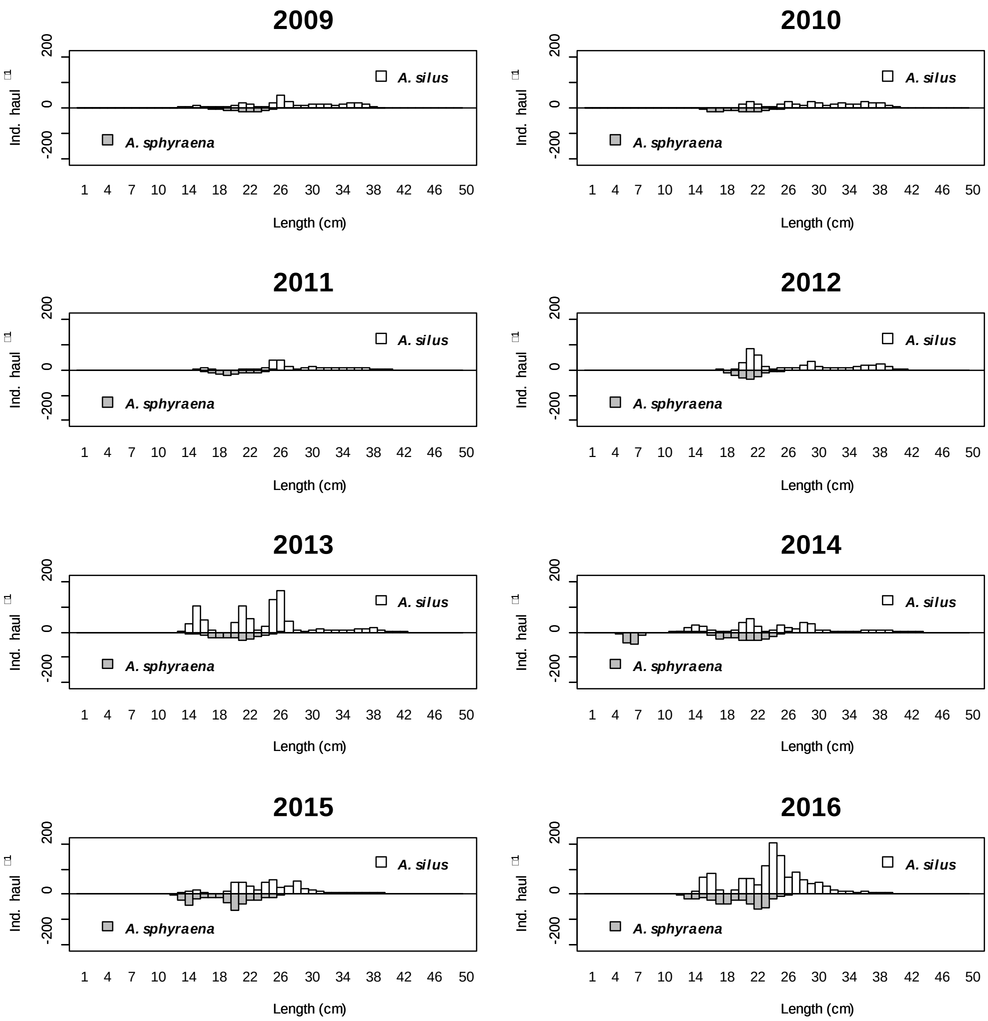


Figure 7.5.2. Mean stratified length distributions of *Argentina* spp. in Spanish Porcupine surveys from Subarea 7.

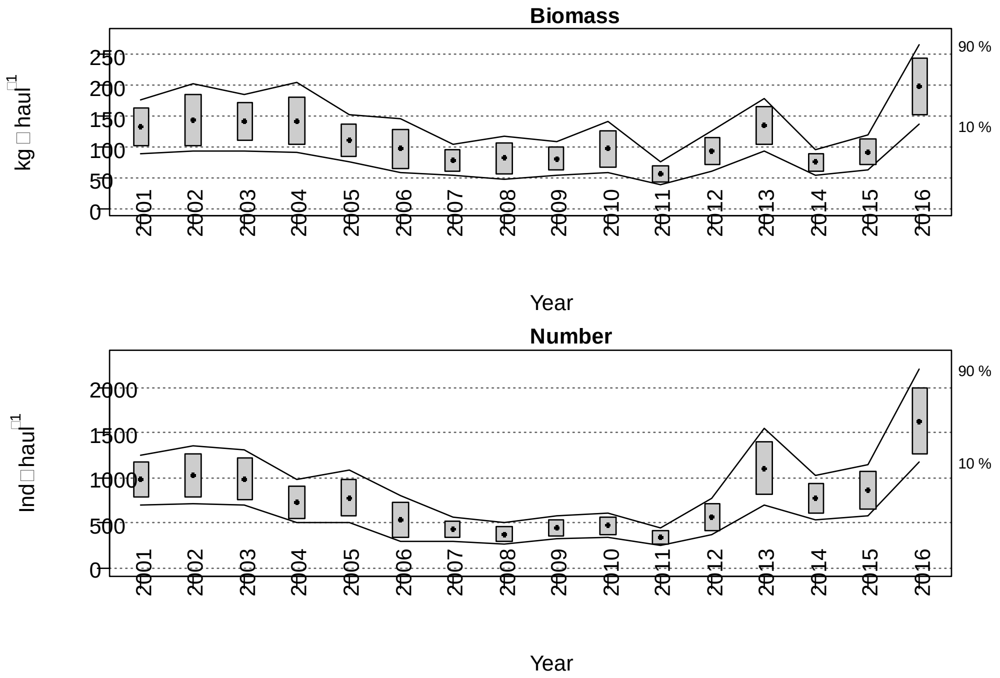


Figure 7.5.3. Greater silver smelt in 7. Changes in *Argentina* spp. (mainly *Argentina silus*) biomass and abundance indices during Porcupine Survey time-series. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

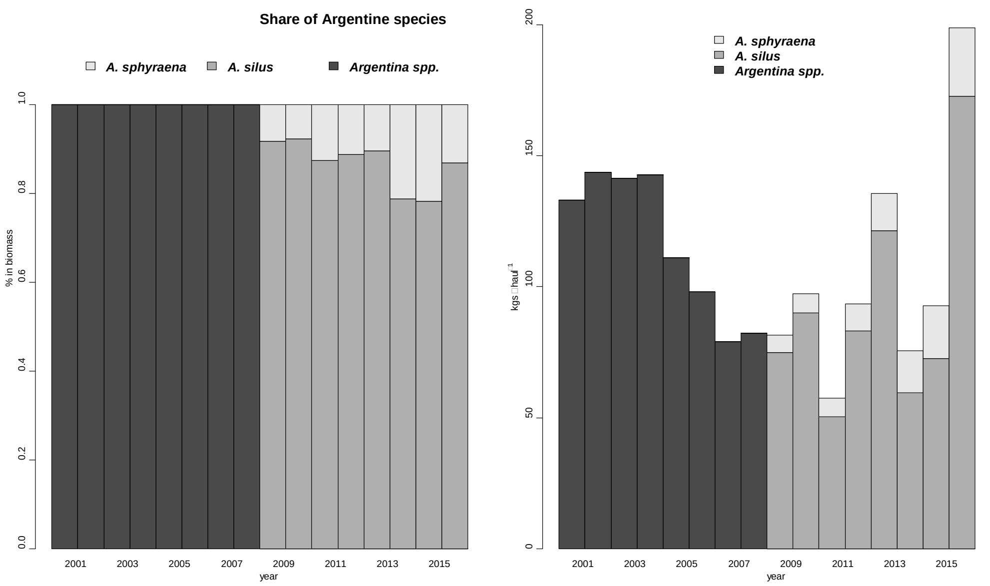


Figure 7.5.4. Share and abundance of Argentine species in Porcupine Bank surveys (2001–2016).

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 6;
- Subarea 7;
- Orange roughy in all other areas.

Given the scarcity of spatial fisheries data, biological and genetics data, 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 Faroese catches by ICES areas in the Northeast Atlantic in 2015.

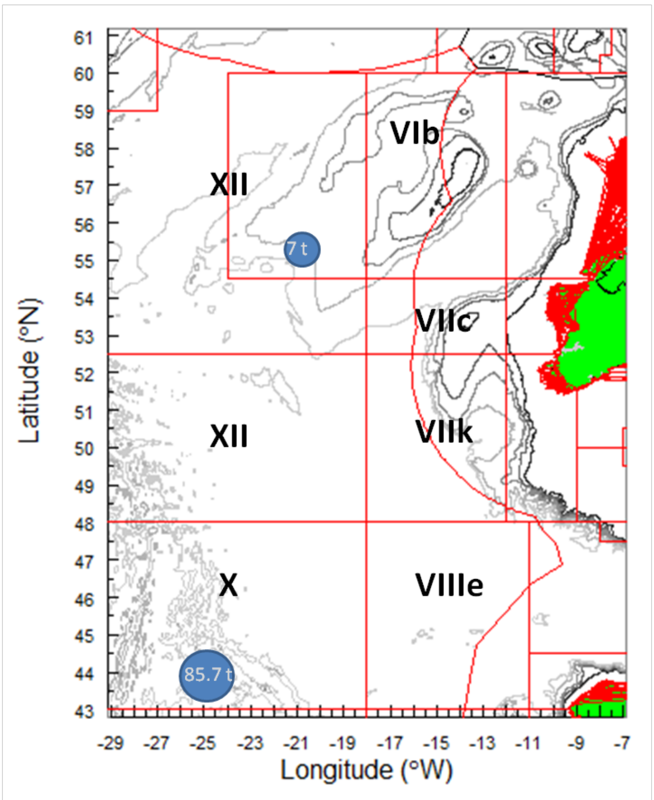


Figure 8.1.1. Faroese catches for orange roughy by ICES areas in Northeast Atlantic in 2016.

8.2 Orange roughy (*Hoplostethus Atlanticus*) in Subarea 6

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 directed fisheries had ceased by 2006.

8.2.2 Landings trends

Table 8.2.0 and Figure 8.2.1 show the landings data for orange roughy for ICES Subarea 6 as reported to ICES or as reported to the Working Group. There were no landings of orange roughy in Subarea 6 recorded in 2015. A small landing, 700 kg rounded to 1 tonne in Table 8.2.0 was landed by the Faroe Islands in 2016. The cumulative landings in Area 6 were 7188 tonnes.

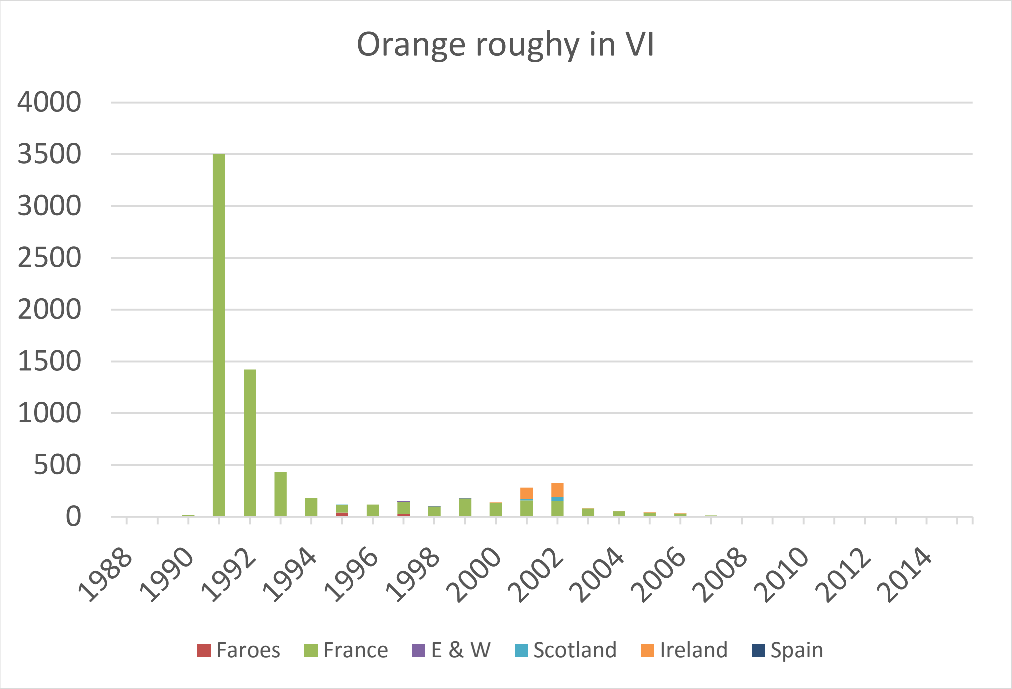


Figure 8.2.1. Time-series of orange roughy landings by country in ICES Area 6.

8.2.3 ICES Advice

The ICES advice was published in 2016 for 2017–2020. It applies to orange roughy in the Northeast Atlantic and states that when the precautionary approach is applied, there should be zero catch in each of the years 2017–2020.

8.2.4 Management

In 2003 a TAC was introduced for orange roughy in Subarea 6, this TAC remained at 88 tonnes until 2006. In order to align the TAC with landings, the TAC for EC vessels in Area 6 was reduced annually between 2007 and 2009. A zero TAC has been set for orange roughy in Subarea 6 since 2010.

Landings in relation to TAC are displayed in Table 8.2.1.

Table 8.2.1. EU TACs and landings in EU and international waters of 6.

		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
2015	0	0	0
2016	0	0	1

8.2.5 Data available

8.2.5.1 Landings and discards

Landings are in Table 8.2.0.

Raised discard weights were not available for 2014 and 2015.For 2016, discards were estimated to 0 -zero).

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

No new analysis was performed in 2016.

8.2.7 Management considerations

The fisheries for orange roughy in Subareas 6 and 7 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. Previous examination of French observer data suggested that bycatch and discarding of orange roughy is currently not significant (<1 tonne).

Due to the closure of the fishery in Subareas 6 and 7 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 Subareas 6 and 7.

Assessment of the susceptibility of orange roughy populations in Subareas 6 and 7 to recent and current deep-water trawl fisheries (see WGDEEP 2014, 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 Subarea 6 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 a small bycatch. Owing to previous estimates of sustainable catch of a few hundred tonnes per year in Subareas 6 and 7, the impact of current fisheries is considered sustainable.

Table 8.2.0. Orange roughy catch in Subarea 6.

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**
2014		0					0
2015							0
2016	1						1

8.3 Orange roughy (*Hoplostethus Atlanticus*) in Subarea 7

8.3.1 The fishery

After the collapse of the fishery in Subarea 6, 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.

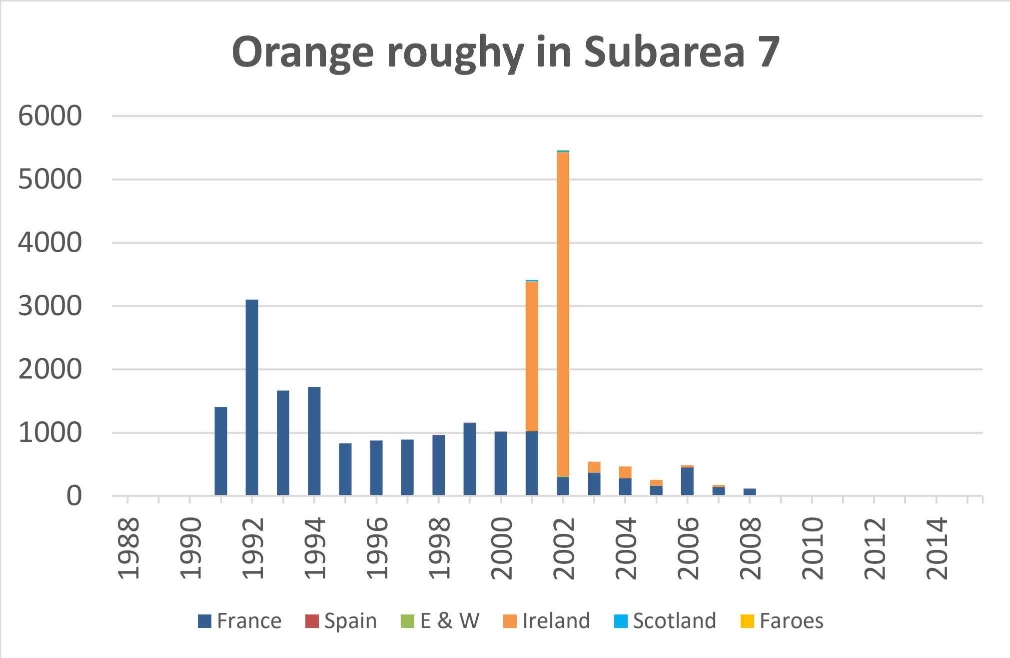


Figure 8.3.1. Time-series of orange roughy landings by country in ICES Subarea 7.

8.3.3 ICES Advice

The ICES advice was published in 2016 for 2017–2020. It applies to orange roughy in the Northeast Atlantic and states that when the precautionary approach is applied, there should be zero catch in each of the years 2017–2020.

8.3.4 Management

A TAC for orange roughy in Subarea 7 was first introduced in 2003. Landings in relation to TAC are displayed in the table below:

Table 8.3.1. EU TACs and landings in EU and international waters of Subarea 7.

		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	0	0
2015	0	0	0
2016	0	0	0

The TAC for orange roughy in Subarea 7 is set to 0 t for 2016 and 2017.

8.3.5 Data available

8.3.5.1 Landings and discards

Landings are shown are in Table 8.3.0.

Discards of Orange roughy from the French mixed deep-water fishery in Subareas 6 and 7 were estimated from observer data. In recent years, discards estimated at fleet level have been calculated for total discards and by species. In 2012, the estimated discards of orange roughy was 400 kg. These data suggest that the bycatch of orange roughy in the mixed deep-water trawl fishery is low. No new information.

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 Management considerations

The fisheries for orange roughy in Subareas 6 and 7 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 Subareas 6 and 7 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 Subareas 6 and 7.

PSA Assessment of the susceptibility of orange roughy populations in Subareas 6 and 7 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 Subareas 6 and 7, the impacts of current fisheries are considered sustainable.

Table 8.3.0. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus,* by country in Subarea 7. Reported landings after 2012 have been 0 and the table was not expanded for these years

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						2

***Preliminary.**

8.4 Orange Roughy (*Hoplostethus atlanticus*) In Subareas 1, 2, 4, 5, 8, 9, 10 12 and 14 and Division 3.a

8.4.1 The fishery

Fisheries have been conducted in Divisions 5.a–b and Subareas 8, 10 and 12. Most started in the early 1990s, the exception being Subarea 10 which started in 1996. In the last seven years, fisheries are mainly occurring in 10 and 12, with sporadic catches in 5.a, 5.b and 9. In 2015 and 2016, one Faroese vessel operated a small directed fishery in ICES Subareas 10 and 12. Information on this fishery is presented in WD Ofstad, 2017.

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.

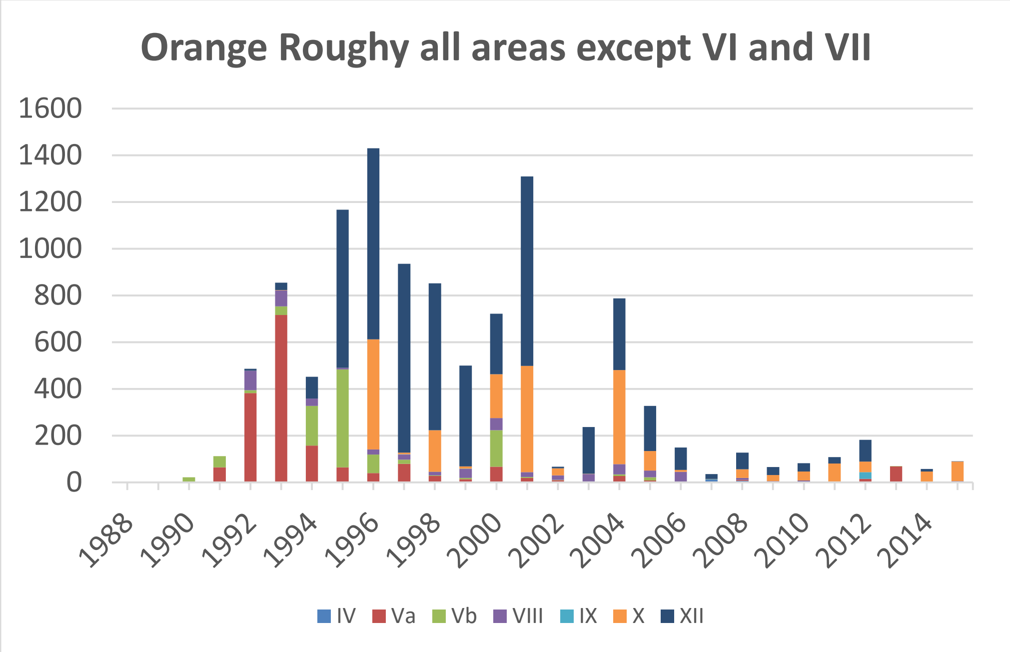


Figure 8.4.1. Time-series of orange roughy landings by in all areas (except Subareas 6 and 7).

8.4.3 ICES Advice

The ICES advice was published in 2016 for 2017–2020. It applies to orange roughy in the Northeast Atlantic and states that when the precautionary approach is applied, there should be zero catch in each of the years 2017–2020.

8.4.4 Management measures

The EU TAC is set to for 0. The TAC applies to Community waters and EC vessels in international waters. Landings in relation to EU TAC are shown in Table 8.4.1.

In the NEAFC Regulatory Area, targeted fisheries for orange roughy are not permitted to vessels of the contracting parties, which must take measures to decrease by-catch (Recommendation 6: 2016).

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.

Table 8.4.1. EU TACs and landings in Community waters and waters not under the sovereignty or jurisdiction of third countries of 1, 2, 3, 4, 5, 8, 9, 10, 11, 12 and 14.

		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
2014	0	0	58
2015	0	0	84
2016	0		

8.4.5 Data available

8.4.5.1 Landings and discards

Landings are in Table 8.4.0. Faroe Islands continued the fishery for orange roughy in 2016 and the Faroese catches was 85.7 tonnes in area 10 and 7.0 tonnes in area 12. In 2016, small discards were reported by Spain in Division 8.c and 9.a, 500 kg overall.

8.4.5.2 Length composition

Sampling of lengths, weight and gender of orange roughy was carried out by trained crew members on board the single Faroese fishing vessel operating in this fishery. Samples were taken randomly from the catch. Approximately 5% of the Faroese landings of 93 tons in 2016 were sampled (1074 individuals). The length distribution of the catch is between 50–70 cm total length (Figure 8.4), which is the same as in the Faroese experimental fishery in the nineties (Thomsen, 1998). The average length and weight of orange roughy females and males were around the same in 2011–2016 compared with the results from the experimental fishery in 1992–1998 (Thomsen, 1998) (Table 8.4.2).

Table 8.4.2. Mean length and weight by sex. From sampling by trained crew members on board the single Faroese fishing vessel targeting orange roughy.

Year	Area	Average length (cm)		Average weight (kg)		
		Female	Male	Female	Male	
1992–1998	Faroe Islands	61.4	58.6	4.4	3.7	Thomsen, 1998
	Hatton Bank	64.6	62.8	4.9	4.3	Thomsen, 1998
	Reykjanes Ridge	58.9	56.4	3.6	3	Thomsen, 1998
	North of Azores	60.6	59.7	3.9	3.7	Thomsen, 1998
2011		61.4	60.5	3.5	3.2	
2012		61.4	60.8	3.5	3.2	
2013		60.9	57.7	4.3	3.8	
2014		62.1	58.4	4.2	3.7	
2015		59.0	58.3	3.7	3.5	
2016		61.4	58.7	4.3	3.7	

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

Catch and effort data were collected on a haul-by-haul basis in the Faroese fishery.

8.4.6 Data analysis

No data analysis was carried out in 2016.

8.4.7 Management considerations

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.

8.4.8 References

ICES. 2014. Report of the Working Group on Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 4–11 April 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:17. 862 pp.

Ofstad, L.H. 2017. Faroese fishery of orange roughy in ICES areas 10 and 12. WD02 WGDEEP 2017.

Thomsen, B. 1998. Faroese quest of orange roughy in the North Atlantic. Copenhagen (Denmark), ICES.

Table 8.4.0a. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Division 5.a.

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
2014	0	0
2015	0	0
2016	0	0

Table 8.4.0b. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Division 5.b.

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
2014	0		0
2015	0		0

Table 8.4.0c. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Subarea 8.

Year	France	Spain 8 and 9	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
2014				0
2015	6			6
2016	0			0

Table 8.4.0d. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Subarea 9.

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
2014			0
2015			0
2016			0

Table 8.4.0e. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Subarea 10.

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
2014	47						47
2015	83						83
2016	86						86

Table 8.4.0f. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Subarea 12.

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	2								2
2014	11								11
2015	1								1
2016	7								7

Table 8.4.0g. Orange roughy total international landings in the ICES area, excluding Subareas 6 and 7.

Year	4	5.a	5.b	8	9	10	12	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	82
2011	0	4	0	0	<1	77	27	108
2012		16	0	0	28	45	94	183
2013		54	1	0	0	0	2	57
2014						47	11	58
2015				6		83	1	90
2016						85	7	92

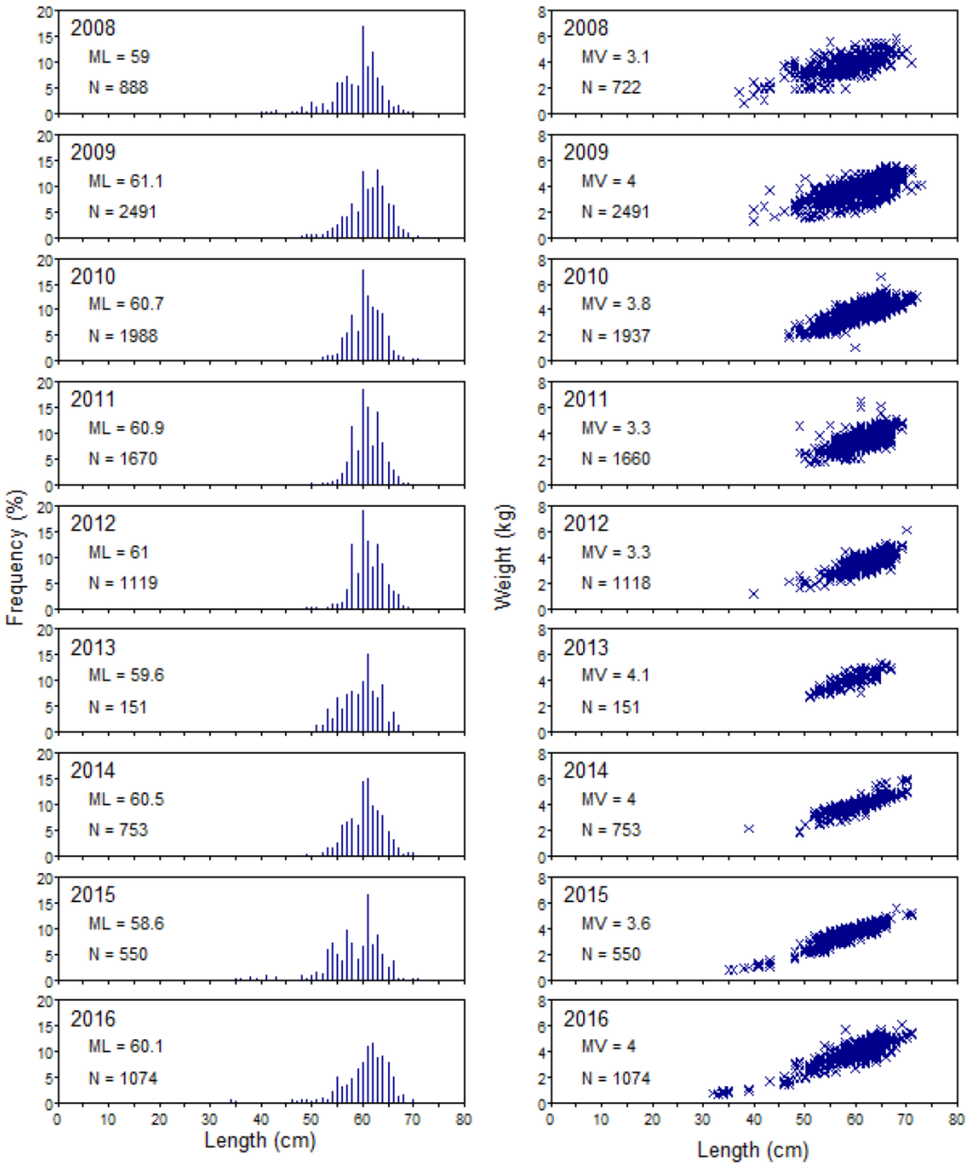


Figure 8.4.1. Length distribution and length–weight relation of orange roughy in Faroese catches 2008 to 2016.

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 (3.a);
- The Faroe-Hatton area, Celtic sea (Divisions 5.b and 12.b, Subareas 5, 7);
- the Mid-Atlantic Ridge 'MAR' (Divisions 5.b, 12.c, Subdivisions 5.a1, 12.a.1, 14.b.1);
- All other areas (Subareas 1, 2, 4, 8, 9, Division 14.a, Subdivisions 5.a.2, 14.b.2).

This current perception is based on what are believed to be natural restrictions to the dispersal of all life stages. The Wyville-Thomson Ridge may separate populations further south on the banks and slopes off the British Isles and Europe from those distributed to the north along Norway and in the Skagerrak. Considering the general water circulation in the North Atlantic, populations from the Icelandic slope may be separated from those distributed to the west of the British Isles. It has been postulated that a single population occurs in all the areas south of the Faroese slopes, including also the slopes around the Rockall Trough and the Rockall and Hatton Banks but the biological basis for this remains hypothetical.

In 2007, WGDEEP examined the available evidence of stock discrimination in this species but, on the available evidence, was not able to make further progress in discriminating stocks. On this basis WGDEEP concluded there was no basis on which to change current practice.

Recent genetic analyses have brought forward new information regarding the issue of stock discrimination in the roundnose grenadier. White *et al*. (2010), investigating a limited geographic area in the central and eastern North Atlantic, found evidence of population substructure and local adaptation to depth. A study by Knutsen *et al*. (in press and summarized 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 (*Coryphaenoidesrupestris*) in Division 5.b and 12.b, Subareas 6 and 7

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 5.b, 6.a, 5.b.2 and Subareas 7, 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 6.b.1 and 12.b.

9.2.2 Landings trends

Official French landings have been revised for 2015 and are preliminary for 2016.

Evidence of substantial mismatches between observer and official Spanish data of landings in Subarea 6 and Division 12.b were presented at WGDEEP in 2010. This has raised some concerns regarding possible misreporting between the different species of grenadiers (*Coryphaenoidesrupestris, Macrourusberglax*and*Trachyrincusscabrus*). This issue is still present for 12.b and 6.b 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 6, 188 t in 12.b. Provisional 2013 landings data show around 179 t and 195 t of *Macrourus berglax* reported in 6.b and 12.b respectively. No landings were reported for *Trachyrincus scabrus* since 2014.

Over the past two decades, landings from Division 5.b, 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 2016, the provisional landings in 5.b are 38 t. These landings are exclusively from French and Faroese trawlers (Table 9.2.0a–f).

In Subarea 6, the highest landings were observed in 2001 (close to 15 000 t) and have decreased to around 1060 t in 2014. Provisional landings are 725 t in 2016. Most of these landings are caught by French and Spanish trawlers.

In Subarea 7, landings close to 2000 t were recorded in 1993–1994, recent annual landings are much lower (from 200400 t/year in 2005–2007, 34 t in 2011). In 2016, provisional landings are 4 t and only from France.

In ICES Division 12.b, 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 832 t in 2014. Provisional landings were 599 t in 2016. There were significant Faroese landings in the mid-1990s, but this fishery disappeared in the 2000s and now amounts for a few tons some years. French fisheries have landed up to 1700 t in 2004 but to almost no landings since 2007.

The landings data are considered uncertain in Division 12.b, 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 2017 and 2018 is: "ICES advises for Subareas 6 and 7 and Division 5.b that when the MSY approach is applied, catches should be no more than 3325 tonnes in 2017 and 3399 tonnes in 2018.If discard rates do not change from the average of the last three years (2013–2015), this implies landings of no more than 3052 tonnes in 2017 and no more than 3120 tonnes in 2018.

ICES advises for Division 12.b that when the precautionary approach is applied, catches should be no more than 572 tonnes in each the years 2017 and 2018. If discard rates do not change this implies annual landings of no more than 526 tonnes for each year."

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 5.b and Subareas 6 and 7, a TAC was set at 3052 t for 2017 and 3120 t for 2018. The TAC since EC regulation 1367/2014 was a combined value for roundnose grenadier and roughhead grenadier (*Macrourus berglax*). For 2017 and 2018, this TAC set by EC regulation 2016/2285 is only for roundnose grenadier but with the following rule that "any bycatches for roughhead grenadier should be limited to 1% of each Member State's quota of roundnose grenadier and counted against that quota, in line with the scientific advice".

The rationale for this change is explained in the EC regulation: "According to the advice provided by ICES, limited on-board observations show that the percentage of roughhead grenadier has been less than 1% of the reported catches of roundnose grenadier. On the basis of those considerations, ICES advises that there should be no directed fisheries for roughhead grenadier and that bycatches should be counted against the TAC for roundnose grenadier in order to minimise the potential for species misreporting. ICES indicates that there are considerable differences, of more than an order of magnitude (more than ten times), between the relative proportions of roundnose and roughhead grenadier reported in the official landings and the observed catches and scientific surveys in the areas where the fishery for roughhead grenadier currently occurs. There are very limited data available for this species, and some of the reported landing data are considered by ICES to be species misreporting. As a consequence, it is not possible to establish an accurate historical record of catches of roughhead grenadier".

In Subareas 8, 9, 10, 12 and 14 the TAC was set at 2623 t in 2017 and 2099 t for 2018. This TAC covers areas with minor roundnose grenadier catches (8, 9 and 10), part of this assessment area (Division 12.b, the western slope of the Hatton bank) and the Mid-Atlantic Ridge (Divisions 12.a,c and Subarea 14). The main countries having quotas allocations under this TAC are Spain and Poland. Therefore these quota allocations are based upon historical landings in 12.b for Spain and in 12.a,c (Mid-Atlantic Ridge) for Poland.

The table below summarizes the TACs in the two management areas and landings in the assessment area.

	5.b, 6, 7		8, 9, 10, 12, 14		Total international Landings 5.b, 6, 7, 12.b
	EU TAC	EU Landings	EU TAC	EU Landings 12.b	
2005	5253	5777	7190	8782	14558
2006	5253	4676	7190	4361	9037
2007	4600	3778	6114	4258	8036
2008	4600	3102	6114	2432	5534
2009	3910	4046	5197	5335	9381
2010	3324	3461	5197	2759	6220
2011	2924	1577	4573	1578	3155
2012	2546	1440	3979	666	9103
2013	4297	1517	3581	796	3841
2014	4297	1147	3223	832	2072
2015	4010	701	3644	314	1015
2016	4078	767	3279	599	1366
2017**	3052		2623		
2018**	3120		2099		

*** provisional.**

**** combined TAC for roundnose grenadier and roughhead grenadier.**

[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 12.b.

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 12 were allocated to Division 12.b (western Hatton bank) or 12.a,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 programme: 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 numbers). In 2013, discards accounts for 15% of the catch in weight and 32% in number. In 2014, discards accounts for 6% of the catch in weight and 16% in number. In 2015 and 2016, discards accounted for 5% of the catch in weight and 15 to 17% 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 2004–2015,observers have covered on average 15±10% (range 3–39%) of the fleet fishing days in Division 6.b, and 12±8% (range 2–33%) in Division 12.b. Although occasionally the discards reached 26% of the total observed weight catch in the period 1996–2015, they are negligible in most sampled months. Annual average discards are 7% (range 0–21%) in weight in both Divisions 6.b and 12.b (range 0–26%). 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 onwards.

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 9.2.1–9.2.3).

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. This survey operates now on a biannual basis therefore no survey was carried out in 2016. Last survey occurred in 2015.

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 2014 and 2015. In 2015, data from only one boat were available therefore the value this year was not included into the assessment. 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. Indices have not been compiled for 2016.

Lpue from the Faroese 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 pairtrawlers 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 pairtrawlers, 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 2014 but the figure is not accurate because of a very small number of hauls with more than 30% of grenadier since 2011 (one in 2014).

Lpue from the Spanish commercial fleet in 12.b

Some basic lpue indices were estimated for the Spanish fleet in order to include the 12.b 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. The time-series was not updated for 2016.

9.2.6 Data analyses

9.2.6.1 Benchmark assessments

Trends from length distribution and individual weight

For France, the modal discarded length has remained constant (Figures 9.2.1–9.2.2) at around 11 cm while the average pre-anal length of the individuals in the landings has decreased from 20.8 cm in 1990 to around 15.5 cm since2011 (Figure 9.2.4).

Size–frequency data provided by Spain for the period 2002–2015 in 6 and 12.b shows the modal length (PAFL) of landings to be closely similar between divisions with female being larger than male by around 2 cm (Figure 9.2.5). The modal length of discards is around 9.5 cm. Over the period 2002–2015, there is no apparent trend in size of discards. However for landed individuals, both the average size for male and female have decreased by 1 cm (from 15.5 cm to 14cm for females and 13.5 to 12.4 cm for males) until 2009. Over the period 2009–2015, in both 6 and 12.b, the mean length in landings has increased by two centimetres for both males and females in 2010–2011. 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 6 and 12.b 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.

Time-series of mean individual weight from the Marine Scotland Deepwater Science survey shows no clear trends because of big confidence intervals. Average weight is around 0.42 kg (Figure 9.2.6).

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 2011–2015. The confidence intervals are however large (Figure 9.2.7).

Lpue from the Faroese commercial fleet

The cpue is stable for the period 2009–2010 although it is above average in 2011. After that period, the small number of hauls carrying more than 30% of grenadier makes cpue estimates highly inaccurate (Figure 9.2.8).

Lpue from the Spanish commercial fleet in 12.b

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 9.2.9).

Lpue from the French tallybooks

The overall trend in abundance (Figure 9.2.10–9.2.11) shows a decline from 2000 to 2003 and has been stable since until 2015.

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 5.b and 12.b and Subareas 6 and 7 but due to uncertainties in the catch in Division 12.b, assessment has been restrained to 5.b, 6, 7 in 2008 and 2009. The WKDEEP benchmark agreed in 2010 that "landings and effort data in Division 12.b should be included into the assessment if they become reliable. A separate assessment for Division 12.b should be carried out separately from the one for Division 5.b, and Subareas 6, 7." The reference assessment ("Ref") is therefore restrained to 5.b, 6, 7 while a full exploratory assessment including 12.b is presented further in this section.

The following datasets were used for the benchmark assessment:

- Landings in 5.b, 6, 7 (1988–2016);

- Overall standardized abundances indices from the French tallybooks (2000–2014) based on rectangles (edge6, other6);
- Life-history parameters to provide initial estimates for the model (Figure 9.2.12).

The various time-series used for those benchmark and exploratory runs are listed in Table 9.2.1.The summary of each assessment output is on Table 9.2.2.

Diagnostics plot are available on Figures 9.2.13–9.2.14 and indicates a relatively good fit of the model. However, the lack of abundance index this year is sensible. As those model highly depends on the availability of an abundance index, no advisory years (as this one) generally provide a degraded assessment in terms of quality and estimates. This is due to the low contrast in information over the last few years associated with the lack of index since 2014. This situation appears to constrain the model to consider that biomass stays low.

Outputs of the assessments are presented on Figure 9.2.15.

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 0.07+/-0.01. Stock biomass has been continuously below B_{MSY} since 2002.

Virgin biomass was estimated to be around 134 kt (+/-3 kt). The magnitude of this number is in line with estimates from previous working groups. Stock biomass in 2016 is around 30 kt (+/-13 kt) which is 10 kt lower than in 2015 as a consequence of the lack of index in 2015 and lack of contrast in information in previous years. B_{MSY} is estimated to be 67 kt (+/-1 kt). MSY $B_{trigger}$ is set at 28 kt (B_{loss} value for 2006).

In 2016, the probability of this stock (5.b, 6, 7) to be above MSY $B_{trigger}$ is 49%, 1% to be above B_{MSY}, 100% to be below H_{MSY} (Table 9.2.2). Model outputs suggest that any TAC set below C_{MSY} (4621 t +/- 329 t) is likely to allow the increase of stock biomass. No projection has been done this year as this year is not advisory.

This assessment does not change the perception that biomass is recovering slowly after a low historical level in 2006–2008. The exploitation rate appears to be below MSY limits and biomass estimates show a slight upwards trend. However absolute numbers of biomass are lower than in previous years because of the lack of new index. Therefore this assessment should be considered as exploratory as it is not fully compliant with the settings used in advisory years.

9.2.6.2 Exploratory assessments

The benchmarked assessment methodology uses data only from 5.b, 6 and 7.

An additional exploratory assessment is always carried out to take account of landings in 12.b.Run "5.b-6-7-12.b" is the standard run using 12.b landings data. French and Spanish standardized lpues are combined with a weighting corresponding to the amount of landings in 12.b and 5.b, 6, 7. Like for the benchmark assessment, the lpue index has not been updated this year.

An additional assessment "5.b-6-7-DS" was carried out using the Marine Scotland Deepwater Science Survey indices. The rationale for using this survey is the reduction of the number of vessels being part of the French tallybook indices. This survey indices also provides some fishery-independent information. Like for the benchmark assessment, the survey index has not been updated this year.

Exploratory run in 5.b, 6, 7 and 12.b (5.b-6-7-12.b run)

The inclusion of landings of 12.b requires a combined abundance indices from the landings and efforts of the Spanish fleet 12.b and the indices from the French tallybooks (Figure 9.2.16). The weighting between indices relies on proportion of landings between the 5.b,6,7 regions and 12.b (Table 9.2.1).

Figure 9.2.17 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 then since 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 218 kt+/-0.3 kt. Stock biomass in 2016 is 71 kt (+/-23 kt). B_{MSY} is estimated to be 109 kt +/- 0.2 kt. From this run, the probability of this stock to be above MSY $B_{trigger}$ (66 kt) is 64%, 7% to be above B_{MSY} and 100% to be below H_{MSY}. Median C_{MSY} is estimated to be 7893 t +/- 829 t. Any catch below this level should lead to an increase of stock biomass. Those values are similar to those last year despite the lack of index in 2016.

It is important to note that the confidence over this assessment including 12.b is lower than for the one restricted to areas 5.b, 6, 7 because of the uncertainty of the landings in 12.b linked to species reporting and evidence of reporting from other areas. Landings in 12.b contributes strongly therefore it should be emphasized that Member States should provide accurate landings and effort information regarding the fishing activity in 12.b as uncertainties associated with the high level of landings in 12.b strongly impact any assessment.

Exploratory run in 5.b, 6, 7 using the Marine Scotland Deepwater Science Survey ("5.b-6-7-DS" run)

The fit of the model on the survey indices is good (Figure 9.2.18 in blue) and shows a steady increase after 2003. The fit captures the overall trend of the median of the survey indices. Outputs of the assessments are presented in Figure 9.2.19. A comparison of biomass and harvest rates trajectories between this run and the reference run is presented on Figure 9.2.20.

Overall, the biomass time-series has the same trends than the reference run with an initial decrease of biomass followed by a stronger decrease from 2001 to 2006 and then a period of recovery. Biomass estimates in 1988 is the same for both runs (135 kt+/-1.6 kt). B_{MSY} and H_{MSY} indicators are also close to reference run respectively 68 kt +/- 0.8 kt and 0.0.09 +/-0.01.

However, biomass estimates, MSY $B_{trigger}$ and C_{MSY}strongly differs as the recovery dynamics is more vigorous using those indices. Biomass in 2016 is estimated to be

80 kt +/-15 kt (166% more than the reference run), MSY $B_{trigger}$ at 47 kt +/-7 kt (71% increase) and C_{MSY}at 6 kt +/-0.6 kt (30%).

This is mainly because the dynamics of the survey indices and commercial indices are not the same. The first one shows a continuous increase through time past 2001 while the commercial indices are in comparison at their lowest from 2002–2006 and then increase slowly.

This assessment does not change, as the others, the perception that biomass is increasing slowly after a low historical level in 2006. The exploitation rate appears to be below MSY limits as the other runs.

However the stock recovers at a faster rate than the reference run but with wider confidence intervals. Probabilities to be above MSY $B_{trigger}$ (1.00) and to reach B_{MSY} are therefore much higher (0.76 against 0.01) compared with the reference run.

Short-term forecasts

No short-term forecast have been carried out this year as this year is not an advisory year.

9.2.7 Management considerations

The harvest rate for roundnose grenadier appears to be below H_{MSY} in 5.b, 6, 7 and also for runs in 12.b. SSB is below B_{MSY} in all regions and at low levels. For 5.b, 6, 7, the assessment suggests a slow recovery of the stock while the inclusion of 12.b landings suggests a more stable situation.

9.2.8 Benchmark preparation

This stock has been benchmarked in 2010 and the assessment methodology based on the surplus production model has not been revised since then. At that time it was considered the assessment was considered to be of category 3. In 2012, this stock assessment was classified as category 1 due to development of short-term forecast.

Yet, some issues have not been resolved since the 2010 benchmark.

- Stock area includes 12.b but the current assessment is only considered to be reliable for 5b, 6, 7 because 12.b landings are likely to include landings of roughhead grenadier (*Macrourus berglax*). Therefore the assessment for the whole area has only be exploratory since 2010. Some work is needed to clean out this time-series if accurate catch data for the different grenadier species are available or if the composition of species is known from observers at sea.
- Discard time-series is available since 1996 and properly quantified since then. It is supposed from various exploratory runs that discard rates might have been higher at the beginning of the fishery. Because of this, discards have not been included in the current assessment and the impact of this is unknown. The reconstruction of a time-series of discard rates is required for the whole time-series.

Additionally, some issues have appeared since then:

- estimates of r (intrinsic growth rates of the surplus production model) are possibly too high in regards of stock dynamics. This should be explored from modelling and data exploration.

- The French tallybooks, due to the decrease of effort and number of vessels in the deep-water French fisheries may no longer be representative to derive abundance indices. On the opposite, the Marine Scotland Science Deep-water survey is available on a biannual basis in line with advisory years and a sufficient time-series. However, comparisons with the French tallybooks show some strong differences of biomass which leaves some doubt on biomass estimates. The reason for those differences have to be investigated and may need to be taken into account in the development of an index (difference of catchability, survey coverage, etc...).
- Multi Year Catch Curves are no longer available. Other indicator of stock status may be considered using for example, length or individual weight.

No new model is expected to be presented during the benchmark. Most of the work is mainly on the data.

Table 9.2.0a. Working Group estimates of landings of roundnose grenadier from Division 5.b.

Year	Faroes	France	Norway	Germany	Russia/USSR
1988				1	
1989	20	181		5	52
1990	75	1470		4	
1991	22	2281	7	1	
1992	551	3259	1	6	
1993	339	1328		14	
1994	286	381		1	
1995	405	818			
1996	93	983		2	
1997	53	1059			
1998	50	1617			
1999	104	1861	2		
2000	48	1699		1	
2001	84	1932			
2002	176	774			
2003	490	1032			
2004	508	985	0	0	6
2005	903	884	1	0	1
2006	900	875	0	0	0
2007	838	862	0	0	0
2008	665	447	0	0	0
2009	322	122	0	0	0
2010	229	381	0	0	0
2011	63	11	0	0	0
2012	16	28	0	0	0
2013	24	36	0	0	0
2014	33	44	0	0	0
2015	24	28	0	0	0
2016*	30	7	0	0	0

***Provisional.**

Table 9.2.0b. Working Group estimates of landings of roundnose grenadier from Subarea 6.

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	14773
2002	821		7209		12	1817		932			6	741	11538
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	468	0	44	3694
2006	34	25	1931	0	5	112	0	0	0	252	0	15	2374
2007	0	10	1552	0	2	31	0	0	0	354	0	4	1953
2008	0	6	1433	0	0	23	0	0	16	336	0	27	1841
2009	0	6	1090	0	0	0	0	0	0	279	0.3	15	1391

Year	Estonia	Faroes	France	Germany	Ireland	Lithuania	Norway	Poland	Russia	Spain	UK (E+W)	UK (Scot)	TOTAL
2010	0	13	1271	0	0	0	2	0	0	189	1.2	23	1500
2011	0	4	1112	0	0	0	0	0	0	335.89	0	8	1460
2012	0	0	1088	0	0	0	0	0	0	257.87	2	0	1348
2013	0	0	934	0	0	0	0	0	0	475.89	6.2032	0	1416
2014	0	0	630	0	0	0	0	0	0	429.4	0	0	1060
2015	0	0	364	0	0	0	0	0	0	274.51	0	0	638
2016*	0	0	422	0	0	0	0	0	0	298.4	0	5.368	725

*** Provisional.**

Table 9.2.0c. Working Group estimates of landings of roundnose grenadier from Subarea 7.

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		0.18		48
2013		40				40
2014		11				11
2015		10				10
2016*		4				4

*** provisional.**

Table 9.2.0d. Working Group estimates of landings of roundnose grenadier from Subarea 12.b

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	10045		1	2		10080
2003			539			1	31	11663			1		12235
2004		8	1 693				120	10880	91		4		12796
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
2014		3.6						828.72					832
2015								313.99					314
2016*								599.48					599

*** Preliminary.**

**** French landings reported in former ICES Subarea 12 allocated to 12.b.**

Table 9.2.0e. Working Group estimates of landings of roundnose grenadier unallocated landings in 5.b, 6 and 12.

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	6997.0
2013	1522.0
2014	92.0
2015	
2016*	

*** Provisional.**

Table 9.2.0f. Working Group estimates of landings of roundnose grenadier 5.b, 6, 7 and 12.b.

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	10276
1992	3817	6782	1556	13	0	12155	12168
1993	1681	8205	1916	328	0	11802	12130
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	10231
1998	1667	5207	1157	4397	0	8031	12428
1999	1996	5642	896	8573	0	8534	17107
2000	1791	8956	859	6195	0	11606	17801
2001	2016	14773	1354	6094	208	18143	24445
2002	1031	11538	1058	10080	504	13627	24210
2003	1532	6598	587	12235	952	8717	21904
2004	1575	7729	568	12796	0	9872	22668
2005	1837	3694	246	8782	0	5777	14559
2006	1775	2374	386	4361	0	4535	8896
2007	1700	1953	227	4258	0	3880	8138
2008	1112	1841	27	2432	0	2980	5411
2009	446	1391	59	5335	0	4046	9381
2010	611	1500	41	2759	0	2152	4911
2011	74	1460	34	1578	0	1568	3146
2012	44	1348	48	666	6997	1440	9103
2013	60	1416	40	796	1522	1517	3835
2014	77	1060	11	832	92	1147	2072
2015	52	638	10	314	0	701	1015
2016*	38	725	4	599	0	767	1366

*** Preliminary.**

Table 9.2.1. Time-series of landings and lpues used for the reference and exploratory assessments.

	Landings 1988–2015		Abundance indices		
Simulations	Reference, 567-DS survey	5.b-6-7-12.b	Reference	Mar. Scot. survey indices	5.b-6-7-12.b
1988	33	33	-	-	-
1989	2698	2750	-	-	-
1990	7279	7279	-	-	-
1991	10104	10276	-	-	-
1992	12155	12168	-	-	-
1993	11802	12130	-	-	-
1994	8528	9014	-	-	-
1995	8990	9634	-	-	-
1996	8173	9701	-	-	-
1997	8182	10231	-	-	-
1998	8031	12428	-	-	-
1999	8534	17107	-	-	-
2000	11606	17801	1.000	1.000	1.000
2001	18143	24445	1.093	1.135*	1.093
2002	13627	24210	1.809	1.269	1.809
2003	8717	21904	0.399	1.258*	1.937
2004	9872	22668	0.424	1.247	1.642
2005	5777	14559	0.387	1.140	1.062
2006	4535	8896	0.332	0.887	0.712
2007	3880	8138	0.465	1.251	0.853
2008	2980	5411	0.546	1.471	0.842
2009	4046	9381	0.493	1.288	1.230
2010	2152	4911	0.429	1.260	1.046
2011	1568	3146	0.403	1.233	0.664
2012	1440	9103	0.462	1.612	0.073
2013	1517	3835	0.497	1.798	1.575
2014	1147	2072	0.399	1.621*	0.628
2015	701	1015	-	1.445	0.522
2016*	767	1366	-	-	-

*** index is interpolated with the immediate neighbouring years.**

**** Preliminary landings.**

Table 9.2.2. Summary of results from the exploratory assessments.

			SIMULATIONS								
	Simulation	Year	Areas	5.b-6-7		Areas 5.b-6-7 - DS			Areas 5.b-6-7-12.b		
			Reference run			survey run			SALY exploratory run		
	Median biomass	1988	134080	+/-	2587	135139	+/-	1630	217828	+/-	314
	+/- std dev	2016	29933	+/-	13171	79654	+/-	14783	70838	+/-	23293
	(tons)										
Standard	Average biomass	1988	133455			134799			217922		
outputs	(tons)	2016	33062			78857			70758		
	Med. Harvest rate	1988	0	+/-	0	0	+/-	0	0	+/-	0
	+/- std dev	2016	0.03	+/-	0.01	0.01	+/-	0	0.02	+/-	0.01
	Median Bmsy	all	67040	+/-	1384	67570	+/-	815	108914	+/-	157
	(tons)										
MSY	MSY Btrigger	2006	27692	+/-	6269	47370	+/-	7338	64550	+/-	8154
reference	(tons)										
points	Median Hmsy	all	0.07	+/-	0.01	0.09	+/-	0.01	0.07	+/-	0.01
	Target Cmsy	all	4621	+/-	329	6005	+/-	592	7893	+/-	829
	(tons)										
	P(B>Bmsy)	2016		0.01			0.76			0.07	
Risks	P(H<Hmsy)	2016		1.00			1.00			0.99	
	P(B>Btrig)	2016		0.49			1.00			0.64	

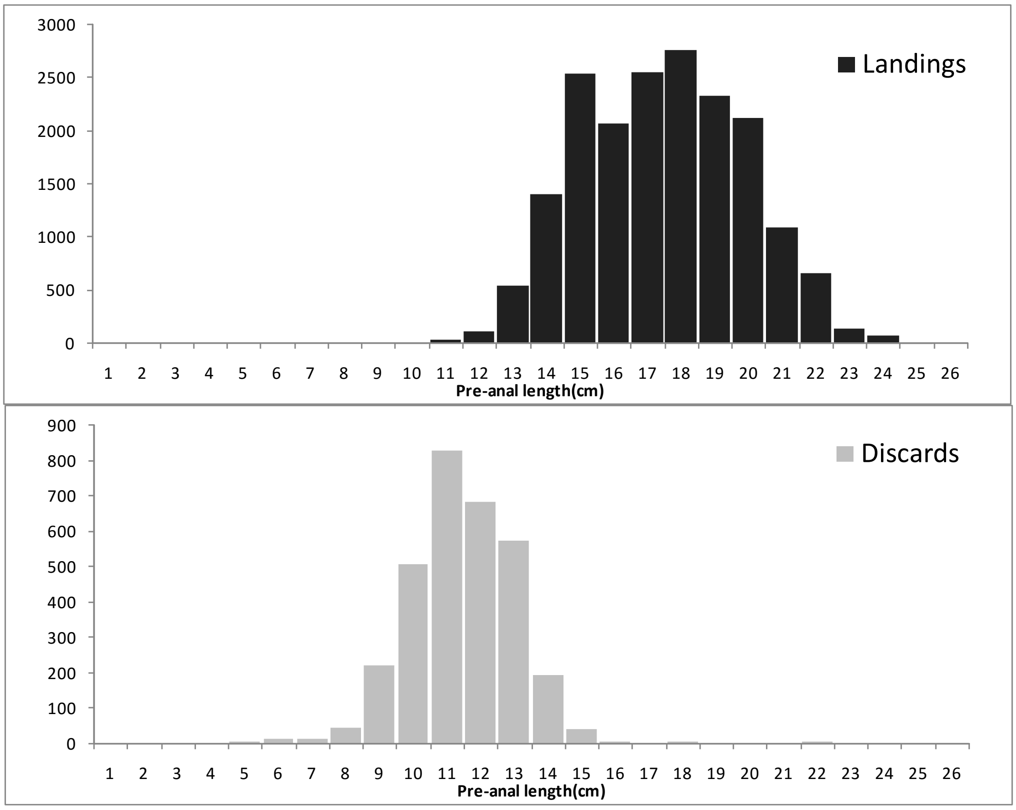


Figure 9.2.1. Length distribution of the landings and discards of the French fleet in Division 5.b, 6, 7 based from on-board observations in 2015.

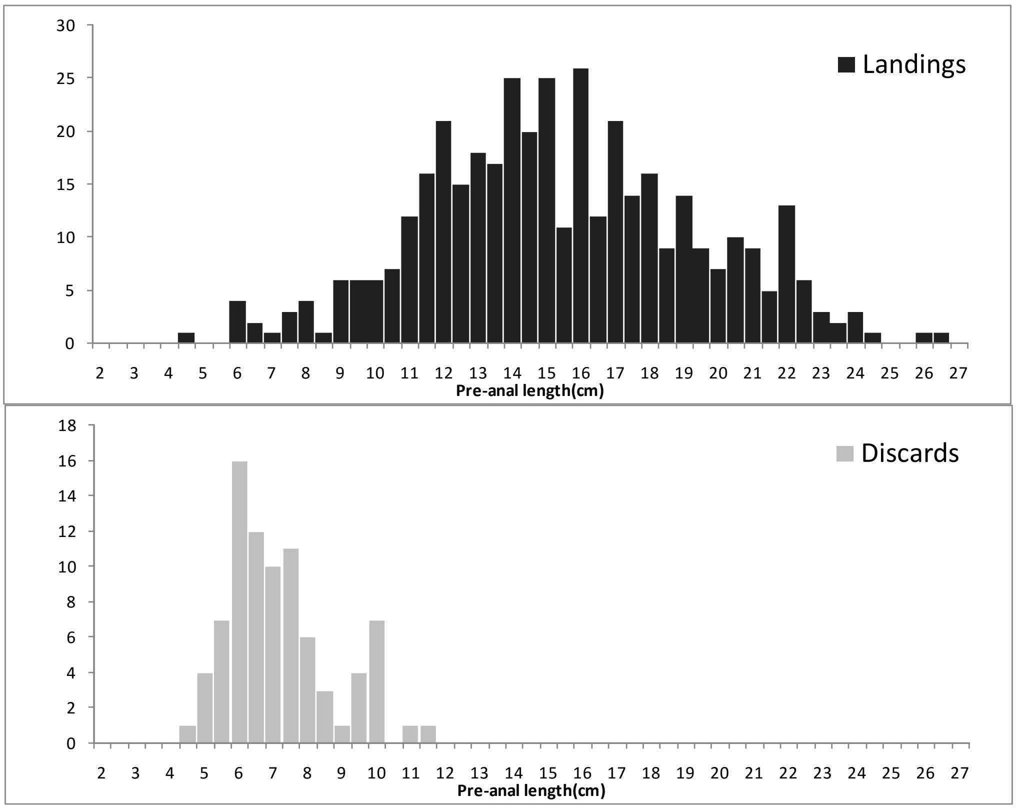


Figure 9.2.2. Length distribution of the landings by sex and discards of the Spanish fleet in Division 6.b based from on-board observations in 2015.

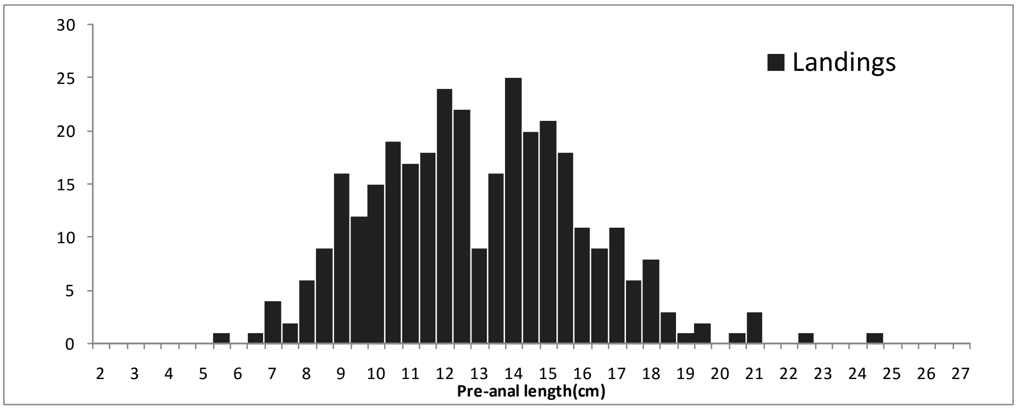


Figure 9.2.3. Length distribution of the landings by sex of the Spanish fleet in Division 12.b based from on-board observations in 2015.

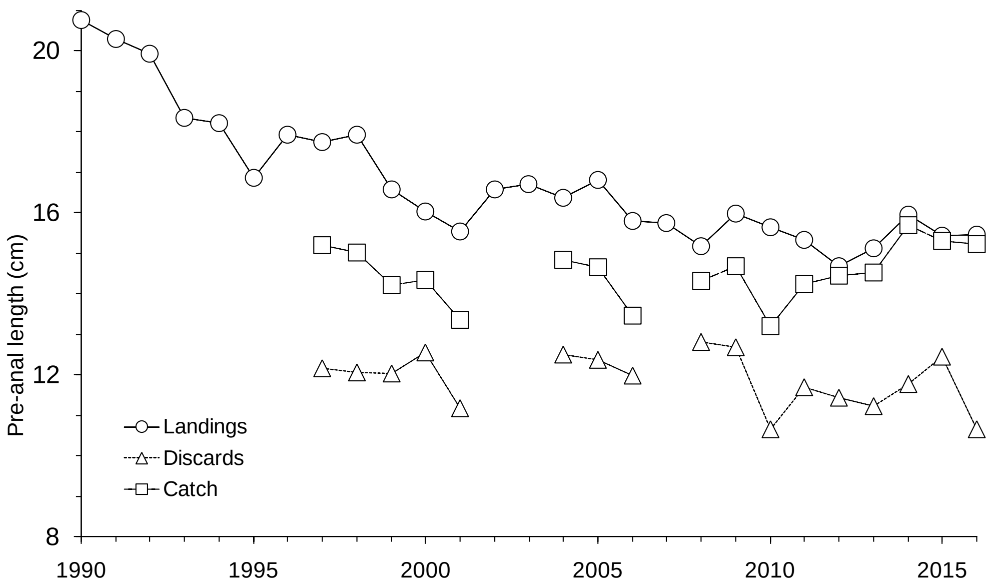


Figure 9.2.4. Evolution of the pre-anal length of roundnose grenadier in the French landings, catch and discards, 1990–2016.

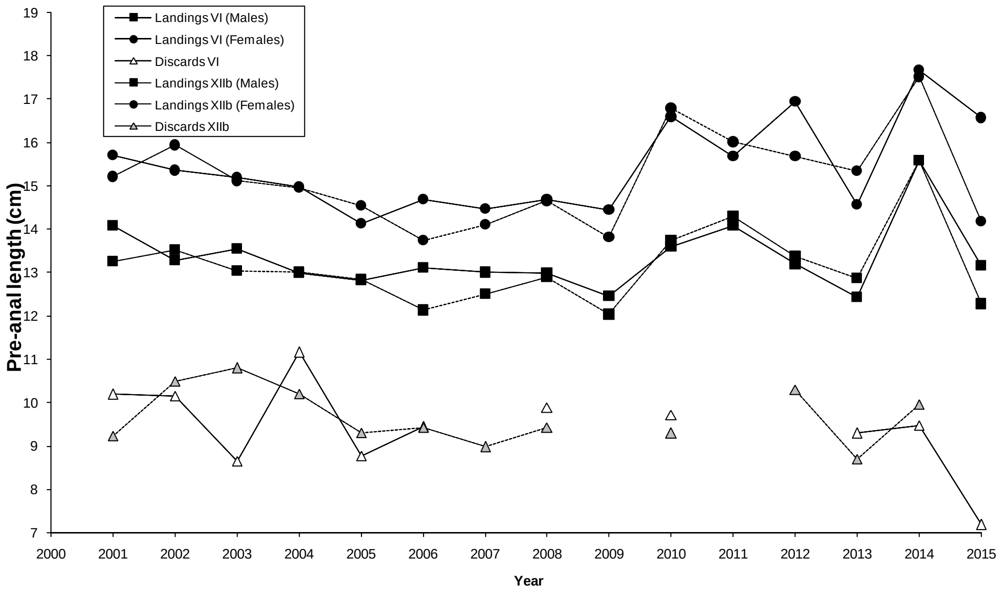


Figure 9.2.5.Evolution of the pre-anal length of roundnose grenadier in the Spanish landings and discards in Divisions 6.b and 12.b, 2001–2015.

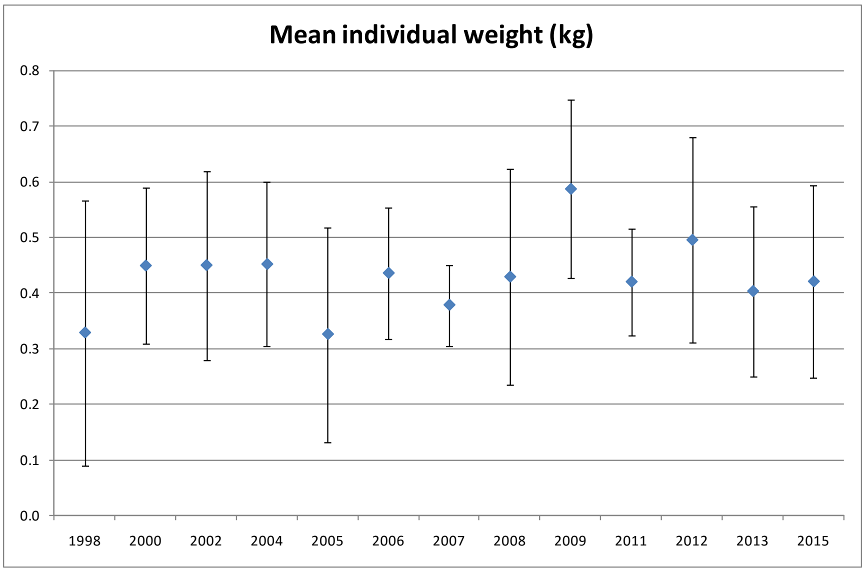


Figure 9.2.6. Mean individual weight of roundnose grenadier according to Marine Scotland deep-water science survey in 6.a.

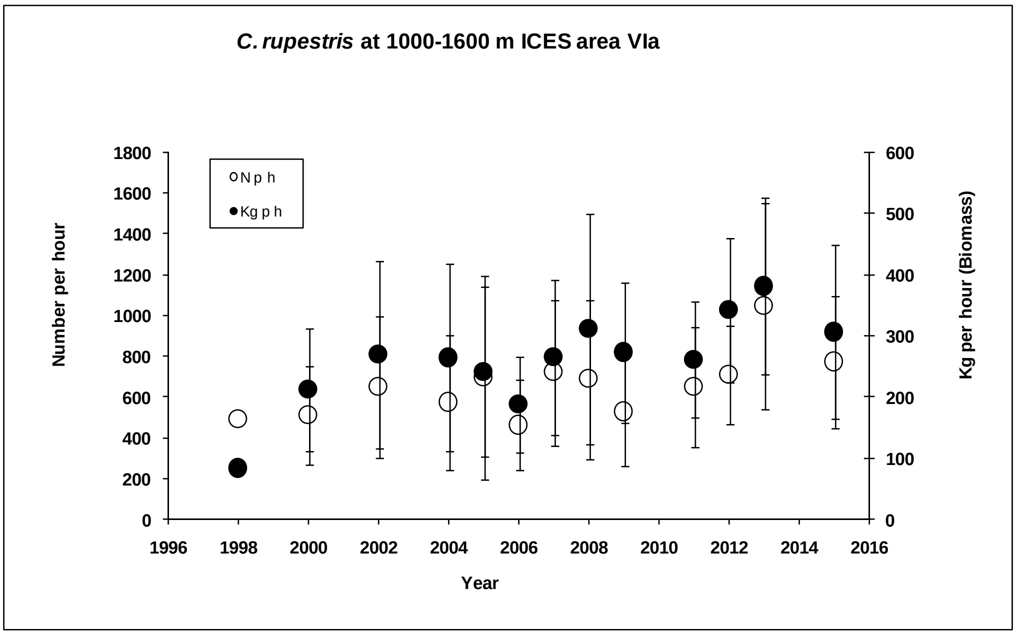


Figure 9.2.7. Abundance indices of roundnose grenadier according to Marine Scotland deep-water science survey in 6.a.

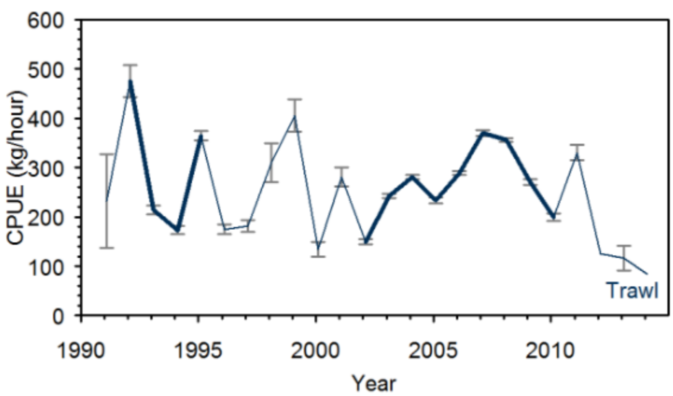


Figure 9.2.8.Roundnose grenadier in 5.b. Cpue from otter-board trawlers. Criteria: >30% of round-nose grenadier in the catch.

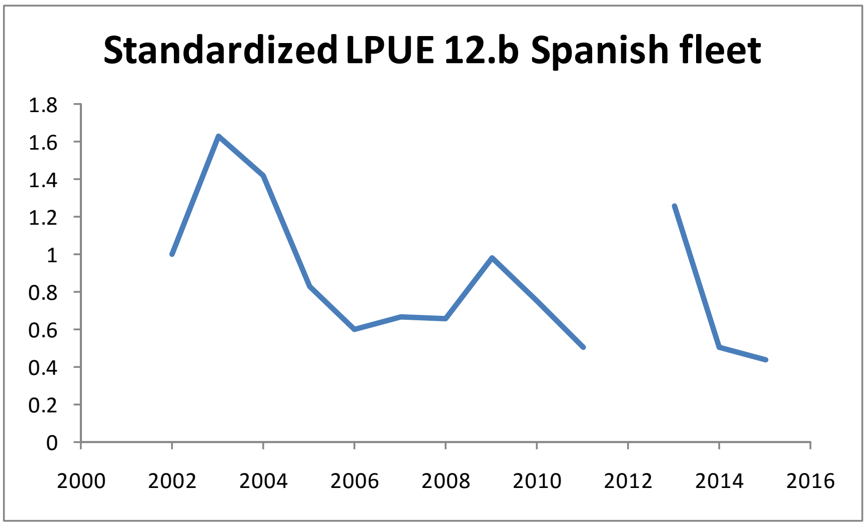


Figure 9.2.9. Lpue from the Spanish commercial fleet operating in 12.b.

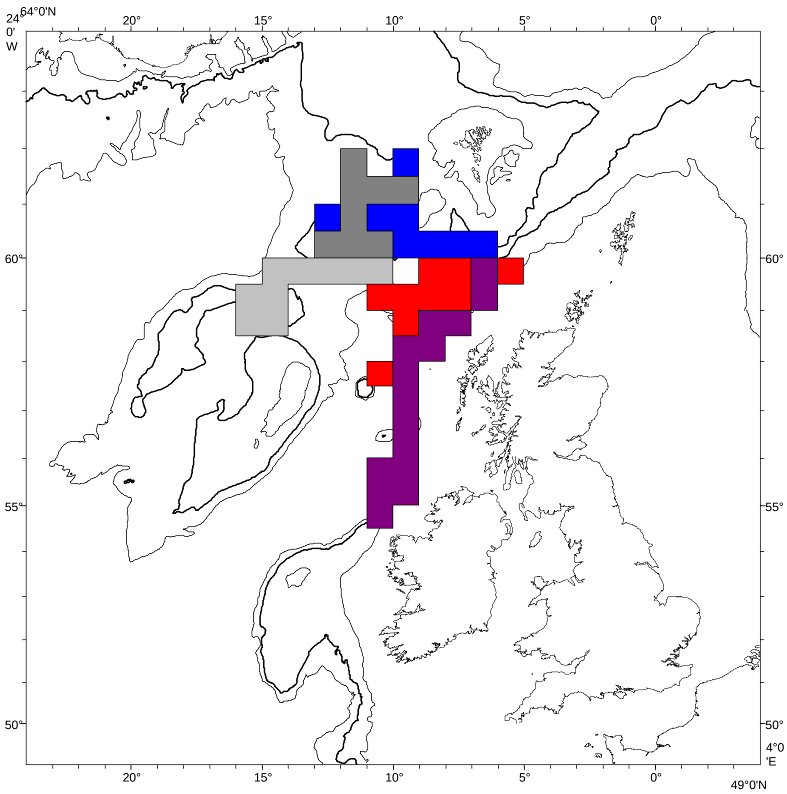


Figure 9.2.10. Reference areas (set of statistical rectangles) used to calculate French lpues (brown: New grounds in 5 (new5), grey new grounds in 6 (new6); red: others in 6 (other6); purple: edge in 6 (edge6); blue: all grounds in 7 (ref7). Depth contours are 200, 1000 and 2000 m.

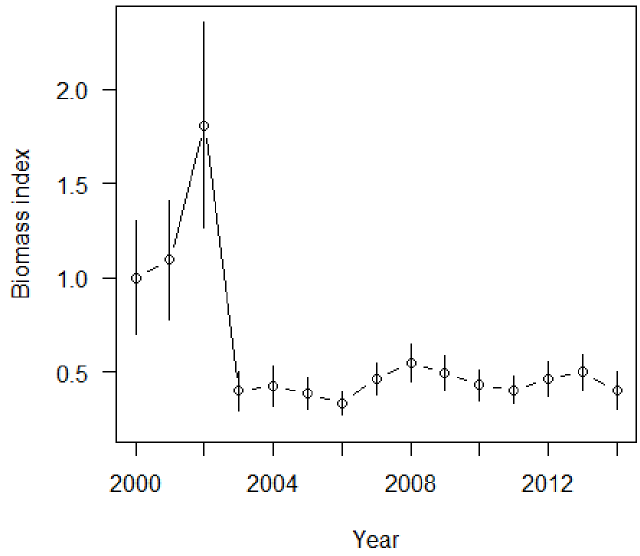


Figure 9.2.11. Time-series of abundance indices (calculated based upon the tallybook data). The grenadier abundance was predicted for the mean length of all tow carried out in every rectangle of the two small areas (edge6, other6) and averaged across rectangle.

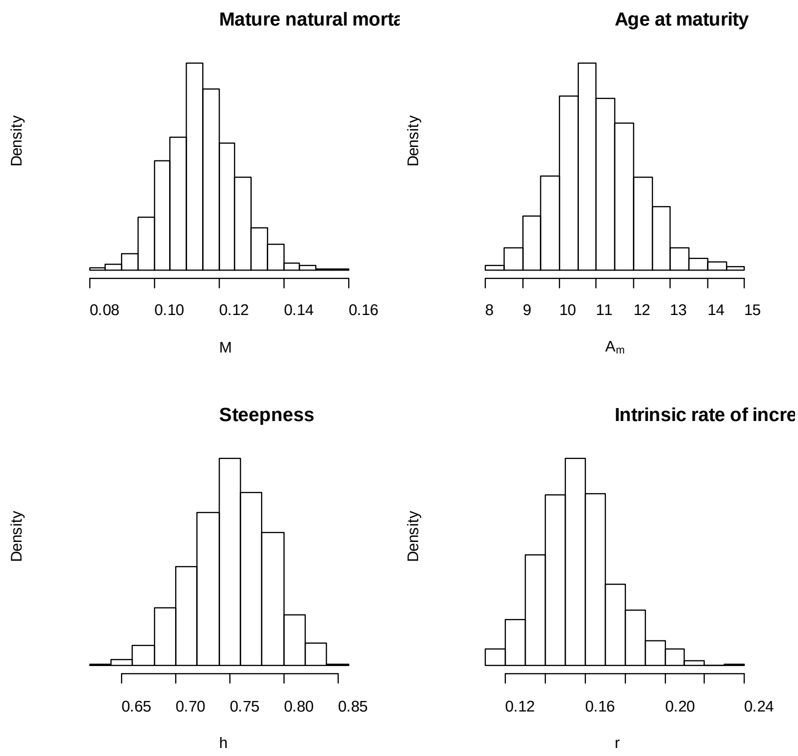


Figure 9.2.12. Distribution of initial life-history parameters used in the surplus production model.

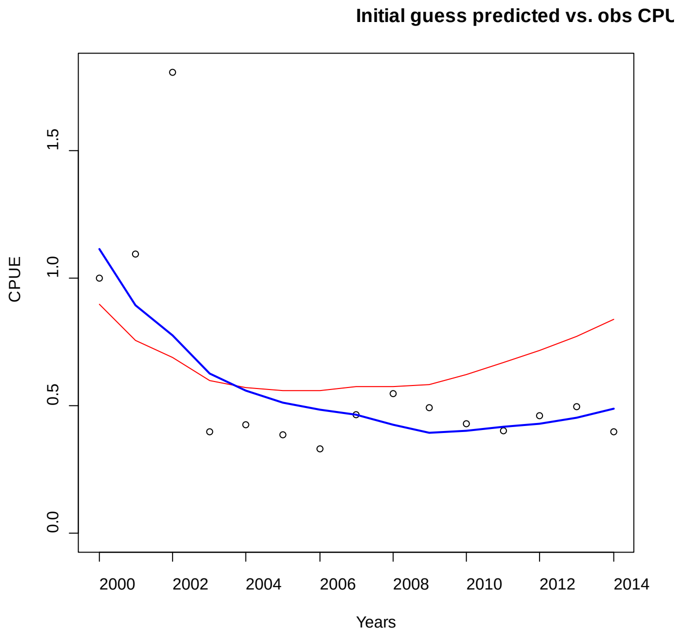


Figure 9.2.13. Predicted vs. initial guess vs. estimates of lpue for roundnose grenadier in 5.b, 6, 7, based on commercial data.

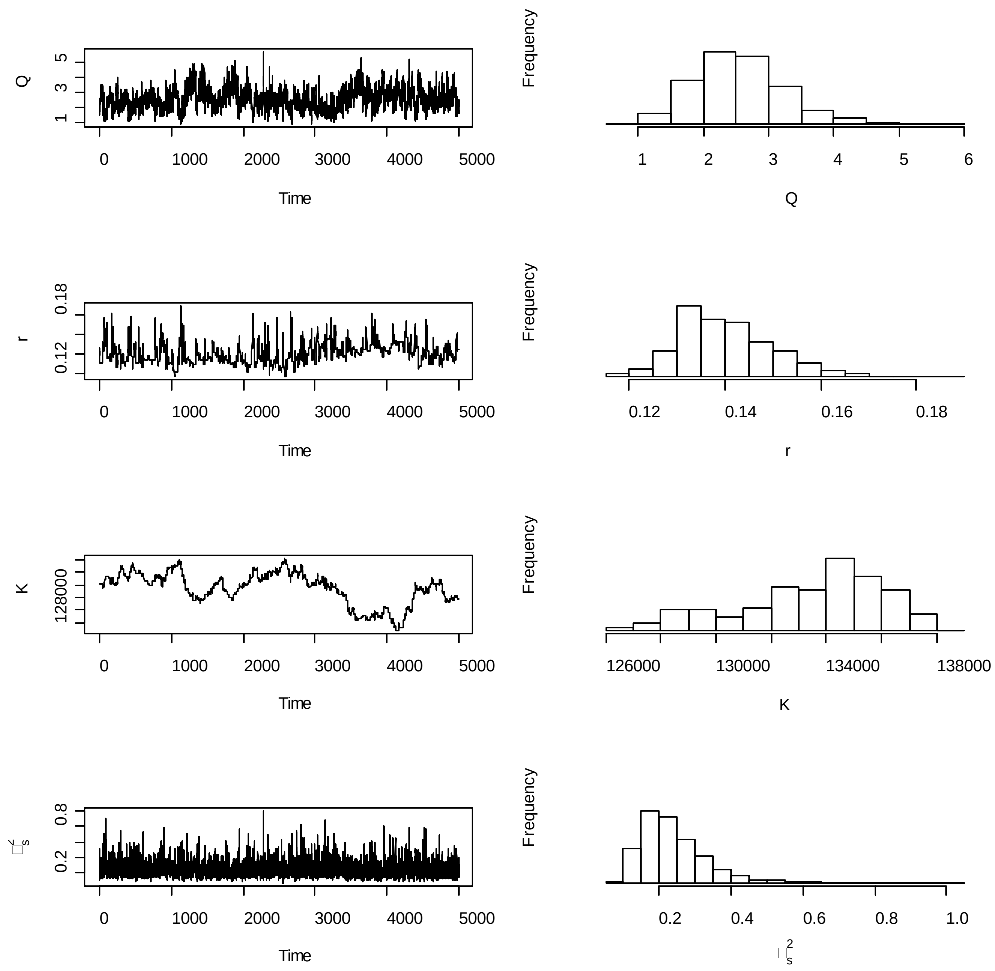


Figure 9.2.14. Diagnostic plots of the reference assessment on roundnose grenadier in 5.b, 6, 7.

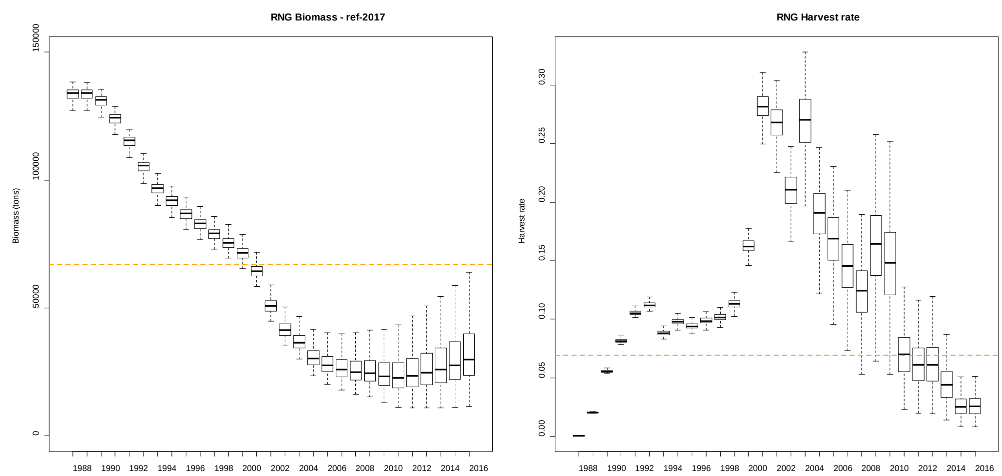


Figure 9.2.15. Estimated biomass and harvest rates from the reference simulation (5.b, 6, 7). Dotted lines are respectively B_{MSY} (left panel) and H_{MSY} levels (right panels).

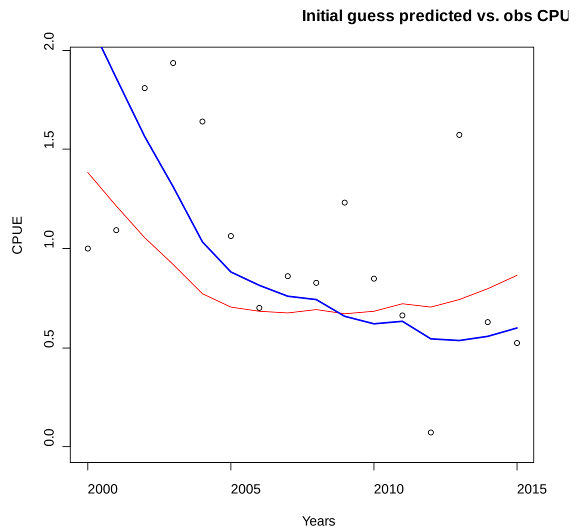


Figure 9.2.16. Predicted vs. initial guess vs. estimates of lpue for roundnose grenadier in 5.b, 6,7, 12.b based on commercial data.

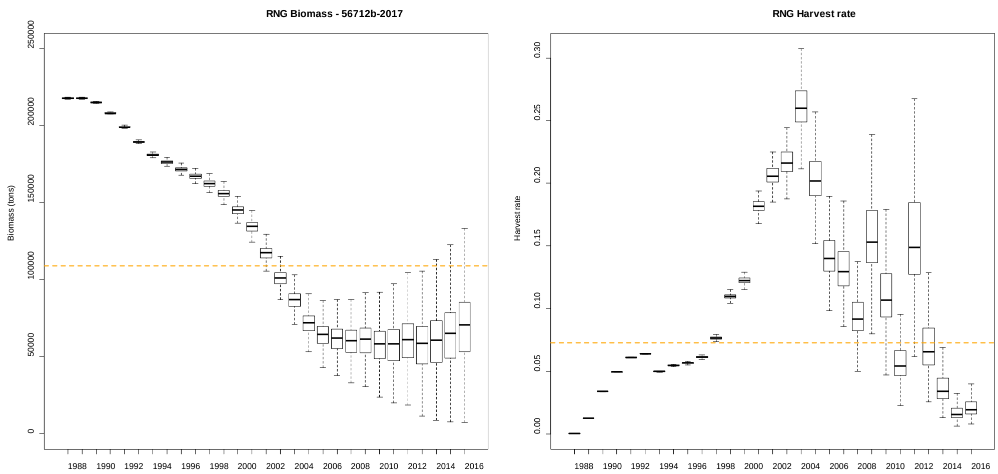


Figure 9.2.17. Estimated biomass and harvest rates using landings in 5.b, 6, 7 and 12.b.

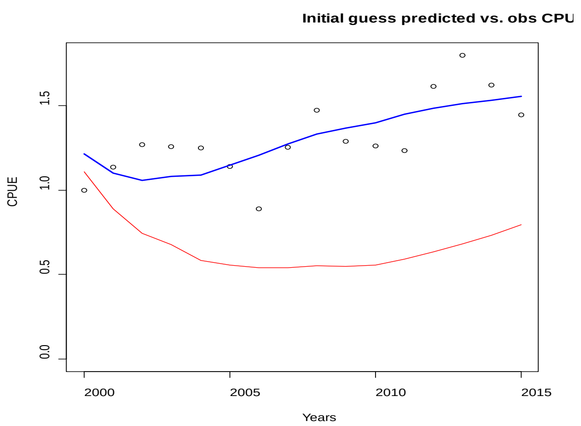


Figure 9.2.18. Predicted vs. initial guess vs. estimates of lpue for roundnose grenadier in 5.b, 6, 7, based on the Marine Scotland Deep-water science survey indices.

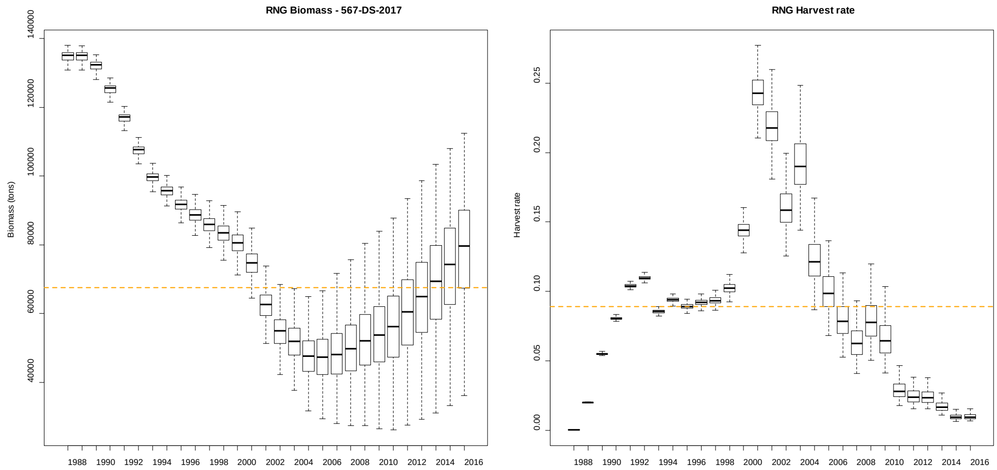


Figure 9.2.19. Estimated biomass and harvest rates using landings in 5.b, 6, 7, based on the Marine Scotland Deep-water science survey indices.

