WORKING GROUP ON THE BIOLOGY AND ASSESSMENT OF DEEP-SEA FISHERIES RESOURCES (WGDEEP)

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Contents

i Executive summary

The ICES working group on biology and assessment of deep-sea fisheries resources (WGDEEP) provides scientific advice on 30 assessment units including stocks of deep-water species and those on shelf areas. Advice is provided in time intervals of 1 to 5 years for different stocks, with 1- and 2-years intervals as the most common.

First draft of advice was prepared for 17 stocks this year. Available time-series for international landings and discards, fishing effort, survey indices and biological information were updated for all stocks and are presented in Sections 4–16 of the report.

A request from the UK and EU about the allocation of advice to different management units for roundnose grenadiers was addressed. A response from the meeting was prepared to be provided to ACOM.

Exploratory assessments were presented to the meeting for tusk and ling in subareas 1 and 2 using length-based spawning potential ratio (LBSPR), and for black spot seabream in area 10 applying both surplus production models (SPiCT and JABBA) and length-based analysis (LBSPR and LBI indicators). In addition, an exploratory data-limited assessment on a stock where recreational fisheries are apparent was presented (Atlantic halibut in Norway).

Main conclusions regarding each stock with advice in 2023:

For Atlantic wolffish in Division 5.a (Iceland grounds) spawning stock biomass has been going up since 1995 but recruitment decreased until 2010. Since 2010, recruitment has remained stable and has increased slightly in recent years. Spawning stock biomass and fishing pressure are at sustainable levels. The advice for 2023/24 is slightly higher than for 2022/23 due to higher biomass and lower fishing pressure.

Blackspot seabream in subarea 10. ICES rfb rule was applied for the first time. Surveys were not conducted in 2020 and 2022. The 2024/25 advice is lower than the last advice because the survey index shows a decrease in the abundance in the most recent available years..

The recruitment of blue ling in division 5.a and subarea 14 has been low since 2010. Biomass indices have decreased slightly in recent years. As the generic simulations on the rfb-rules were based on biennial catch advice, the last years advice (2022/2023) is rolled over to this year´s advice (2023/2024).

The advice for bli.27.nea is a zero catch advice given for the years 2024-2027. The landings have declined over years and are now at total of 636 tons. The reported discards of blue ling are minor and represent only 0.2% of total catch. The stock is regarded as depleted.

Greater silver smelt in areas 1, 2, 3a and 4. According to the recommendations from WKLIFE X, the rfb rule was applied for a trend-based advice. The direct fisheries in Subarea 2 have decreased in later years. The bycatch in Subarea 4 increased substantially in the years 2018-2020, while for the two latest years these catches have decreased again.

For greater silver smelt in division 5.a and subarea 14, the spawning stock biomass has reached a historical high and fishing mortality remains relatively low. Recruitment estimates are low in the past two years but were relatively high prior to these. Spawning stock biomass and fishing pressure are at sustainable levels. Advice for 2023/24 increased slightly from 2022/23.

For greater silver smelt in 5b and 6a fishing mortality and the spawning stock biomass are at sustainable levels. The recruitment is very constant. Upon applying the MSY approach, the catch advice increased slightly compared to last year's advice.

Greater silver smelt in 6b, 7, 8, 9, 10 and 12 has not been benchmarked. The rfb rule was applied for the trend-based advice. Fisheries in this area are very minor, and there are no directed fisheries. Mean discard rate for the years 2015 to 2022 is 80%. It is important to monitor and follow if new fisheries emerge, as catches have been considerable in the past.

Ling in subareas 1 and 2. The biomass index for ling based on the targeted fishery by the Norwegian longliners. The index increased steadily from 2001 and peaked in 2017. Since then, the index has declined. The rfb-rule was applied for the first time this year. The advice was reduced by 17.7% compared to the 2022-2023 advice.

For ling in Division 5.a, the spawning stock biomass and the fishing mortality are at sustainable levels. Recruitment of age 2 decreased from high levels in 2008 in and have remained stable for the past five years. The advice for 2023/2024 is higher than the advice in 2022/2023 because of the upward revision in biomass levels compared to last year's assessment.

For ling in Division 5b the spawning stock biomass is decreasing and is now reaching an unsustainable level and the fishing mortality is high. Catches are still at high level. Recruitment has decreased since 2014 and has been at a low level since 2019 so there are high probabilities that SSB in 2025 will be below sustainable levels.

Ling in subareas 3, 4, 6 - 9, 12, and 14. The rfb rule was applied for the first time. The CPUE index value for year 2021 was not used because the Norwegian longline reference fleet could not fish its regular fishing grounds. About 75% of the landings come from subareas 4 and 6 but there is un-certainty as to whether ling in all subareas comprise more than one stock, and management should be aware of different trends in stock development among them.

Advice for Roundnose grenadier in subareas 1, 2, 4, 8, and 9, Division 14.a, and in subdivisions 14.b.2 and 5.a.2 was last provided in 2019. Advice is based on limited landings only data. This stock is mostly exploited as bycatch from other fisheries and trends in landings are considered to reflect changes in activity in other fisheries rather than in stock abundance. The available information is insufficient to evaluate the status of this stock.

For roundnose grenadier in Divisions 10.b and 12.c, and Subdivisions 12.a.1, 14.b.1, and 5.a.1 the information on landings have been variable and at a considerably lower level down to insignificant. The landing reduction is associated with the change in fishing behavior generated by the implementation of Regulation (EU) 2016/2336 which severely restricted existing NEAFC bottom-fishing areas.

Tusk in subareas 1 and 2. The biomass index for tusk based on Norwegian longliners increased steadily from 2004 to 2017 then decreased until 2022. The landings have been relatively stable since 2006. The rfb-rule was applied for the first time this year. The advice was at the same level as the previous advice.

Tusk in subareas 4 and 7–9, and in divisions 3.a, 5.b, 6.a, and 12.b. The landings of tusk have decreased since 2000. The biomass index (2000-2022) based on Norwegian longliners increased from 2003 to 2012, since then it has been relatively stable. The rfb-rule was applied for the first time this year. The advice was reduced by 11.5% compared to the 2022-2023 advice.

For tusk in Division 5.a and Subarea 14, the total stock biomass has increased since 2020 and the spawning stock biomass is slightly above Blim. Fishing mortality has declined and recruitment of age 1 shows an increase for the past decade.

ii Expert group information

Expert group name	Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP)
Expert group cycle	Annual
Year cycle started	2022
Reporting year in cycle	1/1
Chairs	Elvar H. Hallfredsson, Norway
	Juan Gil Herrera, Spain
Meeting venue and dates	3–9 May 2023, Lisbon, Portugal (23 participants)

1 Ecosystem productivity and ecosystem approach in WGDEEP stocks

1.1 Ecosystem productivity and ecosystem approach for deep-water stocks

Most deep-water stocks present a lower biological productivity than continental shelf and coastal stocks: natural mortality (M) is lower for deep-water stocks, age-at-maturity higher and growth rate lower. The lower productivity of deep-water ecosystems, which is well documented and was subject to a review for the west of the British Isles (Vieira *et al*, 2019), is *de facto* accounted for in population dynamics models of these stocks.

For ICES category 1 stocks this is conveyed in the assessment, forecast and advice by using the stock specific life history traits. For the numerous Category 3 stock assessed by WGDEEP, a population indicator (usually a biomass index from a scientific survey or CPUE series from the fisheries) is used to estimate the stock trend in recent years. By its very nature such indicator is expected to change with both the exploitation rate and the biological productivity of the stock as these factors are confounded in the indicator. In none of the WGDEEP Category 3 stocks these two factors can be quantitatively disentangled. However, for some stocks some ecosystems factors have been identified or hypothesised to influencing observed trends.

Note that decreasing productivity and increasing exploitation would have the same effect of decreasing a biomass indicator.

1.2 Ecosystem considerations for selected WGDEEP stocks

Ecosystem considerations are presented for those WGDEEP stocks where appropriate and relevant knowledge is available. Not all 30 WGDEEP stocks have been subject to this ecosystem consideration so far, and this listing is thus not complete.

1.2.1 Blackspot sea bream (*Pagellus bogaraveo*) in Subarea 9 (Atlantic Iberian waters)

The strait of Gibraltar has been the main area where this stock has been fished since the 1980s. Based on a biomass indicator in the Strait of Gibraltar, the stock biomass decreased in the last decade as a consequence of increasing exploitation. The EU TAC covers Subarea 9 but the Strait of Gibraltar is the path between the Atlantic ocean and the Mediterranean sea and is divided at 36°N between the CECAF and the ICES areas. Blackspot seabream moves across these areas where management regimes differ, while the ICES advice only applies to the ICES area.

In ICES Division 9, in addition to catches from the targeted fishery in the Strait of Gibraltar, there are catches from coastal areas of Northern Spain (Galicia) and Portugal. The stock structure is unclear and the level of mixing of population from Gulf of Cadiz with those at the occidental Iberian coast still unknown. Preliminary genomic studies confirmed low connectivity between the Azorean population and the Atlantic eastern continental margin locations and suggested genetic differentiation between the Strait of Gibraltar and locations further north in Iberian waters (Castilho *et al*., 2022). The overexploited status of the stock is derived from data from the Spanish fishery in the Strait of Gibraltar where in addition the high fishing mortality resulting from the high value of the species and the absence of catch limits in the Mediterranean and CECAF areas, natural mortality may have increased as a consequence of the predation from the recovering blue fin tuna stocks.

Sanz-Fernández *et al*. (2019) suggests that the main factor responsible for the decline in the abundance of blackspot seabream in the Strait of Gibraltar is fishery overexploitation and that environmental conditions (such as water temperature anomaly, salinity anomaly and the NAO index) had a one-off effect which, depending on the year, favoured or harmed the recovery of the stock.

1.2.2 Blackspot seabream (*Pagellus bogaraveo*) in subareas 6, 7, and 8 (Celtic Seas and the English Channel, Bay of Biscay)

This stock collapsed in the 1980s and remains at a historically low level. The stock annex reports that environment has changed in the Bay of Biscay, in particular with a documented warming of the upper layer of water. This warming was considered unlikely to be unfavourable to blackspot seabream, as other stocks of the species are distributed in warmer areas in the Gulf of Cadiz and the Mediterranean Sea.

1.2.3 Blackspot sea bream (*Pagellus bogaraveo*) in Subarea 10 (Atlantic Iberian waters)

The stock reported in this section is from the Azores EEZ (ICES 10.a2). It is distributed along the coastal areas of the islands and seamounts up to 700m. Recruitment occurs on the coastal areas and juveniles migrate subsequently to offshore seamounts. The assessment of the stock is based on the survey trends and currently it is considered intensively exploited. Survey relative abundance indices trends presents high inter annual variability. Causes for this variability may be related to catch dynamics between fish and gear (competition, gear saturation, forage behaviour, etc.) or with environmental effects. Both factors seem to affect catchability. Further studies are necessary to better understand both effects on the abundance estimates.

1.2.4 Blue ling (*Molva dypterygia*) in Subarea 14 and Division 5.a (East Greenland and Iceland grounds)

In 2019, the expert group considered to include further ecological consideration in the assessment used for this stock. In 2018, the biomass indicator was at high level and implied an increase of the catch advice according to survey trend-based assessment. However, as the index of small fishes indicated that the recruitment had been very low since 2010, an increase of adult stock catches seemed inappropriate. The driving factor for the low recruitment might be environmental as the adult biomass continues to be high. In terms of environmental changes, warming of sea temperature and expansion of distribution area of warm-water species such as anglerfish has been observed in Icelandic waters (see stock annex). The effect of these on blue ling recruitment is unknown. Nevertheless, the low recruitment was taken into account in the assessment and advice for the stock. The recruitment is still at low levels.

1.2.5 Roundnose grenadier (*Coryphaenoides rupestris*) in Division 3.a (Skagerrak and Kattegat)

The stock was depleted by a directed fishery that lasted from 2000–05. This stock, compared to other deep-water stock, is distributed in a restricted area. Recruitment was observed to be intermittent (Bergstad *et al*., 2014). Recovery from the depleted status is unlikely to occur until a new strong recruitment event, which is unpredictable. The previous one dates back from the early 1990s.

1.2.6 Ling (*Molva molva*) in Subareas 6-9, 12, and 14, and Divisions 3.a and 4.a (Northeast Atlantic and Arctic Ocean)

CPUE indices from areas where the main fisheries occur are used to assess the stock. These show an increasing trend since the early 2000s. The application of the ICES Category 3 rule lead to an advice catch for 2020-2021 slightly higher than the previous advice. However, the Spanish survey on the Porcupine bank (SPPGFS-WIBTS-Q3) covering ICES divisions 7c,k shows a strong declining trend on abundance and on biomass. The advice was not changed because 90% of the catch from this stock come from Subareas 4 and 6. However, it was considered likely that there are different trends by area. Landings in Subarea 7 have decreased since the late 1980s where they were comparable to landings in each of subareas 4 and 6. WGDEEP considered likely that environmental changes have made Subarea 7 less suitable to ling.

1.2.7 Black scabbardfish (*Aphanopus carbo*) in the Northeast Atlantic and Artic Ocean

The stock structure in the whole Northeast Atlantic is still uncertain. Although available information does not unequivocally support the assumption of a single stock, most available evidences support it. Juveniles are mesopelagic and adults are benthopelagic. The species does not complete its life cycle in one area and either small- or large-scale migrations occur. So far, the known spawning grounds occur in CECAF areas (Madeiran and Canary Islands waters). Juveniles recruit in Northern areas. These particularities are taken into consideration by ICES model adopted to monitor the stock dynamics.

After 2012, both the annual biomass and annual abundance indices are at higher levels, indicating that the population at the Northern component has been increasing. However in recent years, the Icelandic abundance index, the French LPUE index from the west of Scotland show a decreasing trend while both the Icelandic and the Scottish survey biomass indices have been increasing. The analysis of these trends suggests that the level of recruitment have been decreasing. This effect is unlikely to result from an increasing fishing pressure because (1) the TAC set for black scabbardfish have been stable for several years and (2) in EU waters the ban of trawling in areas deeper than 800 m has strongly reduced the fraction of the species habitat which can be exploited as the depth range of the species extends down to 2000 m. Therefore, the observed decrease might be due to ecosystem effects. Acting ecosystem factors may be:

- Changes in the abundance of prey species. In particular the black scabbardfish preys upon blue whiting, which SSB increased in 2011-2016 and have decreased in more recent year (ICES, 2019);
- Changes in abundance of predators. After the heavy exploitation in the 1990s and early 2000, TACs for deep-water species were introduced in 2003 and gradually decreased thereafter. The black scabbardfish fish is one of the most productive deep-water species, with a faster growth than its potential predators particularly deep-water sharks. Target fishing from deep-water sharks have been strongly restricted since 2006 with the ban of deep-water nets and was further restricted in 2012 after the introduction of a 0 TAC for deep-water sharks that applies for all gears. The latter might have been an incentive to diverge fishing to locations where sharks were a small proportion of commercial catches. Lastly the ban, in 2016, of trawling deeper than 800 m in EU waters might have resulted

in reduction of deepwater-sharks bycatch to low levels in trawl fisheries. Although no reliable indicator of deep-water shark abundance is available, population might be increasing in recent years and thus increasing the predation on black scabbardfish.

1.2.8 Greater forkbeard (*Phycis blennoides*) in all ecoregions

ICES currently considers greater forkbeard as a single-stock for the entire NE Atlantic, although the stock structure be more complex. Further studies would be required to justify change to the current assumption. Fishing is a major disturbance factor of the continental shelf communities of the regions. As the fishery of greater forkbeard is mainly a bycatch of trawler fishery in all ecoregions the main ecosystem effects are the impact on the sediment compound.

1.3 The percentage of the total catch that has been taken, and emerging fisheries, in the NEAFC regulatory areas last year

WGDEEP stocks are distributed broadly across the NEAFC Convention Area, with catches of some stocks occurring within the NEAFC Regulatory Area (RA). In the table 1.1 in the WGDEEP 2020 report the WG presented the most likely landings from these RA areas in 2019 based on the official reports and discussions within the WG. For relevant stocks with advice this year the estimated percentage of the total catch that has been taken in the NEAFC Regulatory Area last year is reported in the advice sheets.

No new emerging deep-water fishery were discovered with the available data in the NEAFC Regulatory Area.

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2 Stocks and Fisheries of the Oceanic Northeast Atlantic

2.1 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 continuously increased 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.

2.2 Fisheries overview

Two types of deep-water fisheries occur in the area: 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. Import to note that inside the Azorean EEZ trawling is prohibited. Azorean fishery targets stocks, which may extend south of the ICES area.

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

2.2.1 Azores EEZ

The Azores deep-water fishery is a multispecies and multigear fishery. The dynamics of the fishery is primarily determined by the 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 performed by a small-scale fleet mainly comprised by small vessels (<12 m; 90% of the total fleet), using mainly traditional bottom longline and several types of handlines. The Azorean ecosystem is a seamount and island slope type and fishing operations occur in all available areas, from the islands coasts to the multiple seamounts within the Azorean EEZ. The fishery takes place at depths down to 1000 m, catching species from different community assemblages, with a mode in the 200–600 m strata, which is the intermediate strata where the most commercially important species occur.

2.2.2 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. More than 40 seamounts have been subsequently explored, fished for shorter or longer periods, and regarded as commercially important in Soviet/Russian assessments (Table 2.7.1). Figure 2.7.1 illustrates subareas of the area beyond national jurisdiction (where the Northeast Atlantic Fisheries Commission regulates fisheries) with depths shallower than 2000 m. These are 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 2.7.2) by Russian, Icelandic, Faroese, Polish, Latvian, Spanish and Norwegian vessels. However, few of these (often subsidized) efforts led to lasting regular fisheries. It is suspected that IUU fishing occurred by vessels from other areas, but the scale of such activity is unknown.

During the last decade and in recent years, the fishing activity has declined substantially (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 benthopelagic 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).

2.3 Details on the history and trends in fisheries

2.3.1 Azores EEZ

Since the mid-1990s the landings of deep-water species show a decreasing tendency (Figure 2.7.3 and Table 2.7.2), 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 because of the interdiction by the local Portuguese 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. 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. During the last decade it was observed an expansion of the fishing area for this fleet class.

Also in one other fleet component, the medium size boats, ranging from 12–16 m, 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.

2.3.2 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 2.7.2) 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. Spain have reported regularly landings of roundnose grenadier from subdivision 14.b1 and 12a.1 In 2020 the official Spanish landings were reported 131t from 12.a1.

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 2.7.2). A fishery on the seamount was resumed by Spanish trawlers in the 2000s with biggest catch about 1000 t, but this has ceased. During 2020 Spain reported a landing of 0.272t from 12.a1.

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 2.7.2). 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 for the most recent years' (2009–2014) catches were 45–313 t for both Subareas. There are no landings reported since 2016.

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 2.7.2). 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). During 2019 Faroe report landings of 5 t from area 10.

Current status*:* In the recent years and in ICES Subareas 10 and 12, the deep-water fisheries in the MAR reduced to very low levels. This reduction is due to many reasons, including the economic reason and the implementation of a range of management measures.

2.4 Technical interactions

2.4.1 Azores EEZs

The fishery is multispecies where technological interactions are observed. In the past, the bycatches were 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 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.

2.4.2 Mid-Atlantic Ridge

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

2.5 Ecosystem considerations

2.5.1 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.

2.5.2 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. There are studies on 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).

2.6 Management of fisheries

2.6.1 Azores EEZ

In the Azorean EEZ the management of the fisheries 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). Since 1998, some technical measures were also introduced by the Azores regional government. These include fishing restrictions by area, vessel type and gear, fishing licences based on landing thresholds, minimum lengths, marine protected areas and closed seasons and updated thereafter. Some of the target fisheries are managed based on quota by quarter, island and vessel.

2.6.2 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 management measure aims to prevent expansion of fisheries, including by third parties. The use of gillnets is prohibited beyond 200 m depth.

Specific measures including the TAC 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 2.7.4). The 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.

2.7 References

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2.8 Tables

Table 2.7.2. 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).

	ALFONSINOS (Beryx spp.)	ARGENTINES (Argentina silus)	BLUE LING (Molva dypterigia)	BLACK SCABBARDFISH (Aphanopus carbo)	BLUEMOUTH (Helicolenus dactylopterus)	DEEP WATER CARDINAL FISH (Epigonus telescopus)	GREATER FORKBEARD (Phycis blennoides)	LING (Molva molva)	MORIDAE	ORANGE ROUGHY (Hoplostethus atlanticus)	RABBITFISHES (Chimaerids)	RAGIDAE	ROUGHHEAD GRENADIER (Macrourus berglax)	ROUNDNOSE GRENADIER (Coryphaenoides rupestris)	RED (=BLACKSPOT) SEABREAM (Pagellus bogaraveo)	BEAKED REDFISH (Sebastes mentela)	SHARKS, VARIOUS	SILVER SCABBARDFISH (Lepidopus caudatus)	SMOOTHHEADS (Alepocephalidae)	Trachipterus sp	TUSK (Brosme brosme)	WRECKFISH (Polyprion americanus)	TOTAL
1995	731		602	304	589		75	50		676				644	1115		1385	789			18	244	7222
1996	1510	1	814	455	483		47	2		1289				1739	1052		1264	826	230		158	243	10113
1997	384		438	203	410		32	9		814	32			8622	1012		891	1115	3692		30	177	17861
1998	229		451	253	381		39	2		806	42			11979	1119		1051	1187	4643		1	140	22323
1999	725	2	1363	224	340		41	2		441	115		3	9696	1222		50	86	6549		1	133	20993
2000	484		607	357	452	3	100	7	1	447	48		7	8602	947		1069	28	4146		5	268	17578
2001	199		675	134	301		91	59	88	839	79		10	7926	1034		1208	14	3592		52	232	16533
2002	243		1270	1062	280	14	63	8	113	28	98		7	11 468	1193		35	10	12538		27	283	17272
2003	172		1069	502	338	16	56	19	140	201	81		2	10 805	1068		25	25	6883		83	270	10950
2004	139	4	644	384	282	21	46		91	711	128		28	10 748	1075		6	29	4368		16	189	8161
2005	161		35	198	190	4	22	2	69	324	193		8	513	1383		14	31	6872		66	279	10364
2006	192		65	73	209	10	134		127	104			8	86	958		104	35			64	497	2666
2007	211		1		275	7	201		86	20				2	1070		63	55			19	664	2674
2008	252			80	281	7	18		53	108				13	1089		12	63				513	2489
2009	312			162	267	7	26	1	68	26	22		6	5	1042		1	64			2	382	2393
2010	245		72	240	213	5	14		54	74	0		0	1691	687		7	68			107	238	3715
2011	232		0	163	231	5	11		55	112			0	3366	624		5	148			0	266	5218
2012	222		16	16	190	4	6	0	31	139	2		2726	2724	613		31	282	160	54	29	226	7441
2013	168		9	206	235	4	8	0	52		6		868	1907	692		70	0	17			209	4398
2014	131			85	200	2	9		54	47			448	2075	663			713				121	4493
2015	292		0	7	256	4	10	1	92	84				862	701			429			1	116	2856
2016	156			86	306		10		186	93				660	515			87				101	2200
2017	149	0	0	63	333	5	15	0	169	<1	0	70	0	84	499	2277	75	101	0	0	0	128	3967
2018	157	0	28	17	283	4	75	0	140	0	0	60	0	27	474	2873	0	65	0	0	506	80	4790
2019	143	0	1	21	187	9	13	0	116		0	43	0	215	481	2403	0	65	0	0	0	80	3779
2020	139	0	0	11	130	5	9	0	59	0	0	5	0	131	491	2205	1	88	0	0	0	81	3356
2021*	124	0	0	0	160	4	8	11	10	0		4	0	0	565	51	0	83	0	0	0	68	1088

***- provisional data**

Table 2.7.1. 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

2.9 Figures

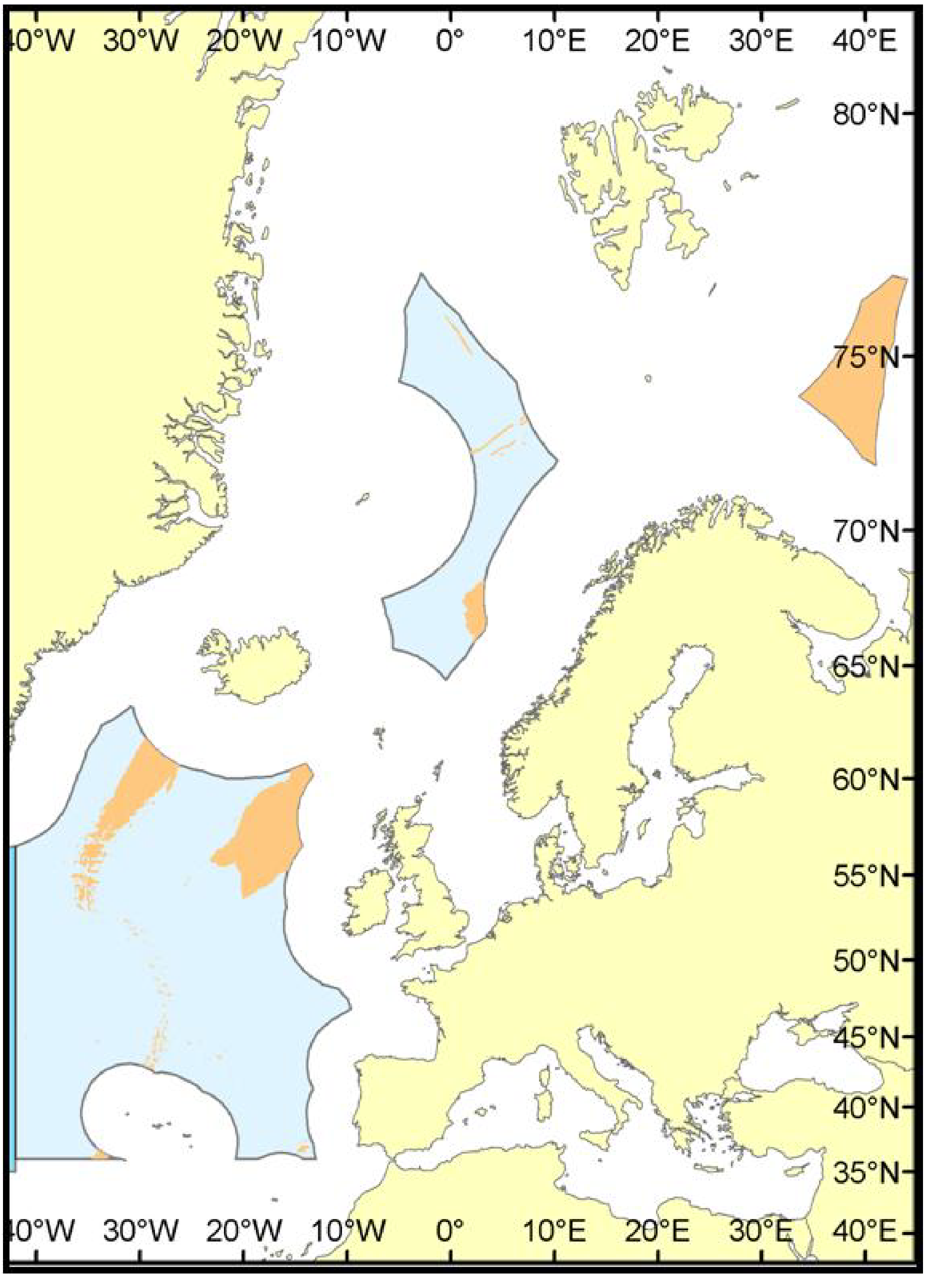

Figure 2.7.1. The NEAFC Regulatory Area (area beyond national jurisdiction) in the Northeast Atlantic (light blue polygons) with superimposed subareas shallower than 2000 m (light brown patches). Note that the NEAFC RA in the Barents Sea is entirely shallower than 2000 m, and that a high Arctic NEAFC RA (beyond 80◦N) is not shown on the map.

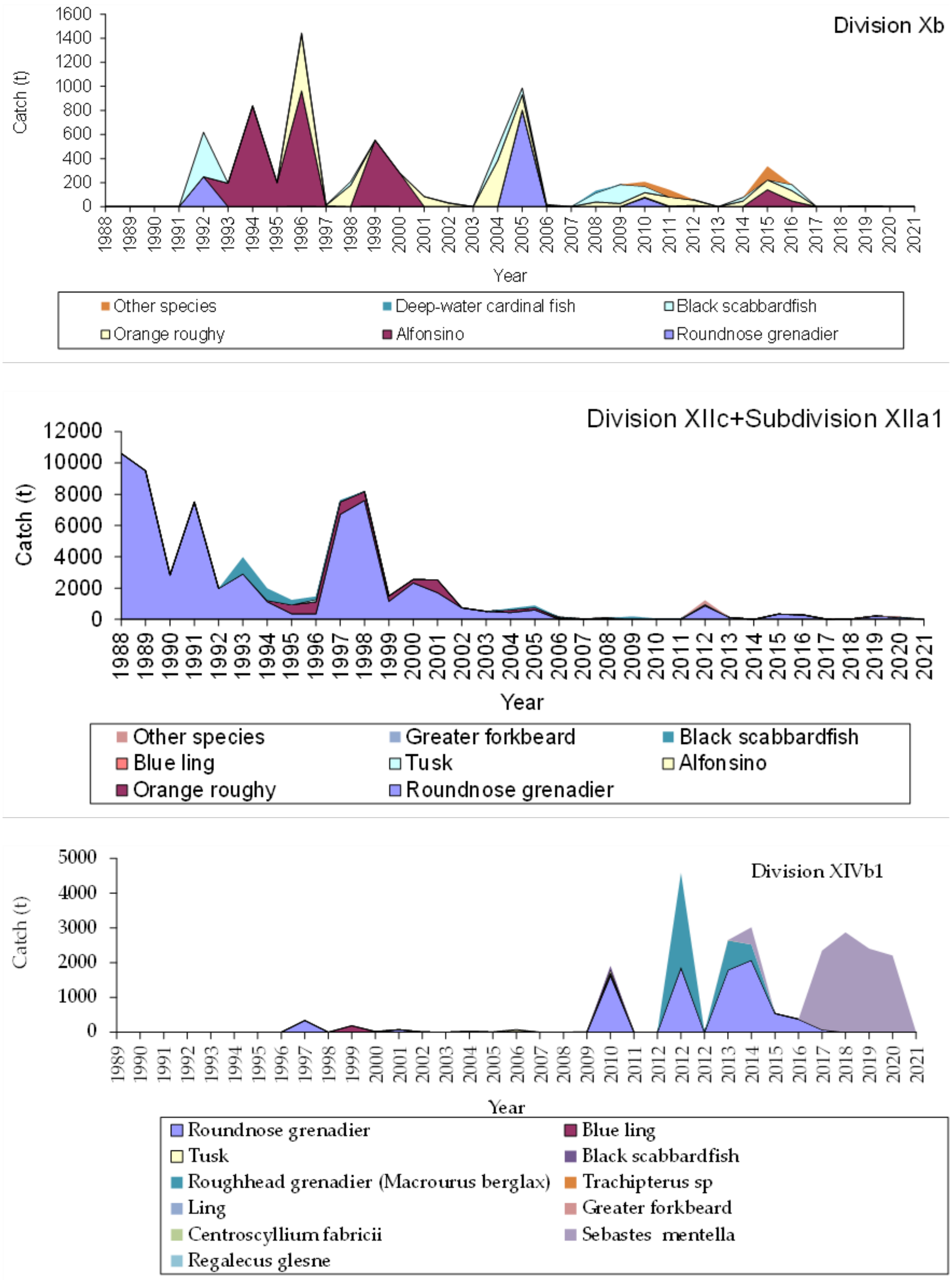

Figure 2.7.2. Annual catch of major deep-water species on MAR in 1988–2020.