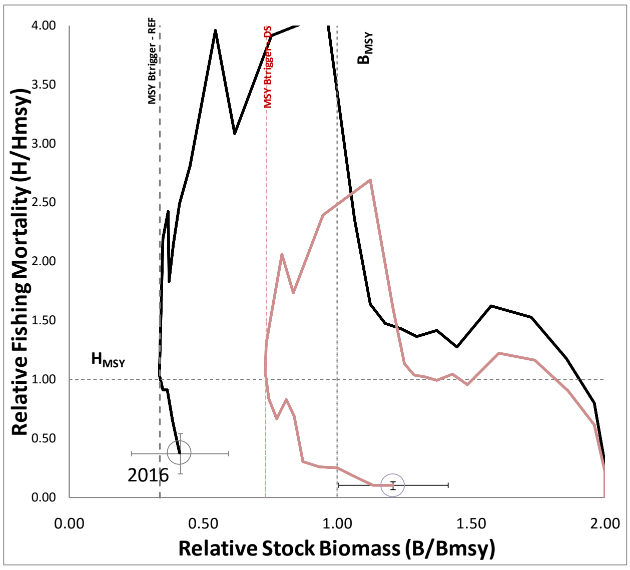


Figure 9.2.20. Comparative estimates of biomass between reference run (black line) in and survey based run (red line) in5.b, 6, 7.

9.3 Roundnose grenadier (*Coryphaenoides rupestris*) in Division 3.a

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 3.a. 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 3.a.

9.3.2 Landings trends

The total landings by all countries from 1988–2016 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 2017 and 2018 is: "ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2017 and 2018".

9.3.4 Management

The directed fishery for roundnose grenadier was stopped in April 2006 based on agreements between Norway and the EU, and has been prohibited since. Norway and the EU has introduced a mandatory use of sorting grids in shrimp fisheries in order to minimize the bycatch of fish.

In Council Regulation (EU) No 1367/2014, fixing for 2015 and 2016 the fishing opportunities for EU vessels for fish stocks of certain deep-sea fish species, a TAC was set to 435 and 348 tons, respectively, for EU vessels in EU waters and international waters of Subarea 3. Since there is no area outside national jurisdiction (international waters) in 3.a, this regulation applies to EU waters unless other agreements are negotiated with Norway.

9.3.5 Data available

9.3.5.1 Landings and discards

Landings data are presented in Table 9.3.0. Discards reported from the Swedish and Danish fishery were 1 t in 2016.

9.3.5.2 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 provided in Figure 9.3.1.

9.3.5.3 Age composition

No new age data are available.

Age data from survey catches in the Skagerrak in 1987 and 2007–2013 are available in Bergstad *et al*., 2014 (see Figure 9.3.4).

9.3.5.4 Bycatch effort and cpue

There is updated information on estimated bycatch of roundnose grenadier in Norwegian shrimp fishery in ICES Division 4.a and 3.a (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 at 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.

9.3.5.5 Survey indices

The Norwegian annual shrimp survey conducted since 1984 samples deeper parts of the Skagerrak and northeastern North Sea (3.a and 4.a), including the depth range where the roundnose grenadier occurs (mainly 300–600 m) (Bergstad, 1990b). The minor area >600 m is an ammunition and warship dumping ground with warning against fishing. The survey is considered to adequately sample the main distribution area of roundnose grenadier, and the sample sizes by year (no. of tows at depths >300 m and >400 m) are presented in Table 9.3.1.

9.3.6 Data analyses

A recent study analysed the time-series of abundance of roundose grenadier through the time-series (Bergstad *et al.*, 2014). 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 4.a and 3.a. Although the discards from the fishery in this area now is reported to be at the same level as the landings, the level on reported total catch is still low and in the range of what it has been since 2007.

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 bycatch of roundnose grenadier from the Norwegian shrimp fishery is shown to be at low levels (less than 100 tonnes /year) but since both the landings and survey catches are at very low levels now and the stock does not seem to recover, there is some concern that mortality from reported current bycatch levels are not fully accounted for. The application of sorting grids most probably reduces retained bycatch, but there is some uncertainty with regards to survival rates during passage of the grids for this species.

9.3.6.2 Size compositions

The recent length distributions from the Norwegian survey data contrasts with the 1991–2004 distributions by their small proportions of small fish (Bergstad *et al.*, 2014). 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 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 2017, also below the level observed in the period prior to the exploitation pulse in 2003–2005. Since the directed fishery is stopped and the bycatches from other fisheries are expected to be low, it is uncertain why the survey catches still declines.

9.3.6.4 Age data

The age distributions 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*., 2014). 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*. (2014) suggested that only a single very abundant recruitment event occurred during the period 1984–2017, perhaps only a single major year class. This event rejuvenated the stock and enhanced abundance in subsequent years.

9.3.6.5 Biological reference points

No biological reference points for category 6 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 a lower level as in the late 1980s and early 1990s, and there is no suggestion of a new recruitment pulse as seen in the 1990s. Recent age distributions almost lack the >20 years old component which was prominent in the 1980s.

Since the targeted fishery has stopped and the bycatch in the shrimp fishery seems low, the potential for recovery of the roundnose grenadier in Skagerrak may be good. However, current abundance levels appear the lowest recorded during the survey period 1984–2017 and rejuvenation and growth of the population would at present seem unlikely due to low recruitment during the recent decade. Additionally, there is some uncertainty regarding the effect of the sorting grid in the shrimp fishery and this could be the source of an unknown mortality.

Table 9.3.0. Roundnose grenadier in Division 3.a. 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		1
2013	1	0		1
2014	0,6	0	0,4	1
2015	0,6	+	+	1
2016*	1,1	0,3	+	1,4

*** Preliminary data.**

Table 9.3.1. Summary of data on the bottom-trawl survey series, 19842016. Rg- rock-hopper groundgear. 'Strapping'maximum width of trawl constrained by rope connecting warps in front of otter doors. MS-RV Michael Sars, HM-RV Håkon Mosby. Data from 2016 survey are included. All trawls were fitted with a 6mm mesh codend liner.

YEAR	SURVEY MONTH	VESSEL	IMR GEAR CODE	ADDITIONAL GEAR INFO.	NO. TRAWLS >300M	NO. TRAWLS >400M	NO. TRAWLS SURVEY
1984	OCT	MS	3230	Shrimp trawl (see text)	10	1	67
1985	OCT	MS	3230	"	21	5	107
1986	OCT/NOV	MS	3230	"	24	9	74
1987	OCT/NOV	MS	3230	"	35	14	120
1988	OCT/NOV	MS	3230	"	31	11	122
1989	OCT	MS	3236	Campelen 1800 35mm/40, Rg	31	7	106
1990	OCT	MS	3236	"	26	5	89
1991	OCT	MS	3236	"	28	9	123
1992	OCT	MS	3236	"	27	10	101
1993	OCT	MS	3236	"	30	10	125
1994	OCT/NOV	MS	3236	"	27	10	109
1995	OCT	MS	3236	"	29	12	103
1996	OCT	MS	3236	"	27	11	105
1997	OCT	MS	3236	"	25	6	97
1998	OCT	MS	3270	Campelen 1800 20mm/40, Rg	23	6	97
1999	OCT	MS	3270	"	27	8	99
2000	OCT	MS	3270	"	25	10	109
2001	OCT	MS	3270	"	18	4	87
2002	OCT	MS	3270	"	24	6	82
2003	OCT/NOV	HM	3230	Shrimp trawl (as in 1984–1988)	13	0	68
2004	MAY	HM	3270	Campelen 1800 20mm/40, Rg	17	6	65
2005	MAY	HM	3270	"	23	8	98
2006	FEB	HM	3270	"	10	0	45
2007	FEB	HM	3270	"	11	1	66
2008	FEB	HM	3271	Campelen 1800 20mm/40, Rg and strapping*	18	5	73
2009	JAN/FEB	HM	3271	"	25	7	91
2010	JAN	HM	3271	"	24	7	98
2011	JAN	HM	3271	"	22	7	93
2012	JAN	HM	3271	"	20	5	65
2013	JAN	HM	3271	"	28	8	101
2014	JAN	HM	3271	"	16	7	69
2015	JAN	HM	3271	"	28	9	92
2016	JAN	HM	3271	"	28	9	108
2017	JAN	KB	3271	"	30	9	128

*** Path width of the tow constrained by a 10 m rope connecting the warps, 200 m in front of otter boards.**

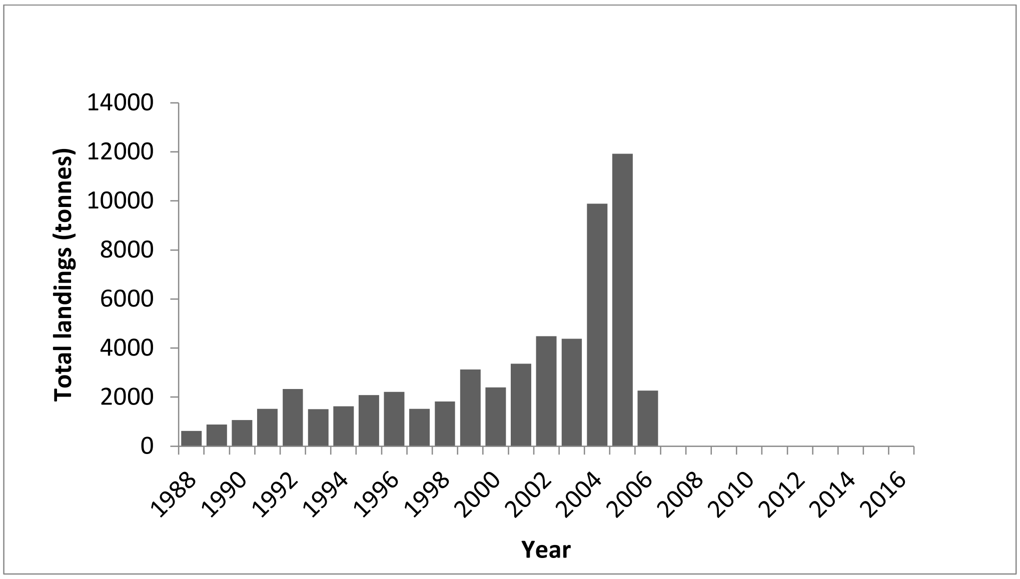


Figure 9.3.0. Landings of roundnose grenadier from Division 3.a. Landings from 2007–2017 are insignificant.

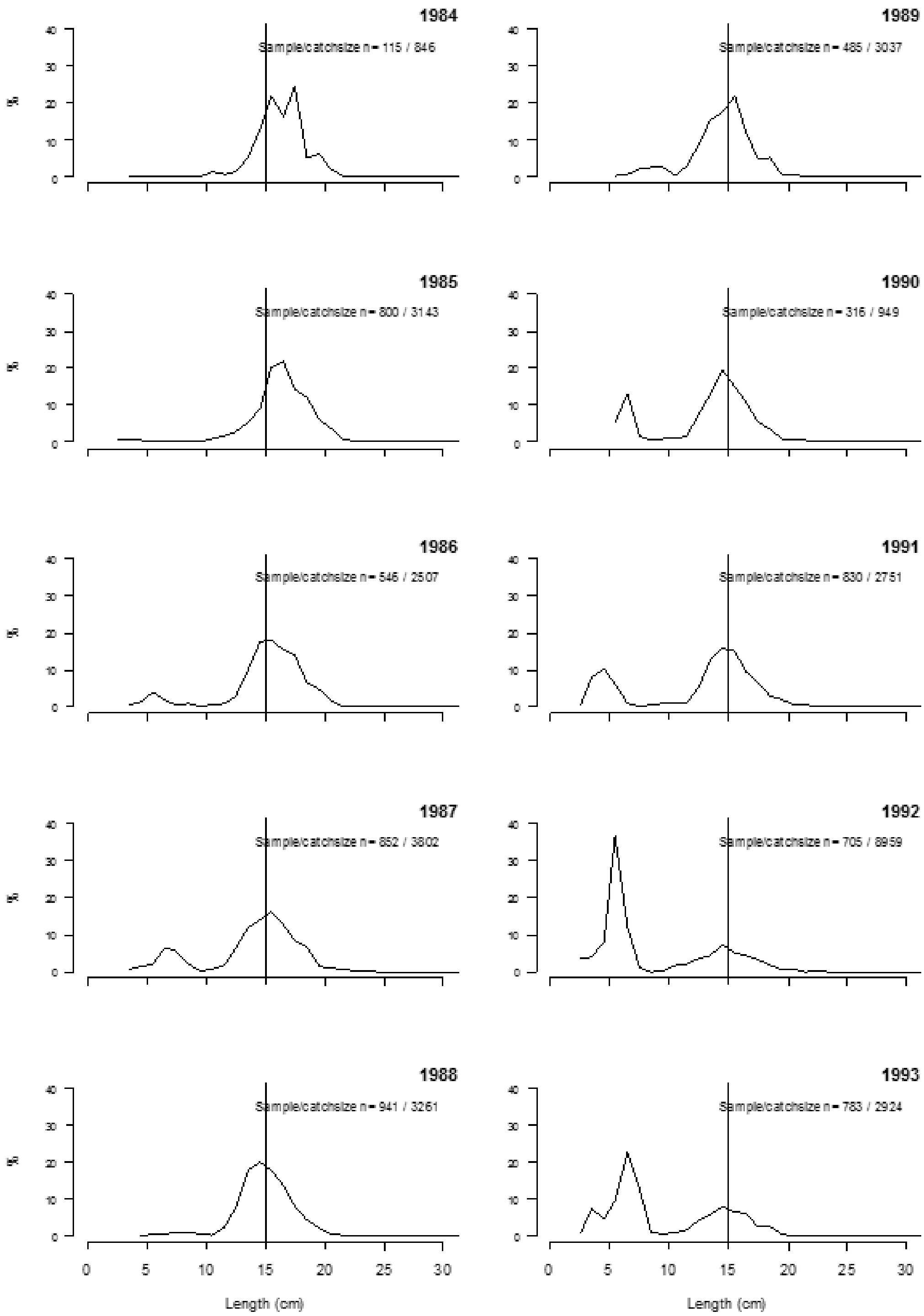


Figure 9.3.1. Length–frequency distributions for roundnose grenadier, 1984–2016. Data from Norwegian shrimp survey, all catches deeper than 300 m. Length is measured as pre-anal fin length in cm. The distributions are calculated as percent number of fish in each cm length interval standardized to total catch number and trawling distance for each station each year.

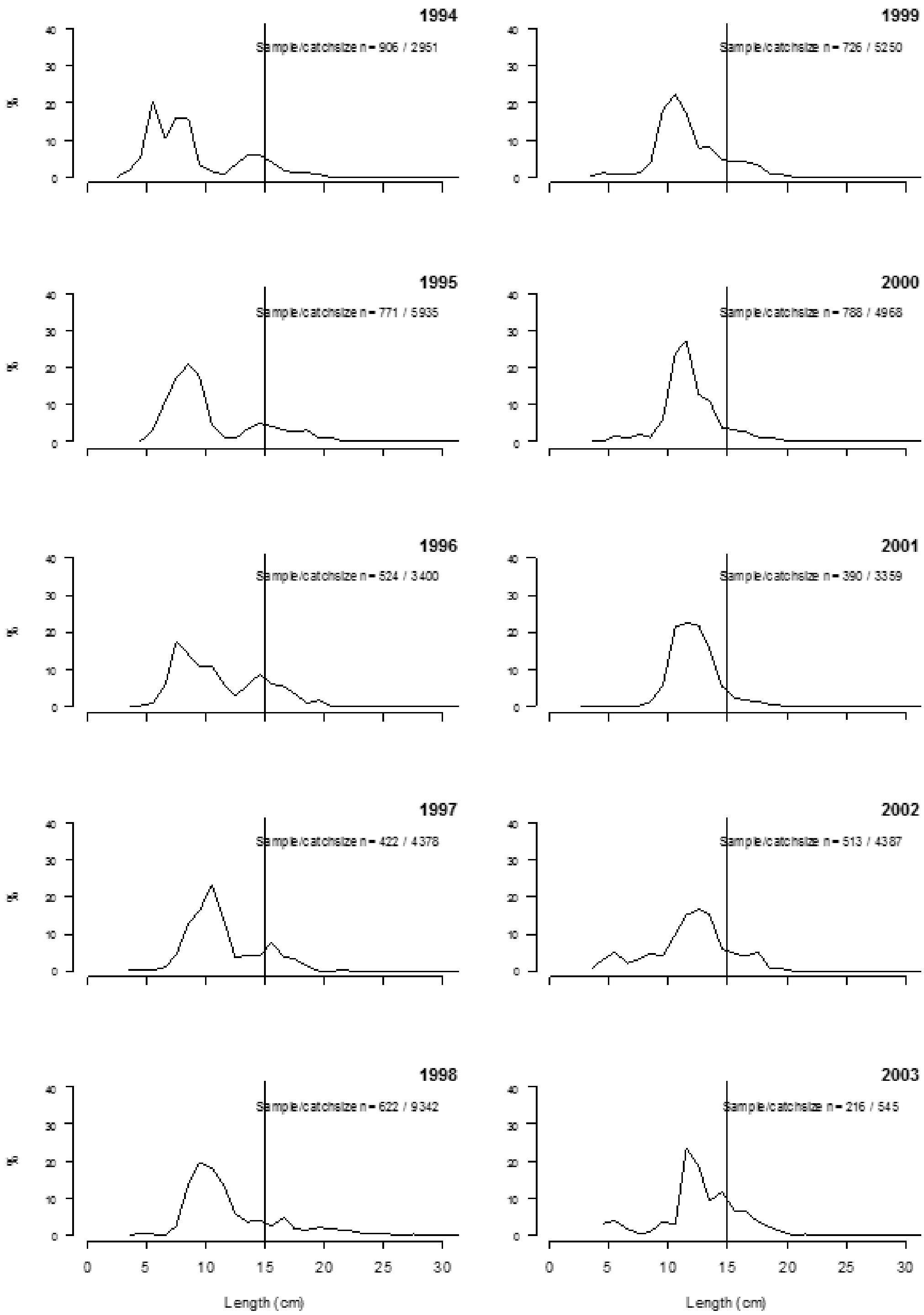
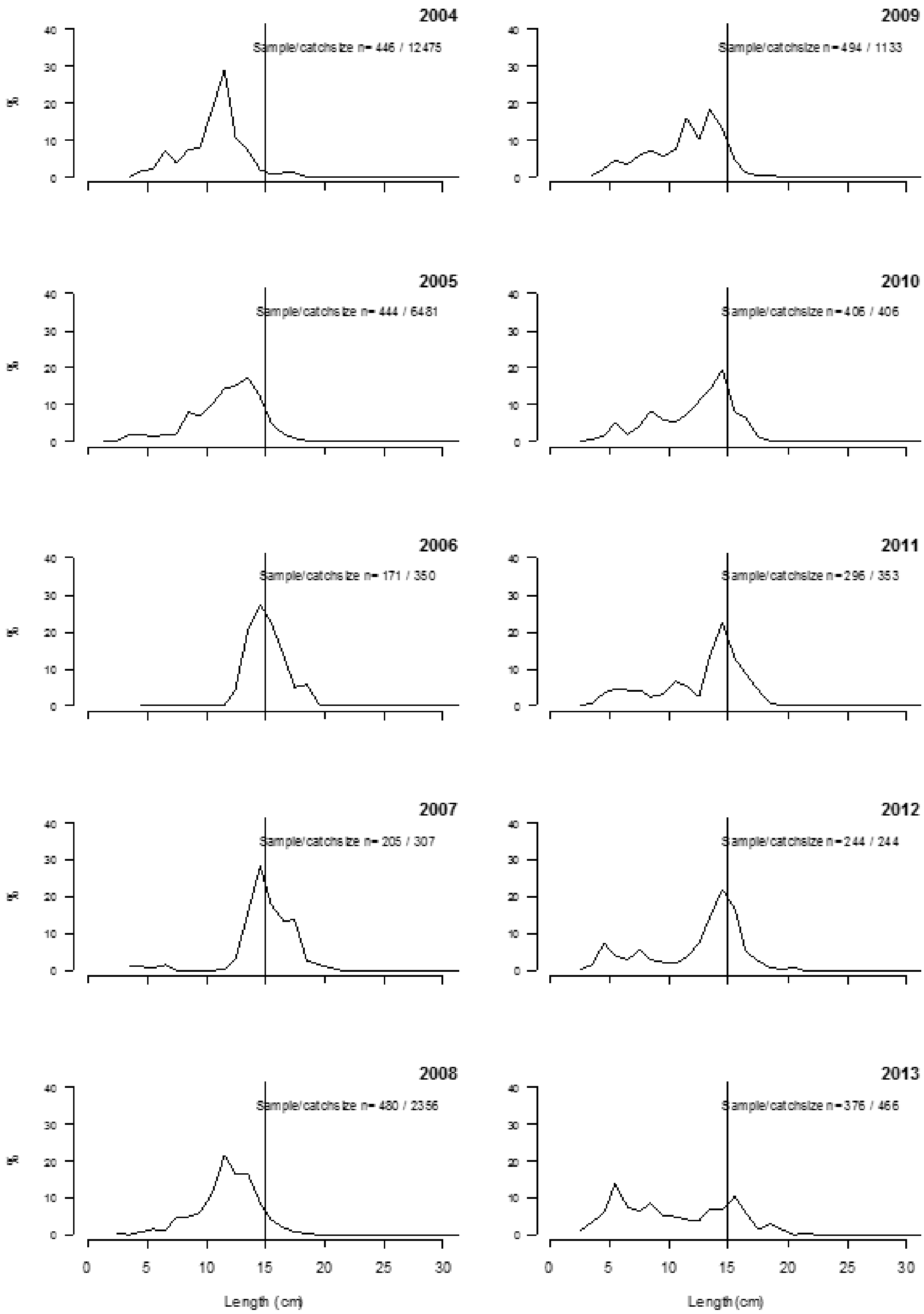


Figure 9.3.1. (Con't).



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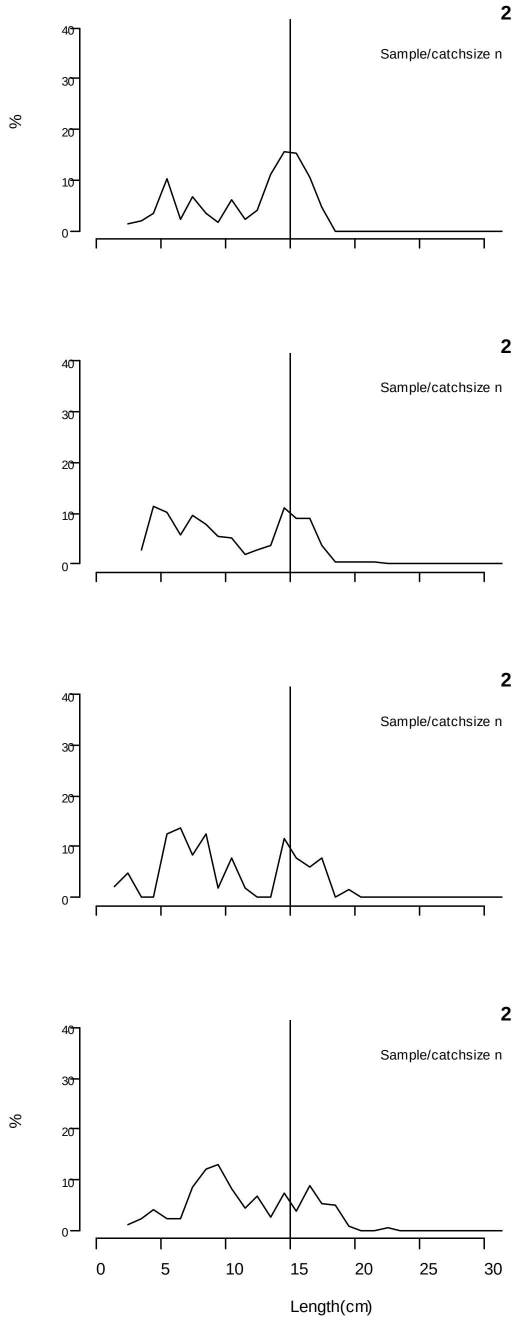

Figure 9.3.1. (Con't).

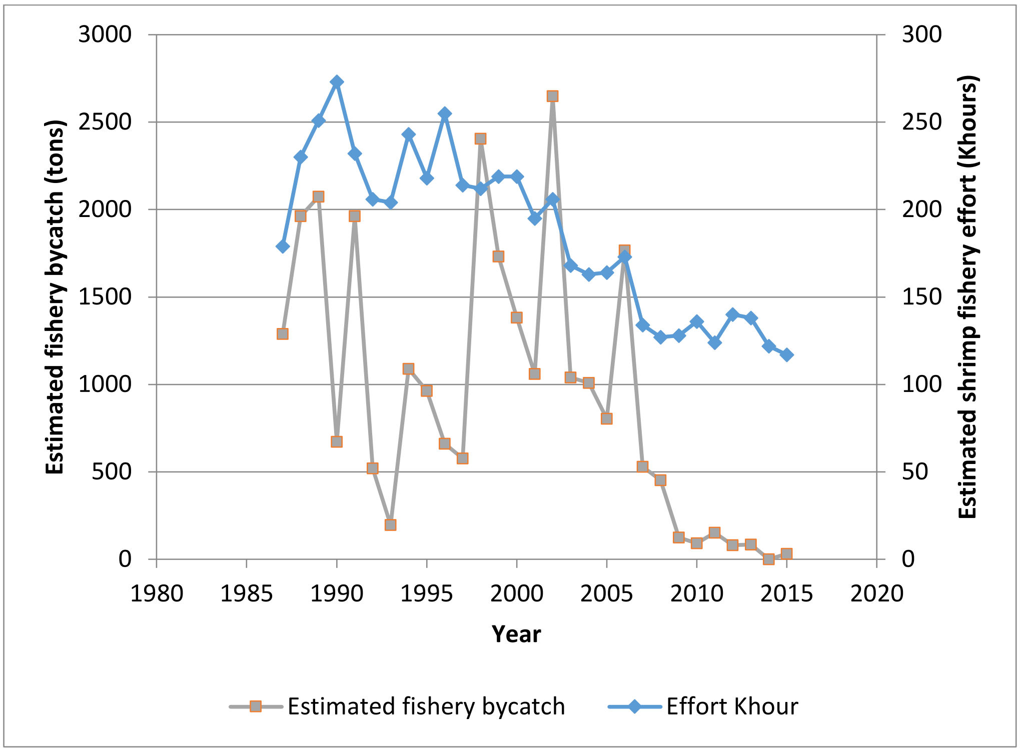

Figure 9.3.2. Estimated bycatch of roundnose grenadier in the Norwegian shrimp fishery in ICES Division 4.a and 3.a, and the estimated commercial shrimp fishery effort in the same area. See text for explanation.

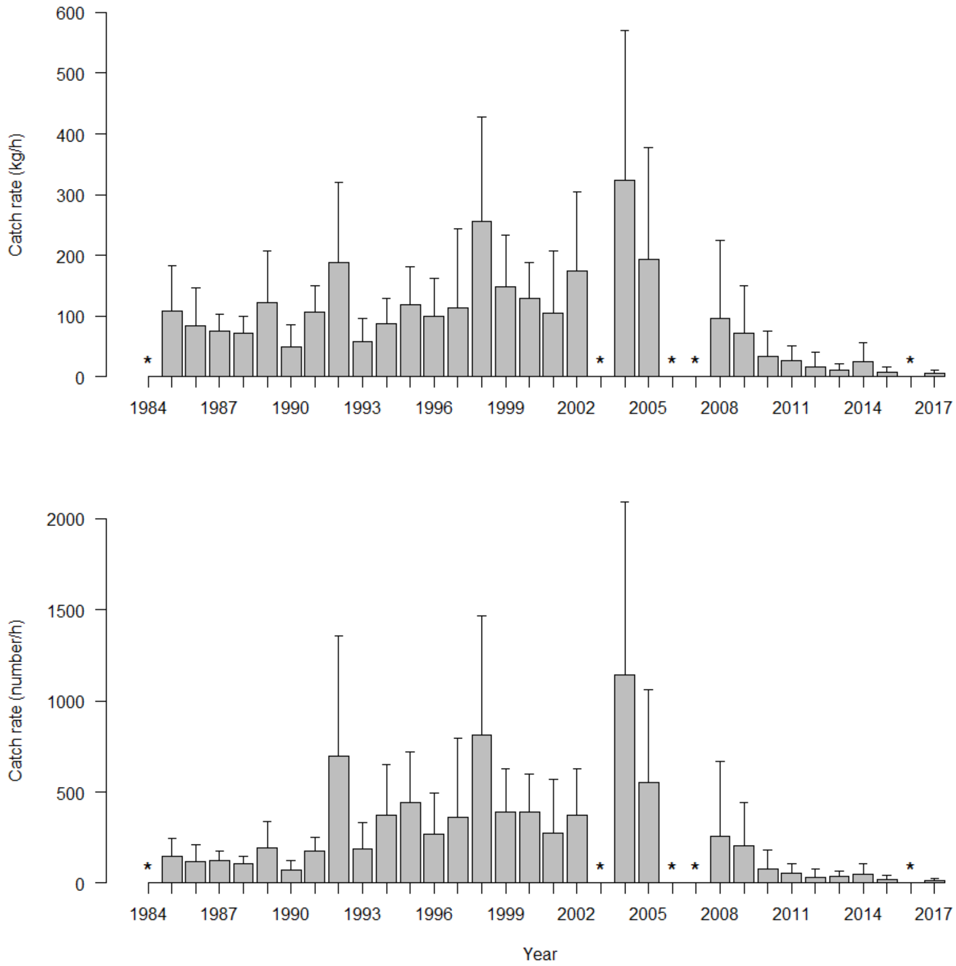

Figure 9.3.3. Survey catch rates in biomass (kg/h) and abundance (nos/h) of grenadier 1984–2017. Note: in 1984, 2003, 2006, and 2007 only a single or no trawls were made deeper than 400 m, thus the primary grenadier habitat was not sampled for those years. For the other years the survey is thought to cover the distribution area of roundnose grenadier Lines indicate estimates of 2SE (Updated from Bergstad *et al.*, 2014).

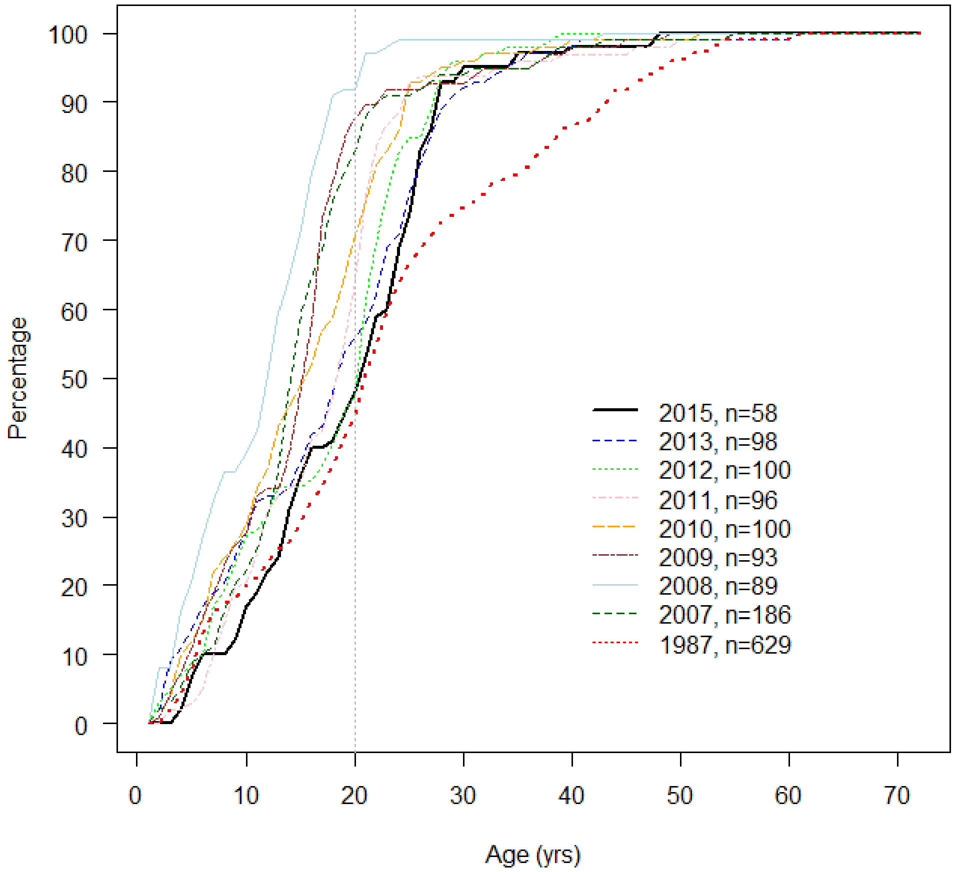

Figure 9.3.4. Cumulative age distributions of roundnose grenadier in the Skagerrak. Data from survey catches in the Skagerrak in 1987 and 2007–2013 and 2015. The distribution from 1987 was modified from Bergstad (1990). Data from 2007 were collected on the deep-water fish survey in April.

9.3.9 References

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9.4 Roundnose Grenadier (*Coryphaenoides rupestris*) in Divisions 10.b, 12.c and Subdivisions 5.a.1, 12.a.1, 14.b.1 (Oceanic Northeast Atlantic and northern Reykjanes Ridge)

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 1990s fisheries on MAR have been sporadic and much smaller in scale. USSR/Russian fleet has the maximum length of the history of fishery and took the greatest volume of landings. Last decades the main countries participating in the fishery are Spain (since 2010) and Russia (since 2000).

9.4.1.1 Landings trends

The greatest annual catch (almost 30 000 t) was taken by the Soviet Union in 1975 (Tables 9.4.1–9.4.5, 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 bycatch in the Faroese orange roughy fishery and Spanish demersal multispecific 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 12.c. 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 10.b.

Also in 2007, the Spanish fleet targeting redfish on the MAR reported landings of roundnose grenadier in 14.b.1 totalling 1722 tonnes. The following years, roundnose grenadier became a target species. In 2011 official landings in 14.b.1 increased to 2239 t. In subsequent years total estimated landings amounted to of 1860, 1790 and 2065 t in 2012, 2013 and 2014 respectively. To these figures an unallocated catch in 14.b.1 of 1015 t must be added. Therefore total estimated preliminary catch in 2014 consists of 3466 t including Spanish catch in 14.b.1, negligible Faroese and French bycatches in 10.a, 12.a and 14.b.1 and discards. In 2015 total Spanish catch was declared as 862 t (533 and 329 tonnes in 14.b.1 and 12.a.1 respectively). No catches were reported by other countries.

In 2015 information on fishery was presented only by Spain. The preliminary official landings for 2016 are 660 t including 371 t in 14.b.1 and 289 t in 12.a.1 (Table 9.4.4).

9.4.1.2 ICES Advice

ICES advice applicable to 2013 and 2014

"Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 1350 t.

This is the first year ICES is providing quantitative advice for data-limited stocks."

In the advice for 2014, the stock status was presented as follows:

F (Fishing Mortality)		
	2009–2011	
Qualitative evaluation	?	Insufficient information
SSB (Spawning-Stock Biomass)		
	2009–2011	
Qualitative evaluation	?	Insufficient information

ICES approach to data-limited stocks

"For this stock, ICES advises that 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."

ICES advice applicable to 2015

"The 2012 advice for this stock was biennial and valid for 2013–2014 (ICES, 2012). New data available do not change the perception of this stock. Therefore, the advice for this fishery in 2015 is the same as the advice for 2013–2014. However, ICES notes that catches for the period 2010–2011 have been revised substantially downwards and mean catch for 2009–2011 is now 896 t (compared to the previous estimates of 1687 t). Applying the same 20% reduction to the revised catches gives catch advice of 717 t.

Based on ICES approach to data-limited stocks, ICES advises that catches should be no more than 717 t."

ICES advice applicable to 2016 and 2017

"ICES advises that when the precautionary approach is applied, landings should be no more than 717 tonnes in each of the years 2016 and 2017. ICES cannot quantify the corresponding catches." In the advice for 2016 and 2017, the stock status was presented as follows:

		Fishing pressure					Stock size			
		2012	2013	2014			2013	2014	2015	
Maximum Sustainable Yield	F_{MSY}	?	?	?	Undefined	MSY $B_{trigger}$	?	?	?	Undefined
Precautionary approach	F_{pa}, F_{lim}	?	?	?	Undefined	B_{pa}, B_{lim}	?	?	?	Undefined
Management Plan	F_{MGT}	-	-	-	Not applicable	SSB_{MGT}	-	-	-	Not applicable
Qualitative evaluation	-	?	?	?	Unknown	-	?	?	?	Undefined

9.4.1.3 Management

There is a TAC for the roundnose grenadier in Subareas 8, 9, 10, 12 and 14. It applies to European Union (EU) waters and EU vessels in international waters (See Section 9.1.2). On the 35th Annual session of NEAFC the recommendation (Rec. 8:2017) on the Conservation and Management of Roundnose Grenadier (*Coryphaenoides rupestris*), Roughhead Grenadier (*Macrourus berglax*), and Roughsnout Grenadier (*Trachyrinchus scabrus*) and other Grenadiers (Macrouridae) in the NEAFCRegulatory Area (Divisions 10.b and 12.c, and Subdivisions 12.a.1 and 14.b.1) was adopted for 2017. It specifies:

1) A total allowable catch limitation of 717 tonnes of roundnose grenadier.

2) No direct fisheries for roughhead grenadier and roughsnout grenadier should be authorised, and bycatches of these grenadiers as well as other grenadiers (Macrouridae) should be counted against the total allowable catch of roundnose grenadier specified in Point 1.

3) Contracting Parties shall submit all data on the relevant fishery to ICES, including catches, bycatches, discards and activity information.

9.4.2 Data available

9.4.2.1 Landings and discards

Landings are given in Tables 9.4.1–9.4.5. There were no discards of roundnose grenadier on Russian trawlers where smallest fish and waste were used for fishmeal processing. The information on discards rate is very poor. The studies of discards were conducted only in 2014, when the discards on Spanish target fishery estimated by scientific observers was at level of 386 t (Tables 9.4.4).

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.

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.

The pelagic trawl Spanish fishery in 2012–2014 caught individuals from 6 to 23 cm pre-anal length, the mean length comprised 12.2–13.5 cm and 13,3–15.0 cm for males and females respectively. The observed length data on Spanish fishery in 2016 showed, that the length composition of catches has substantially changed. The mean length of males was 10,7 cm and mean length of females 12.0 cm. The cause of such significant reduction of fish size could be either overfishing or abundant recruitment. The length compositions of landings and discards of this fishery are presented in Figure 9.4.3.

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 9.4.1–9.4.6 and Figures 9.4.1 and 9.4.4–9.4.6. 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 2003–2009 (Table 9.4.6). Effort data for Spanish fleet are available for 2010–2015 (Table 9.4.7).

Data on biology and distribution of juvenile roundnose grenadier was collected in May–July 2003, 2005, 2007, 2011, 2013 during the international trawl-acoustic survey (ITAS) of redfish *Sebastes mentella* in the Irminger and Labrador Seas, as well as during investigations under the Russian national programme of investigations on the West Iceland and East Greenland slopes. Russian, Icelandic and German research vessels participated in ITAS. In 2015 the survey also was conducted but the information on the distribution of juvenile roundnose grenadier was not available for WGDEEP. Trawl stations were carried out by pelagic trawl (78,7/416) with vertical opening of 43 m and Gloria 896 pelagic trawl with vertical opening of 46 m. In 2003 for the first time, data suggesting a wide distribution of young fish in the high seas pelagial are obtained (Vinnicchenko V. and Khlivnoy V., 2008). Investigation results are evidence of the long passive migrations of this species at early life stages. Outside the island slopes, juvenile roundnose grenadier was registered in most parts of the investigated area between 52°54'–63°41'N, 26°00'–51°06'W above 1200–3200 m depth (Figure 9.4.4). Juveniles were caught in pelagic layer at depths of 120–840. Maximum catches (up to ten individuals per one trawling hour) were registered over the MAR in the layer 500–700 m. Pre-anal length of specimens varied from 2 to 7 cm, age varied from 0+ TO 3. The collected materials indicate a possibility to use ITAS for studies of abundance dynamics in roundnose grenadier. This objective requires more detailed analysis on distribution and abundance of young grenadier.

9.4.3 Data analyses

The source of information on abundance trends was only the cpue series from the Soviet/Russian official data (Table 9.4.6, Figure 9.4.5). 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.

Since 2010 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 Spanish cpue in Subdivisions 14.b.1 were on maximal level in 2011. In 2012–2013 the cpue declined and was stability in 2014–2015 (Figure 9.4.6). The time-series of the cpue for Subdivisions 12.a.1 is very short (Figure 9.4.7).

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 9.4.8). 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 9.4.9) 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 than in 2003 at the most seamounts (Table 9.4.8). The average biomass per one seamount increased from 3900 t in 2003 to 4600 t in 2010.

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 2010. WGDEEP considers that the latest approach for management is applicable for this stock; the TAC in average catch for three recent years. The cpue can be use as indicator of the state of stock in future.

9.4.7 References

Vinnichenko V., Khlivnoy V. 2008. New data on distribution of young roundnose grenadier (*Coryphaenoides rupestris*) in the North Atlantic Grenadiers of the world oceans: Biology, stock assessment and fisheries. American Fisheries Society, 2008. 119–124 pp.

Table 9.4.1. Working group estimates of catch of roundnose grenadier from Subdivision 5.a.1.

Year	USSR/ Russia	Total
1973	820	820
1974	12 561	12 561

Table 9.4.2. Working group estimates of catch of roundnose grenadier from Subarea 10.b.

Year	USSR/ Russia	Faroes1	Total
1976	170		170
1993		249	249

1994			
1995			
1996		3	3
1997		1	1
1998		1	1
1999		3	3
2000			
2001			
2002			
2003			
2004		1	1
2005	799		799
2006			
2007			
2008			
2009			
2010	73		73
2011			
2012			
2013			
2014			
2015			
2016			

Table 9.4.3.Working group estimates of catch of roundnose grenadier from Subareas 12.a.1 and 12.c.

YEAR	USSR/ RUSSIA	POLAND[2]	LATVIA[2]	FAROES[2]	SPAIN	LITHUANIAN	TOTAL
1973	226						226
1974	5874						5874
1975	29894						29894
1976	4545						4545
1977	9347						9347
1978	12310						12310
1979	6145						6145
1980	17 419						17419
1981	2954						2954
1982	12472						12472
1983	10300						10300
1984	6637						6637
1985	5793						5793
1986	22842						22842
1987	10893						10893
1988	10606						10606
1989	9495						9495
1990	2838						2838
1991	32141		4296				75101
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					864	4	868
2013					118		118
2014				4			4

Year	USSR/ Russia	Poland[2]	Latvia[2]	Faroes[2]	Spain	Lithuanian	Total
2015					329		329
20163					289		289

[1]–revised catch data [2]– official ICES data [3]– preliminary data.

Table 9.4.4. Working group estimates of catch of roundnosegenadier from Subdivision 14.b.1.

Year	USSR/ Russia	Spain	Unallocated	Discards	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		57			57
2008		1722			1722
2009					
2010		753			753
2011		2239			2239
2012		1860	1098		2958
2013		1790			1790
2014		2065	1015	386	3466
2015		533			533
2016[3]		371			371

[1]–revised catch data [2]– official ICES data [3]—preliminary statistics.

Table 9.4.5. Working group estimates of catch of roundnose genadier in Divisions 10.b, 12.c and Subdivisions 5.a.1, 12.a.1, 14.b.1, by area.

YEAR	5.A.1	10.B	12.A.1 AND 12.C	14.B.1	TOTAL
1973	820	0	226	0	1046
1974	12561	0	5874	0	18435
1975	0	0	29894	0	29894
1976	0	170	4545	11	4726
1977	0	0	9347	0	9347
1978	0	0	12310	0	12310
1979	0	0	6145	0	6145
1980	0	0	17419	0	17419
1981	0	0	2954	0	2954
1982	0	0	12472	153	12625
1983	0	0	10300	0	10300
1984	0	0	6637	0	6637
1985	0	0	5793	0	5793
1986	0	0	22842	0	22842
1987	0	0	10893	0	10893
1988	0	0	10606	0	10606
1989	0	0	9495	0	9495
1990	0	0	2838	0	2838
1991	0	0	7510	0	7510
1992	0	0	1979	0	1979
1993	0	249	2912	0	3161
1994	0	0	1132	0	1132
1995	0	0	359	0	359
1996	0	3	344	0	347
1997	0	1	6710	3361	10072
1998	0	1	7600	0	7601
1999	0	3	1151	0	1154
2000	0	0	2325	5	2330
2001	0	0	1716	69	1785
2002	0	0	737	239	976
2003	0	0	510	272	782
2004	0	1	444	201	646
2005	0	799	600	0	1399
2006	0	0	1	0	1
2007	0	0	2	57	59
2008	0	0	13	1722	1735
2009	0	0	5	0	5
2010	0	73	0	753	826
2011	0	0	0	2239	2239
2012	0	0	868	2958	3826
2013	0	0	118	1790	1908
2014	0	0	4	3466	3470

Year	5.a.1	10.b	12.a.1 and 12.c	14.b.1	Total
2015	0	0	329	533	862
2016	0	0	289	371	660

Table 9.4.6. Soviet/Russian fishing effort and cpue on the roundnose grenadier fishery on the MAR.

Year	ICES Subarea and Division	Number of fishing days	Catch per fishing day, t
1974	12.a.1+12.c, 5.a.1		35.2
1975	12.a.1+12.c		36.6
1976	12.a.1+12.c, 14.b.1, 10.b		24.0
1977	12.a.1+12.c		17.3
1978	12.a.1+12.c		17.0
1979	12.a.1+12.c		19.6
1980	12.a.1+12.c		17.3
1981	12.a.1+12.c		18.4
1982	12.a.1+12.c		
1983	12.a.1+12.c		17.3
1984	12.a.1+12.c		18
1985	12.a.1+12.c		18.5
1986	12.a.1+12.c		21
1987	12.a.1+12.c		17.3
1988	12.a.1+12.c		21.8
1989	12.a.1+12.c		15.6
1990	12.a.1+12.c		18.4
1991	12.a.1+12.c		14.5
1992	12.a.1+12.c		12.9
1993	12.a.1+12.c, 10.b		10.7
1994	12.a.1+12.c, 14.b.1, 10.b		
1995	12.a.1+12.c, 14.b.1, 10.b		
1996	12.a.1+12.c, 10.b		22.2
1997	12.a.1+12.c, 14.b.1, 10.b		20.3
1998	12.a.1+12.c, 10.b		6.8
1999	12.a.1+12.c, 10.b		8.8
2000	12.a.1+12.c, 14.b.1		9.1
2001	12.a.1+12.c		15.8
	14.b.1		
2002	12.a.1+12.c		13.2
	14.b.1		
2003	12.a.1+12.c	51	10.1
2004	12.a.1+12.c	25	16.1
2005	12.a.1+12.c	42	17.7
	10.b	37	
2006	12.a.1+12.c, 14.b.1, 10.b		
2007	12.a.1+12.c, 14.b.1, 10.b		
2008	12.c	7	
2009	12.c	1	

Table 9.4.7. Spanish fishing effort on roundnose grenadier fishery on the MAR.

Year	ICES Subarea and Division	Number of fishing days	Number of fishing bots
2010	14.b	19	3
2011	14.b	98	4
2012	12.a.1	60	7
2012	14.b	140	7
2013	12.a.1	18	3
2013	14.b	147	6
2014	14.b	150	3
2015	12.a.1	21	1
2015	14.b	38	2
2016	12.a.1	2	2
2016	14.b	24	2

Table 9.4.8. 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.**

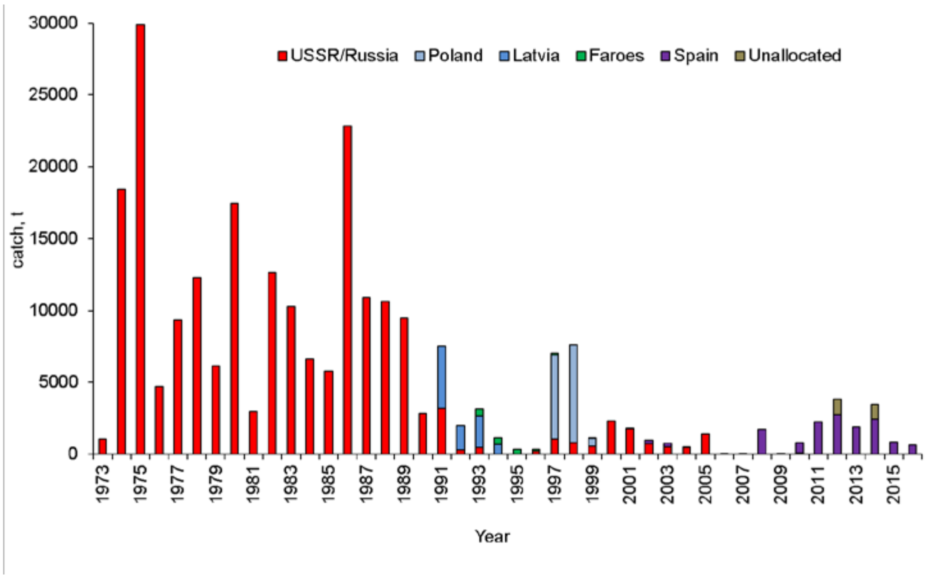


Figure 9.4.1. International catch of roundnose grenadier on the MAR in 1973–2016.

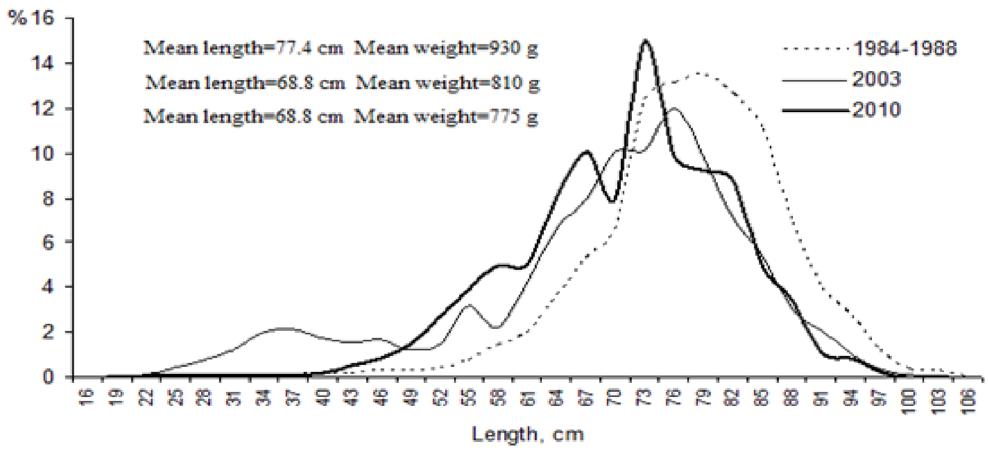


Figure 9.4.2. Total length composition of roundnose grenadier on the MAR in 1984–1988 (47–51°N), in 2003 (47–51°N) and in 2010 (47–50°N).

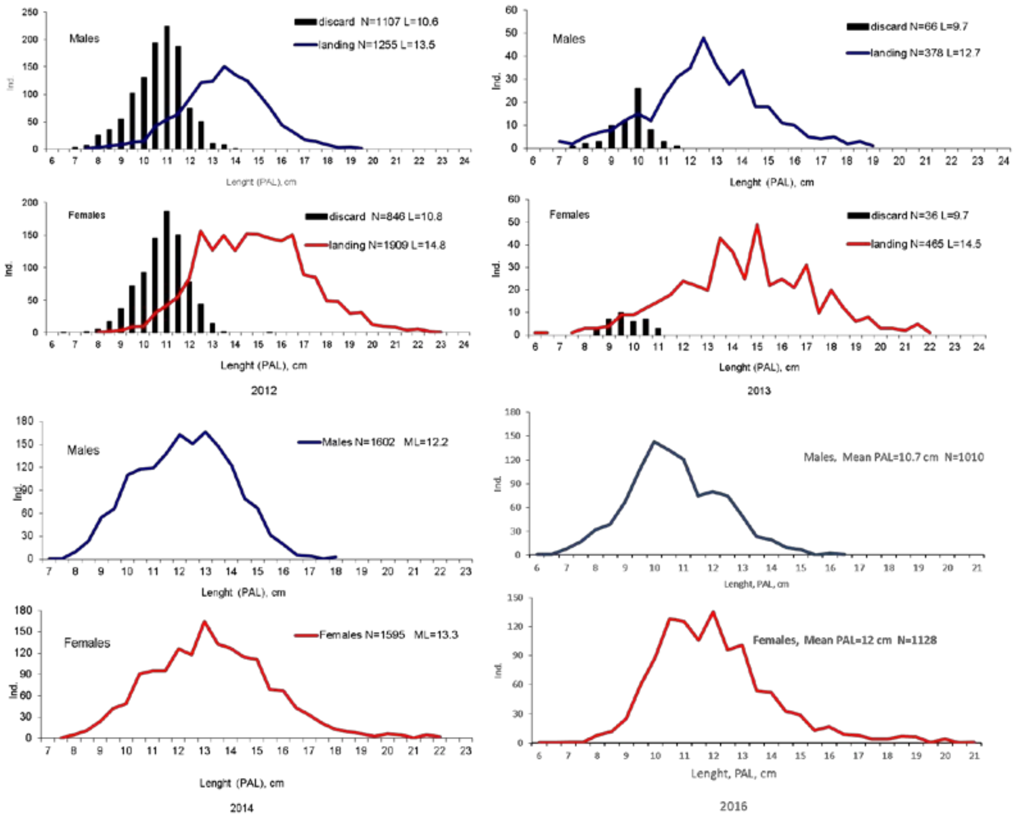


Figure 9.4.3. Length composition (PAL) of landings and discards of roundnose grenadier on Spanish commercial trawl fishery.

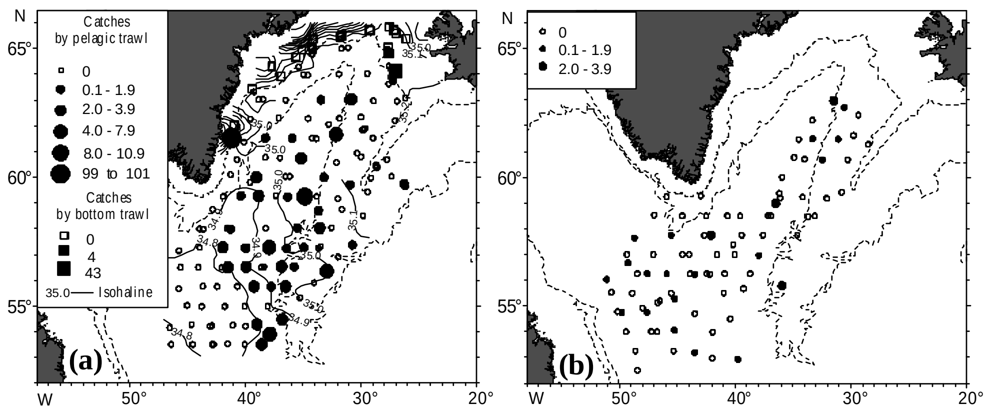


Figure 9.4.4. Catches of young roundnose grenadier (indiv./1 trawling hour) and water salinity at 50 m depth in the North Atlantic in May–July 2003 (a) and in June–July 2005 (b) (Vinnicchenko V., Khlivnoy V. 2008).

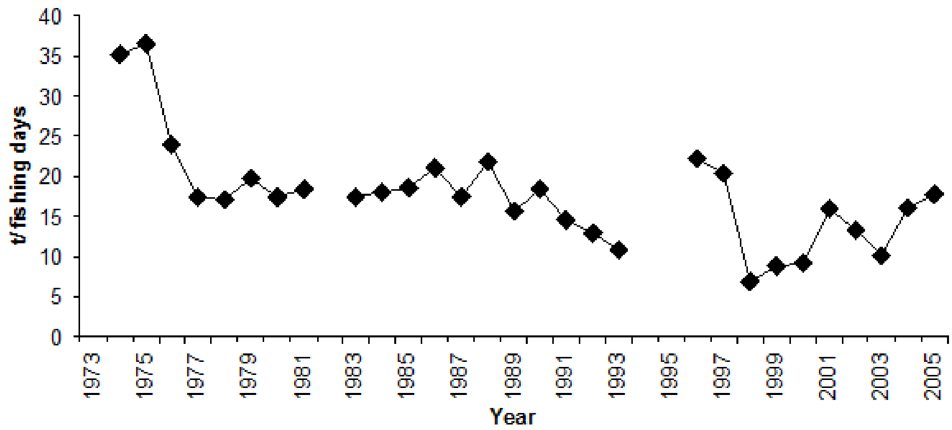


Figure 9.4.54. Soviet/Russian cpue of roundnose grenadier on the MAR in 1973–2005.

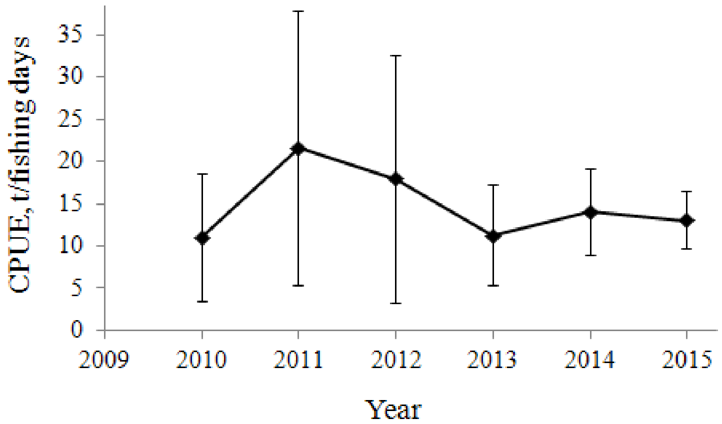


Figure 9.4.6.Spanish cpue of roundnose grenadier on the MAR in Subdivision 14.b.1 in 2010–2015.

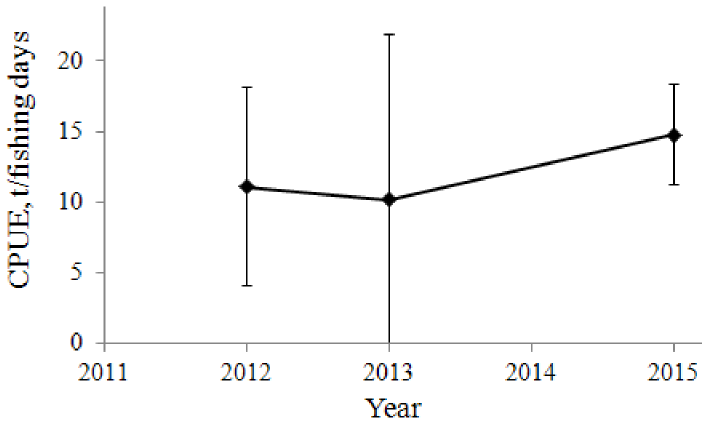


Figure 9.4.7.Spanish cpue of roundnose grenadier on the MAR in Subdivision 12.a.1 in 2012–2013 and 2015.

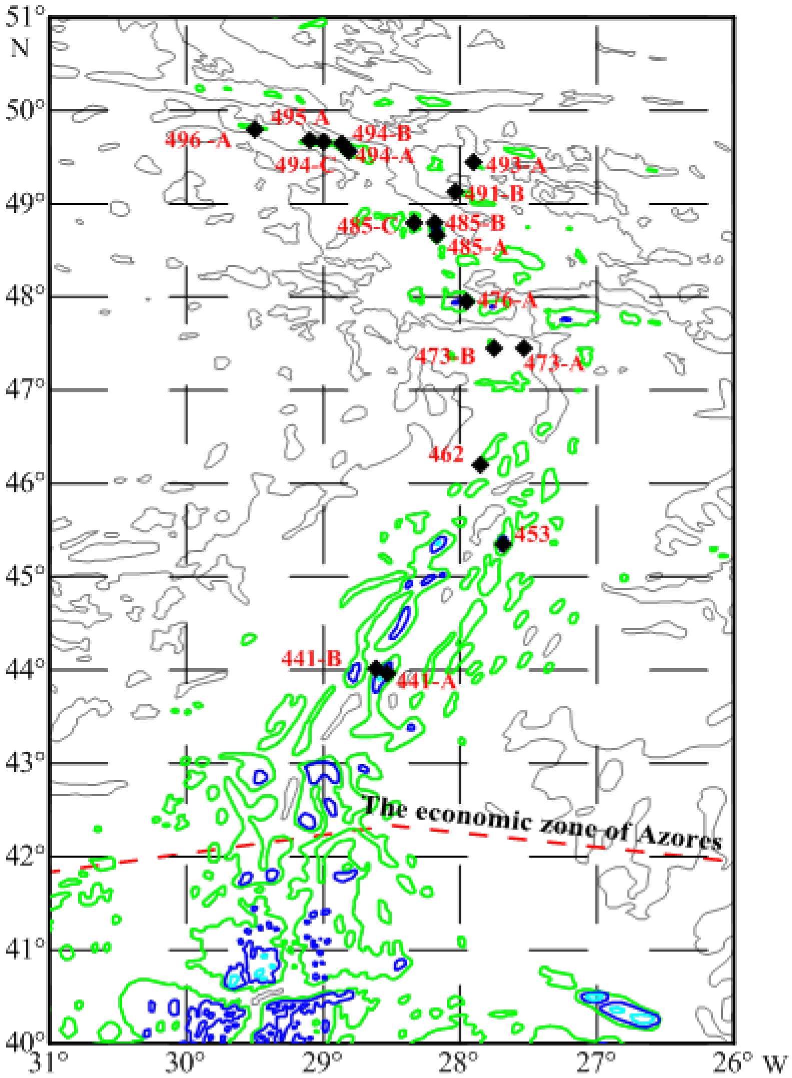


Figure 9.4.7. Location of seamounts surveyed at RV "Atlantida" on the MAR in October 2010.

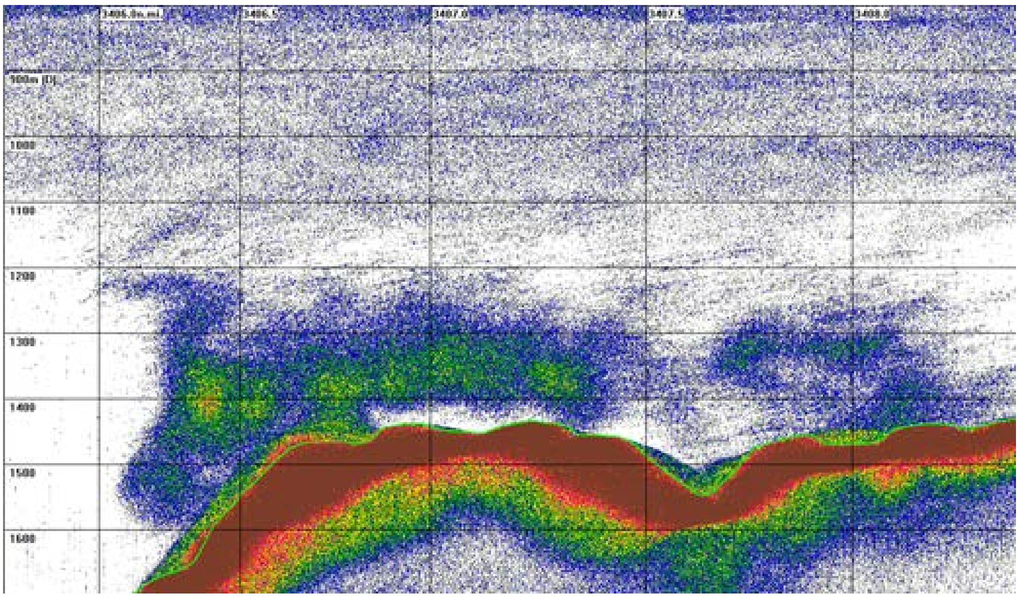


Figure 9.4.8. Echo-records of roundnose grenadier at the MAR seamount 494-A in October 2010.

9.5 Roundnose grenadier (*Coryphaenoides rupestris*) in subareas 1, 2, 4, 8, and 9, Division 14.a, and in subdivisions 14.b.2 and 5.a.2 (Northeast Atlantic and Arctic Ocean)

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 countries in the period 1990–2016 are presented in Tables 9.5.1–9.5.5.

In the Subareas 1 and 2 the catch of roundnose grenadier in 2016 comprised 4 t and was mainly taken as bycatch by Norwegian fleet. Moreover, iinsignificant catch of species was declared by France, 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 roughhead grenadier, so there is no French landings for roundnose grenadier in Subareas 1 and 2.

In Subarea 4, the catch of roundnose grenadier in 2016 was mainly taken by the French fleet and comprised 2 t. The vessels of Norway and Scotland also had negligible catches. 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 1 and 2, earlier landings of roundnose grenadier in Subarea 4 are likely to correspond to roughhead grenadier but 2014 landings are well assigned. Four tons in 2014 may correspond to catch of roundnose close to the Norwegian deep or to misreported roughhead along the slope of the northern North Sea.

During 1990–2016, the landings of roundnose grenadier within Icelandic waters (Division 5.a) 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, but it should be noted that it can include other grenadier species till 1990 (Table 9.5.3). 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 2016 catch in 5.a amounted 52 t.

Roundnose grenadier landings in Subareas 8 and 9 during 1990–2014 were minor and amounted 0 to 28 t annually (Figure 9.5.4). The main contribution to the total catch was made by France (Table 9.5.4). In 2015 landings from the subareas were 1 t. In 2016 were negligible bycatches and discards on French and Spanish fishery. Total amount was less 0.02 t.

Total catch in Greenland waters (Subdivision 14.b.2) in 1990–2016 varied from 1 to 126 t (Table 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 (Table 9.5.5). In 2015 catch was 38 t that mainly was taken by Greenland. In 2016 was no catches declared (Figure 9.5.5).

In the period 2003–2005 the unallocated landings were assigned to Subareas 1, 2, 4,8, 9 and Division 5.a.2 and 14.b.2, the values were 208, 504, and 952 t respectively (Table 9.5.6, Figure 9.5.6).

9.5.1.2 ICES advice

ICES advice applicable to 2013 and 2014

"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.

This is the first year ICES is providing quantitative advice for data-limited stocks."

In the advice for 2014, the stock status was presented as follows:

F (Fishing Mortality)		
	2009–2011	
Qualitative evaluation	?	Insufficient information

SSB (Spawning-Stock Biomass)		
	2009–2011	
Qualitative evaluation	?	Insufficient information

ICES approach to data-limited stocks

"For this stock, since catches are marginal and consist of bycatches, and there is no indication of high discard rates, ICES advises that catches should not exceed 120 t, the average catch from the last three years, unless there is evidence that this is sustainable."

ICES advice applicable to 2015

"The 2012 advice for this stock is biennial and valid for 2013 and 2014 (ICES, 2012). New data available do not change the perception of the stock. Therefore, the advice for this fishery in 2015 is the same as the advice for 2013: 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."

ICES advice applicable to 2016 and 2017

"ICES advises that when the precautionary approach is applied, landings should be no more than 65 tonnes in each of the years 2016–2017. ICES cannot quantify the corresponding catches."

In the advice for 2016 and 2017, the stock status was presented as follows:

		Fishing pressure					Stock size				
		2012	2013	2014			2013	2014	2015	
Maximum Sustainable Yield	F_{MSY}	?	?	?	Undefined	MSY $B_{trigger}$	?	?	?	Undefined
Precautionary approach	F_{pa}, F_{lim}	?	?	?	Undefined	B_{pa}, B_{lim}	?	?	?	Undefined
Management Plan	F_{MGT}	-	-	-	Not applicable	SSB_{MGT}	-	-	-	Not applicable
Qualitative evaluation	-	?	?	?	Unknown	-	?	?	?	Undefined

9.5.1.3 Management

There is a TAC management of the roundnose grenadier fisheries in Subareas 1, 2, 4, 8, 9, Division 5.a and Subdivision 14.b.1 for European Community vessels. 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 owing to bycatch in Spanish fisheries for demersal fish in 8 and 9 did not exceed 2 t in 2012, and did not reached to 1 t in subsequent years.

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 2016.

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 2016.

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 grenadier from Subareas 1 and 2.

Year	Faroes	Denmark	Germany	Norway	Russia/USSR	Germany	UK (E+W)	France	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
2014				4					4
2015				6					6
2016*				4				0	4

*** Preliminary data.**

Table 9.5.2. Working group estimates of landings of roundnose grenadier from Subarea 4.

Year	Germany	Norway	UK (Scot)	Denmark	France	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
2014					3	3
2015*		1	<1		1	2
2016		0	0		2	2

***Preliminary data.**

Table 9.5.3. Working group estimates of landings of roundnose grenadier from Division Va.

Year	Faroes	Iceland**	Norway	UK (E+W)	Denmarck	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
2014		36				36
2015		22			2	24
2016*		52				52

*** Preliminary data. ** includes other grenadiers from 1990 to 1996.**

Table 9.5.4. Working group estimates of landings of roundnose grenadier from Subareas 8 and 9.

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	0		0
2014	0		0
2015	1		1
2016*	0	0	0

*** Preliminary data.**

Table 9.5.5. Working group estimates of landings of roundnose grenadier from Division 14.b.2.

Year	Faroes	Germany	Greenland	Iceland	Norway	UK (E+ W)	UK (Scot)	Russia	Estonia**	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
2014	0				7				4	11
2015			38							38
2016*										

*** Preliminary data.**

**** Estonian landings in 2014 not reflected in ICES catch statistic.**

Table 9.5.6. Working group estimates of landings of roundnose grenadier from 1, 2, 4, 5.a.2, 8, 9, 14.b.2.

Year	1+2	4	Va	8+9	14.b.2	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
2014	4	4	36	0	11		55
2015	6	2	24	1	38		71
2016*	4	2	52	0			58

*** Preliminary data.**

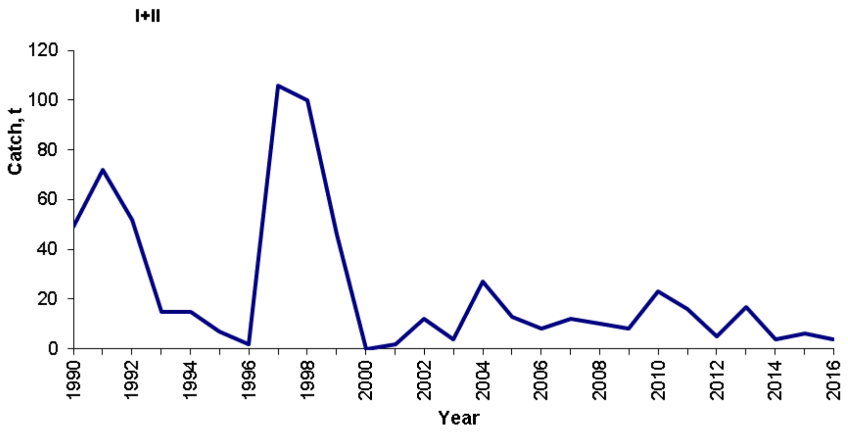


Figure 9.5.1. Roundnose grenadier landings in Subareas 1 and 2, 1990–2016 (data for 2016 are preliminary).

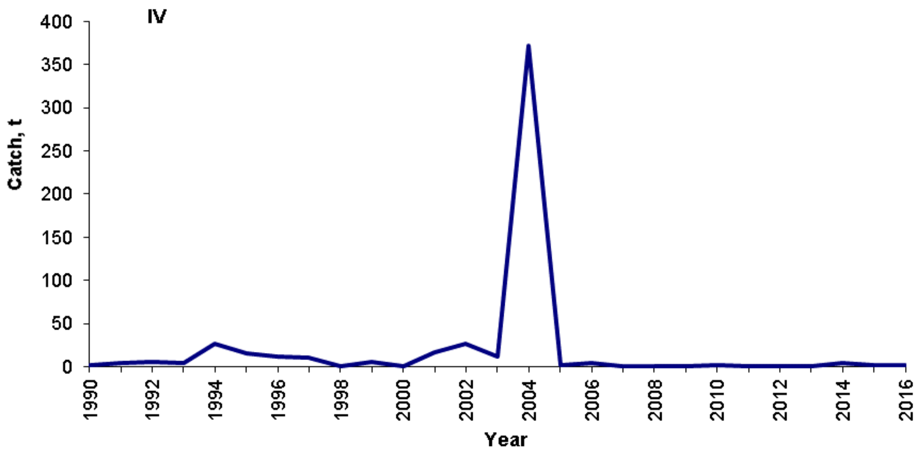


Figure 9.5.2. Roundnose grenadier landings in Subareas 4, 1990–2016 (data for 2016 are preliminary).

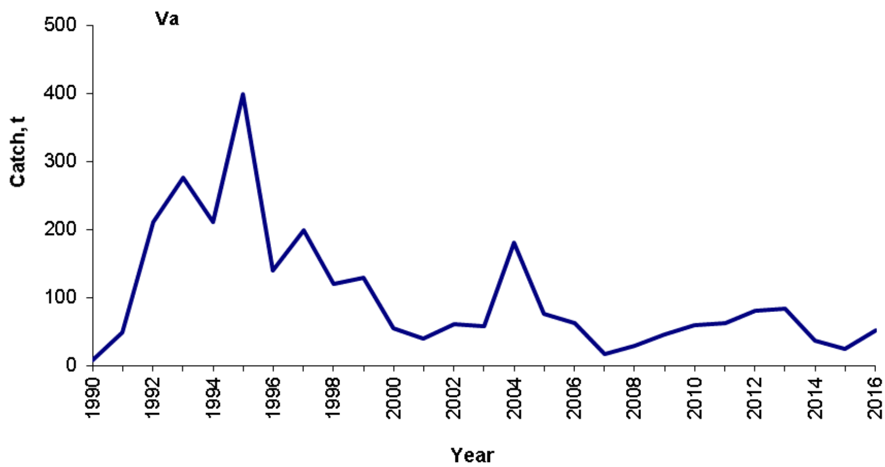


Figure 9.5.3. Roundnose grenadier landings in Division 5.a, 1990–2016 (data for 2016 are preliminary).

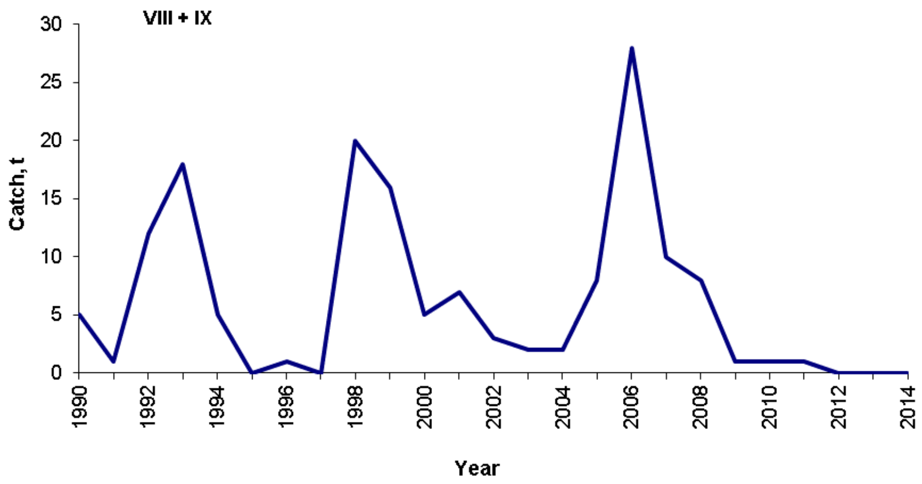


Figure 9.5.4. Roundnose grenadier landings in Subareas 8–9, 1990–2016 (data for 2016 are preliminary).

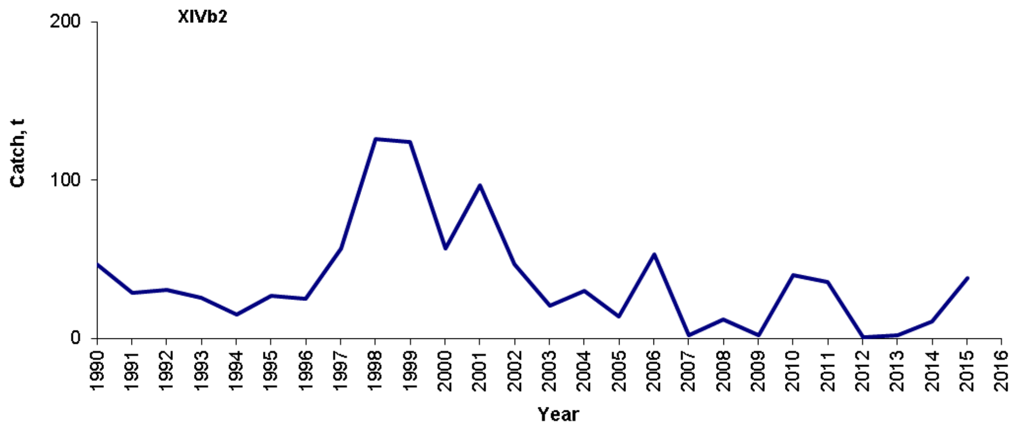


Figure 9.5.5. Roundnose grenadier landings in Subarea 14.b.2, 1990–2016 (data for 2016 are preliminary).

10 Black scabbard fish (*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 at the north of the Scotland-Iceland-Greenland ridges. Juveniles are mesopelagic and adults are bentho-pelagic. 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. Nevertheless, all the available information supports 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 such as ICES Subarea 10.a is less clear, as in this Subarea two different species *A. carbo* and *A. intermedius* coexist (Besugo *et al.*, 2014 WD).

Prior to the 2014 benchmark meeting (WKDEEP, 2014), WGDEEP has considered three assessment units for black scabbardfish (ICES, 2011):

i) Northern (Divisions 5.b and 12.b and Subareas 6 and 7);

ii) Southern (Subareas 8 and 9);

iii) Other areas (Divisions 3.a and 5.a Subareas 1, 2, 4, 10, and 14).

The Northern component comprises fish exploited mainly by trawl fisheries while the Southern component by a longline fishery in Subarea 9.a. In other areas the species is exploited by both longliners and trawlers. Till 2010 the overall landings in those other areas were globally much lower than at the Northern and Southern components. However in recent years, fishing activity in ICES Division 5.a has been regular, with landings rounding about 300 ton *per* year. To guarantee the consistency of the underlying assumption of a unique stock in NE Atlantic and since there are no evidences against this assumption, WGDEEP 2016 agreed to include ICES Division 5.a in the Northern component.

Furthermore based on 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 the two management 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 purposes. However, as all evidence suggests one single stock doing a clockwise migration within these areas, a dynamic population model was fitted data from the Northern and Southern component. The assessment model was benchmarked at WKDEEP 2014.

The link between the northern and southern components and the other areas, excluding ICES Division 5.a, is less clear. Excluding fisheries in ICES Division 5.a fisheries in other areas are more irregular and catches, particularly those from ICES Subarea 10,may also include a high proportion of the congener species, *Aphanopus intermedius* Parin, 1983. As a consequence, “Other areas” is treated separately from northern and southern components.

The present report is structured maintaining the initial separation between management units, except for topics related with the stock assessment and the advice.

10.2 Black scabbard fish in Divisions 5.b and 12.b and Subareas 6 and 7

In this section fisheries, landings trends, management applicable are presented for Divisions 5.b and 12.b and Subareas 6 and 7, but the stock assessment data analyses and management considerations apply to these areas combined to ICES Subareas 8 and Divisions 9.a and 5.a. ICES Division 5.a, was previously included in "Other areas" however in 2016 WGDEEP decided to include ICES Division 5.a in the current stock assessment analyses and on management considerations, as fishing activity in this division has been regular since 2010.

10.2.1 The fishery

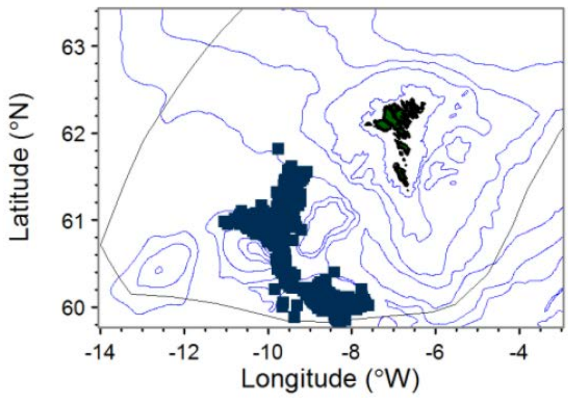


Figure10.2.1. bsf.27.nea. Spatial distribution of the Faroese commercial trawl fishery of black scabbardfish in 5.b (2000–2016).

In Subarea 5.b the main fishing areas of black scabbardfish are located on the slope around the Faroe Bank and on the Wyville-Thomsen ridge close to the southernmost Faroese EEZ boarder (Figure 10.2.1). The Faroese waters only one large trawler have had licence to fish black scabbardfish as a targeted species since 2013. The fishing gear used in a star trawl with 486 meshes, 160 mm. Mesh size in the net was 80 mm. The usual fishing depth varies between 600–1000 m and the trawling hours vary between six to eight hours, but may last less if the species is very abundant.

In 2017, there was no updated information on the fisheries taking place in Subareas 12.b and Divisions 6 and 7.

10.2.2 Landings trends

The historic landing trends on this assessment unit are described in the stock annex.

Annual total landings from the ICES Division 5.b and Subareas 6, 7 and 12 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 since then landings decreased, particularly at ICES Divisions 6 and 7. This decrease appears to be driven by EU TAC management measure adopted (Figure 10.2.2). From 2009 onwards landings have been fluctuating at about 3000 ton *per* year.

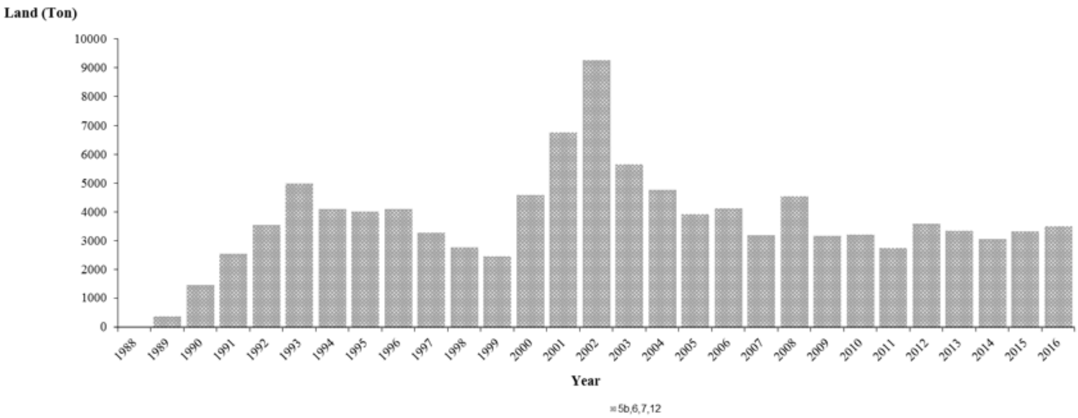


Figure10.2.2. bsf.27.nea Northern component Time-series of annual landings for ICES Division 5.b and Subareas 6+7 and 12 (2016 provisional data).

In earlier years of the time-series, French landings represented more than 75% of the northern component total landings, but from 2000 to 2006 they just represented about 50%. During that period both Faroese and Spanish landings increased and their relative contribution for the Total annual landings increase substantially (Figure 10.2.3). After 2010 the relative importance of French landings, particularly in Subarea 6, augmented. In recent years Faroese landings have a representativeness of about 20% of the total.

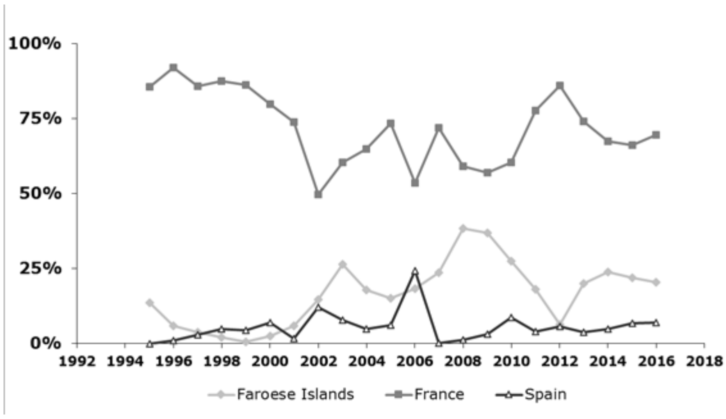


Figure 10.2.3. bsf.27.nea Northern component French, Spanish and Faroese relative contribution to the annual landings for northern component.

10.2.2.1 ICES Advice

The latest ICES advice was that when the precautionary approach is applied catches should be no more than 5894 ton in each of the years 2017 and 2018. Distributed by area this corresponds to annual catches of no more than 2802 ton in Subareas 6 and 7 and Divisions 5.b and 12.b.

10.2.3 Management

Since 2003, the management of black scabbardfish adopted for EU vessels fishing in EU and international waters, includes a combination of TAC and licensing system. TACs and total landings of EU vessels in Subareas 5, 6, 7 and 12 since 2006 to 2015 are presented in the table below.

Year	EU TAC 5, 6, 7 & 12	Landinds 5b, 6, 7 and 12
2006	3042	7455
2007	3042	4885
2008	3042	3722
2009	2738	3082
2010	2547	2582
2011	2356	2350
2012	2179	2155
2013	3051	2772
2014	3966	3048
2015	3649	3326
2016	3357	3496
2017*	2 954	

*** preliminary.**

The difference between the TAC and landings may not necessarily be regarded as TAC overshoot by the EU fleet as some catches occur in waters under the jurisdiction of third countries.

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 Division 5.b and Subareas 6, 7 and 12 (Table 10.2.1) and for ICES Division 5.a, here included in the Northern component (Table 10.4.1c).

Update discard data were also provided for major fishing countries operating at the northern component area. As referred in previous WGDEEP reports, the level of black scabbardfish discards is low. Discard data available for the Northern component, indicates that discards of black scabbardfish are negligible.

10.2.4.2 Length compositions

Annual total length–frequency distributions based on 2016 French on board observer data for Divisions 5.b and 6.a are presented in Figure 10.2.3. Comparing the two, no differences on the length ranges between subareas are noticed, although in Division 5.b smaller specimens appear to have a greater expression (Figure 10.2.4).

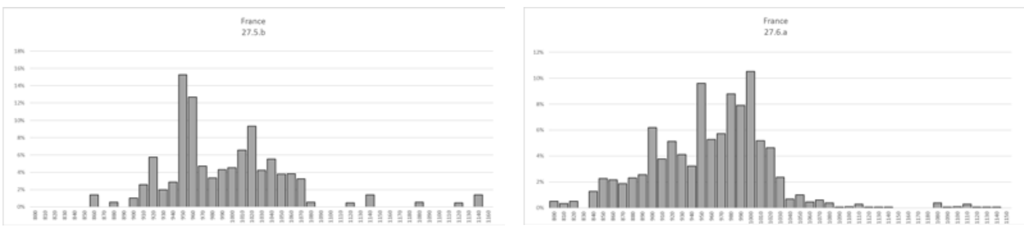
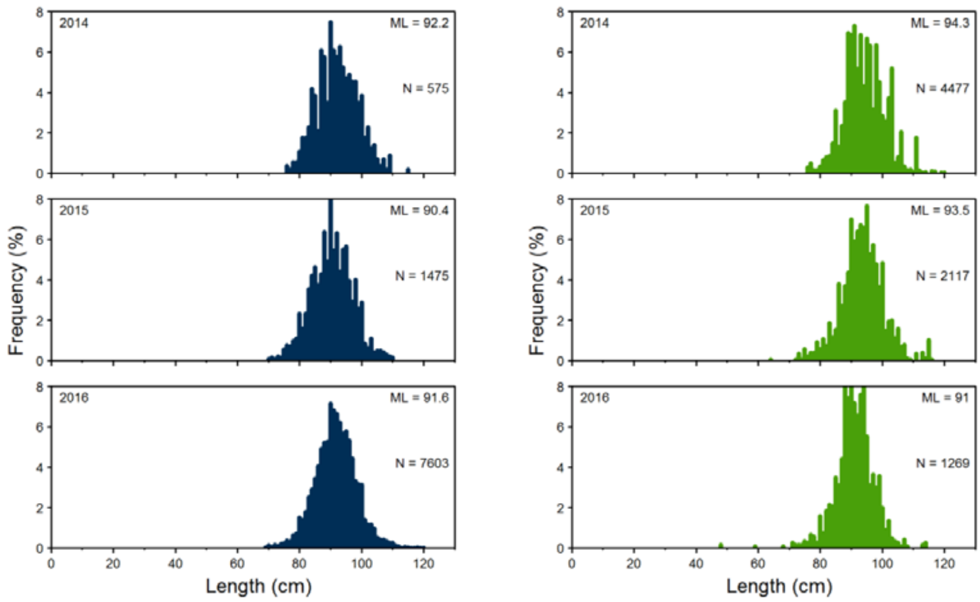


Figure 10.2.4. bsf.27.nea Northern component 2016. Annual frequency–length distribution of black scabbardfish from subarea 5.a and 6.a based on French observer data collected on board commercial vessels.

Annual length–frequency distributions of the Faroese landing data and Faroese surveys (ICES Division 5.b) for the years 2014, 2015 and 2016 are presented in Figure 10.2.5. The average of total length of landed black scabbardfish from commercial vessels is around 90–92 cm. In Faroese research surveys the mean total length of the species was around 94 cm in 2014 and 2015 but in 2016 it was reduced to 91 cm (Figure 10.2.5).



a) b)

Figure 10.2.5. bsf.27.nea Northern component Black scabbardfish 5.b. Annual length–frequency distributions for the period 2014–2016 based on Faroese landing data (a) and on the Faroese deep-water surveys (b).

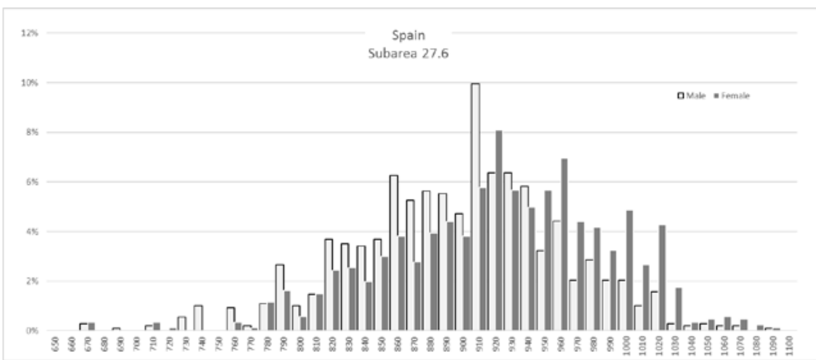


Figure 10.2.6. bsf.27.nea Northern component. Length–frequency distribution based on Spanish on board observed in Subarea 6.

Spanish length data from on-board observer programme were available for males and females sampled in Subarea 6 in 2016 (Figure 10.2.6). Females tend to be larger than the males and the overall length range varies from 67 to 109 cm.

Comparing the French, Faroese and Spanish length–frequency distributions these appear to have similar ranges and in all the majority of specimens have total length smaller than 100 cm. Such similarity further indicates a similar length structure of the population of the black scabbardfish in different areas of the northern component.

10.2.4.3 Age compositions

The exploited population is not structured by age because the methodological approach followed to assess the stock is a stage-based model, with stages defined according to length.

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 5.b, 6, 7 and 12 consistently points out to the predominance of small and immature specimens.

10.2.4.6 Catch, effort and research vessel data

Data on catch and effort from the Faroese fishery in Division 5.b were provided, as well as, unstandardized and standardized cpue series. The inputs for standardizing the cpue were based on fishery data from large Faroese trawlers, restricted to hauls where black scabbardfish represented more than 30% of the total catch, and where the fishing effort was more than two hours of trawling. The mean estimate of standardized cpue for the whole period was 248 kg/h (Figure 10.2.7). The cpue for years 2013 to 2015 were almost twice the mean and this probably reflects the beginning of a directed fishery by one large commercial trawler. In 2015 the cpue was at the highest of 508 kg/hour. In 2016 the cpue estimate has decreased to nearly half of those high values.

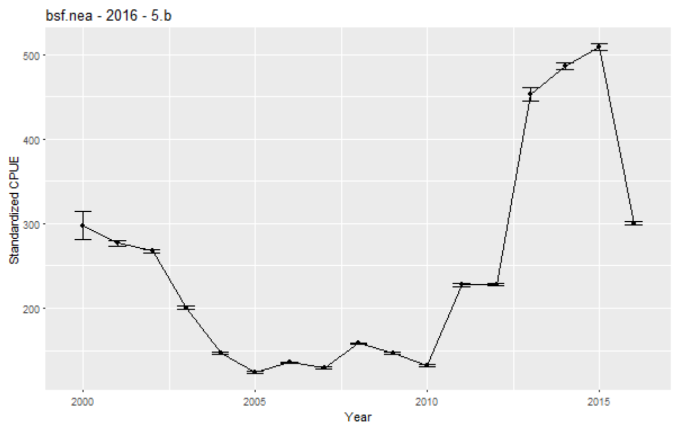


Figure 10.2.7. bsf.27.nea Northern component. Annual standardized cpue ± standard error of the estimate based on Faroese fishery data in Subarea 5.b.

French catch and effort data were presented but not standardized and transformed into a cpue time-series.

Faroese deep-water survey data have been provided for years 2014, 2015 and 2016. The spatial distribution of the catches indicates that the species occurs mainly at Wyville-Thomsen ridge and on the slope north of the Faroe Bank (Figure 10.2.8). Important to note that these two areas represent the main fishing grounds for the species. In addition, it is observed that the species only occasionally occurred in the northwest of the Faroe Bank and as never caught at the Faroe Plateau (Figure 10.2.8).

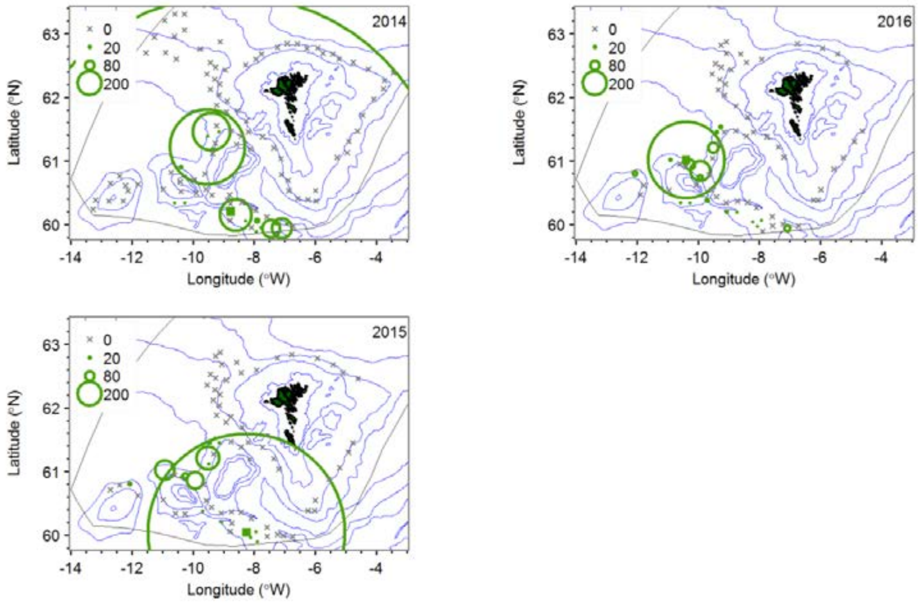


Figure 10.2.8. bsf.27.nea Northern component. Spatial distribution of cpue (kg/h) from the Faroese deep-water surveys from 2014 to 2016 in Division 5.b. The size green bubbles is associated to the relative importance of the high catches.

10.2.5 Data analyses

No new assessment is performed, as 2017 as this is not an advisory year for the stock. Nevertheless, the 2016 information provided lead to admit that the state of bsf.nea stock within ICES area is stable.

For the major fishing countries exploiting the stock in the ICES area, the landing data are considered reliable and discards are considered minor. Nevertheless, the 2014 benchmarked assessment model adopted for this stock includes a parameter that accommodates for the uncertainty on the input catch data.

In Division 5.b, the average Faroese standardized cpue from 2000 and onwards was around 248 kg/h. In recent years, 2013–2015, the cpue value was twice that the mean value (in 2015 the cpue was at the highest of 508 kg/hour). The main reason of this increase is a directed fishery by one large commercial trawler. The cpue in 2016 decreased to 300 kg/hour being around the mean cpue for the whole period (Figure 10.2.7).

The annual standardized Portuguese cpue series covering the period 1998–2016 (Figure 10.3.3.) suggest a stable trend on cpue.

In the assessment model the distribution of parameter related to emigration to northern component is unknown since no survey data available are insufficient to derive a prior distribution for the parameter. Potentially the Scottish survey could provide some information but it is carried in a time of the year that is inappropriate to estimate such index.

A further analysis of annual abundance and biomass indices estimates derived from Scottish survey in Division 6.a (Figure 10.2.9.) and from Icelandic Autumn survey surveys in Division 5.b. (Figure 10.2.10) both show years with very high abundance. This high values of abundance are likely to be related to peaks of recruitment. Such hypothesis is also supported by the spatial distribution catch rates derived from the Faroese trawl fishery for the period 2000 and 2016, as this fishery mainly rely on immature specimens (Figure 10.2.11). To critically evaluate the hypothesis of recruitment pulse more spatial and temporal detailed information is required.

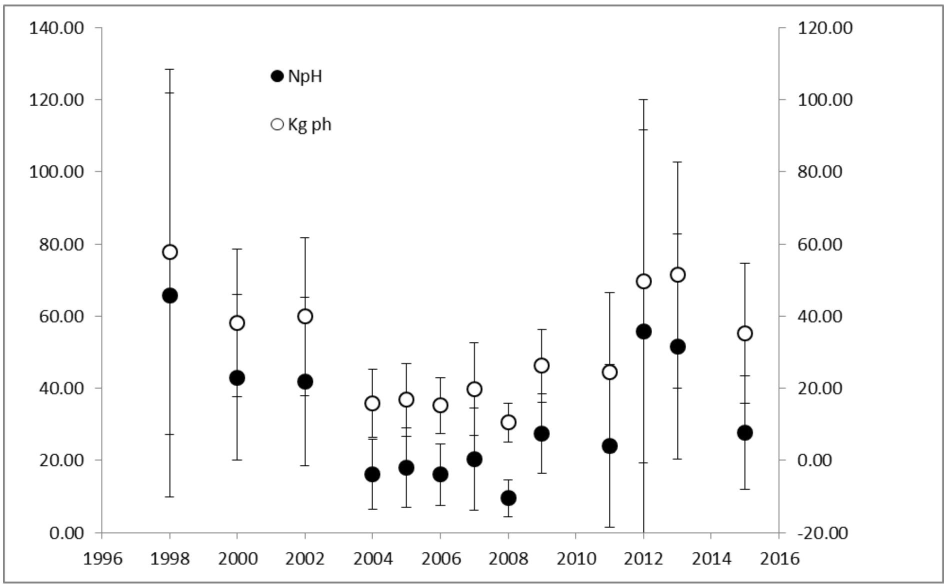


Figure 10.2.9. bsf.27.nea Northern component. Annual abundance (left axis) and biomass (right axis) indices of black scabbardfish in ICES Division 6a from the Scottish deep-water survey.

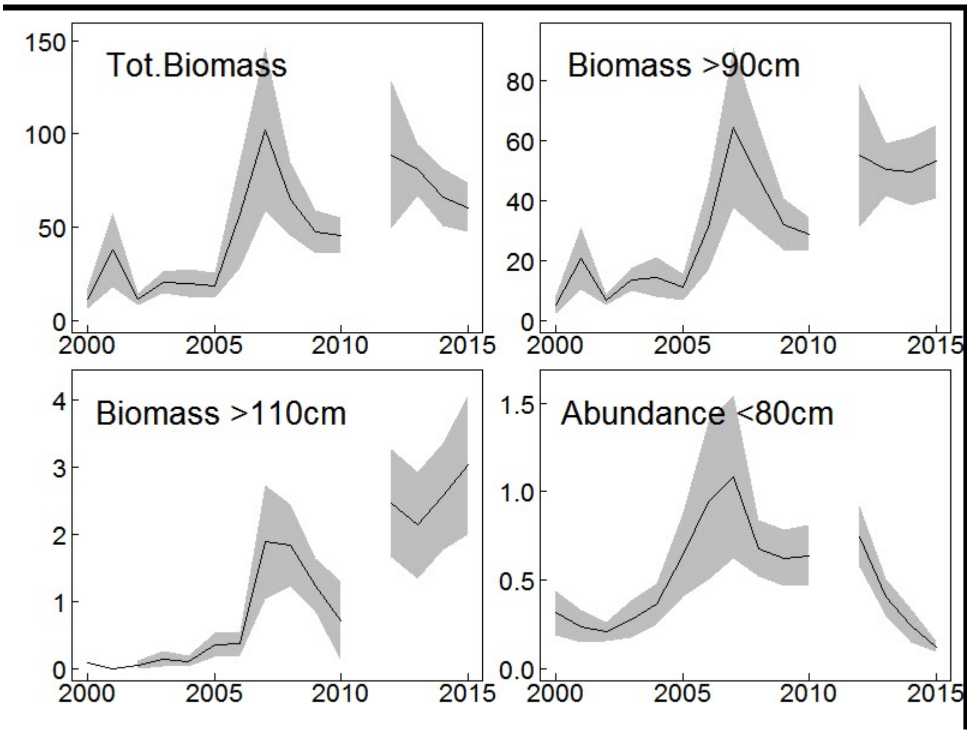
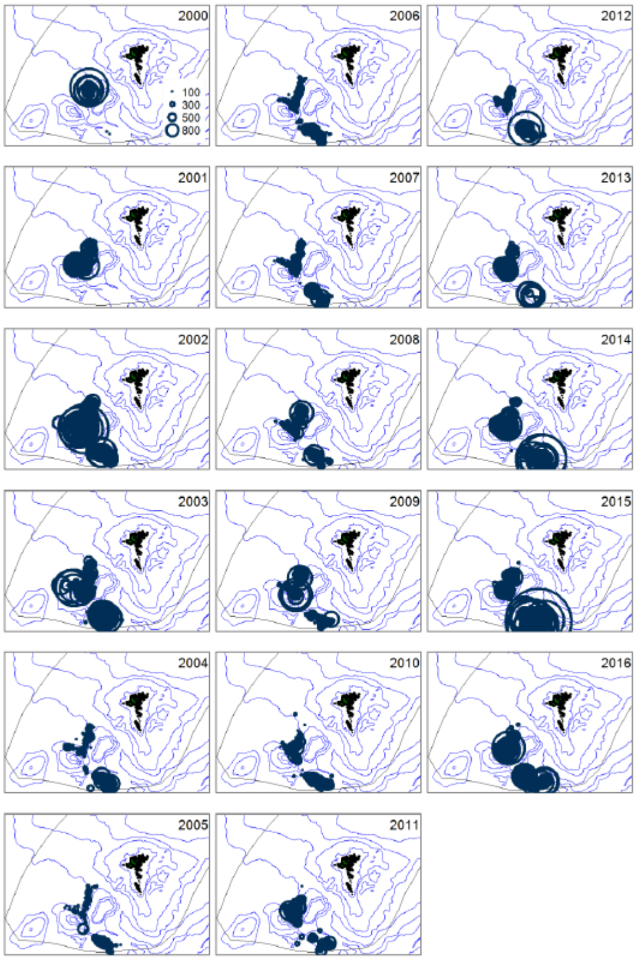


Figure 10.2.10. bsf.27.nea Northern component. 9%% Confidence interval of the biomass indices for all sizes (Tot. Biomass) and for specimens larger than 90 cm (Biomass >90 cm) and 110 cm (Biomass >110 cm) along with abundance of black scabbard fish smaller than 80 cm (Abundance <80 cm) from the 2015 Icelandic Autumn survey.



10.2.11. bsf.27.nea Northern component. Annual spatial distribution of commercial catch rates (kg/hour) derived from commercial trawl fishery in Division 5.b. (Note: only hauls with more than 30% black scabbardfish of the total catch are considered).

10.2.6 Reference points

The admitted linkage between the northern and southern components of the bsf.nea stock determines that the stock be considered as whole in the NE Atlantic considered when giving management advice for either fishery component. Given the presumed sequential nature of the exploitation pattern it was further agreed that the management should take into consideration trends occurring in the separate areas. As a result a harvest control rule was adopted in WKDEEP 2014 so that the catches in two components are updated based on recent trends of total abundance in each component. According to this the adopted rule simply specifies that catch advice should only increase when the abundance trends for the two components are increasing. If either is stable or decreasing, the advised catch for each of the two components should be adjusted according to the rate of change in the one showing the decrease.

Simulations of the temporal evolution of the population at the northern (here referred as BI) and southern (here referred as P) components under same “Recruitment” (i.e. entrance of new individuals in C2 at BI) level and the current TAC indicated that the actual fishing level appears not to be detrimental for each of the two components (Figures 10.2.12. and 10.2.3).

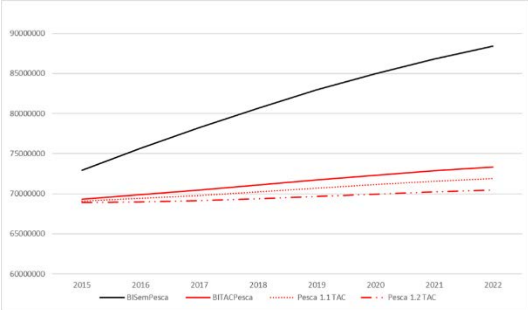


Figure10.2.12. bsf.27.nea. Simulated abundances in BI without fishing (black line) and with fishing at three different TAC Current (red line); 1.1 TAC (red dotted line); 1.2 TAC (red dashed line).

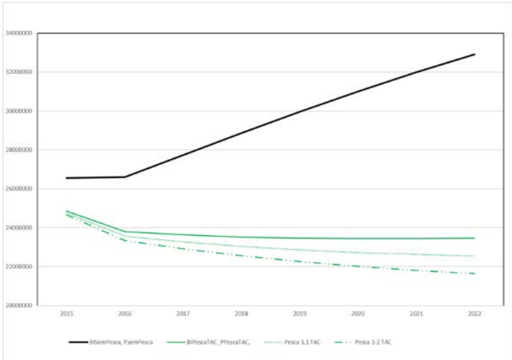


Figure10.2.13. bsf.27.nea. Simulated abundances in P without fishing (black line) and with fishing at three different TAC Current (red line); 1.1 TAC (red dotted line); 1.2 TAC (red dashed line).

However, if the "Recruitment" is maintained at the current level and the TAC is slightly increased both in BI and in P, the increasing trend of the abundance in BI maintained in BI but abundance in P shows a negative trend, even if fishing does not take place in P (Figures 10.2.12. and 10.2.3). Further work on F_{MSY} and B_{MSY} proxies will done for the next WGDEEP meeting.

Meanwhile exploratory analysis on ICES MSY proxies was undertaken during the meeting.

LBI method

Input data

- Only the 2016 length data were considered.
- The length–frequency distributions (5 cm interval) used were:
    - French on-board observed data – case northern;
    - Portuguese 9.a longline fishery – case southern;
    - Madeira (CECAF) longline fishery – case CECAF;
    - Weighted (weights are in relation to the total landings) length–frequency distribution using 1, 2 and 3 – case WHOLE WEIGHTED.

Results

The results obtained for each case considered are presented below

Year	2016
Lmat	103
Lopt	106
Linf	159

Component	L75	L25	Lmed	L90	L95	Lmean	Lc	LFeM	Lmaxy	Lmax5
Northern	99,50	91,50	95,50	102,50	103,50	98,31	92,50	109,13	100,50	106,27
Southern	110,50	101,50	106,50	115,50	118,50	109,42	102,50	116,63	107,50	121,17
CECAF	122,50	113,50	117,50	127,50	130,50	120,29	112,50	124,13	119,50	135,91
WEIGHTED WHOLE	108,50	94,50	100,50	117,50	121,50	104,77	92,50	109,13	100,50	126,55

Component	Lmean_LFeM	Lc_Lmat	L25_Lmat	Lmean_Lmat	Lmean_Lopt	L95_Linf	Lmaxy_Lopt	Lmax5_Linf	Pmega	Pmegaref
Northern	0,90	0,90	0,89	0,95	0,93	0,65	0,95	0,67	0,00	0,30
Southern	0,94	1,00	0,99	1,06	1,03	0,75	1,01	0,76	0,07	0,30
CECAF	0,97	1,09	1,10	1,17	1,13	0,82	1,13	0,85	0,53	0,30
WEIGHTED WHOLE	0,96	0,90	0,92	1,02	0,99	0,76	0,95	0,80	0,10	0,30

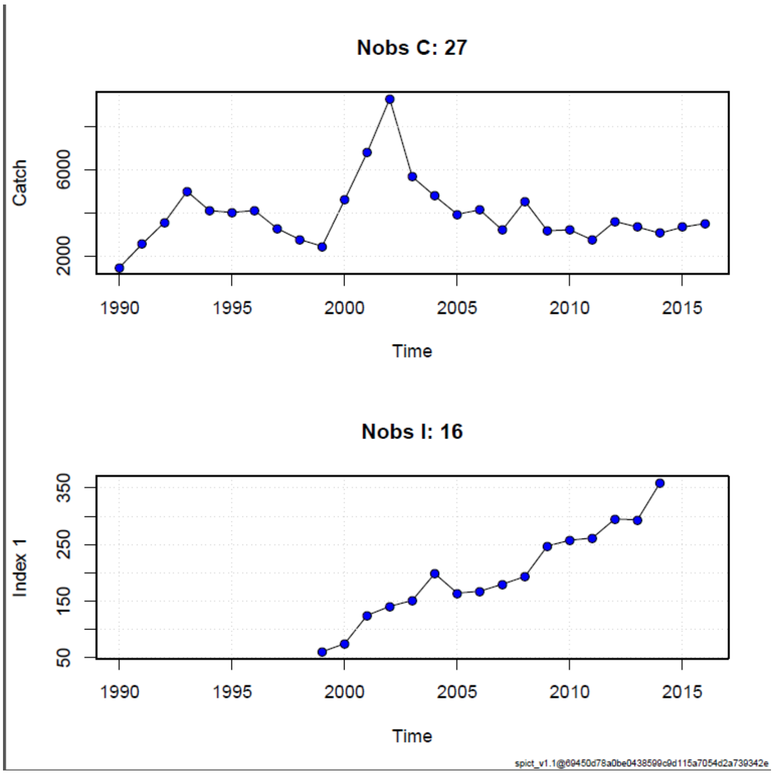
These results appear to be consistent with the demographic spatial structure of the population. These results also put into evidence the inability of the approach to cope such spatial demographic structure.

Stochastic Surplus Production in Continuous Time (SPiCT)

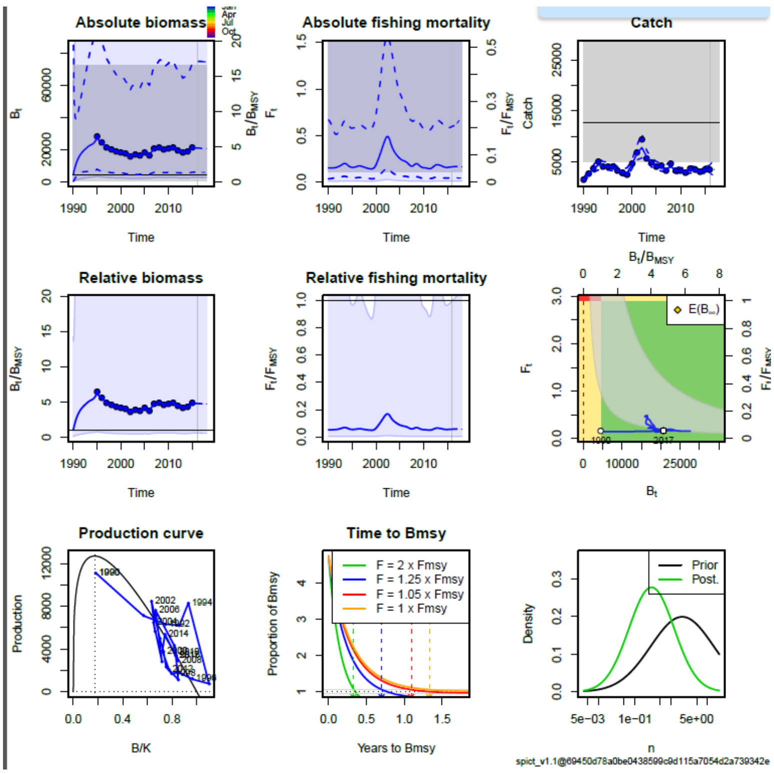
Case 1

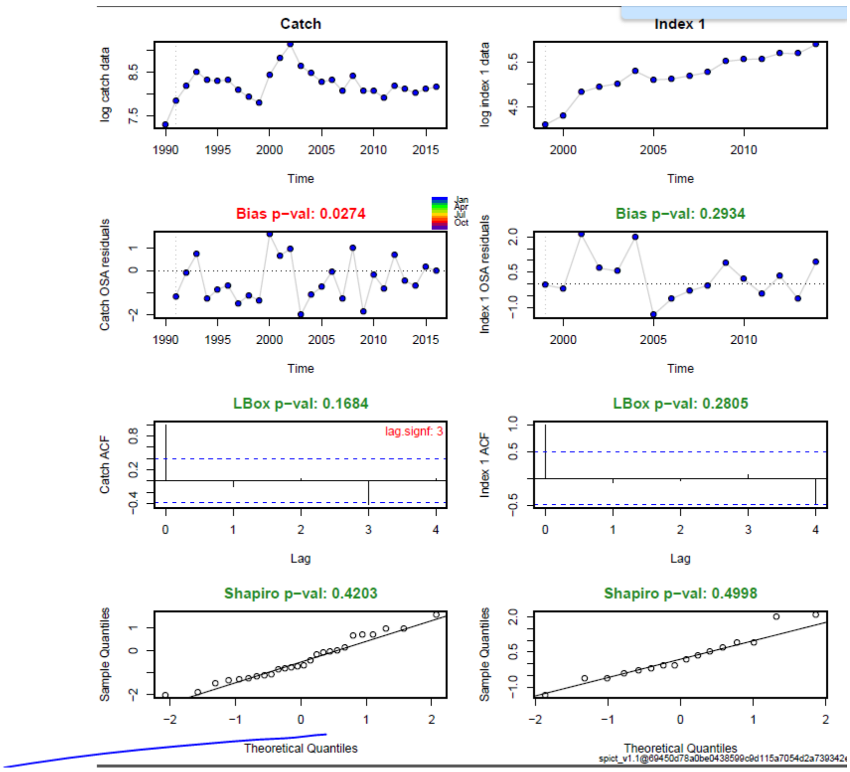
Input data

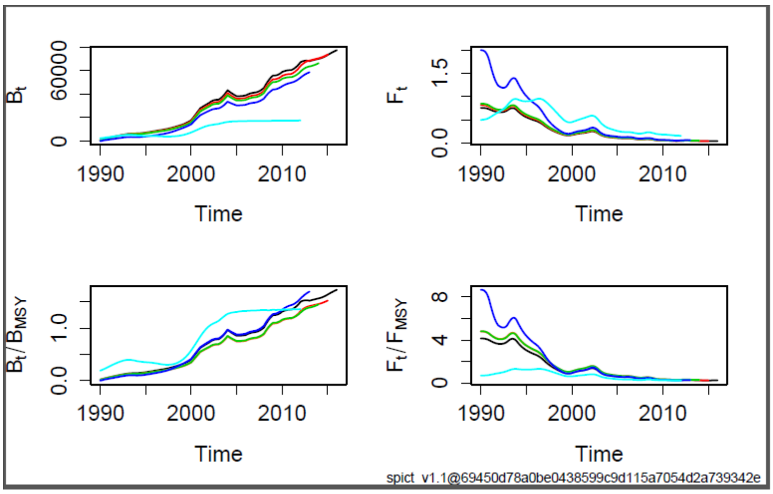
- Total catches in ICES area;
- Cpue indices from French trawler.

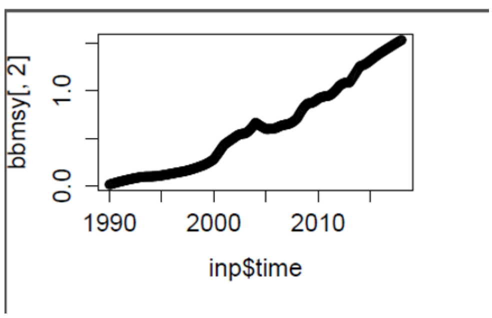

Nobs C: 27
Catch
Time
Nobs I: 16
Index 1
Time
spict_v1.1@69450d78a0be0438599c9d115a7054d2a739342e

Results


Absolute biomass
Absolute fishing mortality
Catch
Relative biomass
Relative fishing mortality
Production curve
Time to Bmsy
F = 2 x Fmsy
F = 1.25 x Fmsy
F = 1.05 x Fmsy
F = 1 x Fmsy
Prior
Post.
Time
B/K
Years to Bmsy
Proportion of Bmsy
Production
Density
spict_v1.1@69450d78a0be0438599c9d115a7054d2a739342e



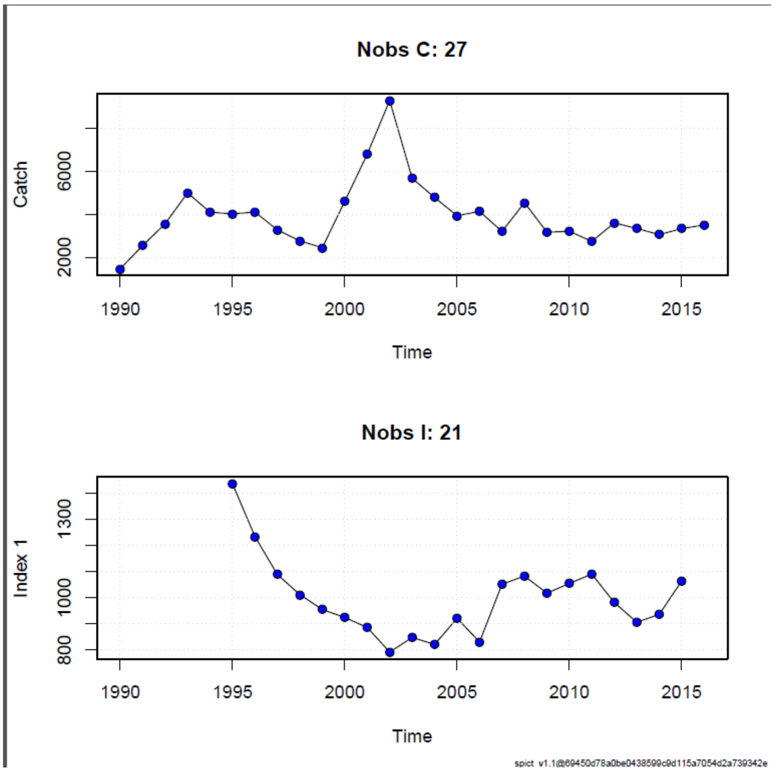




Case 2

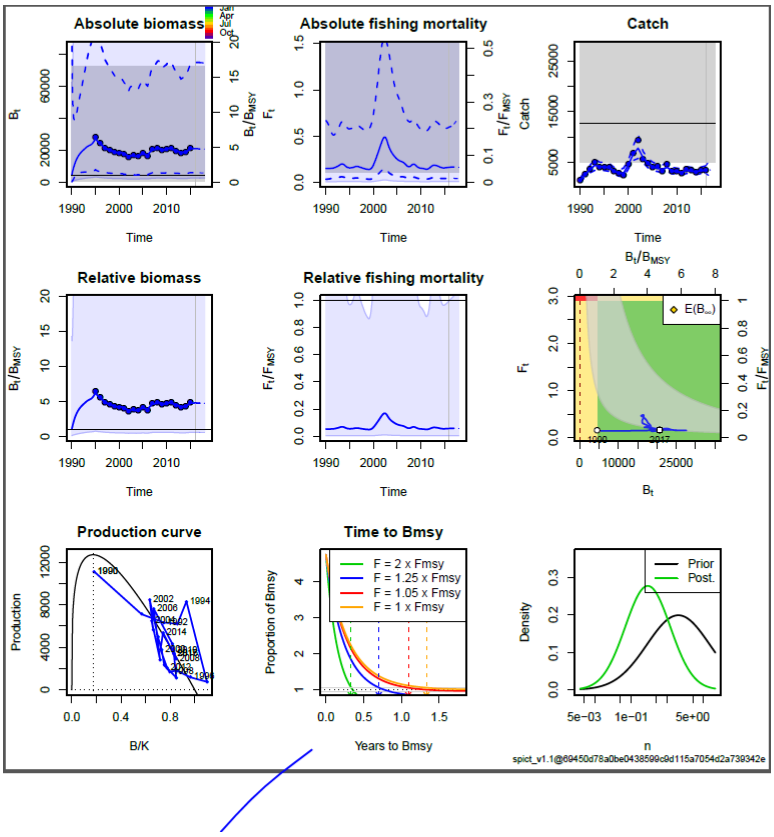
Input data

- Total catches in ICES area;
- Cpue indices from Portuguese longliner.

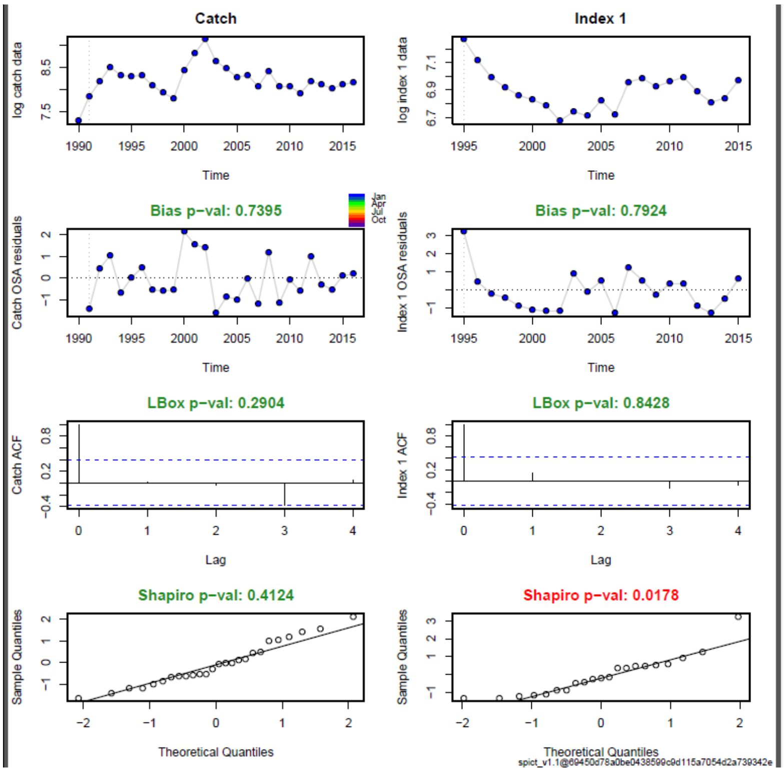


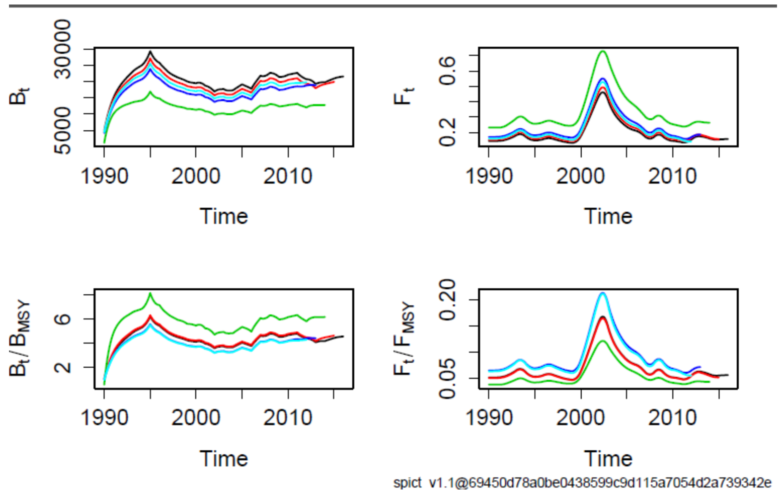
Nobs C: 27
Catch
Time
Nobs I: 21
Index 1
Time
spict_v1.1@69450d78a0be0438599c9d115a7054d2a739342e

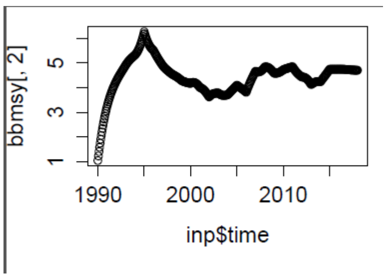
Results



Absolute biomass
Absolute fishing mortality
Catch
Relative biomass
Relative fishing mortality
Production curve
Time to Bmsy
F = 2 x Fmsy
F = 1.25 x Fmsy
F = 1.05 x Fmsy
F = 1 x Fmsy
Prior
Post.
Years to Bmsy
B/K
Production
Proportion of Bmsy
Density
spict_v1.1@69450d78a0be0438599c9d115a7054d2a739342e







Conclusion

The model converged in the two cases. Excluding the residuals plot of index in Case 2, the remaining diagnostic plots did not show any major flaws. Apart from this, it is considered that results should be considered with caution as the underlying assumptions of the production model are considered not to be met. The southern and northern components cannot be globally considered a closed population. In fact, under the information available no spawners are known to occur in ICES area.

The spatial demographic structure of the stock is not taken into consideration and this can be very important aspect as different fisheries are operating. As SpiCT does not include stock demographic data such can be considered a major constrain for its future application on bsfnea stock.

10.2.7 Management considerations

Available information do not unequivocally support the assumption of a single stock for the whole NE Atlantic area, however most available evidences do support it. In face of these evidences catches from ICES Division 5.a were included in the northern component in the assessment of the stock.

Management advice is given based on the harvest control rule adopted at the 2014 WKDEEP for the northern and southern components.

The CECAF area where spawning is known to occur is not considered as information available is insufficient to be accommodated into the assessment model of the stock.

10.2.7.1 CECAF

In 2015 STECF provided an exploratory assessment of the status of the species around Madeira (STECF-14–15). It was mentioned that for the period 2000–2013, there was a general decline in fishing capacity and fishing effort. The number of vessels has also declined by 41% (34 to 20 vessels). Furthermore, in the second half of the last decade, some Madeiran vessels targeting the black scabbardfish had moved to new fishing grounds, some of them located outside the EEZ of Madeira.

According to the STECF report the decline in fishing capacity has not resulted in a commensurate reduction in fishing effort, as the number of hooks deployed has only fallen by 14%. That is because of improvements on individual vessel efficiency that determined that the average number of hooks deployed per vessel increase from 470 000 in 2000 to 700 000 in 2013. Such reasoning does not, however, reflect the impact of spatial displacement of the fleet to new offshore areas outside Madeiran EEZ on the total fishing effort, as the total number of hooks is calculated by integrating the number of days at sea per trip in the calculus and those had also increased.

The previous WGDEEP analysis of Portuguese catches in area 34, Eastern Central Atlantic (CECAF), where Madeira fleet operates and recorded at the FAO global catch statistics (WGDEEP 2016) was updated. Information on Madeiran landings from 1990 to 2016 recorded at the Regional Fisheries Department of Madeira (DSI/DRP) database was used for updating. The annual landings of black scabbardfish derived from Madeiran longliners for the period 2000 and 2016 are presented in Figure 10.2.14. Annual landings have been decreasing since 2000, recent landings are below 2000 Ton. EU has set TACs for 2017 and 2018 for Union and international waters of CECAF 34.1.2 (BSF/C3412-) of 2488 and 2189 ton respectively.

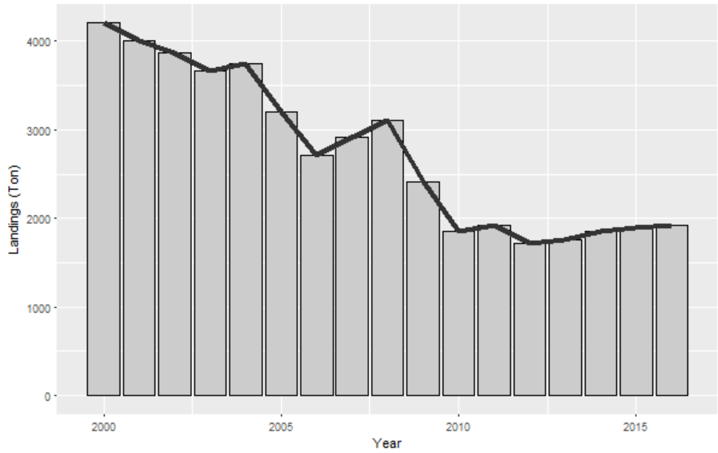


Figure10.2.14. bsf.27.nea Time-series of annual Portuguese landings at CECAF area.

Following the methodology used at WGDEEP 2016, standardized annual catch estimates for period from 1990 to 2016 of the eighteen resources (ordered in terms of total weight catch) and grouped into four groups (1. large pelagics; 2 elasmobranchs; 3 small pelagics and 4 demersals) were determined based on data extracted from DSI/DRP database.

The updated results support previous conclusions, namely that given the diversity of species under analysis (Figure 10.2.15), which includes different taxonomic groups (chondrichthyans and teleosts), lifestyles (benthic, demersal and pelagic) and both short- and long-lived organisms, to admit that declining trends are reflecting changes on resources abundance would imply that Madeiran waters are subject to severe overexploitation.

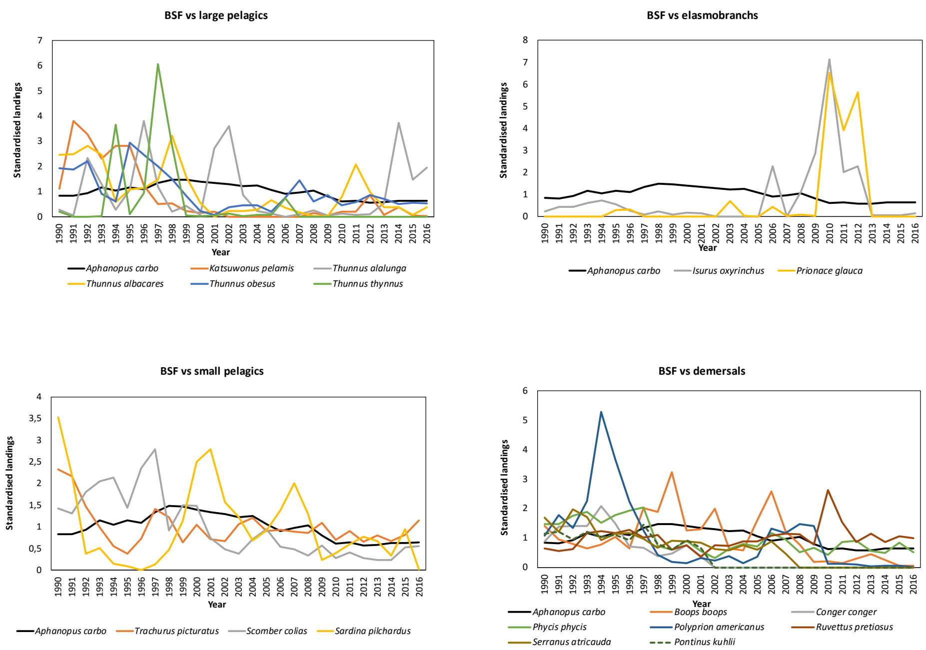


Figure 10.2.15 bsf.27.nea. CECAF area. Trends in standardised landings of black scabbardfish and the 18 other top ranked species in Madeiran landings.

Annual total length–frequency distributions of the exploited population caught by the Madeiran longline fleet in CECAF area for the period 2009–2016 are presented in Figure 10.2.16. The analysis of this figure indicates no changes on the length range between years neither on the mean length (Figure 10.2.16). The average estimates of the annual the total length mean were for the period were about 117 cm and did not vary between years.

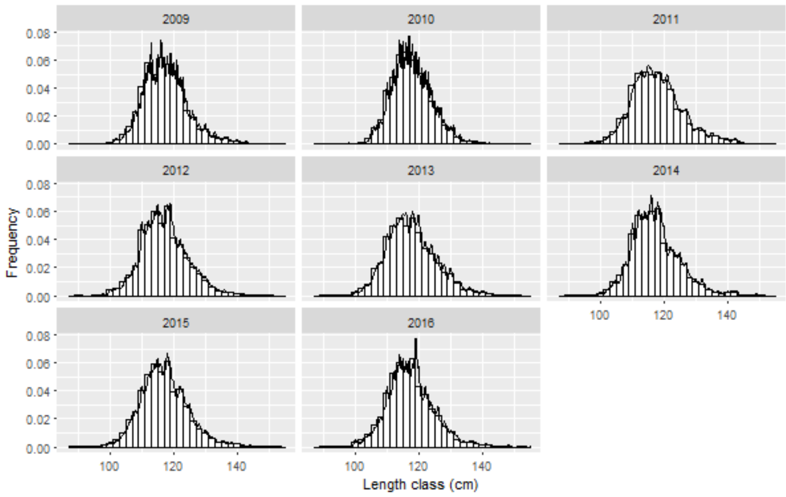


Figure 10.2.16. bsf.27.nea CECAF. Annual length–frequency distribution of specimens landed by the Portuguese longliners operating along CECAF area.

WGDEEP considers that temporal and spatial changes of Madeiran fishing activity should be further investigated. It is expected that this analysis will contribute to clarify the uncertainties regarding species abundance trend inside the Madeira EEZ and its relation with the ICES components.

Table 10.2.1a. Landings of black scabbard fish from Division 5.b. Working group estimates.

Year	Faroese Islands			France	Germany*		Scotland	E&W&NI	Russia	Total
	5.b.1	5.b.2	5.b	5.b	5.b.1	5.b				
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	84	43		115	-	-	-	-	-	**242**
2013	38	379	159	160						**735**
2014	400	181	143	0	0	0	0	0	1	**725**
2015	549	181	0	211			35			**976**
2016	142	509		52						**703**

Table 10.2.1b. Landings of black scabbard fish from Division 12. Working group estimates.

Year	France	Spain	Scotland	Russia(XIIc)**	Poland*	Faroes	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**
2014	-	149	-					**149**
2015	-	51	-			0		**51**
2016		82						**82**

***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								0
2013	1	-	-	-			.	1
2014							.	0
2015								
2016	0							0

* STATLAND data.

Table 10.2.1c. Landings of black scabbard fish from subarea 6. Working group estimates.

Year	France			Faroes		Germany*		Ireland	Scotland		Netherlands *			Lituania*	Estonia *	Poland*	Russia*	Spain	Spain	Unallocated	Total
	6	6.a	6.b	6.a	6.b	6.a	6.b	6.a	6.a	6.b	6.a	6.b	6	6.a	6.b	6.b	6.b	6.a	6.b		
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	-	-		-	-	-	-				**2533**
1998		1553	7			-	-		142	6	-	-		-	-	-	-				**1708**
1999	-	1610	8			-	-		133	58	11	-		-	-	-	-				**1820**
2000	-	2971	27			-	-		333	41	7	-		-	-	-	-				**3378**
2001	-	3791	29		3	-	-		486	145	-	-		3	225	-	226				**4908**
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				**3014**
2005	3	2533	59	38		-	-		18	62	-	-		5	11	-	11				**2741**
2006	-	1713	36	59		-	-	1	63	0	-	-		1	3	-	3				**1879**
2007	-	1991	4	44	37	-	-	0	53	0	-	-		-	-	-	-				**2129**

Year	France			Faroes		Germany*		Ireland	Scotland		Netherlands *			Lituania*	Estonia*	Poland*	Russia*	Spain	Spain	Unallocated	Total
	6	6.a	6.b	6.a	6.b	6.a	6.b	6.a	6.a	6.b	6.a	6.b	6	6.a	6.b	6.b	6.b	6.a	6.b		
2008	-	2348	0	37	0	.	.	0	26	0	14	.		-	.	.	1				**2427**
2009	15	1609	1	39	0	.	.	0	80	0	.	.		.	.	.	-				**1744**
2010	-	1778	1	72		.	.	0	73	0	.	.				.	-				**1923**
2011	5	1791	3	31		-	-		1	0	.	.					-				**1830**
2012	-	1509	0	3		-	-	.	34	0							-			690	**2236**
2013		1799	9	6	-			-	57	.										189	**2060**
2014	0	1902	0	4	2	0	0	-	110	.	3	0		0	0	0	0			0	**2021**
2015		1870		1					124		5							10	172		**2181**
2016		2336		64					96				1					9	163		**2670**

Table 10.2.1d. Landings of black scabbard fish from Division 7. Working group estimates.

Year	France								Ireland			Scotland	E&W&NI	Spain	
	7	7.a	7.b	7.c	7.d-g	7.h	7.j	7.k	7.b,j	7.c	7.k	7.b,c,j,e,k	7.j,k	7	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

Year	France								Ireland			Scotland	E&W&NI	Spain	
	7	7.a	7.b	7.c	7.d-g	7.h	7.j	7.k	7.b,j	7.c	7.k	7.b,c,j,e,k	7.j,k	7	Total
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	-	-	13	36	2	9	63	6	-	-	-	-	-	31	160
2013		0	21	86	1	12	67	1				-	-	9	196
2014		0	14	79	0	9	50	0				.	.		153
2015			26	39	1	3	48							1	118
2016			6	0	0	3	30	0				0		1	40

Table 10.2.1e. Landings of black scabbard fish from Division 6 and 7. 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**
2014	-	-	**0**
2015	-	-	**0**
2016			

10.3 Black scabbard fish in Subareas 8, 9

10.3.1 The fishery

The main fishery taking place in ICES Subareas 8 and 9 is derived from the Portuguese longliners operating in Division 9.a. This fishery was described in 2007 WGDEEP (Bordalo_Machado and Figueiredo, 2007 WD) and updated later by Bordalo_Machado and Figueiredo (2009).

The French bottom trawlers operating mainly in Subareas 6 and 7 have a small marginal fishing activity in Subarea 8. In 2014, 2015 and 2016 (16 ton in Subarea 8) Spain has also reported catches of black scabbardfish in Subareas 8 and 9 but they were low.

10.3.2 Landings trends

Landings in Subareas 8 and 9 are almost all from the Portuguese longline fishery that takes place in Subarea 9.a, representing more than 99% of the total landings (Figure 10.3.1).

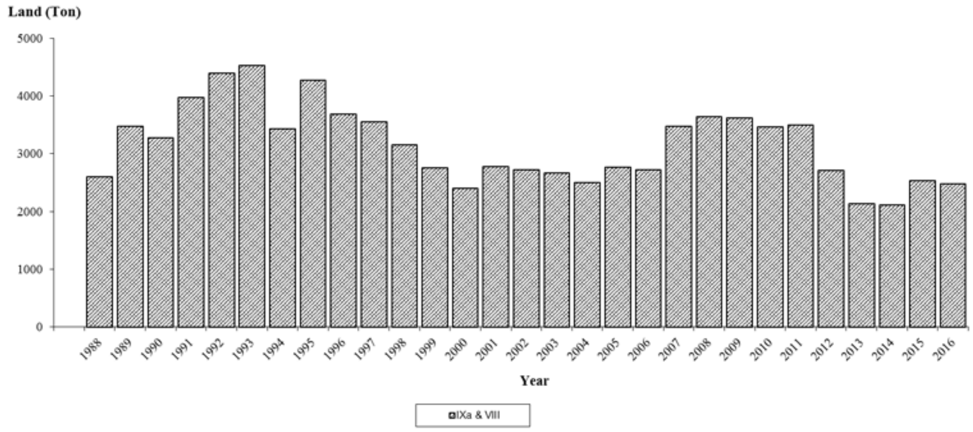


Figure 10.3.1. bsf.27.nea. Southern Component. Annual landings for ICES Subareas 8 and Division 9.a (2016 provisional data).

10.3.3 ICES Advice

The latest ICES advice was that when the precautionary approach is applied catches should be no more than 5894 ton in each of the years 2017 and 2018. Distributed by area this corresponds to annual catches of no more than 2726 ton in Subarea 8 and Division 9.a.

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 2015, as well as, the total landings in Subareas 8, 9 and 10 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	164
2012	3348	2726	462
2013	3700	2147	206
2014	3700	2128	30
2015	3700	2538	241
2016	3700	2479	86
2017*	3 330		

*** 2016 landing estimates are preliminary.**

**** the proportion of *A. intermedius* in the catches is considered high but it is not quantified.**

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) was provided. Discards of most species carried out by Portuguese vessels operating deep-water set longlines (targeting black scabbardfish) within the Portuguese ICES Division 9.a 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.

10.3.5.2 Length compositions

The 2016 annual length–frequency distribution of the black scabbardfish landed at Division 9.a by the Portuguese longline fleet with length data obtained under the DCF/EU landing sampling programme is presented in Figure 10.3.2.

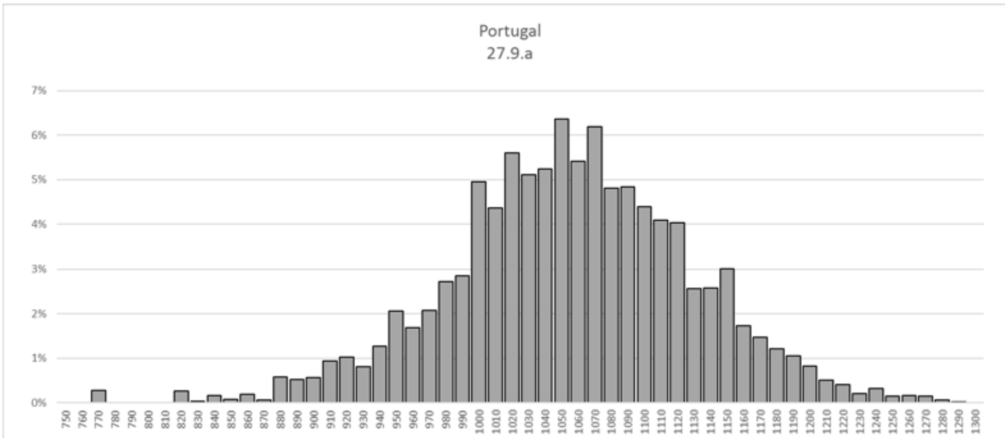


Figure 10.3.2. bsf.27.nea. Southern Component. 2016 length–frequency distribution of black scabbardfish exploited by the deep-water longline fishery.

The range and the mean length obtained for the 2016 length–frequency distribution were similar to those of previous years.

10.3.5.3 Age compositions

The assessment model adopted for bsf.nea stock is not structured by ages, only the age-growth parameters are used. The estimates of these parameters are included in 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 9.a 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.

10.3.5.6 Catch, effort and research vessel data

Standardized Portuguese cpue series covering the period 1998–2016 are presented Figure 10.3.3.

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.

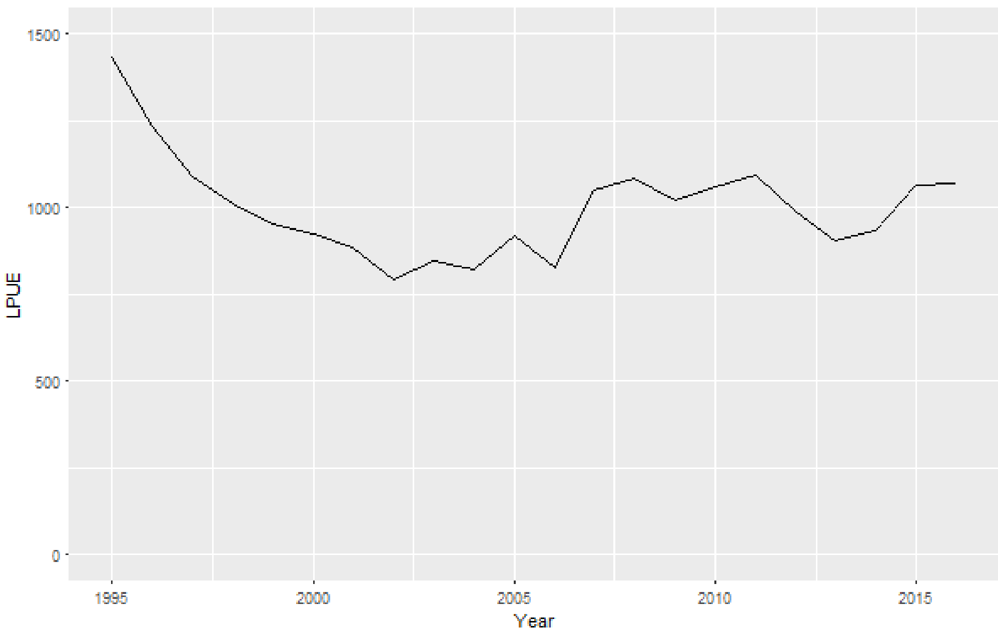


Figure 10.3.3. bsf.27.nea Southern Component. Standardized Portuguese cpue by year.

10.3.6 Data analyses

Data analyses are described in Section 10.1.5 as one single assessment is admitted for the stock, which combines data from the two fisheries areas in 5.b, 6, 7 and 12.b and 5.a on the one hand and 8 and 9 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 scabbard fish from Subarea 9; 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	-	12	**2680**
2013	2130	-	-	**2130**
2014	2109	-	-	**2109**
2015	2528		0	**2528**
2016	2456		0	**2456**

Table 10.3.1b. Black scabbard fish from Subarea 8; Working group estimates of landings.

YEAR	FRANCE						SPAIN	
	8	8.a	8.b	8.c	8.d	8.e		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	-	10	0	-	3	-	18	**32**
2013		5	0	0	2	-	3	**10**
2014		7	0	0	3	-	-	**9**
2015		5	0				0	**5**
2016		2	0		1		16	**19**

10.4 Black scabbard fish other areas (1, 2, 3.a, 4, 10, 5.a, 14)

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 Subareas 1,2,3 and 4. Such low levels may just indicate that the species has a low occurrence in those areas. On the contrary, landings from other areas, particularly in Subarea 10, suggests that the level of abundance of species is significant.

In recent years, fishing activity on black scabbardfish in Division 5.a has been regular, with landings rounding about 300 ton *per* year. To guarantee the consistency of the underlying assumption of a unique stock in NE Atlantic and since there are no evidences against this assumption, WGDEEP 2016 agreed to include ICES Division 5.a in the northern component.

No further information is available on the Faroese exploratory trawl fishery that was taking place in the Mid-Atlantic Ridge area held in 2008.

10.4.2 Landings trends

In ICES Subarea 10 landings have been variable and low but in recent years landings have increased, reaching 464 ton in 2012.

Since 2010 Icelandic landings in ICES Subarea 5.a have significantly increased, been then stable around 300 t in recent years. The 111 ton landings reported in 2010 in ICES Division 14 is considered to be misreported.

10.4.3 ICES Advice

The latest ICES advice was that when the precautionary approach is applied catches should be no more than 5894 ton in each of the years 2017 and 2018. Distributed by area this corresponds to annual catches of no more than 366 ton in Subareas 1, 2, 4, and 10 and Divisions 3.a and 5.a.

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.

In 2010 and 2013 the TACs have been exceeded, particularly in 2010. More information is needed in order to track the situation.

YEAR	EU AND INTERNATIONAL WATERS OF 1, 2, 3 AND 4	EU LANDINGS
2007	15	2
2008	15	0
2009	12	5
2010	12	127
2011	12	1
2012	9	2
2013	9	51
2014	9	10
2015	9	2
2016*	9	

*** 2015 landing estimates are preliminary. TACs and landings for Subarea 10 are included in Table 10.3.4**

10.4.5 Data available

10.4.5.1 Landings and discards

Landings from Subareas 2,4,10 and 14 and Division 5.a.are given in Tables 10.4.1a–e and in Figure 10.4.1. In Subareas 2, 4 and 14 reported landings are considered to be misreported although the extent of this is unknown.

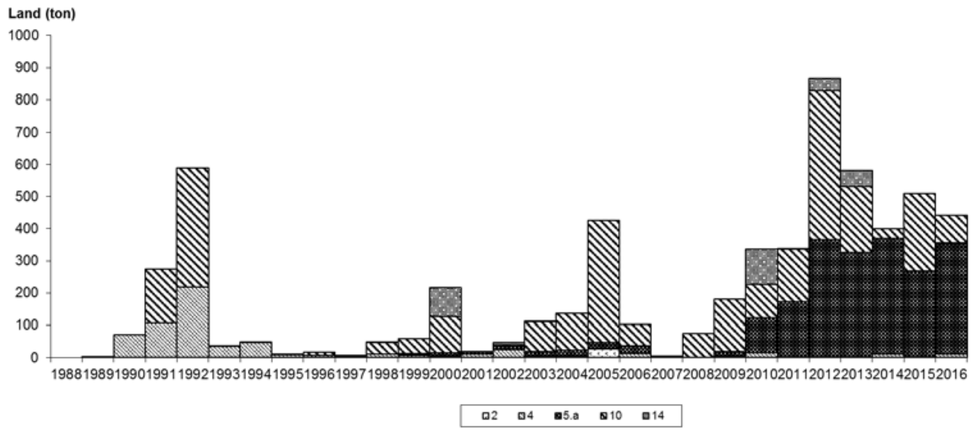


Figure 10.4.1. Annual landings for black scabbardfish by ICES Subareas 2, 4, 5.a, 10 and 14.

10.4.5.2 Length compositions

No new information was provided.

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.

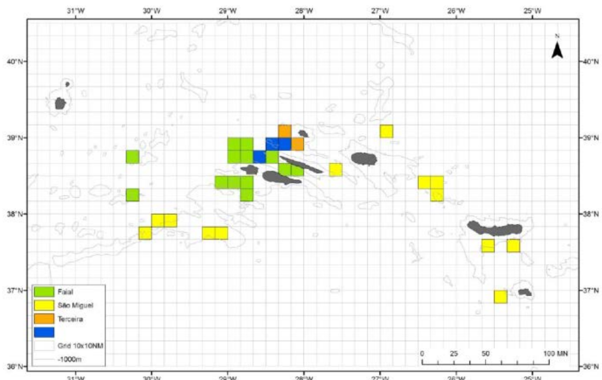
10.4.5.6 Catch, effort and research vessel data

See Section 10.2.4.6 where the Icelandic (ICES Division 5.a) 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 scabbard fish smaller than 80 cm from the Icelandic Autumn survey were provided by Iceland.

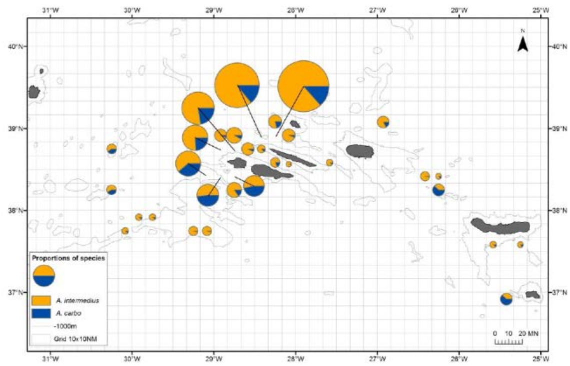
10.4.6 Data analyses

In Subarea 10, the commercial interest for the exploitation black scabbardfish has been increasing over time, but apart from the data presented for Faroese exploratory survey in 2008, the data available are only landings.

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 10.a, *A.carbo* and *A. intermedius* (Besugo *et al.*, 2014 WD). Spatial estimates of the proportion of co-occurrence of the two species are presented in Figure 10.4.3, showing that the overall proportion of *A. intermedius* in relation to the overall catches of *Aphanopus* species is about 0.75. It is however important to remark that the proportion can vary accordingly to the sampling location.



(a)



(b)

Figure 10.4.3. bsf.27.nea. Other areas. Map of the sampling locations (a) and estimates of the proportion of each *A. carbo* and *A. intermedius* at different sampling points (b).

10.4.7 Comments on the assessment

Excluding ICES Division 5.a, and despite the variability on the overall landings along years, data available suggest that ICES Division 10 is area of major concentration of the species.

This spatial aspect is consistent with the current perception on the spatial distribution of the species at NE Atlantic. However the co-occurrence of two different species *A. carbo* and *A. intermedius* in ICES Area 10 (Besugo *et al*., 2014 WD) needs to be taken into consideration when providing advice for this stock.

10.4.8 Management considerations

The information available does 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 ICES Division 5.a data were included in the northern component.

The co-occurrence of two different species *A. carbo* and *A. intermedius* in ICES area 10 needs to, in the future, considered providing advice for this stock.

Table 10.4.1a. Black scabbard fish other Division2.a and 3.a. Working group estimates of landings.

Year	France	Faroes	France	Total
		27.2.a	**27.3.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**
2014	**-**	-		**0**
2015	**-**	-		**0**
2016			0	**0**

Table 10.4.1b. Black scabbard fish other Areas 4. Working group estimates of landings.

YEAR	FRANCE				SCOTLAND			GERMANY *	E&W&NI	TOTAL
	4	**4.a**	**4.b**	**4.c**	**4.a**	**4.b**	**4.c**	**4.a**	**4.a**	
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	0	-	-	-			**1**
2014		10	0	0	0	0	0	0	0	**10**
2015		2	0	0	0	0	0	0	0	**2**
2016		10			0	0	0			

Table 10.4.1c. Black scabbard fish other Areas 5.a. Working group estimates of landings.

YEAR	ICELAND	FAROES	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	325	0	**325**
2014	360	-	**360**
2015	265	0	**265**
2016	346		**346**

Table 10.4.1d. Black scabbard fish other Areas 10. 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**
2014	30	-	-		**30**
2015	234	7			**241**
2016	50	36			**86**

Table 10.4.1f. Black scabbard fish other Areas 14. Working group estimates of landings.

Year	Faroes	Spain	Unallocated	Total
	14.b			
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**
2014	0	0	0	**0**
2015	0	0	0	**0**
2016	0	0	0	**0**

10.4.9 References

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11 Greater forkbeard (*Phycis blennoides*) in all ecoregions

11.1 The fishery

Greater forkbeard is as a bycatch species in the traditional demersal longline and trawl mixed fisheries targeting species such as hake, megrim, monkfish, ling, and blue ling in Subareas 6, 7, 8 and 9.

Since 1988, 77% of landings have come from Subareas 6 and 7. 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 from the French and Spanish trawl and longline fleets in Subareas 8 and 9 (mainly from 8). In Subarea 9 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 9. Portuguese landings of *P. blennoides* present a marked seasonal pattern, being particularly higher between March and July. Reasons for this marked seasonality are unknown, but may be related to abundance variations of this species or to seasonality patterns in other fisheries where this species is taken as bycatch (Lagarto *et al*., 2016).

Minor quantities of *Phycis blennoides* are landed by Portugal in Subarea 10 and by Norwegian and in recent years Faroese vessels in Divisions 5.a and 5.b. 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 0.5% of total deep-water landings in the last five 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 1,2, 3 and 4 only Norwegian landings are significant reaching 454 t in 2016 in these combined subareas. 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 reported 315 t in Subareas 1 and 2 and 561 t in Subareas 3 and 4, since then the landings of this country have been significant but lower than in 2002.

Historically in 5.b the main landings come from France and Norway. However in 2011 and 2012 the landings reached the highest values because Faroes reported 310 t and 145 t respectively. After these years, combined landings in this subdivision dropped to low levels as before because the Faroese fleet did not report landings in 2013 and only 13 t were reported by all countries in 2016.

Traditionally the most important landings in the Northeast Atlantic are recorded in 6 and 7 from Spain, France, Norway, UK and Ireland. Historical landings decreased since the peak of 4967 t in 2000 and they are especially low in 2009 and 2010 due to the low landings reported by Spain in those years. In 2016 the international reported landings were 1265 t, mainly by Spain (641 t) and France (412 t).

The main landings from Subareas 8 and 9 come from Spanish fleets. The average landings in the last ten years is 292 t with a peak of 556 t in 2007. In 2010 landings were the lowest of the series mainly due to the reduction of landings reported by Spain.

In Subarea 10 landings come only from Portugal. After a peak to 136 t in 1994 and 91 t in 2000 the average of international landings in the last ten years is 12 t. In 2014 for first time France reported 0.2 t in this subarea, although since 1991 many countries were involved in the fishery in Subarea 12 only in the period from 2002 to 2009 Spain reported significant landings. From 2013 onwards no country reported landings in this subarea.

11.3 ICES Advice

For 2015 and 2016 ICES advised on "the basis of the data-limited stock approach that landings should be no more than 2628 tonnes".

11.4 Management

Biannual EU TACs for 2015 and 2016 and landings in 2015 and 2016 by ICES subarea are shown below. Landings in Subareas 1, 2, 3 and 4 include Norwegian landings while only EU TACs are shown, resulting in the landings exceeding the TAC. In sub-area landings in 5, 6, 7 and 10, 12 were lower than the EU TAC in this period, but in 8 and 9 were slightly above of the TAC in 2015.

PHYCIS BLENNOIDES	EU TAC	TOTAL INTERNATIONAL LANDINGS	
Subarea	**2015–2016**	**2015**	**2016**
1, 2, 3, 4	37	336	460
5, 6, 7	2434	1505	1278
8, 9	320	323	263
10, 12	65	10	10
Total	2856	2174	2012

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 and in Figure 11.1. Landings by fishing gear in 2015 are shown in the Table 11.1. The discards estimates in 2013, 2014, 2015 and 2016 accounted 36%, 34%, 49% and 25% of the total catches respectively (Table 11.2a). Length frequencies of commercial fleets available indicate that discards affected specially to individuals smaller than 17 cm of which the 100% were discarded in 2015. In 2016 the range of discarded greater forkbeard affected in high proportion also to individuals smaller than 36 cm (Figure 11.7).In 2016 the main reported discards come from Subarea 7 (44%), 6 (33%) and 4 (15%).

11.6.2 Length compositions

Figures 11.2, 11.3, 11.4, 11.5 and 11.6 present the length–frequency distributions of Spanish Groundfish Survey in the Porcupine bank, Northern Spanish Shelf bottom-trawl French IBTS and Portuguese Crustacean Surveys/*Nephrops* TV Surveys (PT-CTS (UWTV (FU 28–29) until 2016.

This year there is presented an estimation of the commercial length frequencies of the French, Spanish, Irish, Portuguese and Scottish fleets in 2015 and 2016 (Figure 11.7).

11.6.3 Age compositions

No new data available.

11.6.4 Weight–at–age

This year there is presented the accumulated mean weight-at-length of the international commercial landings and discards reported to InterCatch in 2016 (Figure 11.8).

11.6.5 Maturity and natural mortality

No new data available.

11.6.6 Catch, effort and research vessel data

In 2017 the following surveys covering the continental slope of Subareas, 3, 4, 6, 7, 8, and 9.a have been included in the analysis of biomass and abundance indices (Figure 11.8):

- Spanish Groundfish Survey in the Porcupine bank (SP-PorcGFS) in Divisions 7.c and 7.k. Biomass and abundance of greater forkbeard from 2001 to 2016 are presented in Figure 11.9.
- French EVHOE IBTS (FR-EVHOE) in Divisions 7.f,g,h,j; and 8.a,b,d). Data of abundance and biomass raised to the total subarea have been provided for a series from 1997 to 2016. (Figures 11.10).
- Irish Groundfish survey (IGFS) in Divisions 6.a South and 7.b. Abundance and biomass Indices (nº per hour and kg per hour) from the period 2005 to 2016. This survey provides abundance indices for the total catches and for individuals <32 cm by shelf and slope strata (Figure 11.11).
- Northern Spanish Shelf bottom-trawl survey (SP-NGFS) in Divisions 9.a and 8.c. Biomass and abundance (kg/30 min tow and No/30 min tow) of greater forkbeard in the Cantabrian Sea from 1990 to 2016 are presented in Figure 11.12.
- North Sea IBTS survey (NS-IBTS) in Divisions 4.abc, 3.a and 3.c. Abundance in number per hour from 1975 to 2015 is presented in Figure 11.13.
- Scottish Western Coast Groundfish IBTS survey (SWC-IBTS) in Divisions 5.b, 6.ab, 7.ab. Abundance in number per hour from 1986 to 2014 is presented in Figure 11.14. No new information is available since 2015.
- Scottish Deep-water trawler survey in Divisions 6.a. As the survey is biennial no new data are available for 2016 Figure 11.15.Portuguese crustacean surveys/*Nephrops* TV Survey (PT-CTS (UWTV (FU 28–29) in Division 9.a

South, Biomass in kg per hour from 1997 to 2016 is presented in Figure 11.16.

Series of Effort data (kWd) since 2014 of the Spanish, French, Swedish, UK (Scotland) and Irish fleets (OTB, LLS and GTR) have been provided by subarea (Table 11.3).

11.7 Data analyses

In the Porcupine bank in 2016 *Phycis blennoides* continued the downward trend after 2014 peak in biomass (Figure 11.8) that was partially due to the big "recruitment" marked in 2012 that can be followed in 2013 and 2014 (Figure 11.2). This last year, in 2017, the decrease was smoother, especially in abundance (from 31.14 ± 2.5 ind haul^{-1} in 2015 to 25.9 ± 2.5 ind haul^{-1} in 2016 and, in biomass, from 24.14 ± 2.2 kg haul^{-1} in 2015 to 14.07 ± 1.4 kg haul^{-1} in 2016). In the last survey, three modes can be clearly observed; the main mode is in 19 cm, and two others in 36–37 cm and 49–50 cm, whereas the time-series presents a well-marked mode about 30 cm and also another one much smaller about 15 cm (Figure 11.3). Geographically, the abundance has decreased in the northeast area and also in the central-south of the bank (Figure 11.17). The depth distribution was between 233 m and 748 m in 2016 for this species (Fernández-Zapico *et al.*, 2017).

The EVHOE IBTS survey in Divisions 7.f,g,h,j and 8.a,b,d indicates an increase in biomass since 1996, with peaks in 2004, 2007 and 2012 and a decrease since 2013. However landings have decreased from 2012 onwards since the most important peak in 2011. Similarly, the abundance shows no clear trend in the series, but has also peaks in 2002, 2007 and 2012. An important decrease was also observed since this year, with a slight peak in 2015. (Figure 11.10). The mean length has increased since the beginning of the series reaching the highest value in 2014 (Figure 11.5).

Iris GFS indicates an increase in the abundance and biomass from 2009 to 2012 and 2013 respectively. From these years onwards a decrease is shown to 2016 in both parameters although a slight peak in the abundance was recorded in 2015. (Figure 11.11).

In the Northern Spanish Shelf bottom-trawl survey (SP-NGFS) in Divisions 9.a and 8.c in 2016 the biomass of *Phycis blennoides* remained close to the values of the two previous years, 0.45 Kg·haul^{-1}, while the abundance decreased following the fluctuations (ups and downs) of recruitment over the last decade (11.12). In addition, 31% of the hauls with *P. blennoides* were found deeper than 500 m and made up nearly half of the biomass in 2016. It in these additional hauls it is interesting to see the large abundance in biomass of greater forkbeard, clearly related with the bloom of juveniles in 2013 that produced the peak of biomass in the additional hauls of the time-series covered in this study, clearly marking the movement of specimens to deeper grounds as they grow. In these additional hauls deeper than 500 m, in the last two years from 2014, the species also followed the decreasing trend found in the standard hauls.

In 2016, *P. blennoides* was caught between 128 m and 847 m and it was widespread in the sampling area although most of the biomass was found in the central area of the Cantabrian Sea (8.c) (Figure 11.18).

Regarding length distribution over the years, large individuals (>25 cm) and almost an absence of recruitment were found this last year (Figure 11.4). In the standard hauls the few specimens caught of *P. blennoides* ranged from 13 cm to 55 cm, with a mode in 30 cm, but in the additional hauls, signs of another mode around 46 cm and specimens of 67 cm was found (Ruiz-Pico *et al*., 2017).

The NS-IBTS recorded in 2012 (40.2 individuals/hour) the most important abundance years of the series although the trend shows a decrease since this year to 2016 (Figure 11.13).

No data for 2015 and 2016 have been updated in the DATRAS system for the SWC-IBTS. The trend series of abundance until 2014 is shown in the Figure 11.14.

The Scottish Deep-water trawler survey covers a core area of the continental slope of the Rockall Trough (6.a) from between 55 to 59°N long with the slope stratified by depth at 500, 1000, 1500 and 1800 m. Historical series of biomass index show a tooth saw profile since 1998, with a minimum of 5.9 kg/hour in 2009 to a maximum 14.8 kg/hour in 2013. Due to the survey is biennial no new data were available for 2016 (Figure 11.15)

In the Portuguese survey in 9.a south the series of biomass and abundance show a decrease trend since 1997 to 2004. After this, the abundance and biomass recorded the highest values in 2008 and 2010 respectively, and dropped to 2013 and increases again up to 2016. Values biomass are in the range of 0 kg/hour to 2.33 kg/hour (Figure 11.16). In the years 2008–2010, catch rates were relatively high in all geographical areas. Length data from specimens caught during held between 1997 and 2016 support that these years were of strong recruitment, particularly the year 2008 (Figure 11.6). The size range observed in the Portuguese continental coast, indicating that the species is able to complete the life cycle in this area. The standardized biomass index of *P. blennoides* are above the overall mean and show an increasing trend. A similar trend is observed for the juvenile component of the population, suggesting that the fishing pressure has not seriously impaired the recruitment (Lagarto *et al*., 2017).

WGDEEP reiterates its previous view that although the data provided by the surveys have increased the area covered in the ecoregion, neither the available surveys nor discard data cover yet the entire distributional stock, especially in Subareas 1 and 2.

11.7.1 Exploratory assessment

No analytical assessment was presented in WGDEEP 2017.

11.7.2 Comments on the assessment

No analytical assessment was presented in WGDEEP 2017.

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. After revision of these data in 2015 landings in 2013 increased from 1836 t to 2143 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.

In the areas Subareas 6, and 7 covered by the Porcupine and Irish IGFS surveys indices indicate a decrease in the abundance since 2012, and in biomass since 2013. The trend in Subarea 8 is not clear showing an increase in biomass and abundance in Divisions 8.abde until 2013 and a decrease in biomass from 2104 to 2016 although abundance recovers slightly in 2015. In Division 9.a south annual standardized biomass and abundance indexes suggest an increase of biomass and abundance since 2011. In Subareas 3 and 4 the abundance dropped strongly since the peak in 2012, although the index in the period 2013–2016 is however well above the long-term mean since 1976.

On the other hand, landings in all ecoregions remain stable in last six years between 2000–2600 t. 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 are high but very variable among years represented 51%, 55%, 93% and 34 of the annual landings from the period 2013–2016.

Due to the species is a bycatch and not all the countries involved in the fishery report data to InterCatch the discard cannot be quantified for the whole stock and are very variable from year to year. In the same sense, the commercial length frequencies are only partially available from some countries and areas and the historical series is short.

11.9 Application of MSY proxy reference points

A Stochastic Production Model in Continuous Time (SPiCT) was applied to The GFB stock using the historical series of landings since 1998 and the standardized biomass indicator (average) from six surveys: IGFS-WIBTS-Q4, EVHOE-WIBTS-Q4F, SpGFS-WIBTS-Q4, SpGFS-WIBTS-Q4, SDS, PT-CTS (UWTV (FU 28–29) from the period 2005–2016.

Residuals could not be calculated because estimation did not converge, so a new input was performed shortening the series of landings to the same period of the Index series (from 2005 to 2016), but again the estimation did not converge.

The inputs and results of the first attempt are shown in the Figures 11.19 and 11.20.

Table 11.0a. Greater forkbeard (*Phycis blennoides*) in the Northeast Atlantic. Working group estimates of landings.

YEAR	1+2	3+4	5B	6+7	8+9	10	12	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	199	169	1802	366	6	0	2641
2013	83	179	11	1588	275	8	0	2143
2014	97	214	24	1566	360	9	0	2269
2015	121	215	34	1471	323	10	0	2174
2016	187	273	13	1265	263	10	0	2012

Table 11.0b. Greater forkbeard (*Phycis blennoides*) in Subareas 1 and 2. Working group estimates of landings.

YEAR	NORWAY	FRANCE	RUSSIA	UK (SCOT)	GERMANY	UK (EWNI)	FAROE ISLANDS	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	0.4						98
2013	83	0.1		0				83
2014	96	0.4						97
2015	121							121
2016	187	0.3		0				187

Table 11.0c. Greater forkbeard (*Phycis blennoides*) in Subareas 3 and 4. Working group estimates of landings.

YEAR	FRANCE	NORWAY	UK (EWNI)	UK (SCOT)[1]	GERMANY	DENMARK	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	1	198					199
2013	1	178	0	0			179
2014	1	210		3			214
2015	1	213		1			215
2016	1	267		2		3	273

[1] Includes Moridae, in 2005 only data from January to June.

Table 11.0d. Greater forkbeard (*Phycis blennoides*) in Division 5b. Working group estimates of landings.

YEAR	FRANCE	NORWAY	UK(SCOT)[1]	UK(EWNI)	FAROE ISLANDS	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	7	7	169
2013	7	3	0				0	11
2014	7	14	0		0		2	24
2015	5	27					1.7	34
2016	7	3	0				2.8	13

[1] Includes Moridae in 2005 only data from January to June.

Table 11.0e. Greater forkbeard (*Phycis blennoides*) in Subareas 6 and 7. 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*	451	16	289	583	3.4	246		0		1588
2014	468	25	159	769	9	135				1566
2015	451	37	135	716	26	105				1471
2016	412	13	97	641	13	90				1265

(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 8 and 9. Working group estimates of landings.

YEAR	FRANCE	PORTUGAL	SPAIN(1)	UK(EWNI)	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	31	8	234	2		275
2014	38	6	315		0	360
2015	38	8	278			323
2016	30	7	226		0	263

(1) **Landings of *Phycis spp* Included from 1988 to 2012.**

Table 11.0g. Greater forkbeard (*Phycis blennoides*) in Subarea 10. Working group estimates of landings.

YEAR	PORTUGAL	FRANCE	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
2014	9	0	9
2015	10		10
2016	10		10

Table 11.0h. Greater forkbeard (*Phycis blennoides*) in Subarea 12. 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							
2014	0						0
2015							
2016							

(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 métier in 2016.**

LANDINGS (T)	2015
Denmark	
OTB_CRU	0
OTB_DEF	3
SSC_DEF	0
Ireland	
OTB_CRU_70-99_0_0_all	0
OTB_DEF_100-119_0_0_all	8
OTB_DEF_70-99_0_0_all	5
Portugal	
LLS_DEF_0_0_0	10
MIS_MIS_0_0_0	7
OTB	0
Spain	
GNS_DEF_>=100_0_0	4
GNS_DEF_120-219_0_0	0
GNS_DEF_60-79_0_0	1
GNS_DEF_80-99_0_0	4
GTR_DEF_60-79_0_0	2
LHM_DEF_0_0_0	2
LHM_DWS_0_0_0	0
LLS_DEF_0_0_0	620
MIS_MIS_0_0_0_HC	1
OTB_DEF_>=55_0_0	61
OTB_DEF_>=70_0_0	2
OTB_DEF_100-119_0_0	141
OTB_DEF_70-99_0_0	16
OTB_MCD_>=55_0_0	2
OTB_MPD_>=55_0_0	5
PTB_DEF_>=70_0_0	0
PTB_MPD_>=55_0_0	4
Sweden	
GTR_DEF_all_0_0_all	0
UK (England)	
GNS_DEF	0
LLS_DEF	1
MIS_MIS_0_0_0_HC	1
OTB_DEF	11

LANDINGS (T)	2015
UK(Scotland)	
LLS_DEF_0_0_0_all	36
MIS_MIS_0_0_0_HC	1
OTB_CRU_70-99_0_0_all	2
OTB_DEF_>=120_0_0_all	52
OTB_DEF_>=120_0_0_all_FDF	0
France	
GNS_DEF_>=100_0_0	13
LLS_DEF_0_0_0_all	46
MIS_MIS_0_0_0_HC	7
OTB_DEF_>=120_0_0_all	44
OTB_DEF_100-119_0_0	122
OTB_DEF_70-99_0_0	7
OTB_DWS_>=120_0_0_all	75
OTB_DWS_100-119_0_0_all	10
OTT_DEF_>=70_0_0	16
OTT_DEF_100-119_0_0_all	96
OTT-DEF	14

Table 11.2a. Reported discards (ton) of *P. blennoides* from 2013 to 2106.

TON	2013	2014	2015	2016
DISCARDS	1185	1166	2068	677
LANDINGS	2143	2269	2175	2012
CATCHES	3328	3435	4243	2689

Table 11.3. Effort (kWd) of *P. blennoides*, *P. Phycis* and *Phycis* spp by the Spanish, Swedish and Irish fleets from 2014 to 2106.

2014	2	3	4	5	6	7	8	9	12
Spain					500 409	534 570	4 676 906	1 330 671	
Sweden		6 908 723	1 666 360						
Ireland			1 019		754 232	9 955 488	619		1 756
2015									
Spain					544 731	6 497 141	15 584 384	12 579 168	
Sweden		6 252 366	2 103 825						
2016									
Spain					567188	4775689	14675183	6589323	
Sweden		881							
UK(Scotland)			11779125	36663		68448	221		
France	548084	213152	3863520	590412	6498055	45211426	46962821		

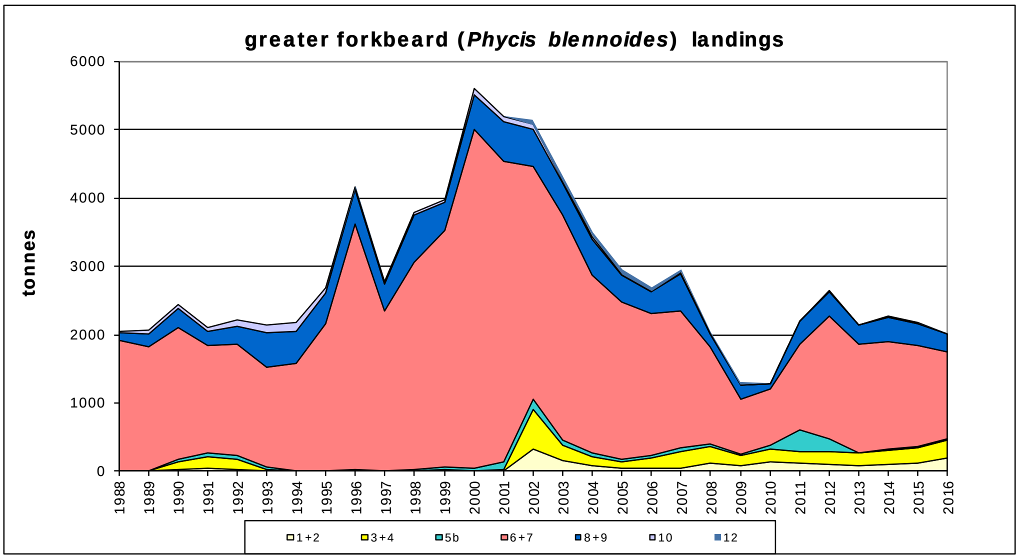


Figure 11.1. Greater forkbeard landing trends in all ICES subareas since 1988.

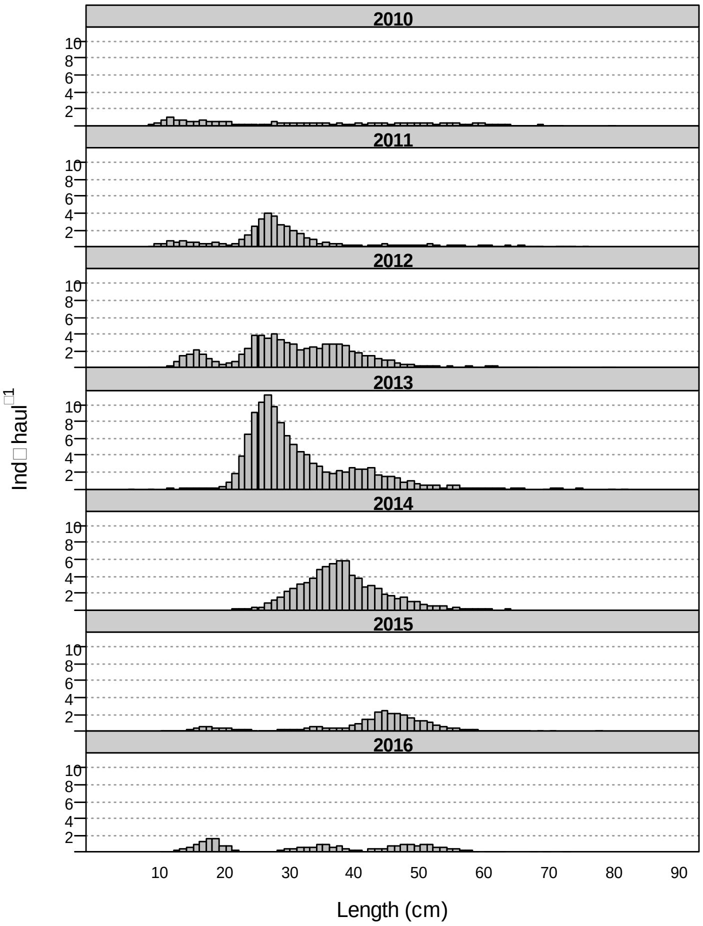


Figure 11.2. Mean stratified length distributions of greater forkbeard (*P. blennoides*) in Porcupine survey (Divisions 7.c and 7.k) time-series (2010–2016).