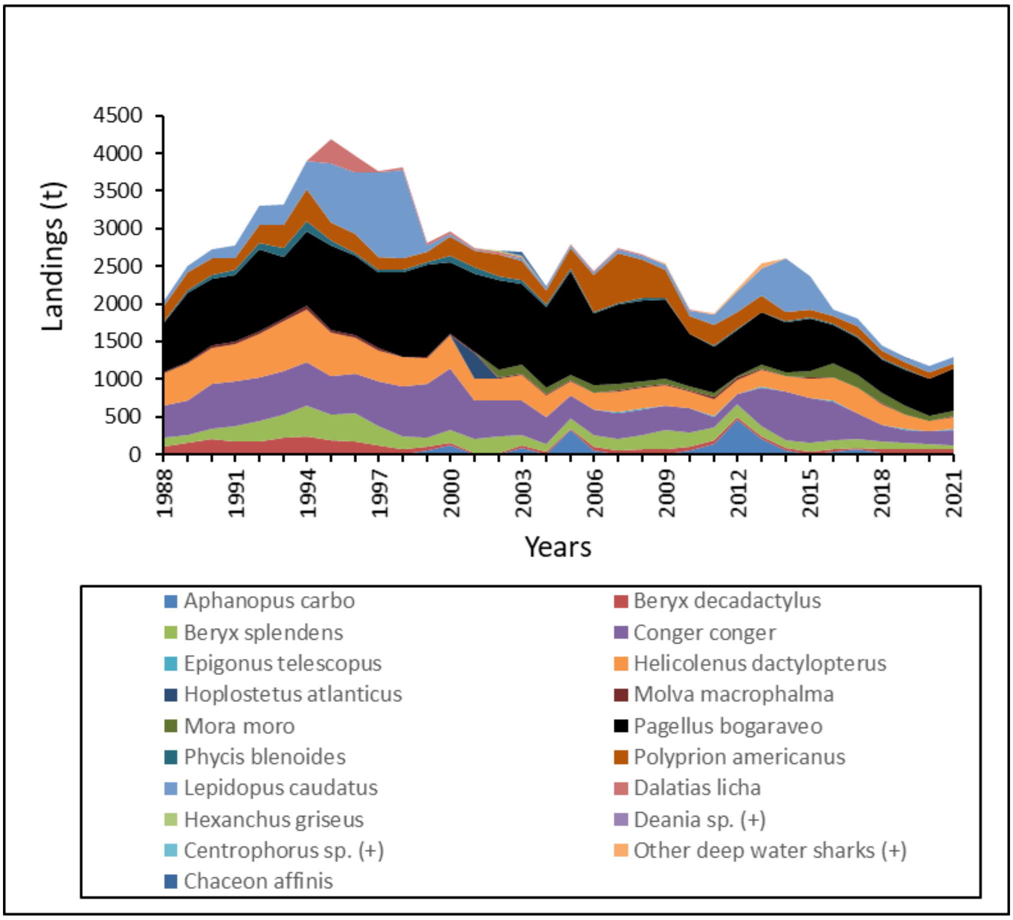

Figure 2.7.3. Annual landings of major deep-water species in Azores from hook and line fishery (1988–2020).

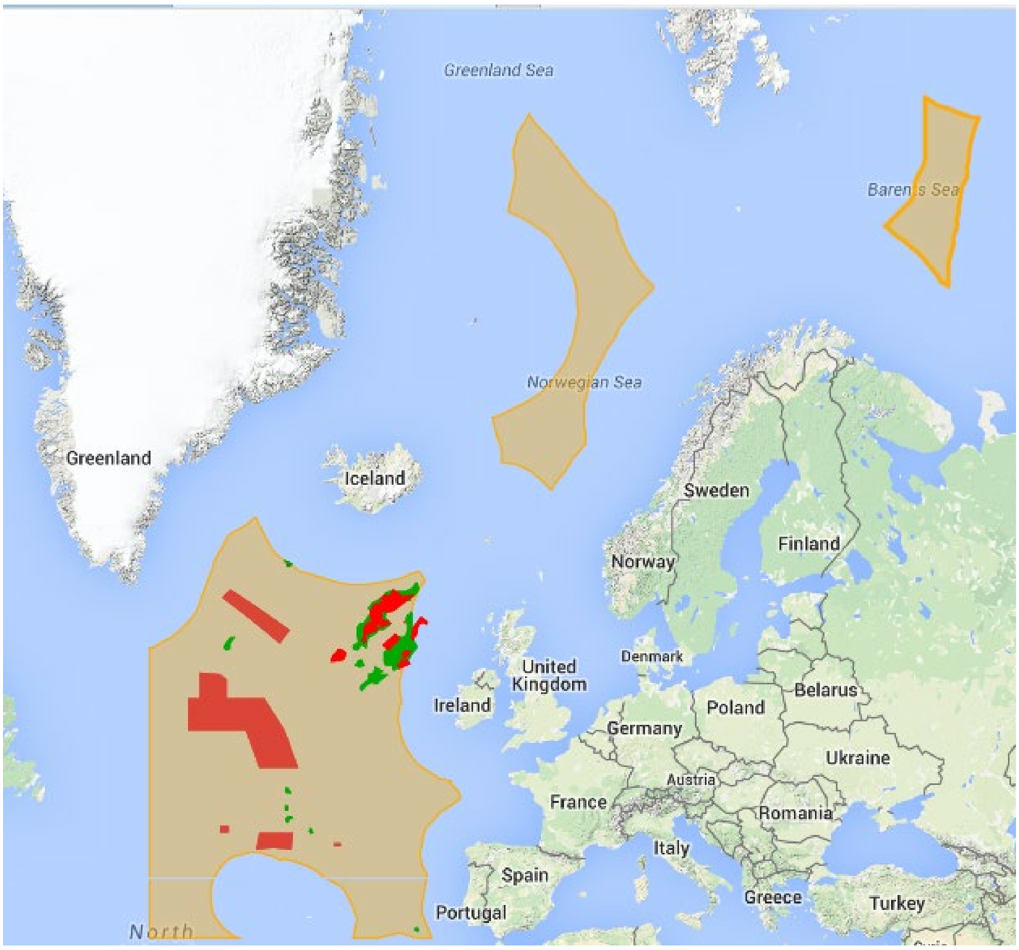

Figure 2.7.4. The regulatory area of NEAFC (light brown) and subareas of the Mid-Atlantic Ridge, seamounts and the Rockall-Hatton areas designated as bottom fishing closures (red), and 'existing fishing areas (green). Areas outside closures and 'existing fishing areas' are only open to pre-assessed exploratory bottom fishing. Source: www.neafc.org .

3 Ling (*Molva molva*)

3.1 Stock description and management units

WGDEEP 2006 indicated: 'There is currently no evidence of genetically distinct populations within the ICES area. However, ling at widely separated fishing grounds may still be sufficiently isolated to be considered management units, i.e., stocks, between which exchange of individuals is limited and has little effect on the structure and dynamics of each unit. It was suggested that Iceland (Division 5.a), the Norwegian Coast (Subarea 2), and the Faroes and Faroe Bank (Division 5.b) have separate stocks, but that the existence of distinguishable stocks along the continental shelf west and north of the British Isles and the northern North Sea (Subareas 4, 6, 7 and 8) is less probable. Ling is one of the species included in a recently initiated Norwegian population structure study using molecular genetics, and new data may thus be expected in the future'.

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

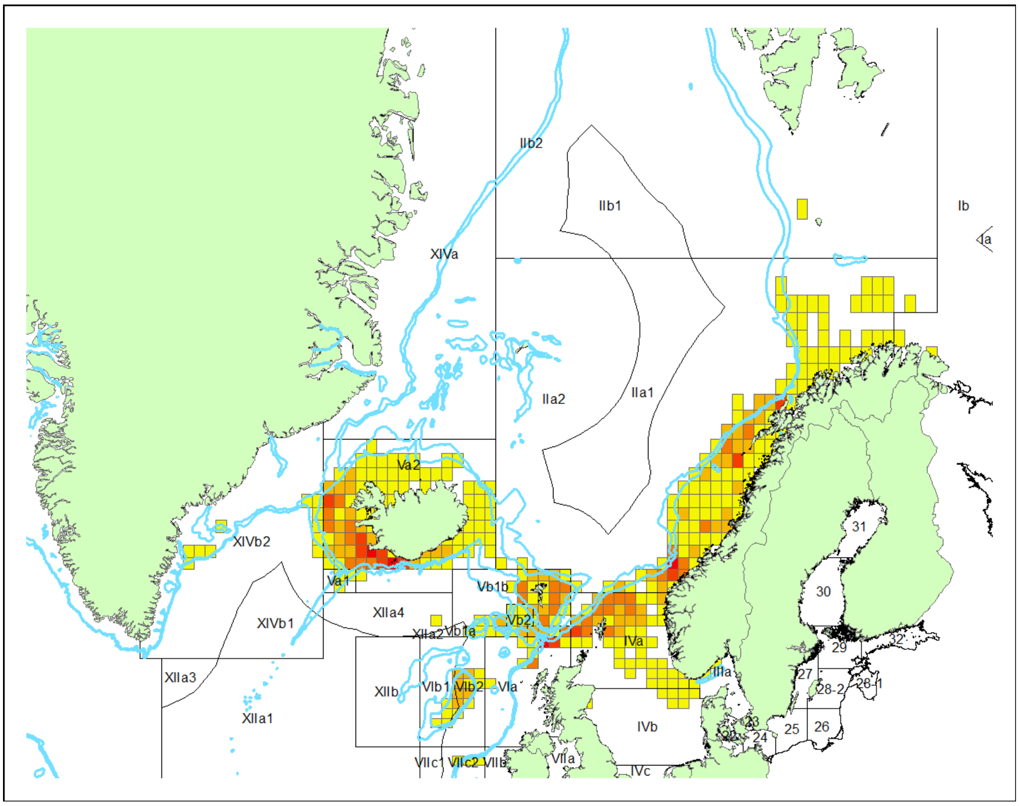

Figure 3.1. Map of fishery distribution (catches) in 2013 (data from Iceland, Faroes and Norway).

A study on population genetic structure of ling in the Northeast Atlantic rejected the hypothesis of a single ling stock in the Northeast Atlantic, and rather suggest the existence of two or more groups, with the main grouping represented by a western (Rockall and Iceland) and an eastern group (Faroe Bank, Norway) (Gonzales *et al.*, 2015). Significant genetic differences coincide with an expanse of deep water that probably limits connectivity facilitated by migration. Retention in gyres and directional oceanic circulation may also prevent drift and admixture during planktonic life stages. On the other hand, the apparent absence of genetic differentiation within the eastern part of the distribution range indicates gene flow, perhaps by larval drift and migration, over considerable distances.

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

3.1.1 References

Blanco Gonzalez, E., Knutsen, H., Jorde, P. E., Glover, K. A., and Bergstad, O. A. 2015. Genetic analyses of ling (*Molva molva*) in the Northeast Atlantic reveal patterns relevant to stock assessments and management advice. – ICES Journal of Marine Science, 72: 635–641.

3.2 Ling (*Molva molva*) in Division 5.b

3.2.1 The fishery

General description of the fishery in Faroese waters is presented in the stock annex. Ling is mainly caught by longliners. Trawlers catch it as bycatch in the saithe fishery. In 2022 the fleet which is comprised of longliners and trawlers were mainly fishing on the slope on the Faroe Plateau and somewhat to the South East on the Faroe Bank and Wyville-Thomson Ridge (Figure 3.2.1). In recent years, foreign catches are mainly caught by the Norwegian longliners.

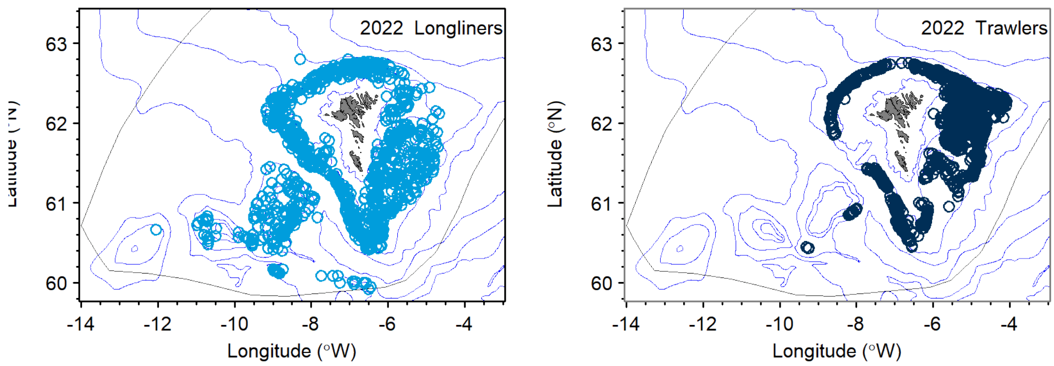

Figure 3.2.1. Ling in 5.b. Spatial distribution in 2022 of the Faroese longliner fishery (left) and pair trawler fishery (bycatch in saithe fishery, right).

3.2.2 Landings trends

Landing statistics for ling by nation for the period 1988–2022 are given in Tables 3.2.1–3.2.3 and total landings data since 1904 are available and shown in Figure 3.2.2. The history of the fishery is described in the stock annex.

Total landings in Division 5.b have in general been very stable since the 1970s varying between around 4000 and 7000 tonnes. From 1990–2005 around 20% of the catch was fished in area 5.b2, and in the period 2006–2021 it has decreased to around 10%. In 2022, 19% of the catch was fished in 5.b2. Preliminary landings of ling decreased in 2022 to 6843 tons of which the Faroes caught 83%. Foreign catches were low between 2011 and 2013 due to no bilateral agreement on fishing rights between the Faroes, Norway and EU.

Around 50–75% of the ling in 5.b was caught by longliners and the rest mainly as bycatch by trawlers (25–40%) (Table 3.2.4).

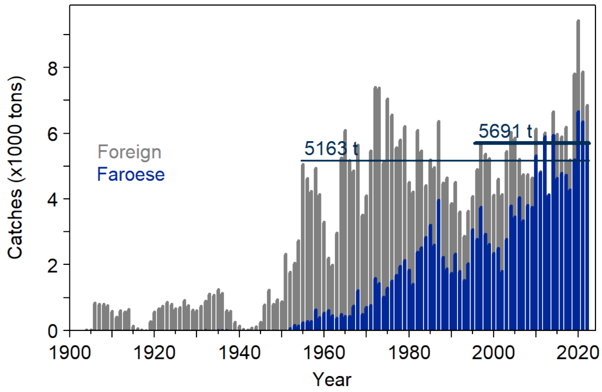

Figure 3.2.2. Ling in 5.b. Total international catches since 1904. Mean catches since 1955 were around 5160 tons. Catches in the assessment period since 1996 were approximately 5700 tons.

3.2.3 ICES Advice

ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 3552 tonnes. All catches are assumed to be landed. ICES is not in a position to advice on the corresponding level of fishing effort.

3.2.4 Management

For the Faroese fleets, there is no species-specific management of ling in 5.b although there is a licensing scheme and effort limitations. 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. Other nations fishing ling in Division 5.b are regulated by TACs. The recommended minimum landing size for ling is 60 cm (total length) which is not enforced due to the discard ban. Regulation is set for juvenile catch and a maximum of 25% of the ling catch (per settings/hauls) can be juveniles e.g., smaller than 75 cm.

Since 1977 a bilateral agreed quota exists between Norway and Faroe Islands except for 2011–2013. For 2023, catches by Norway are as follows; 3000 tons ling/blue ling, 1500 tons tusk and 800 tons of other species as by-catch in the bottom fishery in Faroese waters.

In 2023, the Faroese Government will allow 5 Russian vessels to undertake experimental fishing in the Faroese Fishing Zone at depths deeper than 700 meters provided that a Russian scientific observer is onboard. No more than 3 vessels can simultaneously be operating. 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.

In 2023, a bilateral agreement between the Faroes and UK allows a catch of 225 tonnes of blue ling/ling in the Faroese fishing zone.

The EU regulation of fishing opportunities for 2023 has a table for ling and blue ling in Faroese waters of 5.b. The EU quota is set to zero catches.

Since 2021 (Brexit), the TAC of 32 tonnes in UK Subarea 5 (UK and international waters) has been divided between EU an UK with 26 tonnes and 6 tonnes, respectively.

3.2.5 Data available

Data on length, gutted weight and age are available for ling from the Faroese landings and Table 3.2.5 give an overview of the level of sampling since 1996.

There are also catch and effort data from logbooks for the Faroese longliners and trawlers. In addition, there are data available on catch, effort, and some mean lengths from Norwegian longliners fishing in Faroese waters. In 2022, one sample of 39 length and weight measurements (113 kg) from Scottish trawlers was derived from InterCatch.

From the two annual Faroese groundfish surveys on the Faroe Plateau targeting cod, haddock and saithe, biological data (mainly length and round weight, Table 3.2.6) as well as catch and effort data are available. Data of ling larvae from the annual 0-group survey on the Faroe Plateau has also been investigated.

3.2.5.1 Landings and discards

Landing data is available for all relevant fleets. No estimates of discards of ling are available. But since the Faroese fleets are not regulated by TACs and there 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.

3.2.5.2 Length compositions

Length composition data is available from Faroese commercial longliners and trawlers and from two groundfish surveys (Figures 3.2.3–3.2.5).

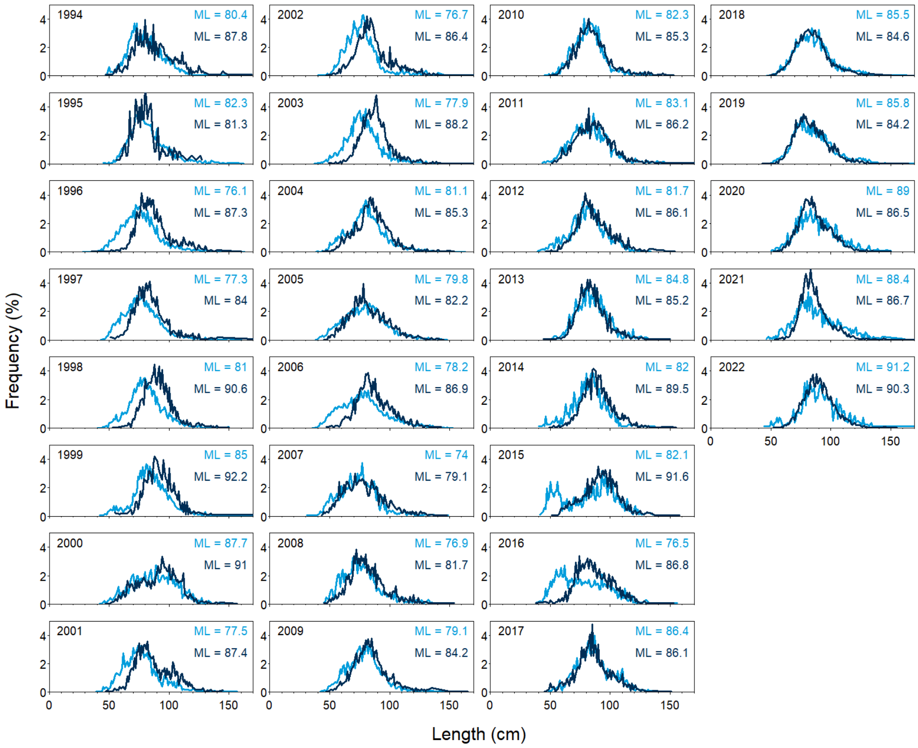

Figure 3.2.3. Ling in 5.b. Length frequencies from the landings of ling from Faroese longliners (>110 GRT, turquoise line) and Faroese trawlers (>1000 HP, dark blue line) (1994-2022). ML- mean length.

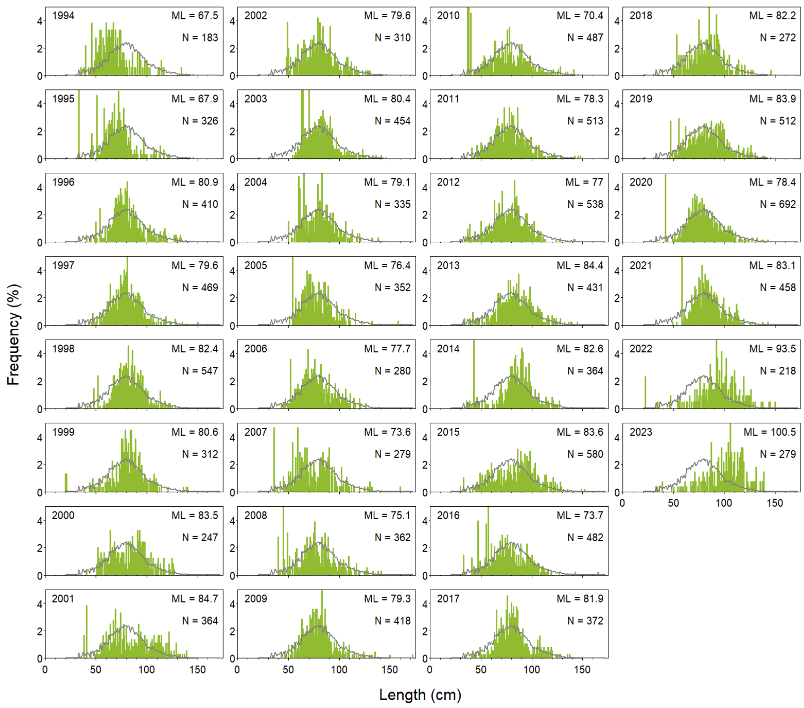

Figure 3.2.4. Ling in 5.b. Length frequencies from the groundfish spring survey (1994-2023). ML- mean length, N–number of calculated length measurements, grey line- mean of all years. Small individuals are often sampled from a subsample of the total catch and scaled up to total catch.

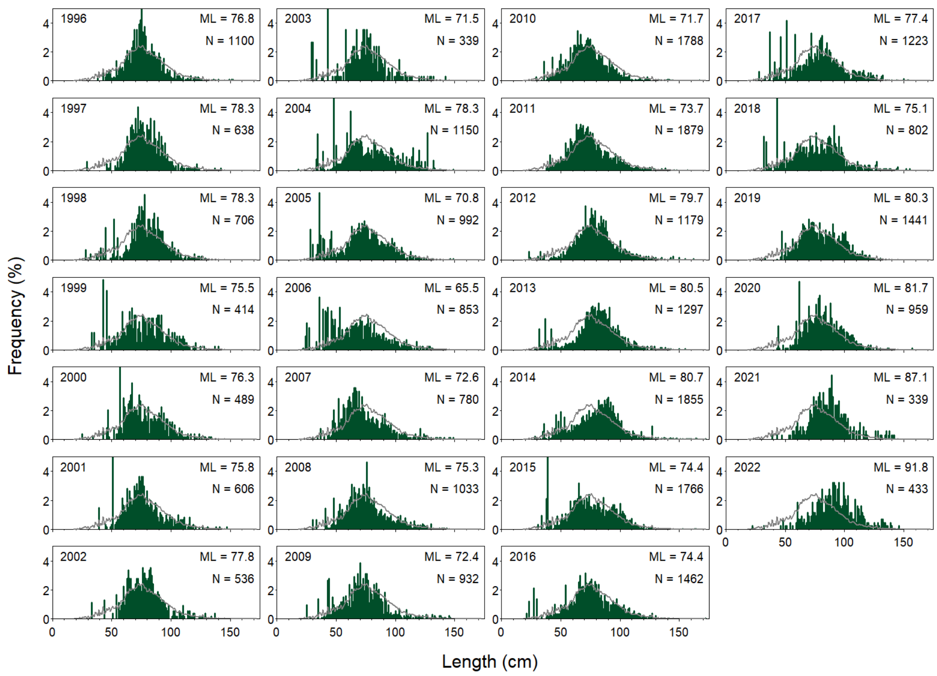

Figure 3.2.5. Ling in 5.b. Length frequencies from the groundfish summer survey (1996-2022). ML- mean length, N–number of calculated length measurements, grey line- mean of all years. Small individuals are often sampled from a subsample of the total catch and scaled up to total catch.

3.2.5.3 Catch-at-age

Catch-at-age data are available from the Faroese fishery in 5.b since 1996. In 2020, a new ALK-program was used to calculate catch number at age (see ICES, 2021, Stock annex). The most frequent age classes in the landings are 5-9 years old (Figure 3.2.6 and Table 3.2.7). Consistency plots of the catch at age data is shown in Figure 3.2.7.

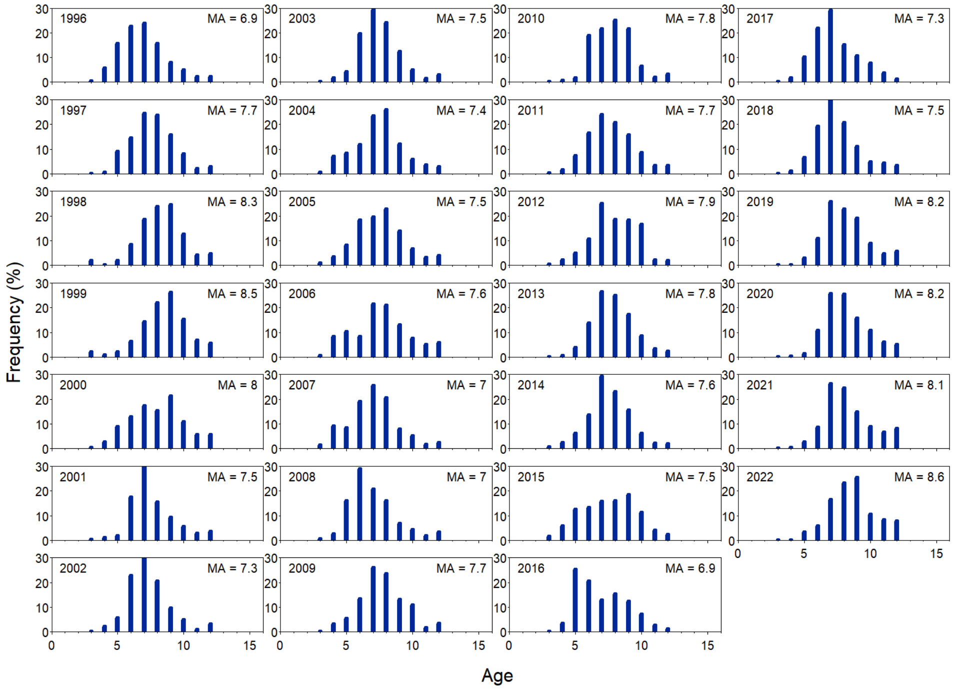

Figure 3.2.6. Ling 5.b. Catch-at-age from the commercial fleets in the assessment (1996-2022). MA- mean age.

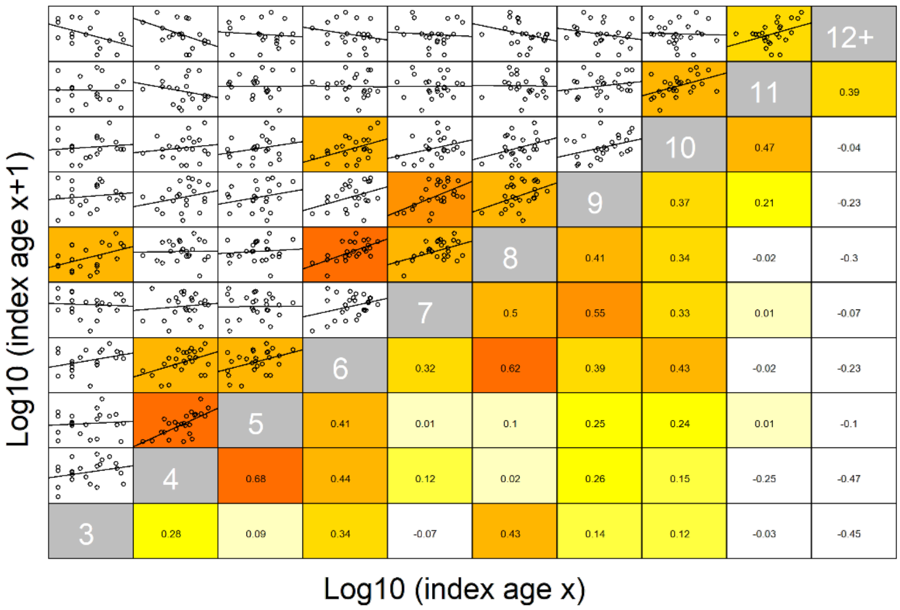

Figure 3.2.7. Ling 5.b. Consistency plots of catch-at-age used in the assessment.

3.2.5.4 Weight-at-age

Mean weight-at-age data from the landings in 5.b is available (Stock annex, ICES, 2021). There are no long-term trends in the mean weights over the period (Figure 3.2.8 and Table 3.2.8).

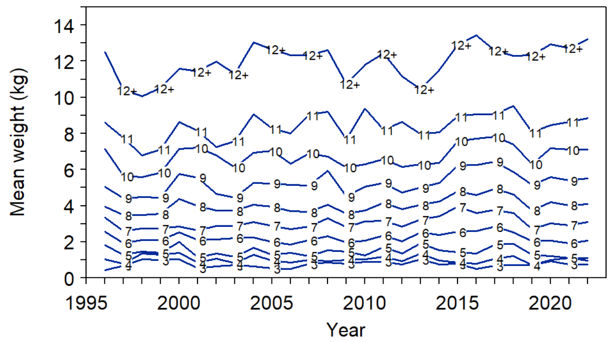

Figure 3.2.8. Ling in 5.b. Mean weight-at-age in the catches (1996-2022).

3.2.5.5 Maturity and natural mortality

Fixed proportion mature at age used in the assessment is presented in the table below. More information of this and maturity ogives of ling are presented in the stock annex.

Age	3	4	5	6	7	8	9	10	11	12+
Prop. mature	0.00	0.04	0.19	0.50	0.79	0.93	0.98	1.00	1.00	1.00

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. That is the same as used for ling in Division 5.a.

3.2.5.6 Catch, effort and research vessel data

Commercial CPUE series

Catch per unit of effort (CPUE) data is available from three commercial series; the Faroese longliners, the Faroese pair trawlers (bycatch in saithe fishery) and Norwegian longliners fishing in Division 5.b. Although no obvious problems were detected in the commercial tuning series, in terms of series trends or problems arising from aggregating fish or fishery targeting, the WKBARFAR benchmark decided not to use the commercial series in the tuning of the assessment model (ICES, 2021). The CPUE series of the Faroese fishery are described in stock annex for ling in 5b whilst the standardized CPUE data from Norwegian longliners operating in Division 5.b are described in the stock annex for ling in 2.a (Section ling in 1 and 2).

Fisheries-independent CPUE series

Survey biomass indices (kg/h) for ling are available from the annual groundfish trawl surveys on the Faroe Plateau targeting cod, haddock, and saithe. The spring survey takes place in February/March (ICES acronym: G1264) while the summer survey is conducted in August (ICES acronym: G3284). Both surveys cover the main fishing grounds and most of the stock spatial distribution in Faroese waters. More detailed information on the surveys and standardization of the data are described in the stock annex. WKBARFAR benchmark adopted both the spring- and summer groundfish surveys as a tuning series of the assessment model (ICES, 2021).

3.2.6 Data analyses

Mean length in the length composition from commercial catches from Faroese longliners and trawlers showed an increase in mean length for both longline and trawl from 74–79 cm in 2007 to around 83–86 cm in 2010 to 2021 and increased to around 90-91 cm in 2022 (Figure 3.2.3). Length composition data are similar in both Faroese trawlers and longliners. Mean length from 2003 to 2009 from the Norwegian longline fleet in Faroese waters was estimated at 87 cm.

Length composition from the two groundfish surveys on the Faroe Plateau shows high interannual variation in mean length. The length varies from 65 to 85 cm which may partly be explained by occasional high abundance of individuals smaller than 60 cm (Figures 3.2.4–3.2.5). The mean length in the surveys have increased by 7-10 cm each year since 2021 (83-83 cm) to spring 2023 (100 cm), indicating missing recruitment.

3.2.6.1 Fluctuations in abundance

Faroese longline CPUE series and trawl bycatch CPUE series showed an increasing trend since around 2001 to a maximum in 2019 (144 kg/1000 hooks, 73 kg/hour), where the longline series started to decrease to 70 kg/1000 hooks in 2022 whereas the trawler bycatch series was still around maximum level (Figure 3.2.9). Norwegian longline series display an overall increase from 50 kg/1000 hooks in 2004 to the highest value of 216 kg/1000 hooks in 2017 and it has decreased to around 160 kg/1000 hooks in 2022 (Figure 3.2.9). It must be noted that there are less than 100 fishing days from Norwegian longliners in Faroese waters in 2009–2014.

The two survey abundance series indicate a stable situation from the late 1990s and an increase to a higher level since 2010, but they have overall decreased since 2020 (Figure 3.2.10).

A size-based recruitment index is compiled for individuals smaller than 40 cm (Figure 3.2.13). The index indicates high recruitment in the period 2013-2018. There has been a decrease since 2016 and has been on a very low level since 2019 in both surveys. In addition, another recruitment index is calculated based on small juveniles (2–3 cm in length) from the annual 0-group survey on the Faroe Plateau since 1983. The index also showed indications of high recruitment in some years (Figure 3.2.12). No juvenile ling individuals are found in the 0-group survey since 2020.

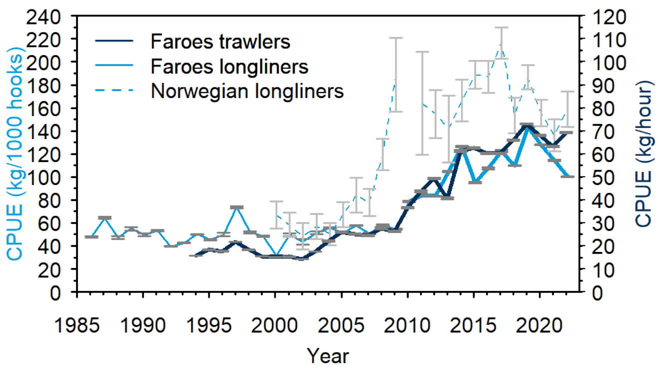

Figure 3.2.9. Ling in 5.b. Standardized CPUE from Faroese pair trawlers (bycatch, dark blue line), Faroese longliners (turquoise line) and Norwegian longliners (turquoise stippled line) fishing in Faroese waters. Data from Faroese trawlers are from hauls where ling was caught and saithe >60% of the total catch. Data from Faroese longliners (>110 GRT) are from sets where ling >30% of the total catch. The error bars show SE. Vertical bars display 95% confidence intervals in the Norwegian data.

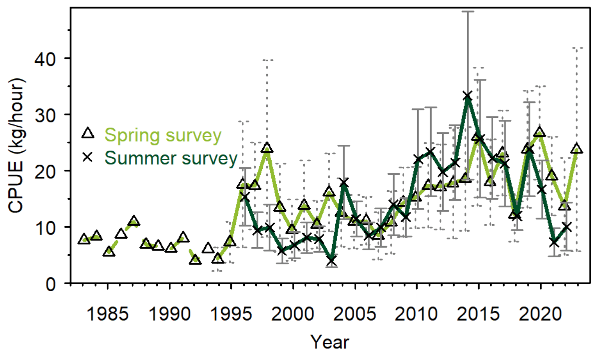

Figure 3.2.10. Ling in 5.b. Standardized CPUE (kg/hour) from the two annual Faroese groundfish surveys on the Faroe Plateau with standard errors. The data for 1983–1993 were not standardized.

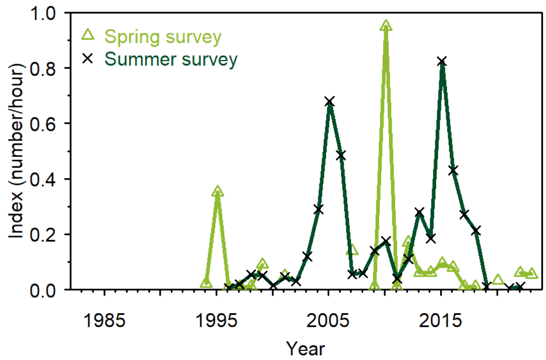

Figure 3.2.11. Ling in 5.b. Index (number/hour) of ling smaller than 40 cm from the spring- and summer survey on the Faroe Plateau.

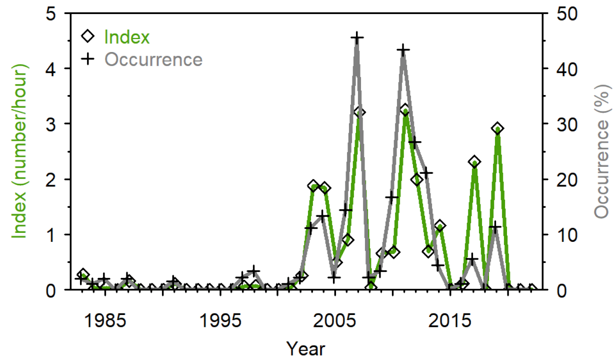

Figure 3.2.12. Ling in 5.b. Index (number/hour) and occurrence (%) of ling (2–3 cm in length) caught in the annual 0-group survey on the Faroe Plateau.

3.2.6.2 Stock assessment

Ling in 5b was updated to Category 1 using SAM as the basis for advice at the WKBARFAR benchmark in 2021 (ICES, 2021 and stock annex).

Analytical assessment using SAM

The input for the SAM model was catch at age for ages 3 to 12+ and for years back to 1996. Maturity at age is compiled from the Faroese survey data and it is fixed for the assessment period. Natural mortality is set to 0.15 for all ages and years. The age-disaggregated tuning series were the Faroese summer survey, ages 3 to 11 (1996-2022) and the Faroese spring survey, ages 4 to 11 (1998-2022). The SAM model configuration settings are described in detail in the stock annex.

Age disaggregated indices from the spring- and summer surveys are presented in Table 3.2.9 and 3.2.10. They show periods of good year classes around 2015. Indications of good year classes were also confirmed in the 0-group survey (Figure 3.2.12). In 2022, these good year classes are at an age that decrease in the fishery and it seems like the recruitment is at a low level.

Stratified catch rates (kg per hour) show increased levels from 2010 to 2019 in both surveys. The index has decreased from 2020 to 2021 and has increased in the latest years (Figure 3.2.10). The internal consistency of the summer survey measured as the correlation between the indices for the same year class in two adjacent years is good, with r^2 ranging from 0.5 to 0.7 for the best-defined age groups (Figure 3.2.13). The internal consistency of the spring index is overall inferior to that of the the summer index (Figure 3.2.14). Ling is fully recruited to the survey at around age 5.

The results and diagnostics of the final assessment **lin.27.5b_wgdeep2023_final** (stockassessment.org) are presented in Tables 3.2.11-3.2.14 and Figures 3.2.15-3.2.19.

Results from the adopted SAM assessment shows that the spawning stock biomass (SSB) has been the largest from 2017 to 2021 although it has decreased from around 25 000 tonnes in 2020 to around 15 000 tonnes in 2022 (Figure 3.2.15, Tables 3.2.11, 3.2.13). Fishing mortality ($F_{6\text{-}10}$) has fluctuated around the historical average ($F_{6\text{-}10}$=0.4). It decreased to levels closed to F_{MSY} in 2017 and 2018 as a consequence of lower catches. It is estimated to $F_{6\text{-}10}$=0.5 in 2022 (Figure 3.2.15, Tables 3.2.11, 3.2.12).

Fishing pressure on the stock is above F_{MSY} but below F_{pa} and F_{lim}; spawning-stock size is below MSY $B_{trigger}$ and between B_{pa} and B_{lim}.

The model diagnostics are shown as model fits to the data (Figure 3.2.16), residuals (Figure 3.2.17), leave-one-out analysis (Figure 3.2.18), retrospective analysis (Figure 3.2.19) and parameter estimates (Table 3.2.14). Overall, it seems that the model fits the data reasonably well. Model residuals are randomly distributed and the leave one out analysis shows that the model is robust. The retrospective pattern shows that F is underestimated and SSB subsequently overestimated. The recruitment was very overestimated in the last years (Figure 3.2.19). Almost all the retrospective runs fall within the confidence intervals of the final assessment. Mohn's rho parameters are estimated at 2%, 6% and 108% for the spawning stock biomass, F and recruitment, respectively.

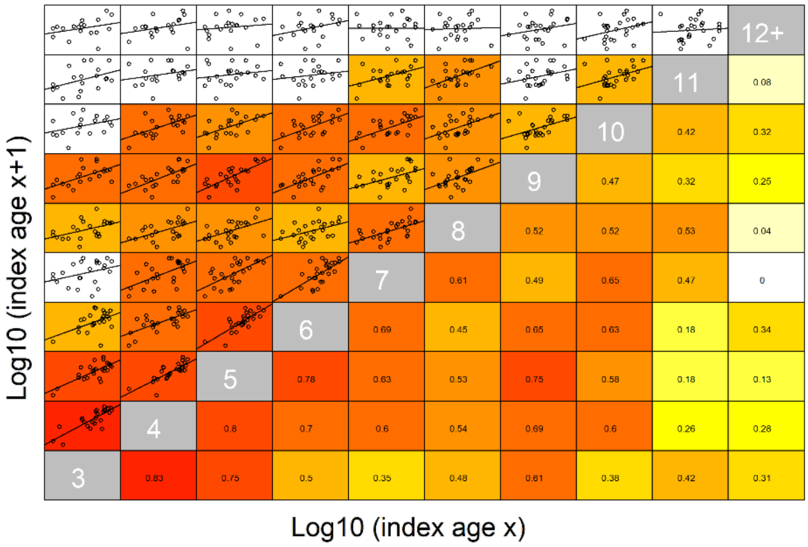

Figure 3.2.13. Ling in 5.b. Consistency plot of catch-at-age in the summer survey tuning series in the assessment.

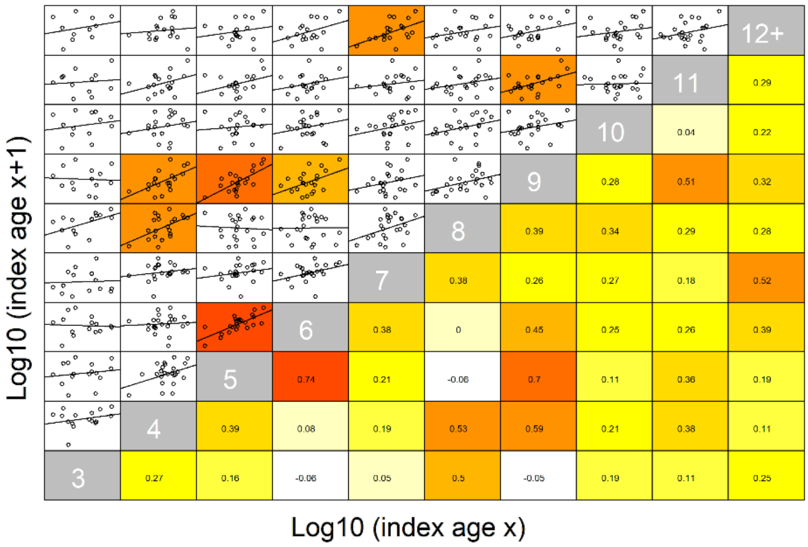

Figure 3.2.14. Ling in 5.b. Consistency plot of catch-at-age in the spring survey tuning series in the assessment.

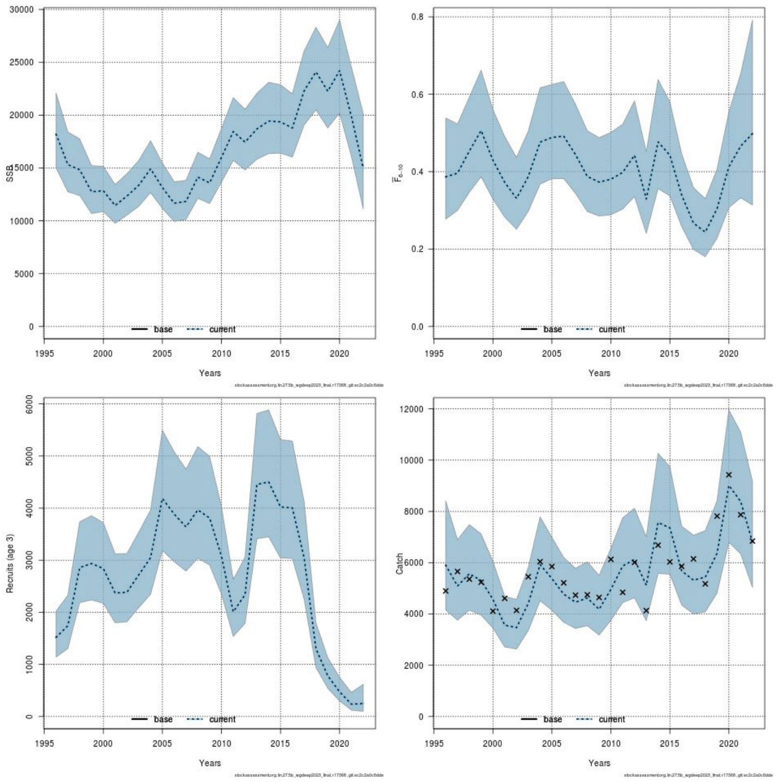

Figure 3.2.15. Ling in 5.b. Output from SAM. Results per year for spawning stock biomass (tonnes, upper left), fishing mortality (F_{6-10}, upper right), recruitment (age 3, thousands, lower left) and catch (tonnes, lower right). Stippled line is median, shaded area is 95% CI and x- is actual catch.

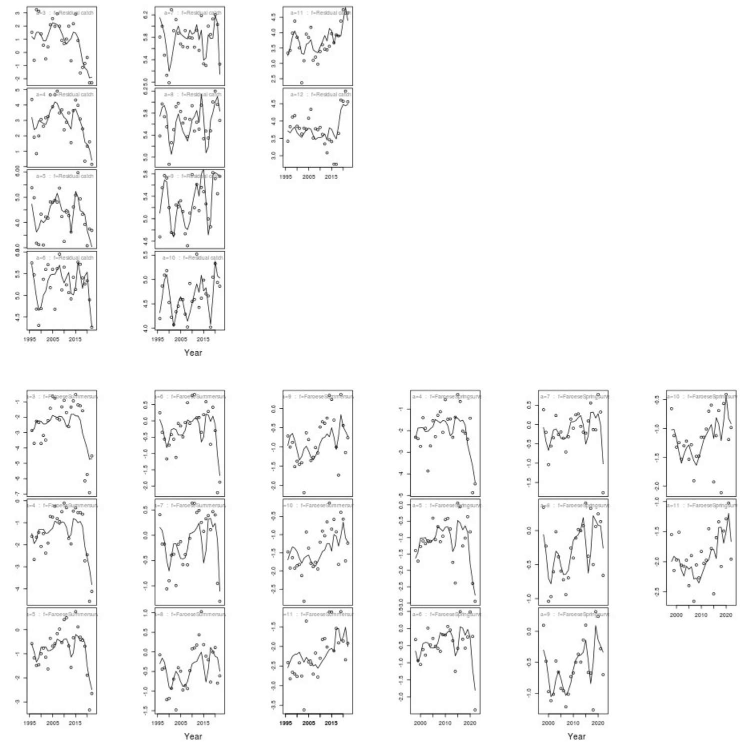

Figure 3.2.16. Ling in 5.b. Output from SAM. Model fit of data; catch (upper left), summer survey (lower left) and spring survey (lower right).

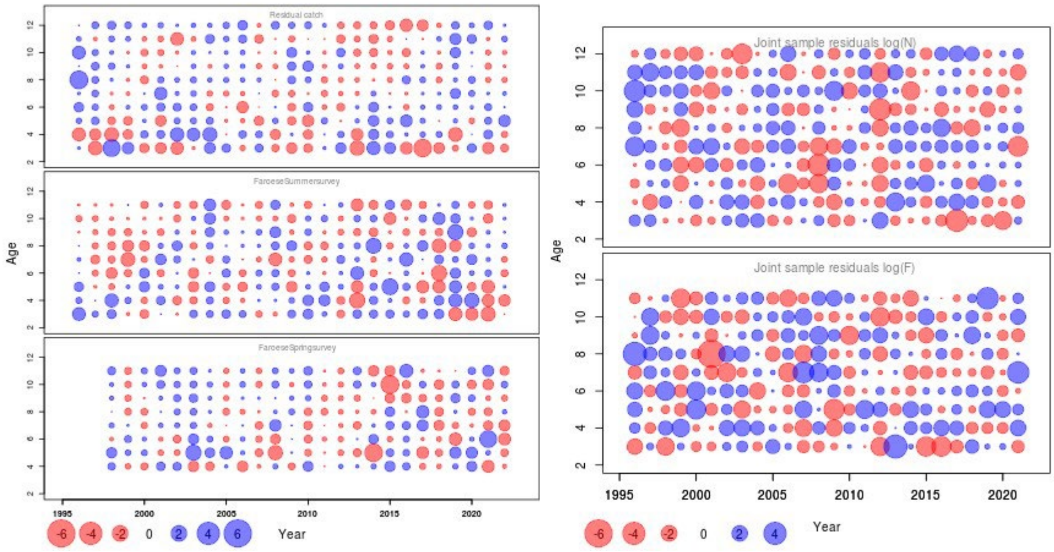

Figure 3.2.17. Ling in 5.b. Output from SAM. Model residuals (left) and process errors (right).

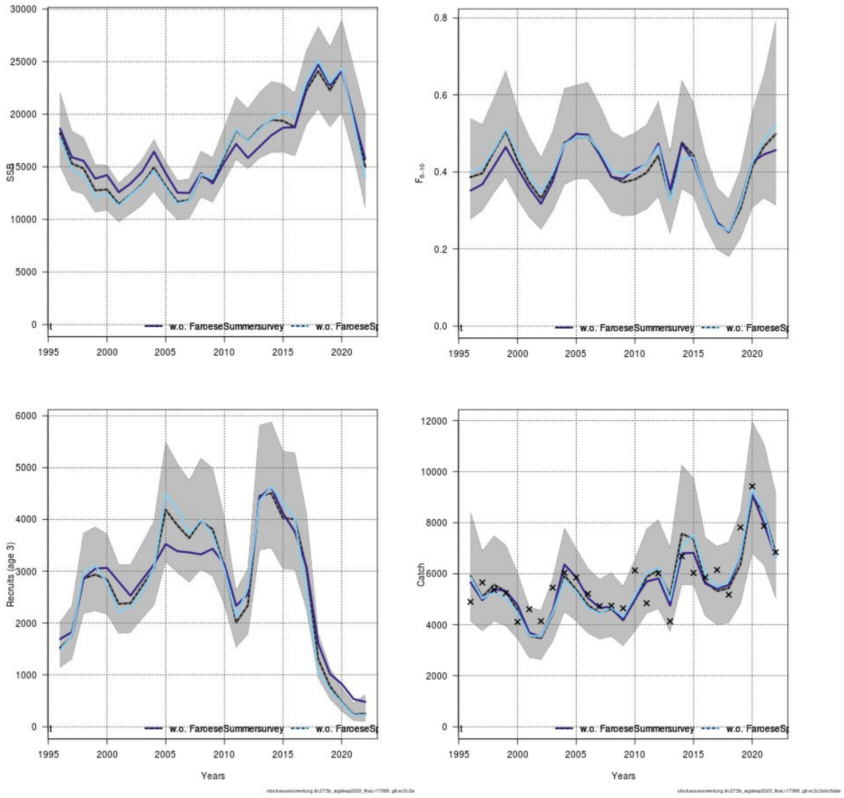

Figure 3.2.18. Ling in 5.b. Output from SAM. Leave-one-out analysis of SSB (upper left), fishing mortality (upper right), recruitment (lower left) and catch (lower right).

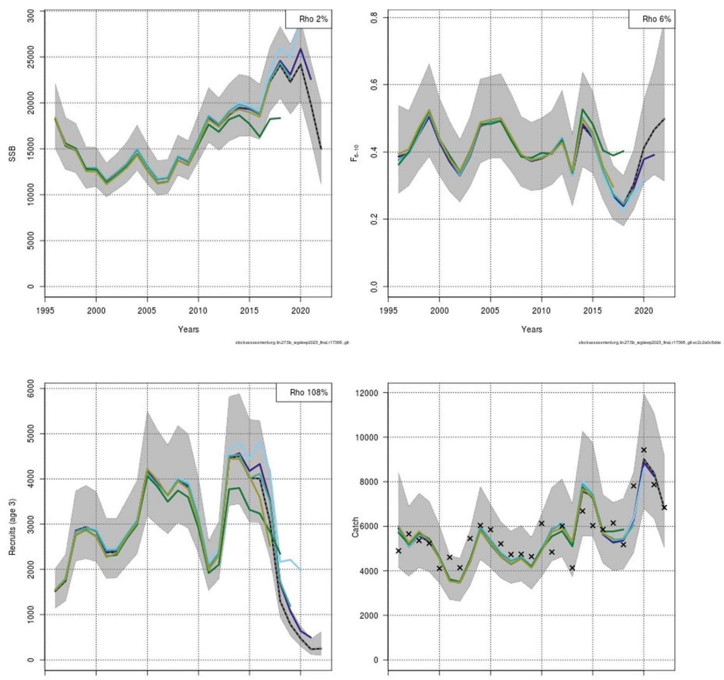

Figure 3.2.19. Ling in 5.b. Output from SAM. Retrospective analysis of SSB (upper left), fishing mortality (upper right), recruitment (lower left) and catch (lower right).

3.2.6.3 Quality of the assessment

Ling 5.b was benchmarked in 2021 (ICES, 2021), where the assessment was upgraded from a trend-based assessment (Category 3) to the SAM state-space model. A comparison between the assessments of WGDEEP 2022 and WGDEEP 2023 indicates that the model results are comparable, although recruitment was estimated quite a bit lower in 2023. Both SSB and TSB was estimated lower in 2023 and F are estimated higher at WGDEEP 2023 than in the 2022 assessment. Though, these values are still inside the 95% CI.

A small correction of the catch number at age in the summer survey tuning series was done for the years 2019, 2020 and 2021 at the WGDEEP 2023 and it had minor importance on SSB and F results in SAM (ling5b_2023_test in stockassessment.org).

3.2.7 Short-term prediction

Settings for the short-term forecast are presented in the stock annex and the output in **lin.27.5b_wgdeep2023_final** (stockassessment.org).

3.2.7.1 Input data

The assumptions made for the interim year and in the forecast are presented in the table below. The resampling of median recruitment was changed to 5 years instead of 25 years at WGDEEP 2023, as ADGDEEP recommended to use a shorter period because of low recruitment. The most resent recruitment datapoint was excluded because it was considered very inaccurate.

Variable	Value	Notes
$F_{ages\ 6–10}$ (2023)	0.498	$F_{sq} = F_{2022}$
SSB (2024)	6409	Short-term forecast fishing at F_{sq}; tonnes.
$R_{age\ 3}$ (2023/2024)	782	Median recruitment, resampled from the years 2017–2021; Thousands.
Total catch (2023)	4497	Short-term forecast using F_{sq}; Tonnes.

3.2.7.2 Results

The F=0 was used at WGDEEP 2023 because the SSB had high risk (75% probability) to be below B_{lim} in year 2025, so the results of short-term forecast using F=0 including confidence intervals (low and high columns) is presented in the Table below. According to the short term forecast with the F=0 advised, catches are projected to 0 tonnes in 2024, resulting in an SSB in 2024 of 6409 tonnes, when assuming a recruitment of 782 thousands in 2023 and 2024. Under these conditions, SSB will in 2025 be at 7523 tonnes, in 2026 at 9054 tonnes (almost at B_{lim}) and in 2027 at 10870 tonnes (above B_{lim}).

Catch options for scenarios with F_{MSY}, F_{pa}, F_{lim}, F_{sq} and F = 0 is presented in Table 3.2.15.

Year	F_{6-10}			Recruitment (thousands)			SSB (tonnes)			Catch (tonnes)			TSB (tonnes)		
	Median	Low	High	Median	Low	High	Median	Low	High	Median	Low	High	Median	Low	High
2022	0.498	0.317	0.765	254	101	651	15136	11378	20560	6668	4995	8887	17021	12921	23003
2023	0.498	0.317	0.765	782	238	3048	10023	6128	15263	4497	3385	5931	12007	7556	17929
2024	0	0	0	782	238	3048	6409	3111	11186	0	0	0	8948	4869	14361
2025	0	0	0	782	238	3048	7523	3846	12881	0	0	0	10822	6382	17073
2026	0	0	0	782	238	3048	9059	4985	14779	0	0	0	13049	7473	20152
2027	0	0	0	782	238	3048	10870	6005	17188	0	0	0	14963	8717	23240

3.2.8 Reference points

Biological reference points for ling in 5.b are shown in the Table below. Description of the reference points calculation is given in the stock annex and in ICES, 2021. In 2021 the definition of F_{pa} of 0.62 was changed to be the same as $F_{p0.5}$.

$MSY_{Btrigger}$	5thPerc_SSB_{msy}	B_{pa}	B_{lim}	F_{pa}	F_{lim}	F_{p05}	$F_{msy\_unconstr}$	F_{MSY}
11627	21707	11627	9340	0.6	0.85	0.6	0.23	0.23

3.2.9 Comments on assessment

All signals from the commercial catches and also surveys indicate that ling stock in Division 5.b at present is in a state with very low recruitment, and this is also confirmed in the assessment. The substantial drop in recruitment since 2016 suggests that the stock will probably decline below B_{lim} in coming years.

3.2.10 Management consideration

Stability in landings and abundance indices do suggest that ling stock in Division 5.b has been stable since middle of the 1980s, with an increasing trend in biomass in the last decade. The available data series does not cover the entire period of the fishery (back to the early 1900s; see Figure 3.2.3) and no information is available on stock levels prior to 1986. There is evidence of increased recruitments in last decade compared to earlier, but there has been a drop in recruitment since 2016 so the stock will probably decline in coming years (Figure 3.2.15).

The only species-specific management in effect for Faroese fisheries of ling in Division 5.b is the recommended minimum landing size (60 cm). But this seems not to be enforced because of the general discard ban. Up to 25% of ling catches (per settings/hauls) can be juveniles i.e., smaller than 75 cm.

The exploitation of ling is influenced by regulations aimed at other groundfish species, i.e., cod, haddock, and saithe, such as closed areas. Fisheries by other nations are regulated by TACs.

The Faroese effort management system introduced in 1996 is in force for the demersal fleets operating on the Faroe Plateau. A preliminary management plan using a harvest control rule was adopted by the Faroese fisheries authorities in 2020 and applied for the first time for the calendar year 2021. The number of fishing days was decided according to the stock status of cod, haddock, and saithe. Although the management plan opens up for the development of special bycatch rules, this has not yet been integrated. The management plan has not been evaluated by ICES.

3.2.11 Ecosystem considerations

Since on average 67% of the catches are taken by longlines, the remaining by trawls, the effects of the ling fishery on the bottom fauna and benthic ecosystem are moderate (Table 3.2.4).

3.2.12 Future research and data requirements

The aim is to collect enough of individual age and maturity samples to cover both the Faroese spring- and summer surveys, especially from the smallest and largest individuals.

3.2.13 References

ICES. 2017. ICES fisheries management reference points for category 1 and 2 stocks. ICES Advice Technical Guidelines. DOI:10.17895/ices.pub.3036

ICES. 2021. Benchmark Workshop for Barents Sea and Faroese Stocks (WKBARFAR 2021). ICES Scientific Reports. 3:21. 205 pp. https://doi.org/10.17895/ices.pub.7920

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3.2.14 Tables

Table 3.2.1. 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		0	13	5983

Year	Denmark[(2)]	Faroes	France	Germany	Norway	E&W[(1)]	Scotland [(1)]	Russia	Total
2015		4375	16		993	1	0	6	5391
2016		4214	8		855	0	103		5180
2017		4371	4		864		54		5294
2018		3836	2		793		42		4673
2019		4862	25		1983		27		6895
2020		5642	16		2537		83		8277
2021		5074	11		1444		0		6529
2022*		4503	3		895		113		5513

***Preliminary.**

(1) Includes 5.b2.

(2) Greenland 2006–2013.

Table 3.2.2. Ling in 5.b2. Nominal landings (1988–present).

Year	Faroes	France	Norway	Scotland	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

Year	Faroes	France	Norway	Scotland	Total
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	7	672
2015	244	1	337	3	585
2016	569	4	126	11	710
2017	359		542		901
2018	428		78	6	512
2019	338		580	2	920
2020	1015		128	6	1149
2021	1268		72		1340
2022*	1200		89	40	1330

***Preliminary.**

Table 3.2.3. 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

Year	5.b1	5.b2	5.b
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	5983	672	6655
2015	5391	585	5976
2016	5180	710	5890
2017	5294	901	6195
2018	4673	512	5185
2019	6895	920	7816
2020	8277	1149	9427
2021	6529	1340	7869
2022*	5513	1330	6843

***Preliminary.**

Table 3.2.4. Ling in 5.b. Catch distribution by fleet and total catch in 1996 to 2021. * preliminary catch.

Year	Trawl (%)	Longline (%)	Other (%)	Total catch (tonnes)
1996	31	68	1	4896
1997	37	62	1	5657
1998	39	61	0	5359
1999	37	62	1	5238
2000	42	57	1	4109
2001	37	61	1	4609
2002	41	57	1	4139
2003	33	65	2	5453
2004	25	73	1	6039
2005	27	72	1	5849
2006	24	75	1	5213
2007	33	66	1	4731
2008	24	75	1	4747
2009	27	72	1	4643
2010	23	76	1	6129
2011	29	71	1	4843
2012	30	70	0	6011
2013	29	70	0	4132
2014	28	72	0	6684
2015	42	58	0	6031
2016	37	62	1	5857
2017	31	69	0	6148
2018	34	66	0	5185
2019	39	61	0	7816
2020	31	69	0	9427
2021	23	77	0	7869
2022	22	77	1	6843*
Average	32	67	1	5691

Table 3.2.5. Ling in 5.b. Overview of the sampling from commercial landings since 1996.

	Lengths			Gutted weights			Ages		
Year	Longliners	Trawlers	Other	Longliners	Trawlers	Other	Longliners	Trawlers	Other
1996	5003	1426	48	290	120	0	709	375	0
1997	6493	1407	0	361	180	0	1195	331	0
1998	4163	1651	193	180	358	0	723	358	0
1999	3024	1067	445	180	120	60	240	180	60
2000	1719	1793	0	120	240	0	120	240	0
2001	2243	1562	0	180	240	0	180	240	0
2002	1845	2454	0	60	120	0	120	180	0
2003	4533	2052	0	120	240	0	421	240	0
2004	4350	2477	0	990	179	0	480	179	0
2005	4995	2172	0	3097	120	0	420	120	0
2006	4936	1291	0	3576	1082	0	157	119	0
2007	2077	1662	172	1034	447	172	60	60	0
2008	1432	1087	0	1215	730	0	60	0	0
2009	2127	2246	0	2102	2246	0	112	120	0
2010	1421	2502	422	1421	2436	422	60	120	0
2011	1438	1765	202	1438	1188	202	0	0	0
2012	1413	1397	0	1283	1164	0	50	0	0
2013	1040	1437	0	1040	1036	0	0	0	0
2014	827	1953	205	827	1242	205	0	20	0
2015	820	1724	0	820	1351	0	40	170	0
2016	1432	1329	0	1432	928	0	180	180	0
2017	1201	1776	0	1201	1225	0	239	241	0
2018	2717	4726	0	2717	4726	0	659	1013	0
2019	2890	3576	0	2890	3576	0	300	592	0
2020	1276	2698	0	705	1911	0	360	569	60
2021	1220	3002	0	1220	3002	0	414	840	0
2022	817	3551	0	817	3551	0	298	760	0

Table 3.2.6. Ling in 5.b. Overview of the sampling from spring-, summer and other surveys since 1996. * Have gender but not maturity.

	Lengths			Round weights			Ages			Gender and maturity		
Year	Spring	Sum-mer	Other	Spring	Sum-mer	Other	Spring	Sum-mer	Other	Spring	Sum-mer	Other
1996	398	1013	235	129	216	26	0	0	11	0	0	15
1997	460	631	274	0	247	79	0	0	0	0	0	0
1998	514	648	280	190	462	173	0	0	0	230*	20	5
1999	300	372	84	252	355	62	0	0	0	248*	3	7
2000	245	433	498	244	360	313	0	0	0	14	1	0
2001	347	553	600	265	503	472	0	0	0	28	0	2
2002	285	510	542	222	477	389	0	0	0	0	0	0
2003	389	284	660	345	284	582	0	0	0	0	0	0
2004	284	857	418	284	802	345	0	0	0	0	0	0
2005	321	821	172	264	719	161	0	0	0	0	0	0
2006	271	647	220	264	612	214	0	0	0	0	1	0
2007	268	729	99	247	662	99	0	0	0	0	0	0
2008	309	973	66	208	779	65	0	0	0	0	10	0
2009	413	859	152	371	608	152	0	0	0	0	0	0
2010	395	1637	125	281	1021	125	0	0	0	0	0	0
2011	507	1826	167	411	1400	165	0	0	0	3	0	0
2012	518	1160	145	518	1109	144	0	0	0	0	0	0
2013	427	1232	120	427	1105	120	100	78	96	100	78	114
2014	336	1725	674	330	1280	658	161	195	200	177	195	206
2015	562	1440	1077	496	1043	962	92	92	234	100	91	235
2016	409	1366	550	409	1265	550	131	191	110	131	193	110
2017	372	1004	306	308	914	247	124	201	112	126	203	115
2018	265	712	682	265	687	682	228	221	343	227	222	345
2019	490	1318	465	435	1089	465	144	147	155	144	147	162
2020	649	900	274	578	884	273	181	140	99	182	140	99
2021	427	339	415	391	338	413	199	288	227	199	288	227

	Lengths			Round weights			Ages			Gender and maturity		
Year	Spring	Sum-mer	Other	Spring	Sum-mer	Other	Spring	Sum-mer	Other	Spring	Sum-mer	Other
2022	214	433	69	210	397	69	152	367	57	152	367	58
2023	192		19	192		19	150			150		19

Table 3.2.7. Ling in 5.b. Catch numbers at age (*1000) used in the assessment.