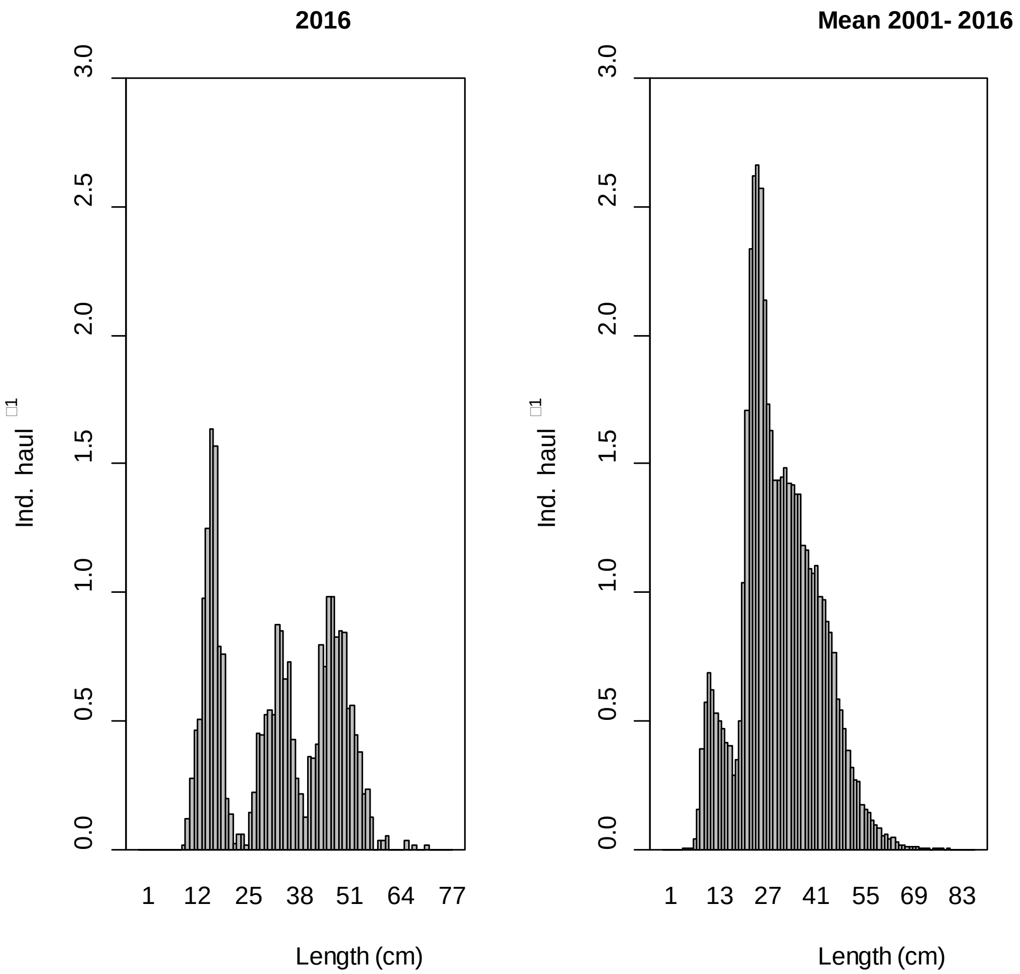


Figure 11.3. Stratified length distributions of *Phycis blennoides* in 2016 and mean values during Porcupine survey (Divisions 7.c and 7.k) time-series (2001–2016).

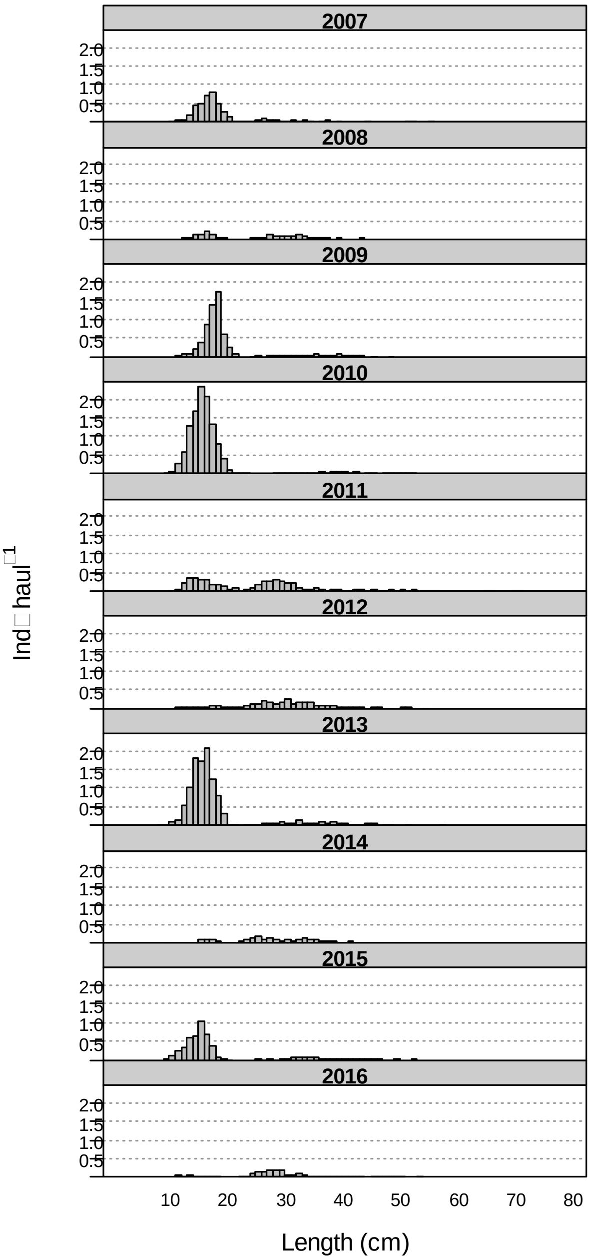


Figure 11. 4. Mean stratified length distributions of greater forkbeard (*P. blennoides*) in Northern Spanish Shelf survey (8.c and 9.a) in the period 2007–2016.

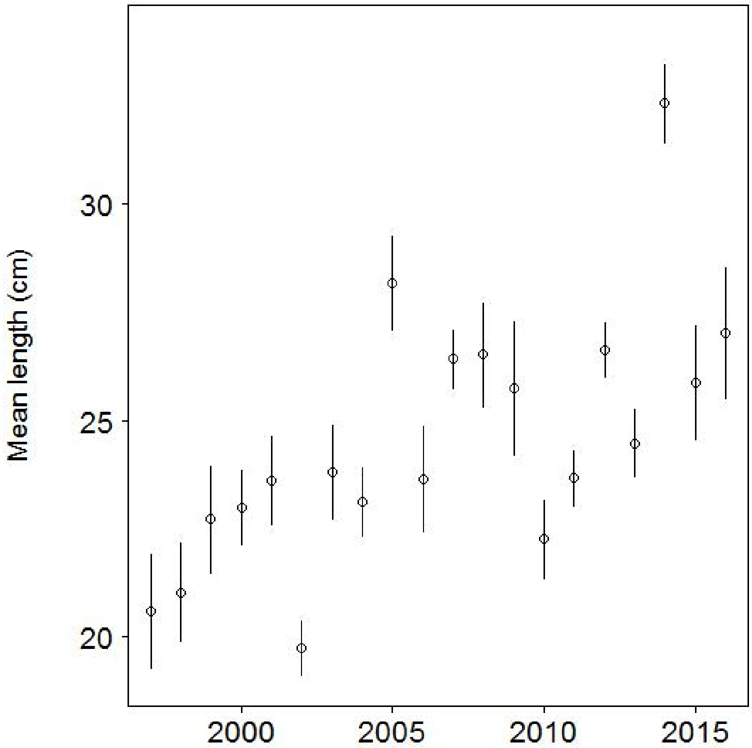


Figure 11. 5. Greater forkbeard series of mean length from the French IBTS survey Divisions 7.fghj and 8.abd until 2016.

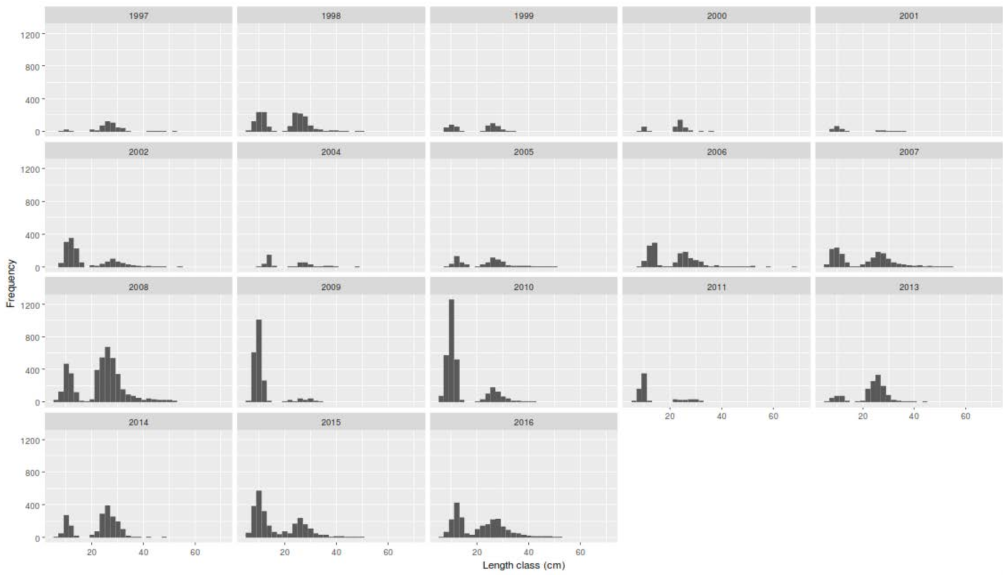
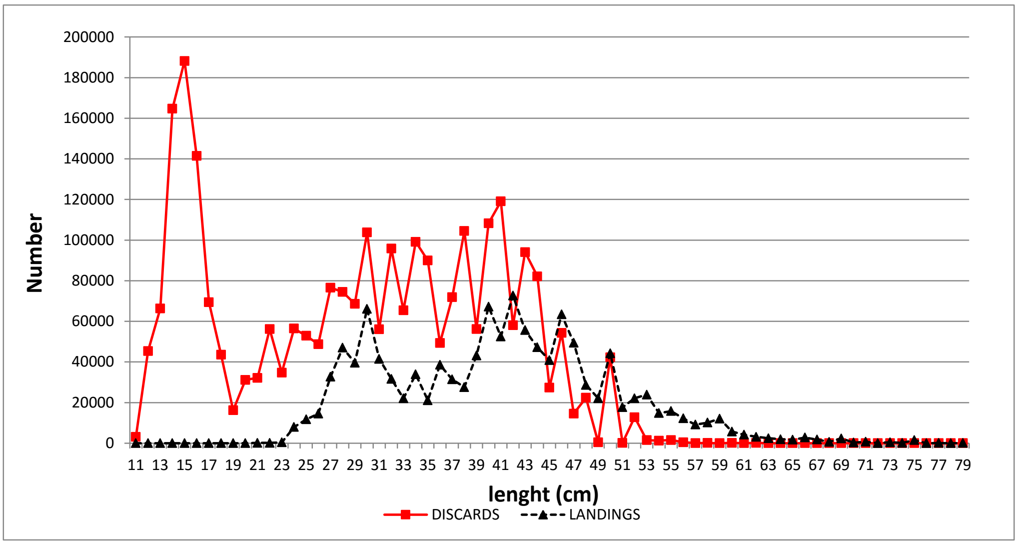


Figure 11.6. Length distribution by year of *P. blennoides* specimens caught during the Portuguese Crustacean Surveys/*Nephrops* TV Surveys (PT-CTS (UWTV (FU 28–29)) undertaken between 1997 and 2016 in Subdivision 9.a. No survey was conducted in 2012.



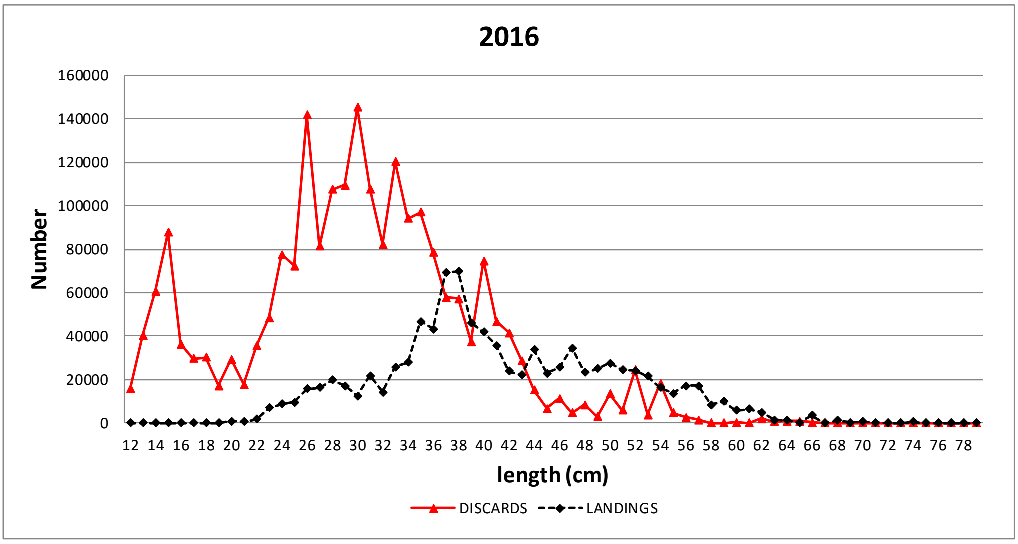


Figure 11.7. Commercial length frequencies of the greater forkbeard landings and discards in 2015 and 2016 from the France, Spain, Ireland, Portugal UK (England) and UK (Scotland).

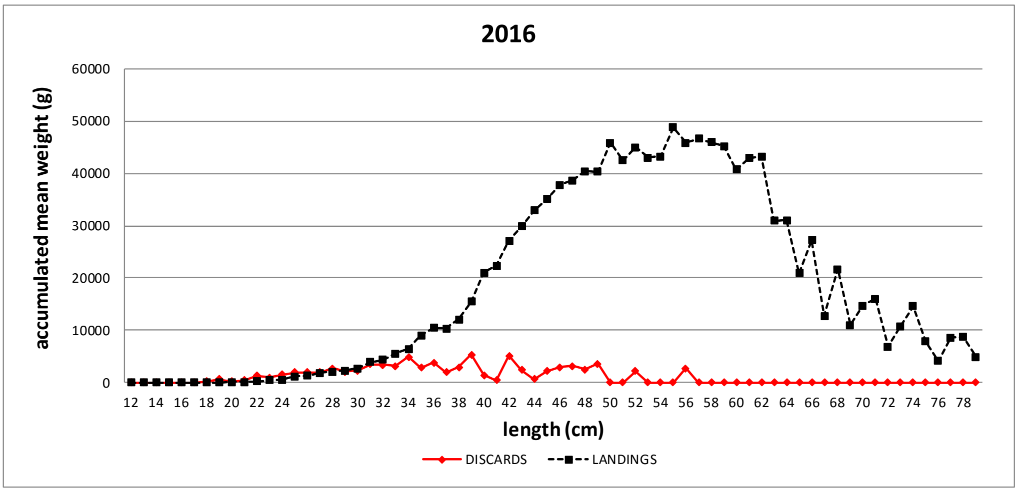


Figure 11.7. Accumulated mean weight-at-length of the international commercial landings and discards reported to InterCatch in 2016.

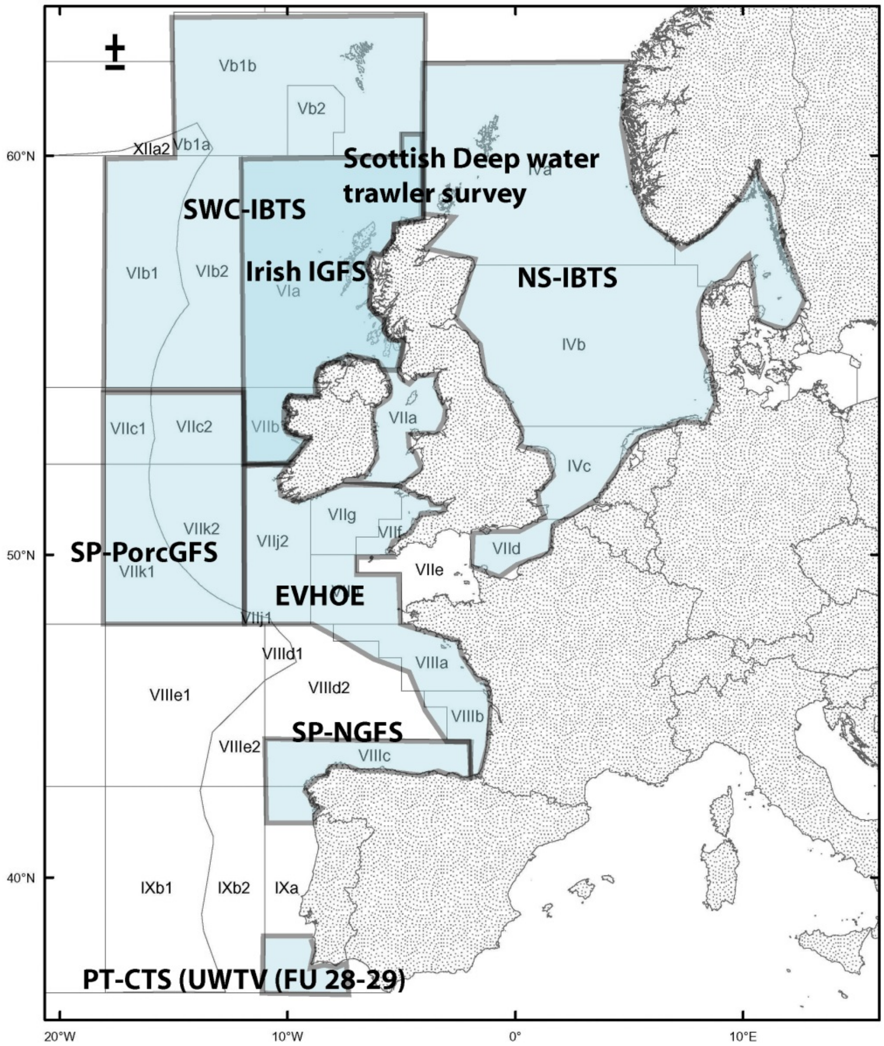


Figure 11.8. Map of the Divisions covered by the eight surveys used in the trend analysis of abundance and biomass of GFB.

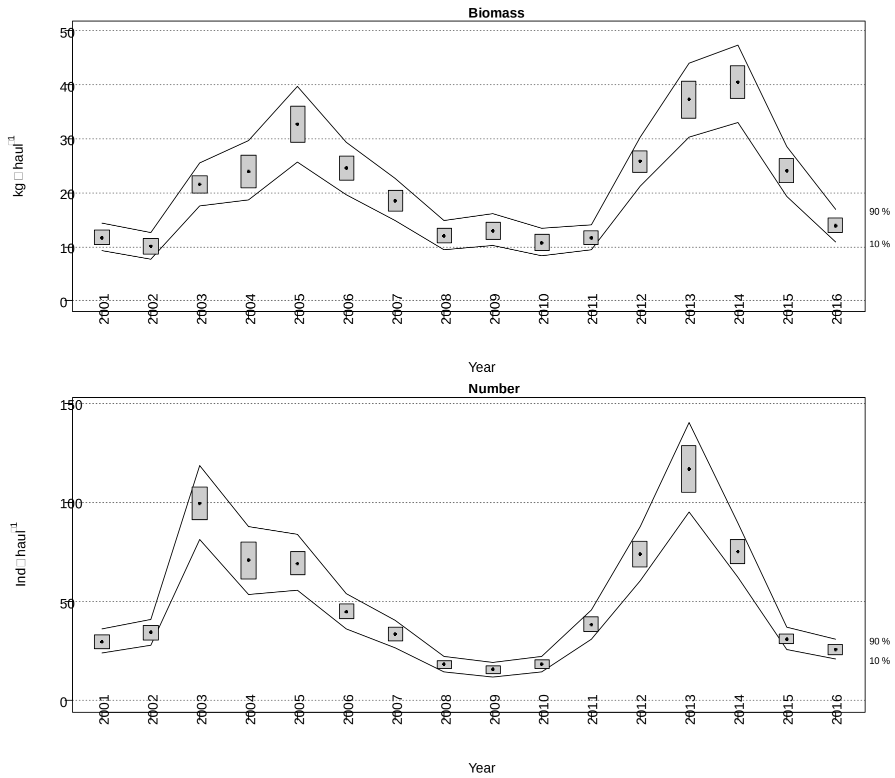


Figure 11.9. Evolution of *Phycis blennoides* biomass and abundance indices during Porcupine Survey time-series (2001–2016) in Divisions 7.c and 7.k. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (⊚ = 0.80, bootstrap iterations = 1000).

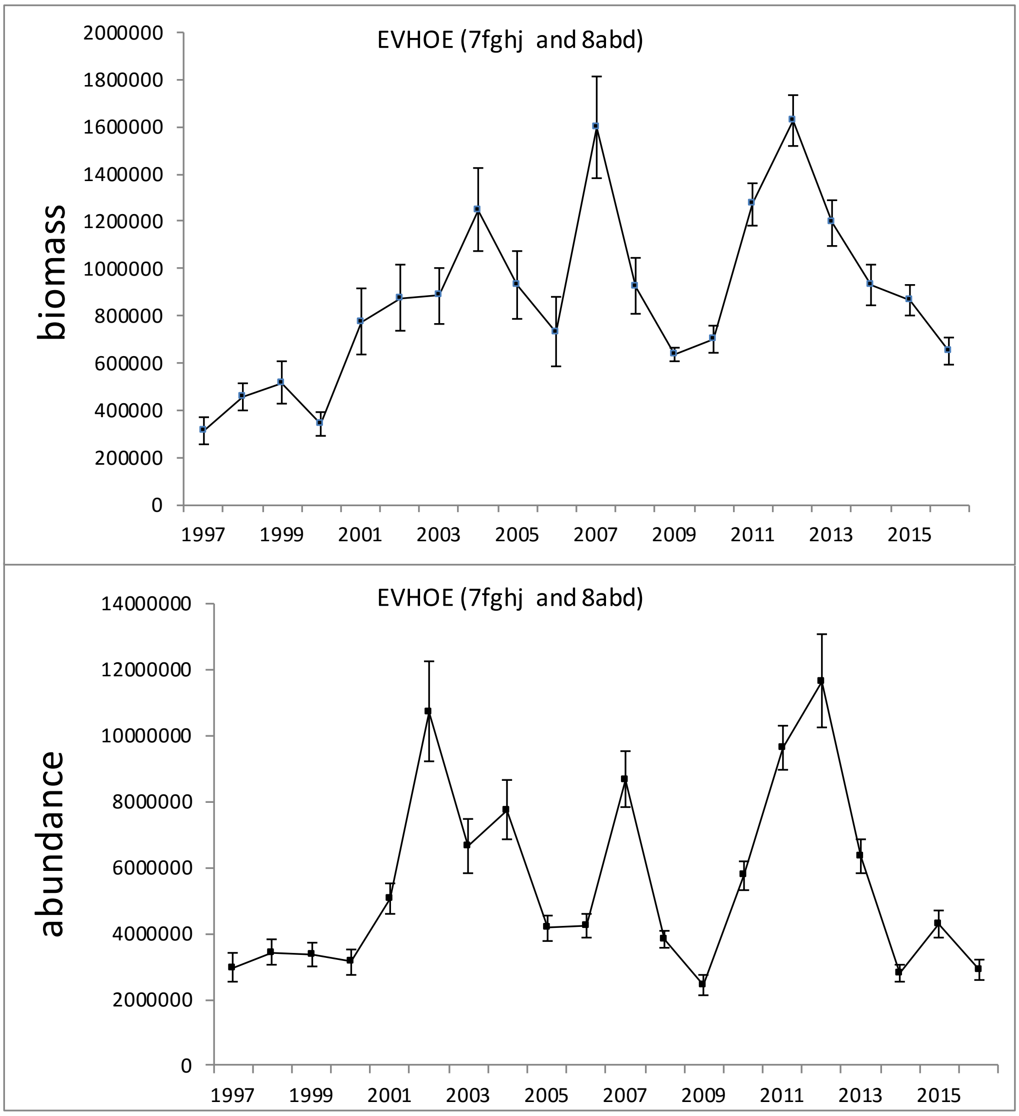


Figure 11.10. Greater forkbeard series of abundance and biomass of the French EVHOE IBTS survey in the Divisions 7.fghj and 8.abd combined until 2016.

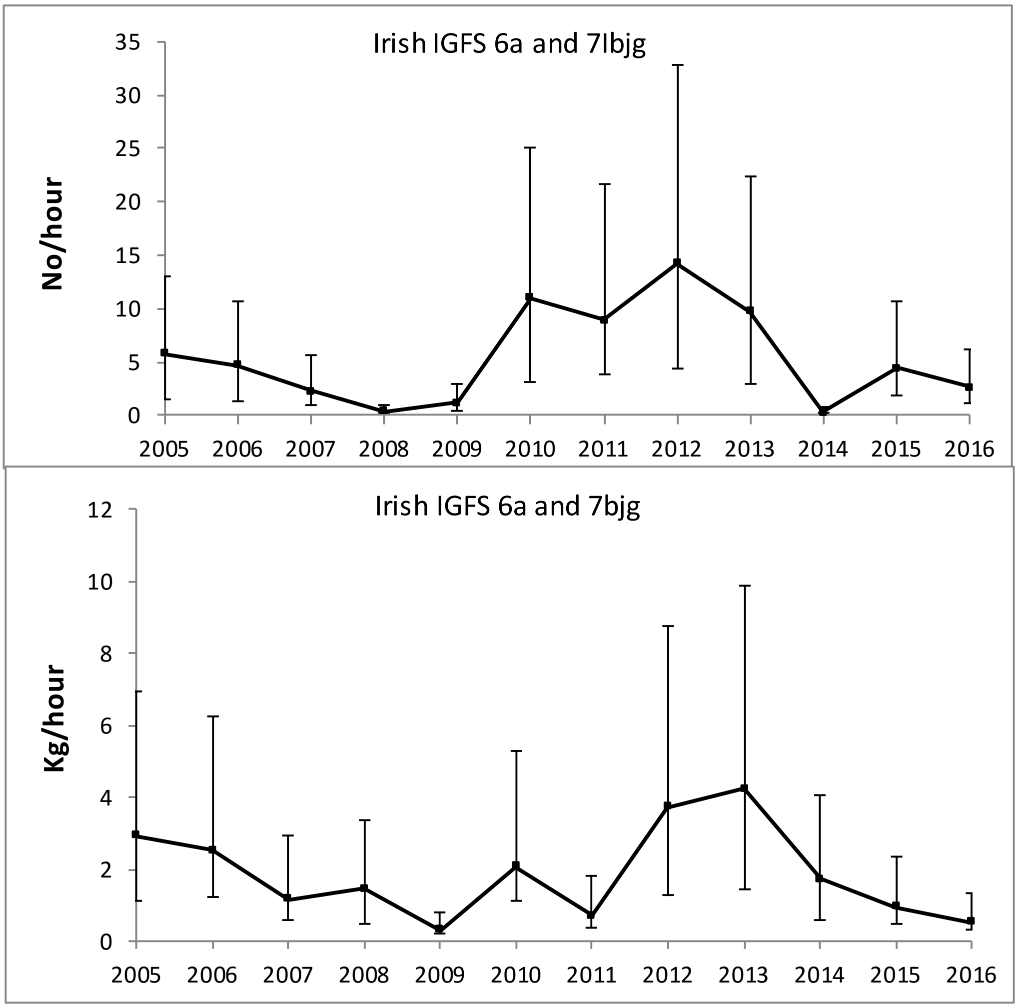


Figure 11.11. Abundance and biomass Indices (nº per hour and kg per hour) of Greater forkbeard total catches of the Irish IGFS Survey in the slope and shelf strata, from 2005 to 2016.

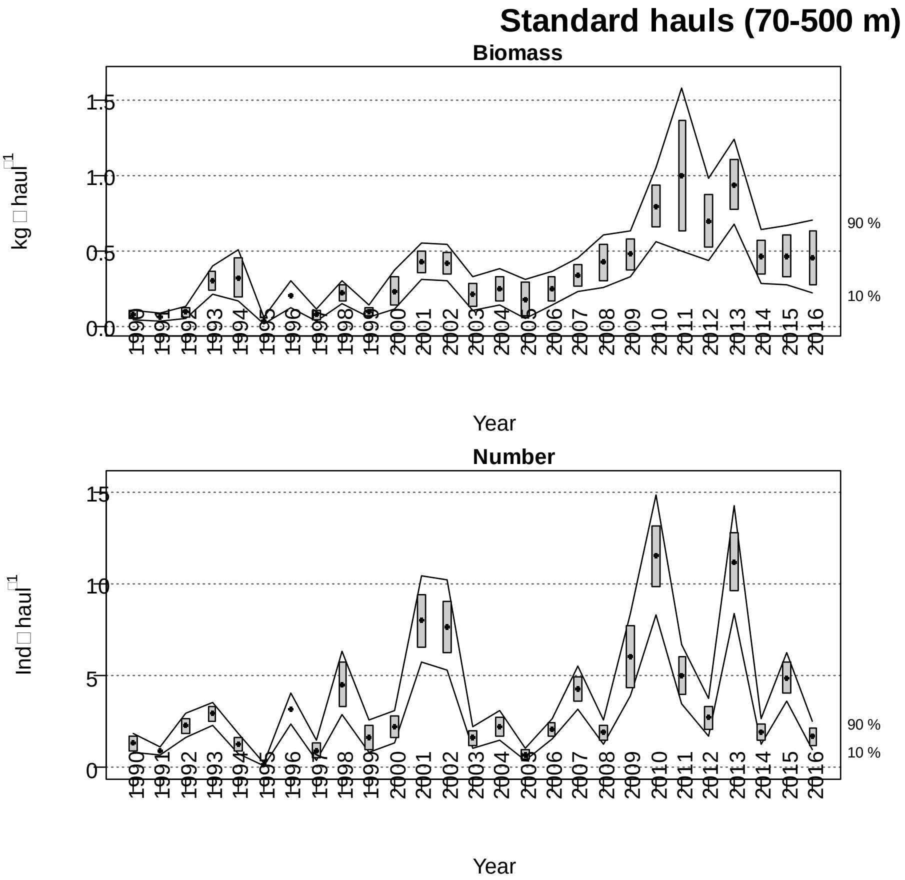


Figure 11.12. Changes in *Phycis blennoides* abundance index (kg/tow and No/tow) during northern Spanish Shelf bottom-trawl survey time-series (1990–2016) in Divisions 9.a and 8.c.

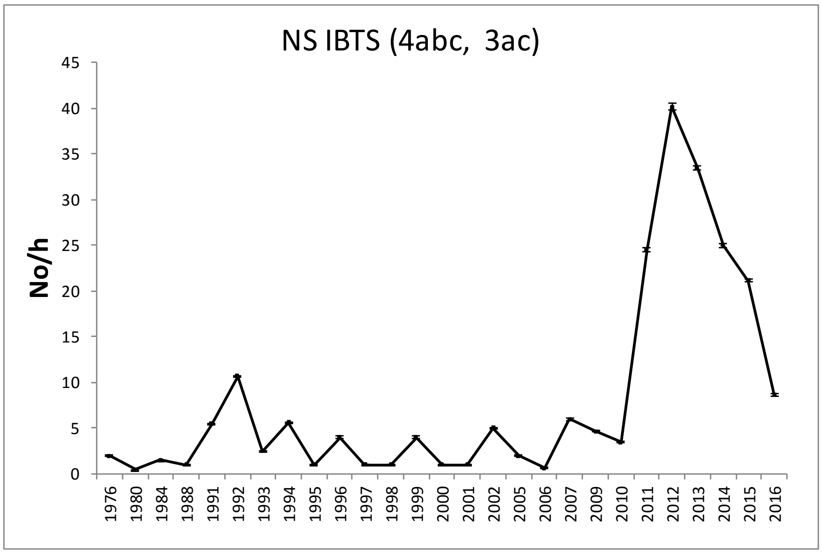


Figure 11.13. Greater forkbeard series of abundance (No/hour of the North Sea IBTS survey (NS-IBTS) until 2016 in Divisions 4.abc and 3.ac.

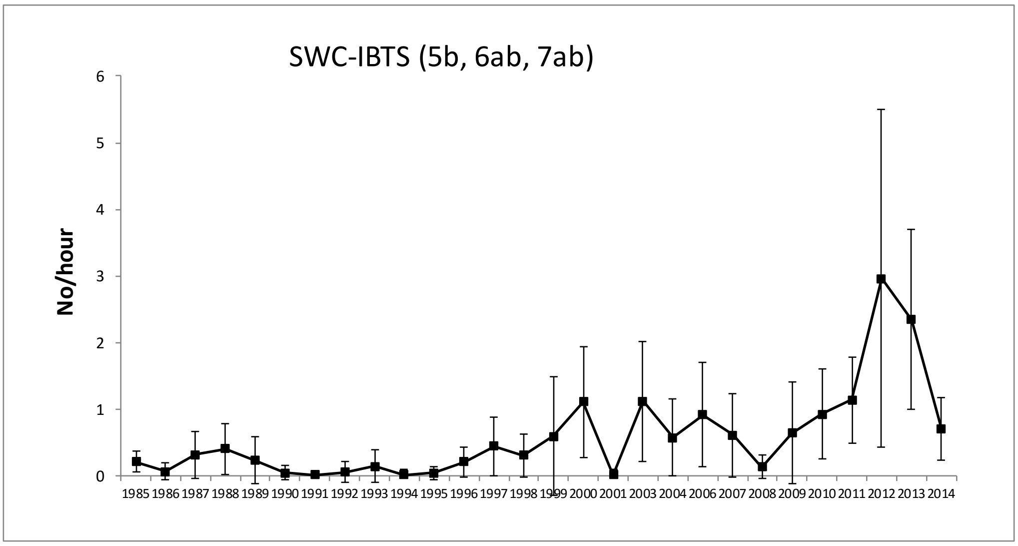


Figure 11.14. Greater forkbeard series of abundance (No/hour) of the Scottish Western Coast Groundfish IBTS survey (SWC-IBTS) until 2014 in Divisions 5.b, 6.ab and 7.ab.

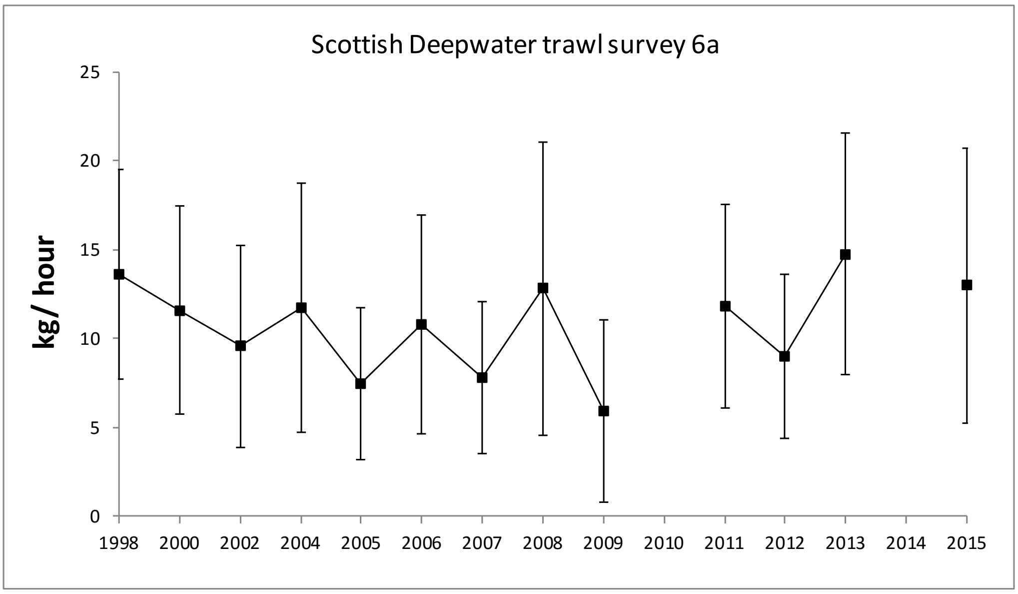


Figure 11.15. Greater forkbeard series of biomass (kg/hour) of the Scottish Deep-water trawl survey until 2015 in Division 6.a.

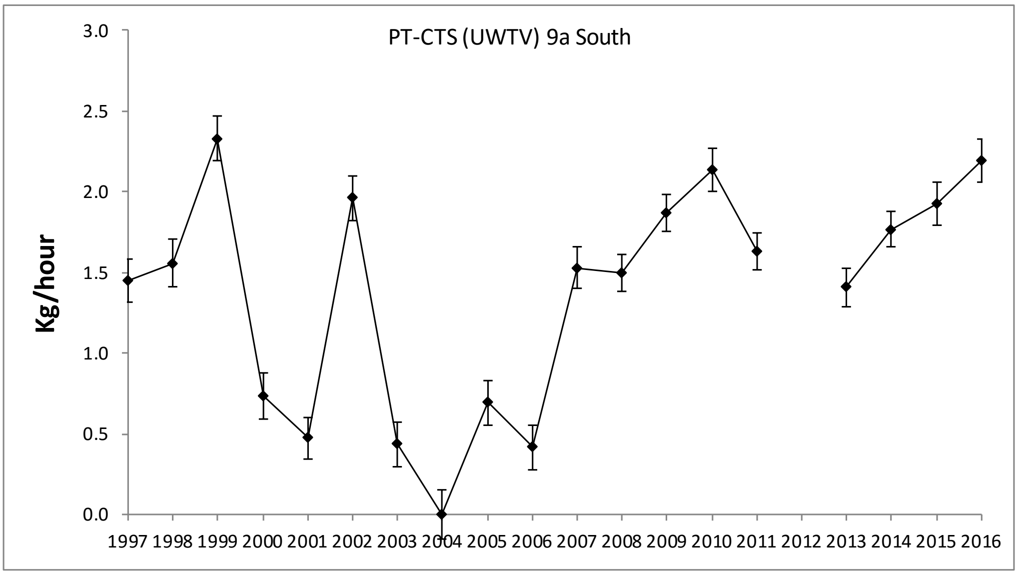


Figure 11.16. Greater forkbeard series of biomass of the Portuguese PT-CTS (UWTV (FU 28–29) survey until 2016 in the Division 9.a South.

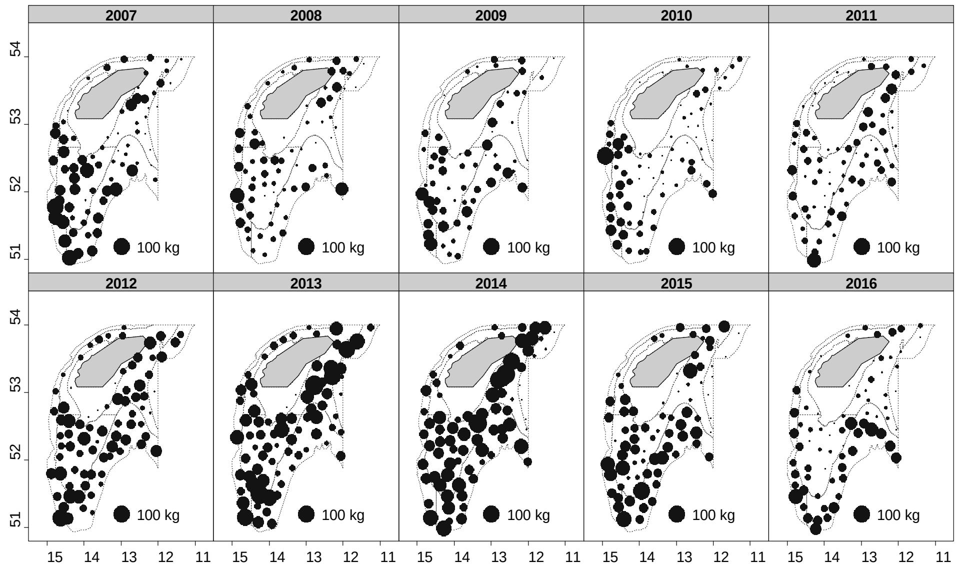


Figure 11.17. Geographic distribution of *Phycis blennoides* catches (kg/30 min haul) in Porcupine surveys between 2007 and 2016.

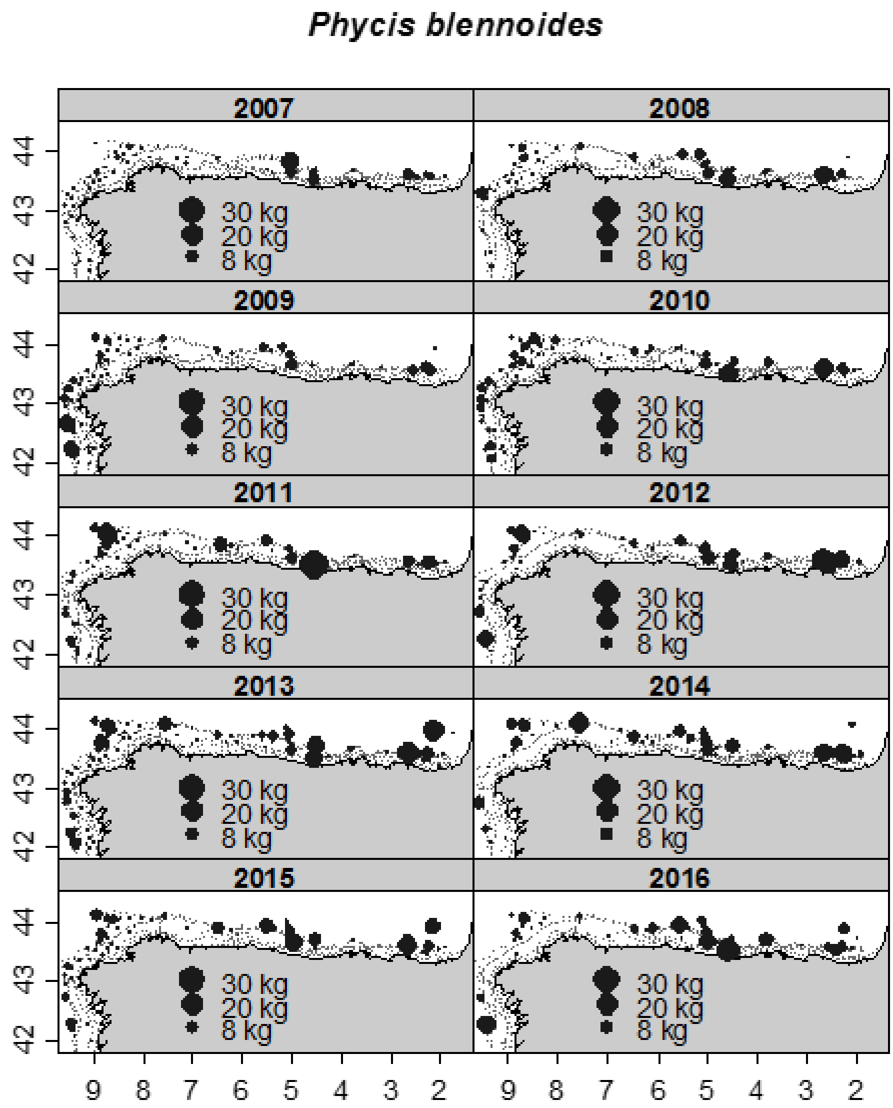


Figure 11.18. Catches in biomass of greater forkbeard on the Northern Spanish Shelf bottom-trawl surveys during the period: 2005–2016.

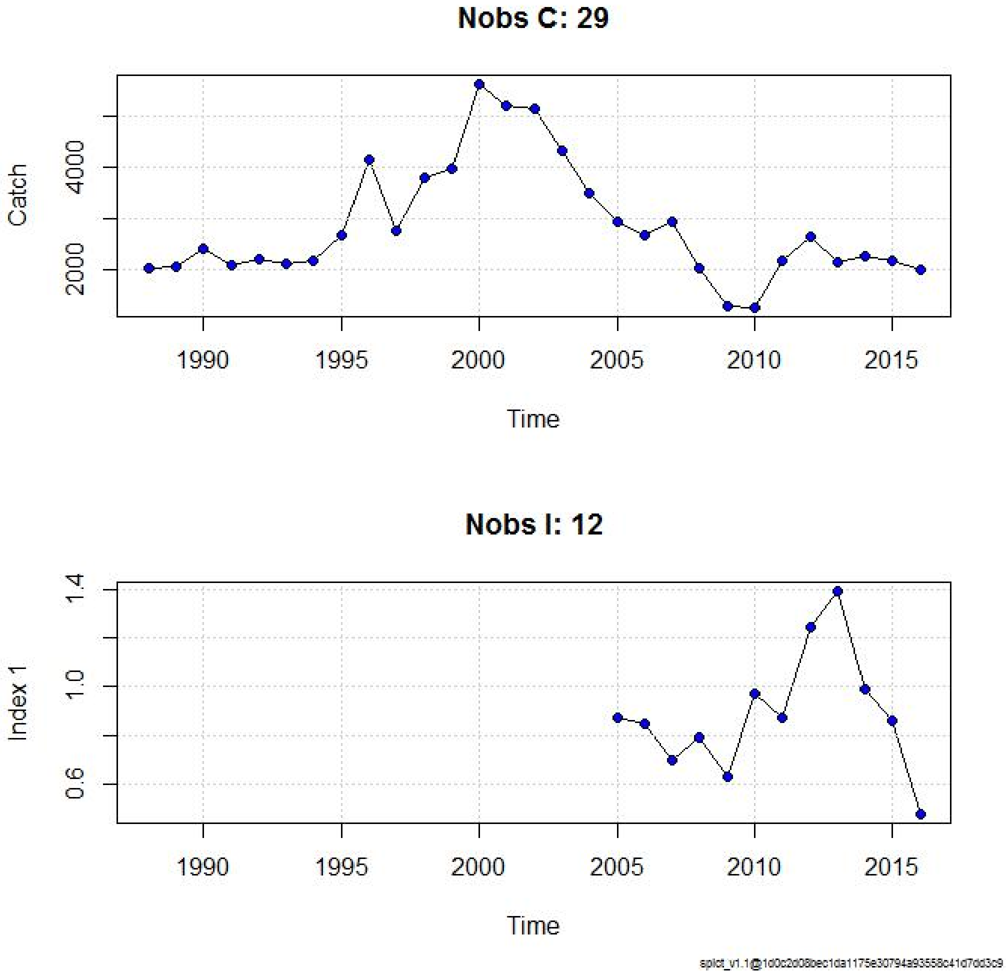


Figure 11.19. Inputs of the SPICT model used in the Greater Forkbeard stock.

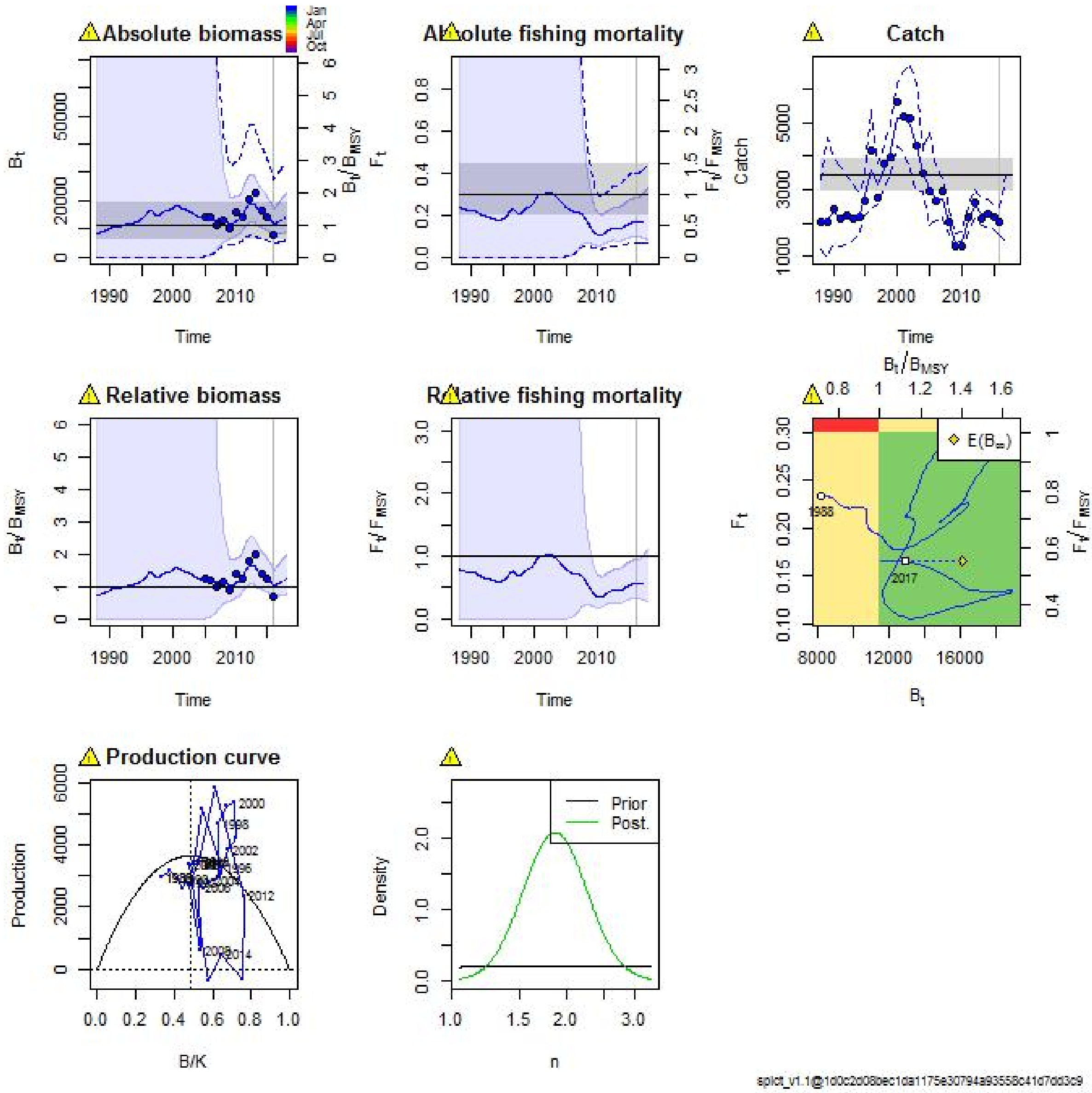


Figure 11.20. Results of the SPICT model for the Greater Forkbeard stock.

11.10 References

Lagarto N., Moura, T., Figueiredo I. 2017. Greater forkbeard *Phycis blennoides* in Portuguese waters (ICES Division 9.a). Working Document for the ICES Working Group on Biology and Assessment of Deep-sea Fisheries Resources Copenhagen, 24 April–1 May 2017. 16 pp.

O. Fernández-Zapico, S. Ruiz-Pico, F. Velasco and F. Baldó. 2017. Results on silver smelt (*Argentina silus* and *Argentina sphyraena*), bluemouth (*Helicolenus dactylopterus*), greater forkbeard (*Phycis blennoides*), Spanish ling (*Molva macrophthalma*) and ling (*Molva molva*) from 2016 Porcupine Bank (NE Atlantic) survey. Working Document for the ICES Working Group on Biology and Assessment of Deep-sea Fisheries Resources Copenhagen, 24 April–1 May 2017. 18 pp.

S. Ruiz-Pico, M. Blanco, O. Fernández-Zapico, I. Preciado, A. Punzón, F. Velasco. 2107. Results on Greater forkbeard (*Phycis blennoides*), Bluemouth (*Helicolenus dactylopterus*), Spanish ling (*Molva macrophthalma*) and Red seabream (*Pagellus bogaraveo*) of the Northern Spanish Shelf Groundfish Survey. Working Document for the ICES Working Group on Biology and Assessment of Deep-sea Fisheries Resources Copenhagen, 24 April–1 May 2017. 24 pp.

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) hook and line fishery in Division 10.a, 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 (10.b) between 1993 and 2000 and some minor landings as bycatch in fisheries targeting other species since 2000. There are no target fisheries currently occurring in Mid-Atlantic Ridge (NEAFC) area since 2000 (see Section 4). Currently landings are reported from bycatch fisheries occurring in the NEAFC regulatory area (RA) of ICES Division 10.b from Faroese vessels and in the EEZ of Portugal (Subarea 9), Spain (6, 7, 8 and 9), France (6, 7 and 8), and from a small-scale target fishery based in the Azores operation in Division 10.a (See Table 12.1e).

12.2 Landings trends

The available landings data for Alfonsinos, (*Beryx* spp), by ICES subarea/division 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 are stabilized since 2005, due to management measures introduced (TAC/quotas and effort regulation), being around 369 t between 2005 and 2016, with high landings during 2012 (605 t). Current catches are 300 t. Faroes reported a landing of 141 t for 2015 and 48 t for 2016 from area 10.b.

12.3 ICES Advice

Based on ICES approach to data-limited stocks, ICES advises that annual catches should be no more than 280 tonnes. All catches are assumed to be landed.

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 296 t for EC vessels is in force since 2014, being reduced to 280 t for the period 2017–2018.

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. These measures were updated during 2015 and 2016. A network of MPAs were implemented on the Azores with closed access to deep-water fisheries (including Sedlo, D. J Castro and Formigas seamounts). The seamount (Condor) was closed to the fishery. There are NEAFC regulations of effort in the fisheries for deep-water species and closed areas to protect vulnerable habitats on the RA. (http://neafc.org/managing_fisheries/measures/current).

Regulation	Species	Year	ICES Area	TAC	Landings
Reg 2270/2004	*Beryx* sp	2005	3, 4, 5, 6, 7, 8, 9, 10, 12	328	422
	Beryx sp	2006	3, 4, 5, 6, 7, 8, 9, 10, 12	328	367
Reg 2015/2006	*Beryx* sp	2007	3, 4, 5, 6, 7, 8, 9, 10, 12	328	396
	Beryx sp	2008	3, 4, 5, 6, 7, 8, 9, 10, 12	328	405
Reg 1359/2008	*Beryx* sp	2009	3, 4, 5, 6, 7, 8, 9, 10, 12	328	382
	Beryx sp	2010	3, 4, 5, 6, 7, 8, 9, 10, 12	328	296
Reg 1225/2010	*Beryx* sp	2011	3, 4, 5, 6, 7, 8, 9, 10, 12	328	331
	Beryx sp	2012	3, 4, 5, 6, 7, 8, 9, 10, 12	328	596
Reg 1262/2012	*Beryx* sp	2013	3, 4, 5, 6, 7, 8, 9, 10, 12	312	272
	Beryx sp	2014	3, 4, 5, 6, 7, 8, 9, 10, 12	296	282
Reg. 1367/2014	*Beryx* sp	2015	3, 4, 5, 6, 7, 8, 9, 10, 12	296	224
	Beryx sp	2016	3, 4, 5, 6, 7, 8, 9, 10, 12	296	252
Reg. 2285/2016	*Beryx* sp	2017	3, 4, 5, 6, 7, 8, 9, 10, 12	280	
	Beryx sp	2018	3, 4, 5, 6, 7, 8, 9, 10, 12	280	

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 reported during 2014 (WD, Pinho, 2014) and were not updated. 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 from the Azores were updated (WD Pinho *et al.*, 2017). These are summarized for both species in Figures 12.6 and 12.7 for the period 1991–2016.

Azorean survey length compositions were updated (WD Pinho *et al.*, 2017) and are resumed for both species in Figures 12.8 and 12.9.

Annual mean length from the Azorean fishery and survey were updated (WD Pinho *et al.*, 2017). Available information for both species are presented in Figures 12.10 to 12.13.

12.6.3 Age compositions

No new information about age compositions of *Beryx* species was available during the WGDEEP meeting. This information was already reported to the working group but there are not relevant changes on the growth of the species.

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 standardized.

Abundance indices from the Azorean longline survey were updated (WD Pinho *et al*., 2017) 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 stabilized 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 6–7. Species-specific landings trends in the Azores fishery showed similar trends for both species (Figure 12.4 and 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). Considering a length of first maturity around 35 cm fork length (FL), it appears that the Azorean fishery have caught mainly immature fish. However, this may be a selective effect of the hook and line fisheries or an uncertainty on the maturity estimates.

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 on 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 small numbers of *B decadactylus* are caught on the survey on the sampled depth strata (50–600 m) (Figures 12.8 and 12.9). For *B splendens* a mode around 25–30 cm is observed and *B decadactylus* show a bimodal or trimodal distribution.

Fishery mean length of *B. splendens* presents a slight decrease a long 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 followed by a decrease in 2016 (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 until 2011 decreasing thereafter (Figure 12.15).

The working group express concerns on the reliability of these indices as an indicator of abundance index due to the relatively small numbers of individuals caught each year particularly for *B. decadactylus*. The survey may not be designed for these highly 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.

12.7.1 Exploratory analysis

12.7.1.1 Length-based indicators

Length-based indicators reported from WKLIFEV were explored and updated. For this exercise was used fishery length compositions of *Beryx splendens* for sexes combined from 1995 to 2016 (discards assumed negligible) reported from the Azores (ICES Subarea 10.a). The following life-history parameters were used: L_{oo}=46.1 cm LF, K=0.13, to=-3.18 (from Isidro, 1996), a= 0.0178 and b=3.0755 (DCF) and L_{mat}=24.7 cm LF for females (from Isidro, 1996). For L_{mat} was also used the females values reported by Pereira (WD Pereira, 2010) as a compromise on the uncertainty of the maturity and stock identity.

Results of the analysis for L_{mat}=24.5 cm option are shown in Figure 12.16 and Table 12.5. Results show that for immature conservation the harvesting occurs slightly above maturity (L_c and L25%>L_{mat}) in the recent years and so exploitation is considered appropriate to mature fraction of the population. However, until 2009 the exploitation pattern was considered inappropriate. This change is only an effect of the minimum size regulation. The results suggests that the large individuals are present during the early years but are more scarce (L_{max}<L_{inf}) on the recent years. Large proportions (40%) of megaspawners (LF>34 cm) are observed on the early years and much less on the recent years (P_{mega} =20%).

For MSY proxy results show that exploitation is lower or at the MSY level ($L_{mean} > \geq L_{opt}$ and $L_{mean} \geq L_{F=M}$).

Overall the perception from the length-based indicators is that the stock has been exploited sustainably at level lower or at optimal and MSY.

Results of the analysis for L_{mat}=35.5 cm option are shown in Figure 12.17 and Table 12.6. Results show that for immature conservation the harvesting occurs well before maturity (L_c and L25%<L_{mat}). This is the main difference of the first option for maturity length.

The exercise was not done for *Beryx decadactylus*.

12.7.1.2 SPiCT

An exploratory analysis was performed for *Bery splendens* on the assumption that this is a management unit for are 10.a.

The production model SPiCT was explored using all available information from ARQDAÇO bottom longline survey (abundance indices in number and weight) from

1995 to 2016 and Azorean fishery landings for the period 1985–2016 (Figure 12.17 and 12.18). Several runs were explored with the two indices using data for all years or restricted periods of years by excluding some points. No convergence was obtained with the index in number. Convergence was only achieved when the index in weight was used.

Model results for the run using landings (1985–2015) and the index in weight (1995–2016) are presented in Figures (12-18-12.20). Analysis of the residuals (Figure 12.19) shows no major problems with no significant bias (P>0.05, residuals are not significant different of zero) and autocorrelations and normality test showing no significant (p>0.05) violations of the assumptions. Variance (95%CI) are of the same level for absolute and relative estimates (with higher upper values) and seems to be reasonable (Figure 13.4.18). The MSY estimates is reasonable for catches but relatively high and skew (higher upper level) for the other estimates (B_{MSY} and F_{MSY}). The model suggests that the stock is currently exploited at a rate consistent with the MSY framework. The current biomass at the level of B_{MSY} and the mortality is lower than F_{MSY}. The biomass should increase recover under the current exploitation pattern (see kobe plot).

12.8 Comments on the assessment

SPiCT exploratory analysis for alfonsino *Beryx splendens* should be interpreted with caution given the assumption of management units for area 10.a. Although theoretical, it may make sense there are a number of uncertainties related with the stock structure that should be clarified. Results show that the model is very sensitive to input data. Small variations on the abundance indices time-series produces very significant differences on the results.

Methods used in this exploratory analysis agree and suggests that the resource is currently explored sustainably.

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 over-exploited by trawl fishing; they can only sustain low rates of exploitation. Population dynamics are uncertain with recent estimates suggesting high longevity (>50 years), while other estimates suggest a longevity of ~15 years. 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. from Subarea 4.

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
2014	0	0
2015	0	0
2016	0	0

***Preliminary.**

Table 12.1b. Alfonsinos (*Beryx* spp.) from Division 5.b.

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
2014	0	0	0
2015	0	0	0
2016	0	0	0

***Preliminary.**

Table 12.1c. Alfonsinos (*Beryx* spp.) from Subareas 6 and 7.

	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	22	0	32	0		54
2009	9	0	0	0	1	10
2010	4	0	0	0	1	5
2011	7	0	33	0	0	40
2012	4	0	337	0	0	341
2013	14	1	33	0	0	77
2014	10	0	38	0	0	49
2015	6	0		6	0	12
2016	5	0.45	13	0	1	20

***Preliminary.**

Table 12.1d. Alfonsinos (*Beryx* spp.) from Subareas 8 and 9.

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	4	21	40	0	65
2012	4	11	27	0	42
2013	5	17	4	0	26
2014	3	18	81	0	102
2015	3	0	59		61
2016	3	1	71	0	76

*** Preliminary.**

Table 12.1e. Alfonsinos (*Beryx* spp.) from Subarea 10.

	10.a	10.b				
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	0	199
2002	243	0	0	0	0	243
2003	172	0	0	0	0	172
2004	139	0	0	0	0	139
2005	157	0	0	0	0	157
2006	192	0	0	0	0	192
2007	211	0	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	4	0	5	0	235
2012	213	10	0	0	0	222
2013	168	0	0	0	0	168
2014	131	0	0	0	0	131
2015	151	141	0	0	0	292
2016	156	48	0	0	0	204

*** Preliminary.**

**** Not official data from ICES Area 10.b.**

Table 12.1f. Alfonsinos (*Beryx* spp.) from Subarea 12.

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
2014	0	0
2015	0	0
2016	0	0

*** Preliminary.**

Table 12.1g. Landings of Alfonsinos (*Beryx* spp.) from 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*		
2014*		
2015*		
2016		

*** No information.**

Table 12.2. Reported landings for the alfonsinos, (*Beryx* spp), by ICES subarea/division.

YEAR	4	5.b	6+7	8+9	10.a	10.b	12	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	0	1776
1997			26	135	379	5	0	545
1998			81	268	229	0	0	579
1999			75	201	175	550	0	1001
2000			133	168	203	281	0	785
2001			180	228	199	0	0	607
2002			95	238	243	0	0	577
2003			84	105	172	0	0	361
2004			64	283	139	0	0	485
2005			70	195	157	0	0	422
2006			78	97	192	0	0	367
2007			65	120	211	0	0	396
2008	0	0	54	101	250	2	0	407
2009	0	0	10	61	311	1	0	383
2010	0	0	5	41	240	5	0	291
2011	0	0	40	65	226	9	2	342
2012	0	0	341	42	213	10	0	605
2013	0	0	77	26	168	0	0	272
2014	0	0	49	102	131	0	0	282
2015	0	0	12	61	151	141	0	365
2016	0	0	20	76	156	48	0	300

***Preliminary.**

Table 12.3. Reported landings of *Beryx splendens* and *B. decadactylus* in the Azores (ICES Division 10.a).

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
2014	109	22	131
2015	120	31	151

***Preliminary.**

Table 12.4. Annual percentage of *Beryx* spp. discarded by year in the Azores (ICES Division 10.a) 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

Table 12.5. L_{mat} 25 cm.

Year	Lc	L25%	Lmax5%	Pmega	Lmean	Lmean
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
	>1	>1	>0.8	>0.3	≈1 (>0.9)	≥1
	Conservation (immatures)		Conservation (large individuals)		Optimal yield	MSY
1995	0,92	1,08	0,94	0,42	1,06	1,13
1996	1,00	1,12	0,90	0,45	1,08	1,09
1997	1,00	1,12	0,93	0,42	1,07	1,08
1998	0,84	1,00	0,93	0,35	1,00	1,13
1999	0,84	1,04	0,88	0,37	1,02	1,15
2000	1,08	1,08	0,90	0,40	1,10	1,06
2001	0,84	1,04	0,89	0,37	1,02	1,15
2002	1,08	1,12	0,88	0,32	1,06	1,03
2003	1,08	1,20	0,89	0,43	1,09	1,05
2004	0,76	1,12	0,86	0,37	1,02	1,22
2005	0,92	1,04	0,84	0,15	0,95	1,02
2006	0,52	1,04	0,89	0,20	0,95	1,38
2007	1,00	1,08	0,87	0,17	0,99	1,01
2008	1,08	1,12	0,85	0,24	1,04	1,00
2009	1,00	1,12	0,85	0,25	1,02	1,03
2010	1,08	1,16	0,83	0,35	1,06	1,02
2011	1,08	1,12	0,80	0,18	1,01	0,97
2012	1,08	1,12	0,80	0,19	1,02	0,98
2013	1,08	1,12	0,78	0,12	1,00	0,96
2014	1,08	1,12	0,81	0,18	1,02	0,98
2015	1,08	1,12	0,85	0,27	1,04	1,01
2016	1,08	1,12	0,82	0,18	1,01	0,98

Table 12.6. L_{mat}=35.5.

Year	Lc	L25%	Lmax5%	Pmega	Lmean	Lmean
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
	>1	>1	>0.8	>0.3	≈1 (>0.9)	≥1
	Conservation (immatures)		Conservation (large individuals)		Optimal yield	MSY
1995	0,66	0,77	0,94	0,42	1,06	1,13
1996	0,71	0,80	0,90	0,45	1,08	1,09
1997	0,71	0,80	0,93	0,42	1,07	1,08
1998	0,60	0,71	0,93	0,35	1,00	1,13
1999	0,60	0,74	0,88	0,37	1,02	1,15
2000	0,77	0,77	0,90	0,40	1,10	1,06
2001	0,60	0,74	0,89	0,37	1,02	1,15
2002	0,77	0,80	0,88	0,32	1,06	1,03
2003	0,77	0,86	0,89	0,43	1,09	1,05
2004	0,54	0,80	0,86	0,37	1,02	1,22
2005	0,66	0,74	0,84	0,15	0,95	1,02
2006	0,37	0,74	0,89	0,20	0,95	1,38
2007	0,71	0,77	0,87	0,17	0,99	1,01
2008	0,77	0,80	0,85	0,24	1,04	1,00
2009	0,71	0,80	0,85	0,25	1,02	1,03
2010	0,77	0,83	0,83	0,35	1,06	1,02
2011	0,77	0,80	0,80	0,18	1,01	0,97
2012	0,77	0,80	0,80	0,19	1,02	0,98
2013	0,77	0,80	0,78	0,12	1,00	0,96
2014	0,77	0,80	0,81	0,18	1,02	0,98
2015	0,77	0,80	0,85	0,27	1,04	1,01
2016	0,77	0,80	0,82	0,18	1,01	0,98

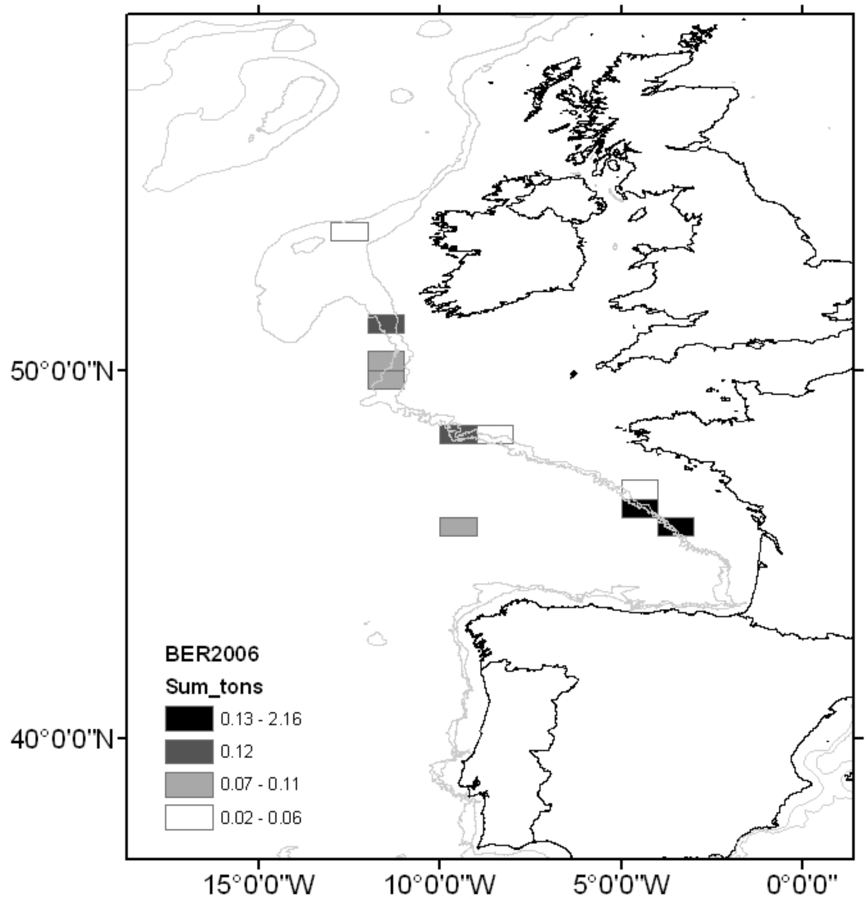


Figure 12.1. Catches of alfonsinos by French, Irish, UK (England and Wales and Scotland) and Icelandic vessels, 2006.

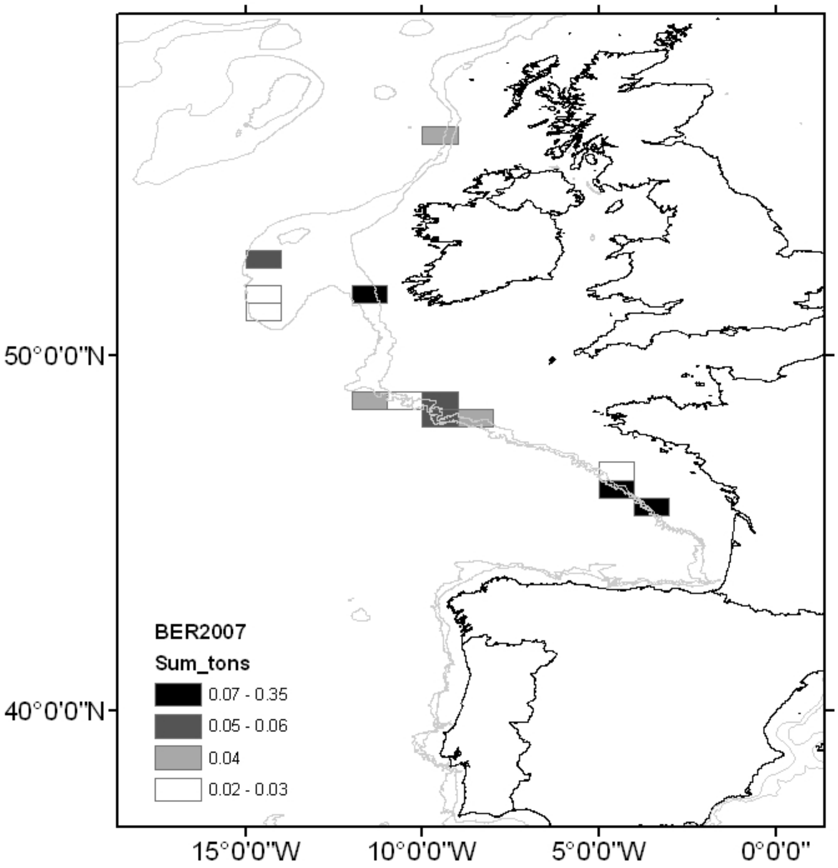


Figure 12.2. Catches of alfonsinos by French, Irish, UK (England and Wales and Scotland) and Icelandic vessels, 2007.

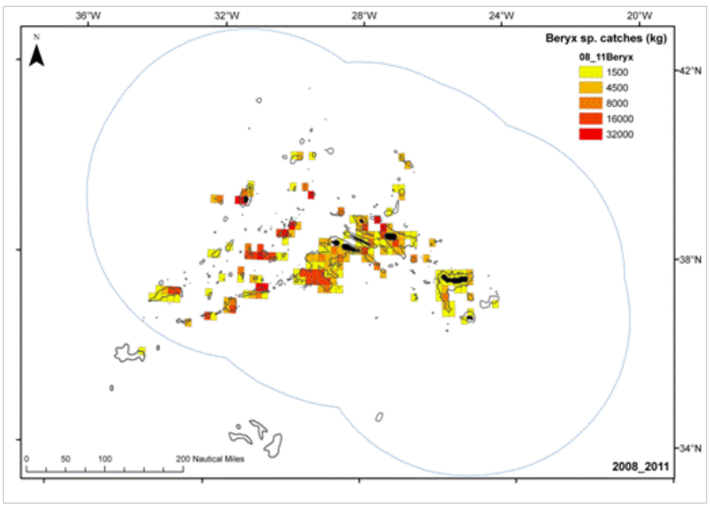


Figure 12.3. Catches of alfonsinos by Azores vessels, 2008–2011 (ICES, 10.a.2).

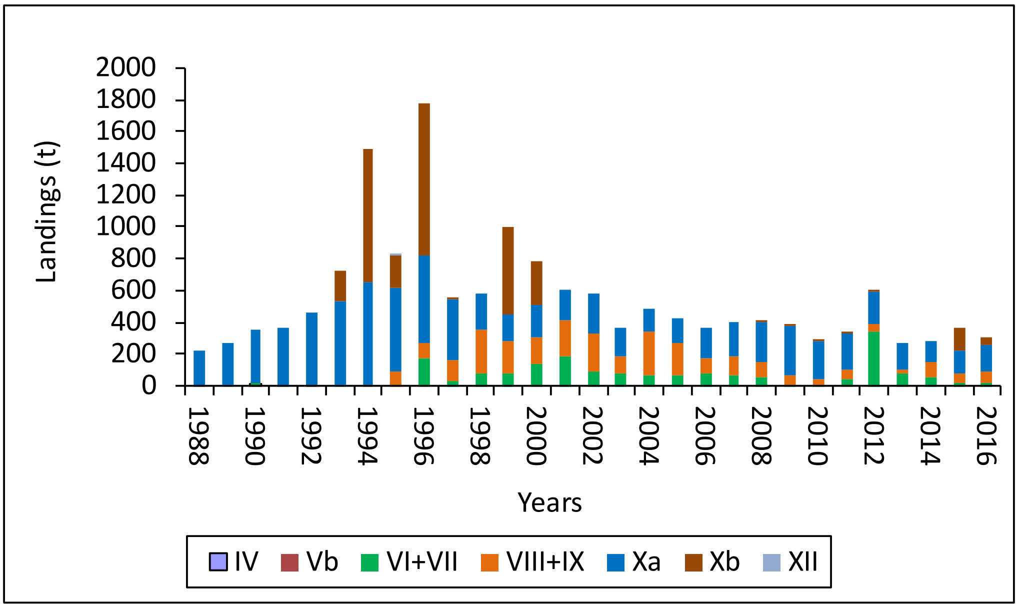


Figure 12.4. Reported landings for the alfonsinos, (*Beryx* spp), by ICES subarea/division.

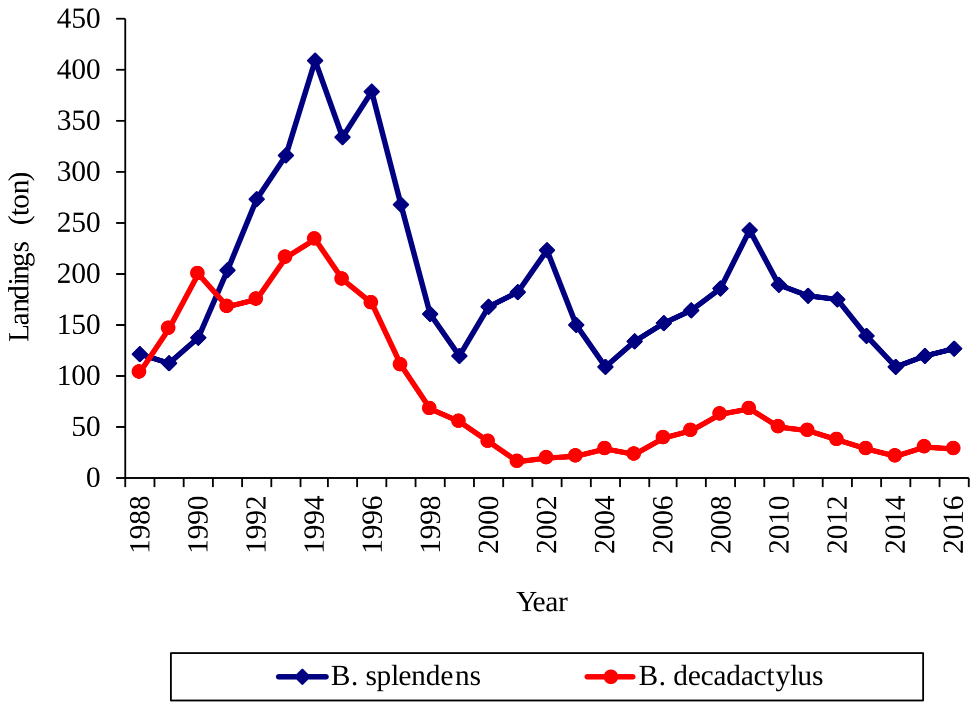


Figure 12.5. Landings of *Beryx splendens* and *B. decadactylus* in Azores (ICES Subarea 10).