Year/Age	3	4	5	6	7	8	9	10	11	12+
1996	4.61	78.35	217.21	315.07	331.78	218.24	107.42	66.60	28.09	30.47
1997	0.55	6.75	146.07	238.84	402.52	390.43	257.69	129.96	30.65	46.49
1998	25.65	2.33	24.05	108.31	240.07	309.48	320.41	162.44	53.70	61.29
1999	22.75	7.35	22.63	74.23	167.75	257.56	306.70	178.02	79.40	63.87
2000	4.08	21.44	75.97	109.44	146.73	130.44	181.12	92.52	46.92	47.02
2001	1.72	13.75	22.35	215.75	540.89	193.18	116.06	68.42	33.26	44.27
2002	0.61	23.90	68.27	271.06	371.53	244.48	113.10	58.66	10.70	37.57
2003	1.52	25.89	64.96	302.49	453.02	371.62	189.99	76.46	21.85	44.53
2004	8.17	105.61	123.96	177.67	354.74	394.72	183.83	85.85	52.06	43.07
2005	13.02	48.96	121.94	271.20	293.16	340.27	204.43	98.64	46.65	59.31
2006	7.26	106.18	132.44	107.98	279.51	275.68	168.54	98.24	64.85	76.51
2007	18.96	134.46	122.59	276.73	372.36	299.89	113.57	72.91	22.21	33.42
2008	7.34	32.64	214.41	386.01	276.34	215.38	91.76	55.91	24.63	43.71
2009	2.49	40.18	69.00	168.71	328.79	295.46	164.51	136.75	19.61	42.54
2010	1.96	10.95	25.69	285.53	325.54	378.05	326.26	94.46	29.59	45.48
2011	2.76	17.90	82.28	189.47	276.87	238.35	180.57	98.56	36.85	37.23
2012	7.33	32.67	71.90	158.38	374.58	280.16	274.01	249.81	31.86	28.24
2013	0.53	4.75	37.42	137.06	261.82	246.96	171.52	83.66	31.18	21.83
2014	8.82	37.92	101.19	225.79	486.84	382.35	259.59	101.01	35.07	31.81
2015	18.28	75.68	161.86	170.67	205.68	207.57	240.45	146.60	52.78	30.18
2016	2.46	53.49	395.66	320.91	199.76	238.59	193.40	110.50	39.20	15.73
2017	0.21	22.12	139.53	305.36	403.18	210.10	147.90	105.84	50.66	15.70
2018	0.32	11.62	75.56	222.94	347.56	239.32	128.53	55.74	48.96	38.21

2019	0.43	1.43	50.59	193.19	458.31	405.07	337.82	155.72	79.56	100.16
2020	0.68	3.78	21.72	208.12	495.24	492.70	303.70	205.84	115.21	96.53
2021	0.10	5.02	42.28	134.06	414.55	386.18	231.97	139.74	102.93	129.46
2022	0.10	1.17	39.90	71.23	204.63	289.22	317.21	129.31	103.55	95.22

Table 3.2.8. Ling in 5.b. Weighted mean weights at age used in the assessment.

Year/Age	3	4	5	6	7	8	9	10	11	12+
1996	0.437	1.033	1.815	2.549	3.356	3.949	5.054	7.143	8.600	12.509
1997	0.689	0.772	1.271	1.932	2.602	3.487	4.427	5.643	7.740	10.415
1998	1.038	1.345	1.469	2.112	2.728	3.500	4.486	5.599	6.786	10.064
1999	0.987	1.299	1.377	2.092	2.739	3.552	4.462	5.843	7.122	10.506
2000	1.037	1.402	2.005	2.517	2.855	4.374	5.775	7.157	8.622	11.587
2001	0.549	0.858	1.154	2.093	2.651	3.983	5.555	7.207	8.136	11.429
2002	0.660	1.081	1.351	2.146	2.888	3.728	4.665	6.798	7.239	11.995
2003	0.701	0.818	1.181	2.225	2.890	3.732	4.463	6.123	7.585	11.290
2004	0.654	1.292	1.674	2.251	3.093	4.042	5.271	6.923	9.080	13.031
2005	0.528	0.964	1.300	2.006	2.890	3.950	5.241	7.034	8.270	12.661
2006	0.495	0.876	1.378	1.867	2.719	3.710	5.145	6.323	7.987	12.332
2007	0.788	1.010	1.216	2.092	2.841	3.651	5.138	6.915	9.019	12.339
2008	0.872	0.942	1.534	2.317	3.295	4.070	5.944	6.713	9.197	12.625
2009	0.796	1.006	1.462	1.965	2.830	3.556	4.514	6.124	7.682	10.750
2010	0.897	1.049	1.248	2.072	3.133	3.730	5.066	6.311	9.372	11.798
2011	0.901	1.173	1.705	2.358	3.165	4.159	5.277	6.564	8.211	12.429
2012	0.770	0.929	1.342	2.043	2.845	3.804	4.716	6.169	8.646	11.149
2013	1.036	1.352	1.912	2.519	3.238	4.048	5.013	6.282	7.947	10.466
2014	0.765	0.963	1.540	2.400	3.424	4.225	5.275	6.356	8.056	11.528
2015	0.775	0.864	1.438	2.565	3.940	4.812	6.233	7.580	8.947	12.918
2016	0.500	0.805	1.364	2.585	3.610	4.575	6.269	7.711	9.064	13.436
2017	0.672	1.085	1.867	2.846	3.763	4.952	6.445	7.821	9.049	12.586
2018	0.735	1.231	1.878	2.516	3.578	4.632	5.886	7.411	9.537	12.299
2019	0.702	0.707	1.294	2.030	2.703	3.738	5.176	6.298	8.056	12.321

2020	0.930	0.995	1.205	2.062	3.013	4.206	5.585	7.200	8.462	12.949
2021	0.757	1.096	1.114	1.943	2.926	4.039	5.394	7.108	8.649	12.734
2022	0.769	0.981	1.104	2.076	3.102	4.078	5.496	7.096	8.862	13.205

Table 3.2.9. Ling in 5.b. Spring survey input to the tuning series in the assessment.

Year	Effort/Age	4	5	6	7	8	9	10	11
1998	99	9.89	24.55	71.72	145.22	139.42	109.23	51.43	21.05
1999	100	9.32	17.96	39.25	81.76	79.70	61.73	32.54	11.70
2000	100	6.56	28.07	35.01	35.48	35.38	37.82	26.64	13.93
2001	100	24.58	33.24	54.15	57.28	37.88	32.66	28.81	22.10
2002	100	15.14	30.60	45.98	70.90	54.61	36.26	21.67	12.77
2003	100	2.10	33.42	101.31	126.24	98.29	61.98	27.26	12.56
2004	100	6.69	32.83	61.94	77.23	68.05	51.93	29.60	13.89
2005	100	21.42	66.62	75.03	82.55	55.15	39.79	21.59	9.09
2006	100	10.26	34.55	59.54	70.37	48.54	38.40	27.83	14.98
2007	100	27.50	51.54	55.93	49.14	39.00	29.58	14.88	7.01
2008	99	32.19	32.12	50.88	72.16	49.44	35.93	22.52	12.70
2009	100	12.53	38.37	83.48	115.08	77.42	48.14	22.83	10.35
2010	100	56.82	63.62	82.75	90.90	66.86	51.17	31.64	16.06
2011	102	23.41	67.54	108.40	131.17	91.45	62.01	32.31	13.43
2012	100	23.31	47.92	95.85	131.63	101.62	69.24	36.49	13.89
2013	100	9.97	17.30	70.18	95.52	99.77	60.88	49.70	23.41
2014	99	24.90	9.11	28.35	81.17	106.26	86.14	54.74	16.70
2015	96	69.48	101.31	53.80	76.77	143.87	106.13	14.00	7.62
2016	100	52.22	94.11	163.49	109.75	68.63	51.51	32.53	20.20
2017	90	11.96	25.69	65.83	157.08	124.76	45.87	45.23	23.65
2018	99	11.88	35.88	55.86	87.03	60.08	27.86	11.99	12.39
2019	100	9.12	69.58	77.89	87.17	106.18	137.35	56.81	22.55
2020	91	21.93	39.91	147.74	198.27	116.33	115.87	60.55	25.11
2021	100	0.77	9.08	79.38	138.28	114.14	75.59	30.44	35.88
2022	100	1.16	5.27	9.27	17.17	51.76	49.72	37.44	14.13

Table 3.2.10. Ling in 5.b. Summer survey input to tuning series in the assessment.

Year	Effort/Age	3	4	5	6	7	8	9	10	11
1996	200	11.38	39.70	111.95	256.77	300.86	185.77	98.00	45.83	17.95
1997	200	4.94	13.89	61.94	140.89	168.21	128.83	73.46	29.36	11.85
1998	201	20.92	38.21	45.48	114.95	168.79	133.77	83.41	39.23	14.09
1999	199	18.93	47.30	46.45	61.87	68.93	58.80	43.86	29.08	13.34
2000	200	4.89	25.12	73.80	95.02	81.32	61.06	50.79	31.30	12.60
2001	200	8.27	45.07	92.59	131.29	135.02	78.89	46.75	32.41	17.82
2002	199	6.10	18.48	63.43	113.29	136.87	99.41	48.59	23.73	12.67
2003	200	21.61	29.24	39.10	65.24	73.98	45.50	22.43	11.78	5.36
2004	200	48.54	97.79	139.48	184.82	167.07	133.66	106.36	79.13	51.71
2005	200	106.85	95.08	101.27	171.28	176.16	122.33	89.16	50.75	18.26
2006	200	93.25	155.98	111.89	122.50	111.92	75.77	51.65	33.39	17.12
2007	199	25.15	88.26	168.60	189.28	135.89	84.28	56.02	30.35	13.32
2008	200	22.87	78.03	204.72	349.54	111.51	78.49	72.37	34.51	22.90
2009	200	52.94	121.59	117.20	184.95	188.36	124.15	63.02	28.61	12.40
2010	200	81.20	179.96	302.53	436.20	378.24	216.37	123.76	59.79	20.05
2011	200	36.65	146.14	327.38	451.03	376.30	221.33	141.50	81.09	32.33
2012	202	14.74	36.49	102.95	221.93	316.95	240.56	137.37	71.99	33.48
2013	202	52.95	28.43	42.21	224.36	330.64	312.16	157.45	105.37	26.94
2014	200	78.55	125.02	142.89	140.83	258.05	557.88	281.63	175.20	65.24
2015	200	119.36	145.39	420.17	242.21	215.94	240.78	253.17	85.59	65.09
2016	199	60.14	116.01	222.53	358.31	275.61	178.93	147.10	111.26	24.05
2017	203	57.55	118.45	148.43	271.06	299.32	165.99	74.49	80.68	43.59
2018	202	41.65	109.80	129.74	98.40	226.02	93.65	35.76	32.80	29.95
2019	200	0.43	13.05	100.61	304.17	319.17	199.48	288.33	135.81	65.70
2020	199	0.65	17.08	30.13	147.82	297.51	222.50	128.20	112.15	30.95
2021	200	0.20	2.08	7.17	22.09	77.24	90.12	63.61	35.77	19.27
2022	198	2.16	3.23	14.02	30.22	53.62	107.53	92.58	57.63	29.10

Table 3.2.11. Ling in 5.b. Estimated recruitment, spawning stock biomass (SSB), and average fishing mortality.

Year	$R_{(age\ 3)}$	Low	High	SSB	Low	High	$Fbar_{(6-10)}$	Low	High	TSB	Low	High
1996	1520	1143	2022	18201	14998	22087	0.387	0.277	0.539	28983	24430	34385
1997	1743	1305	2329	15316	12747	18403	0.396	0.3	0.523	22349	19019	26262
1998	2859	2186	3737	14835	12397	17754	0.453	0.347	0.592	23665	20371	27492
1999	2936	2237	3854	12757	10691	15222	0.506	0.387	0.662	22028	19040	25485
2000	2842	2172	3719	12841	10878	15157	0.43	0.329	0.561	24643	21383	28400
2001	2371	1800	3124	11452	9761	13437	0.372	0.283	0.491	19208	16669	22133
2002	2385	1818	3128	12342	10538	14455	0.331	0.251	0.437	21205	18391	24450
2003	2720	2090	3539	13366	11368	15714	0.388	0.298	0.505	21642	18749	24982
2004	3049	2346	3964	14919	12663	17576	0.476	0.368	0.617	25144	21837	28951
2005	4185	3188	5495	13152	11172	15483	0.488	0.382	0.625	22248	19361	25566
2006	3886	2971	5082	11670	9942	13698	0.492	0.382	0.633	21290	18543	24445
2007	3640	2791	4748	11839	10131	13836	0.444	0.344	0.574	23543	20503	27034
2008	3967	3037	5180	14137	12120	16490	0.388	0.297	0.506	27586	23999	31709
2009	3810	2907	4992	13591	11641	15867	0.373	0.285	0.488	26315	22883	30261
2010	3079	2352	4032	15995	13657	18732	0.38	0.289	0.501	28633	24854	32986
2011	2010	1537	2629	18443	15712	21649	0.398	0.303	0.523	31593	27347	36499
2012	2339	1787	3061	17447	14820	20541	0.442	0.336	0.583	27173	23474	31454
2013	4454	3412	5815	18688	15831	22061	0.329	0.241	0.451	32083	27753	37089
2014	4504	3448	5884	19444	16360	23109	0.477	0.356	0.638	31635	27358	36581
2015	4022	3043	5315	19367	16396	22875	0.442	0.337	0.58	32778	28449	37764
2016	4006	3035	5287	18781	16027	22009	0.339	0.258	0.446	31668	27468	36511
2017	3048	2252	4126	22303	19070	26082	0.267	0.199	0.359	37691	32602	43573
2018	1300	941	1797	24093	20498	28319	0.244	0.18	0.33	37626	32330	43789
2019	782	541	1130	22263	18778	26394	0.305	0.228	0.406	30162	25677	35431
2020	475	299	753	24204	20200	29001	0.413	0.307	0.554	30046	25220	35795
2021	238	122	462	19880	16099	24549	0.466	0.332	0.653	23144	18810	28477
2022	249	101	618	14989	11141	20165	0.498	0.314	0.792	16851	12589	22555

Table 3.2.12. Ling in 5.b. Estimated fishing mortality at age.

Year /Age	3	4	5	6	7	8	9	10	11	12
1996	0.002	0.013	0.053	0.147	0.313	0.400	0.498	0.575	0.474	0.474
1997	0.002	0.009	0.040	0.124	0.293	0.406	0.532	0.625	0.521	0.521
1998	0.002	0.009	0.037	0.120	0.310	0.460	0.630	0.745	0.627	0.627
1999	0.002	0.009	0.036	0.122	0.333	0.517	0.718	0.840	0.707	0.707
2000	0.001	0.008	0.032	0.108	0.286	0.442	0.613	0.699	0.592	0.592
2001	0.001	0.007	0.029	0.101	0.263	0.384	0.520	0.594	0.495	0.495
2002	0.001	0.008	0.031	0.107	0.263	0.357	0.442	0.487	0.402	0.402
2003	0.001	0.012	0.043	0.139	0.331	0.433	0.507	0.529	0.438	0.438
2004	0.002	0.018	0.063	0.185	0.420	0.534	0.607	0.636	0.521	0.521
2005	0.002	0.020	0.067	0.190	0.421	0.535	0.621	0.676	0.578	0.578
2006	0.002	0.020	0.067	0.186	0.411	0.523	0.624	0.715	0.622	0.622
2007	0.002	0.020	0.065	0.181	0.389	0.473	0.554	0.624	0.539	0.539
2008	0.002	0.014	0.051	0.148	0.327	0.401	0.488	0.574	0.497	0.497
2009	0.001	0.010	0.038	0.120	0.286	0.376	0.491	0.593	0.523	0.523
2010	0.001	0.008	0.032	0.104	0.264	0.379	0.529	0.626	0.568	0.568
2011	0.001	0.009	0.035	0.108	0.263	0.385	0.569	0.666	0.605	0.605
2012	0.001	0.010	0.041	0.120	0.282	0.416	0.646	0.747	0.668	0.668
2013	0.001	0.006	0.030	0.088	0.200	0.303	0.499	0.557	0.522	0.522
2014	0.001	0.011	0.052	0.147	0.309	0.439	0.739	0.750	0.682	0.682
2015	0.001	0.012	0.058	0.153	0.298	0.415	0.663	0.683	0.623	0.623
2016	0.001	0.009	0.050	0.133	0.247	0.334	0.494	0.489	0.465	0.465
2017	0.000	0.006	0.036	0.103	0.203	0.273	0.388	0.369	0.364	0.364
2018	0.000	0.005	0.030	0.092	0.187	0.255	0.354	0.331	0.344	0.344
2019	0.000	0.005	0.033	0.104	0.222	0.319	0.449	0.429	0.463	0.463
2020	0.001	0.007	0.046	0.145	0.302	0.422	0.609	0.585	0.648	0.648
2021	0.001	0.008	0.059	0.179	0.360	0.477	0.660	0.654	0.745	0.745
2022	0.001	0.008	0.063	0.196	0.394	0.511	0.701	0.690	0.787	0.787

Table 3.2.13. Ling in 5.b. Estimated stock numbers at age.

Year/Age	3	4	5	6	7	8	9	10	11	12
1996	1520	2031	2351	2357	1870	1016	447	184	73	117
1997	1743	1285	1710	1900	1729	1178	593	235	89	103
1998	2859	1521	1121	1350	1411	1102	676	299	109	99
1999	2936	2423	1343	978	981	859	597	309	122	97
2000	2842	2445	2065	1209	773	576	430	253	113	93
2001	2371	2459	2070	1677	1001	525	311	195	110	99
2002	2385	2051	2098	1739	1303	683	321	157	90	110
2003	2720	2085	1791	1733	1368	859	411	185	82	116
2004	3049	2352	1848	1513	1257	843	477	212	98	111
2005	4185	2594	1966	1504	1099	710	427	226	95	108
2006	3886	3603	2170	1535	1076	623	361	195	100	100
2007	3640	3344	2970	1747	1088	619	320	169	80	93
2008	3967	3070	2759	2337	1235	644	339	155	80	88
2009	3810	3440	2557	2182	1620	803	386	178	75	89
2010	3079	3340	2877	2155	1617	991	485	208	85	84
2011	2010	2694	2927	2369	1663	1045	570	248	96	82
2012	2339	1689	2334	2399	1810	1090	618	275	109	83
2013	4454	1929	1368	1987	1867	1143	605	285	109	83
2014	4504	3996	1647	1184	1514	1407	672	328	135	97
2015	4022	3822	3568	1392	915	968	802	253	134	99
2016	4006	3315	3293	2764	1119	607	552	346	110	105
2017	3048	3498	2664	2632	2021	799	371	301	180	115
2018	1300	2777	3007	2134	2034	1383	511	223	180	176
2019	782	1103	2462	2543	1759	1308	961	320	142	220
2020	475	684	949	2029	2010	1250	792	523	181	198
2021	238	415	551	810	1511	1260	727	355	251	172
2022	249	199	366	438	562	915	666	328	159	173

Table 3.2.14. Ling 5.b. Output from SAM. Model parameters.

Parameter name	par	Sd(par)	Exp(par)	Low	High
logFpar_0	-10.101	0.242	0.000	0.000	0.000
logFpar_1	-8.984	0.139	0.000	0.000	0.000
logFpar_2	-8.225	0.109	0.000	0.000	0.000
logFpar_3	-7.503	0.109	0.001	0.000	0.001
logFpar_4	-7.030	0.109	0.001	0.001	0.001
logFpar_5	-6.813	0.111	0.001	0.001	0.001
logFpar_6	-6.578	0.114	0.001	0.001	0.002
logFpar_7	-6.364	0.121	0.002	0.001	0.002
logFpar_8	-9.631	0.171	0.000	0.000	0.000
logFpar_9	-8.603	0.089	0.000	0.000	0.000
logFpar_10	-7.801	0.087	0.000	0.000	0.000
logFpar_11	-7.212	0.087	0.001	0.001	0.001
logFpar_12	-6.912	0.088	0.001	0.001	0.001
logFpar_13	-6.624	0.089	0.001	0.001	0.002
logFpar_14	-6.497	0.095	0.002	0.001	0.002
logSdLogFsta_0	-1.215	0.214	0.297	0.194	0.455
logSdLogN_0	-0.995	0.167	0.370	0.265	0.516
logSdLogN_1	-2.603	0.282	0.074	0.042	0.130
logSdLogObs_0	-0.662	0.064	0.516	0.454	0.587
logSdLogObs_1	0.188	0.133	1.207	0.925	1.574
logSdLogObs_2	-0.430	0.132	0.650	0.500	0.847
logSdLogObs_3	-0.712	0.110	0.491	0.394	0.611
logSdLogObs_4	-0.223	0.133	0.800	0.614	1.044
logSdLogObs_5	-1.052	0.080	0.349	0.297	0.410
transfIRARdist_0	-1.606	0.243	0.201	0.124	0.326
transfIRARdist_1	-0.450	0.202	0.637	0.426	0.955
itrans_rho_0	1.494	0.303	4.454	2.430	8.164

Table 3.2.15. Ling 5.b. Forecast of recruitment (thousands), SSB (tonnes), catch (tonnes) and TSB (tonnes) when $F=F_{sq}$ in 2022 and 2023 and different scenarios such as $F=F_{MSY}$, F=0, $F=F_{pa}$, $F=F_{lim}$, $F=F_{sq}$. Median values showed.

	Year	F_{6-10}	Recruitment	SSB	Catch	TSB
$F=F_{sq}$, then F_{MSY}	2022	0.498	254	15136	6668	17021
	2023	0.498	782	10023	4497	12007
	2024	0.23	782	6409	1580	8948
	2025	0.23	782	5729	1426	8991
$F=F_{sq}$, then 0	2022	0.498	254	15136	6668	17021
	2023	0.498	782	10023	4497	12007
	2024	0	782	6409	0	8948
	2025	0	782	7523	0	10822
$F=F_{sq}$, then $F_{pa}=F_{p0.5}$	2022	0.498	254	15136	6668	17021
	2023	0.498	782	10023	4497	12007
	2024	0.6	782	6409	3306	8948
	2025	0.6	782	3811	1932	7020
$F=F_{sq}$, then F_{lim}	2022	0.498	254	15136	6668	17021
	2023	0.498	782	10023	4497	12007
	2024	0.85	782	6409	4101	8948
	2025	0.85	782	2952	1841	6147
$F=F_{sq}$	2022	0.498	254	15136	6668	17021
	2023	0.498	782	10023	4497	12007
	2024	0.498	782	6409	2916	8948
	2025	0.498	782	4247	1910	7459
$F=F_{sq}$ then $F_{MSY}*SSB_{2024}/MSYB_{trigger}$	2022	0.498	254	15136	6668	17021
	2023	0.498	782	10023	4497	12007
	2024	0.127	782	6409	932	8948
	2025	0.127	782	6483	957	9767

3.3 Ling (*Molva molva*) in Subareas 1 and 2

3.3.1 The fishery

Ling has been fished in Subareas 1 and 2 for centuries, and the historical development is described in Bergstad and Hareide (1996). In particular, the post-World War II increase in catch caused by a series of technical advances, are well documented. Currently the major fisheries in Subareas 1 and 2 are the Norwegian longline and gillnet fisheries, and bycatches of ling are taken by other gears, such as trawls and handlines. Historically around 50% of the Norwegian landings were taken by longlines and 45% by gillnets, partly in directed ling fisheries and as bycatch in other fisheries. This distribution between the gear types seem to be changing and in 2022 the gillnet fishery was landing 49% and longliners 44 % of the total catches. Other nations catch ling as bycatch in their trawl fisheries. Figure 3.3.1 shows the spatial distributions of the total catches for the Norwegian longline fishery in 2021 and in 2022. There was no fishery in the NEAFC regulatory area in 2022.

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 stabilized at 26. 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 2022 the total number of hooks per year has varied considerably, but with a downward trend since 2002.(for more information see Helle, WD 2023).

The cod stock in the Barents Sea has been very abundant for years, but now there is a downward trend in the cod stock which has resulted in lower quotas. Most likely the of lower quotas for cod has resulted in the observed increase in fishing pressure on ling.

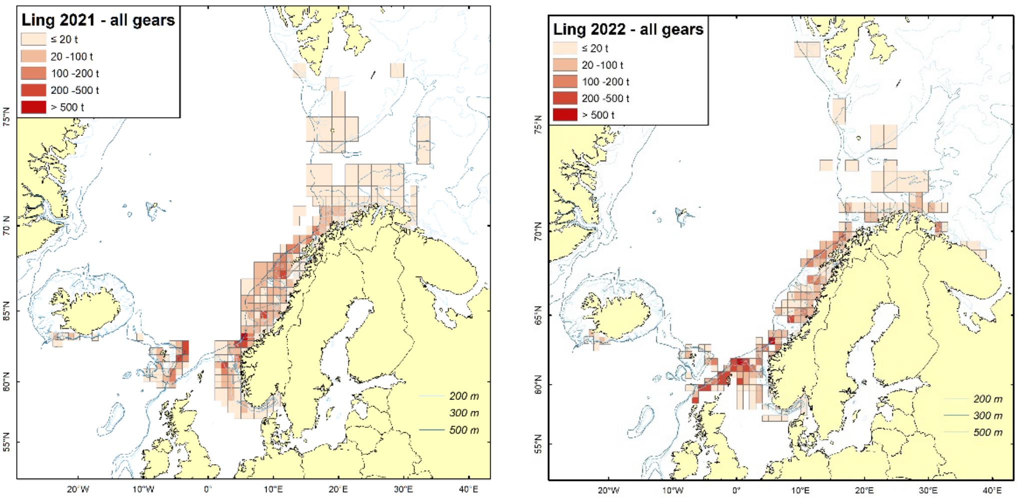


Figure 3.3.1. Distribution of the total catch of ling in Subareas 1 and 2 taken by the Norwegian fishery in 2021 and in 2022.

3.3.2 Landings trends

Landing statistics by nation in the period 1988–2022 are in Tables 3.3.1a–d. During 2000–2005, the landings varied between 5000 and 7000 t, which was slightly lower than the landings in the preceding decade. In 2007, 2008 and 2010 the landings increased to over 10 000 t. After this the landings declined to 8000 tons in 2017 followed by two years with high landings, above 11 000 tons. The preliminary landings for 2022 are 9200 t. Total international landings in Areas 1 and 2 are given in Figure 3.3.2.

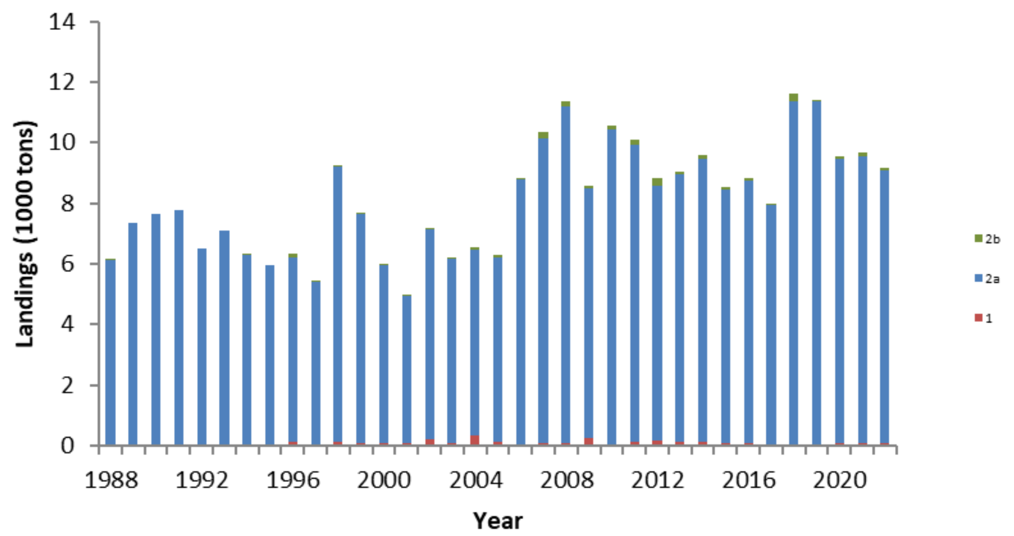


Figure 3.3.2. Total international landings of ling in Subareas 1 and 2.

3.3.3 ICES Advice

Advice for 2022 and 2023: ICES advises that when the precautionary approach is applied, catches should be no more than 10 454 tonnes in each of the years 2022 and 2023.

Advice based on the ICES rfb-rule

The assessment is based on ICES rfb-rule for data limited stocks for the first time this year, where life history traits, exploitation characteristics and other relevant parameters for data-limited stocks are considered (ICES 2021). The rfb-rule has the following form:

$$A_{y+1} = A_{y-1}\ r\ f\ b\ m$$

where A_{y+1} is the advised catch, A_{y-1} is last years advice, r corresponds to the trend in biomass index (as in the current ICES "2 over 3" rule), f is a proxy for the exploitation (mean catch length divided by an MSY reference length) and b a biomass safeguard (reducing the catch when biomass index drops below a trigger value).

The former advice when the ICES "2 over 3" rule was set to 10 454 tonnes.

r is the ratio of the mean of the last two survey indices and the mean of the three preceding values or:

$$r = \frac{\sum_{i=y-2}^{y-1} I_1 /2}{\sum_{i=y-3}^{y-5} I_1 /3}$$

f is the length-ratio component where:

$$f = \frac{\overline{L}_{y-1}}{L_{F=M}}$$

where $\overline{L}$ is is the mean catch length above $L_{F=M}$. $L_{F=M}$ is calculated as:

$$L_{F=M} = 0.75L_c + 0.25L_\infty$$

where L_c is length at first capture and $L\infty$ is von Bertalanffy $L\infty$. L_∞ for ling is 127 cm

b is the biomass safeguard and is used to reduce catch advice when index falls below trigger,

$$b = min(1, I_y - 1/I_{trigger})$$

where $I_{trigger}$ = $i_{loss\omega}$

m is a multiplier based on stock growth. K for ling is < 0.11 and therefore m is 0.95.

3.3.4 Management

In 2023, Norway introduced a quota for ling in areas 1 and 2 of 10 454 tonnes. There is no minimum landing size for the Norwegian EEZ.

In international and union waters of 1 and 2 UK has a TAC of 7 tons, while EU has a TAC of 24 tons.

3.3.5 Data available

3.3.5.1 Landings and discards

Amounts landed were available for all relevant fleets. No discards were reported in 2022. The Norwegian fleets are now regulated by TACs, and there is a ban on discarding, the incentive for illegal discarding is, however, believed to be low. The landings statistics are therefore regarded as being adequate for assessment purposes.

3.3.5.2 Length compositions

Length composition data are available for the longliners and gillnetters from the Norwegian Reference fleet. Figures 3.3.3 and 3.3.4 show the length distribution of ling in Areas 1 and 2 for the period 2001 to 2022. 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 3.3.5.

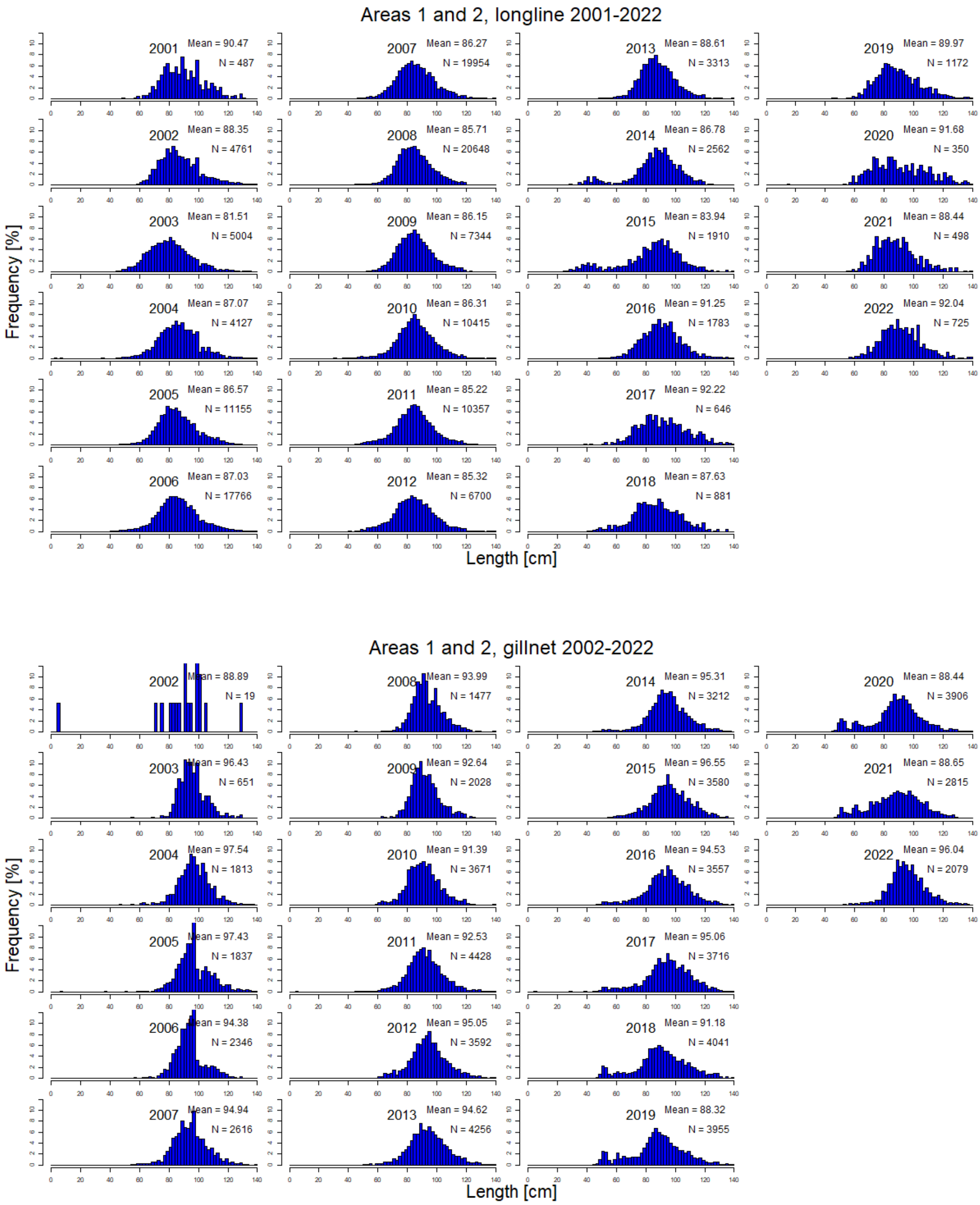


Figure 3.3.3. Plots of the length distributions of ling in Subareas 1 and 2 combined for the period 2001 to 2022 from the Norwegian Reference fleet.

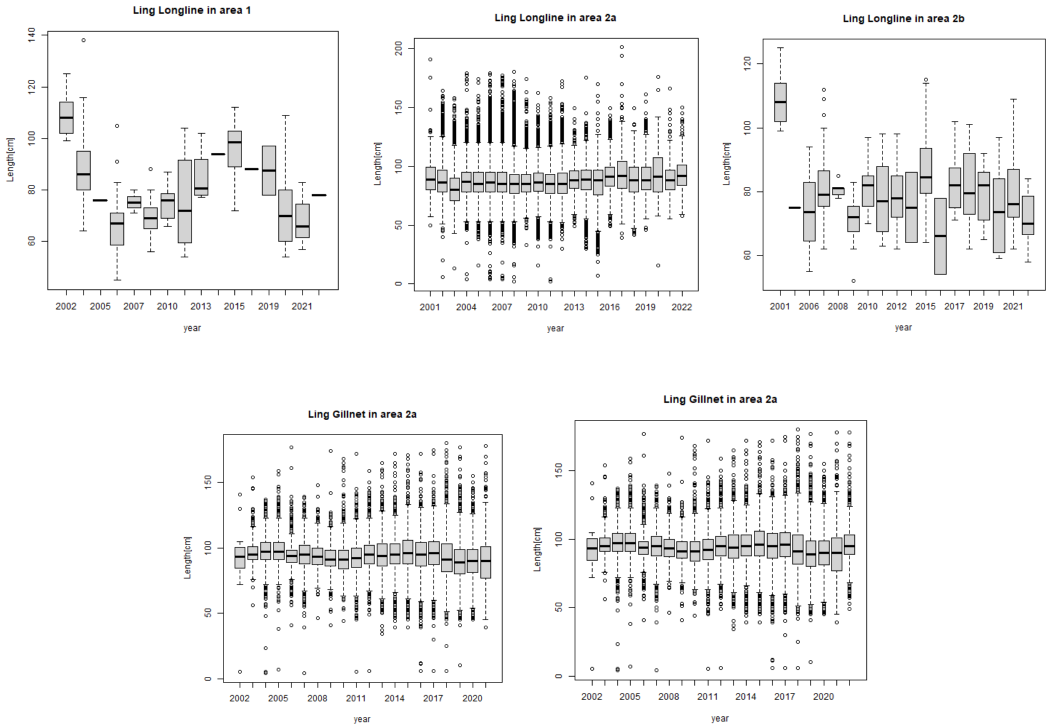


Figure 3.3.4. Box and whiskers plots for the length of ling in Areas 1, 2a and 2b for the period 2001 to 2022 from the Norwegian Reference fleet.

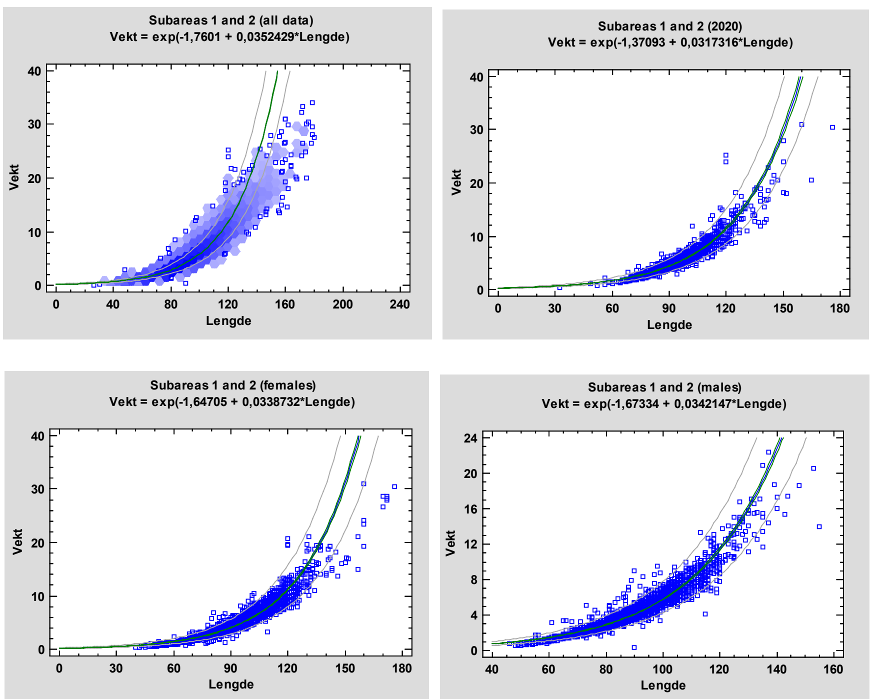
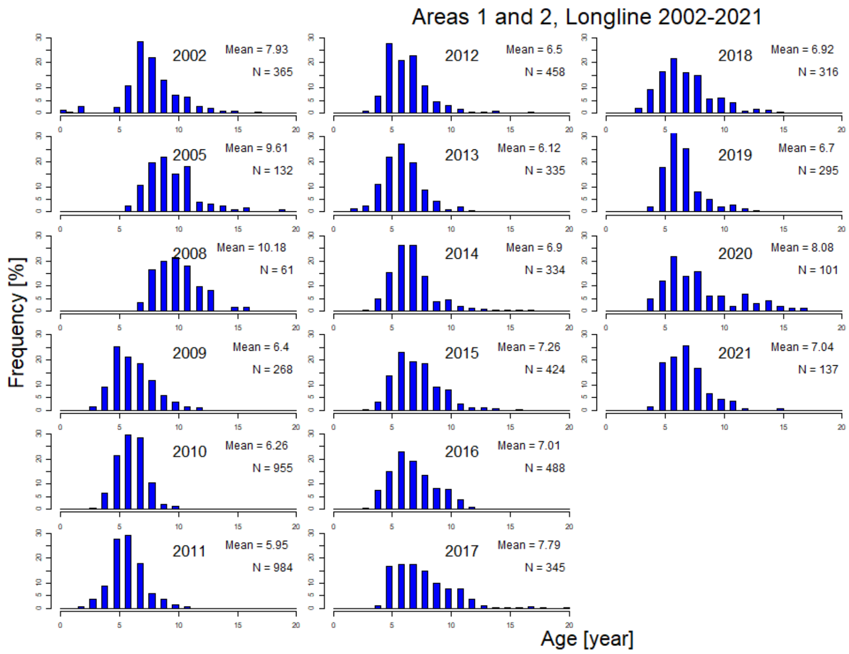


Figure 3.3.5. Weight–length relationship for the period 2008–2020, and only for 2020 (upper panel) and for females and for males, separately (lower panel). Data were collected by the Norwegian Reference Fleet.

3.3.5.3 Age compositions

The Catch-at-age composition for the longline fishery and for the gillnet fishery for 2010–2021 (Figure 3.3.6), and box and whiskers plots for the estimated age distribution of catch for each area are in Figure 3.3.7.



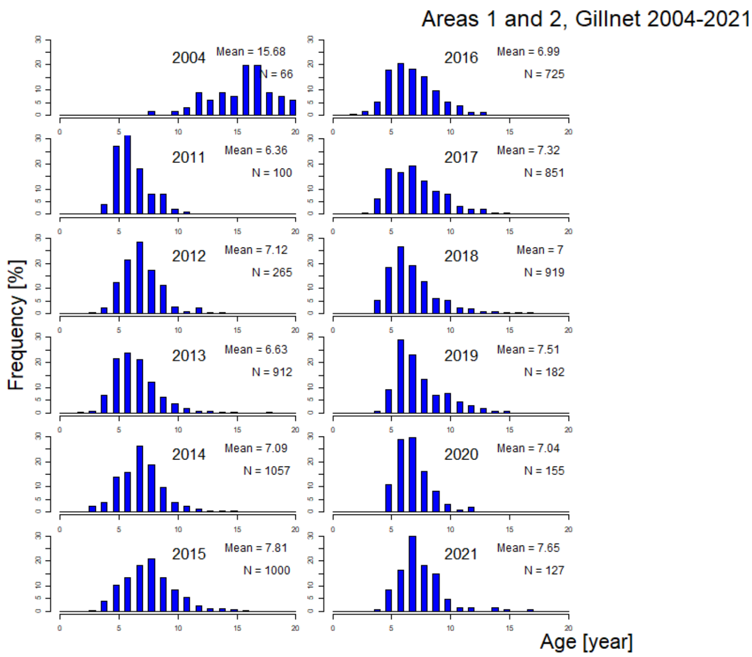


Figure 3.3.6. Ling in Areas 1 and 2, Catch-at-age compositions based on data from the Reference fleet, longliners and gillnetters.

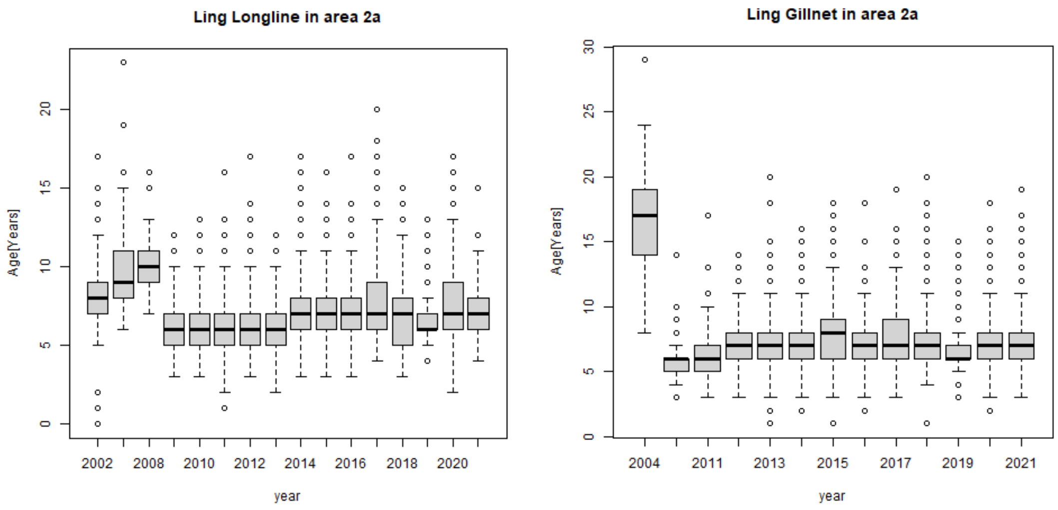


Figure 3.3.7. Age composition of the fish caught by longliners and gillnetters during the period 2002–2021.

3.3.5.4 Length and weight -at-age

Figure 3.3.8 shows the average mean length at age and mean weight at age for the years 2009–2020.

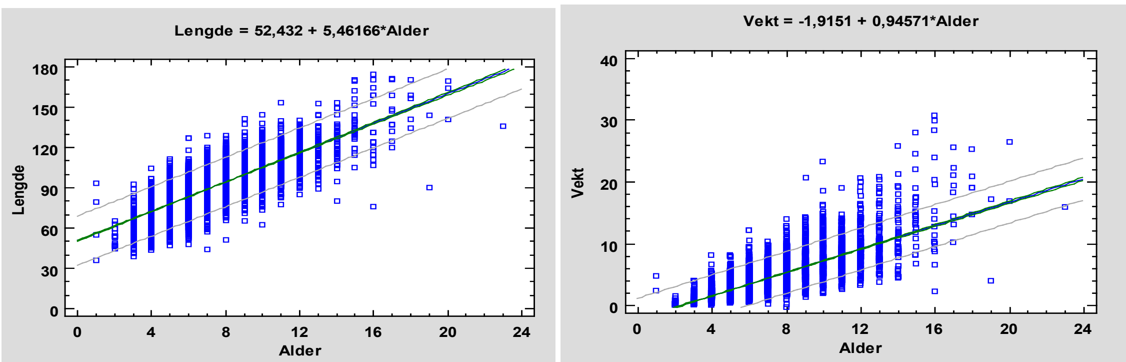


Figure. 3.3.8. Average mean length and mean weight versus age for the period 2010–2020.

3.3.5.5 Maturity and natural mortality

Maturity ogives for ling are in Figure 3.3.9 and in the following table. The results fit well with previous observations that ling reach maturity between ages 5–7 (60–75 cm) in most areas, while males reach maturity at a slightly younger age than females (Magnusson *et al.*, 1997).

Maturity parameters:

Stock	L50	N	A50	N	Source
Lin-arct	73.0	1540	7.0	769	Norwegian long liners (Reference fleet) and survey data

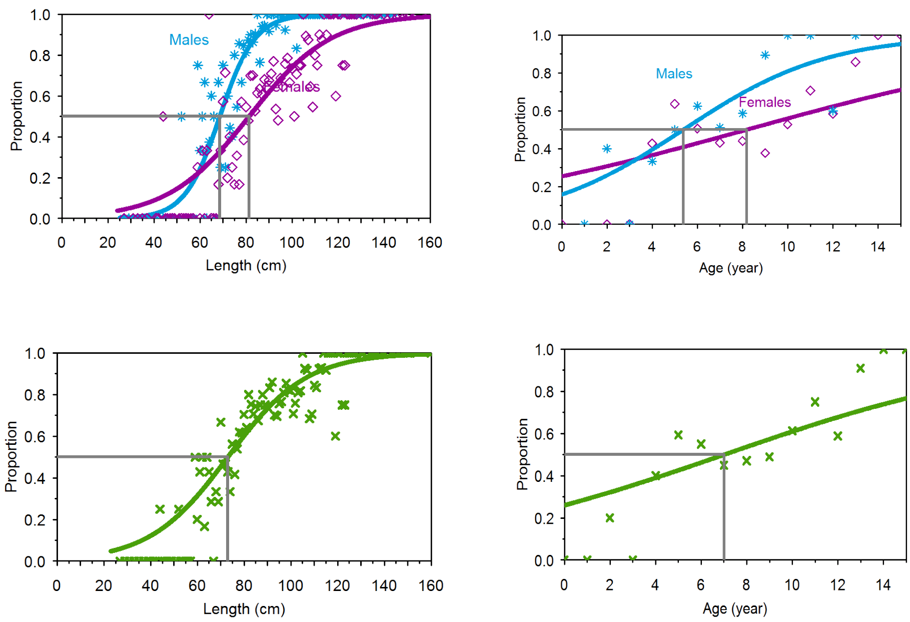


Figure 3.3.9. Maturity ogives for ling in Areas 1 and 2: males and females (upper panel) and for males and females combined (lower panel).

3.3.5.6 Catch and effort data

Two standardized cpue series for 2000–2022 for Norwegian longliners are in Figure 3.3.10. One series was based on all the catch data, and the other cpue series used only catches of ling that made up more than 30% of the total catch by weight, that is it is assumed that these were targeted catches. No research vessel data are available.

3.3.6 Data analyses

Length distribution

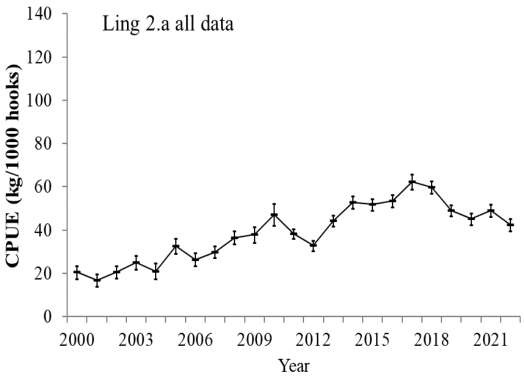
In Figures 3.3.3 and 3.3.4 are plots of the length distributions in Area 1 and 2 for 2001 to 2022. It appears that the mean length in Area 1 has varied slightly, while the mean length in Areas 2a and 2b has been very stable. The average length is slightly higher in the gillnet fishery than in the longline fishery.

Age distribution

In Figures 3.3.6 and 3.3.7 are plots of the age distributions in Area 1 and 2 for 2001 to 2021. It appears that the mean age in Area 2a has been very stable. The average age is slightly higher in the gillnet fishery than in the longline fishery.

Cpue

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 3.3.10. Both cpue series indicate an upward trend for the period until 2017, after 2017 there was a declining trend and then stable trend. The method is described in Helle *et al.*, 2015.



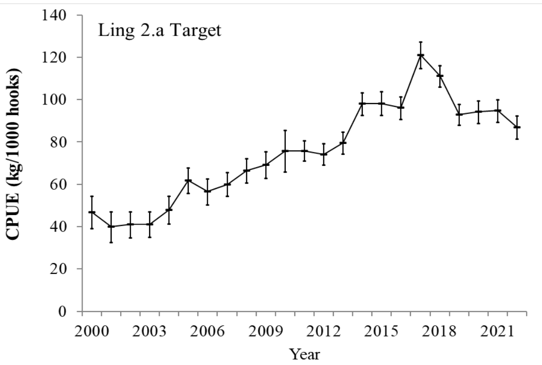


Figure 3.3.10. Estimate of cpue (kg/1000 hooks) for ling in Area 2a based; on all available data, and on catches when ling was considered the target species for 2000–2022. The bars denote the 95% confidence intervals. The data are from skipper's logbooks.

3.3.7 Comments on the assessment data analyses

The two cpue series, based on all data and when ling were targeted, show a stable and positive trend from 2001 until 2017, after this there has been a downward trend. However, the LBI indicates that ling is fished sustainably (see section 3.3.9).

3.3.8 Management considerations

The annual catch of ling since 2006 do not appear to have had a detrimental effect on the stock given that cpue continued to increase steadily, and even with the recent decline the current catch levels are considered appropriate.

However, the cod stock in the Barents Sea has been very abundant for several years but now there is a downward trend in the cod stock which results in lower quotas. Because of lower quotas for cod the fishing pressure on ling appear to have increased.

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 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.

3.3.9 Application of rfb-rule

This is the first year the rfb-rule is applied for ling in 1 and 2. Previously the “3 over 2 rule has been used. The biomass index is based on the CPUE calculated from logbook data from the Norwegian longline fleet 2000-2022 when ling was targeted (more than 30 percent of the daily catch) (Helle et al. 2015). The length data is from the Norwegian longline reference fleet. To get reliable values for K and Linf has been challenging. K=0.11 is the same as in ling subareas 3, 4, 6–9, 12, and 14 and Linf the same as was used for LBI (see chapter 3.3.10)

Rfb-rule:

- r is calculated as the average of last two years values, divided by average of three preceding years values which results in r=0.91 (Figure 3.3.11. Table 3.3.2)

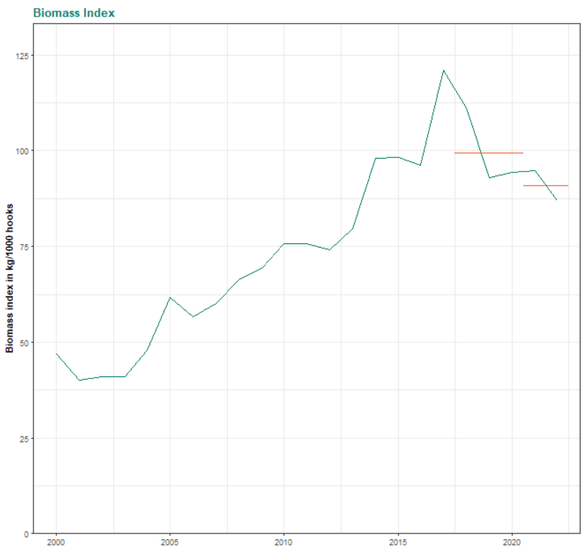


Figure 3.3.11: Ling in 1 and 2. Biomass index since 2000. The red lines show the average of last two years values and the three preceding years.

- *f* is the length-ratio component. The mean length of last years´ catch was 93 cm and the target reference length (L*c* or length at first capture * 0.75 + length ∞ * 0.25) is **98** (figure xxx).

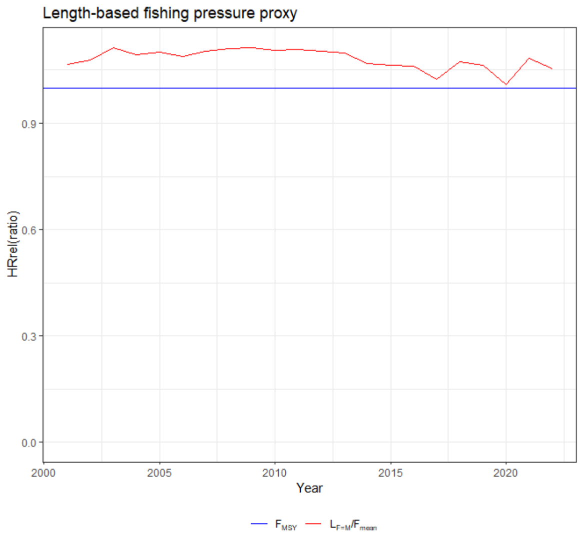


Figure 3.3.12: Ling in 1 and 2. Ling in subareas 1 and 2. Index ratio of the average length relative to the expected length when fishing mortality equals natural mortality ($L_{mean}/L_{F=M}$) for the Norwegian longline fleet from the length-based indicator method used for the evaluation of the exploitation status The exploitation status is below the $F_{MSY\ proxy}$ when the index ratio value is higher than 1.

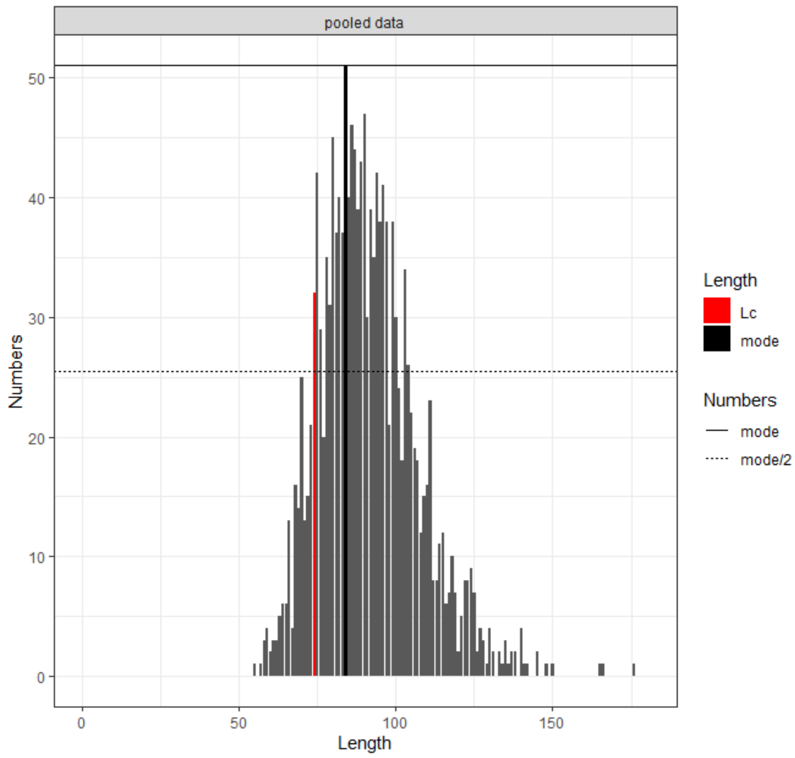


Figure 3.3.13: Ling in 1and 2. Length frequency distribution from catches. Black line is the length of modal abundance, the red line is the length at first capture.

- *b* is the biomass safeguard and is used to reduce catch advice when index falls below trigger. The lowest index or the I_{loss} for ling is 40 and was recorded in the year 2001. $I_{trigger}$ is I_{loss} *1.4 or 56 (Figure 3.3.14). Biomass index this year is above $I_{trigger}$ and *b* is therefore 1.

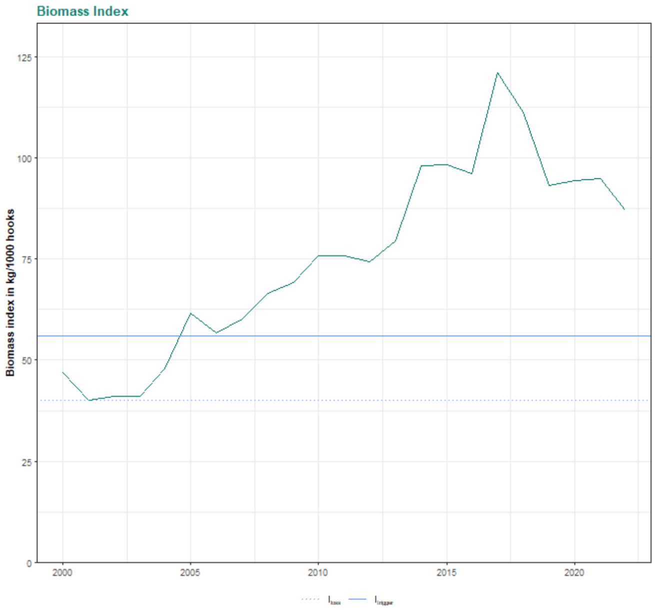


Figure 3.3.14: Ling in 1 and 2. Biomass index values since 2000. The blue line is the $I_{trigger}$ and the doted is the lowest observed value (I_{loss}).

- *m* is the tuning parameter and for slow growing species (with von Bertanlaffy K<0.2), *m* equals to 0.95.

Table 3.3.2. Ling Subareas 1 and 2. The basis for the catch scenarios. Catches are in tonnes.*

Previous catch advice for A_y (2022/23)	10 454 tonnes
Stock biomass trend	
Index A (2021, 2022)	91
Index B (2018, 2019, 2020)	99
r: stock biomass trend (index ratio A/B)	0.91
Fishing pressure proxy	
Mean catch length ($L_{mean} = L_{2022}$)	93cm
MSY proxy length ($L_{F=M}$)	98 cm
f: fishing pressure proxy relative to MSY proxy ($L_{2022}/L_{F=M}$)	0.95
Biomass safeguard	
Last index value (I_{2022})	97
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)	56
b: index relative to trigger value, min{$I_{2022}/I_{trigger}$, 1}	1
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability	
m: multiplier (generic multiplier based on life history)	0.95
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Not applied
Discard rate	0 %
Catch advice for 2024 and 25**	8 600 tonnes
% advice change^	−17.7%

* The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table.
** Formula [$A_y \times r \times f \times b \times m$]
^ Advice value for 2024 and 2025 relative to the advice value for 2023 (-1854 tonnes).

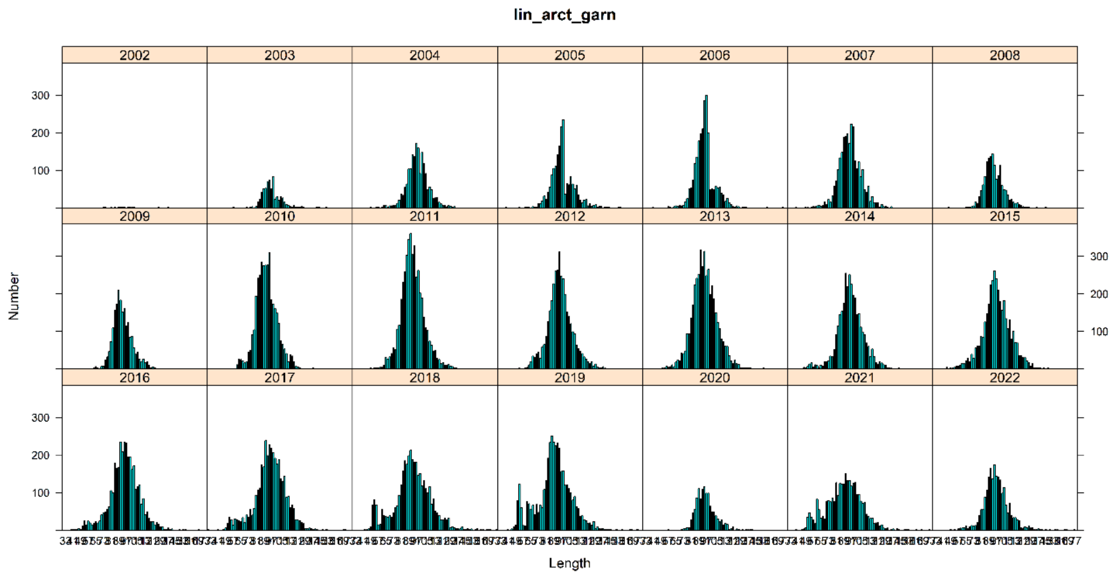
3.3.10 Application of the Length-based indicator method (LBI)

The Length-based indicator method (LBI) were applied for ling in Areas 1 and 2.

Length-based indicator method (LBI)
The input parameters and the length distributions of the catches for the period 2001–2022 are in Table 3.3.3and Figure 3.3.15. The length data used in the LBI model are from the Norwegian gill netter and longline fleet.

Table 3.3.3. Ling in arctic waters (1, 2.a, 2.b). Input parameters for LBI.