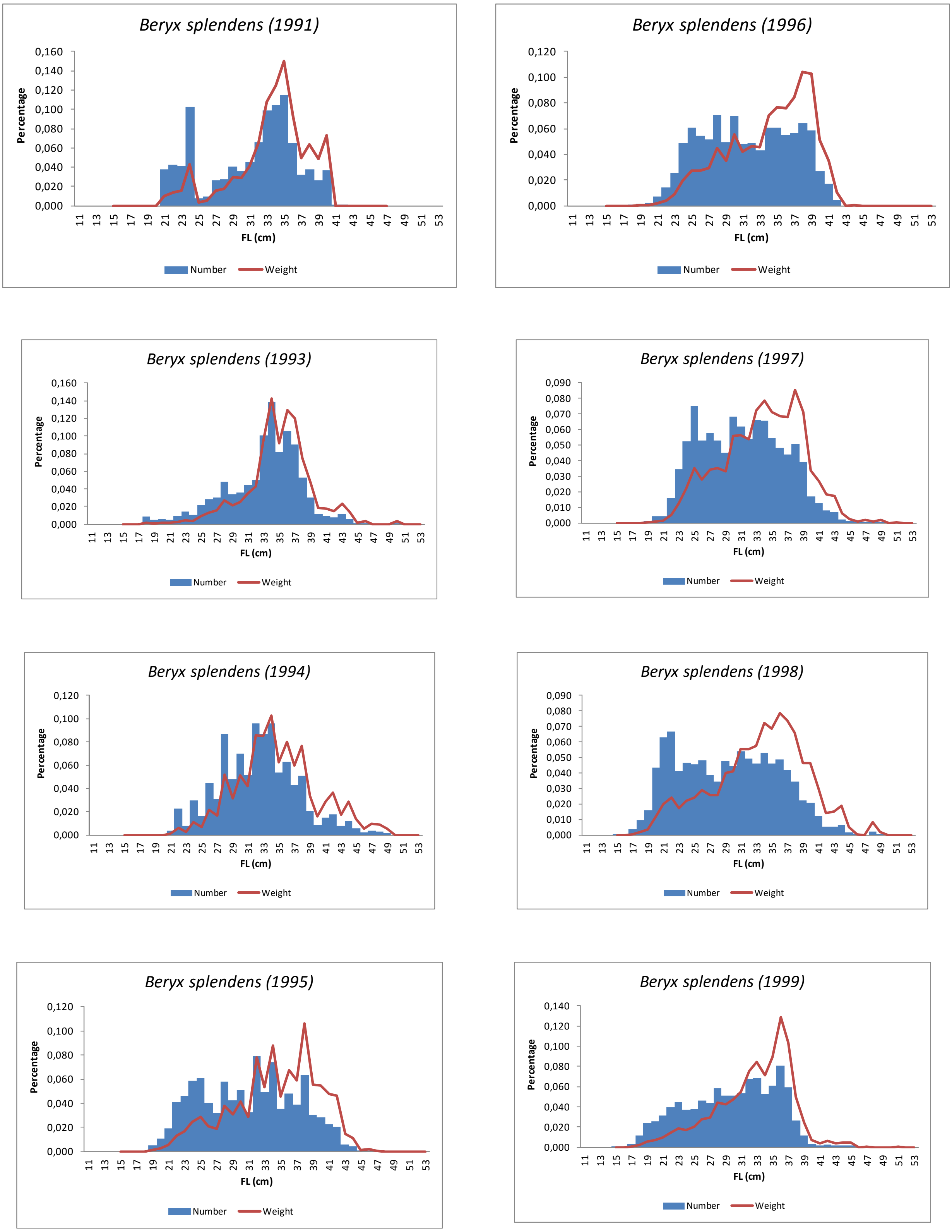


Figure 12.6. ***Beryx splendens*** **Length distribution of the catch from the Azores (ICES Subarea 10). Bars represent the proportion in number of every size class and the red line represents the proportion in weight.**

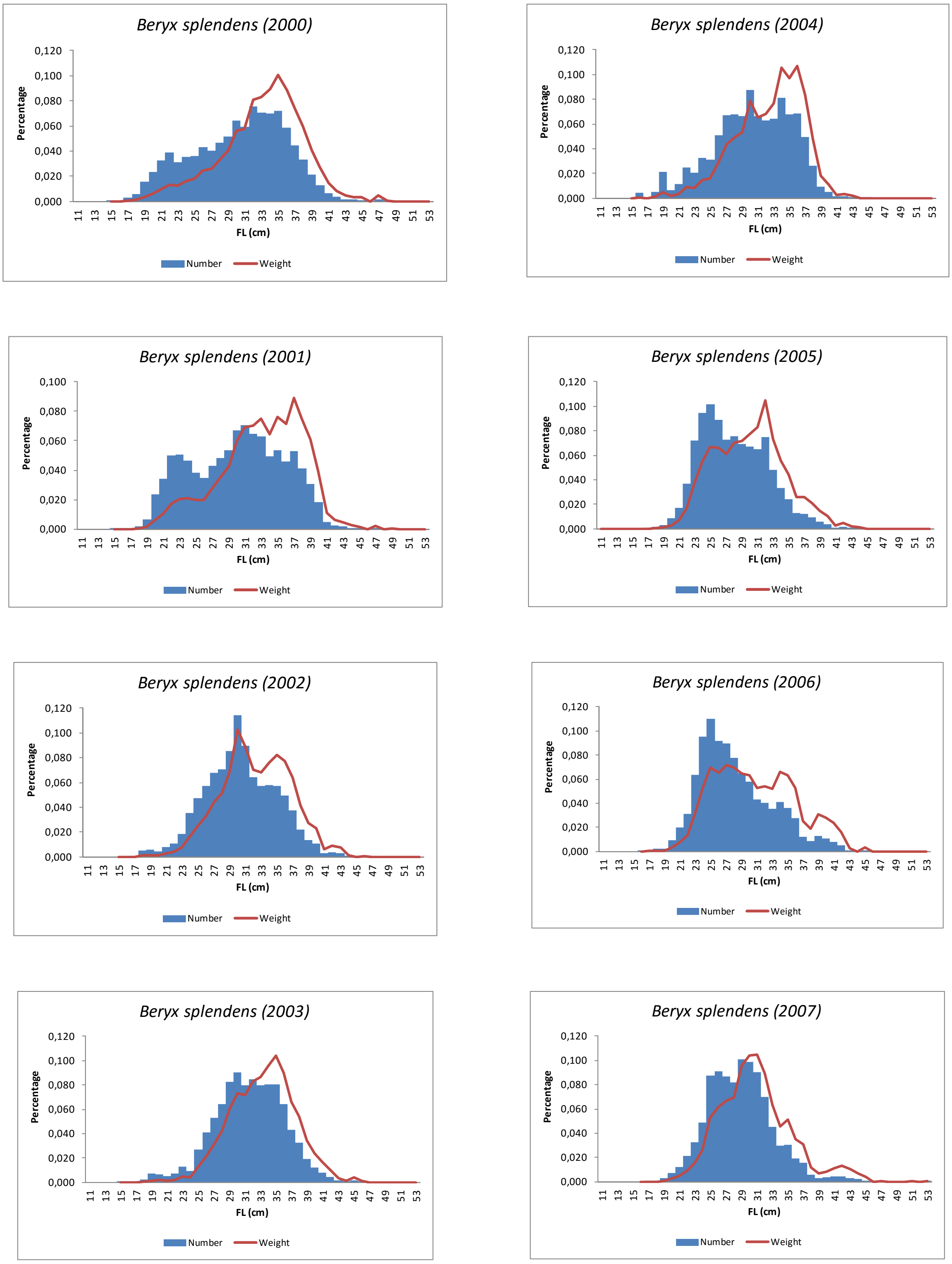
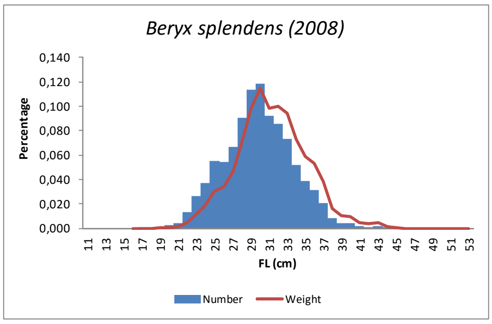
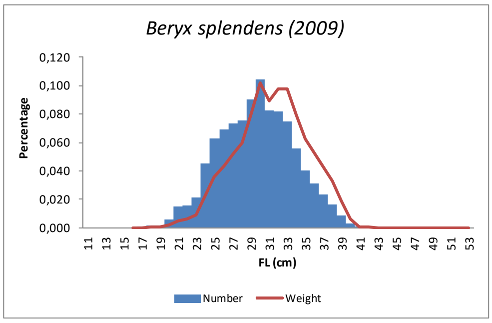
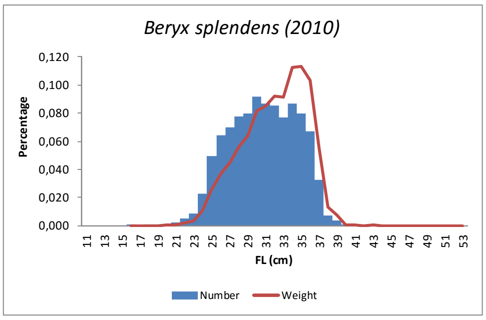
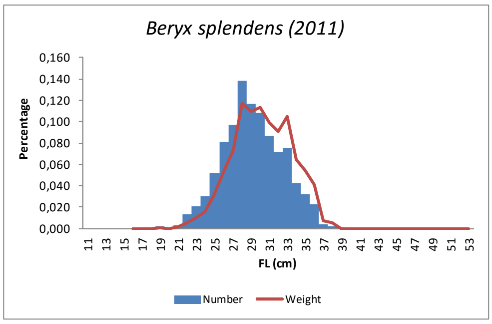


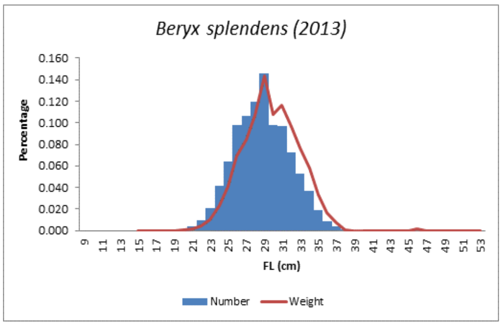
Figure 12.6. ***Beryx splendens*** **Length distribution of the catch from the Azores (ICES Subarea 10). Bars represent the proportion in number of every size class and the red line represents the proportion in the weight.**

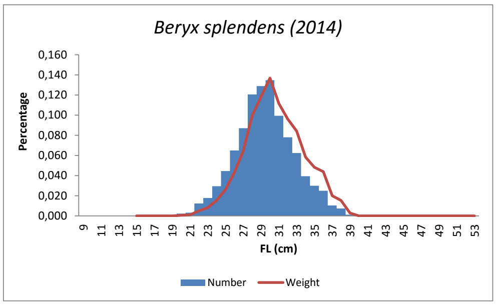

Beryx splendens (2008)
Percentage
FL (cm)
Number
Weight

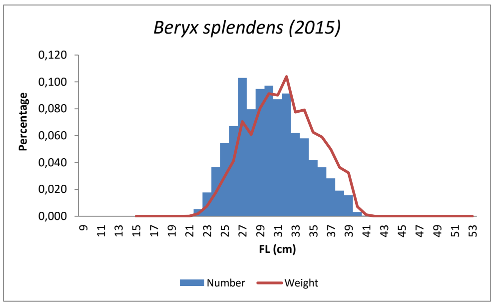

Beryx splendens (2009)
Percentage
FL (cm)
Number
Weight

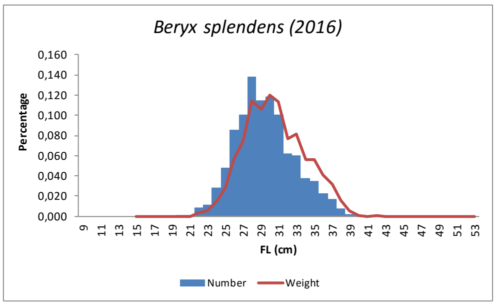

Beryx splendens (2010)
Percentage
FL (cm)
Number
Weight


Beryx splendens (2011)
Percentage
FL (cm)
Number
Weight


Beryx splendens (2013)
Percentage
FL (cm)
Number
Weight


Beryx splendens (2014)
Percentage
FL (cm)
Number
Weight


Beryx splendens (2015)
Percentage
FL (cm)
Number
Weight


Beryx splendens (2016)
Percentage
FL (cm)
Number
Weight

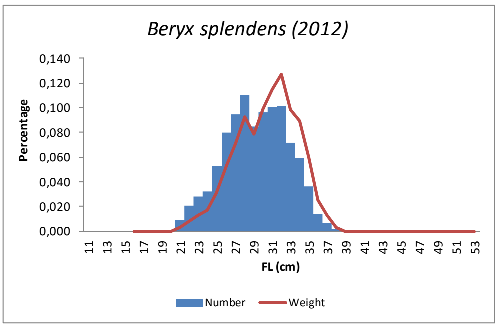


Figure 12.6. ***Beryx splendens*** **Length distribution of the catch from the Azores (ICES Subarea 10). Bars represent the proportion in number of every size class and the red line represents the proportion in the weight.**

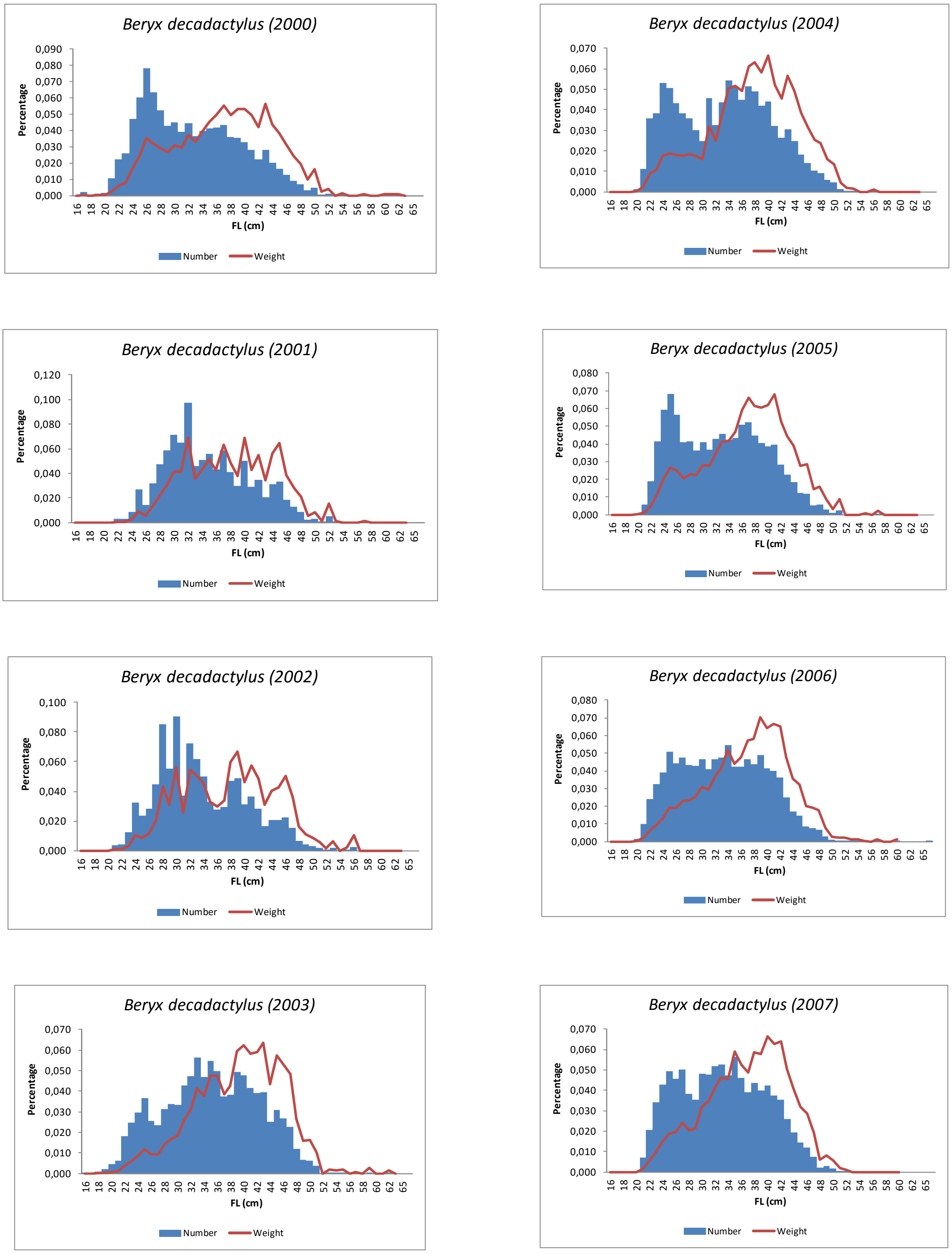
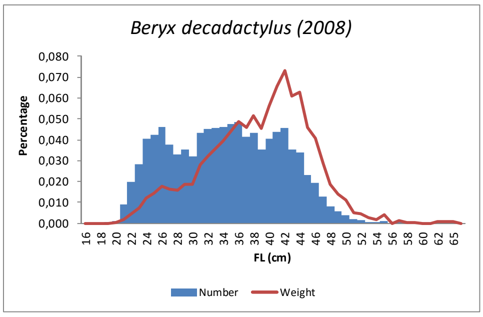
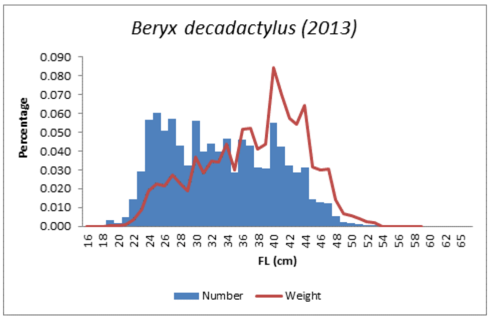
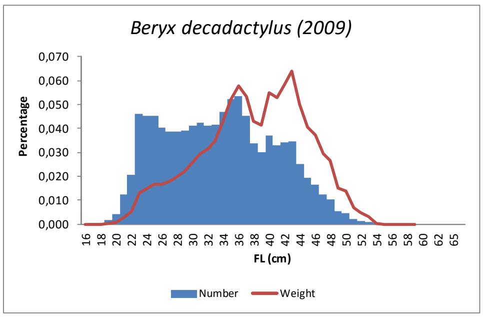
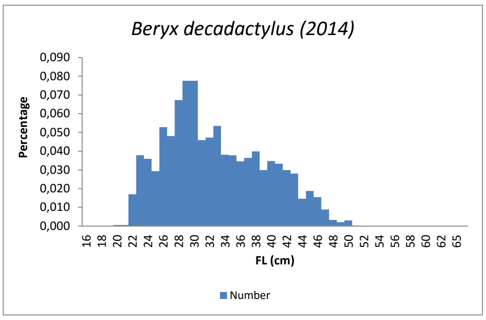


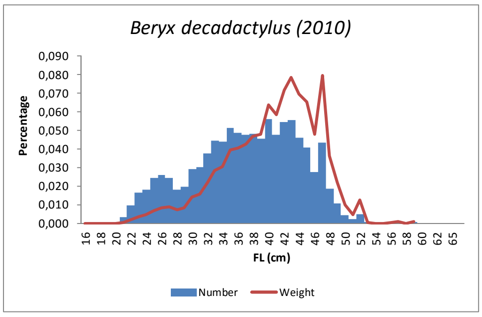
Figure 12.7. ***Beryx decadactylus*** **Length distribution of the catch from the Azores (ICES Subarea 10). Bars represent the proportion in number of every size class and the red line represents the proportion in the weight.**

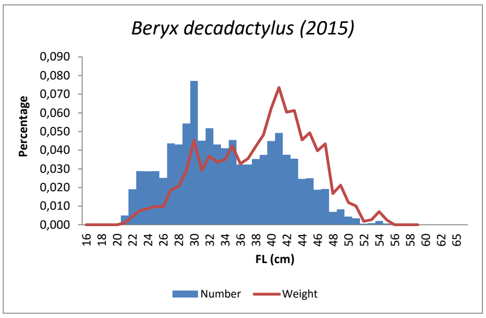

Beryx decadactylus (2008)
Percentage
0,000 0,010 0,020 0,030 0,040 0,050 0,060 0,070 0,080
16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 65
FL (cm)
Number
Weight

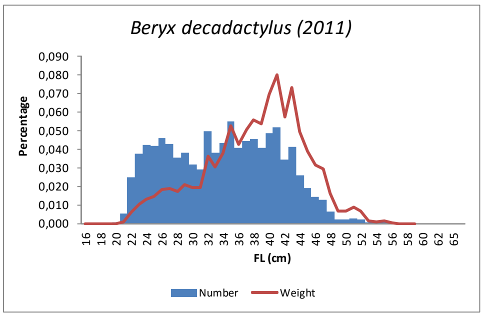

Beryx decadactylus (2013)
Percentage
0.000 0.010 0.020 0.030 0.040 0.050 0.060 0.070 0.080 0.090
16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 65
FL (cm)
Number
Weight

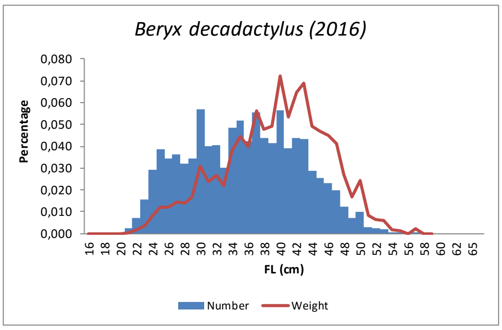

Beryx decadactylus (2009)
Percentage
0,000 0,010 0,020 0,030 0,040 0,050 0,060 0,070
16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 65
FL (cm)
Number
Weight


Beryx decadactylus (2014)
Percentage
0,000 0,010 0,020 0,030 0,040 0,050 0,060 0,070 0,080 0,090
16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 65
FL (cm)
Number


Beryx decadactylus (2010)
Percentage
0,000 0,010 0,020 0,030 0,040 0,050 0,060 0,070 0,080 0,090
16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 65
FL (cm)
Number
Weight


Beryx decadactylus (2015)
Percentage
0,000 0,010 0,020 0,030 0,040 0,050 0,060 0,070 0,080 0,090
16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 65
FL (cm)
Number
Weight


Beryx decadactylus (2011)
Percentage
0,000 0,010 0,020 0,030 0,040 0,050 0,060 0,070 0,080 0,090
16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 65
FL (cm)
Number
Weight


Beryx decadactylus (2016)
Percentage
0,000 0,010 0,020 0,030 0,040 0,050 0,060 0,070 0,080
16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 65
FL (cm)
Number
Weight

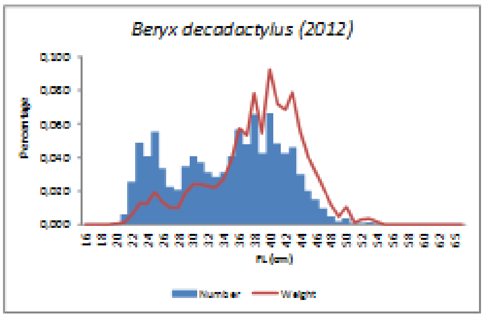


Figure 12.7. ***Beryx decadactylus*** **Length distribution of the catch from the Azores (ICES Subarea 10). Bars represent the proportion in number of every size class and the red line represents the proportion in the weight.**

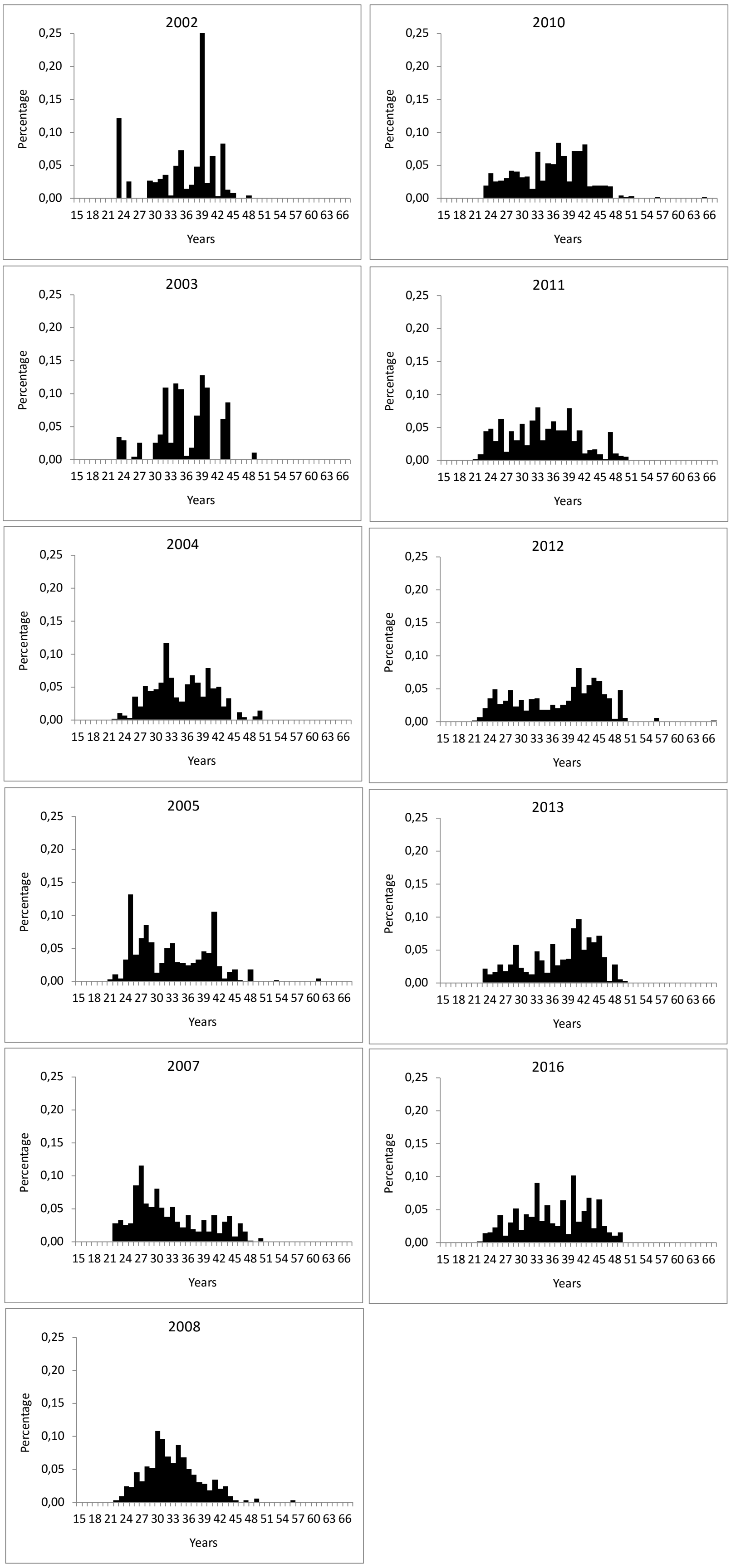


Figure 12.8. ***Beryx decadactylus*** **survey length compositions by year from the Azores (ICES Subarea 10).**

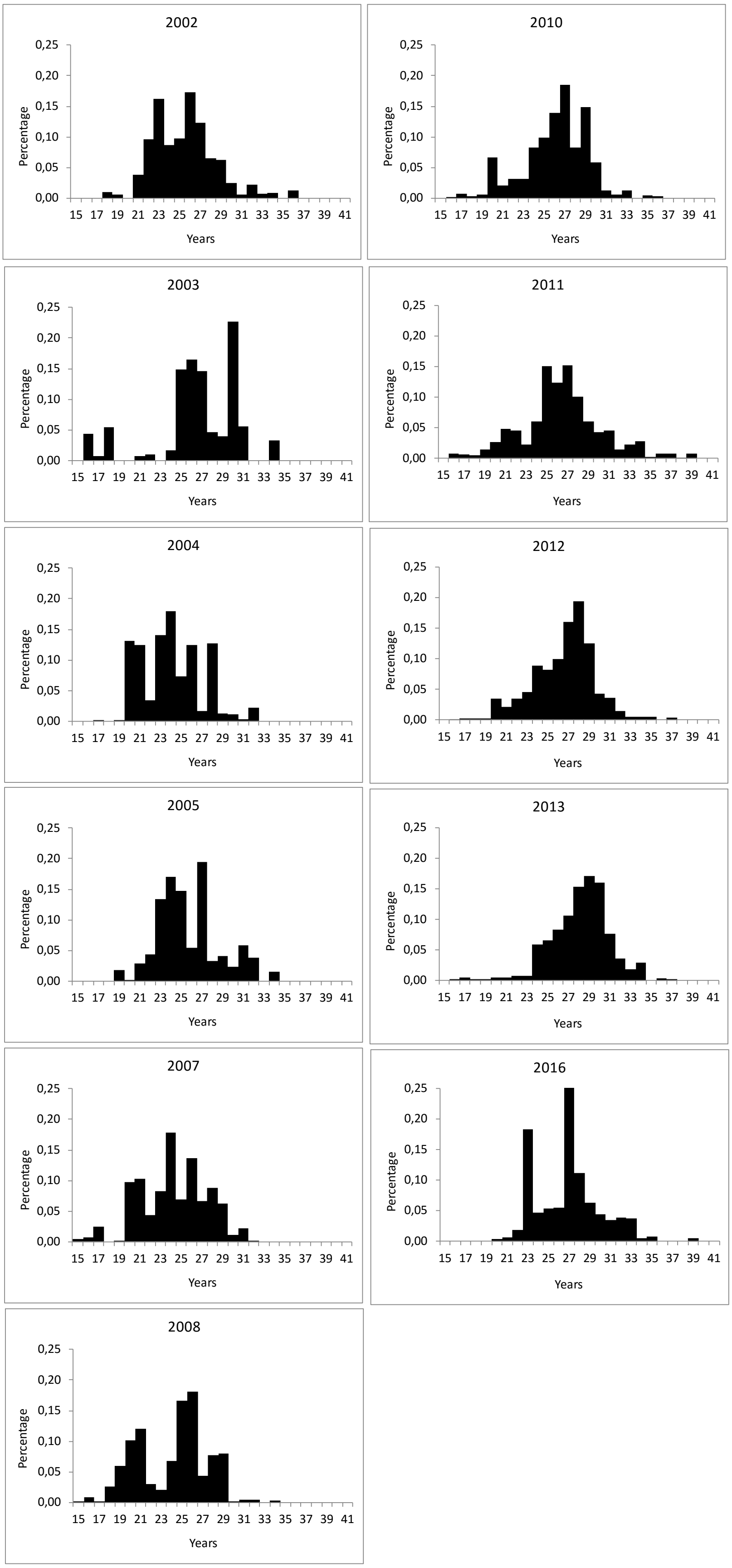


Figure 12.9. *Beryx splendens* survey length compositions, by year from the Azores (ICES Subarea 10).

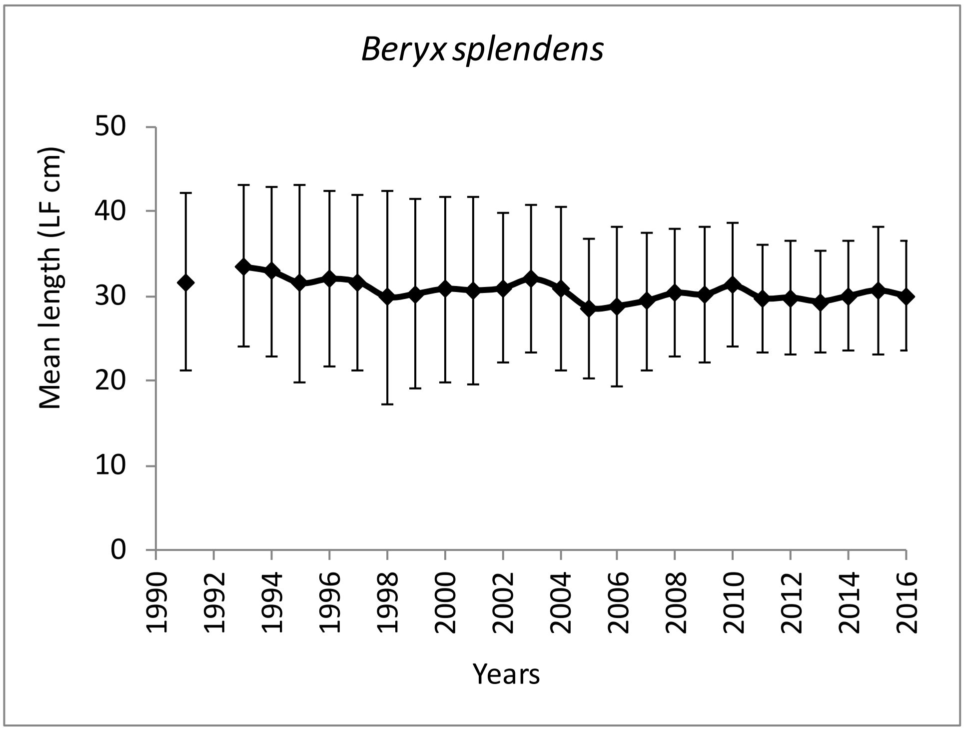


Figure 12.10. Annual mean length of *Beryx splendens* from the Azorean fishery (ICES Subarea 10).Bars are 95% confidence interval.

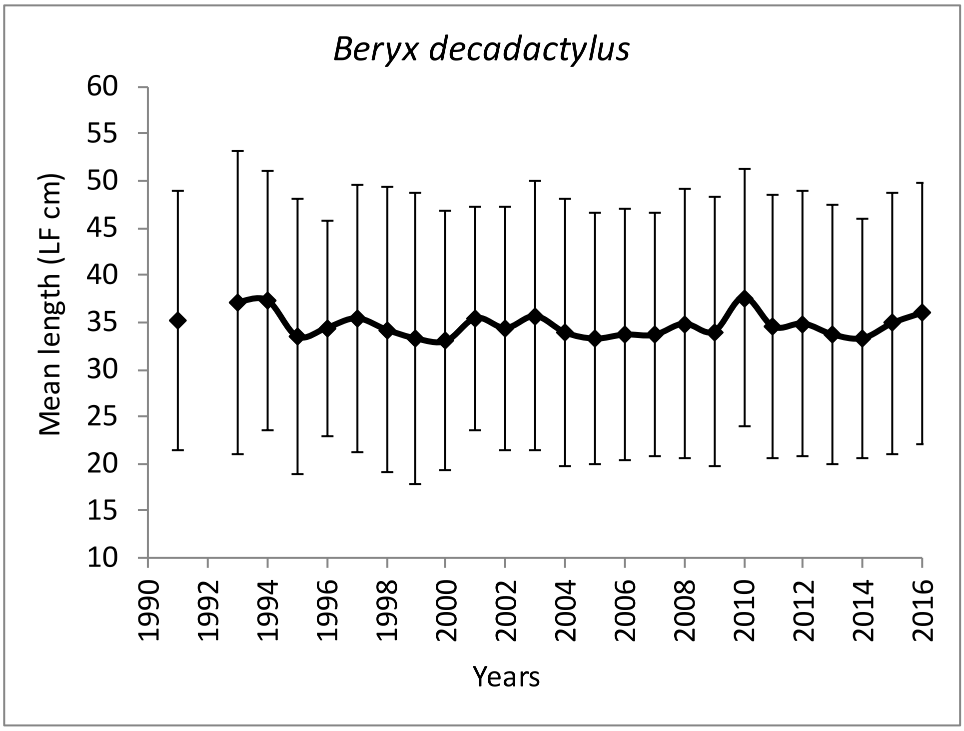


Figure 12.11. Annual mean length of *Beryx decadactylus* from the Azorean fishery (ICES Subarea 10).Bars are 95% confidence interval.

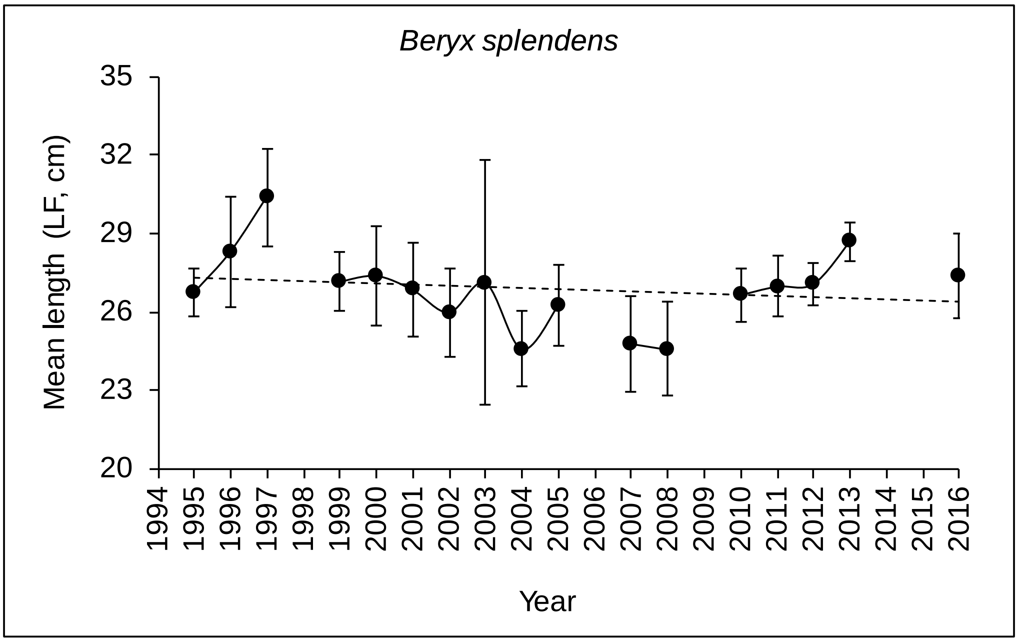


Figure 12.12. Annual mean length of *Beryx splendens* from the bottom longline survey (ICES Subarea 10).Bars are 95% confidence interval.

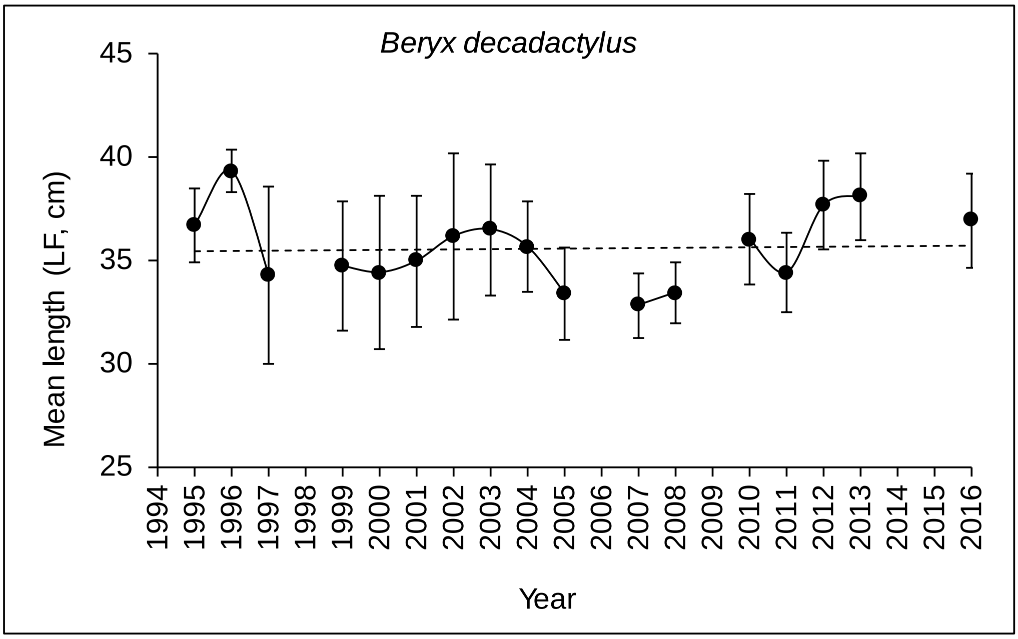


Figure 12.13. Annual mean length of *Beryx decadactylus* from the bottom longline survey (ICES Subarea 10).Bars are 95% confidence interval.

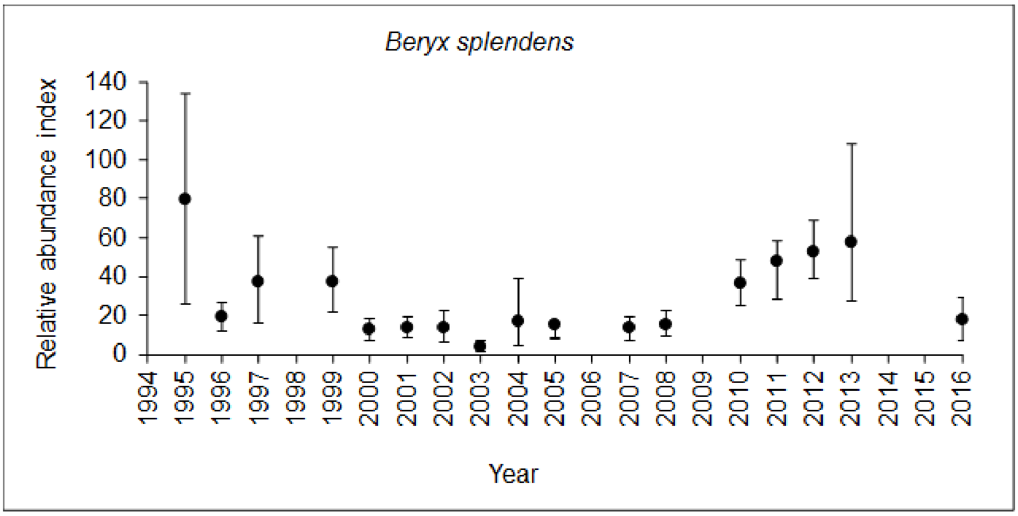


Figure 12.14. Annual bottom longline survey abundance index in number available for the alfonsinos (*Beryx splendens*) from the Azorean deep-water species surveys (ICES Subarea 10).

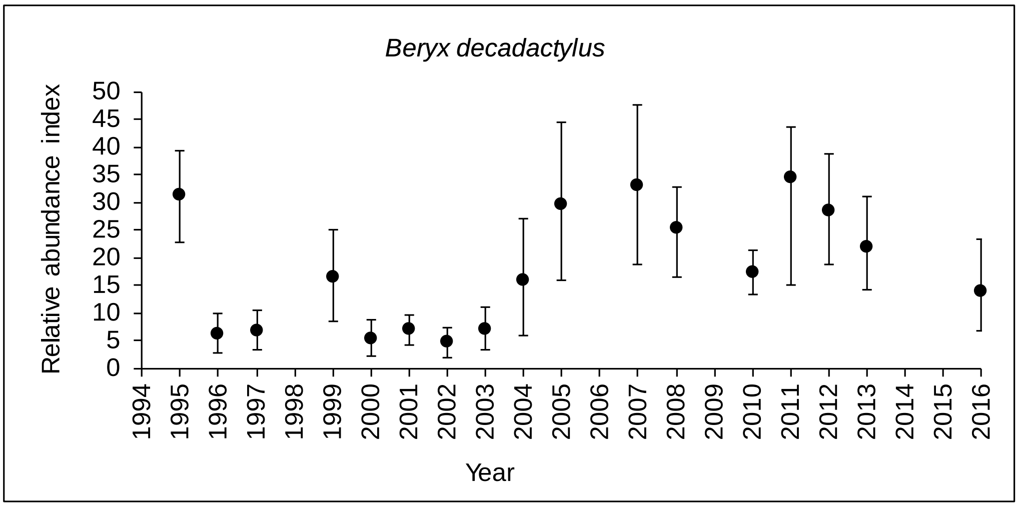


Figure 12.15. Annual bottom longline survey abundance index in number available for the golden eye perch (*B. decadactylus*) from the Azorean deep-water species surveys (ICES Subarea 10).

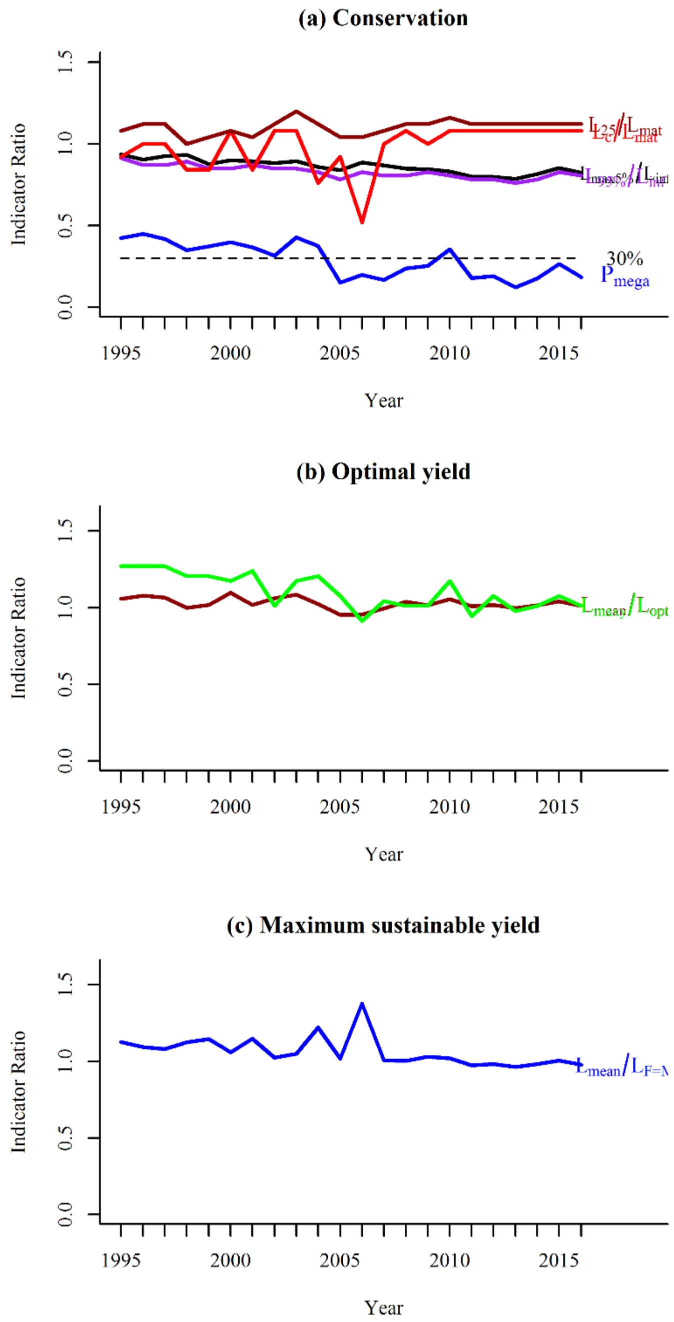


Figure 12.15. Indicator ratios and proxies of reference points (assuming L_{mat}=24,7) for the alfonsinos (*B. splendens*) from ICES Division 10.a.

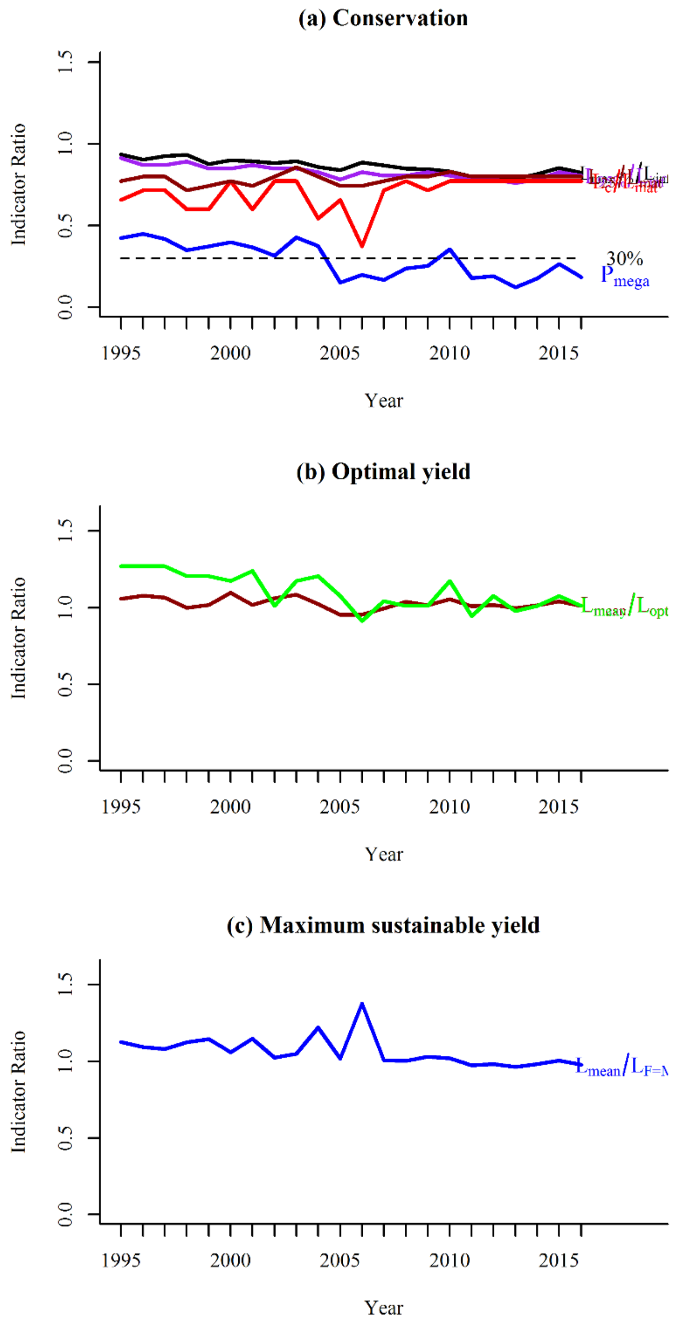


Figure 12.16. Indicator ratios and reference points (assuming L_{mat}=35,5cm) for the alfonsinos (*B. splendens*) from ICES Subarea 10.a.

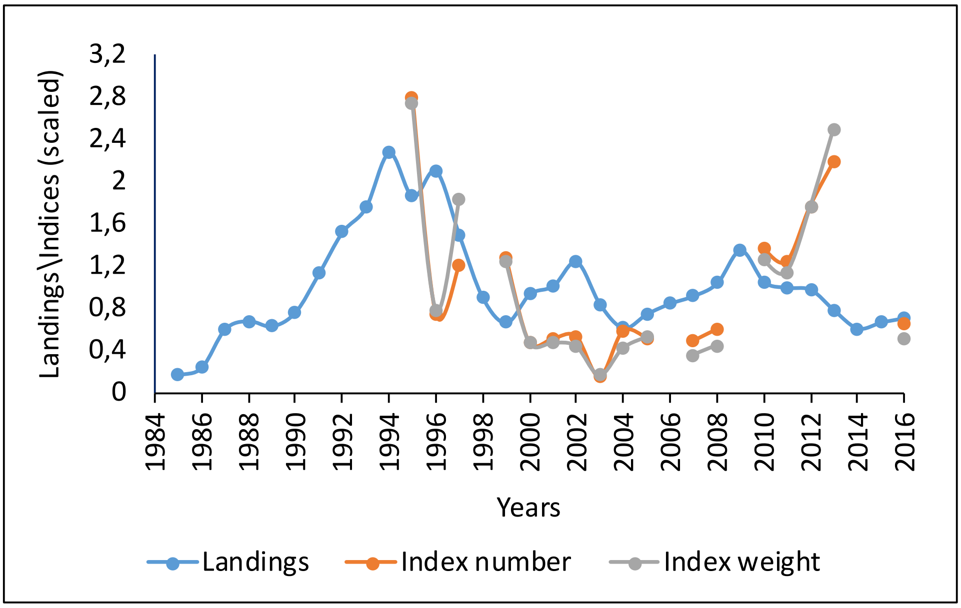


Figure 12.17. Evolution of the alfonsino *Beryx splendens* fishery from the Azores (ICES 10).

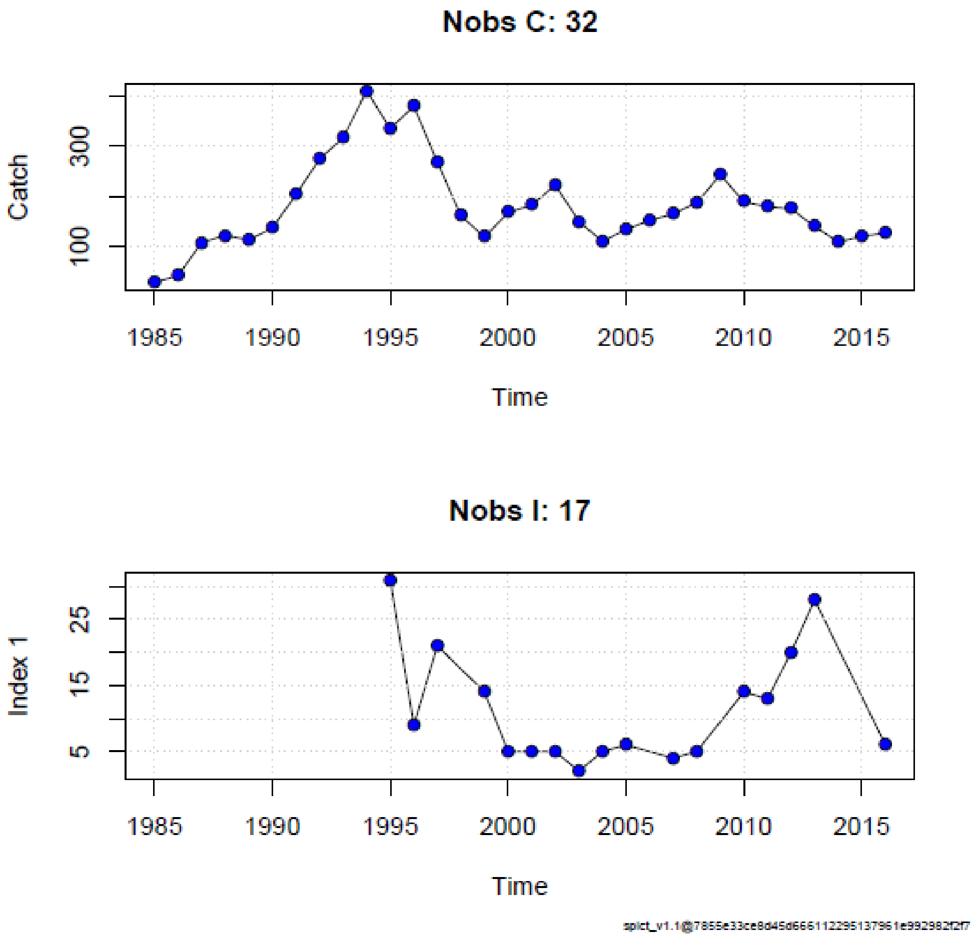


Figure 12.18. Input data, used for SPiCT, of the red seabream from the Azores (ICES 10.a.2).

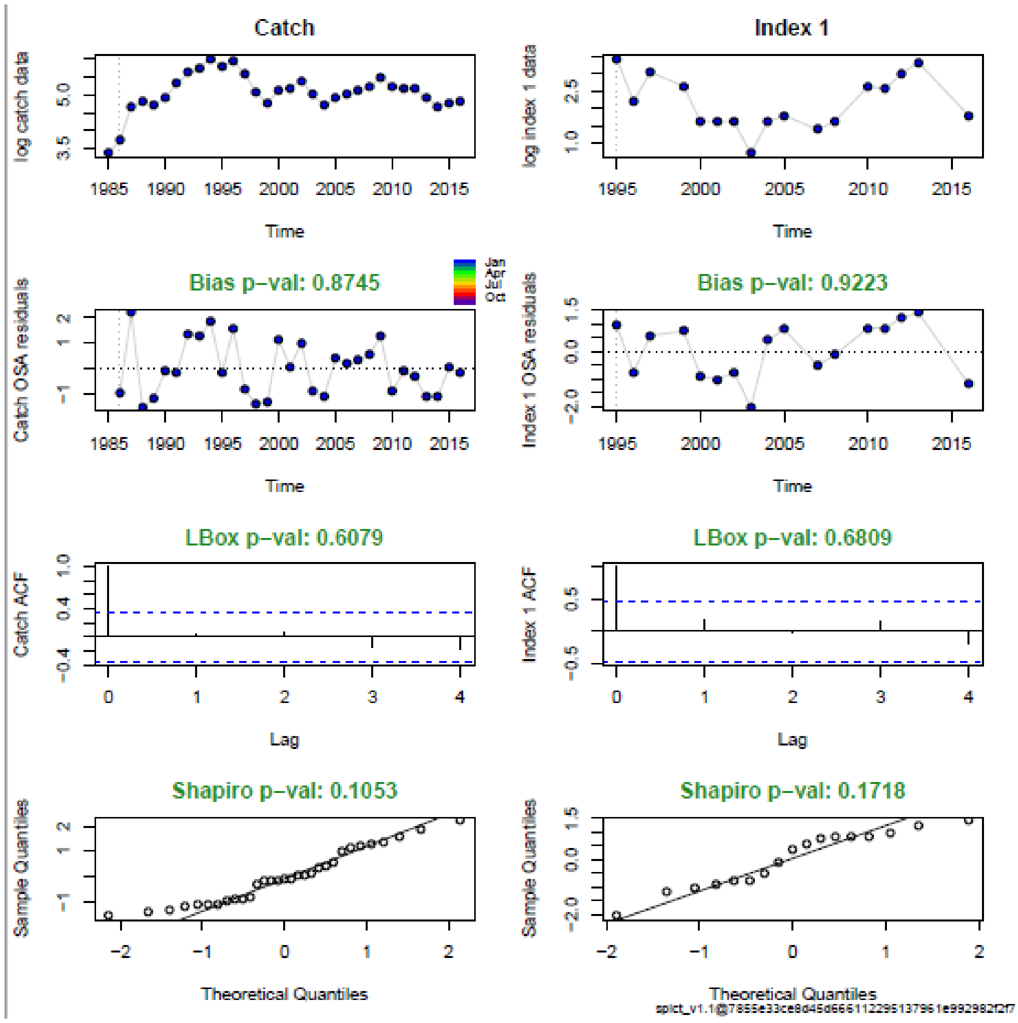


Figure 12.19. Residual results from SPiCT model applies to red seabream from the Azores (ICES, 10).

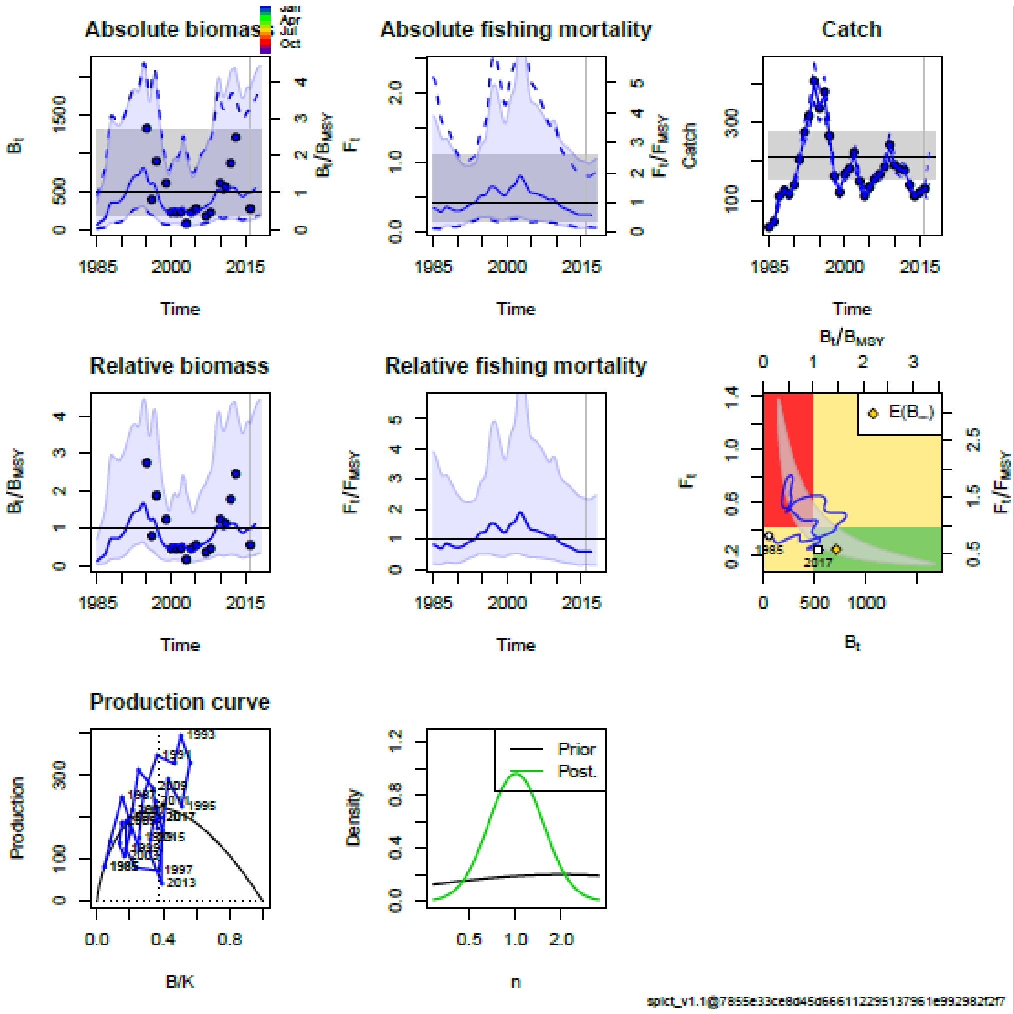


Figure 12.20. Basic results of SPiCT model for the red seabream from the Azores (ICES, 10).

13 Blackspot sea bream (*Pagellus bogaraveo*)

13.1 Stocks description and management units

ICES considered three different components for this species: a) Subareas 6, 7, and 8; b) Subarea 9, and c) Subarea 10 (Azores region), (ICES, 1996; 1998a).

The interrelationships of the blackspot sea bream from Areas 6, 7, and 8, and the northern part of Area 9.a, 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 9.a where the main current fishery currently occurs.

Studies show that there are no genetic differentiation between populations from different locations within the Azores region (east, central and west group of Islands, and Princesa Alice Bank) but there are genetic differences between Azores (ICES Area 10.a.2) and mainland Portugal (ICES Area 9.a) (Stockley *et al*., 2005). These results, combined with the known distribution of the species by depth, suggest that Area 10 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 (6–8, 9 and 10).

13.2 Red (blackspot) sea bream in Subareas 6, 7 & 8

13.2.1 The fishery

From the 1950s to the 1970s, the 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 8.a,b), and by Spanish longliners in the Cantabrian Sea (ICES Division 8.c), 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 (1988–2015), most of the estimated landings from the Subareas 6, 7 and 8 were taken by Spain (68%), followed by France (18%), UK (11%) and Ireland (2%).

The fishery in Subareas 6, 7 and 8 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 8 represent 67% and Subareas 6 and 7 33% of total accumulated landings. At present the blackspot sea bream 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 6, 7 and 8 since the middle of the last century. Figure 13.2.1b shows, in greater detail, landings of the same subareas since 1988. In 2014 UK (Scotland) reported landings for first time in 7.j. This ICES division is however part of the historical area of distribution of the species (Olivier, 1928; Desbrosses, 1932).

For these three subareas combined, landings decreased from 461 t in 1989 to 52 t in 1996, increased again to a peak in 2007 (324 t) and then decreased in following years to 256 t in 2014 and to 164 ton in 2016.

13.2.3 ICES Advice

ICES advices for the period 2015 and 2016 that on the basis of the precautionary considerations, that there should be no directed fishery and bycatch should be minimized.

ICES recommends the establishment of a recovery plan for the stock.

13.2.4 Management

The EU TAC for the Subareas 6, 7 and 8 has been reduced from the 169 t in 2014 to 160 t in 2016. Landings in 2015 and 2016 were slightly above the TAC. A minimum landing size of 35 cm was applied from 2010 to 2012.

Pagellus bogaraveo	TAC		landings	
Subarea	2015	2016	2015	2016
6, 7, 8	169	160	177	164

13.2.5 Data available

13.2.5.1 Landings and discards

The Spanish, French and UK extended landing-series of *P. bogaraveo* in Northeast Atlantic were updated (Figure 13.2.1b). Landings in 2015 and 2016 dropped significantly to 177 t, and 164 t respectively, mainly due to the decrease of landings reported in subareas 6 and 7 since 2013.

Historically, discards are considered negligible. However, from 2014 to 2016 2.4 t, 2.3 t and 0.9 t of discards were reported in all subareas representing 0.6% to 1.3% of the annual catches. As the blackspot sea bream is a highly valued species, it is likely that these reported discards are carcasses in bad condition recovered from nets, misidentification of the species in on-board observation and discards related to low quotas.

Misidentification in on-board observation may occur as the species occurs at low abundance and three similar sparids species occur (*P. acarne*, *P. erythrinus*, *P. bellotii* and *Pagrus pagrus*). Discards resulting from low quotas are compulsory as the fishery for the species was closed. In 2015 and 2016, discards in French fisheries may have resulted from legal closures of quota (MEDDE, 2015; MEEM, 2016).

13.2.5.2 Length compositions

This year's length–frequency distribution of commercial landings and discards in 2015 and 2016 are presented (Figure 13.2.2).

13.2.5.3 Age compositions

No age data were available to the working group. No age estimations are carried out for this stock.

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 the 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 sea bream is rarely caught in the northern surveys by French EVHOE IBTS (Divisions 8.f,g,h,j; 8.a,b, and 7.d) and Irish IGFS (Divisions 6.a South and 7.b) and in the Northern Spanish Shelf Groundfish Survey (SP-NGFS in Divisions 8c and 9a). In French surveys, similar to the current western IBTS, from early 1980s when the stocks were already low it was still in 40–60% 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.

P. bogaraveo is a scarce species in the Northern Spanish Shelf Groundfish Survey (Ruiz-Pico *et al*., 2017). In 2014 for first time in last three years the Northern Spanish Shelf bottom-trawl survey (SP-NGFS) reported catches of only 0.02 kg/hour (juveniles from 21 cm to 24 cm). In 2015 this species reached a high abundance value compared to the mean values of the time-series, both in biomass and number, except the values of 1998 and 2005, unusually high (Figure 13.2.3). In 2016, it was only found in three hauls and the stratified biomass was 0.031 Kg·haul^{-1}. This last survey the biomass and abundance dropped after the slight increase of 2015 (Figure 13.2.3).

The few specimens found this last year ranged from 19 cm to 31 cm, similar to 2015 but with the absence of the smallest individuals of 16 cm and 17 cm (Figure 13.2.4).

The geographic distribution of *P. bogaraveo* remained similar to 2015, with a spot of biomass in the central area of the Cantabrian Sea (Figure 13.2.5).

Catch of blackspot seabream in the EVHOE survey have been too rare to allow the calculation of a survey indicator. However, data from the survey are in accordance with a possible recent increase. In particular, a large catch of more than 1000 individuals occurred in the 2016 survey. Although, one single event is not significant, it is noteworthy that it occurred in the area where on-board observations of the species occur and fishers report an increase occurrence. These indications do not allow revising the stock status which should still be considered to lag below any possible reference point. They however imply that a rebuilding has probably started. A quick appraisal of the level of occurrence that would be expected if the stock rebuilt to past levels can be found from two surveys carried out in the Bay of Biscay only in 1973 and 1976 with the same protocol and gear as the current EVHOE survey, but covering only strata of Bay of Biscay shelf up to 200 m (Figure 13.2.6).

In 1973 and 1976, blackspot seabream was caught in 25% and 55 % of the hauls respectively (Figure 13.2.7). Since the start of the current survey series in 1987, it has always been caught in less than 5% of the hauls in the same strata, some years not at all. In the same strata, it was caught in one out of more than 60 in each of 2015 and

2016. Therefore a ten to thirty-fold increase in occurrence might occur to consider that the stock rebuilt to level from the 1960s and 1970s, where catch amounted to 15 000 t/year.

The current monitoring with on-board observations and the EVHOE survey is insufficient to monitor this rebuilding accurately, while the stock is still low. The increase occurrence in on-board observations is however consistent with fishers reporting more encounter. If the increase persists, which is likely under the current management, occurrences in on-board observations and the survey might become significant in the next few years.

13.2.6 Data analyses

2014 was the second year with a new vessel, the R/V *Miguel Oliver*, carrying the demersal groundfish survey on the northern Spanish Shelf. Data from the 2013 survey indicated differences in the catchability of some species, especially the benthic ones and an additional intercalibration experiment between R/V *Cornide de Saavedra* and the new vessel was carried out. A problem with the sweeps used in 2013 survey was detected, and the data from 2014 seem more coherent with the previous time-series. Nevertheless, as stated in 2014, the possible effect of species with a more "pelagic" behaviour such as blackspot sea bream are not clear, but given the variability and the fact that this species appears mainly in the shallower hauls not considered within the stratified abundance indices reduces the importance of this change for this species.

Landings since 1988 are well below those recorded in the period from 1960 to 1986 in which landings ranged from 2000 t to up to 13 000 t (Figure 13.2.1a). Catches recorded in the surveys are very scarce and are mainly juveniles smaller than 30 cm.

There are reports from fishers that the abundance of the blackspot seabream is increasing to the north of the Bay of Biscay, between 47 and 48°N. This latitude range is the main area where small catch of blackspot seabream have occurred in the 2000. When TACs were set from 2003, there were some conflicts between métiers in this area mainly with small artisanal handliners requesting vessels targeting pelagic species, mostly sardine with trawls and seine, to avoid any bycatch of blackspot seabream. The introduction of the TAC and national quota had an impact on fishing practices.

In the same area, fishers report to encounter more frequently the species in recent years. This was investigated using on-board observations in French fisheries (Figure 13.2.8). The method used consisted in estimating the proportion of fishing operations where the species was caught (landings and discards combined) in French on-board observations to the south of 49°N. The limit at 49°N north was set to include the south of the Celtic Sea to the West of Brittany, where the species was historically abundant. This was made for all bottom trawls types combined and all bottom nets combined for years 2010 to 2016. Some increasing trend in the proportion of hauls with catch of the species can actually be seen for bottom trawls, although the proportion of positive hauls is still small (Figure 13.2.9).

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

In the 2014 advice, ICES recommends the establishment of a recovery plan for the stock. This stock is collapsed and the advice is to reduce mortality by all means to allow the stock to rebuild, however nor a recovery plan nor scientific studies to support this recommendation have been ever applied in these subareas, only a minimum landing size of 35 cm was applied but only for the period from 2010–2012.

Measures should include protection for areas where juveniles occur. Recreational fisheries may be a significant proportion of the mortality of those juveniles owing to their coastal distribution. This was confirmed for the stock in Subarea 10 (Pinho, 2015).

The TAC was exceeded in 2007, 2010, 2012, 2013, 2014 and 2015.

13.2.9 References

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Table 13.2.1a. Red blackspot sea bream in Subareas 6 and 7; WG estimates of landings by country.

YEAR	FRANCE*	IRELAND	SPAIN	UK (E & W)	CH. ISLANDS	UK (Scot)	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		118				156
2013	28		146	4			178
2014	15		35	9		0	60
2015	13	0	21				34
2016	24	0	15	1		0	40

Table 13.2.1b. Red blackspot sea bream in Subarea 8; 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
2014	36	161	0	196
2015	18	125	0	143
2016	7	117	0	124

Table 13.2.1c Red blackspot sea bream in Subareas 6, 7 and 8; WG estimates of landings by subarea.

YEAR	6 AND 7*	8*	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	156	101	257
2013	178	117	295
2014	60	196	256
2015	34	143	177
2016	40	124	164

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

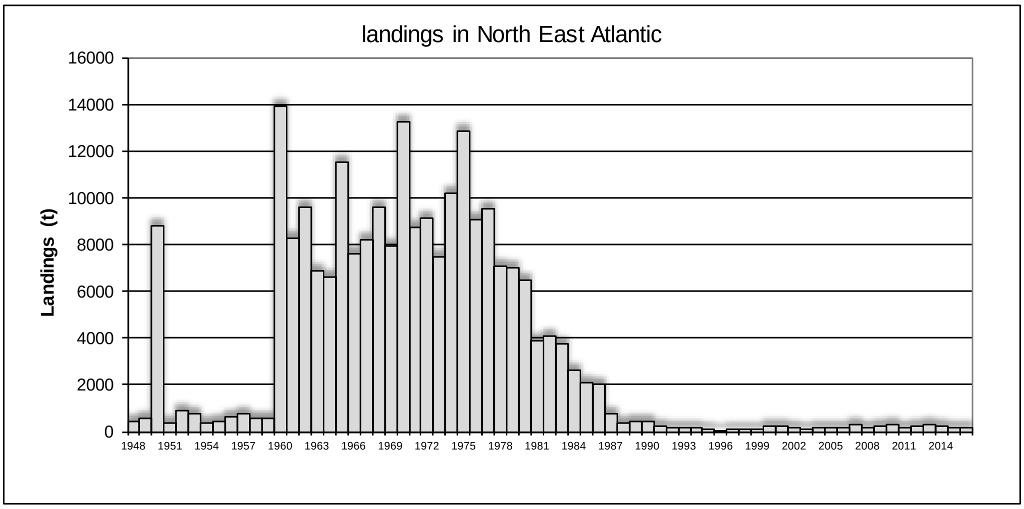


Figure 13.2.1a. Time-series of Red blackspot sea bream landings from 1948–2015 in Northeast Atlantic (Subareas 6, 7 and 8).

Reference/Source (1) of reconstructed landings data for blackspot sea bream in the Bay of Biscay	
France	-Years 1977–1987: Landings of *P.bogaraveo* (*sic*?) from the Northeast Atlantic. M. Pinho, pers. com. Source: SGDeep 1995. -Years 1950–1984: Landings of *Pagellus* sp. ("sea breams") from the Northeast Atlantic. Source: Dardignac (1988), quoted by Castro (1990). SGDeep
Portugal	-Years 1948–1987 Subarea 10: 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 9: Landings of *P.bogaraveo* (*sic*?). M.Pinho, pers. com. Source: H. Krug (for 1948–1969) and SGDeep 1995 (for 1970–1987).
Spain	-Years 1960–1986: Landings of *Pagellus* sp. ("sea breams") from the Northeast Atlantic. Source: Anuarios de Pesca maritima. Castro (1990). SGDeep 1996.Table 13.2.3. -Years 1983–1987: Landings of *P.bogaraveo* (*sic*) from Division 9.a correspond only to southern 9.a (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 8.c" mainly Division 8.c (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 1988–2015 WGDeep official data

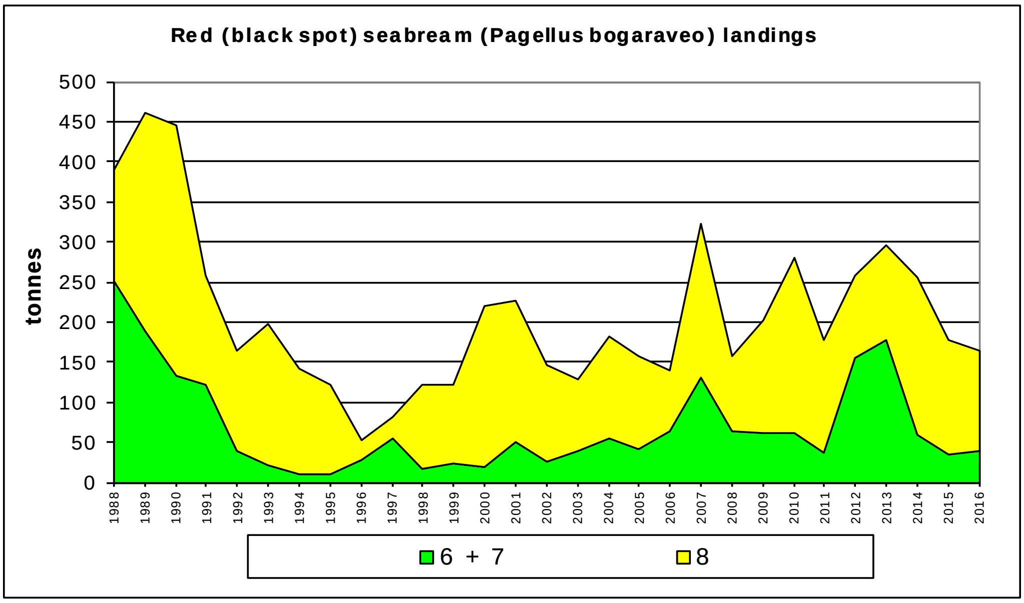
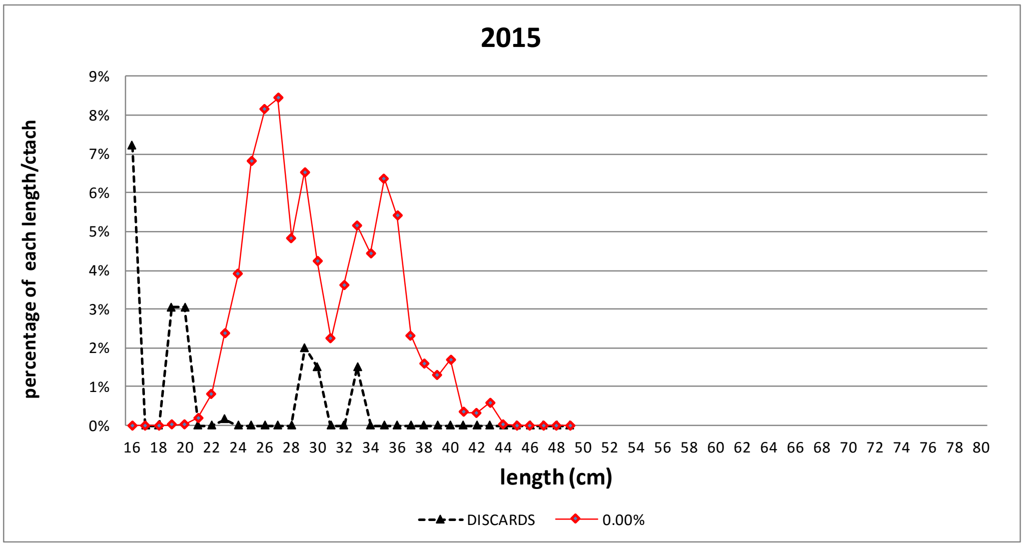


Figure 13.2.1b. Red blackspot sea bream landing trends in ICES Subareas 6 and 7 since 1988.



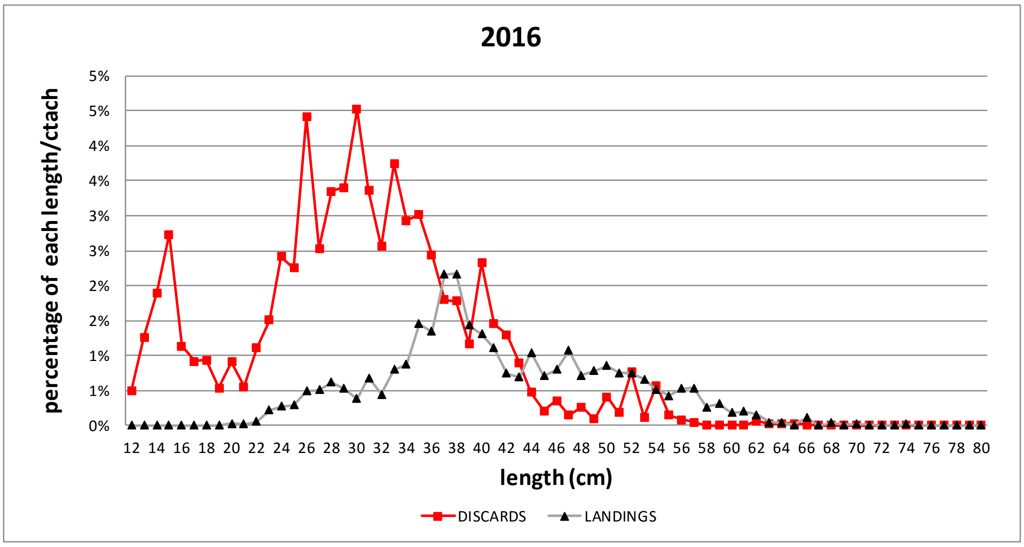


Figure 13.2.2. Length frequencies of the Red blackspot sea bream in commercial catches, landings and discards in 2015 and 2016 in Subareas 6, 7 and 8.

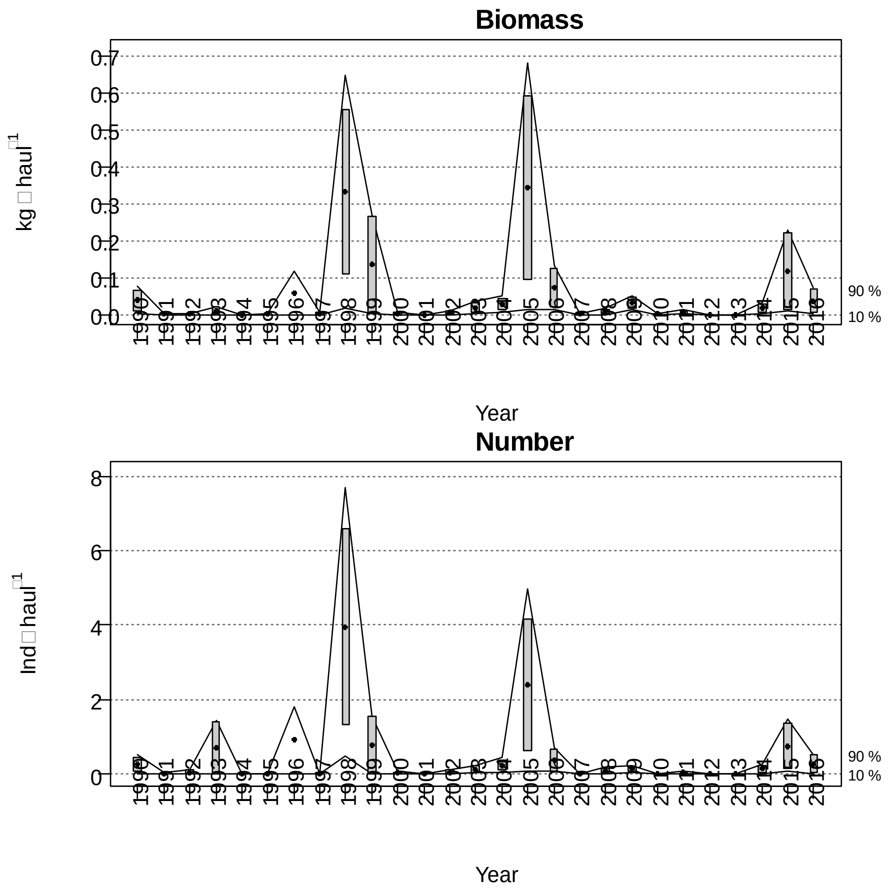


Figure 13.2.3. Evolution of Red blackspot sea bream (*P. bogaraveo*) mean stratified abundance in Northern Spanish Shelf survey time-series (1990–2016).

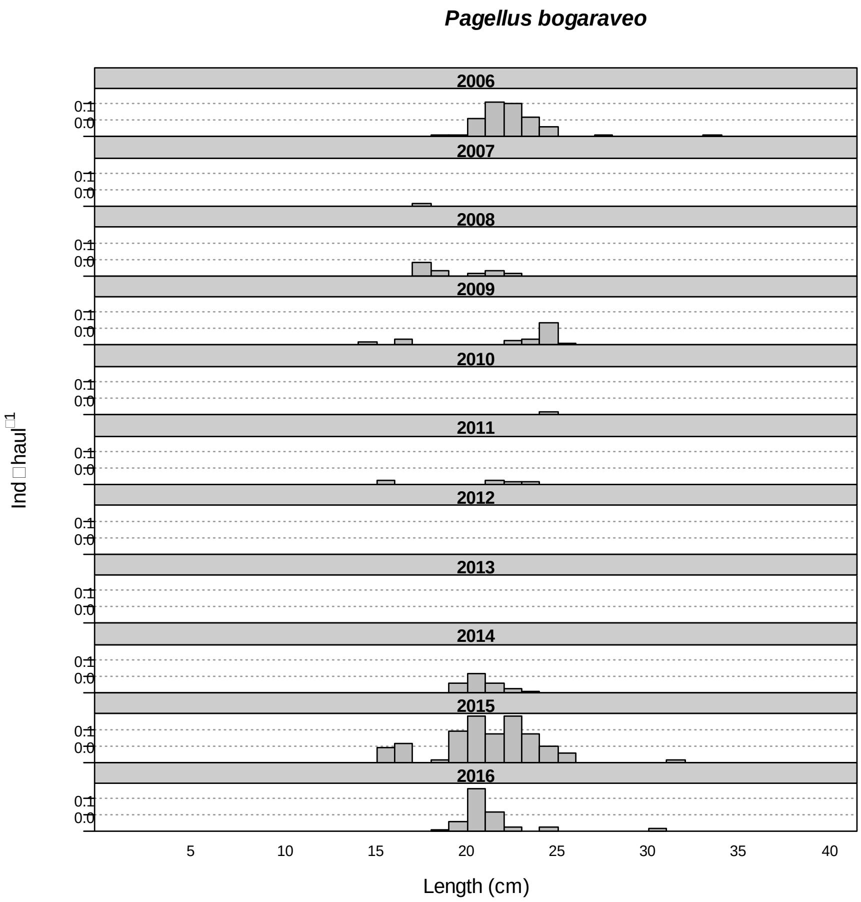


Figure 13.2.4. Mean stratified length distributions of Red blackspot sea bream (*P. bogaraveo*) in Northern Spanish Shelf surveys (2003–2016).

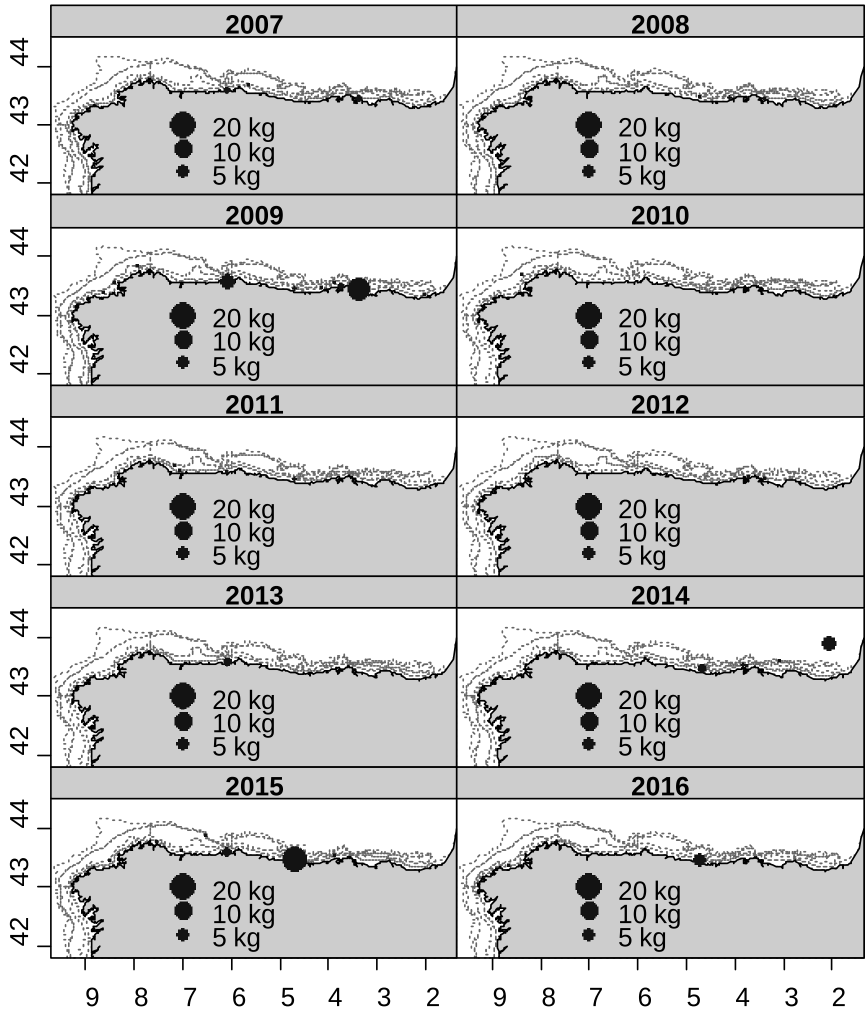


Figure 13.2.5. Catches in biomass of Red blackspot sea bream on the Northern Spanish Shelf bottom-trawl surveys, 2003–2016.

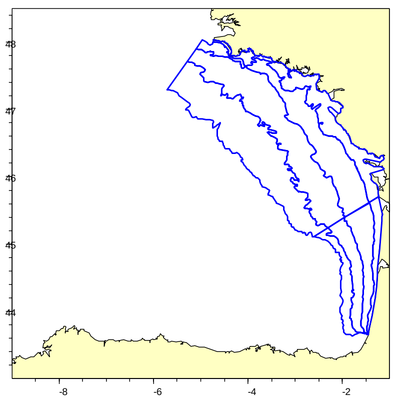


Figure 13.2.6. Strata covering the Bay of Biscay shelf, sampled in the current EVHOE survey and in two previous surveys in 1973 and 1976.

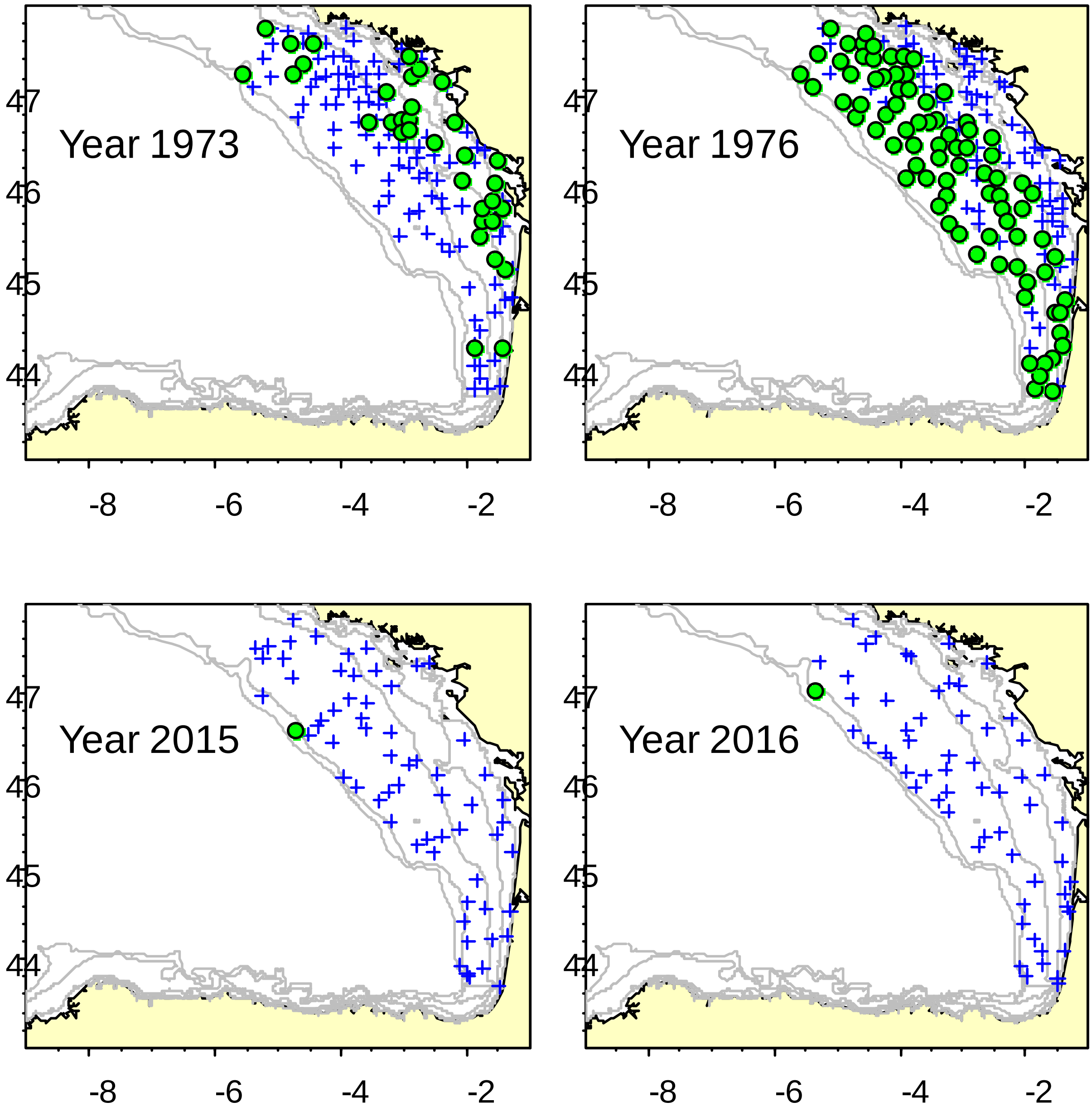


Figure 13.2.7. Occurrences of Red blackspot sea bream in surveys carried out in 1973 and 1976 and in the EVHOE survey in 2015 and 2016.

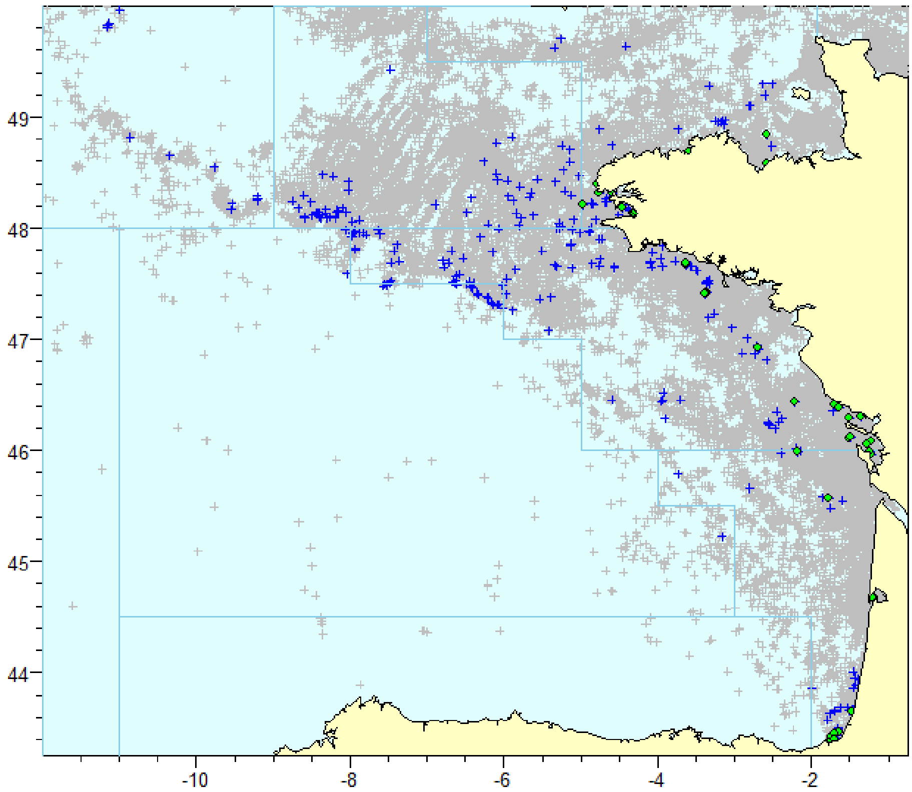


Figure 13.2.8. Geographical distribution on catch of the Red blackspot sea bream in French on-board observations 2010–2016 in the Bay of Biscay and southern Celtic Sea, all métiers. (Grey) all haul/sets observed, (Blue crosses) hauls with catch of blackspot seabream, (Green dots) hauls with catch of blackspot seabream<20 cm which species identification may be uncertain.

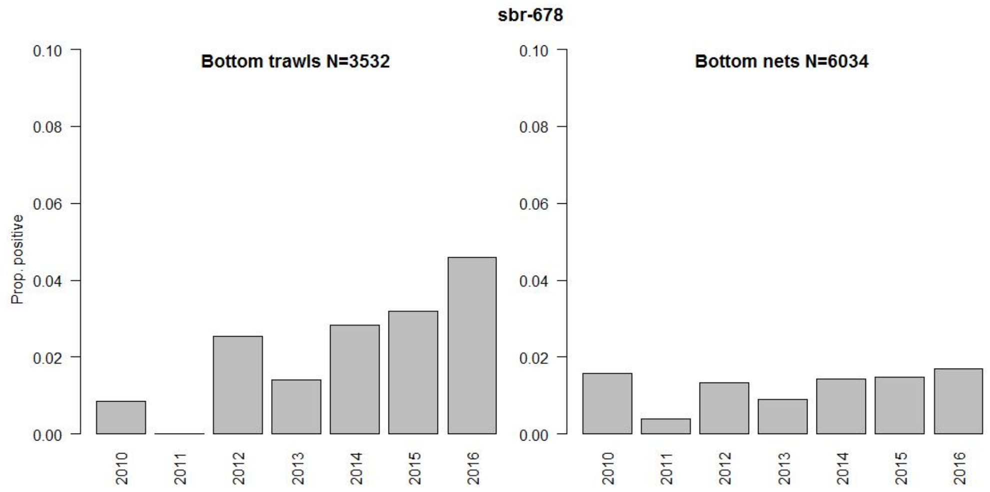


Figure 13.2.9. Proportion of fishing operations with catch of Red blackspot sea bream in bottom trawls (left) and bottom net (right) in French fisheries to the south of 49°N (ICES Divisions 8.a–d and the southern part of 7.d and 7.h–k).

13.3 Blackspot sea bream (*Pagellus bogaraveo*) in Subarea 9 (Atlantic Iberian waters)

13.3.1 The fishery

Pagellus bogaraveo is caught by Spanish and Portuguese fleets in Subarea 9. Spanish landings data from this area are available from 1983, Portuguese data from 1988 and Moroccan information from 2001 till 2013. European landings in Subarea 9, most of which are taken with lines, are from Spain (>60%) and Portugal (<40%) 2012–2016.

An update of the available information on the Spanish target fishery, from the southern part of Subarea 9, Strait of Gibraltar area, has been provided to the Working Group (Gil *et al.*, WD to the WGDEEP 2017). 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 near, i.e. mostly less than 20 nautical mile, the main ports (Tarifa and Algeciras). So, it should be noted that not all the catches/landings come exclusively from ICES Subarea 9: however it was considered from the same stock although the fishing grounds encompass areas of different Regional Organizations/Commissions (ICES, GCFM and CECAF). Fishing takes advantage of the fluctuation of the tide at depths from 350 to 700 m with "*voracera*" gear, a mechanized handline. Since 2002 other artisanal boats have joined the blackspot sea bream fishery from Conil port, although they operate in other fishing grounds and use longlines. This section of the fleet counts currently about six boats. Landings are aggregated into commercial categories due to the wide size range of the catch and size varying prices. Historically these categories have varied with time but from 1999 onwards have remained the same in all ports.