Data type	Years/Value	Source	Notes
Length–frequency distribution	2001–2022	Norwegian gill netters (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	



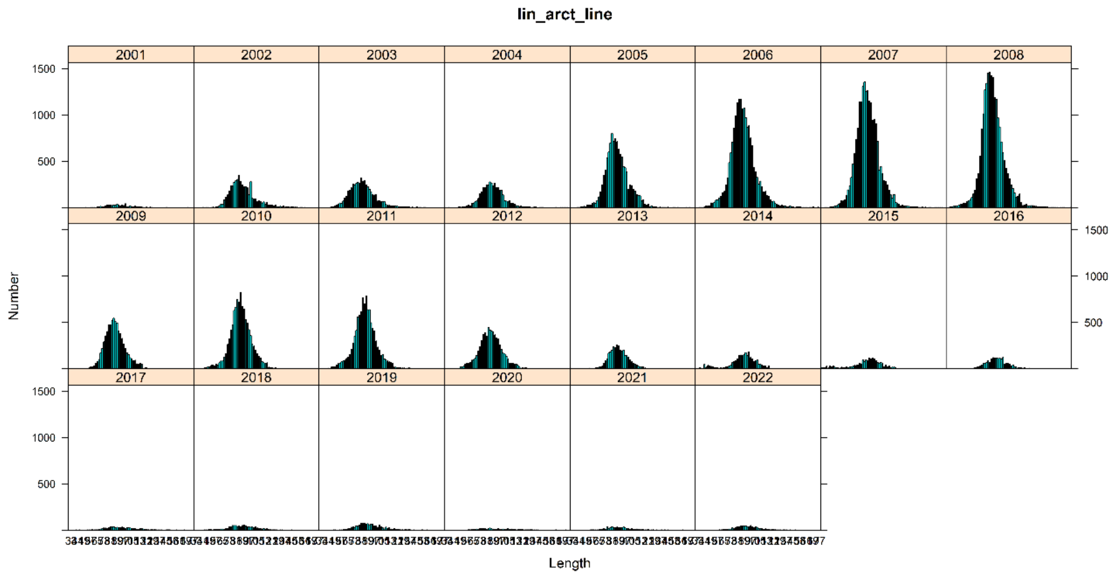


Figure 3.3.15. Ling in arctic waters (1, 2.a, 2.b), upper panel are length data from gillnetters, lower are from longliners. Catch length distributions, 2 cm length classes, for the period 2001–2022 (sex combined).

Outputs from the screening of length indicator ratios for combined sexes under three scenarios: (a) Conservation; (b) Optimal yield; and (c) maximum sustainable yield, for ling from the gillnet and longline fishery are in Figures 3.3.16a and b.

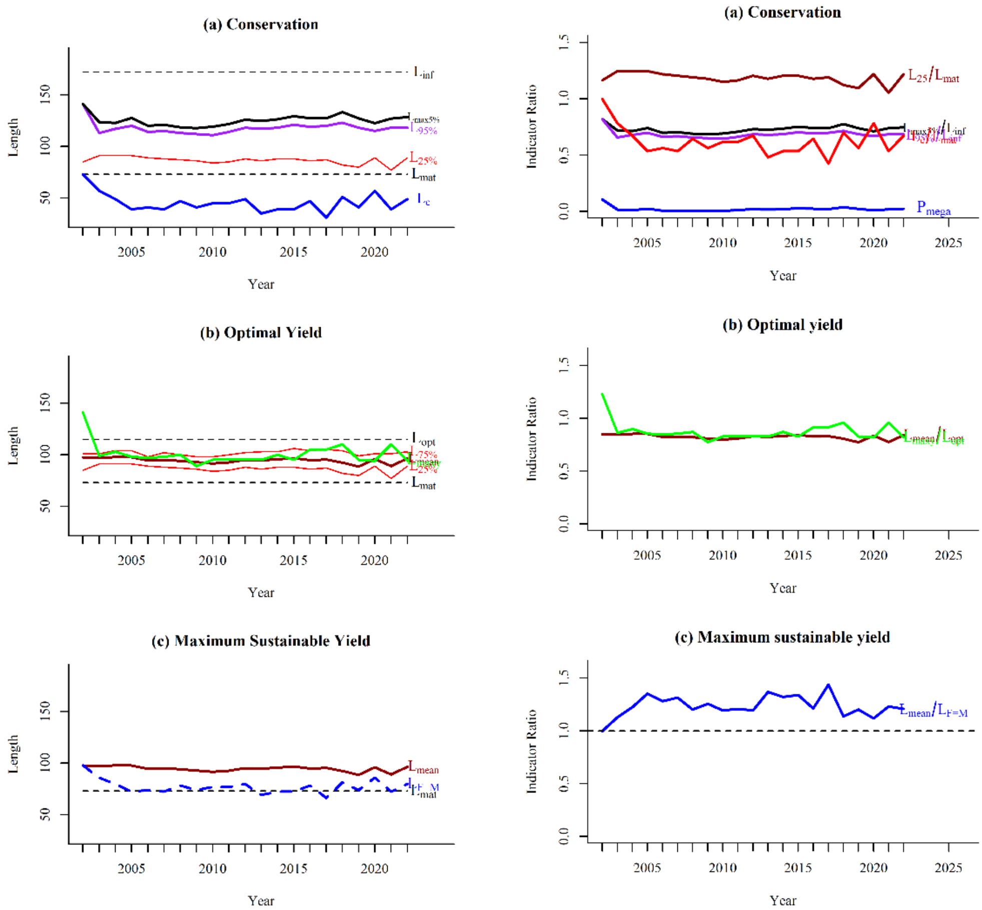


Figure 3.3.16a. Ling from gillnetters in arctic waters (1, 2.a, 2.b). Screening of the length indicator ratios for sex combined under three scenarios: (a) Conservation; (b) Optimal yield; and (c) maximum sustainable yield.

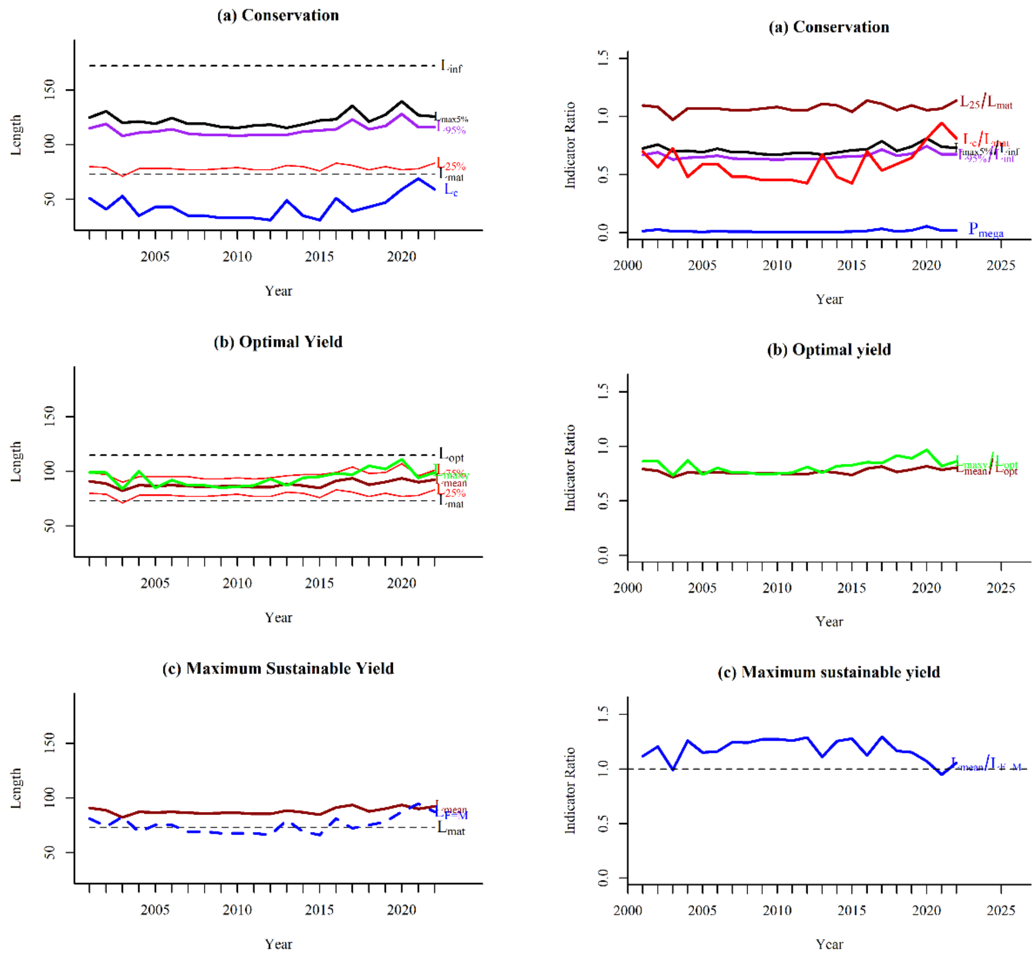


Figure 3.3.16b. Ling from longliners in arctic waters (1, 2.a, 2.b). Screening of the length indicator ratios for sex combined under three scenarios: (a) Conservation; (b) Optimal yield; and (c) maximum sustainable yield.

Analysis of results

The results using length data from gillnet and longline fishery showed the same trend. 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 3.3.16). In 2020–2022, $L_{25\%}/L_{mat}$ was also greater than 1 (Table 3.3.4), 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 3.3.16) and between 0.71 and 0.78 in 2020–2022 (Table 3.3.4), 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 3.3.16), which indicates that ling in arctic waters are fished sustainably. Regarding model sensitivity, the MSY value was always greater than 0.90.

Table 3.3.6. gives the outcomes of all estimates from the LBI, based on data from the gillnet and the longline fishery provided by the Norwegian reference fleet.

Conclusion: The overall perception of the stock during the period 2020–2022 is that ling in arctic waters seems to be fished sustainably (Table 3.3.3a and b). However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

Table 3.3.4a. Ling (gillnetters)in arctic waters (1, 2.a, 2.b). 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**
2020	0,78	1,22	0,71	1 %	0,84	1,12
2021	0,53	1,05	0,74	2 %	0,78	1,23
2022	0,67	1,22	0,75	2 %	0,84	1,21

Table 3.3.3b. Ling (longliners) in arctic waters (1, 2.a, 2.b). 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**
2020	0,81	1,05	0,81	5 %	0,82	1,07
2021	0,95	1,07	0,74	2 %	0,78	0,95
2022	0,81	1,14	0,73	2 %	0,80	1,06

Table 3.3.5Ling in arctic waters (1, 2.a, 2.b). Stock status inferred from LBI for MSY. Green tick marks for MSY are provided because the $L_{mean}/L_{F=M}$ > 1 in each year. Stock size is unknown as this method only provides exploitation status.

Fishing pressure			
	2020	2021	**2022**
MSY (F/F_{MSY})	✓	✓	✓ Fished sustainably

Stock size			
	2020	2021	**2022**
MSY $B_{trigger}$.(B/B_{MSY})	?	?	? Unknown

Table 3.3.6 Outcomes from the LBI, based on data from the gillnet and the longline fishery provided by the Norwegian reference fleet.

	Gillnet			Longline		
Year	2020	2021	2022	2020	2021	2022
L75	101	101	103	107	96	101
L25	89	77	89	77	78	83
Lmed	94	90	95	90	87	91
L90	110	110	112	122	108	110
L95	115	118	118	128	116	116
Lmean	95,88	88,95	96,36	93,58	89,99	92,29
Lc	57	39	49	59	69	59
LFeM	85,75	72,25	79,75	87,3	94,8	87,3
Lmaxy	94	110	94	111	94	99
Lmat	73	73	73	73	73	73
Lopt	114,67	114,67	114,67	114,7	114,7	114,7
Linf	172	172	172	172	172	172
Lmax5%	122,40	126,92	128,32	139,6	126,9	125,6
Lmean/LFeM	1,12	1,23	1,21	1,1	0,9	1,1
Lc/Lmat	0,78	0,53	0,67	0,8	0,9	0,8
L25/Lmat	1,22	1,05	1,22	1,1	1,1	1,1
Lmean/Lmat	1,31	1,22	1,32	1,3	1,2	1,3
Lmean/Lopt	0,84	0,78	0,84	0,8	0,8	0,8
L95/Linf	0,67	0,69	0,69	0,7	0,7	0,7
Lmaxy/Lopt	0,82	0,96	0,82	1,0	0,8	0,9
Lmax5%/Linf	0,71	0,74	0,75	0,8	0,7	0,7
Pmega	0,01	0,02	0,02	0,1	0,0	0,0
Pmegaref	0,3	0,3	0,3	0,3	0,3	0,3

3.3.11 References

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3.3.12 Tables

Table 3.3.1a. Ling 1.a 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
2017	43					43
2018	34					34
2019	37					37
2020	73					73
2021	71					71
2022*	60					60

Preliminary.

Table 3.3.1b. 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

Year	Faroes	France	Germany	Norway	E & W	Scotland	Russia	Ireland	Iceland	Spain	Greenland	Poland	Total
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
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	11	8523	2	3	112		8	2	9	6	8700
2017	17	13	8	7684		3	150		15		4	6	7900
2018	13	9	16	11155			129		4		1	5	11332
2019	5	24	9	11216			60		1			1	11316
2020	8	13	5	9323	1	1	42		2				9395
2021	7	46	2	9395		1	36		1				**9480**
2022*	3	22	1	8980					1		1		**9008**

*** *Preliminary. Table 3.3.1c. 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

Year	Norway	E & W	Faroes	France	Total
2016	53				1
2017	28				28
2018	238				238
2019	55				55
2020	96				96
2021	108				108
2022*	113				113

***Preliminary.**

Table 3.3.1d. 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

Year	1	2.a	2.b	All areas
2007	96	10 058	180	10 334
2008	80	11 104	162	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	8700	54	8819
2017	43	7900	28	7971
2018	34	11332	238	11604
2019	37	11321	55	11413
2020	73	9395	96	9564
2021	71	9480	108	9659
2022*	60	9008	113	9181

***Preliminary.**

3.4 Ling (*Molva molva*) in 5.a

3.4.1 The fishery

The fishery for ling in Icelandic waters has not changed substantially in recent years. Around 100-300 Icelandic longliners annually report catches of ling, around 30-200 gillnetters and around 60-140 trawlers. Most of ling is caught on longlines (Figure 3.4.1 and Table 3.4.1) which has increased since 2000 to around 60% in 2022. At the same time the proportion caught by gillnets has decreased from 20–30% in 2000–2007 to around 4% in 2022. Catches in trawls have varied less and have been at around 20-30 % of Icelandic catches. (Figure 3.4.1, Table 3.4.1). Most of the ling caught by Icelandic longliners is caught at depths less than 300 m, and by trawlers at less than 400 m (Figure 3.4.2). The main fishing grounds for ling as observed from logbooks are in the south, southwestern and western part of the Icelandic shelf (Figure 3.4.3 and Figure 3.4.4). The main trend in the spatial distribution of catches according to logbook entries is the decreased proportion of catches caught in the southeast and increased catches on the western part of the shelf two decades ago. Around 50% of ling catches are caught on the southwestern part of the shelf (Figure 3.4.3). In recent years, the main fishing pressure has shifted towards shallower waters (Figure 3.4.2).

Table 3.4.1: Ling in 5.a. Number of Icelandic boats and catches by fleet segment participating in the ling fishery from logbooks. Total catches include all landings in 5.a.

Year	Bottom trawl	Gill nets	Longlines	Bottom trawl	Gill nets	Longlines	Other	Total catch
2000	140	184	287	890	704	1538	77	3284
2001	130	232	252	639	1061	1093	79	3362
2002	122	203	234	852	648	1282	61	4519
2003	119	172	243	850	454	2210	70	4270
2004	116	165	234	977	545	2017	187	4606
2005	115	127	260	1497	501	2046	268	5198
2006	106	99	258	1697	629	3732	225	7405
2007	105	86	251	1642	633	4042	282	7591
2008	96	68	208	1927	477	5004	330	9283
2009	88	78	208	2193	723	6232	468	10773
2010	86	69	197	2528	363	6532	444	10963
2011	82	61	201	2625	222	5595	348	9626
2012	81	62	206	2509	245	7479	462	11817
2013	85	62	206	2808	345	6779	266	11581
2014	78	57	206	2717	673	8728	231	14246
2015	75	55	193	2802	650	7766	333	13035
2016	71	55	173	2426	681	5244	232	9884

Year	Bottom trawl	Gill nets	Longlines	Bottom trawl	Gill nets	Longlines	Other	Total catch
2017	70	48	157	2063	556	4903	171	8766
2018	68	47	137	2114	387	4061	195	8062
2019	61	33	135	2009	115	4688	180	8269
2020	67	36	114	1985	138	3540	174	7061
2021	66	39	108	2074	126	3812	99	7128
2022	65	30	91	2236	262	4059	242	7657

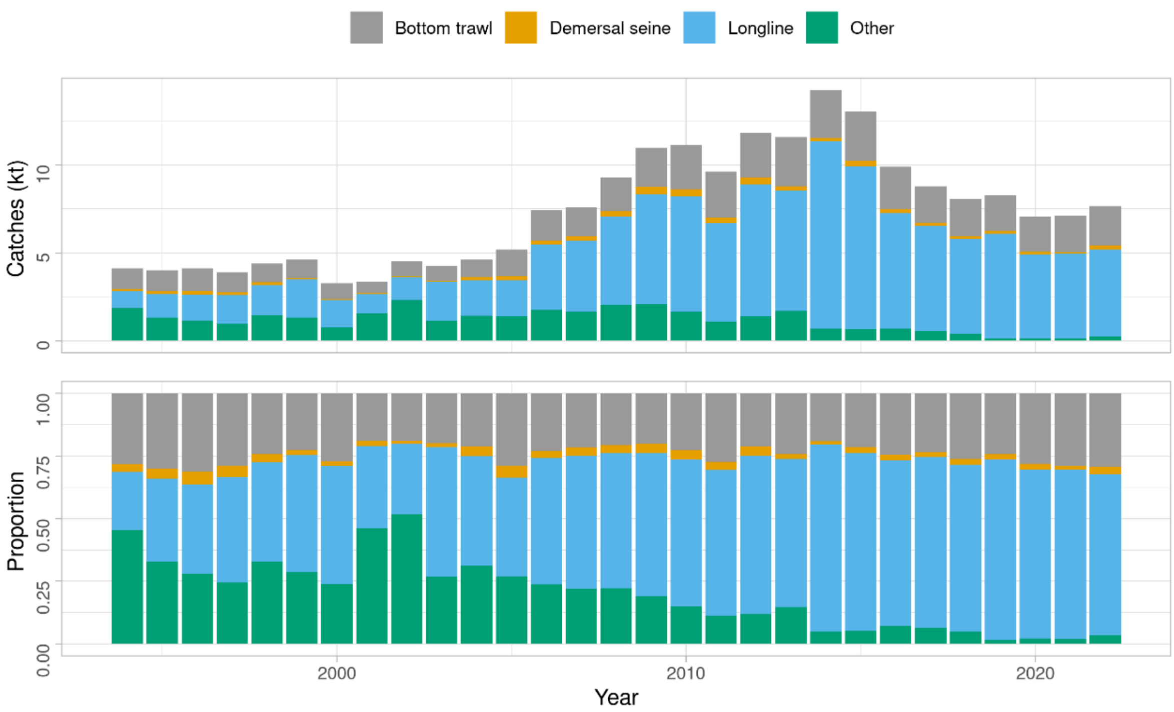

Figure 3.4.1: Ling in 5.a. Commercial catches by gear as registered in Icelandic logbooks.

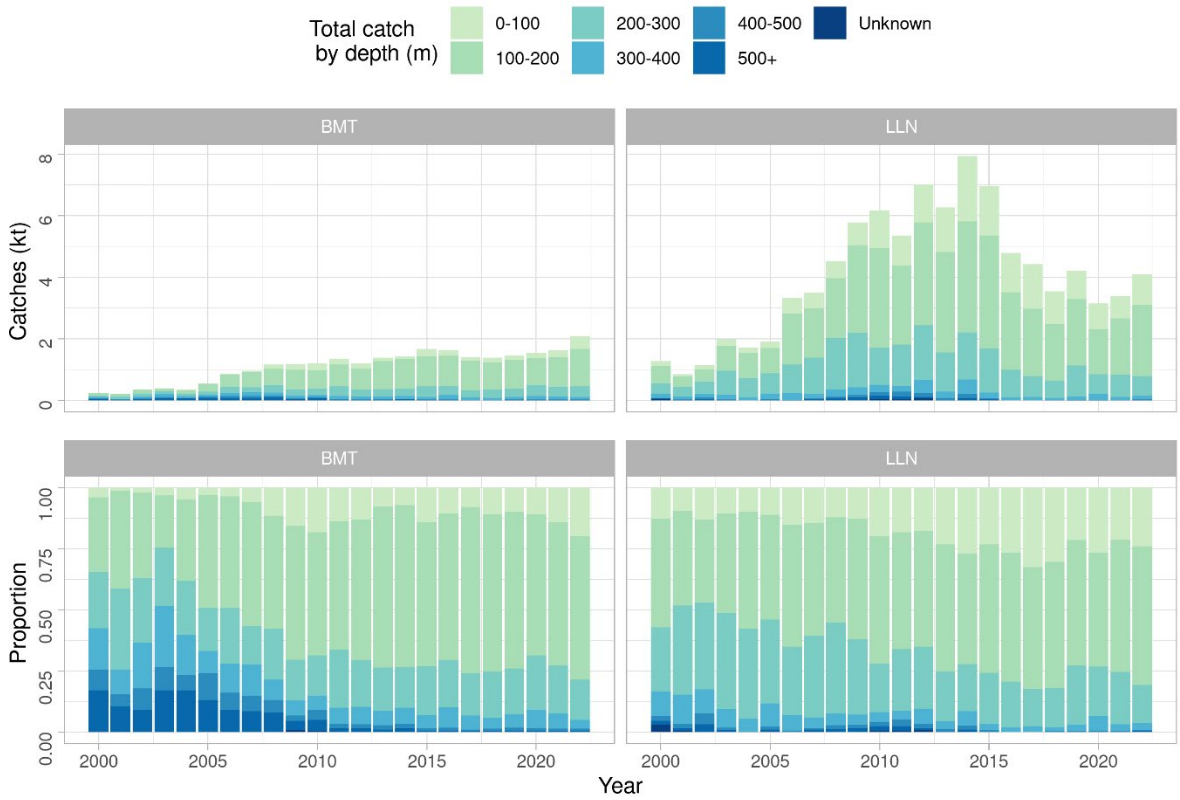

Figure 3.4.2: Ling in 5.a. Depth distribution of catches in 5.a according to logbooks. Bottom trawl (BMT) is on the left and longline (LLN) on the right.

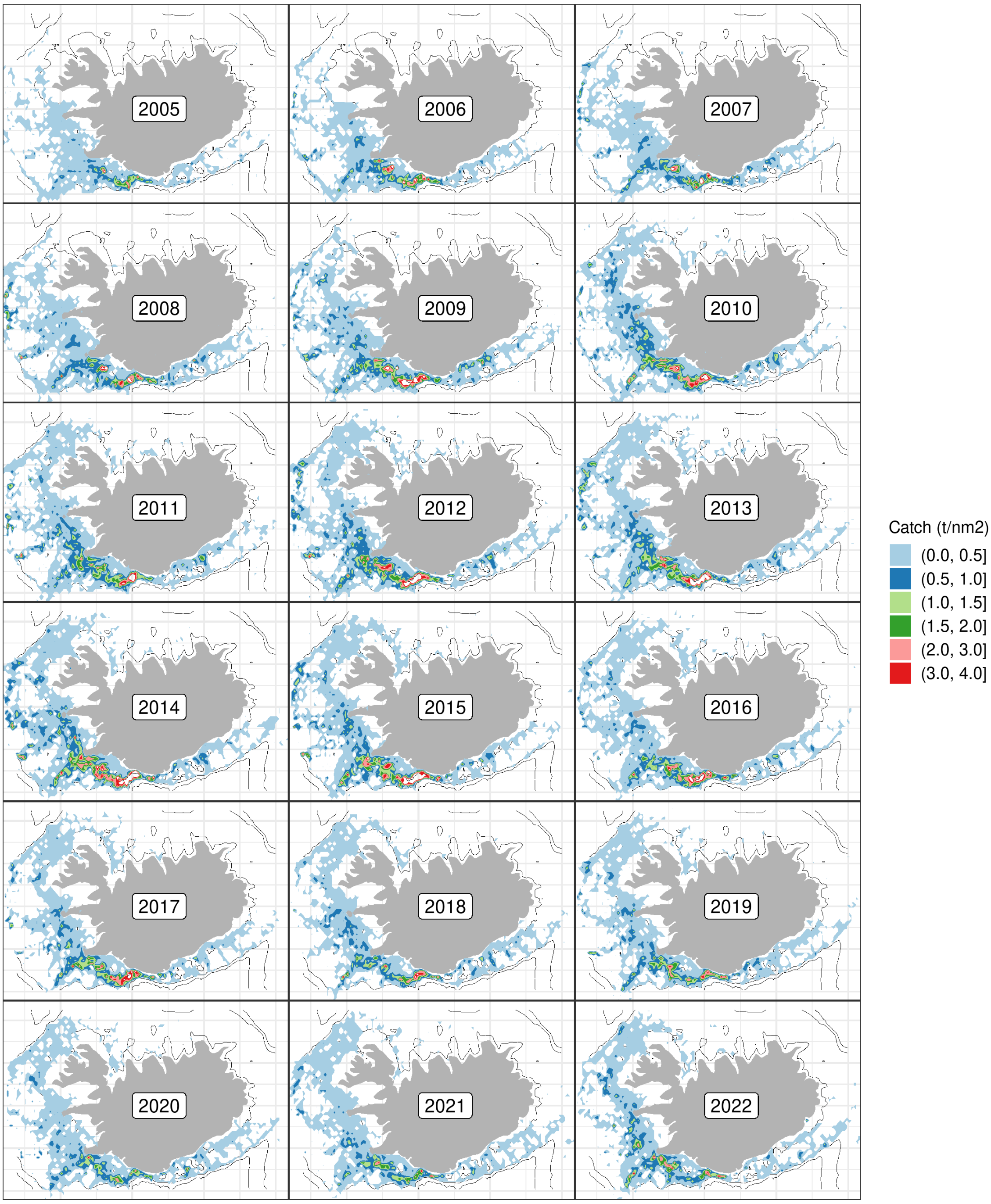

Figure 3.4.3: Ling in 5.a. Spatial distribution of the Icelandic fishery catches as reported in logbooks. All gears combined.

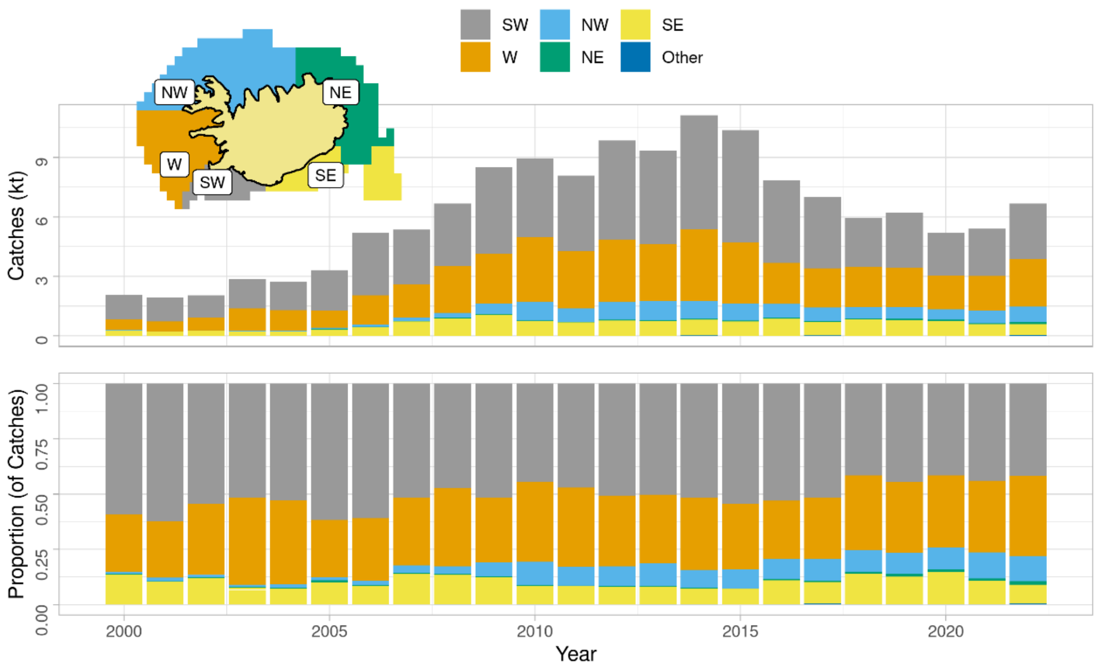

Figure 3.4.4: Ling in 5.a. Changes in spatial distribution of the Icelandic fishery as reported in logbooks. All gears combined.

3.4.2 Landing trends

In 1950 to 1971, landings of ling in Icelandic waters ranged between 7000 to more than 15000 tonnes. Landings decreased between 1972 and 2000 to as little as 3000 tonnes as a result of most foreign vessels being excluded from the Icelandic EEZ. In 2001-2010, catches increased constantly and reached 11000 tonnes in 2010 and remained at that level for the most part until 2014, when the catches increased to 14000 tonnes. Since 2014, ling catches have reduced and in 2022. 7657 tons were landed (Table 3.4.2 and Figure 3.4.5).

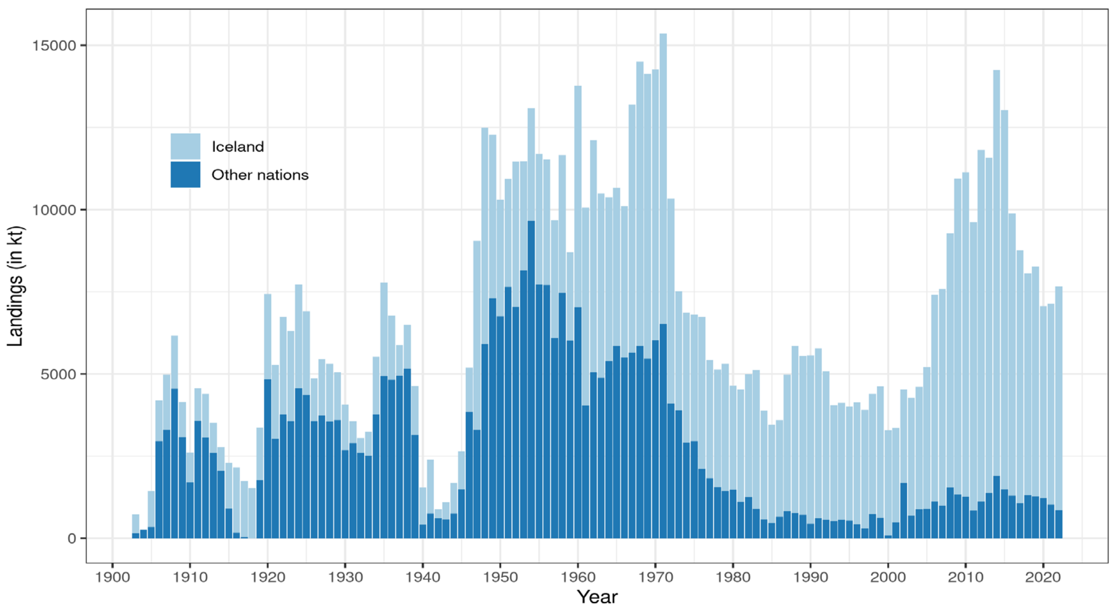

Figure 3.4.5: Ling in 5.a. Landings in 5.a

Table 3.4.2: Ling in 5.a. Percentage of landed catch by gear as reported from logbooks in 5.a.

Year	Bottom trawl	Gill nets	Longlines	Other	Total
1995	35	24	36	5	3552
1996	35	20	39	6	3747
1997	31	17	46	6	3607
1998	29	20	46	5	3695
1999	26	17	54	3	4003
2000	28	22	48	2	3214
2001	22	37	38	3	2881
2002	30	23	45	2	2845
2003	24	13	62	1	3590
2004	26	15	54	5	3727
2005	35	12	47	6	4315
2006	27	10	59	4	6285
2007	25	10	61	4	6599
2008	25	6	65	4	7741
2009	26	8	65	4	9616
2010	30	4	66	4	9868
2011	30	3	64	3	8789
2012	23	2	70	5	10695
2013	28	3	66	3	10257
2014	22	5	71	2	14246
2015	24	6	67	3	13035
2016	28	8	61	3	9884
2017	27	7	64	2	8766
2018	31	6	60	3	8062
2019	29	2	67	2	8269
2020	34	2	61	3	7061
2021	34	2	62	2	7128
2022	33	4	60	3	7657

3.4.3 Data available

In general sampling is considered good from commercial catches from the main gears (longlines and trawls). 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 (Figure 3.4.6, ICES (2012)).