In addition, Moroccan longliners have been fishing in the Strait of Gibraltar area since 2001. These are about 102 boats that are mainly based in Tangier. The average technical characteristics of these boats are: 20 GRT and 160 HP. Moreover, 435 artisanal boats (±15 CV, ≤2 GRT and 4–6 m length) also target this species in the Strait of Gibraltar area (COPEMED II, 2015). 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. Landings information was available only up to 2013

(COPEMED II, 2015) and no information from the Moroccan fishery is available for the last three years.

Detailed information from Portuguese fisheries has been provided to the Working Group by Araújo *et al.* (WD to the WGDEEP 2017). As well as in other Spanish places in Subarea 9, it is admitted that there is no target fishery towards Red (blackspot) sea bream in Portugal mainland: the species is usually caught as bycatch of fisheries targeting other species. The majority of deep-water species landings as fresh fish in mainland Portugal correspond to the polyvalent fleet, which uses mainly longlines, while landings from trawlers are the second more relevant. The main landing ports (≈89% of the species mainland Portugal total landings) from North to South are: Matosinhos, Aveiro, Nazaré, Peniche, Sesimbra and Sagres. Among those, higher landings were registered in the southern ones (Peniche, Sagres and Sesimbra), possibly due to a higher abundance of the species in the nearby fishing grounds. Landings fluctuated along the year and the higher ones were generally registered in the first months: this pattern could reflect differences on the species' availability or differences dues to skippers' seasonal fishing grounds preferences (Aráujo *et al*., WD to the WGDEEP 2017).

13.3.1.1 Landing trends

Since 1990, the maximum catch was reached in 1993–1994 and 1997 (about 1000 t) whereas the minimum (180 t) in 2013 (Figure and Table 13.1.1). Without the Moroccan landings, compared to the minimum from 2013–2015, landings increased more than the 160% in the whole Subarea 9. In addition Gil *et al*. (WD to the WGDEEP 2016) reported more than the 252% in the Strait of Gibraltar fishery. Landings decreased again in 2016. It should be noted that not every Spanish landings from the Strait of Gibraltar come only from ICES Subarea 9.

13.3.2 Advice

The ICES advice for 2017 and 2018 was: "that when the precautionary approach is applied, catches should be no more than 138 tonnes in each of the years 2017 and 2018. All catches are assumed to be landed. ICES notes that the distribution of the stock extends outside Subarea 9 and catch statistics are incomplete. ICES recommends the establishment of a management plan that covers the entire stock distribution area."

13.3.3 Management

Since 2003, TAC and Quotas have been applied to the blackspot sea bream fishery in Subarea 9. The following table shows a summary of *P. bogaraveo* recent years TACs (and European countries landings) in this Subarea:

P. BOGARAVEO	2011-2012		2013-2014		2015-2016		2017-2018	
ICES Subarea	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings
9	780–780	333–295	780–780	180–262	374–183	153 (295*)–165 (242*)	174-165	

***from InterCatch info: Including landings from FAO 34.1.11 and FAO 37.1.1.**

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 6, 7 and 8. Currently, there is no longer a minimum landing size in the TAC regulation but the EU might consider the Mediterranean Minimum Conservation Reference Size (MCRS) of 33 cm as an appropriate for this species in the Atlantic NE. Measures on this matter might be expected in the close future.

European landings have always been far below the adopted TACs although these have been reduced over the years. However, in the last year (2016), considering other areas such as FAO 34.1.11 and FAO 37.1.1, European countries landings (242 t) is above the 2016 TAC (183 t) for ICES Subarea 9 (Figure 13.1.1).

13.3.4 Stock identity

Stock structure of the species in ICES Subarea 9 still unknown.

Several tagging surveys (56 days at sea in 2001, 2002, 2004, 2006 and 2008) have been conducted in the Strait of Gibraltar area. A total of 4500 fish were tagged of which 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.

Araújo *et al*. (WD to the WGDEEP 2017) presents information of blackspot sea bream spatial distribution from Portuguese research surveys. In continental Portugal this species distributes along the coast, but has been preferentially caught in the southern waters. It seems to have a patchy distribution; occurring predominantly in the same areas over the years where the groundfish survey take place, frequently at the Arrifana depth strata from 200 to 500 meters depth (Figure 13.1.2).

13.3.5 Data available

13.3.5.1 Landings and discards

Historical landing dataseries available to the Working Group are described in Section 13.1.1 and detailed in Figure 13.1.1. It should be remembered that 2015 and 2016 landings includes other areas, not only ICES Subarea 9.

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 those that do occur are mainly related to catches of small individuals: therefore, for this stock, all catches are assumed to be landed at this moment.

13.3.5.2 Length compositions

Length frequencies of landings are available for the Spanish "*voracera*" blackspot sea bream target fishery in the Strait of Gibraltar (1983–2016). Figure 13.1.3 show the updated length distribution data (from Gil *et al*., WD to the WGDEEP 2017). The table below shows the mean and median landed size since 1990:

Year	Mean	Std. Dev.	Median	Year	Mean	Std. Dev.	Median
1990	38.39	5.61	39	2004	36.56	5.69	35
1991	39.94	6.20	40	2005	36.79	6.02	35
1992	40.10	6.61	40	2006	35.87	5.58	35
1993	39.98	6.65	40	2007	37.26	5.95	36
1994	39.92	6.33	40	2008	37.76	6.22	36
1995	36.70	6.49	36	2009	38.29	6.23	37
1996	36.72	6.52	35	2010	36.06	5.29	35
1997	35.98	6.38	35	2011	36.31	6.37	34
1998	34.33	5.07	34	2012	36.39	5.90	35
1999	36.23	5.30	36	2013	34.76	3.59	34
2000	36.79	4.81	36	2014	37.11	5.14	36
2001	37.11	5.45	37	2015	39.08	6.27	38
2002	38.10	5.93	38	2016	37.47	5.28	37
2003	38.35	6.27	38				

Only one mean value (in 1998) is lower than the 2013 year´s mean landing size. Median values are well below the mean in recent years. However, changes are small and gradual. There seem to be a long-term decline, despite the mean length ups and downs over the last decade (Figure 13.1.3).

Portuguese research surveys and commercial fleet data are now available (Araújo *et al.*, WD to the WGDEEP 2017). There is a clear increase of specimens' length with depth (Figure 13.1.4): mean length by depth strata is similar between the two Portuguese surveys (100–300 m depth strata). However, overall data suggests that Groundfish survey catches a greater amount of smaller specimens. Figure 13.1.5 shows length–frequency distribution by gear in Peniche landing port from 2009 to 2016: longlines caught a major proportion of larger fish (30–40 cm) while gillnets and bottom trawl get smaller (25–30 cm).

13.3.5.3 Age compositions

Age and growth, based on otolith readings, were revised at the ICES, WKAMDEEP meeting (October, 2013): The maximum age was estimated at ten years of age based on otolith readings in the Strait of Gibraltar area. However two tags from the tag–recapture programme were recaptured after 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 these biased age estimates may have substantial consequences.

13.3.5.4 Weight-at-age

No new information was presented to the group.

13.3.5.5 Maturity and natural mortality

No new information was presented to the group.

13.3.5.6 Catch, effort and research vessel data

Figure 13.1.6 presents cpue information, restricted to the Strait of Gibraltar fishery (Gil *et al.*, WD to the WGDEEP 2017). Effort, as indicated, from sales sheets is not standardized and is potentially an underestimate in some years as the effort unit chosen may be inappropriate while standardized cpue estimated from VMS analysis shows the same trend.

Figure 13.1.7 presents mean catch rates from the two main gears used at Peniche port: polyvalent and trawl. Results have been quite stable for the polyvalent fleet while the trawler fleet has been more variable from 2009 to 2016 (Araújo *et al.*, WD to the WGDEEP 2016).

13.3.5.7 Data analyses

From Figure 13.1.1 the trend is fairly clear; although Moroccan landings from the Strait of Gibraltar are not available from the years 2014 to 2016. Landings have declined significantly till 2013 which may be considered as an indication of a substantial reduction in exploitable biomass. Mean length distribution and cpue decreasing trends throughout these years may also be consistent with an overexploited population. However, in the most recent years (2014 and 2015) all signals (landings, cpue and length distribution) showed increasing signs but without any evidence of its sustainability and in 2016 drops again.

A discrete biomass–abundance dynamic model was implemented by Gutiérrez-Estrada *et al*. in 2017 to obtain a simulated monthly time-series of blackspot sea bream biomass from the Strait of Gibraltar Spanish target fishery information: the proportion of variance non-explained by the AutoRegressive Integrated Moving Average (ARIMA) fitted models was correlated with a time-series of sea surface temperature (SST) and North Atlantic Oscillation (NAO). The analysis of global, annual and winter correlation between the proportion of variance not explained by the ARIMA models and environmental variables showed that significant associations were not detected over the full time-series. So, in the Strait of Gibraltar, overexploitation might be the main factor for the commercial depletion of the blackspot seabream population.

13.3.6 Comments on the assessment

An exploratory assessment (gadget model) was presented to the Group. Model definition and the estimated parameters are conditioned by the available information. It should be remarked that this preliminary model was developed only with the Spanish target fishery information ("*voracera*" fleet). So, the effect of the inclusion of Morocco data from the Strait of Gibraltar area is unknown but it is desirable its future incorporation to the model.

13.3.7 Management considerations

A TAC regime (174 and 165 t) was established for 2017 and 2018 for whole Subarea 9. Although the advice aims to reduce total catch within the whole fishing area, it should be noted that the current TAC does not limit the whole fishery because it only applies to Subarea 9, nevertheless catches in the GFCM area 37.1.1 and CECAF area 34.1.11 shall be reported (Council Regulation (EU) 2016/2285). Recent landings are far below previous TAC levels but in the last year, 2016, landings (including other areas such as FAO 34.1.11 and FAO 37.1.1) are above the 2016 TAC.

Only the Spanish target fishery ("*voracera*" gear) in the Strait of Gibraltar is under a local fishing plan. Therefore, from a precautionary point of view, the local technical measures adopted, such as an authorized vessels list, the cessation fishing for two and half months, (during the period of 15th January–31st March), should be continued or even expanded. It is suggested to enforce a minimum retainment- and landing size. In 2013, the minimum landing size for the species in Spain on the Atlantic part was reset to 25 cm whereas in the Mediterranean it is 33 cm. A common minimum landing size is desirable in both sides of the Strait of Gibraltar. The combination of a future minimum size of 33 cm for the species in the NE Atlantic (which is already applied in the Mediterranean) and the landing obligation (EU Regulation 2013/1380) might have an effect on this fishery.

WGDEEP reiterates its advice of a need for a recovery plan for the Strait of Gibraltar fisheries: vital to its success is the involvement of non-EU countries (primarily Morocco).

As well as in other ICES Subareas (6, 7, 8 and 10), measures should include protection for areas where juveniles occur: recreational fisheries may be a significant proportion of the mortality of those juveniles owing to their coastal distribution.

Besides, it may be considered not appropriate to infer the population status of the Red (blackspot) sea bream from the Strait of Gibraltar data, where an intense target fishery is known to take place to the whole ICES Subarea 9. Alternates such as the definition of functional units for assessment and management purposes, like in the Norway lobster (*Nephrops norvegicus*) case, appears to be a more reasonable solution (Araújo *et al*., WD to the WGDEEP 2017).

13.3.8 Application of MSY proxy reference points (ToR h)

Figures 13.1.8 and 13.1.9 presents the preliminary results of the SPiCT model attempted within the WGDEEP 2017. Surprisingly, the model does not have problems fitting the data inputs: blackspot seabream landings (1983–2016) and cpue from VMS (2009–2016). However, the WG considers that the estimates (with wide confidence intervals) are not in conformity with the current perception of the stock status. Further work should be done for the application of MSY proxy reference points (based on SPiCT and/or Length Based Indicators) in order to produce relevant results.

Table 13.1.1. Blackspot sea bream (*Pagellus bogaraveo*) in Subarea 9: 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

Year	Portugal	Spain	Morocco	Unallocated	TOTAL
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	146	92	295
2013	90	91	118		180
2014	59	203	n/a		262
2015	66	87 (142*)	n/a		153 (295*)
2016	70	95 (77*)	n/a		165 (242*)

***Figures in brackets includes blackspot sea bream from other areas (FAO 34.1.11. and FAO 37.1.1): 153 t in ICES 9, 64 t in FAO 34.1.11 and 78 in FAO 37.1.1 for the total (without Morocco) in 2015 landings and 165 t in ICES 9, 29 t in FAO 34.1.11 and 48 in FAO 37.1.1 for the total (without Morocco) in 2016 landings.**

Table 13.1.2. Spanish "*voracera*" blackspot sea bream fishery of the Strait of Gibraltar (ICES Subarea 9): Estimated cpue using sales sheets or VMS data as effort unit (adapted from Gil *et al.*, WD to the 2017 WGDEP).

YEAR	CPUE	VMS CPUE
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
2014	39	22
2015	49	32
2016	41	27

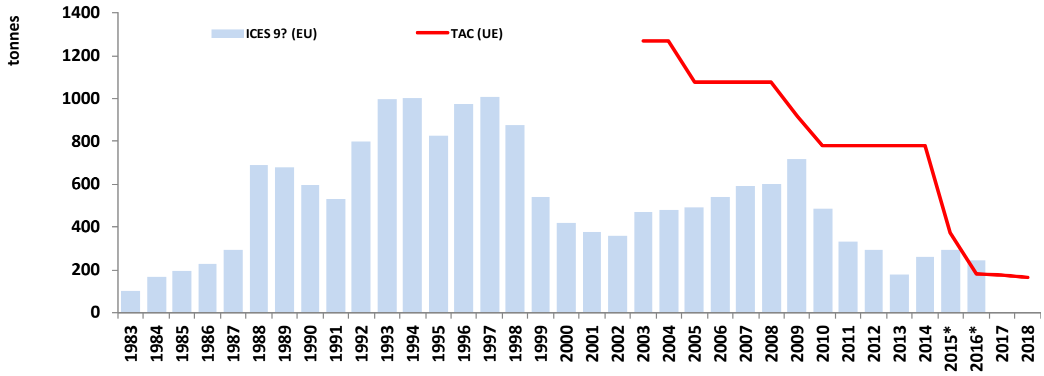


Figure 13.1.1. Blackspot sea bream in ICES Subarea 9: Total European landings (Morocco landings are not included) and EU TACs. *In 2015 and 2016 landings from Strait of Gibraltar includes other areas (FAO 34.1.11 and FAO 37.1.1).

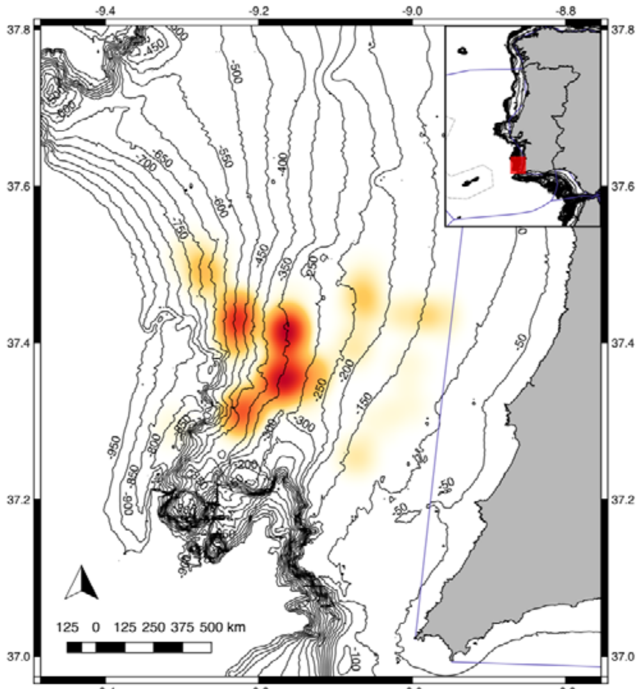


Figure 13.1.2. Blackspot sea bream in ICES Subarea 9: density distribution at the Arrifana depth strata, from 200 to 500 meters (from Araújo *et al.*, WD to the 2017 WGDEEP).

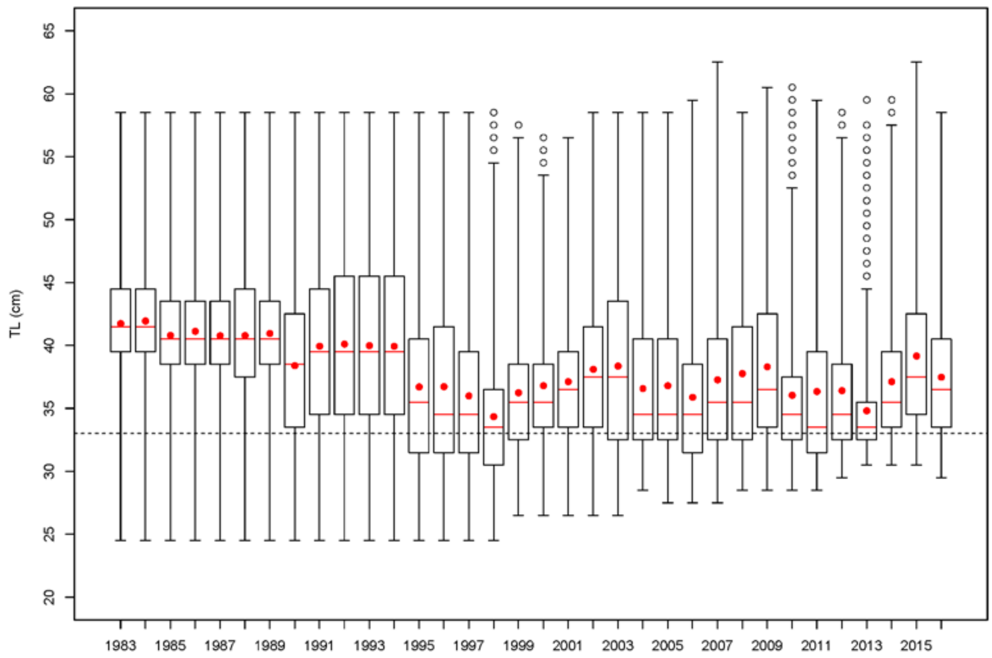
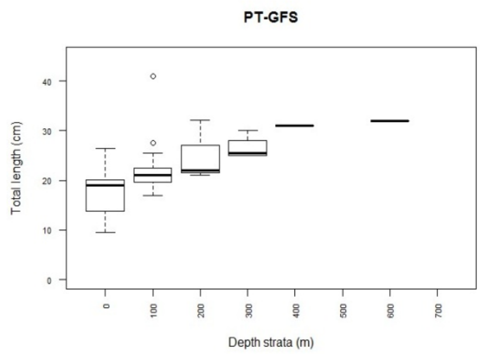


Figure 13.1.3. Spanish "*voracera*" blackspot sea bream fishery of the Strait of Gibraltar: 1983–2016.



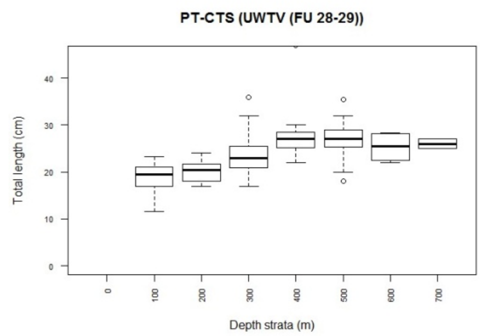


Figure 13.1.4. Backspot sea bream in ICES Subarea 9: Boxplot of length distribution of *P. bogaraveo* by depth strata based on the the Portuguese Autumn Groundfish Survey (PT-GFS), between 1990 and 2015 (no survey was conducted in 2012) and the Portuguese crustacean surveys/*Nephrops* TV Surveys (PT-CTS (UWTV (FU 28–29)) undertaken between 1997 and 2015 (no survey was conducted in 2012) (from Araújo *et al.*, WD to the 2017 WGDEEP).

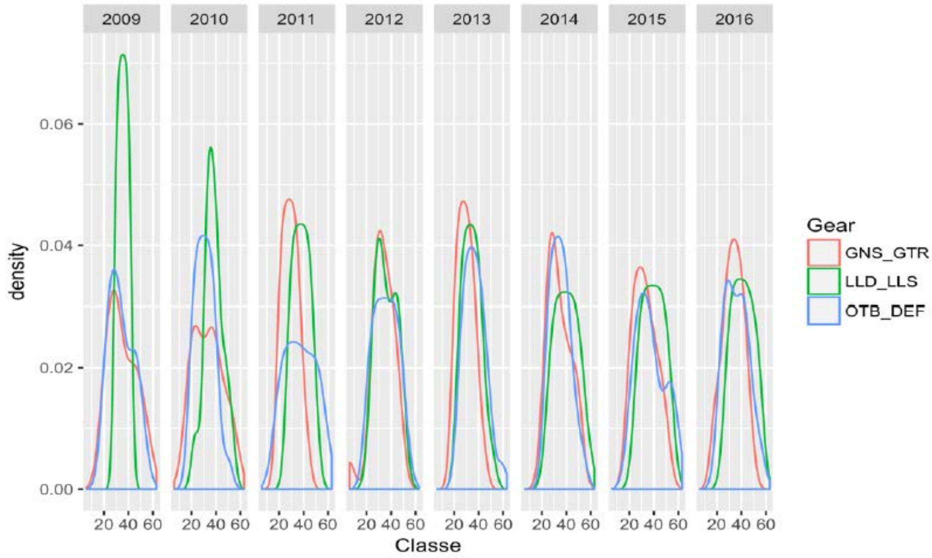


Figure 13.1.5. Blackspot sea bream in ICES Subarea 9: length–frequency distribution by gear (longlines, gillnets and bottom trawl) in Peniche landing port(from Araújo *et al.*, WD to the 2017 WGDEEP).

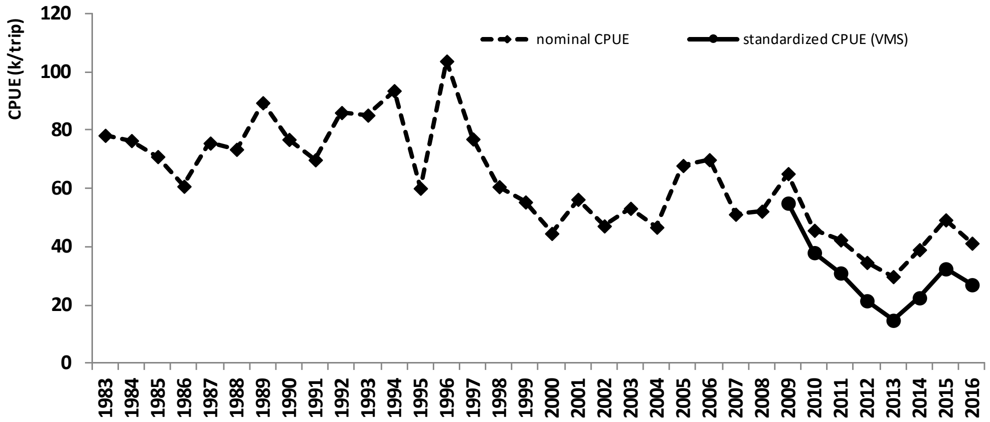


Figure 13.1.6. Blackspot sea bream in ICES Subarea 9: Spanish "*voracera*" fishery of the Strait of Gibraltar estimated cpue using sales sheets (dashed line) and VMS data as unit of effort (solid line) (from Gil *et al.*, WD to the 2017 WGDEEP).

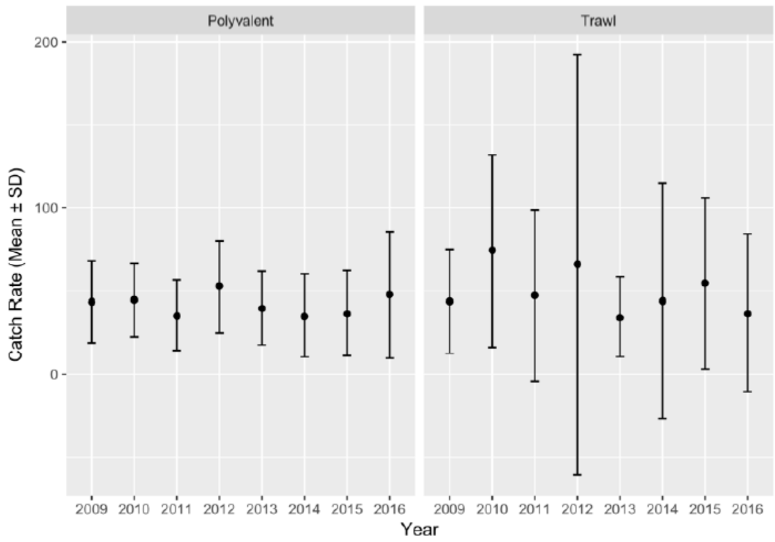


Figure 13.1.7. Blackspot sea bream in ICES Subarea 9: Mean catch rate of *P. bogaraveo* for the polyvalent and trawl fleets landed in Peniche port, from 2009 to 2016 (from Araújo *et al.*, WD to the 2017 WGDEEP).

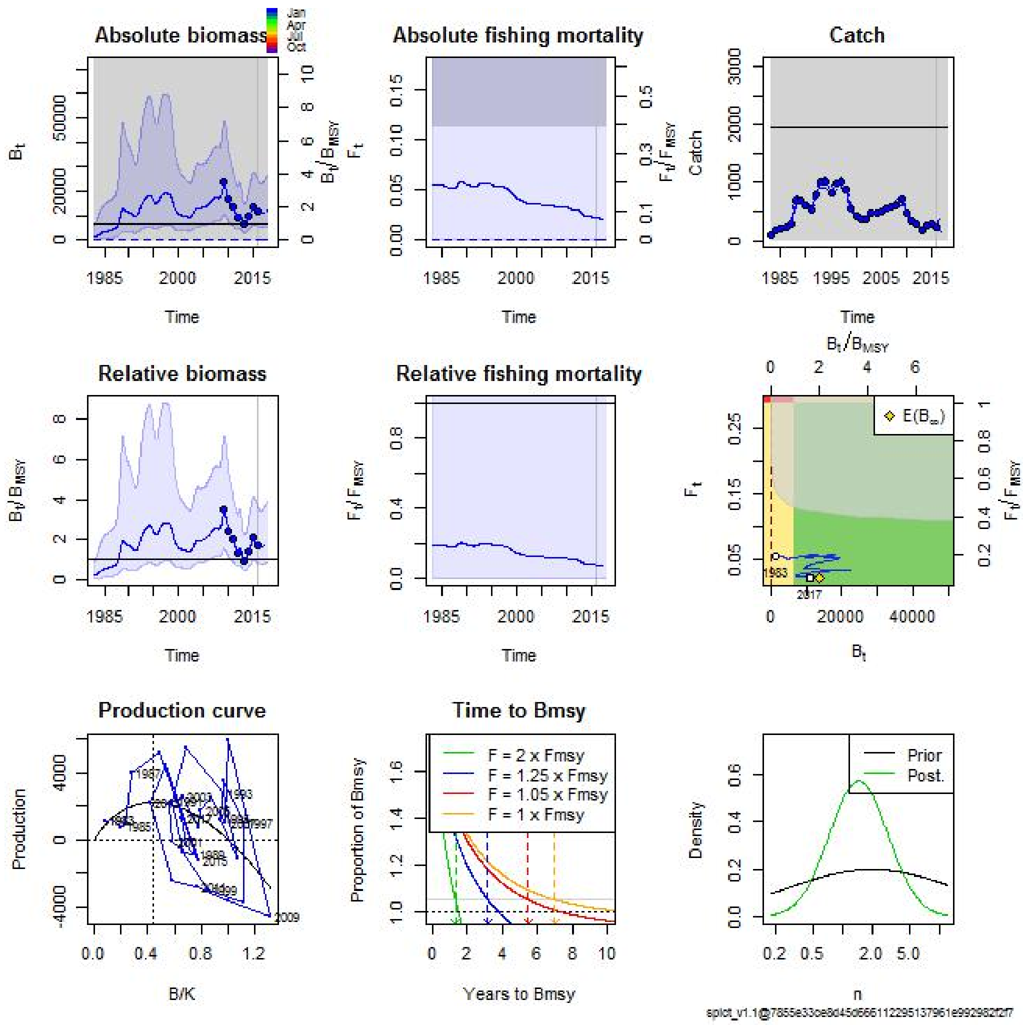


Figure 13.1.8. Blackspot sea bream in ICES Subarea 9: SpiCT summary results.

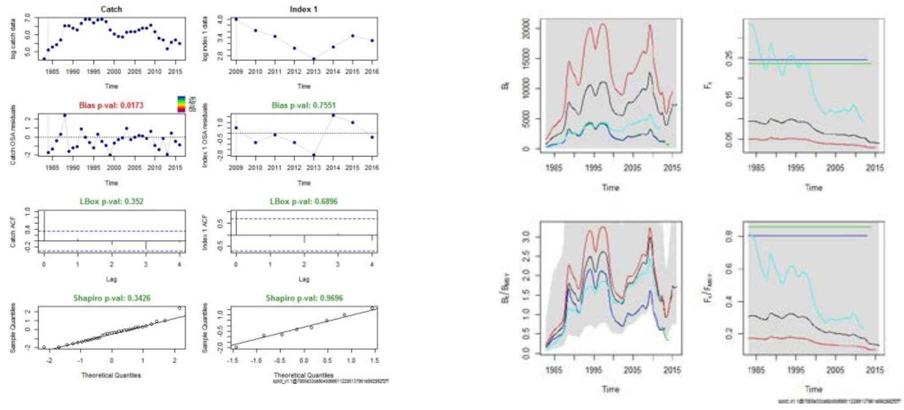


Figure 13.1.9. Blackspot sea bream in ICES Subarea 9: SpiCT diagnostics.

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13.4 Red (blackspot) sea bream (*Pagellus bogaraveo*) in Division 10.a

13.4.1 The fishery

Blackspot sea bream has been exploited in the Azores (Area 10.a.2), 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; Pinho *et al.*, 2014). 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 but during the last years the fishery are only authorized to operate on offshore (>6 nm) banks and seamounts (Pinho *et al.,* 2014; Diogo *et al.,* 2015). 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*., 2014). 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. Important expansion of the fishery to offshore seamounts occurred during this period, particularly made by the longline fleet as a consequence of spatial management measures introduced. During the period 2010–2012 the landings decreased significantly to an average of 641 t, which correspond to about 57% of the TAC during that period, maintaining thereafter around this value due to the TAC introduced. In general a continuous decrease has been observed since 2005.

Landings of 2016 are 515 t.

13.4.3 ICES Advice

The ICES advice for 2015 and 2016 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	663
	Reg (CE) Nº. 1367/2014				Reg (CE) Nº. 2285/2016			
P. bogaraveo	**2015**		**2016**		**2017**		**2018**	
ICES Sub-Area	**TAC**	**Landing**	**TAC**	**Landing**	**TAC**	**Landing**	**TAC**	**Landing**
Xa2	**678**	**701**	**507**	**515**	**507**		**507**	

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 and bottom gillnets 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 to allow a multidisciplinary research (ecological, oceanography and geological). During 2015 and 2016 additional technical measures were introduced limiting the fishing area for longliners. Undersize proportion of fish permitted on board of fishing levels was updated introducing a lower tolerance limited. A close season to reduce effort on the spawning aggregations was introduce (covering the period January 15 and end of February) and implemented in 2016.

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.*, 2017). Landings from Area 10.a.2 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 was not updated (WD, Pinho, 2015). On average about 0.6% of blackspot sea bream was discarded annually on sampled trips between 2004 and 2012.

13.4.5.2 Length compositions

Length composition data of the catch of the fishery is available for the period 1990 to 2016. However data from 1990–1994 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 be relate to catchability factors. The length distributions present some sort of truncation for the last five years because the reduction of juveniles due to minimum size measures and a reduction of large individuals.

13.4.5.3 Age compositions

The information is available from the fishery and surveys, were updated but are not presented here because it is not relevant to the current assessment.

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. Natural mortality was reviewed in 2015 (WD Silva *et al*., 2015) exploring several empirical methods for the M estimation. A mean value of M=0.3 was estimated but with a considerable uncertainty.

13.4.5.6 Catch, effort and research vessel data

Standardized fishery cpue was not updated. Available information from last years 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. Nominal cpue is presented for the recent years (2011–2016).

Survey data were updated and are resumed on Figure 13.4.5 and Table 13.4.3.

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 (Figure 13.4.1) and survey abundance indices (Figure 13.4.5) over the same period, except for the last year.

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). The survey time-series is not continuous because in some years there was no survey. Survey indices from 1995 to 2016 show no trend with a high value every three years until 2005 and for the year 2016 (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 survey abundance indices from 2010–2013 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 until 2010 and a decrease thereafter, particularly on the landings time-series. However, an increase is observed on the fishery values for the last two years.

Mean length of mature stock for the entire period (1995–2016) 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. However, a decrease trend is observed on mean length for mature fish since 2000.

No analytical assessment was carried out this year.

Exploratory analysis

Total mortality (Z)

Catch curve analysis was explored during 2015 (WD Pinho *et al.*, 2015) to estimate total fishing mortality. An update was done for the current year. Fishery age compositions were used. Age–length compositions were compute by converting length to age using Age–Length Keys from the survey age readings for the period 1995–2015. For the years 2014–2015 was adopted the ALK of 2013. Survey data were used because it covers a longer period than DCF data with age interpretation made by the same reader. A pseud cohort (equilibrium) approach was used, considering that the annual population structure is approximately the same as the cohort along life. Age–length keys covers the age range between 1 and 15. Data from age 1 to 8 were used considering age 9 as a plus group because very small numbers of individuals are observed annually on the age range 9–15. Fishing mortality (F) was then estimated assuming a constant value of natural mortality (M=0.2) for the full recruited age interval. An annual mean exploitable biomass (B) was then estimated from the catch equation ($\bar{\bar{B}}$=Y/F) and the annual trend was compared with the abundance indices from the longline survey.

Results show that annual Fishing mortality (F), presented an increase trend but with high fluctuations, with peaks during 1996–1997, 2003–2004, 2008 and 2011–2015 (Figure 13.4.10). Estimates of fishing mortality, lower than the adopted value of natural mortality (M=0.2) were observed for the period 2000–2002. Sensitivity analysis show that mortality estimates can vary according the age range selected for the regression (WD Pinho *et al.*, 2015), however, the same general increase trend is observed.

The estimated exploitable biomass, assuming the annual fishing mortality computed from the catch curve, correlated too well with the survey abundance estimates except for the years 2000 and 2001 (Figure 13.4.11). This result suggests that annual fishing mortality (F) is inversely correlated with the abundance observed each year with low mortality in the years of high abundance and vice versa. It also suggest that the variability of the total landings is in phase with the variability of the survey abundance indices. The source of this variability is not well understood but it appears that a change on the availability of the resource to the gear occurs in some years. The current mortality estimated (F=0.6–0.7) from the catch curve analysis for the recent years (2011–2016) is too high when compared to the stock natural mortality (M=0.2). An average fishing mortality of F=0.5 is estimated for the mean period of 1995–2016. These results should be used with caution because there are uncertainties on the age–length keys.

Yield-per-recruit

Length-based yield-per-recruit formulation (Thompson and Bell type) was used to explore the optimal exploitation pattern for this species. All the computations were performed using fishing mortality varying between 0 and 2, step 0.01). For each analyse a set of variables where computed from each simulation and per recruit curves constructed and resumed in a graph, showing yield (Y/R), exploitable biomass (B/R) and females spawning biomass (SSB/R) evolution by fishing mortality. Changes on the relative exploitation pattern were not simulated. Input data used on the YPR analysis are resumed in Tables 13.4.4 and 13.4.5.

A set of reference points were computed: Y_{MAX}; $F_{0.1}$ and F_{SPR}, and the correspondent values of exploited biomass (B_x), spawning biomass (SSB_x), fishing mortality (F_x) or yield (Y_x) according each case (x). For the $F_{0.1}$ estimates we follow the procedure suggested by Cadima (2003), presenting whenever possible the "Fo.1 curve" (U) on the graphs. For the spawning potential ratio (SPR) was estimated the fishing mortality that reduces the SSB between 20 and 40% of the pristine level following the suggestions of Mace and Sissenwine (1993). Additionally the maximum sustainable yield (Y_{MAX}) in value (euros), and the correspondent F, B and SSB, was computed in order to address economic aspects.

Results for the base case (assuming current exploitation pattern and constant M=0.2 for all lengths) are resumed in Figure (13.4.15) and Table 13.4.6. The model is not able to estimate adequately fishing mortality correspondent to maximum sustainable yield (F_{max}) because the flat top nature of the yield-per-recruit curve. The stock at the current fishing mortality (F_{curr}=0.4) is considered unsustainable at long-term because the exploitable spawning biomass (SSB_{curr}/R) is about 12% of the pristine level. Total exploitable biomass (B_{curr}/R) estimated by the model at F_{curr} is about 33%. However, considering that the species is a protandric hermaphrodite the female SSB may be depleted at this fishing mortality because the skewed sex ratios in favour of males due to size selective fishing. Values of SSB about 30% depletion of pristine level are estimated for the $F_{0.1}$ reference point (which results are similar to $F_{30\%}$). The fishing mortality value estimated for the $F_{0.1}$ (F=0.18) is near the value of the natural mortality (M=0.2). Adopting $F_{0.1}$ as a long-term reference point YPR results suggests that the stock is overexploited since current fishing mortality is 54% above this level of fishing mortality (Figure 13.4.15). This reduction from F_{curr} to $F_{0.1}$ corresponds to an increase in SSB of about 139%.

In summary, the results show that if we intend to maintain the actual hook size (correspondent to length of first capture L_c=30 cm FL) there is considerable advantage in reducing the current fishing mortality between 30% and 54% to maintain the fishing mortality at the level of $F_{20\%}$ and $F_{0.1}$ respectively (correspondent to SSB/R depletion between 20 and 30% of the unexploited level). This option corresponds to a considerable increase in the females SSB/R (between 60% and 139% respectively). However, this results should be viewed with caution because this is a sex change species and this characteristic was not modelled on the YPR. A key question is to know what change can be observed on the behaviour of the long-term Y/R and SSB/R when introducing some source of plasticity on maturity ogive due to sex-change. The current knowledge of the species biology suggests that the species reacted to fishing pressure reducing the length of first maturity from 34 cm LF to 30 cm. The exploitation pattern seems also to be inadequate since length of first capture is around the length of first maturity. However, it is not yet clear what is the effect on the population of a hook change because different selection curves types (from logistic to normal) are obtained for different relative exploitation patterns selected. Simulations show however (WD

Pabon *et al.*, 2015) that assuming a logistic selection curve there is no advantage on changing the relative exploitation pattern because sustainability is always found to be on the range of $F_{0.1}$ reference point of ($F_{0.1}$=0,2).

Length base indicators

Length-base indicators reported from WKLIFEV were explored and updated. For this exercise were used fishery length compositions for sexes combined from 1995–2016 (discards assumed negligible). Main life-history parameters used are resumed in Table 13.4.4.

Results from the analysis are shown in Figure 13.4.14 and Table 13.4.7. Results show that for immature conservation a substantial harvesting occurs before maturity (L_c and L25%<<L_{mat}).This was expected since the current relative exploitation pattern corresponds to a L50%=L_{mat}. This L_{mat} value is already considered low (L_{mat} moved from 34 cm to 30 cm along time) being probably a response of the population to the fishing pressure.

For mature fraction of the population the results suggests that the large individuals are present but are scarce (L_{max}<L_{inf})L_{mat} (30 cm) is considerable lower than L_{opt} (37 cm) and the results of P_{mega} indicator clearly that the megaspawners on the fishery landings are lower than 30% during all period of the analysis. This information is also supported by survey data.

For MSY proxy results show that exploitation is above the MSY level (L_{mean}<<L_{opt} and L_{mean}<$L_{F=M}$). Only in the period 1998–2000, 2005 and 2012–2013 the exploitation was considered at the sustainable levels close to MSY (Table 13.4.7 and Figure 13.4.2) because the effect of the suddenly increase of large individuals on the catch (see also Figures 13.4.2 and 13.4.3).

Overall the perception from the length base indicators is that the stock has been exploited unsustainable at level above optimal and MSY.

SPICT

The production model SPICT was explored using all available information from ARQDAÇO survey (abundance indices in number and weight) from 1995 to 2016 and commercial fishery, landings for the period 1985–2016 and nominal cpue for the period 1990–2016, (Figure 13.4.15). Several runs were explored with the different indices analysing different periods of years by excluding some points. When survey abundance indices are used, no convergence was obtained for any combination of data, probably due to high interannual variability observed on the survey indices. Convergence was only achieved when nominal cpue was used but excluding the 2016 landing and cpue.

The basic plotting of the results for the run using landings (1985–2015) and nominal cpue (1990–2015) is presented in Figures 13.4.16–13.4.18. Analysis of the residuals (Figure 13.4.17) shows no major problems with no significant bias (P>0,05, residuals are not significant different of zero) and autocorrelations showing no significant (p>0.05) violations of the assumptions. Variance (95%CI) is very high for absolute estimates (except catch) but reasonable for the relative estimates (Figure 13.4.18). The MSY estimates is reasonable for catches but very high for the other estimates (B_{MSY} and F_{MSY}). The model suggest the resource is overexploited (being explored unsustainable almost during all the time-series) and will be depleted under the current exploitation pattern (see kobe plot).

Comments on the explanatory analysis

Results from the methods used in the exploratory analysis seems to be all in agreement suggesting that the stock has been explored at or above the MSY level. However, it should be noted that this is a sex change stock and methods, particularly LBI must be interpreted with care.

There are some data analysis that should be explored in future work, which can improve considerable the assessment:

Standardize the fishery abundance indices;

Analyse survey data, particularly related with the effects of factors like competition, gear saturation and soak time, to better understand the reliability of this indices for the assessment;

Analyse the reproduction aspects of the resource clarifying the aspects of sex change transition to better estimate the structure of the population characteristics (males, females, mature and immature);

Analyse the uncertainties on the age–length keys;

Management considerations;

TACs should be consistent with catches in recent years.

13.4.7 References

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Table 13.4.1. Historical landings of *Pagellus bogaraveo* from the Azores (ICES Area 10.a.2).

Year	Azores (10.a.2)	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
2014	663	663
2015	701	701
2016	515	515

Table 13.4.2. Nominal and standardized bottom longline fishery abundance index (scaled cpue to the mean) of the backspot sea bream (*Pagellus bogaraveo)* in Subarea 10.

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
2011	0.450		
2012	0.481		
2013	0.663		
2014	0.901		
2015	0.606		

Table 13.4.3. Survey relative abundance index in number of *Pagellus bogaraveo* from the Azores (ICES Area 10.a.2).

YEAR	RPN	CV
1995	127,0	0,10
1996	41,7	0,10
1997	62,1	0,12
1998	na	na
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	na	na
2007	93,2	0,15
2008	101,7	0,09
2009	na	na
2010	80,5	0,10
2011	87,9	0,12
2012	83,80	0,08
2013	61,05	0,11
2014	na	na
2015	na	na
2016	162,1	0,08

Table 13.4.4. Input constant parameters used in Yield-per recruitment analysis for *Pagellus bogaraveo* of the Azores (ICES area 10).

Parameters	Value	Definition	Obs.
L_{oo} (cm)	56,72	Asymptotic average maximum length	ICES, 2012
K (year-1)	0,13	Growth coefficient of the von Bertalanffy growth model	ICES, 2012
T_o (year-1)	-1,46	Hypothetical age at which the species has zero length	ICES, 2012
a=	0,0172	Condition factor parameter of length-weight relationship	Rosa *et al.*, 2006
b=	3,0273	Slope parameter of length–weight relationship	Rosa *et al.*, 2006
L_{max} (L_F, cm)	55	Maximum length usually observed on the population (not the max ever observed)	Pinho *et al.*, 2012
L_r (L_F,cm)	20	Length of recruitment to the fishing area	
Tr (year-1)	2	Age of recruitment to the fishing area	
L_c (L_F, cm)	30	Length of first capture to the fishery (L50% from selectivity curve)	Sousa *et al.*, 1999
T_c (year-1)	4	Age of first capture to the fishery (age at L50%)	
M	0,2	Natural mortality	ICES, 2006
Zcurrent	0,6	Current total fishing mortality	Pinho *et al.*, 2015
Fcurrent	0.40	Current fishing mortality	Pinho *et al.*, 2015

Table 13.4.5. Length-specific input parameters used in the yield-per-recruit analysis for *P. bogaraveo* of the Azores (ICES area 10). Selectivity (si) of the gear (Sousa *et al.*, 1999); females sex-ratio for the period 1982–1991 (% Females) from Krug (1998) as computed by Pinho (2003); Maturation females for the year 1991 from Krug (1998) as computed by Pinho (2003).

Length	si	% Females	Maturation	Price per Kg (€)	Length	si	% Females	Maturation	Price per Kg (€)
20	0,000	0,055	0,000	2,4	38	0,985	0,605	0,985	13
21	0,000	0,065	0,001	2,4	39	0,985	0,648	0,992	13
22	0,000	0,077	0,002	2,4	40	0,985	0,688	0,996	13
23	0,000	0,091	0,003	6,6	41	0,985	0,726	0,998	13
24	0,001	0,108	0,006	6,6	42	0,984	0,760	0,999	13
25	0,002	0,126	0,011	6,6	43	0,984	0,792	0,999	13
26	0,007	0,148	0,021	6,6	44	0,984	0,820	1,000	13
27	0,021	0,172	0,041	6,6	45	0,984	0,845	1,000	13
28	0,063	0,200	0,076	6,6	46	0,983	0,868	1,000	13
29	0,173	0,230	0,138	6,6	47	0,983	0,887	1,000	13
30	0,393	0,264	0,238	6,6	48	0,983	0,904	1,000	13
31	0,664	0,301	0,378	6,6	49	0,982	0,919	1,000	13
32	0,853	0,340	0,541	6,6	50	0,982	0,931	1,000	13
33	0,939	0,382	0,696	6,6	51	0,982	0,942	1,000	13
34	0,970	0,426	0,817	13	52	0,981	0,951	1,000	13
35	0,981	0,471	0,897	13	53	0,981	0,959	1,000	13
36	0,984	0,516	0,944	13	54	0,980	0,966	1,000	13
37	0,985	0,561	0,970	13	55	0,980	0,971	1,000	13

Table 13.4.6. Results from the yield-per-recruit analysis. Fvalues – Fishing mortality; Y/R – Yield-per-recruitment in weight; Yecn/R – Yield-per-recruit in value; %B₀ – Depletion level of exploitable biomass relative to pristine level; SSB0Depletion level of exploitable spawning biomass relative to pristine level; WmedCatch – Mean weight in the catch.

REF. POINT	FVALUES	Y/R	YECN/R	%B0	%SSB0	WMEDCATCH
$F_{0.1}$	0,184	198	2219	48%	29%	1017
F_{max}	0,696	235	2109	25%	6%	729
F_{ecn_max}	0,316	224	2355	37%	17%	893
$F_{current}$	0,400	230	2329	33%	12%	840
F_{Change}	0,276	219	2346	39%	19%	924
$F_{SPR20\%}$	0,272	218	2344	40%	20%	927
$F_{SPR30\%}$	0,18	197	2208	49%	30%	1022
$F_{SPR35\%}$	0,152	186	2111	52%	35%	1060
$F_{SPR40\%}$	0,128	173	1992	56%	40%	1096

Table 13.4.7. Results from the yield-per-recruit analysis showing the percentage change corresponding to a change of the current fishing mortality to each reference point.

	PERCENT CHANGE (FROM FCURRENT TO THE REFERENCE POINT)					
REF. POINT	Y/R	YECN/R	B/R	SSB/R	WMEDCATCH	F
$F_{0.1}$	-14%	-5%	47%	139%	21%	-54%
F_{max}	2%	-9%	-23%	-54%	-13%	74%
F_{ecn_max}	-3%	1%	12%	34%	6%	-21%
$F_{current}$	0%	0%	0%	0%	0%	0%
F_{Change}	-5%	1%	20%	57%	10%	-31%
$F_{SPR20\%}$	-5%	1%	21%	60%	10%	-32%
$F_{SPR30\%}$	-14%	-5%	48%	144%	22%	-55%
$F_{SPR35\%}$	-19%	-9%	60%	182%	26%	-62%
$F_{SPR40\%}$	-25%	-14%	72%	223%	31%	-68%

Table 13.4.7. Traffic light indicators for red sea bream from the Azores (ICES 10.a).

Year	Lc	L25%	Lmax5%	Pmega	Lmean	Lmean
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
	>1	>1	>0.8	>0.3	≈1 (>0.9)	≥1
	Conservation (immatures)		Conservation (large individuals)		Optimal yield	MSY
1990	0,63	0,77	0,78	0,04	0,77	1,01
1991	0,70	0,73	0,77	0,03	0,75	0,94
1992	0,70	1,03	0,82	0,13	0,94	1,18
1993	0,70	0,80	0,79	0,04	0,76	0,96
1994	0,83	0,90	0,81	0,06	0,86	0,98
1995	0,83	0,87	0,80	0,05	0,83	0,94
1996	0,83	0,90	0,75	0,03	0,83	0,95
1997	0,77	0,87	0,86	0,07	0,81	0,97
1998	0,77	0,83	0,91	0,12	0,85	1,02
1999	0,57	0,83	0,92	0,17	0,86	1,20
2000	0,70	0,87	0,89	0,13	0,87	1,09
2001	0,77	0,83	0,87	0,09	0,83	0,99
2002	0,83	0,90	0,86	0,09	0,87	0,99
2003	0,77	0,87	0,84	0,07	0,81	0,97
2004	0,83	0,87	0,83	0,06	0,84	0,95
2005	0,77	0,87	0,85	0,10	0,84	1,01
2006	0,83	0,93	0,82	0,08	0,87	0,99
2007	0,83	0,90	0,81	0,06	0,86	0,98
2008	0,83	0,90	0,82	0,07	0,86	0,98
2009	0,83	0,93	0,83	0,08	0,87	0,99
2010	0,90	1,00	0,83	0,07	0,89	0,97
2011	0,90	0,93	0,81	0,05	0,86	0,94
2012	0,50	0,93	0,80	0,05	0,84	1,25
2013	0,63	0,97	0,82	0,05	0,85	1,12
2014	0,83	0,90	0,80	0,04	0,82	0,94
2015	0,90	0,93	0,82	0,06	0,86	0,94
2016	0,90	0,97	0,86	0,10	0,89	0,97

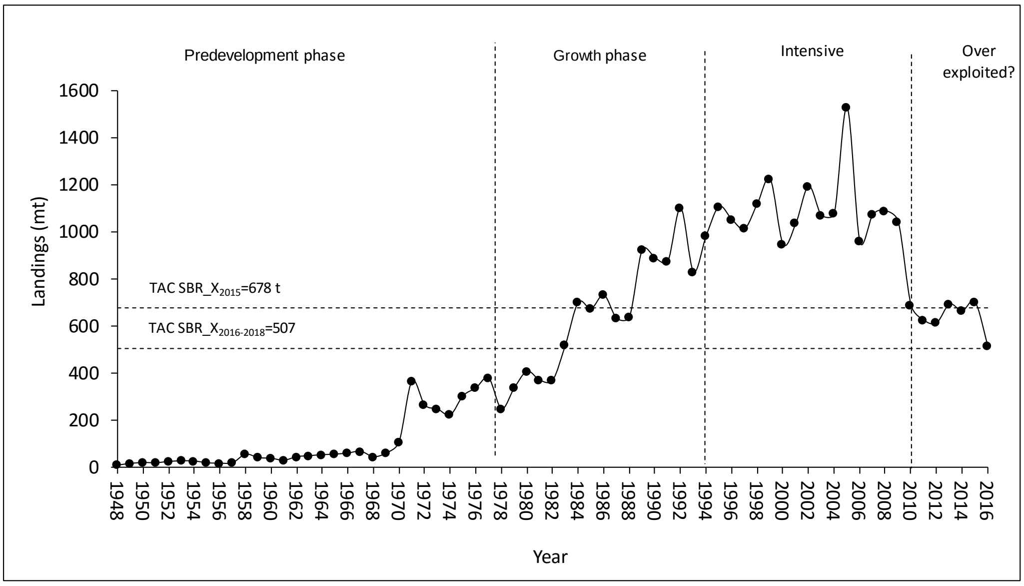


Figure 13.4.1. Historical landings of *Pagellus bogaraveo* from the Azores (ICES Area 10.a.2). Main technical management measures introduced to the fishery are also shown on the graph.

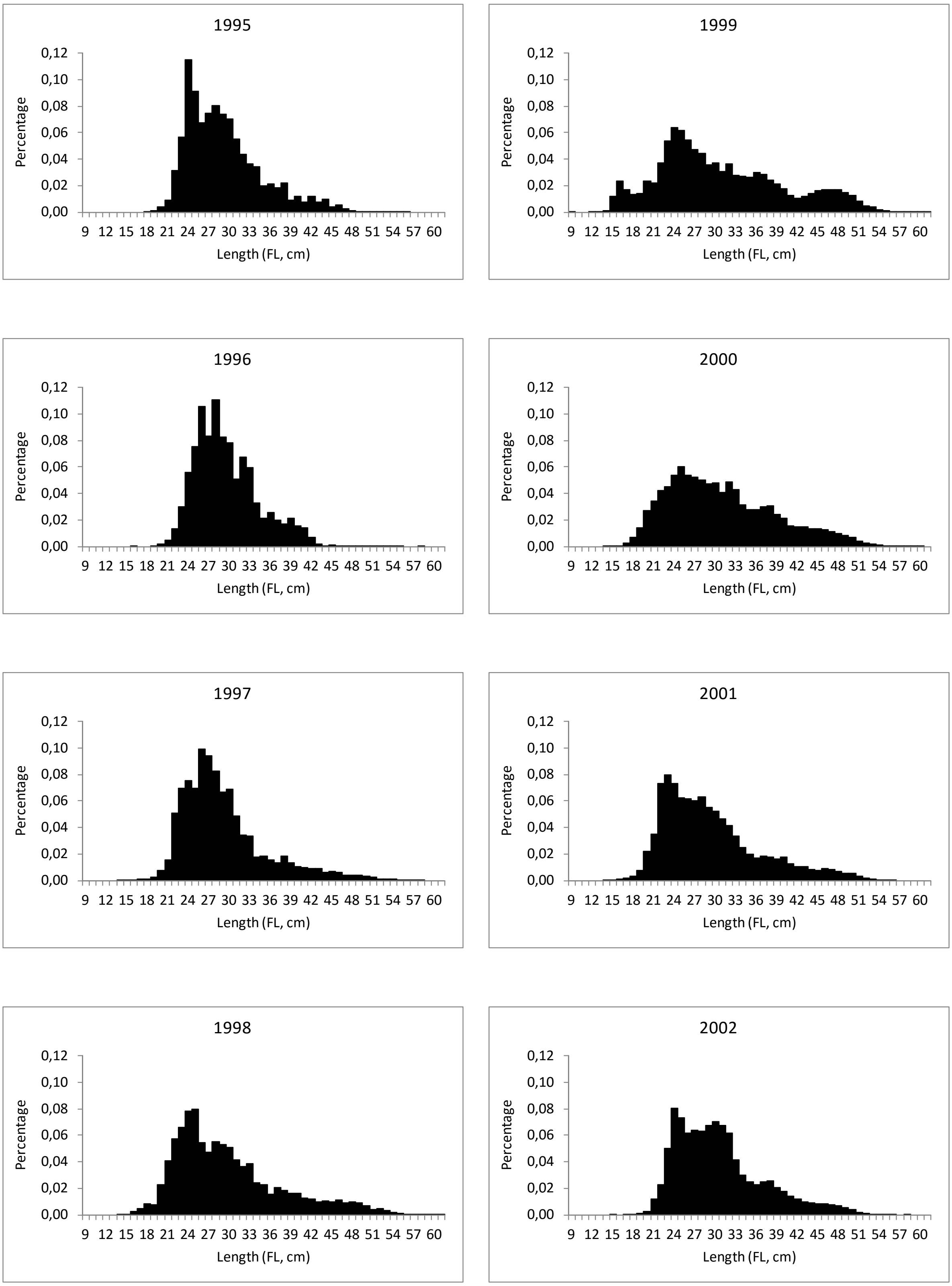


Figure 13.4.2. Annual length composition of *Pagellus bogaraveo* from the fishery for the period 1995–2013 (ICES Area 10.a.2).

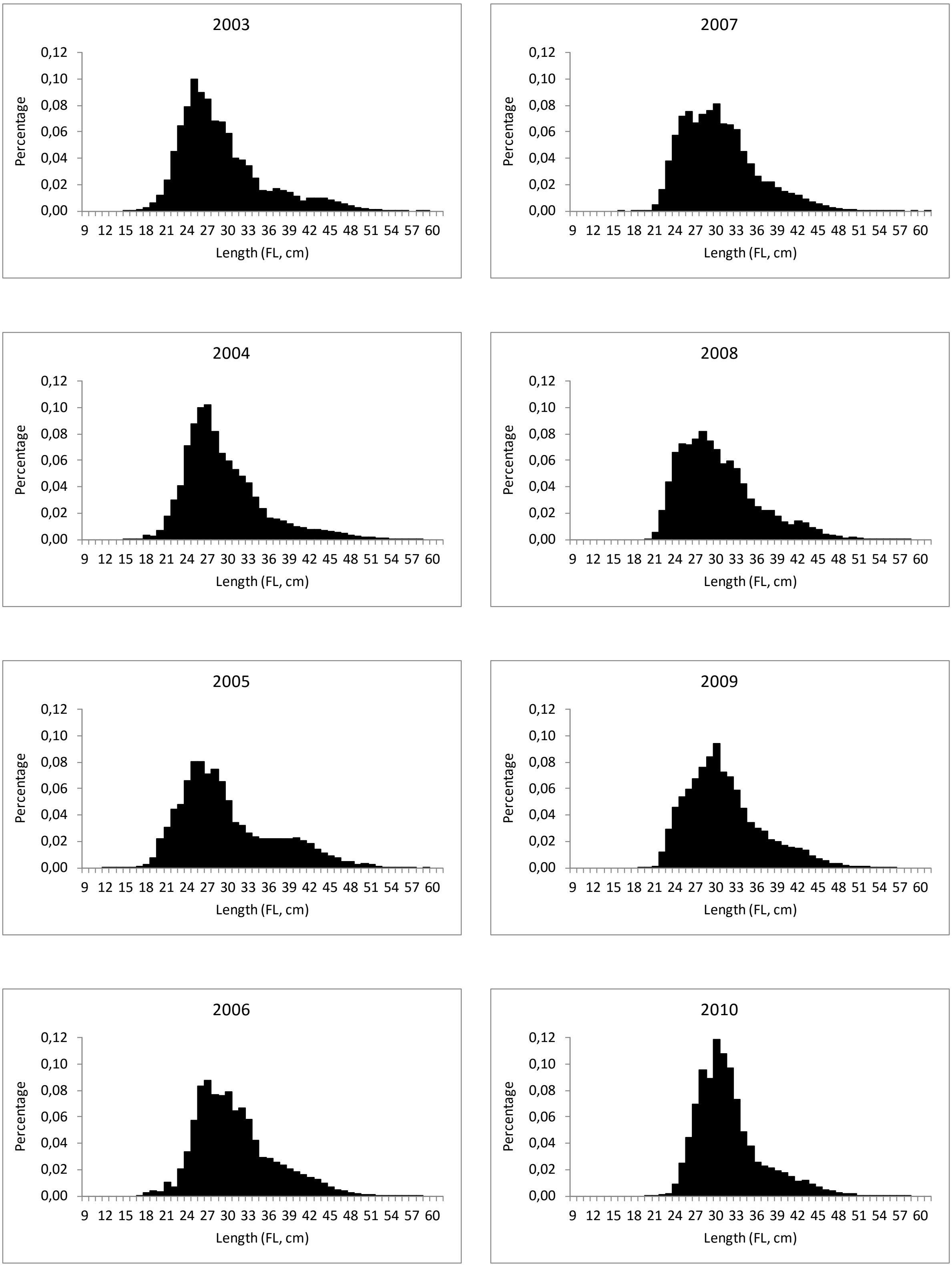


Figure 13.4.2. (Cont.). Annual length composition of *Pagellus bogaraveo* from the fishery for the period 1995–2013 (ICES Area 10.a.2).

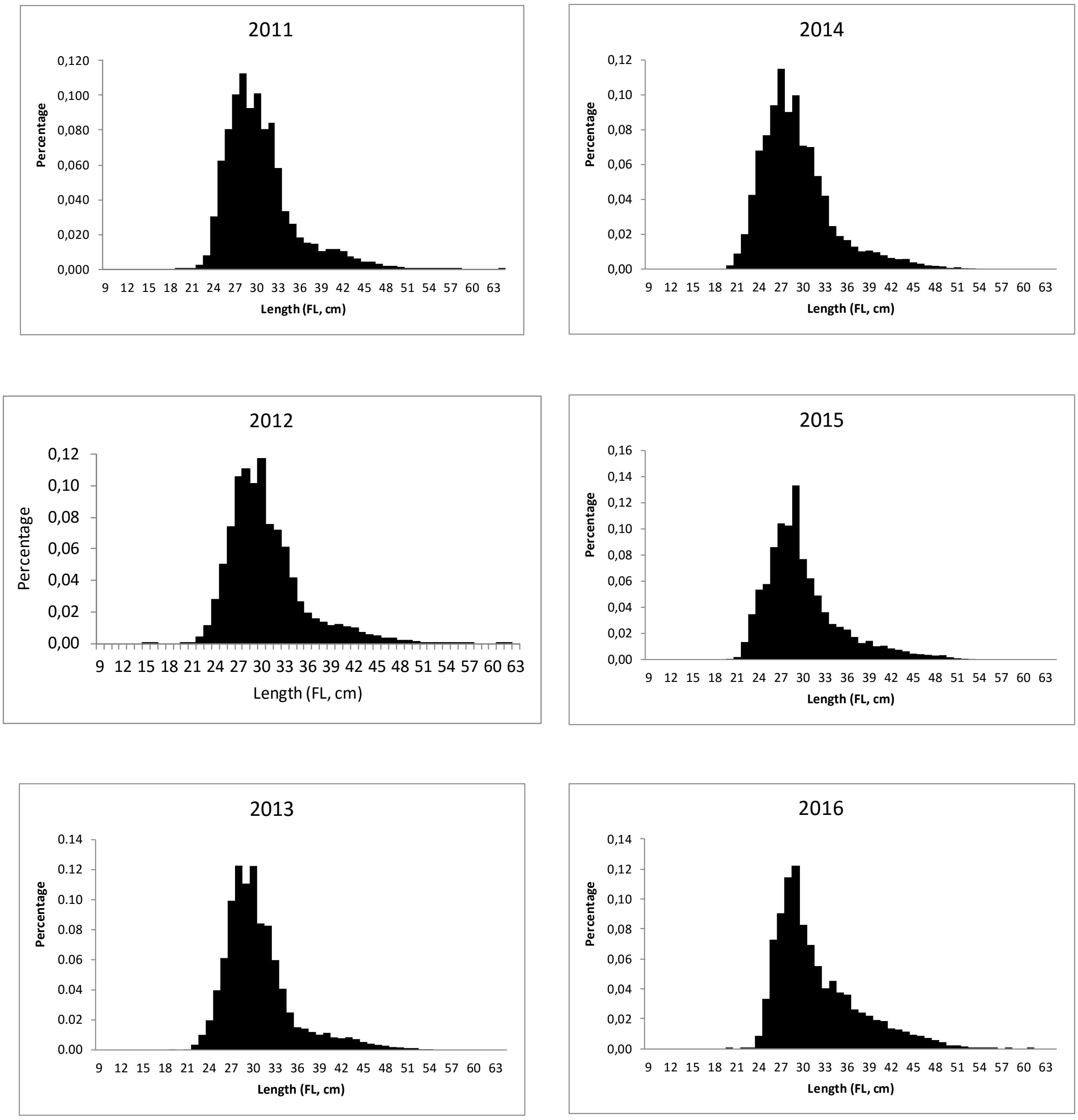


Figure 13.4.2. (Cont.) Annual length composition of *Pagellus bogaraveo* from the fishery for the period 1995–2013 (ICES Area 10.a.2).

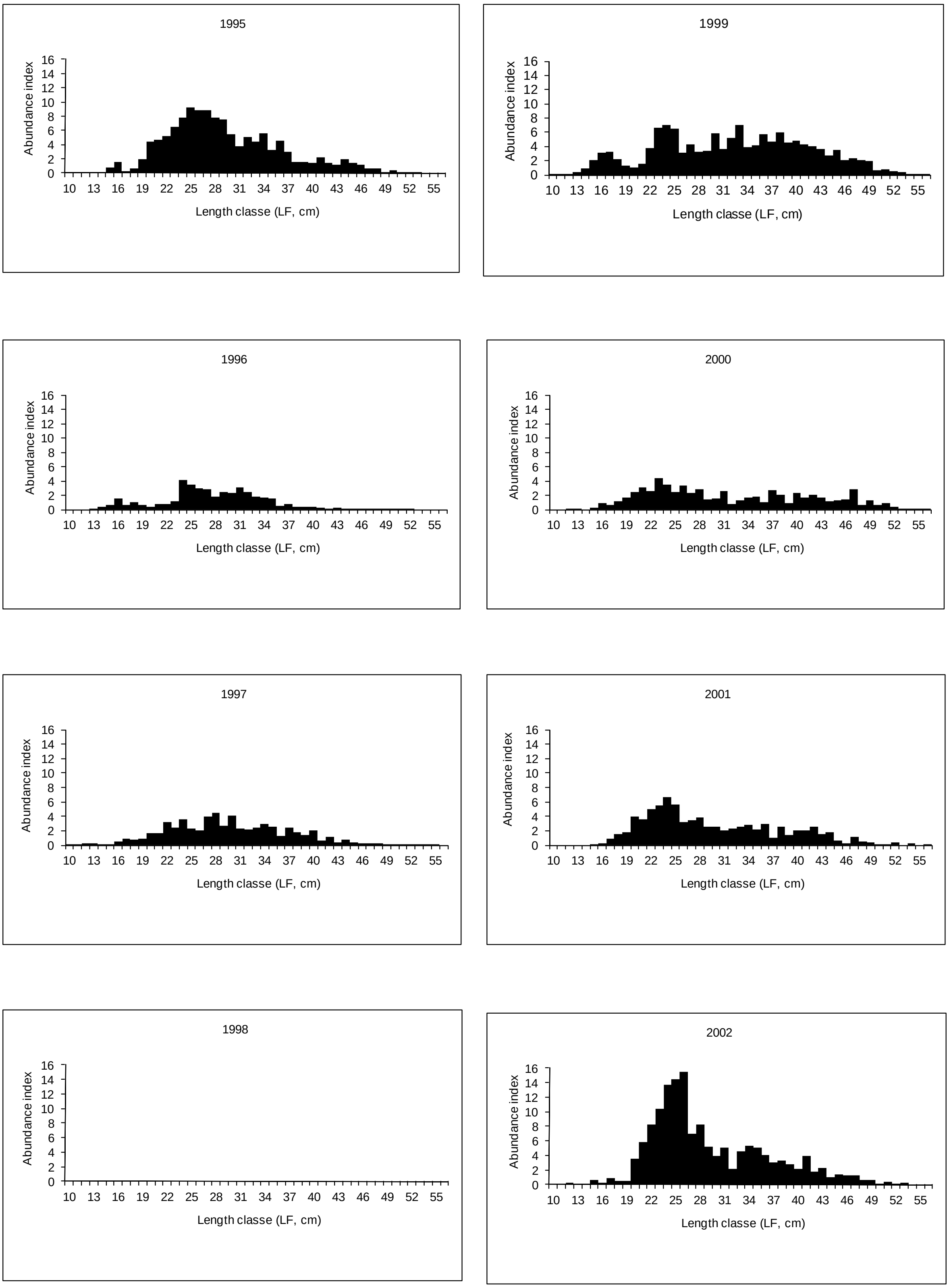


Figure 13.4.3. Annual length composition of *Pagellus bogaraveo* from the Azorean spring bottom longline survey for the period 1995–2003 (ICES Area 10.a.2).

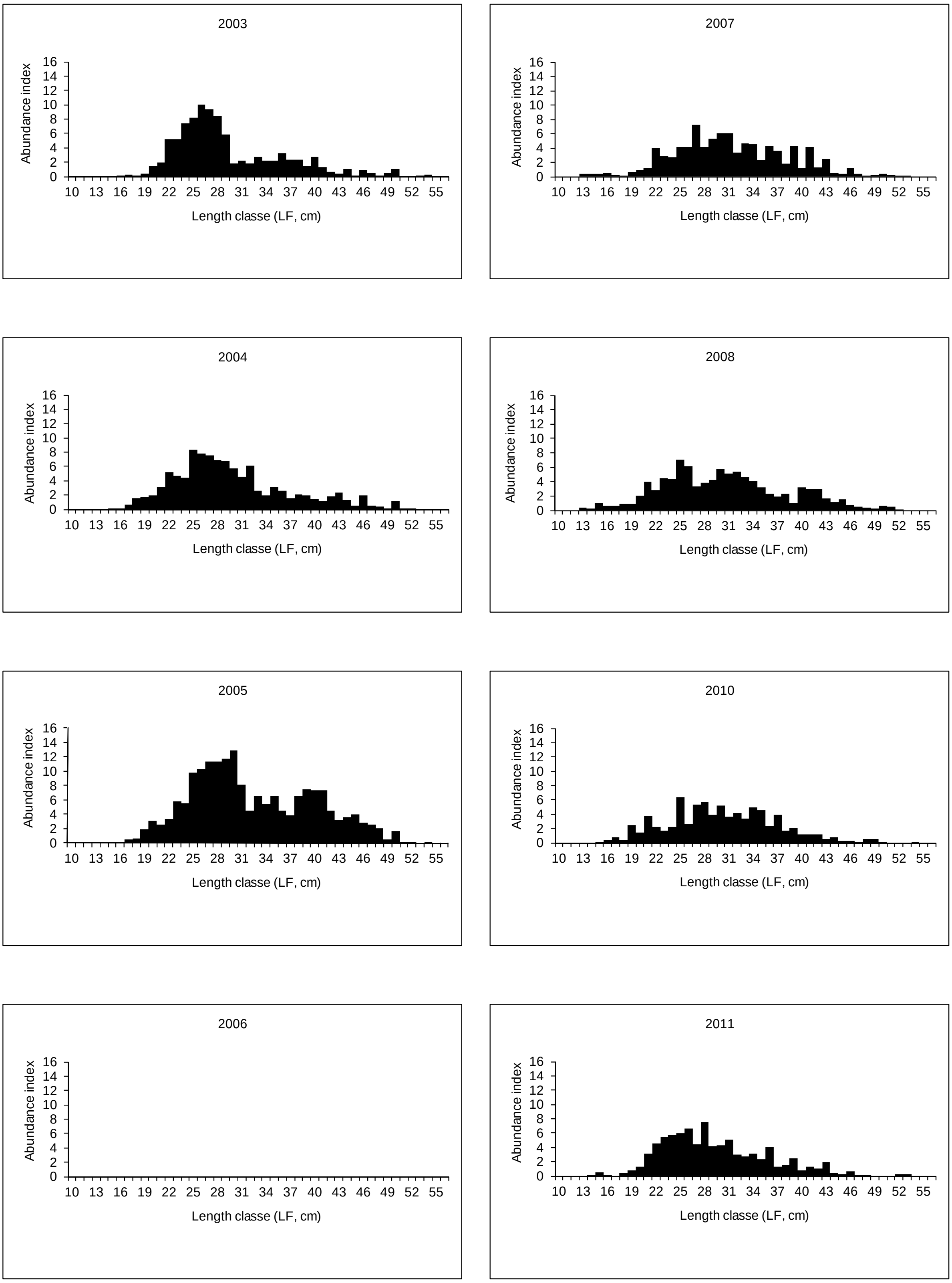
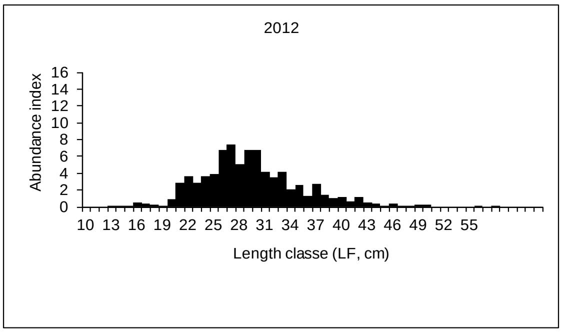
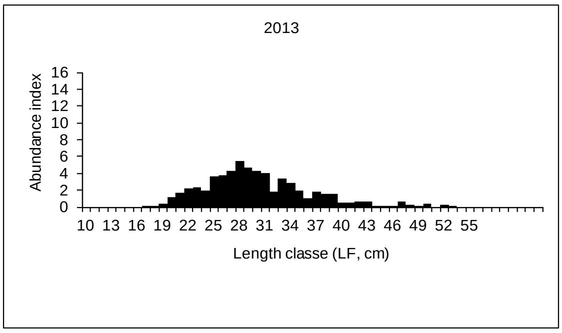


Figure 13.4.3. (Con't). Annual length composition of *Pagellus bogaraveo* from the Azorean spring bottom longline survey for the period 1995–2013 (ICES Area 10.a.2).





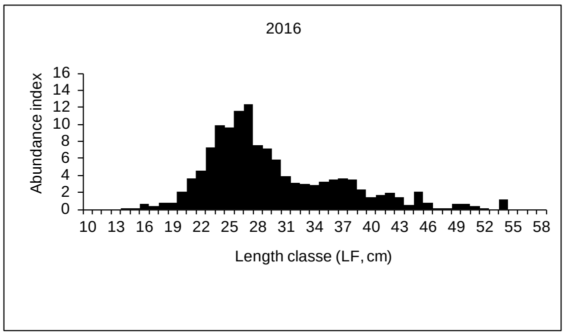


Figure 13.4.3. (Con't) Annual length composition of *Pagellus bogaraveo* from the Azorean spring bottom longline survey for the period 1995–2013 (ICES Area 10.a.2).

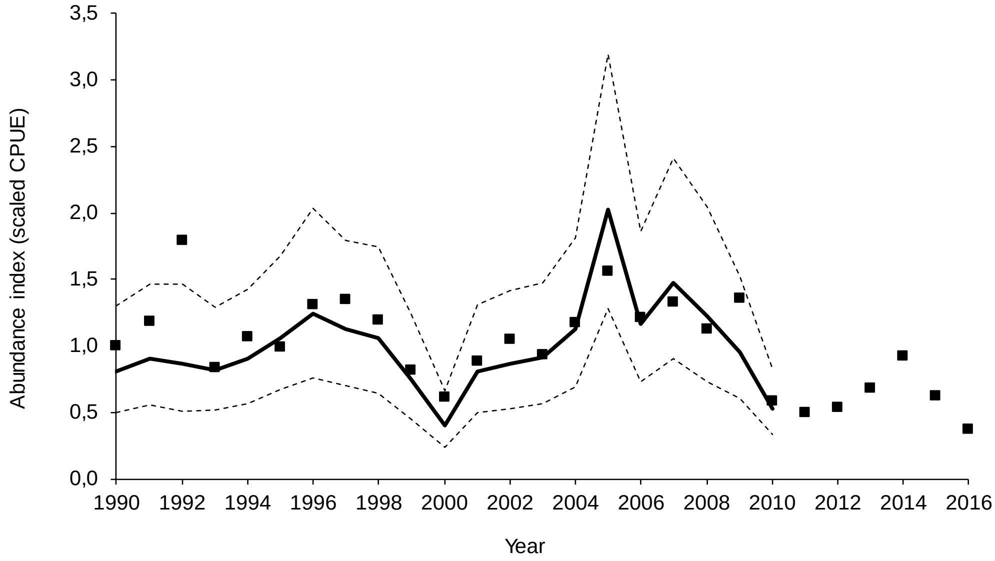


Figure 13.4.4. Standardized fishery catch rates of *Pagellus bogaraveo* from ICES Area 10.a.2. In the graph are shown the nominal cpue (squares), standardized cpue (solid line) and confidence intervals (dashed line).

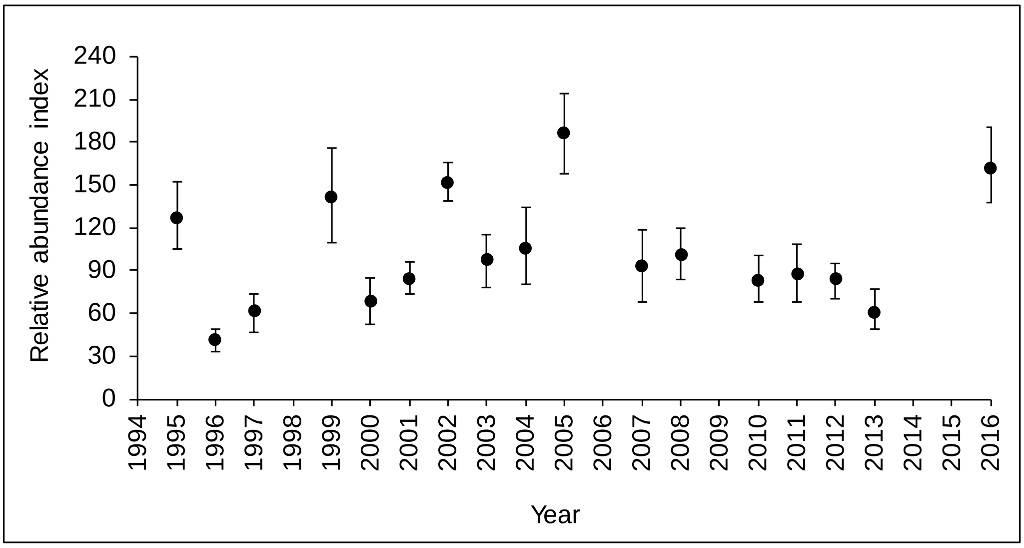


Figure 13.4.5. Annual abundance in number (Relative Population Number) and in weight (Relative Population Weight) of *Pagellus bogaraveo* from surveys for ICES Area 10.a.2.

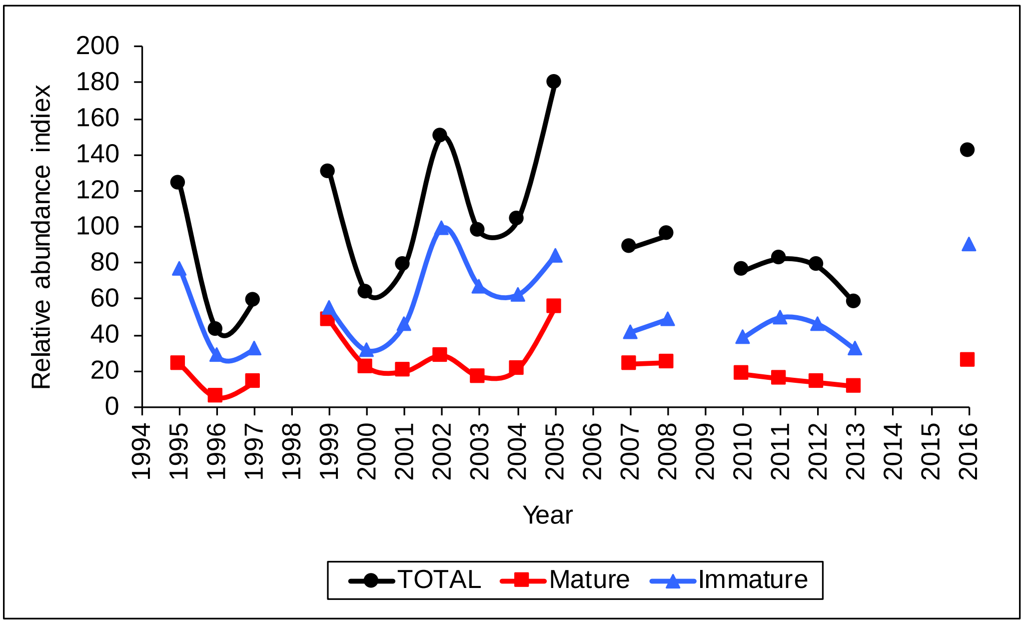


Figure 13.4.6. Survey abundance indices for mature and immature stock.

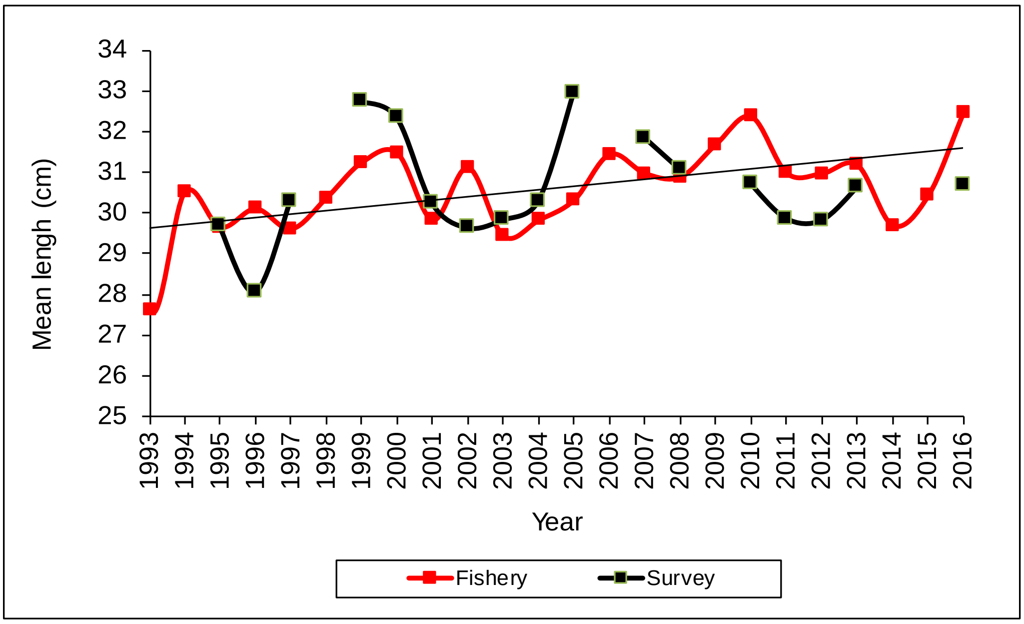


Figure 13.4.7. Annual mean length from the fishery (1990–2010) and from survey length compositions (1995–2008).

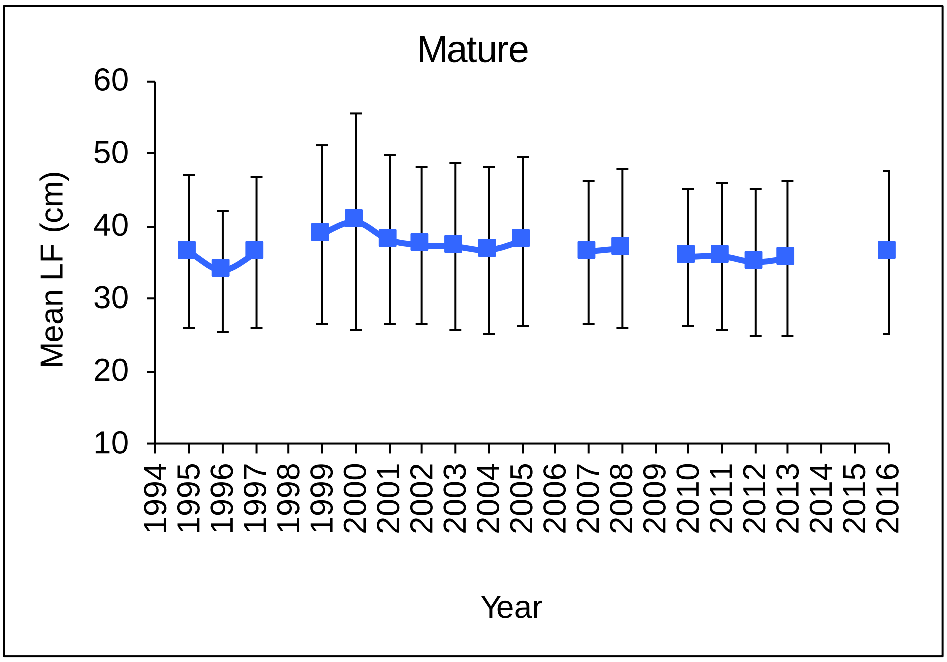


Figure 13.4.8. Annual mean length of mature individuals from the Azorean longline survey.

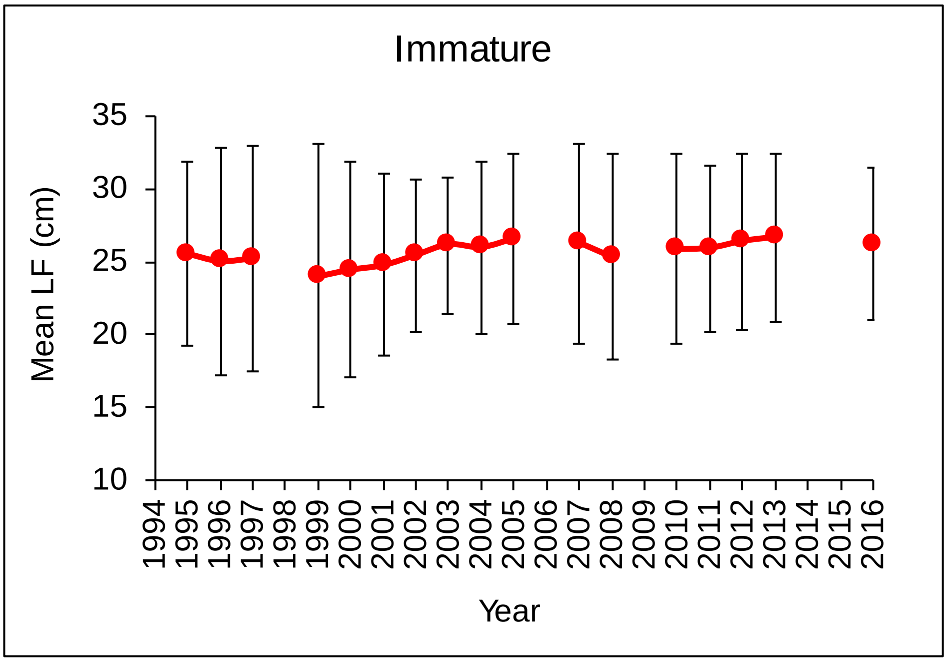


Figure 13.4.9. Annual mean length of immature individuals from the Azorean longline survey.

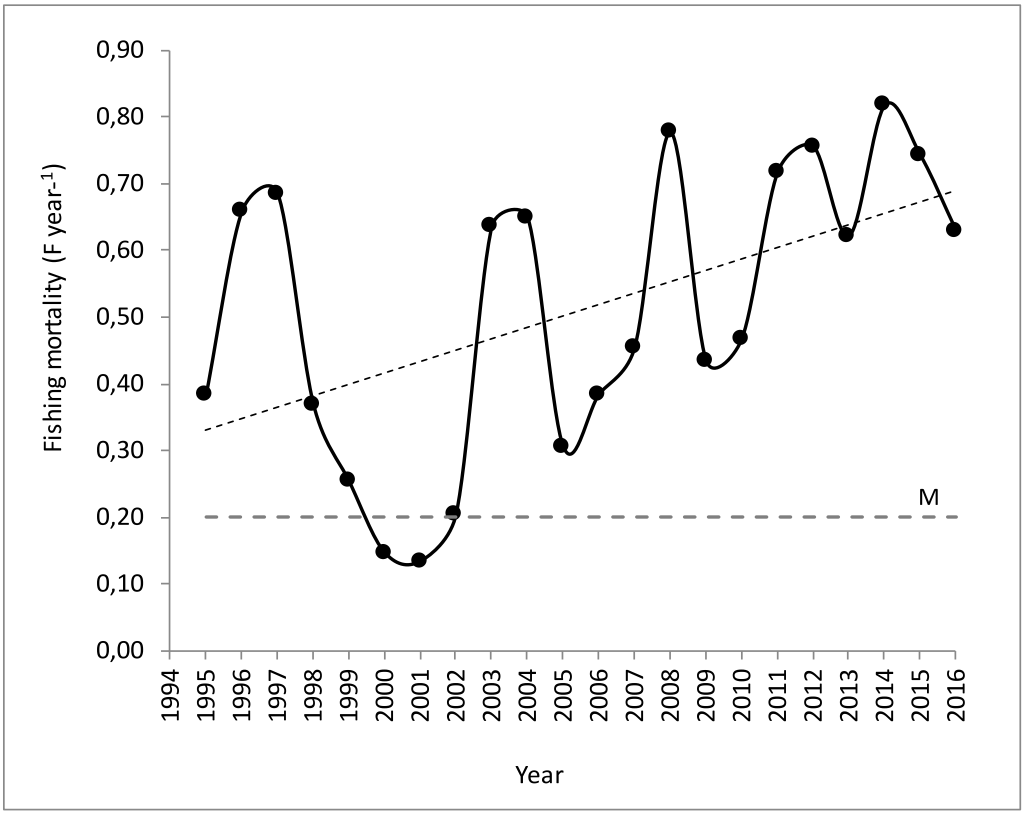


Figure 13.4.11. Annual evolution of fishing mortality (F) estimated for *Pagellus bogaraveo* fishery of the Azores (ICES 10.a.2) using catch curve analysis. Black dashed line shows the trend and grey line shows the value of natural mortality (M=0.2) traditionally used in the assessments.

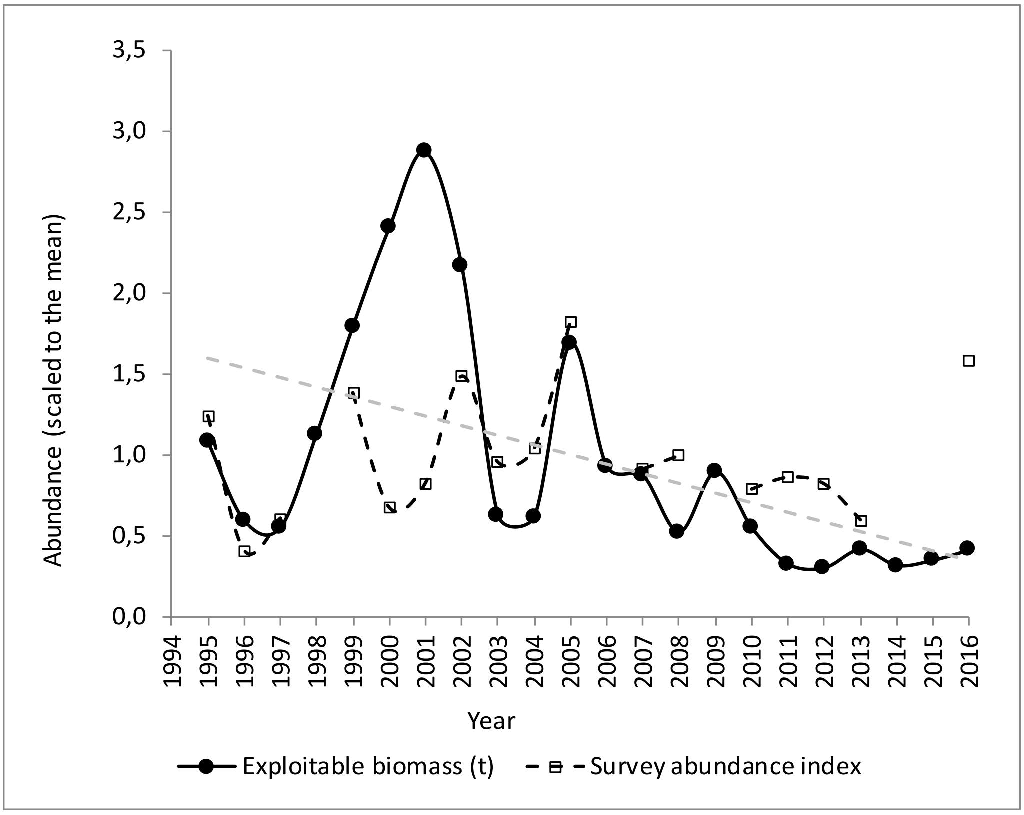


Figure 13.4.12. Annual biomass estimates from the catch curve analyses. On the graph are also shown for trend comparison the survey abundance index estimates for the same period. Grey dashed line shows the trend of the exploitable biomass.

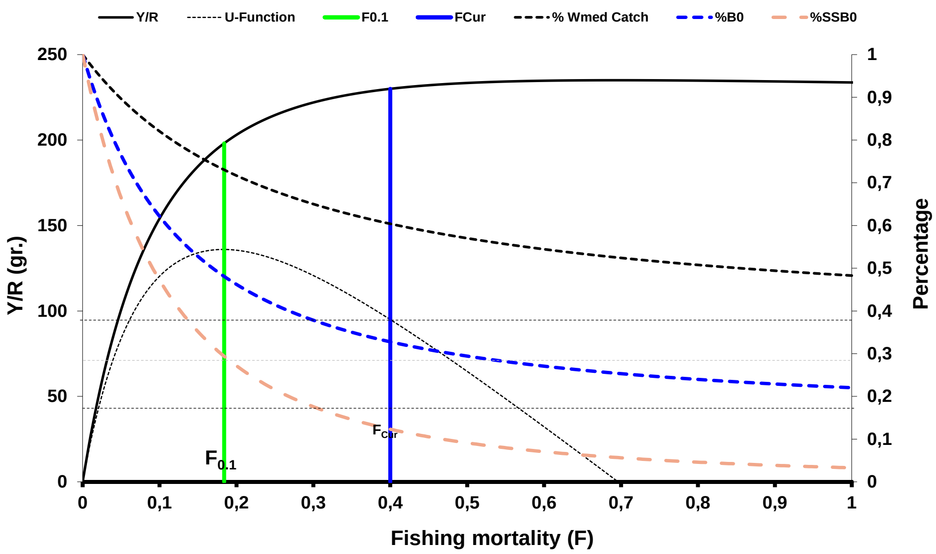


Figure 13.4.13. Yield-per-recruit analyse for the current exploitation pattern (Lc=30 cm) and M=0.2 constant for all lengths. Horizontal dashed grey line represents the 20–40% Spawning Potential.

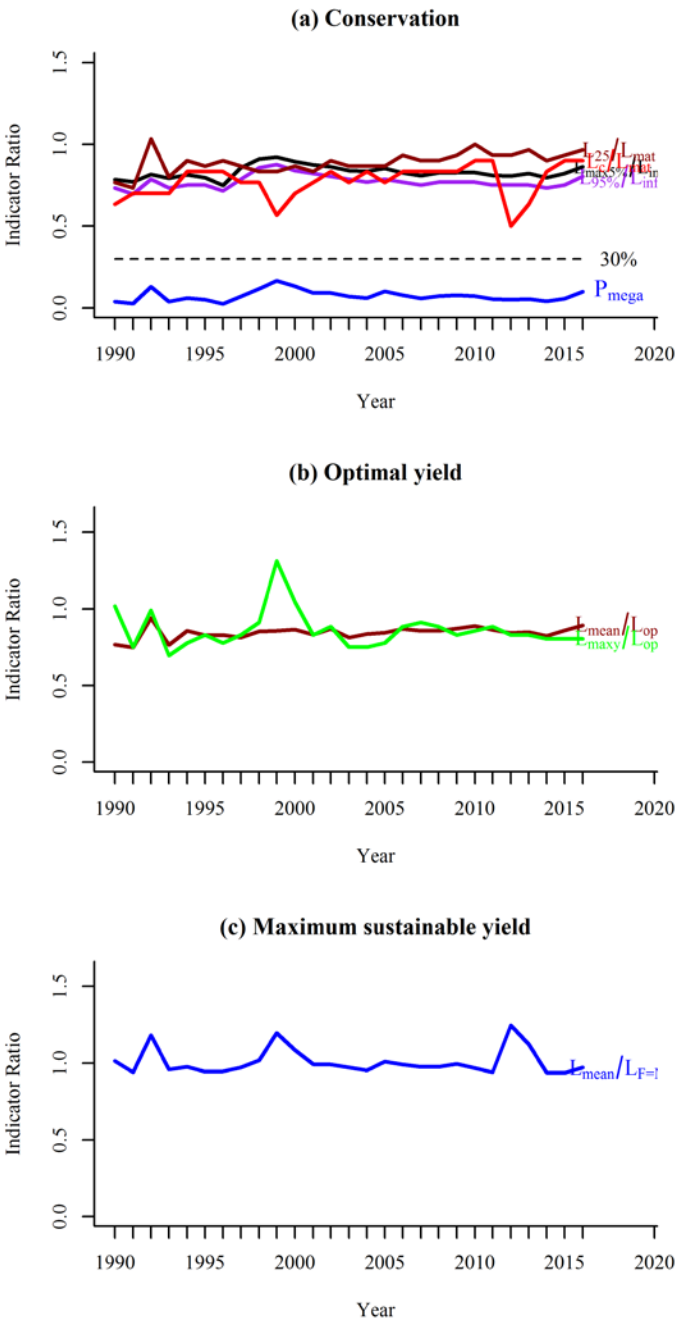


Figure *13.4.14*. Indicator ratios and reference points for red sea bream in the Azores (ICES 10.a) for the period 1993–2015.

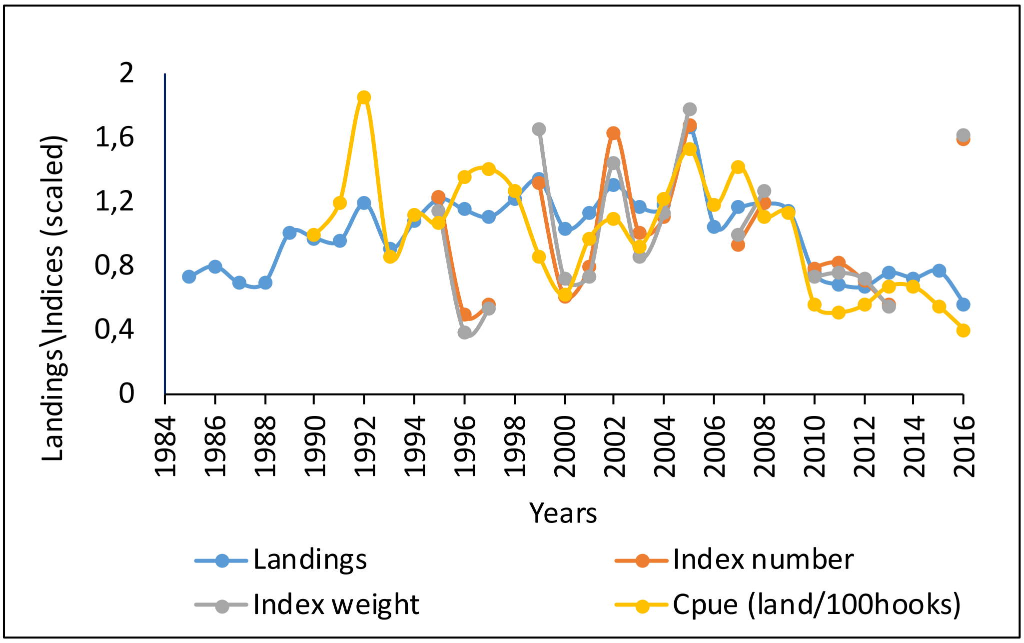


Figure 13.4.15. Evolution of the red seabream fishery from the Azores (ICES 10).

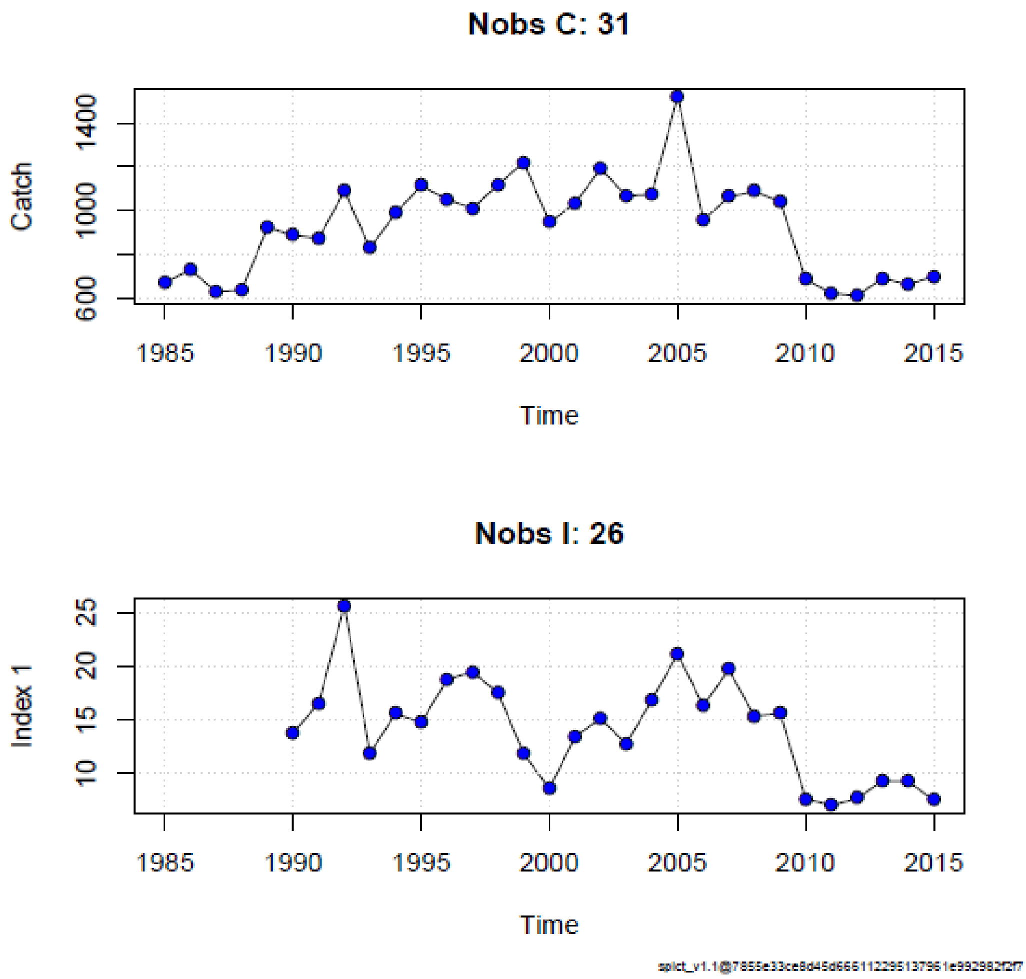


Figure 13.4.16. Input data, used for SPICT, of the red seabream from the Azores (ICES 10.a2).

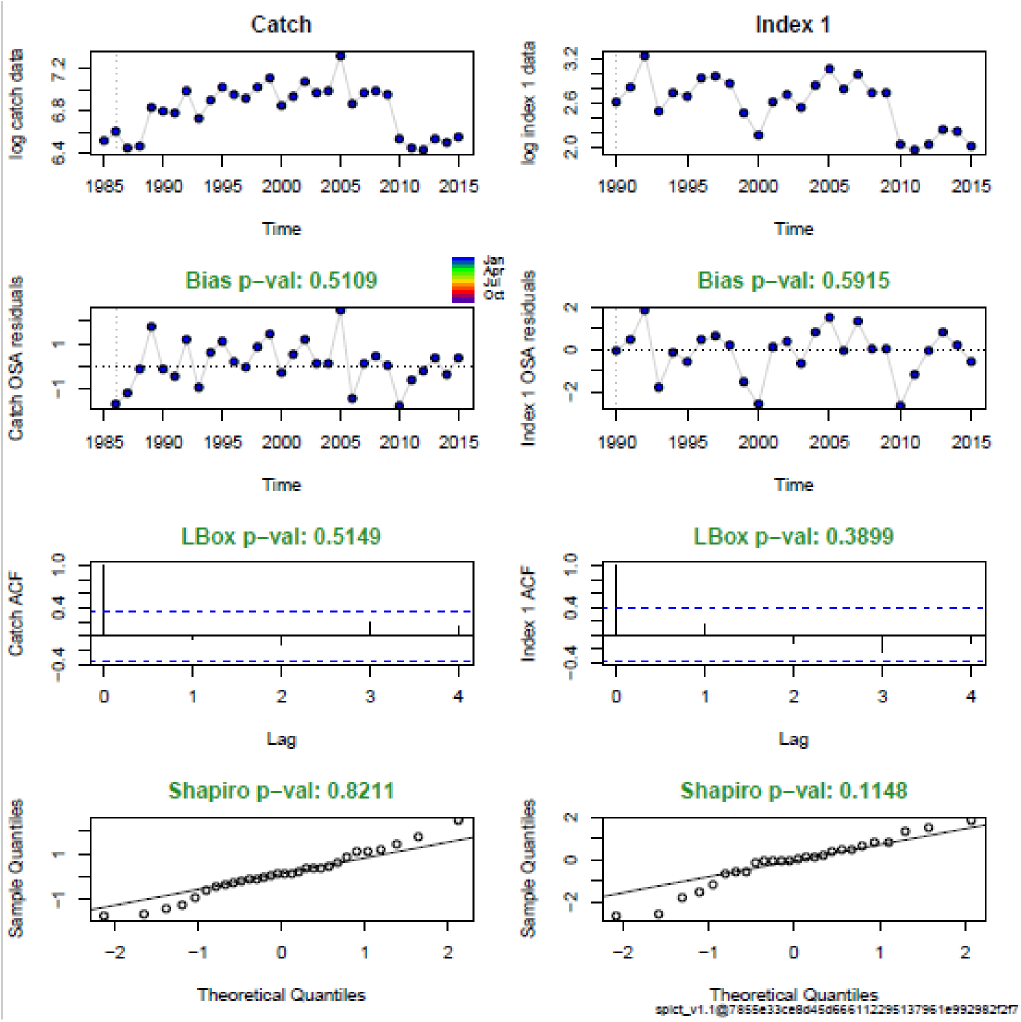


Figure 13.4.17. Residual results from SPICT model applies to red seabream from the Azores (ICES, 10).

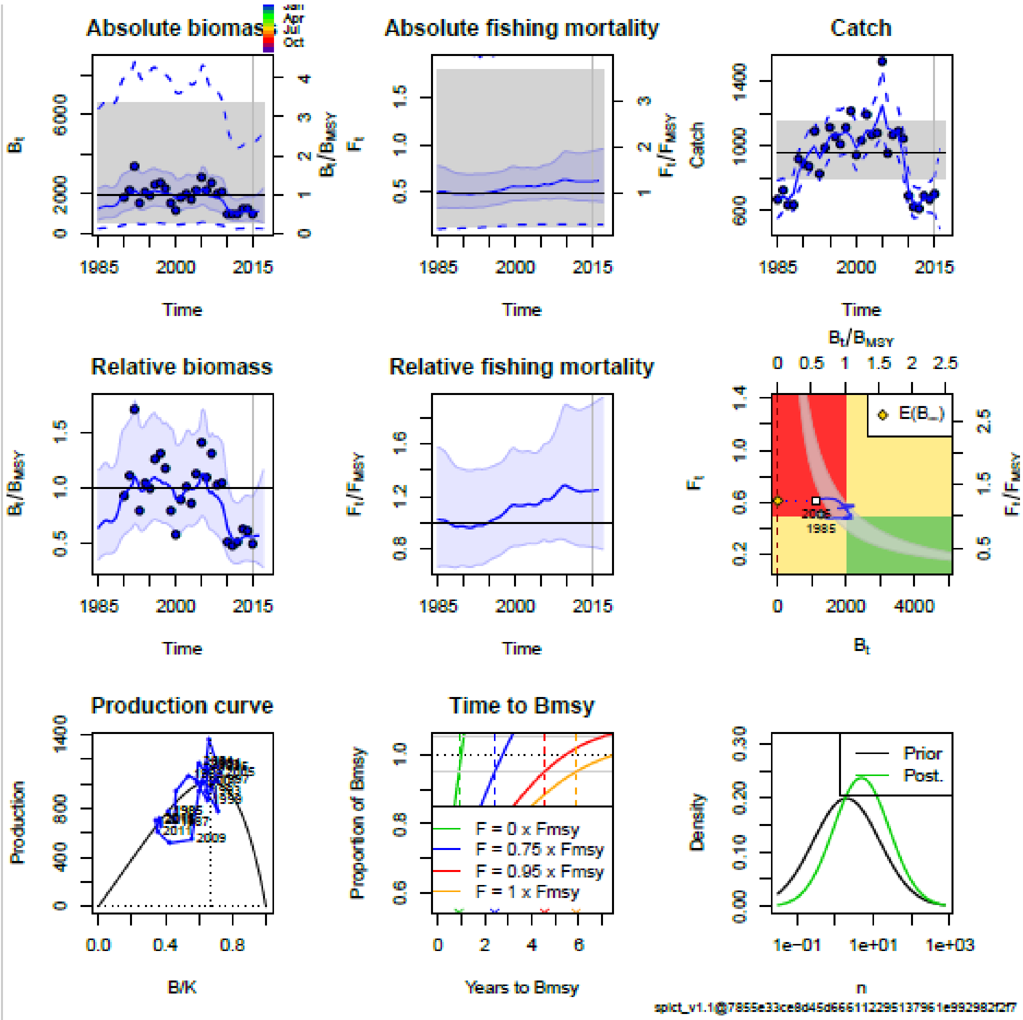


Figure 13.4.18. Basic results of SPICT model for the red seabream from the Azores (ICES, 10).

14 Roughhead grenadier (*Macrourus berglax*) in the Northeast Atlantic

14.1 Stock description and management units

The population structure of roughhead grenadier in the Northeast Atlantic in unknown. The species occurs at small abundance in some areas, mostly to the North of 60°N. The assessment unit considered by ICES is the whole Northeast Atlantic, this does not postulate anything about the population structure.

14.2 The fishery

Roughhead grenadier has a low commercial value and the scarce landing data available correspond mostly to landed bycatch. However, there were recent records of unusually large catches (> 500 t) in Subarea 6 from 2005 to 2007, in Subarea 12 from 2002 to 2006 and 2012 as well as in Subarea 14 from 2012 to 2014.

Roughhead grenadier is mostly caught with bottom trawl but catches in 14 and 12.a are from the Spanish fleet targeting redfish and were taken with pelagic trawl, a GLORIA type in the first year (2010) and a modified alfonsinos pelagic trawl in the following years.

The Spanish fleet fishing grenadiers on the Mid-Atlantic ridge (MAR) consists of ten trawlers with an average length of 62 m and average GRT of roughly 1000 t, although the maximum number of ships present in the fishing ground in any given year is seven. This fleet alternates the redfish and grenadier fisheries. Most landings are taken in 14.b.1, where the fishing season lasts between three and seven months. Effort and catches peak in late spring and early summer.

14.3 Landings trends

Because there is no stock defined or management units, this section describes the landings data available for the different ICES divisions.

In Subareas 1 and 2 there are landing records since 1990, year with the highest catch, about 600 t. Landings have declined significantly and since 2005 they are in the range of 30 to 50 t. Most landings are from Norway with a minor contribution from Russia. Landings from France are occasional and negligible, below 0.5 t in most years (Table 15.1).

Landing records from Subareas 3 and 4 also started in 1990 and have been very low, peaking in 2005 at 39 t. The remaining years landings oscillated between 0 and 10 t, mostly to Norway, France, UK (Scotland) and Ireland have also reported landings in a few years (Table 15.2).

In Division 5.a, roughhead grenadier is occasionally caught but since 2010 the average landings reported have increased to 19 t/year a (Table 15.3).

Landings have been reported in 5.b since 1997. The highest catch was 99 t in 1999, but in other years landings were <12 t and in the last three years only 1 t/year was (Table 15.4).

Landings from Subareas 6 and 7 were mostly caught by the Spanish demersal multispecies fishery in Hatton Bank operated by freezer trawlers. The series starts in 1992, with official landings peaking during the period 2011–2013, when they reached 632 t in 2012 due to an exceptional report of 436 t by Lithuania. France has taken part in the fishery for a longer period but with much lower landings. Other minor participants in the fishery are Norway, UK, Ireland and Russia (Table 15.5).

Occasional landings of less than 0.5 tonne have been occasionally reported from Subarea 8. These should be considered as coding errors or area misreporting as the species is not known to occur in Subarea 8.

Official landings in Subarea 12 include landings from both the demersal multispecies fishery in Hatton Bank (12.b) and the pelagic redfish and grenadier fishery on the MAR (12.a). The series starts in 2000, and peaks in 2005 at 2200 t and in 2009 at 2832 t. Most years however, landings were <500 t. Most of the landings correspond to the Spanish freezer fleet. Smaller landings were reported by Norway, Russian and France (Table 15.6).

Low landings have been reported from Subarea 14 have been reported since 1993. In 2010–2014, Spain reported landings of 500–2700 tonnes/years (Table 15.7). Norway and Russia reported landings earlier that other countries, and Greenland and the UK have occasionally also recorded very small catches. Landings decreased since 2013 but more strongly in 2014 and 2015 to less than 85 t.

14.4 ICES Advice

The only ICES advice on roughhead grenadier was published in 2015 and states that "for the years 2016 to 2020 there should be no directed fisheries for roughhead grenadier, and bycatch should be counted against the TAC for roundnose grenadier to minimise the potential for species misreporting."

14.5 Management

There is no management plan for roughhead grenadier in NEAFC and 5.a. There has been no species-specific EU TAC for this species nor other species-specific management measure. Since 2015, bycatch of the species should be reported under the roundnose grenadier quota for the same area and may not exceed 1% of the quota. No directed fisheries of roughhead grenadier are permitted. This accounting of roughhead grenadier landings under quotas for roundnose grenadier was subject to an action for annulment at the EU court of justice and was rejected (http://curia.europa.eu/juris/liste.jsf?language=en&num=C-128/15).

14.6 Data available

14.6.1 Landings and discards

Official landing data are available from Subareas 1 and 2 since 1990, from Subareas 3 and 4 since 1992, from Division 5.a since 1996, from Division 5.b since 1997, from Subareas 6 and 7 since 1993, from Subarea 8 for 2002 and 2006, from Subarea 12 since 2000, and from Subarea 14 since 1993.

Discard data for most years from 1996 to 2015 from Subareas 6, 12 and 14, collected by Spanish scientific observers, on-board commercial Spanish trawlers were used to estimate discard rates. Discard rates, estimated as the discarded catch divided by retained catch of the species, are high, averaging 0.77 $\pm$ 0.42 (mean $\pm$ standard deviation) for Subarea 6, 0.68 $\pm$ 0.23 for Subarea 12 and 0.53$\pm$ 0.50 for Subarea 14.b (Table 15.8).

14.7 Length composition of the landings and discards

No data available.

14.8 Age composition

No data available.

14.9 Weight-at-age

No data available.

14.10 Maturity and natural mortality

No data available.

14.11 Research vessel survey and cpue

14.11.1 Research vessel survey

The Icelandic autumn groundfish survey IS-SMH is the main source of fishery-independent data for *M. berglax* in Icelandic waters. Further, data can be compiled from several other older surveys of exploratory nature.

The IS-SMH survey covers Icelandic shelf and slope at depths from 20 to 1500 m. It is a stratified systematic survey with standardized fishing methods. Small-meshed bottom trawls (40 mm in the codend) equipped with rock-hopper are towed at a speed of 3.8 knots for a predetermined distance of 3 nautical miles (See the stock annex for greater silver smelt for a detailed description of methodology).

14.11.2 Cpue

The data available to WGDEEP only allow an estimation of non-standardised cpue for the Spanish fleet operating in Subareas 6, 12 and 14.

14.12 Data analyses

No data analysis was carried out.

14.13 Benchmark assessments

There has been no benchmark for this stock.

14.14 Management considerations

Only landings are available and the time-series considered reliable is restricted to 1992–2001. Years 2002–2015 are not considered because catches reported in some divisions are significantly larger than the historical landings and there are major doubts about the reality of these catch (ICES, 2014). Information from scientific on-board observers and exploratory surveys in Subareas 6, 12 and 14 indicates that the species occurs at low density over these fishing grounds, making it unlikely that such quantities can have been caught.

There are no biological data (length or age composition, weight-at-age, maturity, mortality) that could be used to assess changes in stock status.

Literature based mostly on survey data from Canadian waters indicates that this is a long-lived, slow-growing species, of low fecundity and vulnerable to overfishing (see

Devine and Haedrich, 2008 and references therein; Gonzalez-Costas, 2010). Age estimations from otoliths have found specimens of up to 23 years (Savvatimsky, 1984) and the species has been classified as of concern due to a decline of >90% of the survey index within Canadian waters over a period of 15 years (COSEWIC, 2007).

Thus, no expansion of the actual fisheries should be permitted until enough data are collected from the exploited population to identify the stock and conduct an appropriate assessment.

14.15 References

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Table 15.1. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in Subareas 1 and 2.

Year	Germany	Norway	Russia	France	Spain	TOTAL
1988						
1989						
1990	9	580				589
1991		829				829
1992		424				424
1993		136				136
1994						0
1995				1		1
1996				3		3
1997		17		4		21
1998		55				55
1999				<0.5		0
2000		35	13	<0.5		48
2001		74	20	<0.5		94
2002		28	1	<0.5		29
2003		47	30			77
2004		78	1			79
2005		64	13	<0.5		77
2006		74	4	<0.5		78
2007		44	5			49
2008		49	6			55
2009		51	2			53
2010		39	6			45
2011		29				29
2012		54				54
2013		34	1	1		36
2014						
2015	0	26	17	0	+	43
2016		38	8			46

Table 15.2. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in Subareas 3 and 4.

Year	France	Ireland	Norway	UK (Scot.)	TOTAL
1991					
1992			7		7
1993					
1994					
1995					
1996	4				4
1997	5				5
1998	1				1
1999	< 0.5				
2000	< 0.5	1	3	< 0.5	4
2001	< 0.5	1	9		10
2002	< 0.5		3	< 0.5	3
2003	< 0.5		2		2
2004	< 0.5		< 0.5	1	1
2005	1		38	< 0.5	39
2006	< 0.5				
2007					
2008					
2009					
2010				< 0.5	
2011	2				2
2012	1			< 0.5	1
2013	1				1
2014					
2015	+	0	+	0	+
2016	< 0.5		< 0.5		< 1

Table 15.3. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in 5.a.

Year	Iceland	TOTAL
1995		
1996	15	15
1997	4	4
1998	1	1
1999		
2000	2	2
2001	1	1
2002	4	4
2003	33	33
2004	3	3
2005	5	5
2006	7	7
2007	2	2
2008	< 0.5	
2009	5	5
2010	22	22
2011	21	21
2012	16	16
2013	16	16
2014		
2015	20	20
2016	20	20

Table 15.4. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in Division 5.b.

Year	France	Norway	UK (Scot.)	Russia	TOTAL
1997	6				6
1998	9				9
1999	99				99
2000	1				1
2001	2	2			4
2002	3		< 0.5		3
2003	12				12
2004	9		1		10
2005	6				6
2006	10				10
2007	3			2	5
2008	1			2	3
2009					
2010		1			1
2011					
2012	2		1		3
2013	2				2
2014	< 0.5				
2015	1	+	0	0	1
2016					

Table 15.5. Official landings (t) roughhead grenadier (*Macrourus berglax*) in Subareas 6 and 7.

Year	UK (E+W)	France	Norway	UK (SCO)	Spain	Ireland	Russia	Lithuania	TOTAL
1988									
1989									
1990									
1991									
1992									
1993	18								18
1994	5								5
1995	2	2							4
1996		13							13
1997		12							12
1998		10							10
1999		38							38
2000	< 0.5	3		8					11
2001		2	27	16					45
2002		4	2	6					12
2003		8	2		1				11
2004		6		5	0				11
2005		6		2	0				8
2006		10		< 0.5	0	75			85
2007		21			0	18			39
2008		2			222		4		228
2009		12		< 0.5	0				12
2010		8		1	51		1		61
2011		3			346				349
2012		1		4	191			436	632
2013		2			179				181
2014					42				42
2015		11	+		21				32
2016		11			32				43

Table 15.6. Official landings (t) roughhead grenadier (*Macrourus berglax*) in Subarea 12.

Country	Norway	France	Spain	Russia	Lithuania	TOTAL
1999						
2000	7	< 0.5				7
2001	10	< 0.5				10
2002	7		1136			1143
2003	2	< 0.5	223			225
2004	27	< 0.5	725			752
2005		< 0.5	2200	5		2205
2006		< 0.5	968	8		976
2007			420			420
2008			252			252
2009	6		2826			2832
2010			580			580
2011			441			441
2012			526		4	530
2013			210			210
2014			164			164
2015			53			53
2016	<0.5		33			33

Table 15.7. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in Subarea 14.

Country	Greenland	Norway	Russia	Spain	UK (E+W)	TOTAL
1992						
1993	18	34				52
1994	5					5
1995	2					2
1996						
1997						
1998		6				6
1999		14				14
2000						
2001		26				26
2002		49	4			53
2003		33				33
2004		46	9			55
2005		30	10			40
2006		1	3			4
2007		6	9			15
2008			3			3
2009		3			1	4
2010		1	13	1500	1	1515
2011			27	1516		1543
2012		16	18	2687		2721
2013			32	803		835
2014			11	450		461
2015*	3	68	0	12		83
2016		73	8	4		84

(*) Preliminary data.

Table 15.8. Average discard rate (discarded catch / total catch) 1996–2015, estimated from data collected by scientific observers on board commercial trawlers.

Year	6.b	12.a	12.b	14.b
1996			0.00	0.00
1997				
1998	0.42		0.56	
1999				
2000		1.00	0.41	0.12
2001	0.94		0.40	0.00
2002	0.79		0.50	1.00
2003	0.65		0.00	0.00
2004	1.00		0.97	
2005				
2006	0.33		0.00	
2007				
2008	0.00		0.04	
2009			0.00	
2010			0.17	
2011				0.13
2012				
2013	1.00		1.00	1.00
2014				
2015	NA	NA	NA	NA
Mean	0.79	1.00	0.37	0.51

15 Roughsnout grenadier (*Trachyrincus scabrus*) in the Northeast Atlantic

15.1 Stock description and management units

There are taxonomic issues with this stock. The roughsnout grenadier (*Trachyrincus scabrus*) was formerly *Trachyrincus trachyrincus,* with various spellings. The rough-nose grenadier (*Trachyrincus murrayi*) is a closely related species that is abundant throughout the north of Northeast Atlantic (Jonsson, 1992). The scientific names and spelling of these species changed over time. The similarity of the English names (roughsnout grenadier and roughnose grenadier) can only add more to the confusion.

Along the slope to the west of Scotland in ICES Division 6.a, only *Trachyrincus murrayi* was caught in surveys spanning depths from 500–2000 m and that took place in the 1970s and 1980s (Gordon and Duncan, 1984). In recent years, *Trachyrincus murrayi* is caught by the Marine Scotland deep-water research surveys in sufficient numbers to allow the estimation of population indicators (Neat and Burns, 2010).

Published literature does not report the occurrence of *Trachyrincus scabrus* at significant level in northern areas of the Northeast Atlantic. In particular, there are no records of the species in surveys held along the Mid-Atlantic Ridge (Fossen *et al*., 2008). *Trachyrincus scabrus* is not caught in Icelandic surveys where *Trachyrincus murrayi* is caught in large numbers.

T. scabrus has been reported in the Porcupine Seabight (ICES Division 7.j,k) at depths 500–1300 m. The species was also recorded further south in the Cantabrian Sea (ICES Division 8.c). In the latter area, *T. scabrus* was report to occur at a high abundance on the Le Danois Bank (ICES Division 8.b) at depths from 500–800 m (Sanchez *et al*., 2008).

Unlike in the Atlantic Ocean, *Trachyrincus scabrus* occurs in most of the Mediterranean Sea, along the Spanish slope to the Ionian Sea (D'Onghia *et al*., 2004; Moranta *et al*., 2006). In the Mediterranean Sea high abundances were reported at depths ranging from 800–1300 m. In the Mediterranean Sea, *T. scabrus* reaches larger size than the other macrourid species occurring at the same depth range.

Therefore, *T. scabrus* is a species occurring in the Mediterranean Sea and in the Atlantic and does not seem to occur at levels susceptible to support commercial fisheries in most areas north of 52°N.

The other *Trachyrincus* species (*T. murrayi*) occurs in Subareas 5, 6 and 12. There is no known fishery for this species, it does not reach sufficient sizes to be of commercial interest. It is only a bycatch of deep-water fisheries in Subareas 5, 6 and 7 and probably 12.

As *T. scabrus* and *T. murrayi* can be misidentified this chapter addresses the two species.

Landings of *T. scabrus* were reported for ICES Subareas 6, 12 and 14. In these areas the species is considered to be at most a minor bycatch. The occurrence of the species is even not confirmed in Subareas 12 and 14. It may be that only *T. murrayi*, occurs in these Subareas. Therefore the species identity of commercial landings reported as *T scabrus* needs to be confirmed. The reporting of 0 landings in response to the data call for landings and discards in 2016, tends to confirm that landings reported for 2012 were misidentification or coding errors.

15.1.1 Landings trends

Landings have been reported in 2012 only amounting to 54 tonnes in Subarea 10 and 3 tonnes in Division 14.b.

15.1.2 ICES Advice

The ICES advice for the years 2016–2020 is that "there should be no directed fisheries for roughsnout grenadier, and bycatch should be counted against the TAC for roundnose grenadier to minimize the potential for species misreporting."

15.1.3 Management

There is no current species-specific management measure for the roughsnout grenadier. Despite the advice for years 2016–2020, the EU regulation for TACs of deep-water species in 2017–2018 makes no mention of the roughsnout grenadier (Council regulation (EU) 2016/2285). There is no regulation for this species in other countries (Norway, Iceland, Faroe Islands) where these species should be landed when caught.

15.1.4 Data availability

15.1.4.1 Landings and discards

Landings data are presented in Table 15.1.

T. murrayi is discarded by the French deep-water fishery. Both *T. murrayi* and *T. scabrus* are recorded in on-board observation but the identification of these species may be uncertain. The total discards of the two combined have been less than of 0.2% of total catch in deep-water fishing hauls since 2010 (Table 15.2). These species have not been landed at all by the French fishery. It can be concluded that *T. scabrus* and *T. murrayi* have a minor contribution to the total catch in weight in ICES Divisions 5.b and 6.a and Subarea 7, where the French fishery operates.

Discards of *Trachyrincus* spp. are expected to occur in all deep-water fisheries and also in the other fisheries along the upper slope such as fisheries targeting hake, monkfish and megrims, which may operate down to 800 m.

The stock was included in the data call for 2017 and data were delivered to WGDEEP through InterCatch and file provided by members. France, Spain and Portugal reported through InterCatch and no landings and discards were uploaded. The absence of landings matches expert knowledge that the species is not commercial. The absence of discards from InterCatch may come from the absence of landings so the standard raising variable being absent discards were raised to 0. Faroe Islands, Iceland and Norway, reported landings of deep-water species on the WGDEEP SharePoint and there were no landings of *Trachyrincus* spp. included. As the fisheries from these countries make no discards, there was no catch of roughsnout grenadier or these catch were not identified to species level.

15.1.5 Length compositions

No length data are available.

In the Icelandic autumn survey specimens of *T. murrayi* with sizes up to 40 cm total length have been recorded. Nevertheless the bulk of the catch is made of specimens with a length range from 5 to 20 cm.

T. murrayi of 45 cm total length would weigh less than 300 g using the following weight–length relationship estimated Length–weight relationship for *T. murrayi*: W=0.00129 LT^3.232 (Borges *et al.*, 2003).

15.1.5.1 Age compositions and longevity

No age composition is available. There are, however some studies on growth and longevity.

In the Mediterranean *T. scabrus* has a maximum age of eleven years (Massutti *et al.*, 1995).

Swan and Gordon (2001) analysed otoliths from 218 specimens of *T. murrayi*, with head length ranging from 2.1–11.7 cm and found up to nine growth bands on otolith. Converting the head length (HL) to total length (TL)by using the conversion estimated by the Swan and Gordon (2001): HL=3.630*HL0.402 (n=488), the largest fish in the sample had 42 cm total length, which seems to be at or close to the maximum length of the species in the area.

It can be concluded that the two *Trachyrincus* species appear to have similar longevities, of around ten years. Similar lifespans have been estimated for other small macrourids (Coggan *et al.*, 1999).

15.1.5.2 Weight-at-age

No weight-at-age data are available.

15.1.5.3 Maturity and natural mortality

No data were available.

15.1.5.4 Catch, effort and research vessel data

Population indicators of *T. murrayi* were estimated from data collected during deepwater research surveys held by the Marine Scotland. The abundance and length distribution varied along the period under analysis (2000–2008) and no trend was observed (Neat and Burns, 2008). Recent Scottish survey data for this species were not requested to Marine Scotland in 2017.

15.1.6 Data analyses

Available data on *T. murrayi* suggest that the species is too small to have commercial interest. In fact, the weight of the largest specimen caught in Icelandic survey (45 cm TL) was not more than 500 g. Available data on *T. scabrus* suggest that the species occurs at too level in the Northeast Atlantic to support any commercial fishery.

15.1.6.1 Biological reference points

Not applicable.

15.1.7 Comments on assessment

Not applicable.

15.1.8 Management considerations

The roughsnout and roughnose grenadiers are small bycatch in some deep-water fisheries (see example in Table 14.2).

Owing to the smaller size and shorter longevity of *T. murrayi* and *T. scabrus* compared to the target species of deep-water fisheries, levels of fishing mortality that are sustainable to the target species are most likely to be also sustainable for these smaller species.

The only, management that can be proposed is to include minor landings of any macrourid species in the TAC of the main grenadier species, the roundnose grenadier. This should not imply any increase of the TAC of roundnose grenadier, because catches of *Trachyrincus* spp. and all other macrourids are small compared to that of the roundnose grenadier in all ICES divisions.

15.1.9 References

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Table 15.1. Official landings of roughsnout grenadier by ICES Subarea.

Year	Spain 6.b	Spain 12.a	Spain 12.b	Spain 14.b	Total
2012		54		3	57
2013					0
2014	42	4	155	448	649
2015	0	0	0	0	0
2016	0	0	0	0	0

Table 15.2. Discards of *T. murrayi* and *T. scabrus* in the French deep-water trawl fishery compared to the catch of the target species and the total landings and discards from 2010 to 2016. Raw observation data, no raising applied.

	2010	2011	2012	2013	2014	2015	2016
Total catch in observed hauls (tonnes)	530	846	652	551	533	377	317
Landings (tonnes)	451	694	526	440	477	334	290
Discards (tonnes)	79	151	126	111	56	43	27
Catch (landings+ discards) of roundnose grenadier, black scabbardfish and blue ling (tonnes)	387	616	456	373	388	257	225
Discards of *T. murrayi* and *T. scabrus* (tonnes)	0.10	0.42	1.16	0.55	0.52	0.12	0.10

16 Other deep-water species in the Northeast Atlantic

16.1 The fisheries

The following species are considered in this chapter: 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*). Mora, rabbitfish, smoothheads, blackbelly rosefish and deep-water cardinal fish are taken as bycatch in mixed-species demersal trawl fisheries in Subareas 6, 7 and 12 and to a lesser extent, 2, 4 and 5.

Mora, wreckfish, blackbelly rosefish and silver scabbardfish are caught in targeted and mixed species longline fisheries in Subareas 8, 9 and 10.

Deep-water red crab were formerly caught in directed trap fisheries principally in Subareas 6 and 7 but this fishery ceased to operate in the ICES area since 2008.

16.1.1 Landings trends

Landings reported to the Working Group are presented in Tables 16.1–16.9 and official landings for 2006–2014 in Tables 16.10–16.17. These official landings were taken from official nominal catch 2006–2014 on the ICES website, similar data are not yet available for 2015–2016.

16.1.2 ICES Advice

ICES has not previously given specific advice on the management of any of the stocks considered in this chapter.

16.1.3 Management

No TACs are set for any of these species in EC waters or in the NEAFC Regulatory Area. None of these species were included in Appendix I of Council Regulation (EC) No 2347/2002 meaning that vessels were 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. They are now included in the Council Regulation (EC) 2016/2336 repealing the previous one.

16.2 Stock identity

No information available.

16.3 Data available

16.3.1 Landings and discards

Landings for all of these species are presented in Tables 16.1–16.9. In 2015, other deep-water species (OTH_COMB) were included in the data call for deep-water species, accompanied with a list of species for which landings data are required. The annual reporting of these species to WGDEEP has varied in quality and quantity. In some years and countries provided a single value for other species combined. Therefore species-specific landings data are incomplete and time-series would need being revised.

In 2016, some data provided to the working group were not suitable. One country reported species which are not deep water, such as coastal Rajidae, another reported American plaice (*Hippoglossoides platessoides*) and Spotted wolffish (*Anarichas minor*).

In some cases considerable differences exist between the working group data and therefore, the official catch number as for these species are presented in Tables 16.10–16.17. In Subareas 6 and 12 landings of silver scabbardfish are suspected to be misreported (probably of black scabbardfish) as the occurrence of the species is not supported by scientific evidence. These issues remain unresolved but need to be explored further.

The reported landings of black belly rosefish (*Helicolenus dactylopterus*) was high in 2016 but similar to 2012–2013.

16.3.2 Length compositions

For several species data on length compositions are available from survey data. Length distributions of *H. dactylopterus* in the Spanish Porcupine survey is shown in Figure 16.1 while Figure 16.2 presents the length–frequency distributions from the Spanish bottom-trawl survey in the Northern Spanish Shelf (SP-NGFS) in Divisions 9a and 8c. Time-series of length distributions of *H. dactylopterus* in the Faroese summer groundfish survey is shown in Figure 16.3. Trends in mean length of *H. dactylopterus* in the French EVHOE survey (Bay of Biscay) is shown in Figure 16. 4. The length distribution of *L. caudatus, Mora moro* and *P.americanus* in Azorean surveys are presented in Figures 16.5, 16.6 and 16.7, respectively.

16.3.3 Age compositions

No new information.

16.3.4 Weight-at-age

No new information.

16.3.5 Maturity and natural mortality

No new information.

16.3.6 Catch, effort and research vessel data

For *H. dactylopterus* standardized indexes from the Spanish Porcupine Bank Survey (abundance and biomass), the Portuguese longline survey in the Azores Islands (abundance), the French EVHOE survey (biomass), the cpue series from the Faroese groundfish survey and the Spanish bottom-trawl survey (SP-NGFS) in Divisions 9.a and 8.c are given in Figures 16.7–16.11.

Abundance indices for *L.caudatus*, *Mora moro* and *P.americanus* from the Portuguese longline survey in the Azores Islands are given in Figures 16.12 to 16.14.

16.3.7 Data analysis

In general, modal length of *H. dactylopterus* appears to have increased in surveys shown here (Figures 16.1–16.4). Standardized biomass and abundance indices in the Spanish Porcupine Bank Survey (Figure 16.7) declined between 2006 and 2011 but have increased since then and remained at similar level from 2013 to 2015 and decrease again in 2016. In the Azores, the abundance index for this species seems to have declined since 2008 (Figure 16.8) and after increased slightly from 2013 onwards. Trends in biomass in Bay of Biscay (Figure 16.9) and in Faroese (Figure 16.10) survey cpue show an increasing trend for this species since 2010. Similarly, in the SP-NGFS the biomass and abundance of *H. dactylopterus* even the decrease in 2016, after the peak of 2015, still above the mean values of the time-series and much above the minimum found in 2010 (Figure 16.11).

The standardized abundance index for *L. caudatus* in the Azores Islands longline survey (Figure 16.12) was at the same low level in 2016 than in 2001–2003. Mean length has declined across the time-series but seems rather increasing since 2005 (Figure 16.5).

The cpue for *P. americanus* in the Azores Islands longline survey (Figure 16.13) fluctuated greatly with no overall trend between 1995 and 2008. Since 2010, the level has remained low, with the lowest value in 2013. In 2016 the value shows a significant increase. Mean length showed no trend unless the higher value appears in 2016, the last analysed year (Figure 16.7).

The cpue for *M. moro* in the Azores longline survey (Figure 16.14) show no clear trend unless the last year (2016) reach the higher value of the whole series. The mean length seems rather high in 2012 and 2013 but decreases again in 2016 (Figure 16.6).

16.3.8 Comments on the assessment

16.3.9 Management considerations

Currently no advice is required for these stocks.

Table 16.1. Working Group estimates of landings of *Mora moro* and *Moridae* (t).

Year	2	5b	6 and 7	8 and 9	10	12	14b	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
2014				1	54			55
2015				51	92			92
2016		1	40					41

Table 16.3. Working group estimates of landings of rabbitfish (t) (*Chimaera monstrosa* and *Hydrolagus* spp).

Year	1 and 2	3 and 4	5a	5b	6 and 7	8	9	12	14	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
2014		4		32	131	4		77		178
2015	79	14		25	30			1		149
2016	78	49		40	225	15	31	4		364

Table 16.4. Working Group estimates of landings of Baird's smoothhead (t).

Year	5a	5b	6 and 7	12	14	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
2014			235 0+	228		463
2015			127 3+	91		218
2016			131	258		389

Table 16.5. Working Group estimates of landings of wreckfish (t).

Wreckfish (*Polyprion americanus*) All areas				
Year	**6 and 7**	**8 and 9**	**10**	**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
2014		95	121	216
2015			116	116
2016	4	19	101	124

Table 16.6. Working Group estimates of landings of blackbelly rosefish (t). Data from 2015 are provisional.

Year	3 and 4	5b	6	7	8 and 9	10	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			105	193	214	281	752
2009			182	14	75	267	450
2010			195	6	120	213	294
2011			176	14	149	231	400
2012		2	161	944	1332	190	2629
2013			121	20	1320	235	1696
2014			25	23	141	200	389
2015		+	+			256	256
2016			452	516	537	306	1811

Table 16.7. Working Group estimates of landings of silver scabbardfish (t).

	6 and 7	8 and 9	10	12	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		361	123	648
2014	253		713	88	1056
2015			429	41	470
2016	188	134	87	33	442

Table 16.8. Working Group estimates of landings of deep-water cardinal fish (t).

Year	5b	6	7	8 and 9	10	12	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
2014		4	1	2	2		9
2015					4		4
2016					6		6

Table 16.9. Working Group estimates of landings of deep-water red crab (t).

Year	4and5	6	7	8 and 9	12	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
2013						0
2014						0
2015						0
2016						0

Table 16.10. Official landings of *Mora moro* and *Moridae* (t) 2006–2014.

YEAR	27.5	27.6	27.7	27.8	27.9	27.10	TOTAL
2006	1	43	22	17	2	62	147
2007	1	51	51	6	1	52	162
2008	0	38	31	1	0	31	101
2009	0	35	52	1	1	57	146
2010	2	37	46	4	0	55	144
2011	0	38	42	9	0	68	157
2012	0	17	46	14	0	53	130
2013	0	19	71	14	1	86	191
2014	0	5	97	39	0	92	233

Table 16.11. Official landings of rabbitfish (t) (*Chimaera monstrosa* and *Hydrolagus* spp.) 2006–2014.

YEAR	27.1	27.2	27.3	27.4	27.5	27.6	27.7	27.8	27.10	27.12	TOTAL
2006	28	1	13	11	24	0	5	0	76	5	163
2007	63	2	13	0	45	4	0	2	47	0	176
2008	79	2	7	2	38	1	0	2	11	0	142
2009	88	1	6	7	42	0	0	0	6	0	150
2010	199	1	21	12	31	1	0	0	23	0	288
2011	149	4	6	13	220	4	1	0	45	0	442
2012	105	2	23	26	265	17	3	0	3	0	444
2013	109	3	37	52	305	2	1	0	0	0	509
2014	83	0	22	64	228	0	0	0	0	5	402

Table 16.12. Official landings of Baird's smoothhead (t) 2006–2014.

YEAR	27.5	27.6	27.7	27.8	27.9	27.12	27.14	TOTAL
2006	0	403	3	67	0	241	0	714
2007	0	192	0	0	0	14	0	206
2008	4	1043	0	0	0	790	42	1879
2009	0	739	0	0	0	776	1	1516
2010	0	672	0	0	0	896	0	1568
2011	0	785	0	0	0	718	0	1503
2012	15	360	1	0	18	551	5	950
2013	0	304	0	0	27	346	0	677
2014	14	248	0	0	15	241	0	518

Table 16.13. Official landings of wreckfish (t) 2006–2014.

YEAR	27.4	27.6	27.7	27.8	27.9	27.10	TOTAL
2006	0	15	52	33	407	498	1005
2007	0	20	197	65	710	686	1678
2008	0	9	149	168	386	523	1235
2009	0	1	245	212	217	395	1070
2010	0	0	232	392	105	240	969
2011	4	6	409	352	144	277	1192
2012	0	0	96	101	154	228	579
2013	0	0	39	46	114	209	408
2014	0	0	8	29	92	142	271

Table 16.14. Official landings of blackbelly rosefish (t) 2006–2014.

YEAR	27.2	27.4	27.5	27.6	27.7	27.8	27.9	27.10	TOTAL
2006	0	0	1	195	839	168	161	209	1573
2007	1	0	1	387	1968	157	363	277	3154
2008	2	0	1	138	1175	314	213	287	2130
2009	0	2	1	150	1320	436	216	317	2442
2010	0	1	0	201	1681	1665	197	216	3961
2011	0	1	3	176	2302	1558	264	239	4543
2012	0	0	1	161	954	991	412	192	2711
2013	0	7	3	131	516	941	386	235	2219
2014	0	1	6	149	489	471	337	224	1677

Table 16.15. Official landings of silver scabbardfish (t) 2006–2014.

YEAR	27.6	27.7	27.8	27.9	27.10	27.12	TOTAL
2006	27	346	83	470	37	3	966
2007	25	68	14	746	55	1	909
2008	24	1	1	900	64	20	1010
2009	43	107	314	396	64	34	958
2010	144	21	284	510	68	66	1093
2011	890	0	35	451	148	105	1629
2012	778	0	2	58	271	286	1395
2013	225	0	1	279	361	144	1010
2014	240	0	2	529	912	91	1774

Table 16.16. Official landings of deep-water cardinalfish (t) 2006–2014.

YEAR	27.6	27.7	27.8	27.9	27.10	TOTAL
2006	27	66	10	17	10	130
2007	10	17	1	29	7	64
2008	5	12	4	7	7	35
2009	10	13	2	32	7	64
2010	7	11	27	3	5	53
2011	4	45	2	1	5	57
2012	16	4	3	1	4	28
2013	10	2	1	1	4	18
2014	5	1	0	1	4	11

Table 15.17. Official landings of deep-water red crab (t) 2006–2014.

YEAR	27.4	27.6	27.7	27.8	27.9	27.12	TOTAL
2006	7	217	72	34	0	123	453
2007	0	163	82	46	5	72	368
2008	10	73	85	31	0	64	263
2009	0	110	75	10	0	115	310
2010	2	247	79	13	33	71	445
2011	0	246	148	12	25	43	474
2012	10	67	45	10	0	21	153
2013	3	91	34	7	11	32	178
2014	1	112	29	3	0	48	193

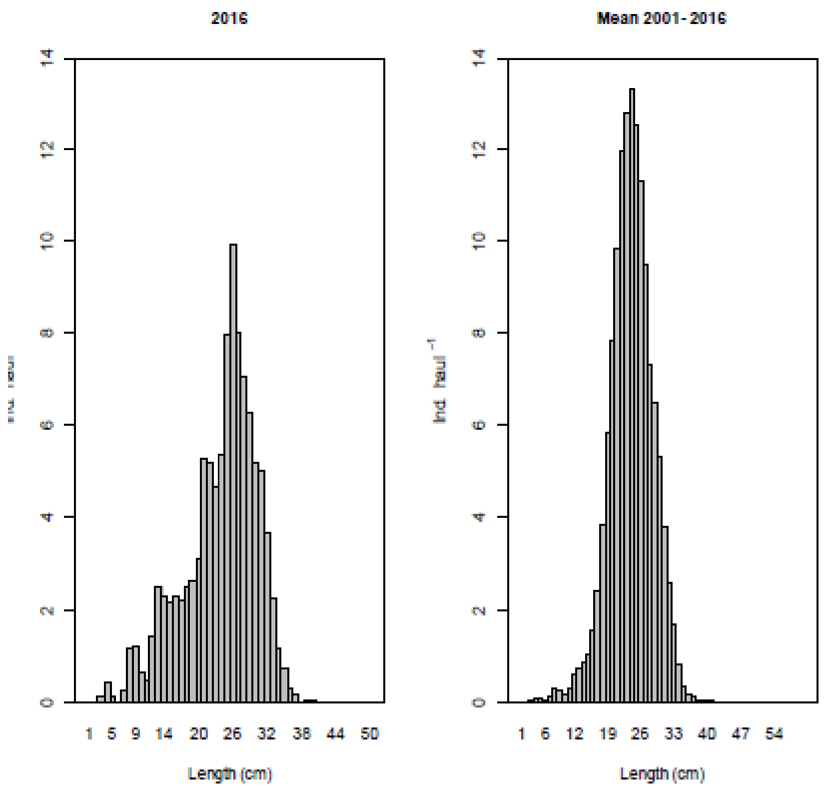

Figure 16.1. Stratified length distributions of *Helicolenus dactylopterus* in 2016 Porcupine survey, and mean values during Porcupine survey time-series (2001–2016).

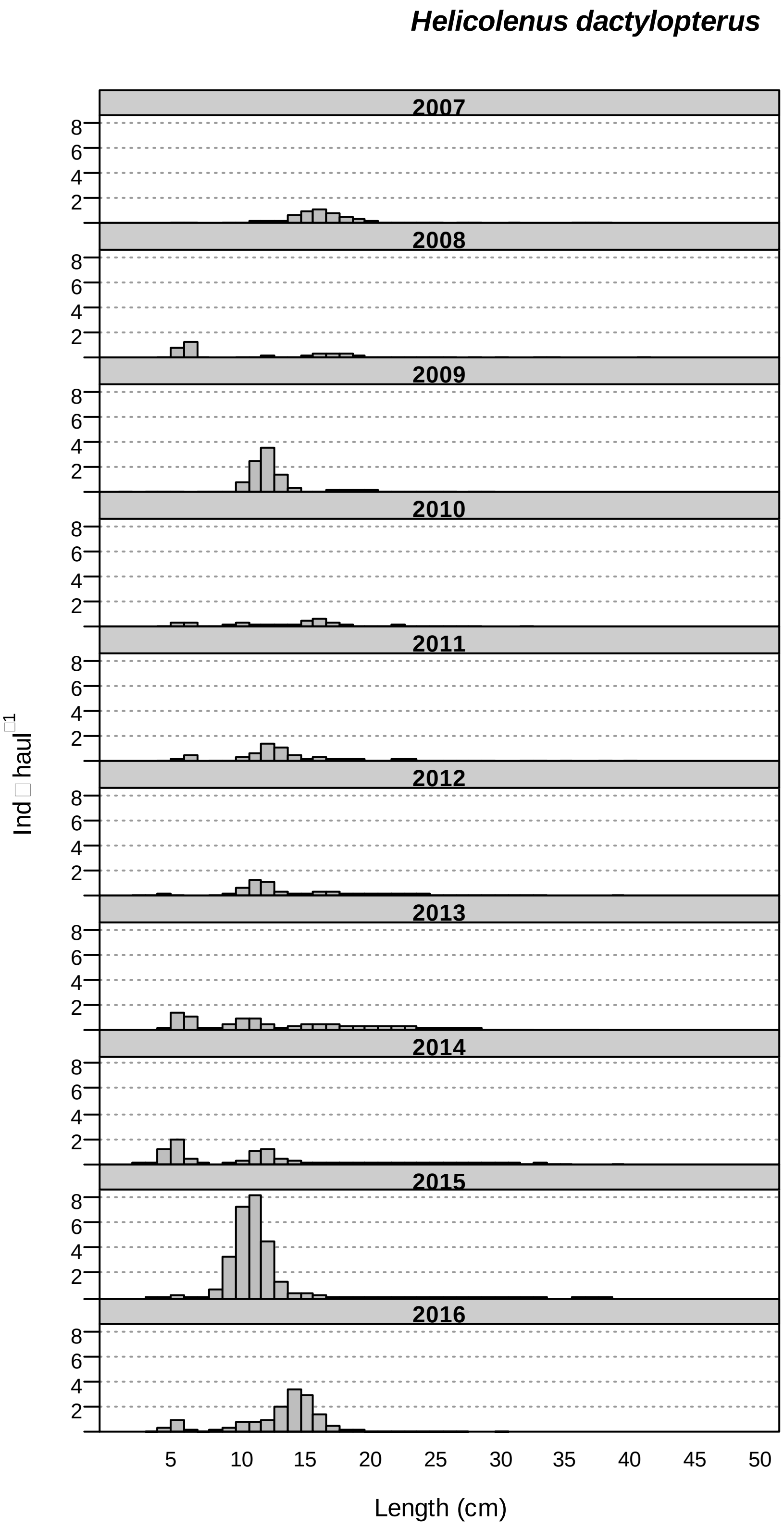

Figure 16.2. Mean stratified length distributions of bluemouth (*H. dactylopterus*) in Northern Spanish Shelf surveys (2007–2016).

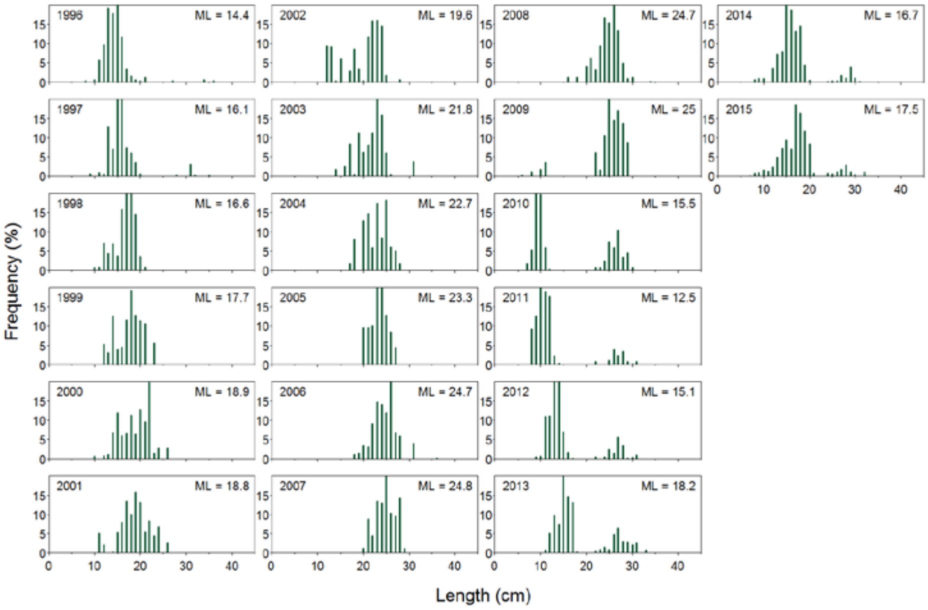

Figure 16.3. Length distributions of *Helicolenus dactylopterus* in Faroese summer survey 1996–2015.

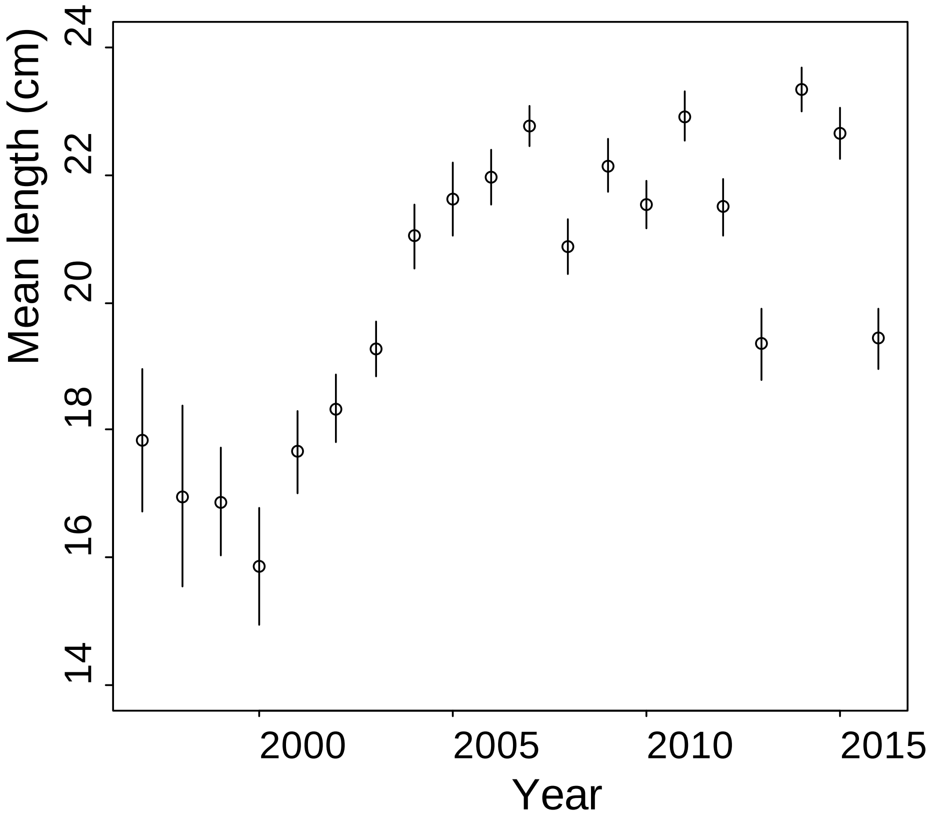

Figure 16.4 Trend in mean length of *Helicolenus dactylopterus* in the French survey in Bay of Biscay and Celtic Sea (EVHOE).

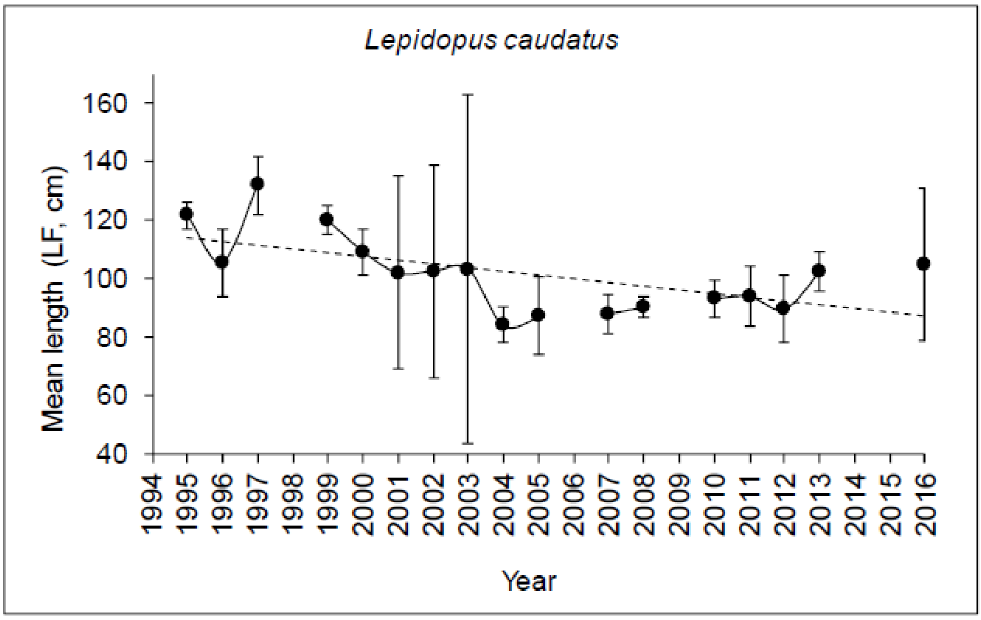

Figure 16.5. Mean length of *Lepidopus caudatus* in Azores bottom longline survey 1995–2016.

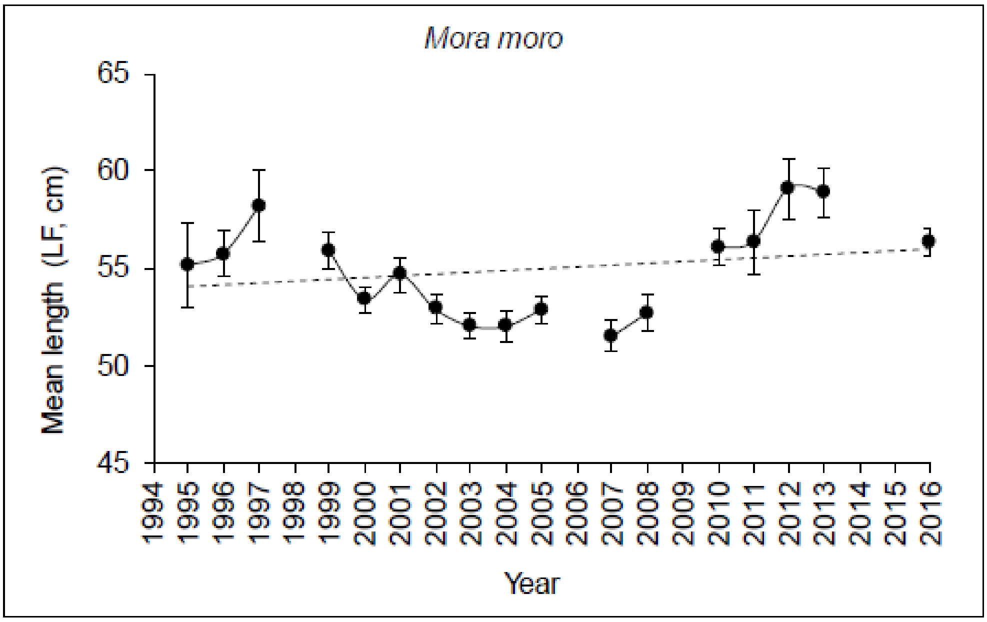

Figure 16.6. Mean length of *Mora moro* in Azores bottom longline survey 1995–2016.

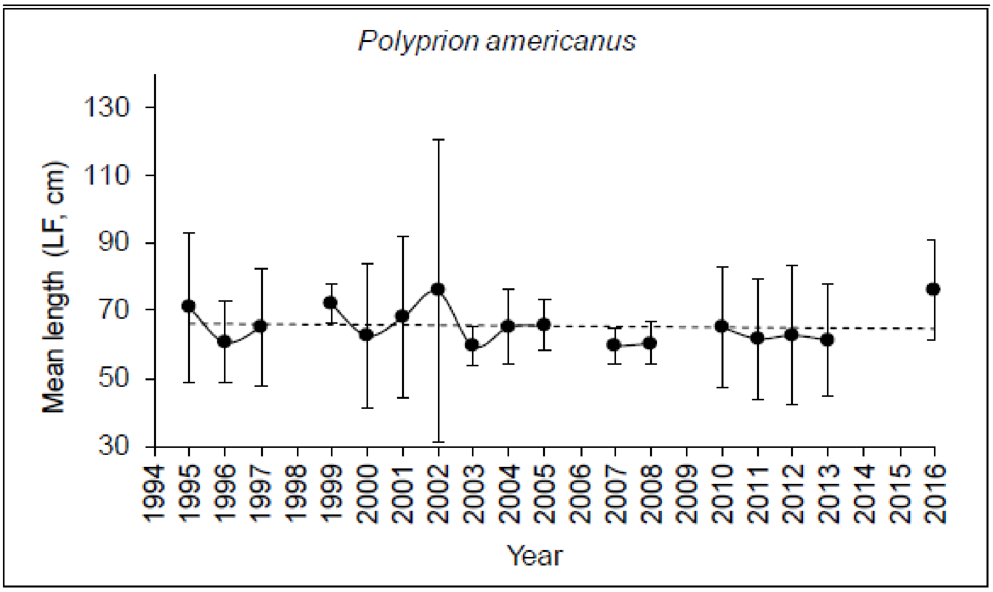

Figure 16.7. Mean length of *Polyprion americanus* in Azores bottom longline survey 1995–2016.

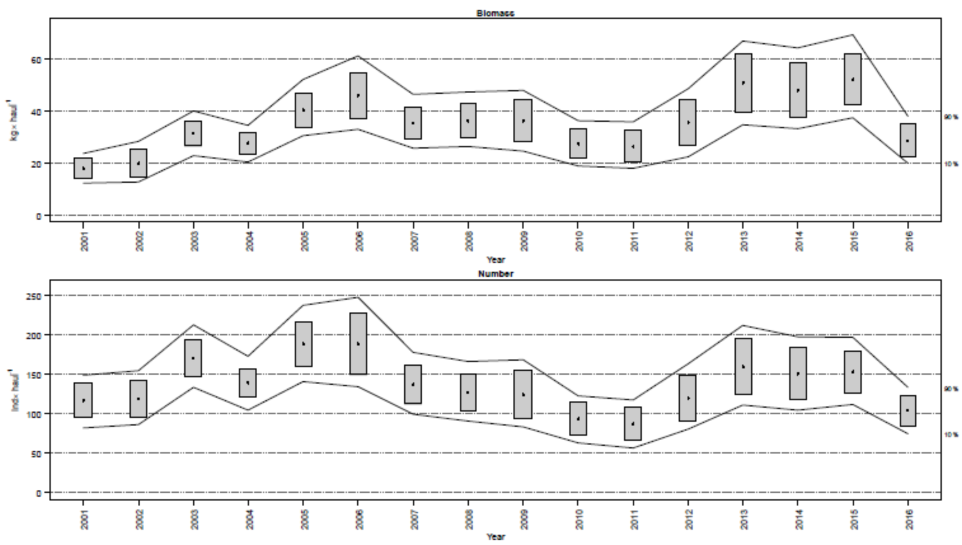

Figure 16.7. Trends of *Helicolenus dactylopterus* biomass and abundance indices during Porcupine Survey time-series (2001–2016). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

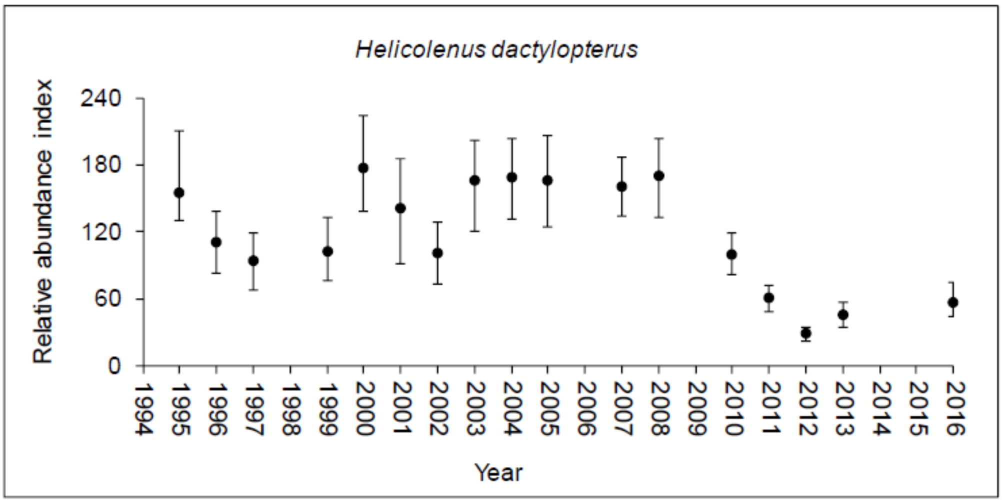

Figure 16.8. Annual bottom longline survey abundance index for *Helicolenus dactylopterus* in Azorean bottom longline surveys.

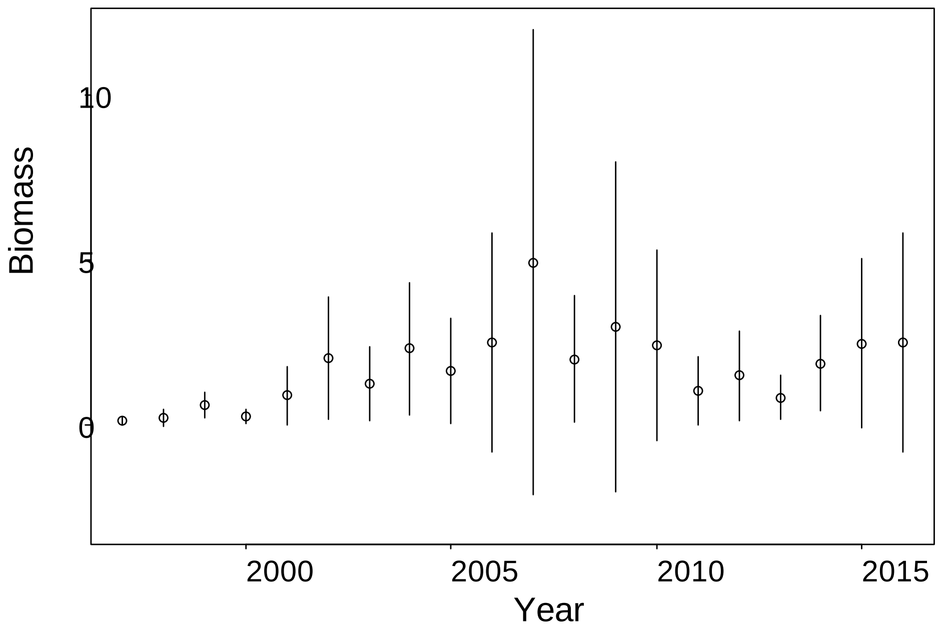

Figure 16.9. Survey biomass index from the French survey (EVHOE) for *Helicolenus dactylopterus*.

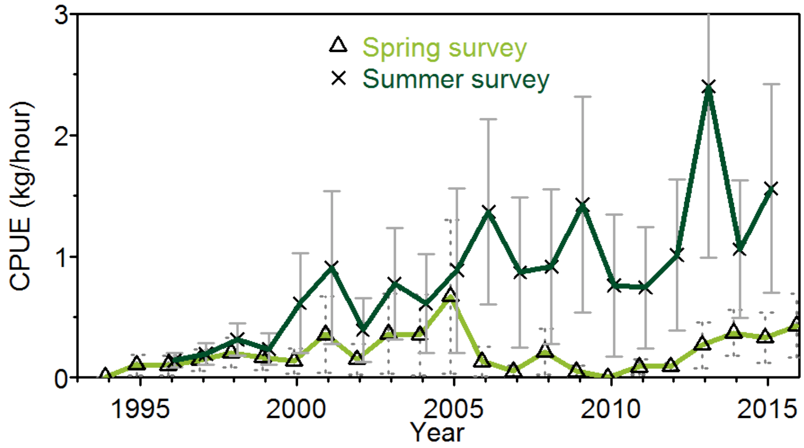

Figure 16.10. Cpue time-series for *Helicolenus dactylopterus* in the Faroese groundfish surveys.

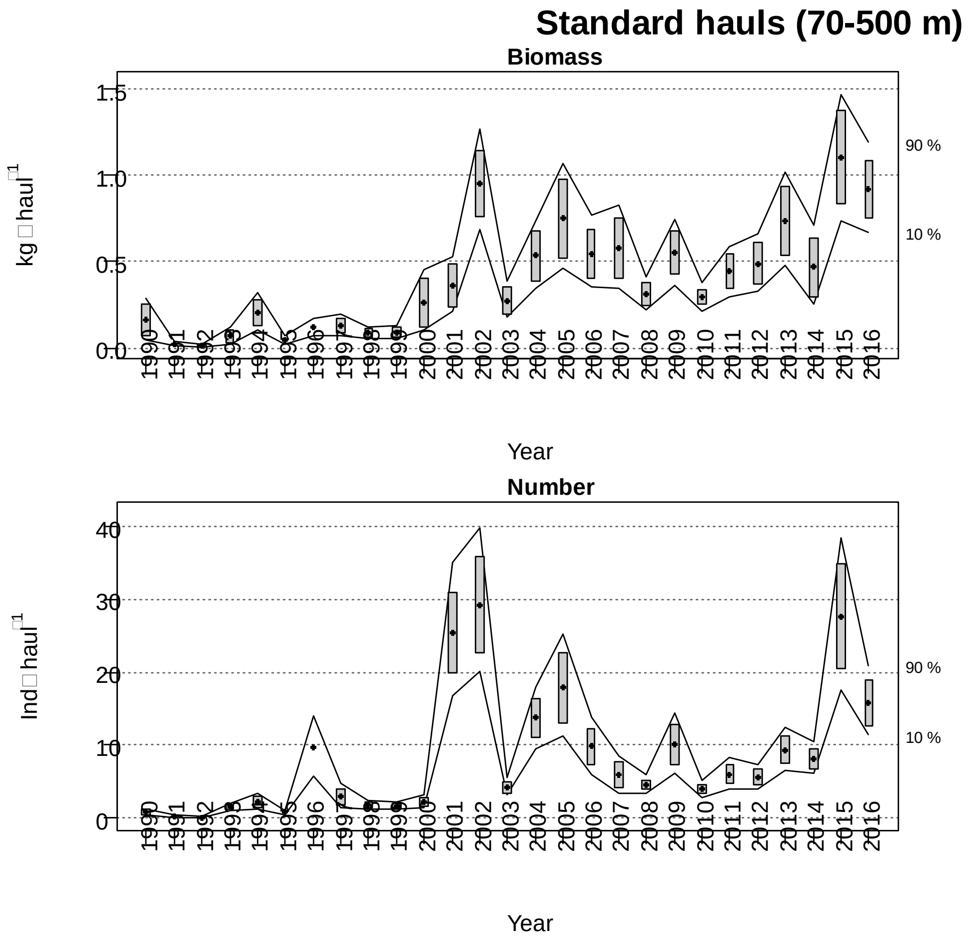

Figure 16.11. Evolution of *Helicolenus dactylopterus* mean stratified biomass and abundance in Northern Spanish Shelf surveys time-series (1990–2016). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000).

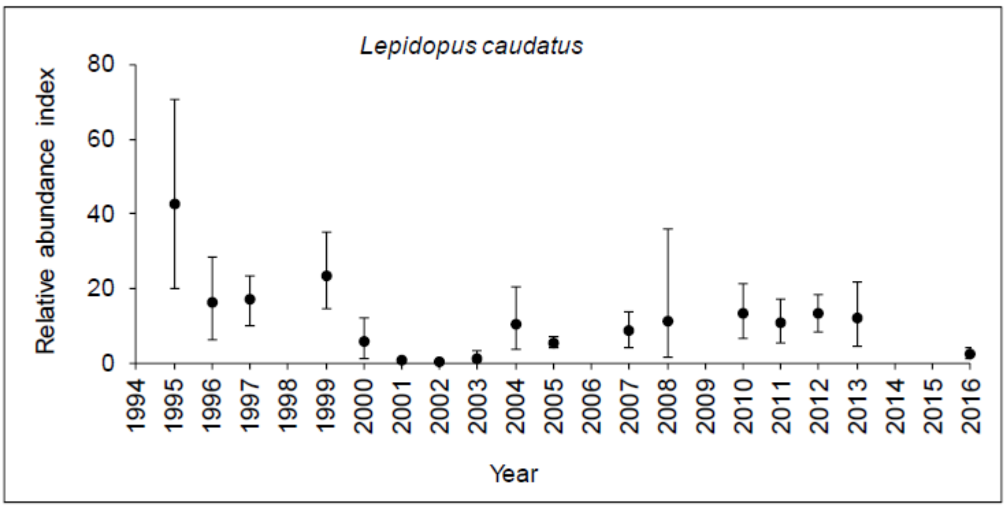

Figure 16.12. Annual bottom longline survey abundance index for *Lepidopus caudatus* in Azorean bottom longline surveys.

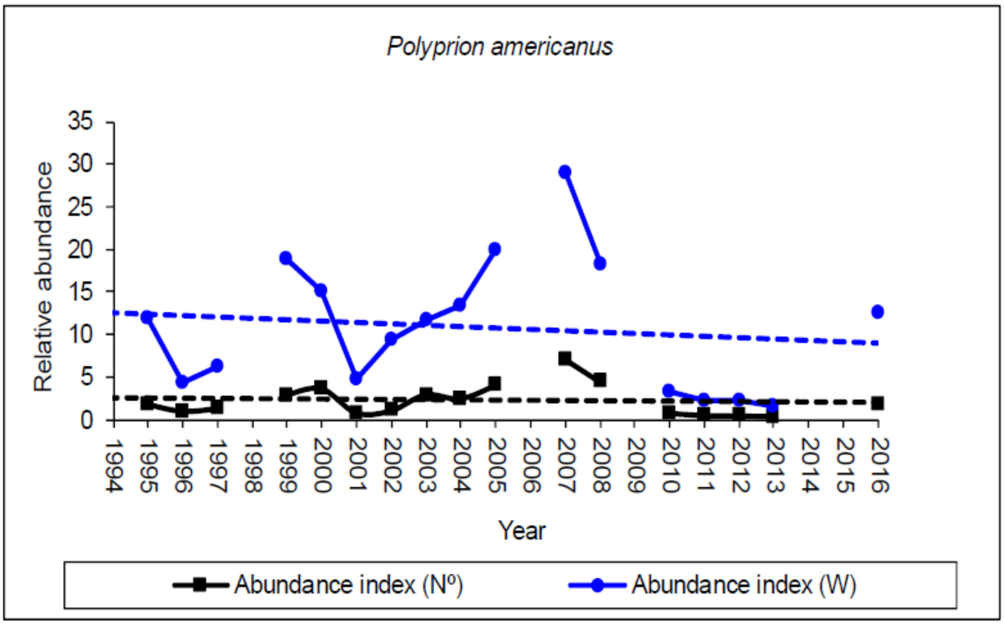

Figure 16.13. Annual bottom longline survey nominal cpue for *Polyprion americanus* in Azorean bottom longline surveys.

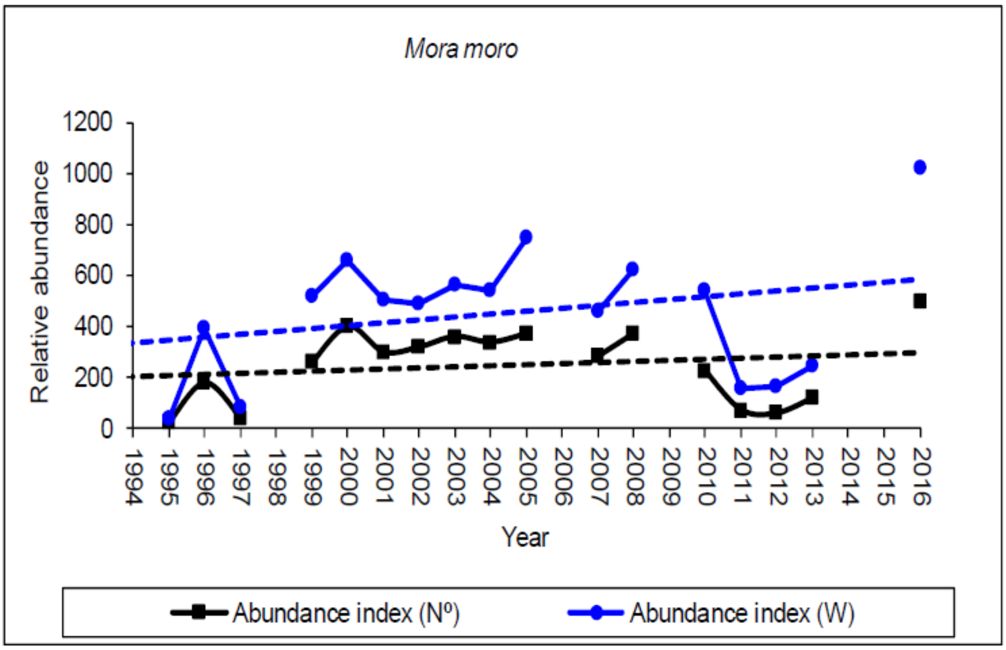

Figure 16.14. Annual bottom longline survey nominal cpue for *Mora moro* in Azorean bottom longline surveys.

17 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 Regulatory Area 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 Regulatory Area and describe and prepare a first Advice draft of any emerging deep-water fishery with the available data in the NEAFC Regulatory Area.

17.1 Landings in the NEAFC regulatory area

17.1.1 Data availability

Changes to the way 2014 landings data were reported to ICES in 2015 meant that data to discriminate catches/landings and fishing effort inside versus outside the EEZs were no-longer routinely available to WGDEEP.

In previous years, WGDEEP requested national data providers to submit data disaggregated to the lowest possible level. Many countries responded by providing data at the level of ICES statistical rectangle and this facilitated the splitting of catches between EEZs and NEAFC waters and production of maps showing catch locations.

The ICES data-call for deep-water species in 2015 specified that landings data should be aggregated at the level of ICES subarea. Hence, very few countries supplied data at the level of statistical rectangles.

In 2017, the bulk of 2016 landings in the ICES preliminary catch statistics were however reported according to the coding of ICES divisions, which separate areas inside outside EEZs, e.g. 27.6.b.2 and 27.6.b.1 respectively inside and outside the EEZ to the west of Scotland. Some landings were reported by larger Subareas, e.g. 27.10 and most of these could be allocated to either EEZs or the RA based on knowledge of the fisheries from WGDEEP.