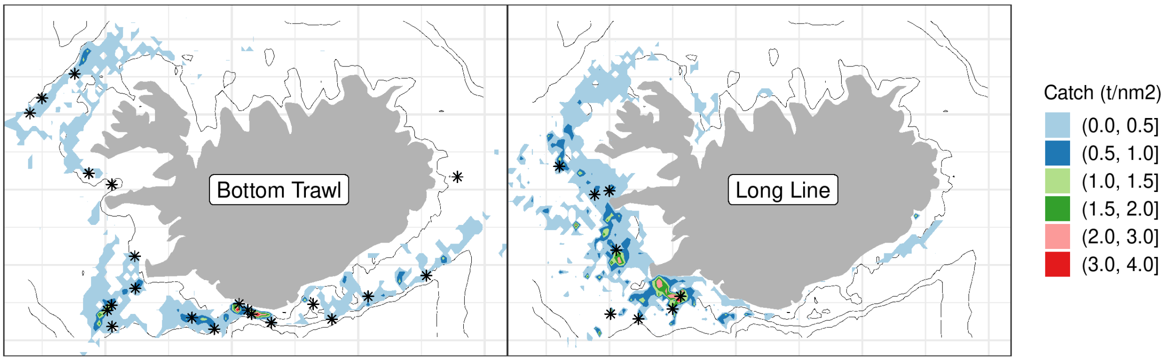

Figure 3.4.6: Ling in 5.a. Fishing grounds in 2022 as reported by catch in logbooks (tiles) and positions of samples taken from landings (asterisks) by longliners and trawlers.

3.4.4 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 long-line fishery for ling are estimated very low (<1% in either numbers or weight) (ICES (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 stock annex and Iceland fisheries overview (ICES (2022) and ICES (2019).

3.4.5 Length composition

An overview of available length measurements is given in table 3.4.3. 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 3.4.7. Sampling from commercial catches of ling is considered good; both in terms of spatial and temporal distribution of samples (Figure 3.4.6). Mean length as observed in length samples from catches decreased from 2005-2008 from around 86 to 80 cm (Figure 3.4.7). This may be the result of increased recruitment in recent years rather than increased fishing effort. Mean length has gradually increased since 2015 and the mean length in 2022 was the highest recorded, or 99 cm. 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 10; but from longlines the age is between 6 to 11.

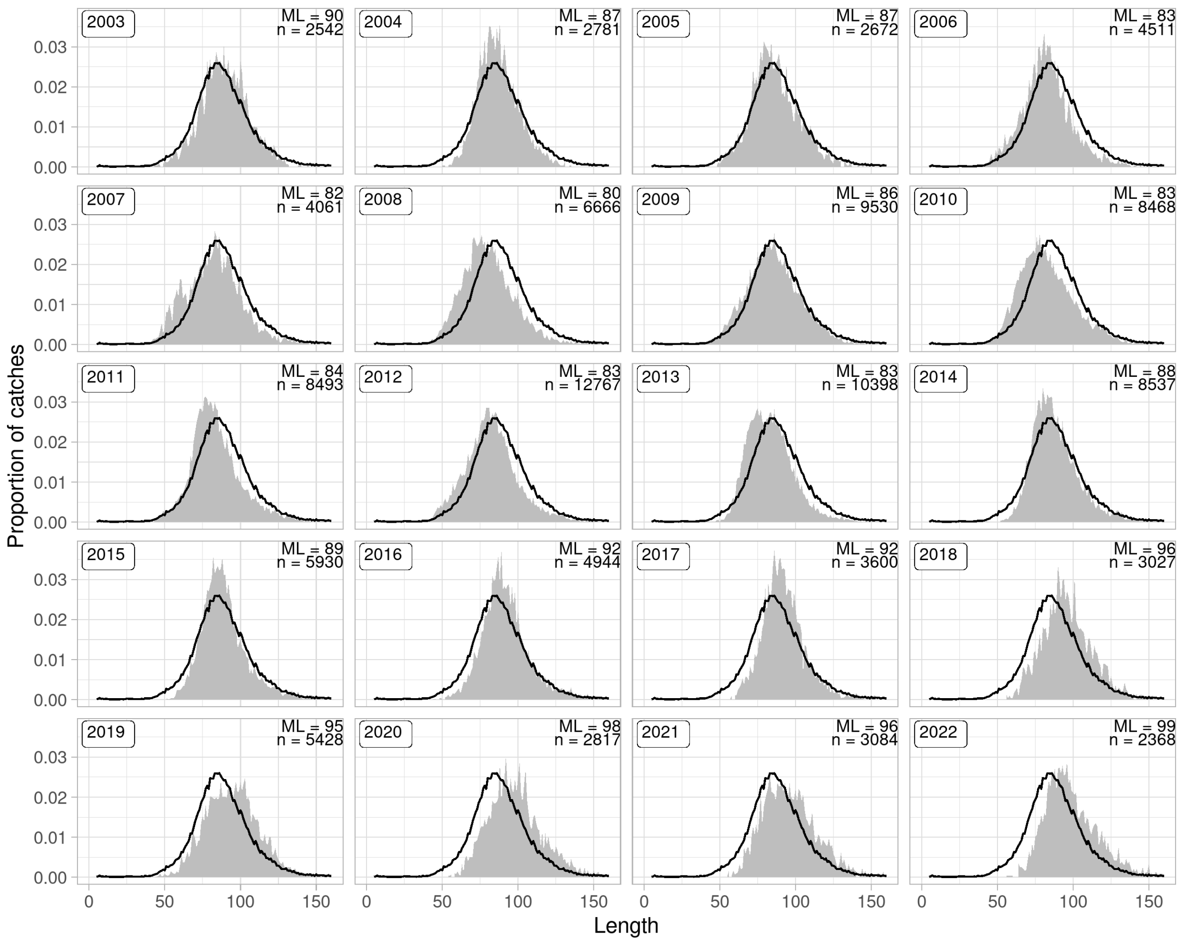

Figure 3.4.7: Ling in 5.a. Length distribution from the Icelandic fleet (grey area) from 2003-2022. Black line is the average mean of the period.

Table 3.4.3: Ling in 5.a. Number of available length and age measurements from Icelandic commercial catches.

Year	Length measurements					Age measurements					
	BMT	DSE	GLN	LLN	Other	LLN	GIL	DSE	BMT	Other	Total
2000	383	0	566	1624	6	650	200	0	150	0	1000
2001	37	0	493	1661	0	550	193	0	37	0	780
2002	221	0	366	1504	0	519	166	0	150	0	835
2003	280	0	300	2404	143	900	100	0	100	50	1150
2004	141	46	348	2640	150	750	50	46	100	50	996
2005	499	101	31	2323	180	750	0	0	181	50	981
2006	1558	0	645	3354	405	1138	289	0	450	100	1977
2007	400	76	0	3661	0	1300	0	50	100	0	1450
2008	969	15	357	5847	150	1950	150	0	315	50	2465
2009	966	0	410	9014	450	2550	150	0	250	150	3100

Year	Length measurements					Age measurements					
2010	1200	0	57	7322	1200	2498	50	0	450	400	3398
2011	1995	150	0	7248	750	2546	0	50	450	250	3296
2012	2748	150	85	12770	1337	3526	50	50	541	400	4567
2013	2337	122	267	10771	1344	2590	100	50	350	450	3540
2014	5053	120	1286	6448	2964	665	225	20	399	514	1823
2015	5667	0	1563	3315	3052	595	300	0	484	520	1899
2016	3673	0	2039	2483	1212	440	345	0	460	220	1465
2017	3189	0	485	1637	1226	310	85	0	370	225	990
2018	1603	0	559	1424	712	245	100	0	310	120	775
2019	1830	0	0	3598	819	385	0	0	340	140	865
2020	1718	0	4	1099	498	225	40	0	355	102	722
2021	2028	0	0	1056	466	180	0	0	398	100	678
2022	1805	0	370	497	1600	163	80	0	400	338	981

3.4.6 Age composition

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 (ICES (2011):WD07). Substantial progress has been made since 2010. Now aged otoliths are available from the 2000 onwards (Table 3.4.3). 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.

3.4.7 Catch, effort and research vessel data

3.4.7.1 CPUE and effort

The CPUE estimates of ling in Icelandic waters have not been considered representative of stock abundance.

3.4.7.2 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. 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. In addition, a gillnet survey is conducted in areas closer inshore every April during cod spawning periods, designed to sample the cod spawning stock. A detailed description of the Icelandic spring, autumn groundfish surveys and the gillnet surveys are given in the stock annex. Figure 3.4.8 shows both a recruitment index and the trends in biomass from both surveys. Length distributions from the spring survey are shown in Figure 3.4.9 (abundance) and changes in spatial distribution in the spring survey are presented in Figure 3.4.10.

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 3.4.8). In the years 1995 to 2003 these indices were half of the mean from 1985–1989. In 2003 to 2007, the indices gradually increased until 2017. Since then, indices have decreased. The index of the large ling (80 cm and larger) shows similar trend as the total biomass index (Figure 3.4.8). The recruitment index of ling, defined here as ling smaller than 40 cm, also showed a similar increase in 2003 to 2007 and but then decreased by around 25% and remained at that level until 2010. Then the juvenile index fell to a very low level in 2014 and has fluctuated at a low level since. (Figure 3.4.8). However, 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 3.4.8).

The shorter autumn survey shows that biomass indices were low from 1996 to 2000 but have increased since then (Figure 3.4.8). 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 shows much lower recruitment, in absolute terms compared with the spring survey (Figure 3.4.8). This discrepancy is likely a result of much lower catchability of small ling (due to different gears) in the autumn survey, where ling less than 40 cm has rarely been caught.

April (gillnet) survey indices at length and age were available from 2002. Northern extensions to the survey were added in 2002 so 1998 - 2001 data were excluded. ALKs from the spring survey were used directly as this survey occurs directly after that spring survey.

Changes in spatial distribution as observed in surveys: According to the spring survey, most of the increase since 2010 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.

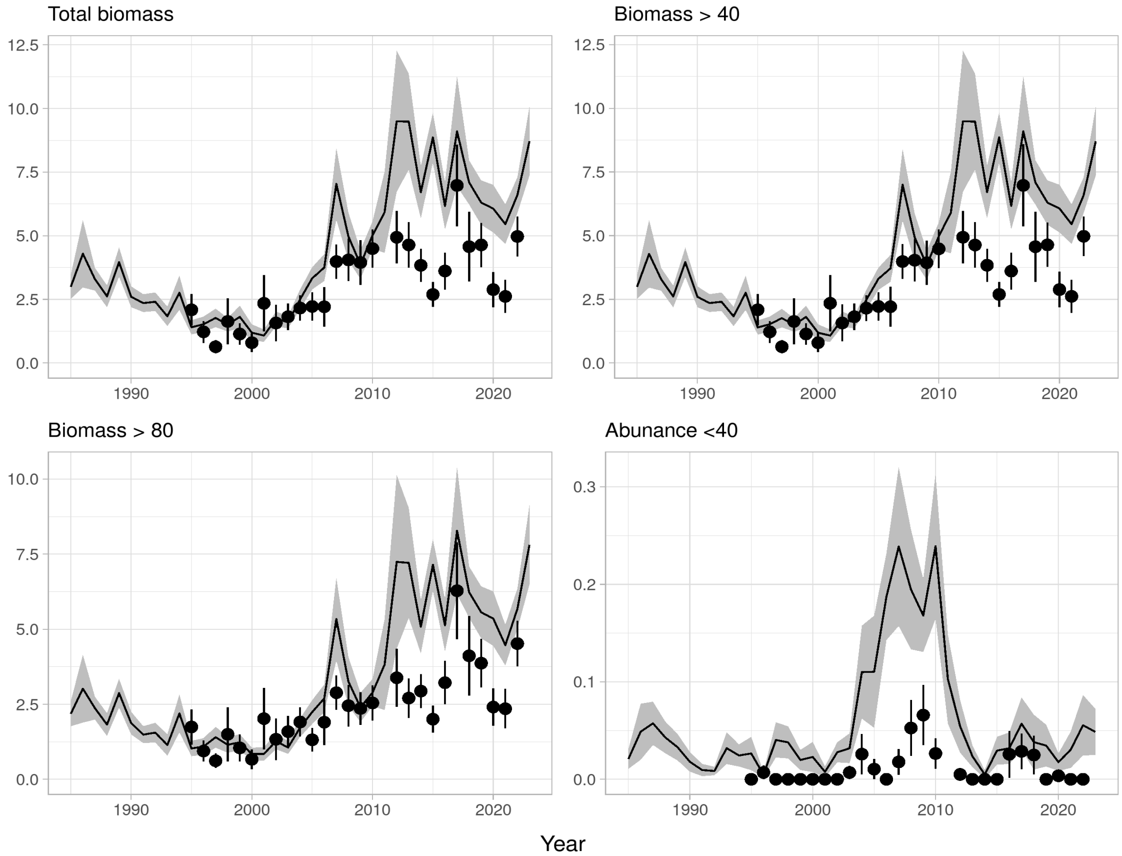

Figure 3.4.8: Ling in 5.a. Total biomass indices, biomass indices larger than 40 cm, biomass indices larger than 80 cm and abundance indices <40 cm. The lines with shaded area show the spring survey index from 1985 and the points with the vertical lines show the autumn survey from 1997. The shaded areas and vertical lines indicate +/- standard error.

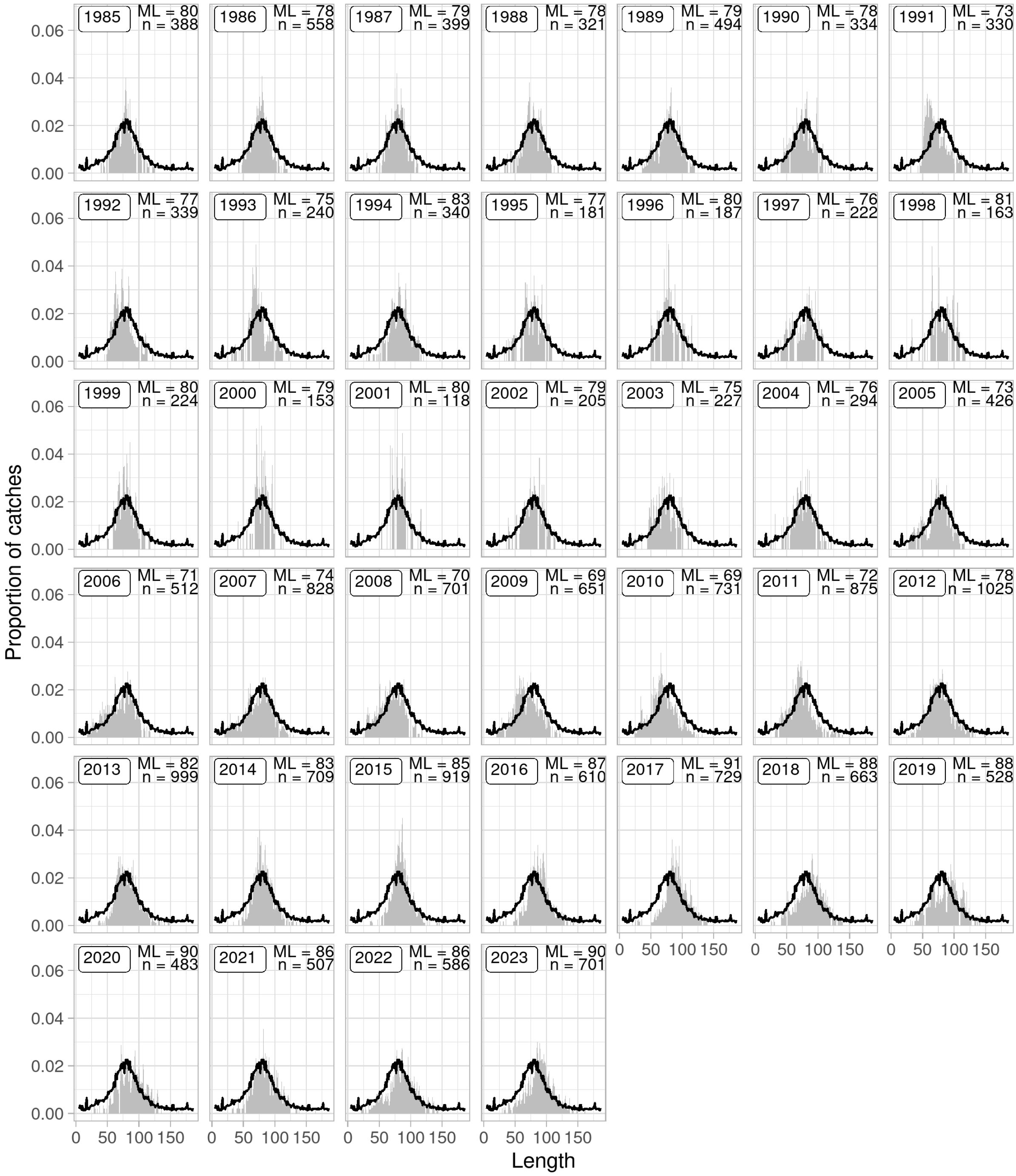

Figure 3.4.9: Ling in 5.a. Length distribution (grey area) from the spring survey. Black lines are the average mean of the period.

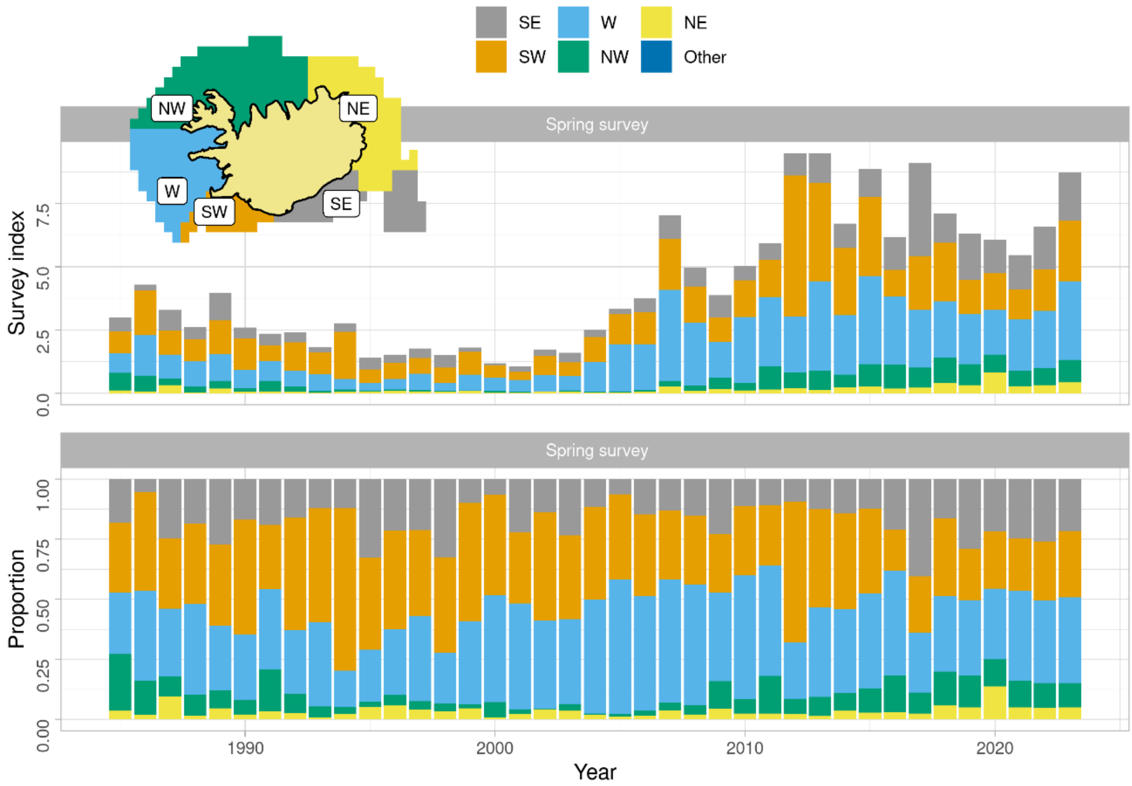

Figure 3.4.10: Ling in 5.a. Estimated survey biomass in the spring survey by year from different parts of the continental shelf (upper figure) and as proportions of the total (lower figure).

3.4.8 Data analyses

3.4.8.1 Analytical assessment using SAM

In 2022, Ling in 5.a was re-assessed as the previously benchmarked Gadget model had begun to show great instability in retrospective patterns in recent years. As a part of a Harvest Control Evaluation requested by Iceland, the stock was benchmarked (WKICEMSE 2022) which resulted in changes in the assessment method and updated reference points. Model setup and settings are described in the Stock Annex (ICES 2022).

3.4.8.2 Data used and model settings

Data used for tuning are given in the stock annex.

3.4.9 Diagnostics

3.4.9.1 Model fit

Figure 3.4.13 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 group. Summed up over survey biomass the model overestimates the biomass in the terminal years.

The model fit to survey indices and catch are shown in figure 3.4.11.

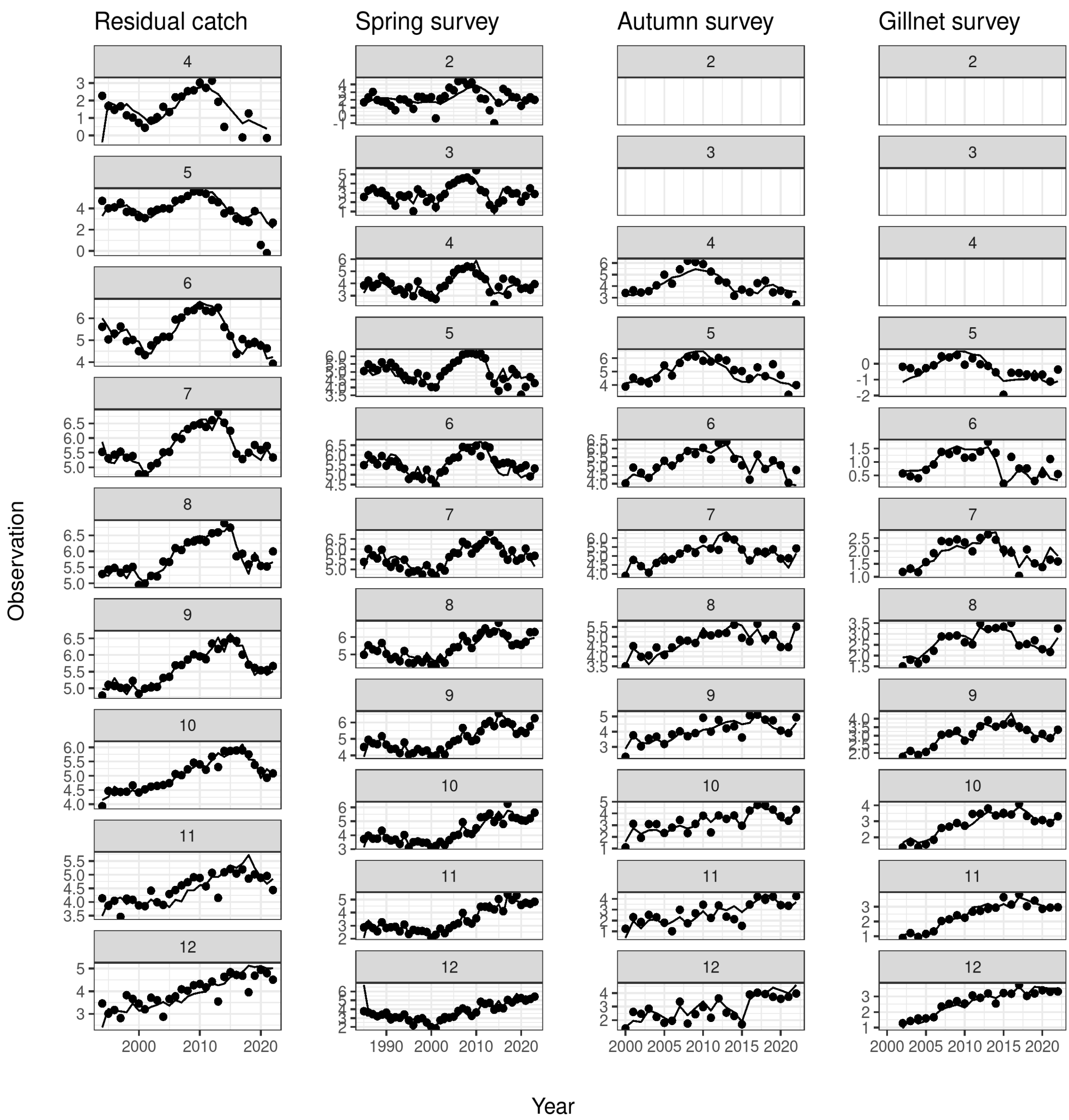

Figure 3.4.11: Ling in 5.a. Model fit to catches, spring survey, autumn survey and gillnet indices. Black dots are observed values and the black line is the model fit.

Figure 3.4.12: Ling in 5.a. Model results of population dynamics overview: estimated catch, average fishing mortality over ages 8 - 11 (Fbar), recruitment (age 2), and spawning stock biomass (SSB).

3.4.10 Results

Population dynamics of the ling estimated in this model show a clear trend of a high recruitment period from 2004 - 2010, corresponding with increased spawning stock biomass (SSB) and catches during the 2010 - 2019 period. Despite this trend, fishing mortality has remained rather steady or slightly declined (Fig. 3.4.12).

3.4.10.1 Retrospective analysis

The results of an analytical retrospective analysis are presented. The analysis indicates that there was an upward revision of biomass over the first 2 years of the 5-year peel followed by a downward revision of biomass (SSB) over the last 3 years, and subsequently a downward then upward revision of F. This period of larger retrospective patterns is the result of rapidly changing biomass levels. Estimates of recruitment are decently stable except for the apparent peak in 2017 - 2018. As explained in reference to the survey indices, this is likely the influence of highly variable survey indices that, for the smallest sizes in the most recent years, have no repeated observations at larger sizes with which this influence can be tempered. Therefore, it is expected that these recruitment peaks may simply be the result of uncertainty in survey indices and are likely to disappear in the coming assessment years.

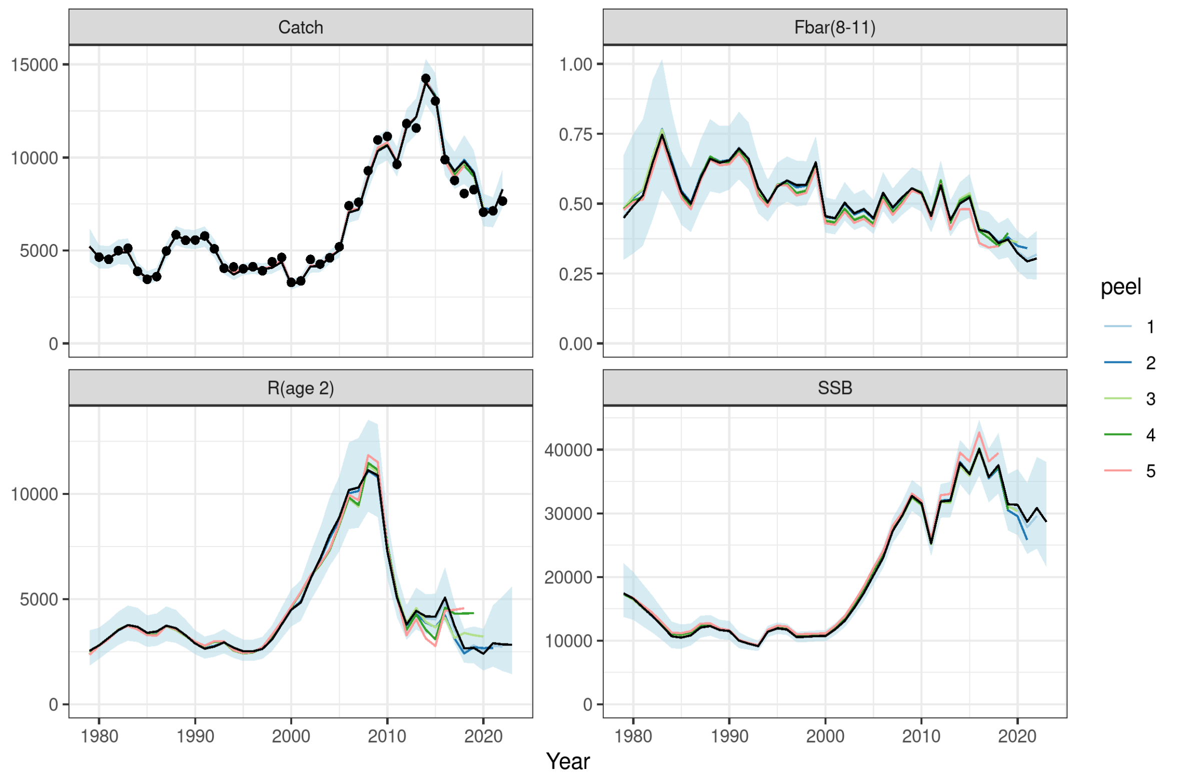

Figure 3.4.13: Ling in 5.a. Retrospective plots illustrating stability in model estimates over a 5-year 'peel' in data. Results of spawning stock biomass, fishing mortality F, and recruitment (age 2) are shown.

Mohn's rho was estimated to be -0.0301 for SSB, 0.0720 for F, and 0.312 for recruitment.

Neither observation nor process residuals show obvious trends (Figs. 3.4.14 and 3.4.15).

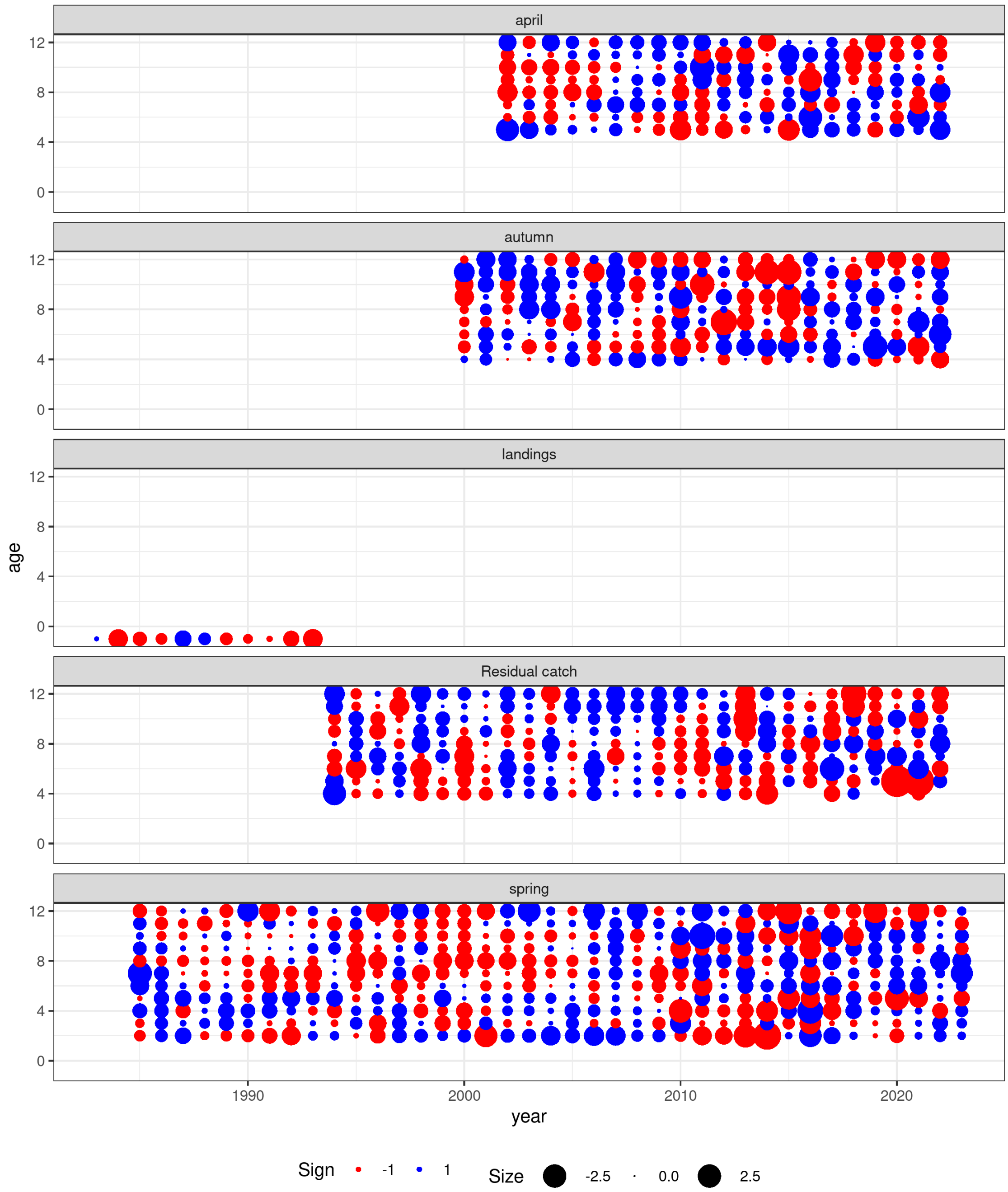

Figure 3.4.14: Ling in 5.a. Observation error residuals of the SAM model.