Thus it was possible to update Table 17.1, albeit with lower confidence that previous years when data by statistical rectangle were available. It was not possible to update maps of landings/catches by statistical rectangle, thus Figures 17.1–17.6 show data from 2013.

17.1.2 Characterisation of fisheries in the NEAFC RA

Deep-water fisheries in the NEAFC Regulatory Area occurred predominantly in two regions; the Mid-Atlantic ridge (ICES Divisions 27.10.b, 27.12.a;1, 27.12.c and 27.14.b.1) and the Rockall-Hatton area (Divisions 27.6.b.1 and 27.12.b). 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). In 2014-2015, there were also minor landings from Subdivision 27.5.b.1 which is an extension of the longline fishery that occurs in the Faroese EEZ into Areas Beyond National Jurisdiction (ABNJ). No landings of deep-water species was reported in the preliminary catch for this area in 2016. This fishery is described in Section 3.1.

Figures 17.1–17.6 show reported landings of roundnose grenadier, black scabbardfish, blue ling, ling tusk and alfonsino in the ICES area in 2013 by statistical rectangle.

Since 2014, equivalent data have not been available to update these figures. 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 6.b.1, 12.b, and 14.b.1 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". This no longer occurred for 2016 landings. These landings were not available by statistical rectangle for 2013 and so are not included in the maps. Landings of deep-water species from the NEAFC RA are therefore considerably underestimated in Figures 17.1–17.6.

The Working Group noted as a recent development the increase in the reported landings of roughhead grenadier on the mid-Atlantic Ridge in 2012, 2013 and 2014 reaching 2726 tonnes, 868 tonnes and 448 tonnes respectively (Ch. 3). Catches in previous years were mostly well below 10 tonnes. It was the consensus of the working group, based on expert judgement, that these catches are misreported. Roughhead grenadier occurs on the MAR, but published catch rates in research trawls are very low (Hareide and Garnes, 2001; Bergstad *et al.*, 2008). In 2015 and 2016 the estimated catches were down to similar levels as before 2012, likely as a result of changed EU regulations of these fisheries for the years 2015 and 2016 (council regulation (EU) No 1367/2014), which required landings of roughhead grenadier to be reported under the same quotas and roundnose grenadier.

Table 17.2 provides an overview of the fisheries and ICES advice by stock fished in the NEAFC area.

17.2 Spawning aggregations and areas of local depletion in the NEAFC Regulatory Area

No new information was available in 2017. The information compiled in 2014 is presented below.

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 17.1. In Iceland, the depletion of the spawning aggregation in a few years was documented two decades ago (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 (ICES Division 6.b) and along the eastern and southern margins of Hatton Bank (6.b). NEAFC has had a seasonal closure in force since 2010 (http://neafc.org/managing_fisheries/measures/current; latest regulation: *Recommendation on Regulatory Measures for the Protection of Blue Ling in the NEAFC Regulatory Area (ICES Division XIV) from 2017–2020*, valid until 31 December 2020).

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. Small landings of 19 tonnes were reported in 2016 after two years with zero landings.

Table 17.1. Landings from fisheries in the NEAFC regulatory area (RA) in 2014–2016.

	2014	2015		2016	
ICES stock code	Landings in NEAFC RA (TONNES)	Landings in NEAFC RA (TONNES)	Percentage of TOTAL catch of STOCK taken in NEAFC RA	Landings in NEAFC RA (TONNES)	Percentage of TOTAL catch OF STOCK taken in NEAC RA
lin.27.3a4a6-91214	79	124	<1.0%	143	<1%
bli.27.5b67	4	33	<1%	41	1.5%
bli.27.nea	80	12	6%	0	0
usk.27.12ac	0	0	N/A	0	N/A
usk.27.6b	10	43	19%	20	22%
usk.27.3a45b6a7-912b		Uncertain			
(5 tonnes in 2013)	<1% (2013)	0	0		
ory.27.nea	58	84	100%	19	100%
rng.27.5b6712b	1261	933	69%	742	92%
rng.27.5a10b12ac14b	3477	2256	100%	382	94%
bsf.27.nea	179	292	99%	277	4%
alf.27.nea	0	141	39%	11	5%
rhg.27.nea	655	65	10%	64	23%

Table 17.2. Description of fisheries in the NEAFC area and ICES advice applicable in 2017 (issued in 2016 or before).

ICES stock code	Stock	NEAFC Deep Sea Stock Category	location of NEAFC fisheries	description of NEAFC fisheries	ICES advice applicable
lin.27.3a4a6-91214	Ling (*Molva molva*) in Subareas 6–9, 12, and 14, and in in Divisions 3.a and 4.a (Northeast Atlantic and Arctic Ocean)	4	Rockall Bank (see Figure 17.4)	longline fisheries on Rockall bank. The majority of the fishery occurs within the EU EEZ, but it extends very slightly into the NEAFC Regulatory Area.	ICES advises that when the precautionary approach is applied, catches should be no more than 14 746 tonnes in each of the years 2016 and 2017.
bli.27.5b67	Blue ling (*Molva dypterygia*) in Subareas 6–7 and Division 5.b (Celtic Seas, English Channel, and Faroes grounds)	4	Rockall, Hatton and Lousy Banks (see Figure 17.3)	Mixed deep-water trawl fisheries on Rockall and Hatton Banks. Longline fishery on Lousy Bank	Based on the ICES MSY approach ICES advises that catches should be no more than 11 314 and 10 763 tonnes in 2017 and 2018.
bli.27.nea	Blue ling (*Molva dypterygia*) in Subareas 1, 2, 8, 9, and 12, and in Divisions 3.a and 4.a (other areas)	2	Hatton Bank. (see Figure 17.3)	Landings in 12.b come from the same fishery and assessment unit as those in 6.b. WGDEEP has recommended that the stock definition be reviewed and 12.b included in the bli.27.5b67 assessment unit.	No directed fisheries and a reduction in bycatches should be considered
usk.27.12ac	Tusk (*Brosme brosme*) in Subarea 12, excluding Division 12.b (southern Mid-Atlantic Ridge)	4	Mid-Atlantic Ridge	Sporadic small catches have occurred in the past.	When the precautionary approach is applied, catches should be no more than 8415 tonnes in each of the years 2016 and 2017.

ICES stock code	Stock	NEAFC Deep Sea Stock Category	location of NEAFC fisheries	description of NEAFC fisheries	ICES advice applicable
usk.27.6b	Tusk (*Brosme brosme*) in Division 6.b (Rockall)	4	Rockall (See Figure 17.5)	longline fisheries on Rockall bank. The majority of the fishery occurs within the EU fishing zone, but it extends very slightly into NEAFC waters	When the precautionary approach is applied, catch-es should be no more than 350 tonnes in each of the years 2017 and 2018 t.
usk.27.3a45b6a7-912b	Tusk (*Brosme brosme*) in Subareas 4 and 7–9, and in Divisions 3.a, 5.b, 6.a, and 12.b (Northeast Atlantic)	4	Lousy Bank (see Figure 17.5)	Longline fisheries in 5.b1a. The majority of the fishery occurs within the Faroes EEZ, but it extends very slightly into NEAFC waters	ICES advises that when the precautionary approach is applied, catches should be no more than 8415 tonnes in each of the years 2016 and 2017.
ory.27.nea	Orange roughy (*Hoplostethus atlanticus*) in Subareas 1–10, 12 and 14 (Northeast Atlantic and adjacent waters)	Subarea 10 = 1; Subareas 6+7 = 2	Mid-Atlantic Ridge	Directed fisheries occurred on the Mid-Atlantic Ridge and a seamount in Subarea 6.b	ICES advises on the basis of precautionary considerations that there should be no directed fishery and bycatch should be minimized.
rng.27.5b6712b	Roundnose grenadier (*Coryphaenoides rupestris*) in Subareas 6–7, and in Divisions 5.b and 12.b (Celtic Seas and English Channel, Faroes grounds, and western Hatton Bank)	1	Rockall and Hatton Bank	Mixed deep-water trawl fisheries on Rockall and Hatton Banks.	Catches should be no more than 3325 tonnes in 2017 and 3399 tonnes in 2018 in Subareas 6 and 7 and Division 5.b. For Division 12.b catches should be no more than 572 tonnes in each the years 2017 and 2018.

ICES stock code	Stock	NEAFC Deep Sea Stock Category	location of NEAFC fisheries	description of NEAFC fisheries	ICES advice applicable
rng.27.5a10b12ac14b	Roundnose grenadier (*Coryphaenoides rupestris*) in Divisions 10.b and 12.c, and in Subdivisions 12.a.1, 14.b.1, and 5.a.1 (Oceanic Northeast Atlantic and northern Reykjanes	1	Mid-Atlantic Ridge	Recently developed deep-water trawl fishery on the Mid-Atlantic Ridge. For 2014–2015, landings figures presented here include official landings data and "unallocated" landings derived from observer data. In 2015, 1015 tonnes were unallocated.	Catches should be no more than 717 t
bsf.27.nea	Black scabbardfish (*Aphanopus carbo*) in Subareas 1, 2, 4, 6–8, 10, and 14, and in Divisions 3.a, 5.a–b, 9.a, and 12.b (Northeast Atlantic and Arctic Ocean)	4	Rockall Bank, Hatton Bank (see Figure 17.2) and Mid-Atlantic Ridge	Mixed deep-water trawl fisheries on Rockall and Hatton Banks. Catches on the Mid-Atlantic Ridge have varied between 0 and 150 t in recent years.	Catches should be no more than 5894 tonnes in each of the years 2017 and 2018. Distributed by area, annual catches of no more than 2802 tonnes in Subareas 6 and 7 and Divisions 5.b and 12.b; no more than 2726 tonnes in Subarea 8 and Division 9.a, and no more than 366 tonnes in Subareas 1, 2, 4, and 10 and Divisions 3.a and 5.a.
alf.27.nea	Alfonsinos (*Beryx* spp.) in Subareas 1–10, 12 and 14 (Northeast Atlantic and adjacent waters)	Subareas 6-9 = 4; Seamounts and ridges in RA = 3	Mid-Atlantic Ridge	Directed trawl fisheries existed in this area in the past, landings were small in recent years.	Landings should be no more than 280 tonnes in each of the years 2017 and 2018.

ICES stock code	Stock	NEAFC Deep Sea Stock Category	location of NEAFC fisheries	description of NEAFC fisheries	ICES advice applicable
rhg.27.nea	Roughhead grenadier (*Macrourus berglax*) in Subareas 5–8, 10, 12 and 14 (Northeast Atlantic and Arctic Ocean)	Subareas 4, 12 and 14 = 2; other areas = 4	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.	For the years 2016 to 2020 there should be no directed fisheries for roughhead grenadier, and bycatch should be counted against the TAC for roundnose grenadier to minimise the potential for species misreporting

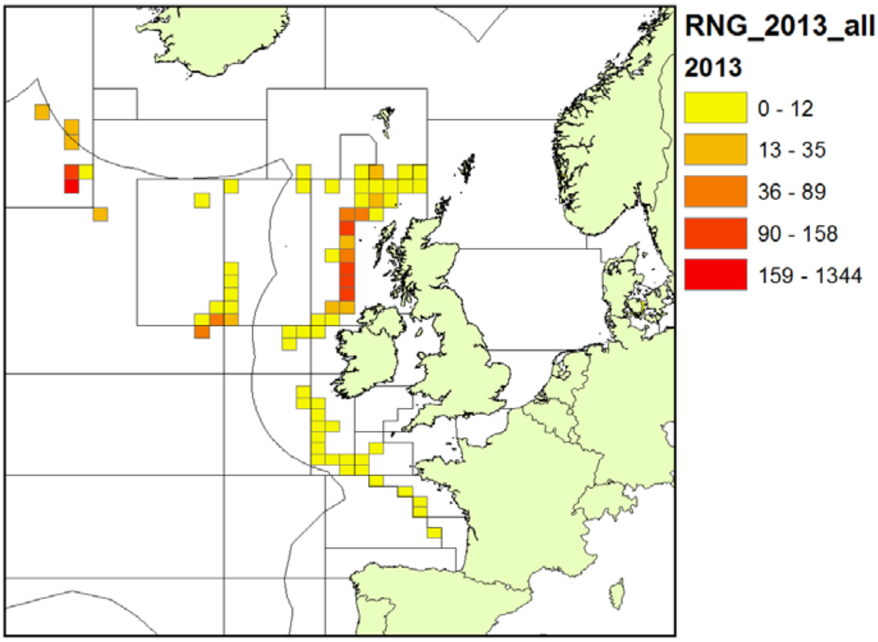

Figure 17.1. Reported landings of roundnose grenadier in the ICES area by statistical rectangle, 2013. Data from the France, UK (England and Wales), and Spain. Landings shown in this figure account for 84% of all reported landings in the ICES area. Landings data by statistical rectangle in the NEAFC area (Subareas 6.b, 12.b and 14.b) are incomplete with only 1740 tonnes (55% of reported landings) reported by statistical rectangle. Data on unallocated landings in the NEAFC area of 6.b and 12.b (1403 tonnes) were not reported to the working group by statistical rectangles and hence not included in this figure.

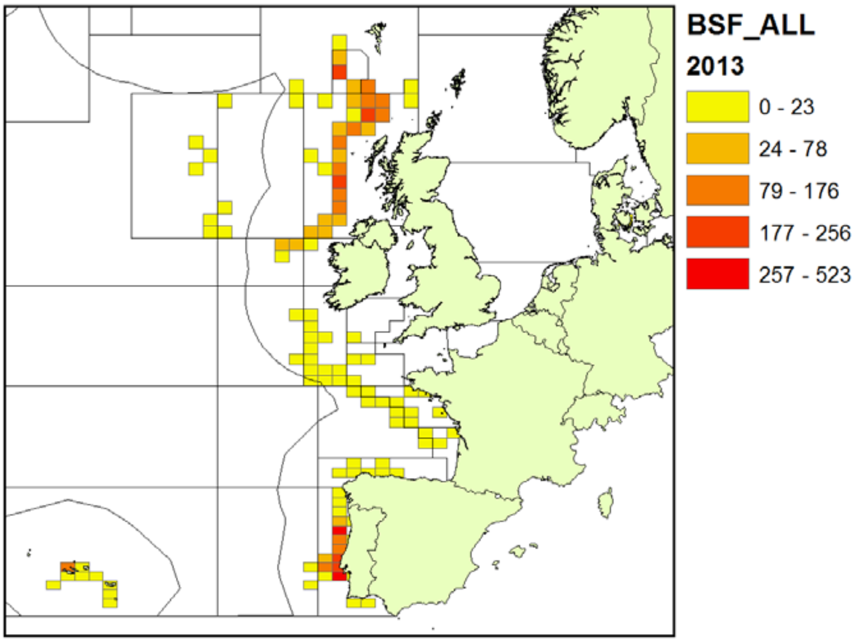

Figure 17.2. Reported landings of black scabbardfish in the ICES area by statistical rectangle, 2013. Data from the Faroes, France, UK (England and Wales), Spain and Portugal. Landings shown in this figure account for 92% of all reported landings in the ICES area. Landings data by statistical rectangle in the NEAFC area (Subareas 6.b and 12.b) are incomplete with only 4.9 tonnes (5% of reported landings) reported by statistical rectangle. Data on unallocated landings in the NEAFC area of 6.b and 12.b (455 tonnes) were not reported to the working group by statistical rectangles and hence not included in this figure.

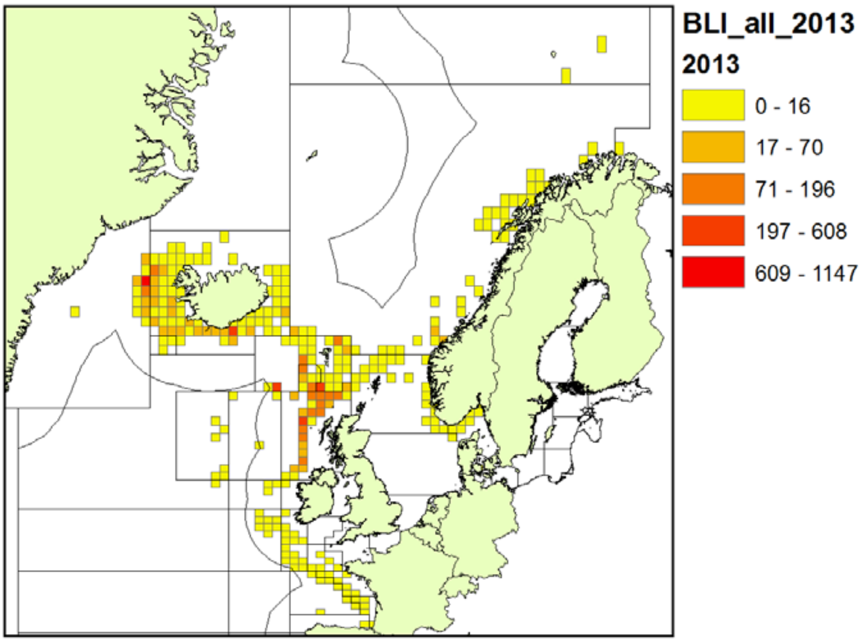

Figure 17.3. Reported landings of blue ling in the ICES area by statistical rectangle, 2013. Data from the Faroes, Norway, France, UK (England and Wales), and Spain. Landings shown in this figure account for 96% of all reported landings in the ICES area. Landings data by statistical rectangle in the NEAFC area (Subareas 6.b and 12.b) are incomplete with only 27 tonnes (15% of reported landings) reported by statistical rectangle. Data on unallocated landings in the NEAFC area of Division 12.b (86 tonnes) were not reported to the working group by statistical rectangles and hence not included in this figure.

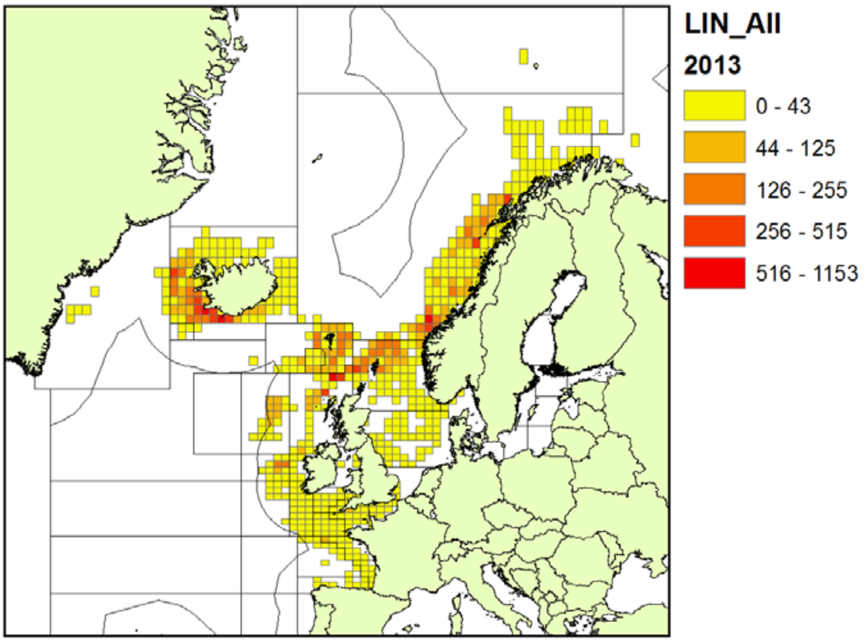

Figure 17.4. Reported landings of Ling in the ICES area by statistical rectangle, 2013. Data from Norway, Faroes, Iceland, UK (England and Wales) and Spain. Landings shown in this figure account for 53% of all reported landings in the ICES area.

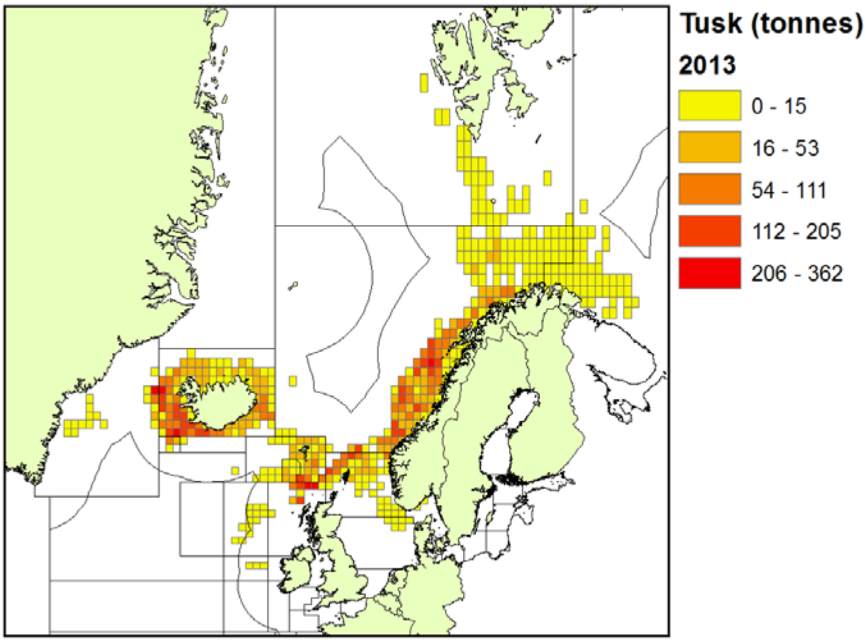

Figure 17.5. Reported landings of tusk in the ICES area by statistical rectangle, 2013. Data from Norway, Faroes, Iceland, France, UK (England and Wales) and Spain. Landings shown in this figure account for 99% of all reported landings in the ICES area.

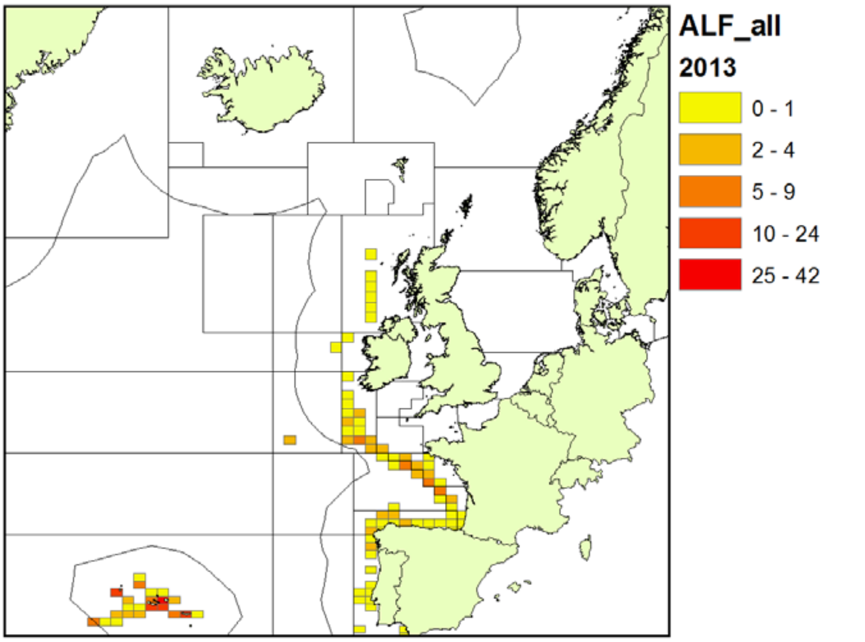

Figure 17.6. Reported landings of *Beryx* spp in the ICES area by statistical rectangle, 2013. Data from Portugal, France, and Spain. Landings shown in this figure account for 97% of all reported landings in the ICES area.

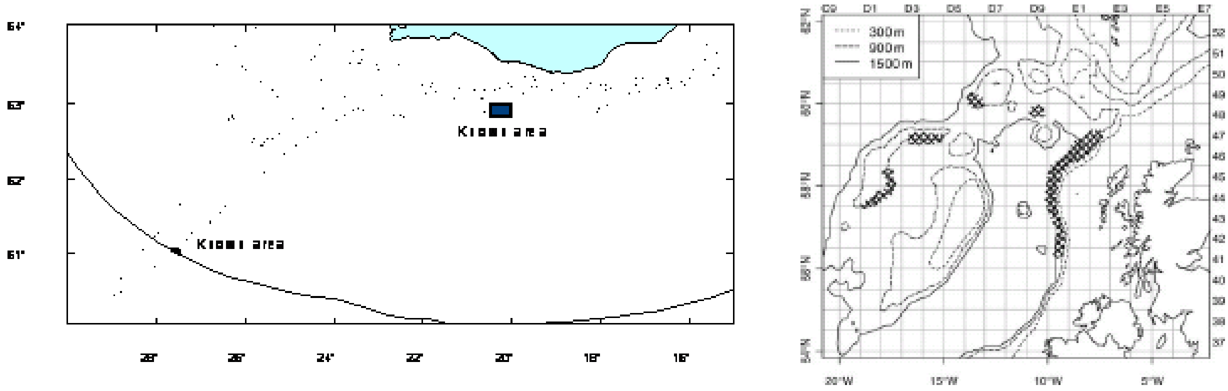

Figure 17.8. Known spawning areas of blue ling in Icelandic water (a) and to the West of Scotland (b), from Large *et al.*, 2010.

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Annex 2: WGDEEP Stock Annexes

The table below provides an overview of the WGDEEP stock annexes updated at the WKICEMSE 2017 meeting. Stock annexes for other stocks are available on the ICES website Library under the Publication type "Stock Annexes". Use the search facility to find a particular stock annex, refining your search in the left-hand column to include *year*, *ecoregion*, *species* and *acronym* of the relevant ICES expert group.

STOCK ID	STOCK NAME	LAST UPDATED	LINK
lin.27.5a	Ling (*Molva molva*) in Division 5.a (Iceland grounds)	June 2017	lin-icel
usk.27.5a14	Tusk (*Brosme brosme*) in Subarea 14 and Division 5.a (East Greenland and Iceland grounds)	June 2017	lin-usk

Annex 3: WKProxy review

Great silver smelt in 1, 2, 3a, and 4 (arg-oth)

Category 3

General comments

1) **Assessment method(s)**: SPiCT for category 3 methods and trends from survey and fishery indices.

2) Evaluating Uncertainties

- The EG is aware of the increasing discards in recent years, but stated that the discards were negligible.
- The EG reported that there is no new information on natural mortality or maturity for this species. This makes is difficult to assess what proportion of the juveniles are removed in the fishery.
- There were large CI on the parameter estimates from the SPiCT model which was based on a rather short time-series (2002–2016)

3) Consistency

- The trends from the acoustic and bottom trawl surveys agreed that there was an increase in biomass in the past few years along the continental slope in Norwegian EEZ.
- The pooled length distributions appear to vary year by year more than expected in Figures 7.2.6 and 7.2.7.

4) Stock status

- Reference points:
  - The EG concluded that there were no acceptable reference points and no proxy reference points were accepted.
  - The EG found the results from the SPiCT model to be promising, but did not approve the method for management considerations for this year’s assessment.
- Stock status
  - Overfished/ Overfishing occurring?
    - The RG is unclear on the decision on overfishing and overfished from the EG report. The EG believes that the stock status is acceptable because there are no changes in age and size structure of the target fisheries over the past seven years. The fishery is targeting smaller and younger fish, but this is attributed to the fact that there is an ontogenetic stratification with younger fish higher up in water (where the fishery occurs) and larger, older fish deeper (>500 m).
- Recruitment
  - The EG did not discuss recruitment.

5) Comments & Suggestions

- The EG appears to be well aware of the caveats with the data and has reasonable explanations to several major developments within the time-series.

- The RG hesitantly concurs with the EG that the stock is in an 'equilibrium' state, but does not know whether that would be overfished/ overfishing occurring or not. The RG agrees that overall the age and size composition have been similar in the past seven years since the change in regulations.
- The RG acknowledges and accepts the EG's explanation of the targeting of smaller and younger fish due to the age/ size stratification with larger/ older fish occurring in deeper waters.
- The RG is concerned with the continuous decline of mean length from the shrimp survey time-series (only series covering entire fishery development). The RG realizes that some larger fish reappeared that rivalled the fish size when the fishery first began, but the RG suggests that the EG keep close watch on this decline.
- The RG concurs with the EG that the MSY from the SPiCT model looks reasonable, the B_{MSY} estimate may be low and the F_{MSY} estimate may be high. The RG suggests that the poor model estimates might be attributed to short time-series and possibly low contrast. Even with the high CI from the SPiCT parameter estimates, the general trends suggest the fish stock is at acceptable levels.
- The RG suggests further exploration of SPiCT in future assessments using the full time-series, but fixing some parameters and ratios. Because there is data from the beginning of the fishery (from the shrimp trawl survey), fixing starting values by specifying B_0 might be a reasonable way to help stabilize the model outputs.
- The RG also suggests assessing the stock using the mean length estimator (MLZ) or length-based SPR (LB-SPR) methods to assess the stock and obtain proxy reference points.

Proxy reference points: Conclusions

1) **Proxy Reference Points**: The EG did not present any proxy reference points. SPiCT method was explored, but did not produce acceptable proxy reference points, thus was rejected. The EG did state that this method looks promising for future assessments. The status of the stock was based on trends from the fishery and surveys.
2) **EG Conclusions**: The EG concluded that the stock was in an acceptable state based on the trends from the fishery catches and surveys. There has been very little change to the size and age composition within the past seven years (during which there were consistent fishing regulations), indicating a stable state. There was a sharp decline in abundance in 2004–2005, but abundance has recovered since then. Additionally, the acoustic and bottom trawl surveys show an increase in biomass in the most recent years and some larger sized fish have been recently caught that match the sizes found when the fishery first began.
3) **RG Conclusions**: The RG agrees with the EG that the stock status is acceptable, but with major reservations. The RG agrees with the EG's above conclusions, but also has some concern with the continuously decreasing mean length over time from the shrimp survey. Another large concern of the RG is the catch of smaller, younger fish in the fishery, which the RG assumes are juveniles (no maturity information was presented). Given the data presented, the RG suggests that the EG further investigate the SPiCT

model using the entire time series, but fixing one or more parameters and/ or ratios, as well as exploring other category 3 methods such as MLZ and LB-SPR. These other models can provide proxy reference points to better inform the EG of the stock status.

BLI.5a14 [Blue Ling (*Molva dypterygia*) in divisions 5.a (Iceland) and 14]

Category 3.3

General comments

1) Assessment method(s): LBI and SPiCT

2) Evaluating Uncertainties

- The targeting of blue ling and spatial distribution of catches has changed over time. Originally a bycatch species, blue ling became a target species, and subsequently became part of a multispecies fishery which also targeted redfish and Greenland halibut. Blue ling is caught by a mix of longline and trawl gears.
- The spatial distribution of blue ling catch has expanded from southern to western parts of the Icelandic shelf. As a result of this spatial expansion, the EG decided that the commercial cpue is not likely to be an indicator of stock abundance.
- The EG stated that the spring survey covered depths that were too shallow to be a reliable indicator of abundance. The autumn survey samples deeper depths which better covers the depth distribution of blue ling, but the time-series is shorter.
- Estimates of maturity were provided but the EG did not state the source of these estimates.
- The EG stated that no growth and natural mortality estimates were available.
- The EG stated that the prior for the K/B_0 ratio was set at 0.035 in the SPiCT analysis. This would indicate that B_0 was greater than K at the beginning of the assessment period, and appears to be a typo that should read B_0/K.

3) Consistency

- Applications of LBI and SPiCT presented by the EG both showed that the stock is in good condition.

4) Proxy reference points & stock status

- The EG advises that catches are not to exceed 1956 tonnes in 2017 based on a harvest control rule developed in 2012. The catch advice was obtained by multiplying F_{proxy} = 0.175 (the ratio of yield and survey biomass in 2002–2009 when the stock was presumably fished sustainably) by the autumn survey biomass in 2016. No uncertainty cap was applied because the index did not decrease by more than 20% compared to the previous year.
- All LBI are greater than their reference level in 2016 ($L_{25\%}/L_{mat} > 1$, $L_{max}5\%/L_{inf} > 1$, $P_{mega} > 0.30$, $L_{mean}/L_{opt} > 1$, $L_{mean}/L_{f=m} > 1$) except L_c/L_{mat} (< 1). Many LBI have been increasing over time since 2012.
- SPiCT estimated that $B>B^{MSY}$ and $F<F_{MSY}$, although the wide range in uncertainty suggests that B/B_{MSY} could fall below 1 and F/F_{MSY} could be much greater than 1. The RG believes that uncertainty in reference points estimated by SPiCT is too great to draw any conclusions without further analyses.
- The EG did not explicitly state whether the specific results from the LBI and SPiCT analyses were accepted or rejected. The EG questioned whether

LBI and SPiCT were appropriate methods to assess blue ling, without further discussion. The RG believes that SPiCT could be appropriate if implemented appropriately.

5) Comments & Suggestions

- The estimate of L_{inf} = 128 cm (as the 99% percentile of observed lengths in MFRI database) appears reasonable assuming that the database is comprehensive and contains samples when the stock was lightly exploited.
- The RG agrees with the EG that the nominal commercial cpue is not indicative of stock abundance due to spatial expansion of the fleet. If high resolution spatial data are available through a vessel monitoring system (VMS), then spatial imputation of the cpue using the method of Walters (2003) may be feasible to develop an index of abundance from these data.
- The RG shares the EG's concern that recruitment has decreased as evidenced by the decreased abundance of <40 cm animals in the autumn survey and the lack of animals <70 cm in the length composition. The EG noted that "the biomass index is still rather high compared to its lowest values." If blue ling is a long-lived species, then the RG believes that the effects of poor recruitment will not be seen until much later.
- Due to the large decrease in recruitment observed in the data, the RG does not believe that the LBI are appropriate. The trends in the LBI arise from changes in recruitment and not changes in exploitation.
- The EG also states that "selection pattern from the fishery is good as only large blue ling are being caught." The RG believes this is good from a growth overfishing point of view, but poor recruitment may still lead to recruitment overfishing with this selectivity pattern if fishing pressure is too high.
- It appears that the EG estimated parameters that could be fixed or be given very informative priors in the SPiCT model (e.g., $\alpha = 1$, $\beta = 1$, $n = 2$). Estimating these quantities is one possibility for the high standard error of F/F_{MSY} and B/B_{MSY} estimates. Fixing α, β, or n can reduce uncertainty and improve the stability of estimated parameters.
- The EG did not attempt to use the mean length Z and LB-SPR methods. However, both methods assume constant (or at least stationary) recruitment and it is likely that the recruitment trends would have confounded mortality estimates. The RG notes that declining recruitment would cause the mean length Z method to underestimate Z (few small fish results in a large mean length which is interpreted as low Z). The RG suggests that discussing these implications for model suitability in the EG report would be beneficial.

Proxy reference points: Conclusions

- Due to the inferred changes in recruitment from the survey and length composition data, recruitment is confounding changes in mortality in LBI (for example, P_{mega} increased due to the decrease in recruits in the population, not necessarily a change in selectivity or reduction in mortality). Therefore, the RG does not believe that the LBI are appropriate for providing management advice.
- The RG believes that SPiCT is an appropriate method to use because recent recruitment trends can be accounted for by estimating process error. How-

ever, no definitive conclusions with respect to F/F_{MSY} and B/B_{MSY} reference points can be drawn from the presented model run. Simpler modifications could reduce model uncertainty to use for management.

- In lieu of the Category 3 proxy methods, the RG agrees with the EG that the catch advice from the 2012 control rule is better suited to provide management advice from the decreased abundance due to recent trends in recruitment, though this is not in the mandate of the Review Group.

References:

Walters, C. 2003. Folly and fantasy in the analysis of spatial catch rate data. Canadian Journal of Fisheries and Aquatic Sciences 60:1433–1436.

Great silver smelt in divisions 5.b and 6.a

Category 3

General comments

1) **Assessment method(s)**: Length-Based Indicators (LBI) and SPiCT for category 3 methods. Also used age-based methods, SAM and XSA.

2) Evaluating Uncertainties

- The EG assumed that all discards (if any) were included in the landings.
- Natural mortality was assumed to be 0.1, however EG offered no explanation behind this value.
- There are a number of data issues (gaps in the Dutch length distribution, possible mixed species catches, questions about Faroese cpue)
- The EG provided little detail for their decision to perform age-based analyses, thus it was difficult for the RG to evaluate uncertainties.
- Depth influences the length compositions of the commercial fisheries and survey catches, but it was unclear what depths are typically fished in each nation's fishery. The RG wonders how differences in the fishing depths for each fishery affect the models.

3) Consistency

- The mean lengths in the Dutch and Faroese landings are similar
- Previous assessments were based off cpue trends from fishery-independent Faroese summer survey, but EG has incomplete data from Dutch fishery to compare with Faroese fishery. This is the first assessment to use additional methods.
- The EG showed that SAM appeared to be more stable than XSA, and the RG notes that in general the SSB, F, and recruitment for the two methods followed similar trends.
- The EG showed that while the LBI method suggested that the stock was exploited around MSY levels, results from SAM were not as clear. Depending on which F_{MSY} proxy is chosen, the stock status varies from being exploited around MSY to overfishing occurring. The RG is unclear what the EG concluded from this.

4) Stock status

- Proxy reference points
  - The EG computed or inferred F_{MSY} proxy reference points based on LBI, eqsim, C_{MSY}, and YPR, but did not comment on which proxies should be used or discarded. The EG did reject the SPiCT method.
- Stock status
  - The EG attempted five different stock assessment models but did not explicitly accept any reference points.
  - The EG stated that, based on the LBI method, the stock appears to be currently exploited around MSY levels.
  - The EG's exploratory analysis using SAM shows that since 2008, SSB has been in decline and F has been increasing. The RG notes that these trends do not seem extreme, and seem consistent with the landings.

  - The SAM analysis produced absolute SSB and Fs (with F_{2016} = 0.23), but the EG did not compare these to any of the proxy reference points they computed, and thus did not provide their opinion on stock status. The RG notes that the stock status changes depending on which proxy reference point is used.
  - The RG agrees with the EG that the summer survey cpue time-series should not be used to determine the state of the fished biomass, as the survey does not cover the entire depth range.
- Recruitment
  - The EG uses Faroese summer survey as a recruitment index, which appears to be relatively stable. The EG does not further discuss recruitment trends.

5) Comments & Suggestions

- Although ages are available, the RG suggests that the EG explore the other category 3 methods (MLZ and LB-SPR). A combination of these methods might develop a better prediction of the stock status.
- The RG suggests that more detail should be given about the values of life-history parameters used in the models along with a discussion of the impact of the uncertainty in those parameter values.
- The EG provided little discussion as to why certain methods were considered or what biases potentially exist for other methods. The RG thinks it would have been useful for the EG to comment on the strengths and weaknesses of using each approved method for this stock.
- The RG suggests including the time-series of LBI indicator values (see figure attached to last page here) for future reports. The indicator values are around or above 1 and are fairly stable for the most of the time-series, thus the RG agrees that the stock is in good health.
- The RG notes that the large P_{mega} values is indicative that recruitment overfishing is not occurring.
- The EG did not specify why they think the SPiCT model did not converge (e.g. lack of contrast, conflicting data sources, quality of survey cpue data). If the EG thinks there is an issue with the contrast in the data, the RG suggests exploring the model further by fixing certain parameters or altering priors. However, if the survey data are not appropriate, then the RG agrees that SPiCT may not be the best data-limited method. In that case, other methods that don't rely on a cpue index (e.g. LB-SPR, MLZ) should be considered.
- The RG suggests using the empirical estimator (Then *et al.*, 2015) to obtain M estimates from the age data and do sensitivity analyses for a variety of M values.

Proxy reference points: Conclusions

1) **Proxy Reference Points**: The EG presented various proxy reference points, but, for reasons that are not clear, did not comment on which were most appropriate. EG based the stock status on SAM analysis results and LBI values.

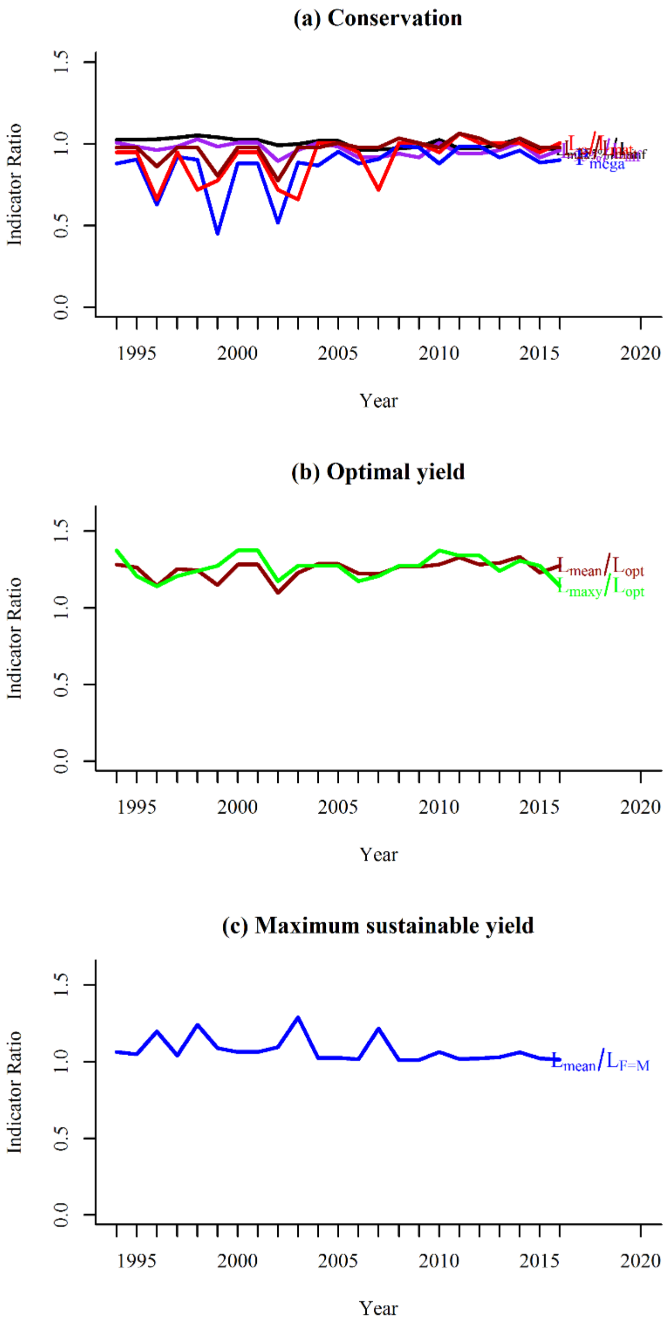
2) **EG Conclusions**: The EG did not explicitly report on which proxy reference points were acceptable, but the group did accept the methods SAM

and LBI. The EG concluded that SSB_{2016} was around 70 000 tonnes and F_{2016} = 0.23, based on SAM analysis. Depending on which proxy reference points are chosen, this could indicate that that the stock is experiencing overfishing or that fishing is currently around MSY. However, the EG concluded that the stock was being harvested at optimal yield (MSY) based on LBI results.

3) **RG Conclusions**: The RG concludes that, while considering all proxy reference points presented by the EG, in general the F_{2016} from SAM indicated that fishing is occurring around MSY, indicating a healthy stock. The time-series of LBI indicator ratios also indicates a healthy stock. The RG finds these methods and this conclusion acceptable, but in future would like further exploration of the other category 3 methods (MLZ, LB-YPR and SPiCT through fixing parameters if the EG has confidence in cpue indices) to have a more consistent picture of the stock status.

References

Then, A.Y., J.M. Hoenig, N.G. Hall and D.A. Hewitt. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. ICES J. Mar. Sci. 72:82–92.


(a) Conservation
Indicator Ratio
0.0
0.5
1.0
1.5
1995
2000
2005
2010
2015
2020
Year
L_{mega}
(b) Optimal yield
Indicator Ratio
0.0
0.5
1.0
1.5
1995
2000
2005
2010
2015
2020
Year
L_{mean}/L_{opt}
L_{maxy}/L_{opt}
(c) Maximum sustainable yield
Indicator Ratio
0.0
0.5
1.0
1.5
1995
2000
2005
2010
2015
2020
Year
$L_{mean}/L_{F=M}$

Greater silver smelt (*Argentina silus*) in 6.b, 7, 8, 9, 10 and 12

Category 3.3

General comments

1) Assessment method(s): SPiCT

2) Evaluating Uncertainties

- The EG stated that no new age composition, maturity and natural mortality estimates were available. It is not clear to the RG what the natural mortality or maturity estimates are from previous years as it is not stated in the report by the EG specifically.
- The EG stated that recent investigations have revealed that survey catches from the Spanish Porcupine bank (Subarea 7) survey contain a mix of Greater and Lesser silver melt, influencing the biomass indices used for SPiCT.
- The biomass index only comes for Porcupine Bank and does not cover the total stock area according to the EG.
- The EG does not have an estimate of the proportion of lesser silver smelt to greater but they indicate that further investigation is needed.
- The EG notes that Greater Silver Smelt can be found in the discard of trawls in areas 6 and 7 that reach depths from 300–700 m. The data used for analysis come from bottom trawl surveys that only go to 400 m and do not likely cover the depth range of greater silver smelt.

3) Consistency

- Advice is given every two years for this stock. In 2015, the EG stated that ICES advised that when the precautionary approach is applied, landings should be no more than 15 t in year 2016 and 2017. The EG has not explicitly stated what this year's advice would be for 2018 and 2019.

4) Proxy reference points & stock status

- The EG was not able to get SPiCT to converge therefore the EG did not give any advice on proxy reference points. The RG believes that SPiCT could be appropriate if implemented with some parameters fixed or with narrower priors (see below).
- The EG did point out that Porcupine bank survey biomass indices have increase in 2015 and 2016. The RG believes this could be some indication of stock status. However, due to the fact that the biomass index might not cover the whole stock, the RG concludes that the stock status is unclear.

5) Comments & Suggestions

- Given the current document it is unclear to the RG what data are available for this stock. It is hard for the RG to make suggestions on the model selection. The RG suggests that the EG list and describe all of the data that are available for this species and then use that information to determine which method to use.
- The EG did not attempt to use the LBI, mean length Z or the LB-SPR methods. The RG suggests discussing the pros and cons of each of these methods in terms of their application given the available data.
- The report does not appear to have a section on model parameterization for the SPiCT model, this would be helpful for the review process.

- It is possible that the EG estimated parameters that could be fixed or be given very informative priors in the SPiCT model (e.g., $\alpha = 1$, $\beta = 1$, $n = 2$). This is one possibility for the failure of the model to converge. Fixing these parameters can reduce uncertainty and improve the stability of estimated parameters. The RG suggests attempting to fix these values as a sensitivity run.

Proxy reference points: Conclusions

- The EG did not get results using SPiCT or any other method. Therefore, there are no proxy reference points.
- The RG believes that the use of SPiCT should be explored further (fixing some parameters or defining narrower priors). In addition, length-based methods should be evaluated.

Ling in 5.b

Category 3

General comments

1) **Assessment method(s)**: Length Based Indicators (LBI) and SPiCT for category 3 methods and SAM and XSA analysis methods.

2) **Evaluating Uncertainties**

- The EG reported that there is no information on natural mortality and assumed M of 0.15 for all ages.
- The EG believes that the L_{inf} calculated from Faroese survey data is overestimated, thus used L_{max} in place of L_{inf}, which alters the LBI results.
- The EG noticed that the LBI results were sensitive to changes in L_{mat} and L_{inf}.
- The RG notes that the uncertainty regarding M and L_{inf} will also influence the length-based YPR, as yield is maximized by balancing growth and natural mortality.
- There were seasonal patterns in the log q residuals of the SAM model that were pointed out by the EG that warrant further investigation.
- XSA assumes catch-at-age is known without error yet the catch-at-age was estimated using a single age–length key for all years (1996–present). Assuming this was a forward age–length key, the RG thinks this is likely introducing considerable uncertainty since probability of age at size changes on an annual basis (see Westrheim and Ricker, 1978). Using the same key for each year tends to preserve the age composition for the year from which the key was derived.

3) Consistency

- The EG calculated two F_{proxy} reference points ($F_{0.1}$ and F_{max}) that, when compared to F, gave different views of the stock. The EG did not state which proxy they thought was most appropriate.
- The EG found retrospective patterns in SAM results that could bias overall conclusions, but graphs of these patterns were not included in the report.
- The EG stated that overall the trends in survey indices and recruitment indices are consistent with SAM output, with which the RG agrees.
- The RG notes that the LBIs over time are stable with no apparent trends.

4) Stock status

- Proxy reference points
  - The EG proposed no reference points, but proxy references points were provided and accepted by the EG. The proxy reference points were based on the LBI method, expert judgement and a modified yield per recruit.
  - The proxy reference points calculated from YPR were F_{max} and $F_{0.1}$. The EG suggested $F_{0.1}$ as a conservative proxy and also stated that F_{max} was well-defined. The EG rejected the SPiCT model, as it did not converge.
- Stock status
  - Overall, the EG concluded that the stock was in good status.

- The EG concluded that the stock was not overfished based on expert judgement, survey data, SAM results and LBI indicators. The recent adult abundance was above the overall mean abundance for the time-series, thus the EG concluded that the SSB is above MSY $B_{trigger}$. The results from SAM also showed an increasing SSB and decreasing F.
- The EG concluded that overfishing was not occurring based on decreasing F trends and SAM analysis (F_{2015} = 0.25). The EG calculated F_{MSY} proxies of $F_{0.1}$ (0.18) and F_{max} (0.35), but did not state which proxy they were using to infer that overfishing was not occurring. The choice of F_{MSY} proxy changes the overall conclusions. The RG is wondering if the EG considered $F_{0.1}$ and F_{max} as bounds for some F_{MSY} proxy, and because $F_{0.1} < F_{2015} < F_{max}$, the EG then concluded that overfishing was likely not occurring. The RG would like clarification on this issue.
- The RG agrees with the conclusions from the EG of the LBI results that the stock is being fished sustainably based on the MSY indicator being >1 and fairly stable throughout most of the time period.
- The RG examined two indicators that do not rely on L_{inf} (L_c/L_{mat} and $L_{25\%}/L_{mat}$). Based on these indicators, the RG concludes that there is some, but not heavy exploitation of immature juveniles.

- Recruitment
  - The EG's juvenile survey indices show an increasing trend. The SAM model presented by the EG shows a dramatic increase in recruitment since 2013.

5) Comments & Suggestions

- Although ages are available, the RG suggests that the EG explore the other category 3 methods (MLZ and LB-SPR). A combination of these methods might develop a better prediction of the stock status.
- The EG provided little discussion as to why certain methods were considered or what biases potentially exist for other methods. The RG thinks it would have been useful for the EG to comment on the strengths and weaknesses of using each approved method for this stock.
- The RG is unclear where the M of 0.15 value came from and would suggest trying empirical methods (e.g. Then *et al.*, 2015) and doing sensitivity analyses.
- The EG should make it clear in the report what value of L_{max} was chosen as the L_{inf} proxy.
- The EG did not specify why they think the SPiCT model did not converge (e.g. lack of contrast, conflicting data sources, quality of survey cpue data). If the EG thinks there is an issue with the contrast in the data, the RG suggests exploring the model further by fixing certain parameters or altering priors. However, if the survey data are not appropriate, then the RG agrees that SPiCT may not be the best data-limited method. In that case, other methods that don't rely on a cpue index (e.g. LB-SPR, MLZ) should be considered.
- The EG noted that log q residuals from the SAM model showed a seasonality pattern. The EG also noted that there was a retrospective pattern that showed that recruitment and F tended to be underestimated and SSB was overestimated. RG suggests that the EG includes this information in the future assessments as it would have been useful for the RG to examine the

residuals and retrospective pattern. The RG suspects these patterns may have been influenced by the use of a single ALK covering all years.

- The EG discussed that they suspected their L_{inf} was overestimated and that the indicators were sensitive to changes in L_{inf}. For the LBI analysis, the EG set the L_{inf} to L_{max}, hence the results of 0% P_{mega}. The RG understands that obtaining a true L_{inf} for a deep-water fish such as this one is difficult, and the RG would have liked to see the growth data and model fits. The RG suggests that the EG select a variety of L_{inf} values including lower and upper bounds to examine which LBI indicators are more robust to changes in L_{inf}. For example, the L_{mean}/ $L_{F=M}$ indicator for MSY was fairly robust to changes in L_{inf} (see tables attached to the bottom of review, Table 1).

Proxy reference points: Conclusions

1) **Proxy Reference Points**: The EG provided and accepted proxy references points based on the LBI method, expert judgement and a modified yield-per-recruit. The EG rejected the SPiCT model due to lack of convergence.

2) **EG Conclusions**: EG's final conclusions were drawn from all three above methods. The group concluded that the ling stock was in good status; the stock was not overfished and overfishing was not occurring. The EG determined that the SSB is above MSY $B_{trigger}$, which aligned with the increasing SSB and decreasing F trends from the SAM analysis. Additionally, the EG concluded that the F_{2015} is between $F_{0.1}$ and F_{max}, thus, if the RG understands correctly, overfishing is not occurring.

3) **RG Conclusions**: The RG believes that an acceptable proxy method (LBI) was used and concurs with the EG that the stock is not overfished and is not experiencing overfishing. Based on the analysis provided by the EG, the trends from SAM results and LBI indicators, the RG determined that the stock is in good health. However, the RG is a little unclear about the F_{MSY} proxy. The EG stated that $F_{0.1}$ can be used as a conservative estimate for F_{MSY}, but the F_{2015} is greater than $F_{0.1}$. The RG concluded that the stock was not experiencing overfishing due to the F trends, F_{2015} compared to F_{max}, and LBI values. The RG also discovered that by varying the L_{inf} to represent several possible L_{inf} values, the MSY and most of the optimizing yield indicators tended not to be influenced by changes in L_{inf}. These proxy values indicated that the stock was in good health.

References

Then, A.Y., J.M. Hoenig, N.G. Hall and D.A. Hewitt. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. ICES J. Mar. Sci. 72:82–92.

Westrheim, S.J. and W.E. Ricker. 1978. Bias in using an age–length key to estimate age–frequency distributions. Journal of the Fisheries Research Board of Canada 35:184–189.

Extra tables

Table 1. Traffic light tables of LBI indicators with varying Linf values.

Linf	125					
Year	Lc_Lmat	L25_Lmat	Lmax5_Linf	Pmega	Lmean_Lopt	Lmean_LFeM
2012	0.565217	1.086957	0.952252	0.269751	1.006727	1.386677
2013	0.652174	1.101449	0.937699	0.264029	1.020344	1.308133
2014	0.681159	1.144928	0.958966	0.323953	1.043564	1.307724
2015	0.681159	1.130435	0.987983	0.479953	1.065514	1.33523
2016	0.565217	1	0.952268	0.29808	0.978372	1.34762

Linf	150					
Year	Lc_Lmat	L25_Lmat	Lmax5_Linf	Pmega	Lmean_Lopt	Lmean_LFeM
2012	0.565217	1.086957	0.793544	0.053737	0.83894	1.256838
2013	0.652174	1.101449	0.781416	0.044812	0.850287	1.193385
2014	0.681159	1.144928	0.799139	0.061307	0.869637	1.195377
2015	0.681159	1.130435	0.82332	0.095912	0.887928	1.22052
2016	0.565217	1	0.793557	0.066643	0.81531	1.221438

Ling in subareas 1 and 2 in Arctic Ocean

Category 3

General comments

1) **Assessment method(s)**: Length-Based Indicators (LBI) and SPiCT for category 3 methods and cpue trends.

2) Evaluating Uncertainties

- A large concern of the RG is the representation of the length distribution in the fishery when only using longline data. Gillnets also make up a significant portion of the catch and should not be ignored.
- The EG reported that only cpue from the fishery was used, which is assumed to be tracking the abundance of the ling stock. However, the EG notes that this may not be the case.
- The EG used L_{mat} for all sexes combined, but L_{mat} for females was shown to be different than L_{mat} for males.
- The EG noticed that the LBI results were sensitive to changes in L_{mat} and L_{inf}. Additionally, the EG does not discuss the certainty and validity of the L_{inf} value that was used in the analyses. The RG noticed that in the EG Table 1.1, the EG used L_{max} as their L_{inf}.

3) Consistency

- This assessment had new GLM-based cpue time-series estimation and MSY proxy reference points compared to previous assessments.
- Past cpue trends from the fisheries data have shown a slow increase in abundance, which is in agreement with general trends from the SPiCT results and LBI values. This was deemed logical to the EG due to the change in fishing quotas for a different species (cod).
- The LBI values for the conservation of immatures has inconsistent results. One indicator (L_c/L_{mat}) shows that the immatures are being fished ($L_c > L_{mat}$), but the other ratio ($L_{25\%}/L_{mat}$) value suggests the fishery is not fishing the immature lings unsustainably.

4) Stock status:

- Reference points
- The EG concluded that there were no suitable reference points, but accepted proxy reference points based on LBI. The EG found the results from SPiCT very uncertain, and so did not accept this method.
- Stock status
    - Overfished/ Overfishing occurring?
        - **No.** The RG agrees with the EG that the stock seems to be healthy. Overfishing is not occurring and the stock is not overfished based on LBI.
        - The RG also concluded that the cpue indices show a slight positive trend, indicating an increasing population.
        - Most of the ratios and parameters from the LBI analysis appeared to be fairly stable over time. There were some inconsistencies with the conservation of immatures, and there was a lack of mega spawners in the catch. The optimizing yield parameter suggests

that the fishery is fishing smaller fish than optimal, but the MSY indicator suggests the ling are being fished sustainably.

- Recruitment
  - The EG did not discuss recruitment.

5) Comments & Suggestions

- The RG suggests that the EG explore the other category 3 methods (MLZ and LB-SPR). A combination of these methods might develop a better prediction of the stock status. The RG recognizes the limitations in the length data; however, the RG thinks that if the LBI method was accepted with the same data, then additional length-based methods could be explored. If these methods are inappropriate to the EG, it would be useful to comment on the reasons behind their opinion.
- The RG agrees with the EG that the cpue indices from the fishery should be used with caution because false positive cpue indices can lead to hyperstability.
- The EG comments on the sensitivity of values, L_{mat} and L_{inf}. The RG agrees that the LBI analysis is sensitive to these values and suggests conducting a sensitivity analysis to determine at what point the indicator ratios change from positive outlook of the stock to negative outlook. In particular, the RG suggests using the L_{mat} for females because this value is higher than the combined L_{mat}. The RG also noticed that the EG set the L_{inf} in their LBI analysis to L_{max}. Typically L_{inf} will be somewhat less than L_{max}, and so the RG thinks conducting a sensitivity of L_{inf} would also be useful to prove the robustness of the LBI method.
- The EG suggests that there might be a truncation in the length distribution of the fishery, which would explain the lack of mega-spawners in the catch. The RG agrees that this is a likely scenario, but would want the EG to further explore this scenario. For example, any information of movement or location of larger individuals would be useful.
- The RG questions using length data only from the longline fishery. The RG points out that the gillnet fishery represents ~45% of the catch (which is a significant portion). It appears to the RG that the gillnet fishery fishes slightly larger animals than the longline fleet. This would influence the LBI values and if there were larger ones in the stock, would most likely have a more positive perspective of the fishery.
- SPiCT results were not robust and demonstrated retrospective patterns. The RG suggests exploring the model further by fixing certain parameters or altering priors.

Proxy reference points: Conclusions

1) Proxy Reference Points: The EG based the proxy reference points on LBI values and general cpue time series trends. The EG did not deem SPiCT results appropriate to use as proxy reference points.

2) EG Conclusions: The EG concluded that the ling stock in the Arctic in subareas 1 and 2 was being fished sustainably; the stock is not overfished and overfishing is not occurring. The EG determined that the increasing cpue trends, MSY indicator values ($L_{mean}/L_{F=M}$) that were above 1 for the past three years, and the general trends from SPiCT suggest the being fished at

the optimal level. The EG also concluded that the immature lings were not being overfished.

3) RG Conclusions: The RG concurs with the EG that the ling stock is being fished at sustainable levels (the stock is not overfished and overfishing is not occurring) based on results presented in the report. The increasing cpue trends and general SPiCT trends, despite the large CI, suggests the stock is healthy. Likewise, some of the LBI ratios suggest that the stock is being fished at optimal levels. The RG agrees with the EG that the length distribution might have a truncation point, meaning that the fishery is not catching the mega-spawners. However, the RG should explore this scenario more closely. Additionally, the RG suggests exploring the other length-based methods for category 3 stocks, particularly the mean-length estimator (MLZ) and fixing parameters or altering ratios in SPiCT to help stabilize the results.

Lin-oth: Ling in subareas 6-9, 12, 14 (divisions 3.a & 4.a) NE Atlantic & Arctic Ocean

Category 3

General comments

1) **Assessment method(s)**: Length-Based Indicators (LBI) and SPiCT for category 3 methods and cpue trends.

2) Evaluating Uncertainties

- Only the length composition from the Norwegian longline fishery is considered for the LBI analysis. The RG noticed that the gillnet composition (and ages) were slightly larger than the longline length composition, which can influence the LBI results if they were to be included.
- The EG did not discuss the accuracy of L_{inf} estimates.
- The confidence levels on the SPiCT model runs made it difficult to concur definitive results.
- Managing multiple distinct areas may mask smaller declines in the population in certain areas.

3) Consistency

- The indicators of the conservation of immatures from the LBI analysis had opposing results.
- The EG determined that the mean length of the Norwegian longline fleet did not show apparent time trends. The RG disagrees and thinks this might be worth exploring further.

4) Stock status

- Reference points
  - The EG concluded that there were no acceptable reference points, but used proxy reference points.
  - The proxy reference points were based on LBI values because the EG found the results from the SPiCT model to be too uncertain and did not accept the SPiCT results.
- Stock status
  - Overfished/ Overfishing occurring?
    - **No.** The EG concluded that the stock seems to be healthy. There is no overfishing occurring and the stock is not being overfished.
    - The RG also concluded that most of the cpue indices over the entire area are stable or increasing during the last decade, indicating a healthy population.
    - Most of the ratios and parameters from the LBI analysis appeared to be fairly stable over time except L_c/L_{mat} and $L_{mean}/L_{F=M}$. There also appears to be a slight increase in some parameter estimates in the last few years (e.g. L_{max}/L_{opt}).
    - There were some inconsistencies with the conservation of immatures, and there was a lack of mega spawners in the catch. The optimizing yield parameter suggests that the fishery is fishing

smaller fish than optimal, but the MSY indicator suggests the ling are being fished sustainably.

- Recruitment
  - The EG did not discuss recruitment.

5) Comments & Suggestions

- The RG agrees with the EG that in the past the discard has been considered minimal compared to the overall catch. However, it appears to be increasing. In the future the RG suggests the EG be aware of the increasing discards and the inclusion of the discards (or estimated discards) in the analyses (e.g. are discards a certain size range?).
- The EG comments on the sensitivity of values L_{mat} and L_{inf}. The RG agrees that the LBI analysis is sensitive to these values and suggests conducting a sensitivity analysis to determine at what point the indicator ratios change from positive outlook of the stock to negative outlook. In particular, the RG suggests using the L_{mat} for females because this value is higher than the combined L_{mat}. Additionally, the EG did not discuss their confidence (accuracy) of L_{inf} estimate.
- The RG questions the use of only the length data from the longline fishery. It appears to the RG that the gillnet fishery fishes a portion of the stock that is larger in length. This would influence the LBI values.
- The RG suggests that the EG further explore the contradictory results from the LBI for the conservation of the immatures and discuss which indicator is selected to determine the status of immatures. The RG is not aware of any work that could guide the EG in making this decision.
- SPiCT results were not robust and demonstrated retrospective patterns. The biomass appears to be on the lower spectrum of biomass levels for the stock and the recent fishing mortality estimates suggest the fishing pressure is at an acceptable level, but the CI are rather large and difficult to make definitive conclusions. The RG suggests exploring the model further by fixing certain parameters or altering priors.
- The EG determined that the mean length in the Norwegian longline fleet did not show apparent time trends; the RG disagrees. There appears to be a slight downward trend in mean length over time.

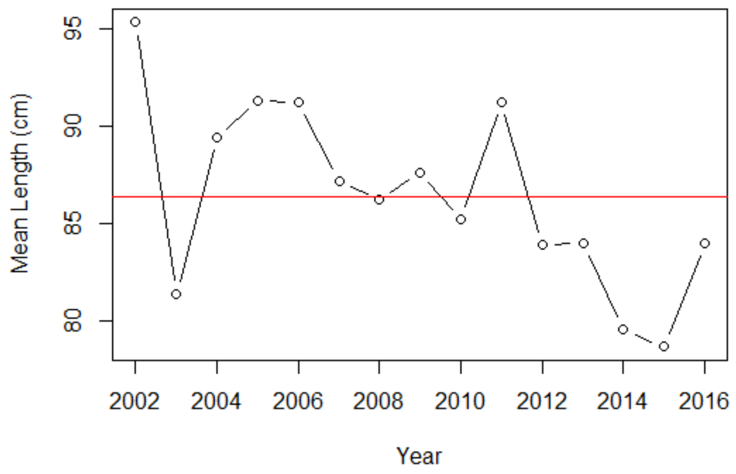


Figure 1. Plot of mean length each year, with red line denoting the average mean length over all years.

- General trends from SPiCT suggest an increase in biomass in recent years and decrease in fishing mortality.

Proxy reference points: Conclusions

1) Proxy Reference Points: The EG accepted the proxy reference points for LBI values and general cpue time-series trends. The EG rejected the use of SPiCT results to establish proxy reference points.

2) EG Conclusions: The EG concluded that the ling stock in the other areas in the Northeast Atlantic and Arctic Oceans was being fished sustainably; the stock is not overfished and overfishing is not occurring. The EG determined that the increasing cpue indices from all the areas, MSY indicator values ($L_{mean}/L_{F=M}$) that were above 1 and the SPiCT results suggest the being fished at the optimal level. The EG also concluded that the immature lings were not being overfished.

3) RG Conclusions: The RG concurs with the EG that the ling stock is being fished at sustainable levels (the stock is not overfished and overfishing is not occurring) based off results presented in the report with some reservations. The increasing cpue trends and general SPiCT trends, despite the large CI, suggests the stock is healthy. Likewise, some of the LBI ratios suggests that the stock is being fished at optimal levels. However, the L_{mean}/L_{opt} indicator does have a promising outlook on the stock. The RG agrees with the EG that the length distribution might have a truncation point, meaning that the fishery is not catching the mega-spawners. However, the EG should explore this scenario more closely. The RG suggests exploring SPiCT further by fixing parameters, as well as the other length-based methods for category 3 stocks, particularly the mean-length estimator (MLZ).

aru.27.5a14 [Greater silver smelt (*Argentina silus*) in divisions 5.a (Iceland)]

Category 3.3

General comments

1) **Assessment method(s)**: LBI methods were used, and a SPiCT model was run.

2) Evaluating Uncertainties

- Although the EG noted that greater silver smelt have been captured as by-catch for years and discarded, discarding was ignored in the current assessment due to the large mesh size used in the redfish fishery. Although discarding is currently banned in Icelandic waters, the EG states that unknown quantities of greater silver smelt were likely discarded prior to 1996.
- The spatial distribution of catches has changed over time, with an increasing proportion of fish taken from the western and northwestern areas.
- The EG stated that the Icelandic spring survey was not a reliable indicator of abundance due to spatial discrepancies. The autumn survey was assumed to represent stock biomass of greater silver smelt, although details regarding the survey were not provided (stock annex). Since depths less than 500 m are not sufficient as a measure of relative abundance, the depth strata of the autumn survey should be discussed further.
    - Moreover, L_{mat}, L_{inf}, and the length–weight relationship were calculated from data obtained via the Icelandic autumn survey for LBI analyses. If there is a chance that these parameters are not accurate due to inadequate spatial coverage, an additional sensitivity run should be conducted with respect to these parameters in the LBI analyses.
- The EG stated that the prior for the K/B_0 ratio was set at 0.95 in the SPiCT analysis, because the stock was not exploited prior to the assessment period. This indicates that B_0 was greater than K at the beginning of the assessment period, and appears to be a typo that should read B_0/K. We also note that an unknown quantity of greater silver smelt were discarded (with a discard mortality rate that is not discussed in the report and seemingly unknown) prior to 1996, suggesting uncertainty with respect to this value. The implications of fixing this value should be discussed and considered.

3) Consistency

- The EG report regularly references a "stock annex" detailing previous assessments and management history, which was not provided to the RG.

4) Proxy reference points & stock status

- The EG advises that catches are not to exceed 9310 tonnes in 2017 based on a F_{proxy} = 0.171 multiplied with the 2016 survey biomass estimates, with an additional uncertainty cap of 20%. Because F has increased in recent years, the TAC for 2016/2017 was set to 7885 t, which is a decrease from the 2015/2016 fishing year.
    - The reasoning for implementing an F_{proxy} = 0.171 is unclear to the RG, as this does not match the F_{proxy} values calculated using the survey data and presented in Table 7.3.5 and Figure 7.3.8.

- Based on the LBI, all reference points are greater than their reference level in 2016 ($L_c/L_{mat} > 1$, $L_{25\%}/L_{mat} > 1$, $L_{max5\%}/L_{inf} > 1$, $P_{mega} > 0.30$, $L_{mean}/L_{opt} > 1$, $L_{mean}/L_{f=m} > 1$).
- All LBI reference points appear to be fairly stable over time, potentially excepting L_c (which was less than L_{mat} in 2007, 2008, 2013, 2014, and 2015), $L_{25\%}$ (which was below L_{mat} in 2013 and 2014), and $L_{f=m}$ (which was below L_{mat} in 2007 and 2015).
- SPiCT results suggest that $B>B_{MSY}$ and $F<F_{MSY}$, although the wide range in uncertainty suggests that B/B_{MSY} could fall below 1 and F/F_{MSY} could be much greater than 1.
- The EG did not explicitly state whether the specific results from the LBI and SPiCT analyses were accepted or rejected. Rather, the EG concluded that the cumulative LBI and SPiCT results indicated "that the fishing pressure is below F_{MSY} and the stock biomass is above possible MSY $B_{trigger,proxy}$." The RG agrees that based on LBI analyses, the stock appears to be not overfished with no overfishing occurring. However, we believe that uncertainty in reference points estimated by SPiCT is too great to draw any conclusions without further analyses.
- The EG questioned whether LBI and SPiCT were appropriate methods to assess the greater silver smelt, without further discussion. The RG believes that both methods could be appropriate if implemented appropriately (see Conclusions).

5) Comments & Suggestions

- It appears that mean length and mean age of greater silver smelt landings has decreased over time since 1997.
- The EG makes no attempt to estimate M, despite having requisite data. Based on the otolith samples, M can be estimated using the maximum observed age using the empirical estimator of Then *et al.* (2015).
- The RG assumes that the EG assumed M/K = 1.5 for L_{opt} and $L_{F=M}$ associated with the LBI. However, there is enough information to have estimated M/K for this stock, with M and von Bertalanffy K from the age data. This information can be used to re-calculate L_{opt} and $L_{F=M}$ with the updated M/K.
- The length data are sufficient to use the mean length Z estimator and LB-SPR method. These methods would have avoided the issues regarding the indices of abundance for Greater Silver Smelt.
- The EG stated that GLM-based index of abundance generated from commercial dataset was not suitable due to patterns in residuals. The RG would prefer to see residual plots to validate this conclusion.
- The EG noted that variances of indices of relative abundance were high due to schooling behaviour, and it was unclear what distribution was used to generate the indices using GLMs (which was fit to cpue data). We suggest attempting to use a discrete distribution (i.e. negative binomial) to model catch using effort as an offset, or, if necessary, exploring zero-inflated models (i.e. delta lognormal, zero-inflated, hurdle models).
- Plots included in the write up (Figure 7.3.7) do not have associated legends, making it unclear which line represents the un-altered biomass (we assume red) and which line represents the Winsorized biomass (we as-

sume blue). We suggest that the EG be careful to include legends in the future to ensure clarity.

- Plots 7.3.6 and 7.3.7 both show "un-altered," total indices of relative abundance from the autumn Icelandic survey. However, the indices in each graph do not follow the same trend and are not plotted on the same scale. This discrepancy should be addressed.
- It would be useful for the EG to have provided estimates of LBI parameters (including L_c, $L_{max5\%}$, L_{opt}, $L_{f=m}$) to ensure that the estimated values, and subsequent reference points, align with visuals (histograms, etc.) provided.
- It appears that the EG estimated parameters that could be fixed in the SPiCT model (e.g., $\alpha = 1$, $\beta = 1$, $n = 2$). Fixing these parameters can reduce uncertainty and improve the stability of estimated parameters. We suggest attempting to fix these values as a sensitivity run.

Proxy reference points: Conclusions

- The RG agrees with the EG that the stock is likely not overfished and no overfishing is occurring based on the history of the stock and the results of the proxy methods.
- The RG believes that the LBI are appropriate methods to use for this stock. With an updated M/K, the reference points L_{opt} and $L_{F=M}$ can be recalculated to reflect the life history of the stock.
- The RG believes that SPiCT is an appropriate method to use assuming that the autumn survey samples up to depths of 800 m where adults inhabit. Additionally, simpler modifications can reduce the model uncertainty to use for management. However, given the current level of uncertainty, no definitive conclusions with respect to F/F_{MSY} and B/B_{MSY} reference points can be drawn.

References

Then AY. Hoenig JM. Hall NG. Hewitt DA. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. ICES J Mar Sci 72(1): 82–92.

usk.27.3a45b6a7-912b [Tusk (*Bromse bromse*) in areas 3a, 4a, 5b, 6a, 7, 8, 9 and other areas of 12 (Northeast Atlantic)]

Category 3.2

General comments

1) **Assessment method(s)**: LBI methods and SPiCT analysis were run.

2) Evaluating Uncertainties

- The EG reports that ageing of tusk is challenging, such that parameters requiring age information are uncertain.
- The EG reports von Bertalanffy growth parameter estimates for combined sexes that are much different from those reported for either males or females (e.g. L_{inf} for combined sexes = 109.6 cm; females = 84.4 cm; males = 76.2 cm). These estimates presented in Table 3, also do not match plots presented in Figure 6.6.12, in which male L_{inf} appears to be larger than female L_{inf}, and combined L_{inf} does not appear to be much greater than for either sex.
- The report is based on data from several distinct management areas. Although there is no information to suggest that these areas are representative of stock structure, estimates of reference points (e.g. L_{inf}, L_{mat}) are frequently based on data from within a single area, and may differ in other areas. Particularly, as noted by the EG, LBI results are sensitive to input values including L_{inf} and L_{mat}.
- Given the wide variety of areas included in the analysis, indices of relative abundance showed data conflict, and thus, SPiCT results are dependent on the abundance index included in the model. Sensitivity runs should be conducted to ensure reference points remain the same with a different input index.

3) Consistency

- The results from LBI and SPiCT analyses were contradictory.

4) Proxy reference points & stock status

- The EG reports that catches should not be greater than 8415 t in 2016 and 2017, and that discards are negligible. The reasoning for this should be explained.
- It appears that LBI indicator ratios (i.e. L_c/L_{mat}, L_{maxy}/L_{opt}, L_{mean}/L_{opt}, $L_{25\%}/L_{mat}$, $L_{95\%}/L_{mat}$, etc.) are gradually increasing over time (since 2002) with respect to constant reference points, suggesting slow improvements in stock status.
- Based on the LBI analyses, the EG reported that it appears that tusk is overfished and overfishing is occurring. However, these results were subject to concern with respect to the values selected for L_{inf} and L_{mat}. It is unclear to the RG whether the EG accepted the LBI results or not. The RG is also concerned with the values estimated for L_{inf} and L_{mat}. If L_{inf} and L_{mat} were assumed to be too large, than the stock may be healthier than reference values suggested in the current assessment.
- The EG presents results from SPiCT analysis, but does not make any statements or conclusions about the results in the report. The figures in-

cluded in the report that are representative of SPiCT results do not have associated captions. We would have liked to see these results discussed in the report.

5) Comments & Suggestions

- Mean weight-at-age in the commercial catches in Faroese waters appear to increase from ~2005 to 2016.
- Longline landings are largely of 6–10 year old fish and mean age in catch were around 8–9 years. Age-at-maturity was reported to be 6 years for females and 7.77 years for males. Landings are largely composed of almost mature or mature fish.
- The EG reported that no information on natural mortality of tusk is available. The EG could have estimated M with available data (e.g. M can be estimated using the maximum observed age using the empirical estimator following Then *et al*., 2015).
- The EG stated that P_{mega} and L_{mean}/L_{opt} were not used because "tusk is a slow growing, deep-water species." No further discussion was presented. The RG does not understand why these would be unsuitable for tusk on first principles.
- The length data are sufficient to use the mean length Z estimator and LB-SPR method. These methods could have been explored, and we would like a rationale to be provided justifying use of the selected methods.
- The EG used a L_{inf} value of 125 cm (based on L_{max}) for LBI analyses based on data provided from Norwegian longliners. Based on all length data presented in Section 6.6.5.2, it appears to the RG that no lengths greater than 100 cm were observed in the commercial or survey catches. The L_{inf} = 125 cm implemented in the LBI analyses is also much greater than the L_{inf} estimates produced in Section 6.6.5.3 and displayed in Table 3. Generally, L_{max} is greater than L_{inf}, suggesting that the L_{inf} implemented for LBI analyses was too large. This would tend to give too pessimistic a picture.
- Despite discussing concerns with respect to using a commercial index as an index of relative abundance in assessments, the EG used the Norwegian longline fleet cpue dataseries in the SPiCT analysis, despite being shorter temporally than other fishery-independent indices available. The RG would have liked the EG to justify their choice to use the Norwegian longline index as an input to SPiCT analysis.
- The retrospective patterns resulting from the SPiCT analysis are concerning, and suggest inconsistencies in the time series, such that the past two years of data are driving the resulting estimates of stock status.

Proxy reference points: Conclusions

- Based on the LBI results presented, the EG indicates that the stock appears to be overfished with overfishing occurring. The EG does not explicitly state whether these conclusions are accepted or rejected due to the above mentioned caveats. While the RG agrees that LBI is an appropriate metric to explore for tusk, we are concerned that the EG's choice of a large L_{inf} resulted in an overly pessimistic view of the stock.
- We agree that SPiCT was an appropriate method to implement for tusk, given the temporal span of observations and the contrast in the data. Although the EG does not interpret the results of the SPiCT analysis in the re-

port, the RG notes that, based on these results, tusk in these regions are not overfished and no overfishing is occurring ($B>B_{MSY}$ and $F<F_{MSY}$). However, the patterns in the retrospective analysis are concerning. The RG also notes data conflict over all indices of relative abundance available. The cpue series included in the SPiCT analysis was that based on the Norwegian longline data (>30% total catch). We would have liked to see the sensitivity of the SPiCT results with respect to the index included in the analysis (i.e. what do the results look like when the Faroe longline index, annual groundfish survey index, or Faroe Plateau index was implemented instead?).

Usk.1.2 [Tusk (*Bromse bromse*) in areas 1, 2 (Norway)]

Category 3.2

General comments

1) **Assessment method(s)**: LBI methods and SPiCT analysis were run.

2) Evaluating Uncertainties

- Two commercial cpue indices (standardized using GLM models) were presented by the EG. Both indicate an upward trend in catch rates since the mid-2000s.

3) Consistency

- The results from LBI and SPiCT analyses were contradictory.

4) Proxy reference points & stock status

- The EG did not explicitly accept or reject the methods for setting proxy reference points.
- The LBI analysis showed that the LBI were below their respective reference points: $L_c/L_{mat} < 1$, $L_{25\%}/L_{mat} < 1$, $L_{max5\%}/L_{inf} < 1$, and $L_{mean}/L_{F=M} < 1$. P_{mega} and L_{mega}/L_{opt} were not used for tusk.
- SPiCT estimated that overfishing is not occurring ($F < F_{MSY}$) and the stock is not overfished ($B > B_{MSY}$).

5) Comments & Suggestions

- The EG stated that estimates of L_{mat} and L_{inf} are uncertain for this stock. Several mean length-at-age curves were presented in the report. Based on the sampled ages in the figure, the RG believes that L_{inf} could be well estimated. However, the samples were obtained from a fishery-independent survey that is very limited spatially and the EG stated that ageing of tusk is difficult. In lieu of a model estimate of L_{inf}, it appears that the EG used L_{max} (the maximum length) as the proxy for L_{inf}.
- The RG does not understand why the estimate of L_{mat} in uncertain. The EG presented a maturity ogive. The data used to fit the ogive appear to be well-behaved.
- The EG stated that P_{mega} and L_{mean}/L_{opt} were not used because "tusk is a slow growing, deep-water species." No further discussion was presented. The RG does not understand why these would be unsuitable for tusk on first principles.
- The EG is concerned that the commercial cpue may not reflective of the stock abundance. Based on the figure showing the spatial distribution of the catch in the past four years, the RG believes that the spatial distribution of the fishing fleet is not contracting. Thus, hyper-stability of the cpue due to such behaviour by the fleet is unlikely.
- The catch and cpue show contrast and the SPiCT model performed well. The catch time-series start in 1988 and the model appears to have estimated biomass in 1988 to be near the carrying capacity. If fishing has occurred prior to 1988, then the RG would like to see a model run with a narrow prior with $B_0/K < 1$.

Proxy reference points: Conclusions

- The EG did not explicitly accept or reject the methods for setting proxy reference points.
- The RG currently concludes that L_{mat} is well estimated. Thus, the RG believes that the LBI based on maturity, i.e. L_c/L_{mat} and $L_{35\%}/L^{mat}$, are suitable for setting proxy reference points. However, the EG should indicate the concerns regarding the $L_{50\%}$ estimate presented in the report.
- The RG believes that L_{inf} for the stock is likely to be less than L_{max}. If the conclusions from the LBI do not change when alternative values of L_{inf} are used, then the LBI requiring L_{inf} are appropriate for setting reference points. The alternative values should be reasonable.
- The RG believes that the current SPiCT model run is also appropriate for proxy reference points, although the model currently estimates the biomass in 1988 to be near virgin conditions. The RG suggests an alternative model run with a narrow prior on $B_0/K < 1$ if extensive fishing occurred prior to 1988.

Usk.6b [Tusk (*Bromse bromse*) in area 6.b (Rockall)]

Category 3.2

General comments

1) **Assessment method(s)**: LBI methods and SPiCT analysis were run.

2) Evaluating Uncertainties

- Landings are dominated by the Norwegian longline fleet. Length composition is also provided by the Norwegian fleet.
- Logbook data suggest a very short fishing season (with an average of less than seven days of fishing per year in Area 6.b). The trend in days fished has remained stable if not decreasing since 2000. However, the number of longline hooks deployed has increased over time since 2000.
- The EG used L_{max} (the maximum length) as the proxy for L_{inf}. The estimate of L_{mat} was obtained from the Faroese stock of tusk.

3) Consistency: N/A

4) Proxy reference points & stock status:

- The EG used LBI and SPiCT models to obtain proxy reference points. However, only figures are presented for the SPiCT model.
- The LBI analysis showed that some of the LBI were below their respective reference points: $L_c/L_{mat} < 1$, $L_{25\%}/L_{mat} < 1$. On the other hand, $L_{25\%}/L_{mat} > 1$, $L_{max5\%}/L_{inf} > 1$ in 2016, and $L_{mean}/L_{F=M} > 1$ in 2015 and 2016. The EG did not consider P_{mega} and L_{mega}/L_{opt} for tusk.
- Both the catch and cpue show a decreasing trend and the SPiCT model did not perform well.

5) Comments

- The EG stated that P_{mega} and L_{mean}/L_{opt} were not used because "tusk is a slow growing, deep-water species." No further discussion was presented. The RG does not understand why these would be unsuitable for tusk on first principles.
- Simpler model runs of SPiCT with model parameters alpha = 1, beta = 1, and n = 2 may provide tractable results, but the RG does not believe this will occur based on the trends in catch and cpue.

Proxy reference points: Conclusions

- The EG did not explicitly accept or reject the methods for setting proxy reference points.
- The RG considers the LBI that use L_{inf} to be appropriate for setting proxy reference points. The RG believes that the true L_{inf} is likely to less than L_{max}, assuming that the selectivity of the longline gear is logistic (not dome-shaped) and that fishing pressure has not severely truncated the length distribution of the population. The LBI are favorable using L_{max} as the proxy for L_{inf}, the LBI will still remain favourable with lower alternative values of L_{inf}. Thus, the conclusions from the LBI based on L_{inf} are robust to uncertainty in that parameter.
- The two LBI that consider conservation of small individuals, L_c/L_{mat} and $L_{25\%}/L_{mat}$, provide opposite conclusions for this stock. Thus, the EG must

choose one of the two in order to determine stock status. The RG is not aware of any work that could guide the EG in making this decision. The estimate of L_{mat} is also borrowed from another stock. The RG concludes that these LBI are not appropriate for setting proxy reference points.

- The RG believes that results from the current SPiCT model run cannot be used for proxy reference points. However, simpler model runs may provide more tractable estimates.

Annex 4: WGDEEP 2017 Working documents

The Spanish Red seabream fishery of the Strait of Gibraltar: an update of the available information. Juan Gil, Candelaria Burgos, Carlos Farias, Juan José Acosta and Mar Soriano, CEO, Cádiz, Spain.

Some comments on estimating cpue series for some deep-water species based on commercial catch data. Michael Pennington and Kristin Helle, IMR, Norway.

Is it possible to differentiate between environmental and fishery effects on abundance-biomass variation? A case study of blackspot seabream (*Pagellus bogaraveo*) in the Strait of Gibraltar. Juan Carlos Gutiérrez-Estrada, Juan Gil-Herrera, Inmaculada Pulido-Calvo and Ivone Alejandra Czerwinski, Spain.

Results on Greater forkbeard (*Phycis blennoides*), Bluemouth (*Helicolenus dactylopterus*), Spanish ling (*Molva macrophthalma*) and Red seabream (*Pagellus bogaraveo*) of the Northern Spanish Shelf Groundfish Survey. S. Ruiz-Pico, M. Blanco, O. Fernández-Zapico, I. Preciado, A. Punzón and F. Velasco, CEO, Santander, Spain.

Faroese fishery of orange rought in ICES area 10 and 12. Lise H. Ofstad, MRI, Faeroe Island.

Roundnose grenadier in Faroese waters. Lise H. Ofstad, MRI, Faeroe Island.

Black scabbardfish in Faroese waters. Lise H. Ofstad, MRI, Faeroe Island.

Tusk in Faroese waters (Division 5.b).Lise H. Ofstad, MRI, Faeroe Island.

Greater forkbeard *Phycis blennoides* in Portuguese waters (ICES division 9.a). Neide Lagarto, Teresa Moura and Ivone Figueiredo, Institute of Sea and Atmosphere, Portugal.

Update on Norwegian fishery independent information on abundance, recruitment, size distributions and exploitation of roundnose grenadier (*Coryphaenoides rupestris*) in the Skagerrak and northeastern North Sea (ICES Division 3.a and 4.a). Hege Øverbø Hansen, Odd Aksel Bergstad and Terje Jørgensen, IMR, Norway.

Resuming data from deep-water fishery of the Azores. Mário Rui Pinho, DOP, Portugal.

Survey data from the Azores for deep-water species. Mário Rui Pinho and Helder Silva, DOP, Portugal.

Blue ling in Faroese waters (Division 5.b). Lise H. Ofstad, MRI, Faeroe Island.

New data on *Pagellus bogaraveo* in the Portuguese continental waters (ICES division 9.a). Gonçalo Araújo, Tresa Moura and Ivone Figueiredo, Institute of Sea and Atmosphere, Portugal.

Exploration of reference points with length-based indicators for ling and tusk in Arctic and other areas, ling in Faroese waters and tusk at Rockall. Lise Helen Ofstad, Hege Øverbø Hansen and Kristen Helle.

Greater silver smelt in Divisions 5.b and 6.a. Lise H. Ofstad, MRI, Faeroe Island.

Exploratory assessment of ling in Faroese waters (Division 5.b).Lise H. Ofstad, MRI, Faeroe Island.

Greater silver smelt in ICES areas 1, 2, 3.a and 4. Elvar H. Hallfredsson, Odd Aksel Bergstad, Lise Heggebakken, Hege Øverbø Hansen and Alf Harbitz.

Russian fisheries and investigations of Deep-water fish in the Northeast Atlantic in 2016. Dmitrii I. Aleksandrov, PINRO, Russia.

Results on silver smelt (*Argentina silus* and *Argentina sphyraena*), bluemouth (*Helicolenus dactylopterus*), greater forkbeard (*Phycis blennoides*), Spanish ling (*Molva macrophthalma*) and ling (*Molva molva*) from 2016 Porcupine Bank (NE Atlantic) survey. O. Fernández-Zapico, S. Ruiz-Pico, F. Velasco and F. Baldò, CEO, Spain.