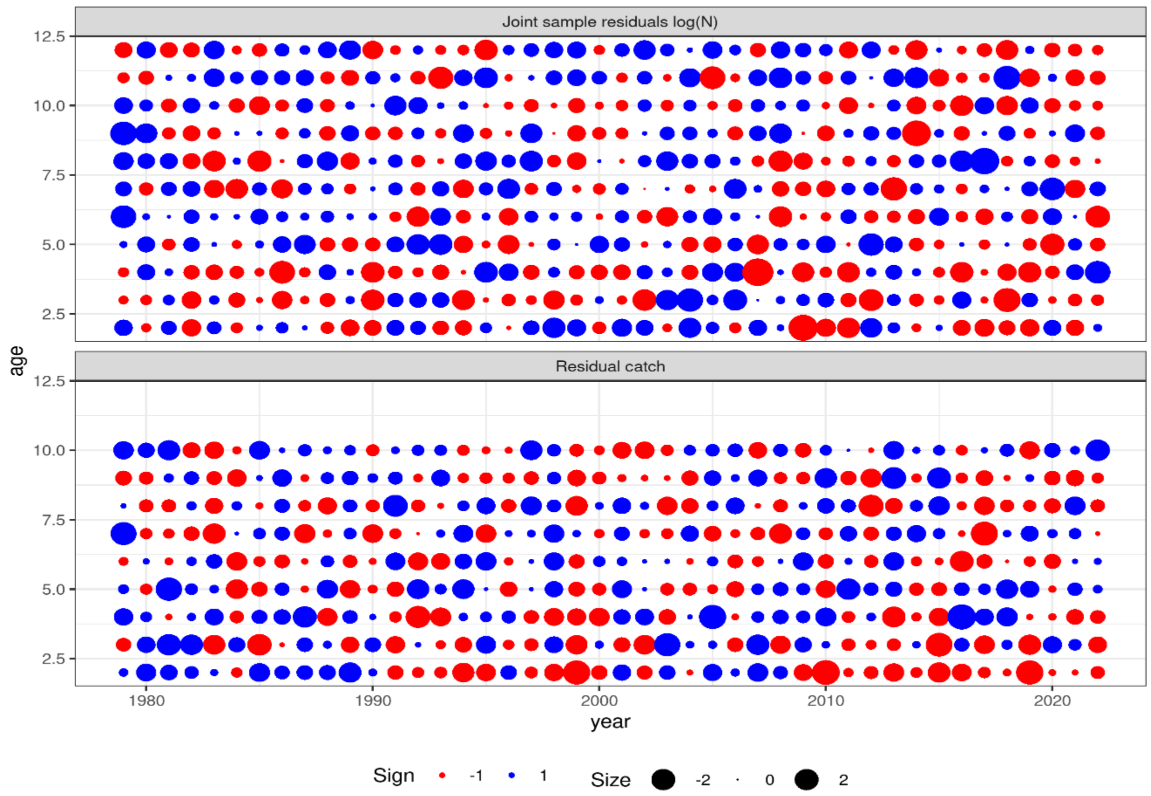

Figure 3.4.15: Ling in 5.a. Process error residuals of the SAM model.

3.4.10.2 Reference points

As part of the WKICEMSE 2022 HCR evaluations, the following reference points were defined for the stock (Table 3.4.4).

Table 3.4.4: Ling in 5.a Reference points adopted from ICES 2022

Framework	Reference point	Previous value	Revised value	Revised technical basis
MSY Approach	MSY $B_{trigger}$	9930	11100	B_{pa}
	F_{MSY}	0.28	0.30	F that produces MSY in the long term
Precautionary Approach	B_{lim}	7090	9000	B_{loss} (SSB in 1993)
	B_{pa}	9930	11100	$B_{lim} \times e^{1.645*\sigma B}$, using the default σ_B=0.2
	F_{lim}	0.70	0.95	Fishing mortality that in stochastic equilibrium will result in median SSB at B_{lim}
	F_{pa}	0.41	0.62	F_{p05}, maximum F at which the probability of SSB falling below B_{lim} is <5%
Management plan	MGT $B_{trigger}$	9930	11100	No lower than MSY $B_{trigger}$
	F_{MGT}	*	0.30	No higher than F_{msy}

*** The previously used HCR was based on a harvest rate (HR) relative to stock reference biomass, so no F_{MGT} was used**

The management plan proposed by Iceland is:

The proposed HCR for the Icelandic Ling fishery, which sets a TAC for the fishing year y/y+1 (September 1 of year y to August 31 of year y+1) based on a fishing mortality F_{MGT} of 0.30 applied to ages 8 to 11 modified by the ratio SSB_y/MGT $B_{trigger}$ when SSB_y < MGT $B_{trigger}$, maintains a high yield while being precautionary as it results in lower than 5% probability of SSB < B_{lim} in the medium and long term. WKICEMSE 2022 concluded that the HCR was precautionary and in conformity with the ICES MSY approach.

3.4.11 Management

The Icelandic Ministry of Food, Agriculture and Fisheries 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 MFRI and the set TAC from 2002/2003 to 2013/2014 but amounted to less than two thirds in 2015/2016 (Table 3.4.5). 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 (Figure 3.4.17) and additional catches by Norway and the Faroe Islands, taken in accordance with 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.

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 (ICES 2022).

Table 3.4.5: Ling in 5.a. TAC recommended for ling in 5.a by the Marine and Fisheries Research Institute, national TAC and total landings.

Fishing Year	MFRI Advice	National TAC	Landings
1999/00			3 961
2000/01			3 451
2001/02	3 000	3 000	2 968
2002/03	3 000	3 000	3 715
2003/04	3 000	3 000	4 608
2004/05	4 000	4 000	5 238
2005/06	4 500	5 000	6 961
2006/07	5 000	5 000	7 617

Fishing Year	MFRI Advice	National TAC	Landings
2007/08	6 000	7 000	8 560
2008/09	6 000	7 000	10 489
2009/10	6 000	7 000	10 713
2010/11	7 500	7 500	10 095
2011/12	8 800	9 000	11 133
2012/13	12 000	11 500	12 445
2013/14	14 000	13 500	14 983
2014/15	14 300	13 800	13 166
2015/16	16 200	15 000	11 229
2016/17	9 343	8 143	8 426
2017/18	8 598	7 598	8 573
2018/19	6 255	5 200	8028
2019/20	6 599	5299	7154
2020/21	5700	5700	7214
2021/22	4735	4735	6699
2022/23	6098	6098	
2023/24	6566		

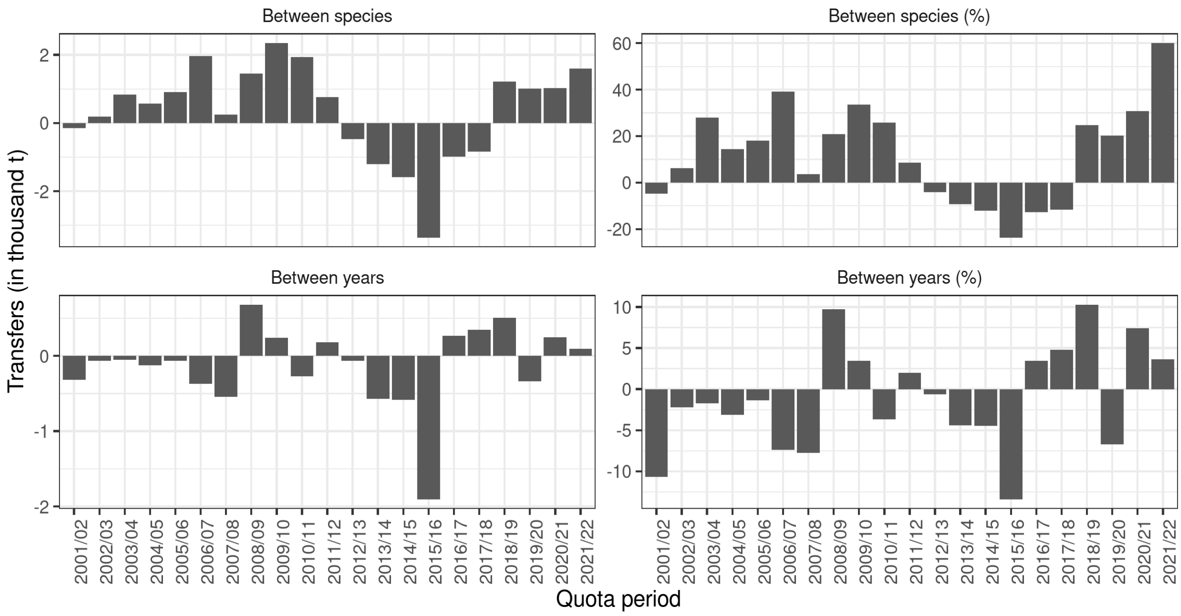

Figure 3.4.16: Ling in 5.a. Net transfer of quota in the Icelandic ITQ system by fishing year. Between species (upper): Positive values indicate a transfer of other species to ling, but negative values indicate a transfer of ling quota to other species. Between years (lower): Net transfer of quota for a given fishing year (may include unused quota).

3.4.12 Management considerations

All the signs from commercial catch data and surveys indicate that ling is at present in a good state, even though the survey indices show downward trend in most recent years. This is confirmed in the SAM 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 exploitation pattern as the selectivity of the gillnet fleet is substantially different from other fleets.

Table 3.4.6: Ling in 5.a. Landings (tonnes) by country in 5.a.

Year	Faroe Islands	Germany	Iceland	Norway	UK
2002	1631	0	2843	45	0
2003	570	2	3585	108	5
2004	739	1	3727	139	0
2005	682	3	4313	180	20
2006	962	1	6283	158	0
2007	807	0	6599	185	0
2008	1366	0	7738	179	0
2009	1157	0	9616	172	0
2010	1095	1	9868	168	0
2011	588	0	8789	249	0
2012	875	0	10695	248	0
2013	1030	0	10198	294	0
2014	1738	0	12350	158	0
2015	1233	0	11552	250	0
2016	1072	0	8583	230	0
2017	829	0	7692	244	0
2018	1103	0	6756	203	0
2019	1093	0	6992	184	0
2020	989	0	5836	237	0
2021	926	0	6110	91	0

2022	726	0	6799	132	0

Table 3.4.7. Ling in 5.a. Estimates of spawning–stock biomass (SSB) in thousands of tonnes, recruitment at age 2 (thousands), fishing mortality over ages 8 - 11 (Fbar) and catch from SAM.

Year	Recruitment			SSB			Total	F		
	Age 2	97.5%	2.5%		97.5%	2.5%	Catch	Ages 8-11	97.5%	2.5%
	thousands			tonnes			tonnes			
1979	2537	3519	1830	17430	22167	13705	5224	0.45	0.67	0.30
1980	2798	3637	2153	16600	20783	13260	4616	0.49	0.75	0.32
1981	3157	3989	2499	15202	18903	12226	4587	0.53	0.80	0.35
1982	3520	4404	2814	13849	17068	11237	4877	0.64	0.94	0.44
1983	3762	4690	3017	12300	15011	10079	4897	0.75	1.02	0.55
1984	3679	4584	2953	10678	12993	8775	3919	0.64	0.83	0.50
1985	3394	4225	2727	10472	12538	8746	3512	0.54	0.69	0.42
1986	3459	4313	2774	10832	12694	9244	3693	0.50	0.63	0.40
1987	3733	4653	2995	12052	13905	10445	4939	0.59	0.73	0.48
1988	3615	4481	2917	12283	14028	10756	5781	0.66	0.80	0.54
1989	3282	4025	2676	11664	13280	10245	5592	0.65	0.78	0.54
1990	2887	3511	2374	11501	13105	10093	5574	0.66	0.78	0.55
1991	2641	3215	2170	9999	11353	8807	5715	0.70	0.83	0.59
1992	2744	3341	2254	9519	10572	8571	5079	0.66	0.79	0.55
1993	2939	3572	2418	9125	9956	8363	4110	0.56	0.67	0.47
1994	2686	3281	2199	11408	12332	10552	3705	0.51	0.59	0.44
1995	2516	3076	2057	11925	12869	11050	3978	0.56	0.65	0.49
1996	2513	3069	2058	11737	12660	10883	4052	0.58	0.67	0.51
1997	2627	3202	2156	10554	11411	9760	3982	0.57	0.65	0.49
1998	3077	3748	2527	10603	11498	9777	4075	0.57	0.65	0.49
1999	3793	4613	3119	10709	11604	9883	4374	0.65	0.74	0.57
2000	4492	5457	3697	10722	11639	9878	3161	0.46	0.52	0.40
2001	4840	5902	3969	11752	12734	10846	3357	0.45	0.51	0.39
2002	5956	7216	4917	13091	14177	12089	4140	0.50	0.58	0.44
2003	6907	8385	5689	15156	16416	13993	4159	0.47	0.54	0.41

Year	Recruitment			SSB			Total	F		
2004	8029	9817	6567	17497	18897	16200	4622	0.48	0.55	0.42
2005	8874	10835	7269	20260	21843	18792	5007	0.45	0.51	0.39
2006	10180	12445	8327	22996	24733	21380	7039	0.54	0.61	0.47
2007	10300	12652	8386	27233	29291	25319	7202	0.49	0.55	0.43
2008	11126	13521	9154	29652	31942	27527	8912	0.52	0.59	0.46
2009	10876	13310	8887	32733	35253	30393	10343	0.56	0.63	0.49
2010	7274	8853	5976	31570	34090	29236	10648	0.54	0.61	0.47
2011	5064	6196	4139	25283	27454	23284	9731	0.46	0.53	0.40
2012	3793	4695	3065	31846	34606	29306	11617	0.57	0.66	0.49
2013	4438	5542	3554	32020	34943	29342	12171	0.44	0.51	0.38
2014	4175	5227	3335	37907	41531	34599	14026	0.50	0.58	0.43
2015	4162	5253	3297	36146	39872	32767	13252	0.52	0.61	0.45
2016	5069	6518	3941	40095	44712	35956	9996	0.41	0.48	0.35
2017	3721	4825	2870	35692	40163	31718	9254	0.40	0.47	0.34
2018	2658	3586	1970	37573	42622	33122	9800	0.36	0.43	0.30
2019	2676	3697	1937	31434	36157	27328	9166	0.37	0.45	0.31
2020	2397	3587	1602	31337	36954	26574	7121	0.32	0.40	0.26
2021	2900	4708	1786	28673	34807	23620	7005	0.29	0.37	0.23
2022	2845	5130	1578	30836	38868	24464	8284	0.30	0.40	0.23
2023	2828	5603	1428	28657	38100	21555	6762			

3.4.13 Ecosystem considerations

In 2010 to 2013, the distribution of ling expanded to the north and recruitment peaked (Figure 3.4.3 and Figure 3.4.8). These suggest favourable environmental conditions during this time; however, recruitment has returned to previous levels and therefore biomass levels are naturally expected to follow. In addition, there have been no obvious changes in maturity patterns or growth through time. Demographic patterns of ling should be monitored as other Icelandic demersal species have exhibited recent changes (e.g., haddock). Multispecies interactions are not currently considered to be a concern for the assessment.

3.4.14 References

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3.5 Ling (*Molva molva*) in subareas 3,4, 6–9, 12, and 14 (Northeast Atlantic and Arctic Ocean)

3.5.1 The fishery

Significant fisheries for ling are conducted in Subareas 3 and 4 at least since the 1870s pioneered by Swedish longliners. Since the mid-1900s, the major ling targeted fishery is Area 4.a. There Norwegian longliners fished around Shetland and in the Norwegian Deep. There are little catches in ICES Division 3.a. The Norwegian total landings in 2022 in Subareas 3 and 4 were: 72% taken by longlines, 18% by gillnets 9% by trawls, and the remainder by other gears. 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 central and southern North Sea (4.bc) are bycatches from various other fisheries.

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

Catches from Norwegian vessels in subareas 4 and 6 dropped from 5854 tonnes in 2020 to 1276 tonnes in 2021 as a consequence of a reduction in their access to British waters, and increased again to 7732 tonnes in 2022.

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

Landings in subareas 8 and 9, 12 and 14 are bycatches from various fisheries and are minor compared to subareas 4 and 6. In addition landings from Subarea 7 have been declining over the past 3 decades, and are now at low level whilst they were comparable to landings from subareas 4 and 6 30 years ago.

The Norwegian fishery

The Norwegian longline fleet increased from 36 in 1977 to a peak of 72 in 2000, and afterwards the number of vessels decreased and then stabilized at 26 in 2015 to 2018 but increased to 30 in 2020. 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 Divisions 4.a and 6.a. During the period 1974 to 2020 the total number of hooks per year has varied considerably, but with a downward trend since 2000. This is also reflected in the number of fishing days (Figure 3.5.1).

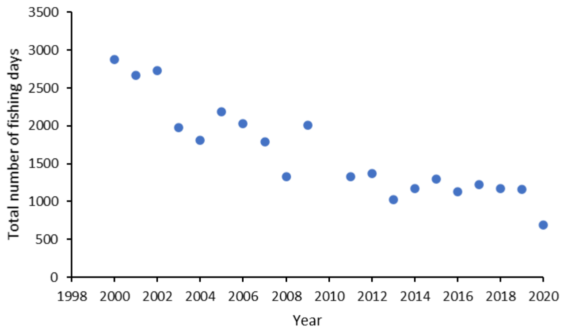

Figure 3.5.1. Ling in subareas 3,4, 6–9, 12, and 14, total fishing days by the Norwegian longliners (2000-2020).

The French fishery

French vessels operating in 6, 7b-k are mainly otter trawlers, gillnetters and longliners.

The number of otter trawlers operating in the region has decreased from around 70 in the beginning of 2000 to 28 in 2018. Gillnetters have varied from 24 vessels in 2005 to 5 in 2016. In 2018, the number of vessels increased to 14. The number of longliners has increased from 1 in 2000 to 16 in 2019 (Table 3.5.3).

Since 2000, otter trawlers effort has decreased by a factor of 2. Gillnetters had a peak effort in mid-2000 followed by a steep decrease by a factor of 5 since 2010 as increase in 2017 and 2018. The recorded fishing efforts by longliners were imprecise due to lack of information in the first part of the 2000s. The activity seems to have peaked in 2007 followed by a sharp decrease to 2009. Since 2009, the effort has been steadily increasing (Figure 3.5.13).

Landings of ling by otter trawlers increased from 2004 to 2014, and since declined. For gillnetters and longliners, landings are closely related to changes in efforts.

The Spanish fishery

The bulk of Spanish landings since 2012 are from Division 6.a. The Spanish catches of ling in ICES Subarea 7, are mostly in divisions b, c and g–k, and are mainly taken by longliners. However, there are also important bycatches of ling by trawlers operating in the Subarea 7. Porcupine Bank is an important fishing area for the Spanish trawlers.

3.5.2 Landings trends

Landing statistics for ling by country and area in the period 2001–2021 are in section 3.5.12 and in Figures 3.5.2 and 3.5.3. For the early time-series, from 1988 to 2000, only international landings by area are presented (table 3.5.2), see stock annex for details of landings by country and area before 2000. Detailled landings by area and country are presented for the time-series 2001-2021 only (Tables 3.5.1a to 3.5.1n in section 3.5.12).

There was a decline in landings from 1988 to 2003, and since landings have been stable and slightly increasing until 2019, a marked decreased occurred in 2020 and 2021. In 2022, landings increased again to a level similar to year 2016-2019, at 18 556 tonnes (preliminary figure).

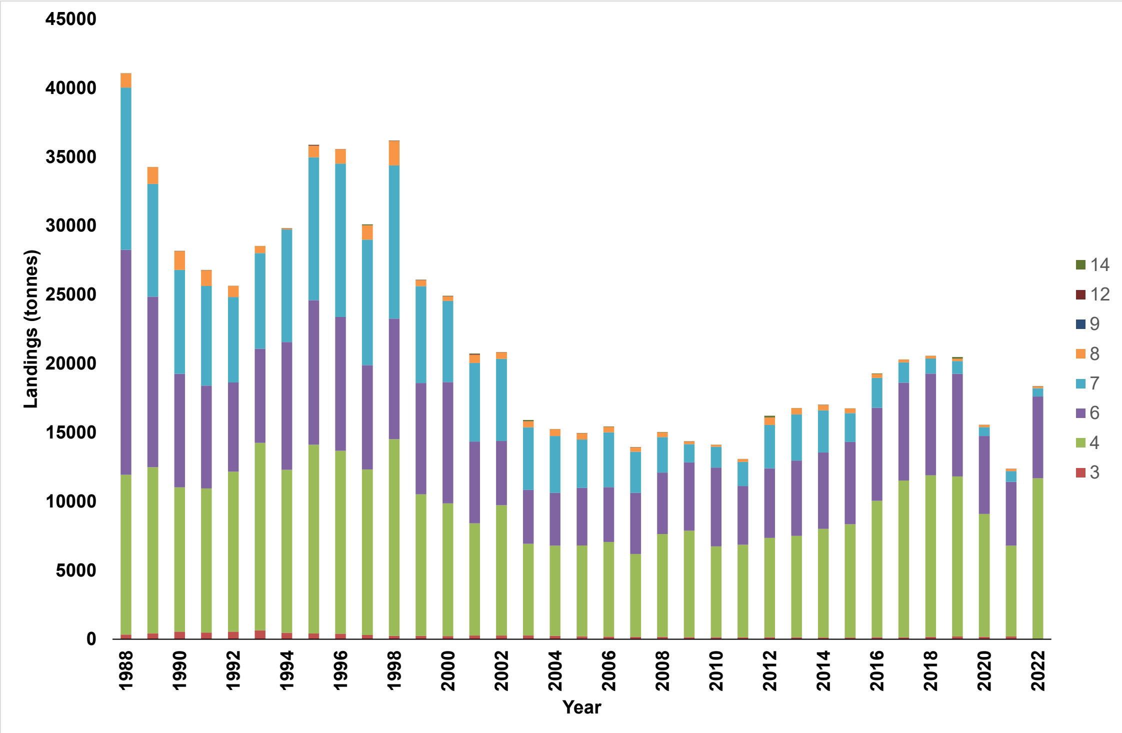

Figure 3.5.2. International landings of ling in subareas 3,4, 6–9, 12, and 14 from 1988 to 2022.

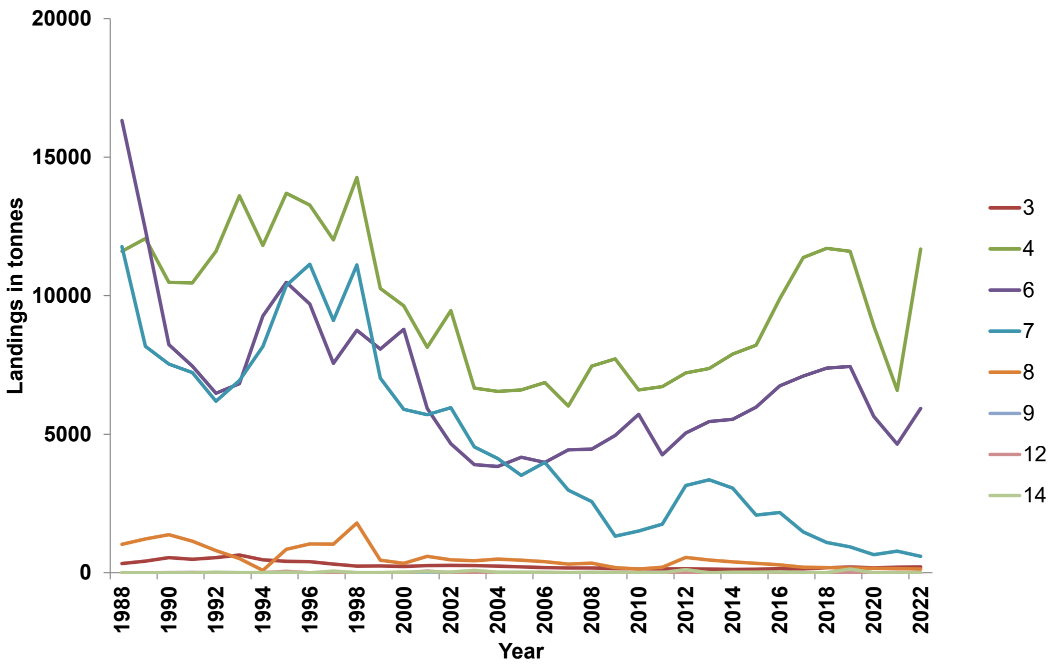

Figure 3.5.3. International landings of ling in subareas 3,4, 6–9, 12, and 14 from 1988 to 2022.

3.5.3 ICES Advice

Advice for 2022 to 2023: "ICES advises that when the precautionary approach is applied, catches should be no more than 15 092 tonnes in each of the years 2022 and 2023".

3.5.4 Management

Norway has a licensing scheme in EU waters, and in 2020 the Norwegian quota in EU waters is 8000 t. The Faroe Islands has a quota of 200 t in Divisions 6.a and 6.b. The quota for the EU in Norwegian waters of Subarea 4 was set at 700 and 500 tonnes respectively in 2022 and 2023.

The Norwegian quota in EU waters decreases in 2021 and 2022 as a consequence of UK waters between separated from EU waters following the Brexit.

EU TACs in EU and international waters (2016-2020), EU and UK TAC in EU, UK and international waters in the stock area and EU quota in Norwegian waters 2016–2022.

	2016	2017	2018	2019	2020	2021	2022	2023
Division 3a	87 t	87	87	170	179	175	144	144
Subarea 4 (UK and EU waters)	2912	3494	3843	4035	4237	3813	3127	2577
Subarea 4 (Norwegian waters)	950	1350	1350	1350	1350	900	700	500
Subarea 6, 7,8, 9 and 10, international waters of 12 and 14	16 997	20 396	20 396	20 396	20 396	18 356	15 052	12 371

3.5.5 Data available

3.5.5.1 Landings and discards

Landings were available for all relevant fleets. Within the Norwegian EEZ and for Norwegian vessels fishing elsewhere, discarding is prohibited and therefore are no information about discards. Discards by countries are given in Table 3.5.4. In all years discards are <5% but are however included in the assessment. The bulk of the discard is from UK (Scotland).

Data for 2022 were taken from InterCatch for UK, Sweden, Norway, Spain, Ireland, Denmark and Germany and from ICES preliminary catch statistics for other countries. The comparison of the two data sources was mostly goof except for Germany in Division 4.a and 4bc for which 85 and 6 tonnes respectively of landings were reported in preliminary catch statistics and 0 in InterCatch. The preliminary catch statistics figure was kept as more consistent with the time series for this country in this Division.

Table 3.5.4. Ling in subareas 3,4, 6–9, 12, and 14, total discards of ling by country for the years 2012 to 2022.

	Denmark	Spain	Ireland	France	Sweden	UK (Scotland)	UK (England)	Total discard	Total catches	%discard
2012		46	176					222	16435	1.35
2013		101	160	29				290	17063	1.70
2014		54	435	15				504	17518	2.88
2015		0	0	131	4	704		839	17596	4.77
2016		1	220	72		1302	22	1598	20881	7.74
2017	1	10	105	71	2	959		1147	21443	5.35
2018	1		43	89		876	3	1012	21566	4.69

	Denmark	Spain	Ireland	France	Sweden	UK (Scotland)	UK (England)	Total discard	Total catches	%discard
2019	3	8	70	13		993	9	1096	21837	4.85
2020	4	37	19	1	0	346	0	407	15664	0.081
2021	1	15	36	4	5	213	0	274	12541	2.17
2022	5	20	16	NA	9	262	0	316	18 872	1.68

3.5.5.2 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 Divisions 4a, 6a, 6b for ling are shown in Figure 3.5.4–3.5.6, respectively. Data are from the Norwegian longline reference fleet. The length-weight relationship from sex combined is $W=0.0055*TL^{3.0120}$.

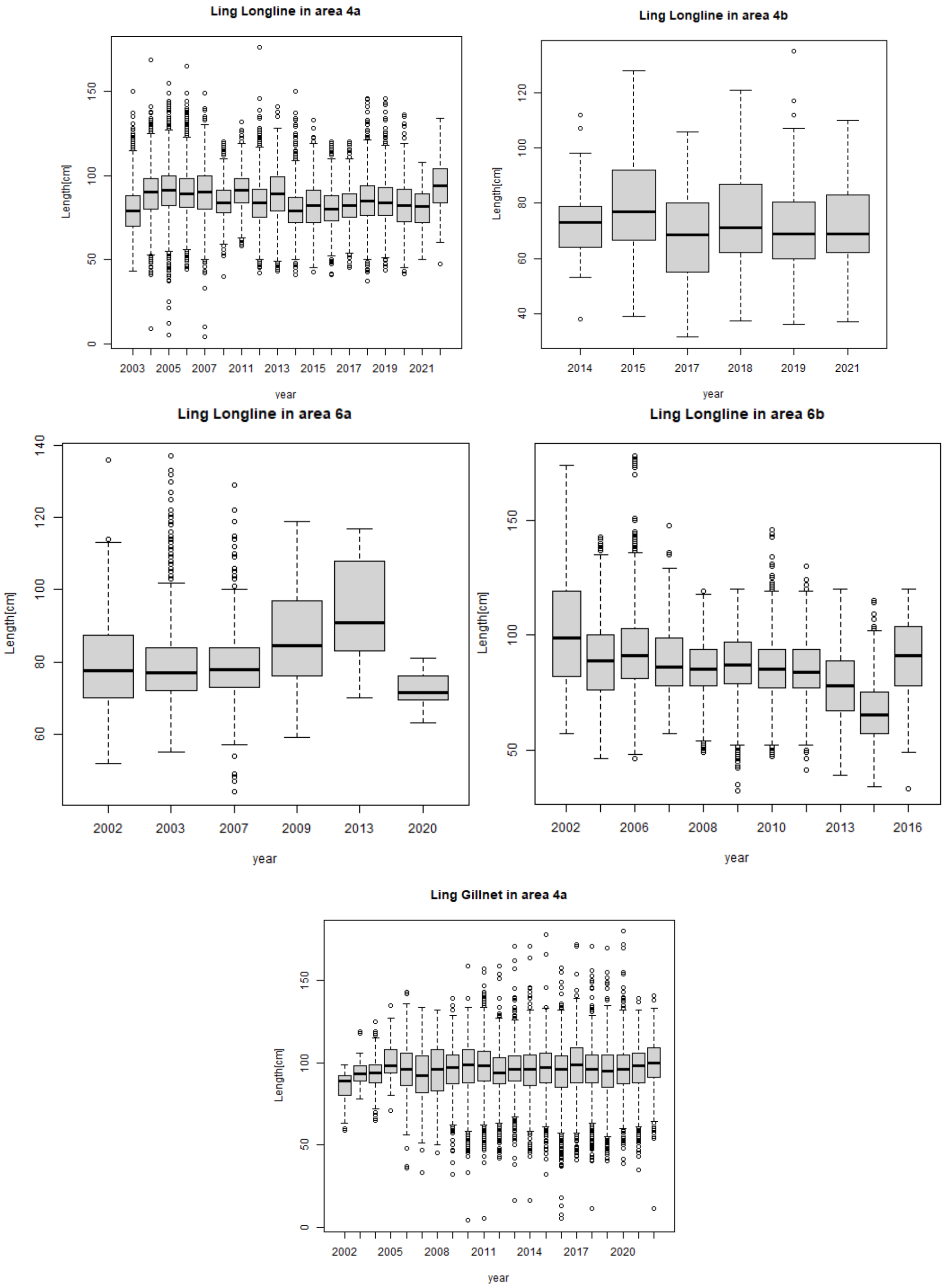

Figure 3.5.4. Ling in subareas 3,4, 6–9, 12, and 14, time-series of mean length of ling caught by the Norwegian longline reference fleet in divisions 4.a, 4.b, 6.a and 6.b (note that some years are missing in some divisions).

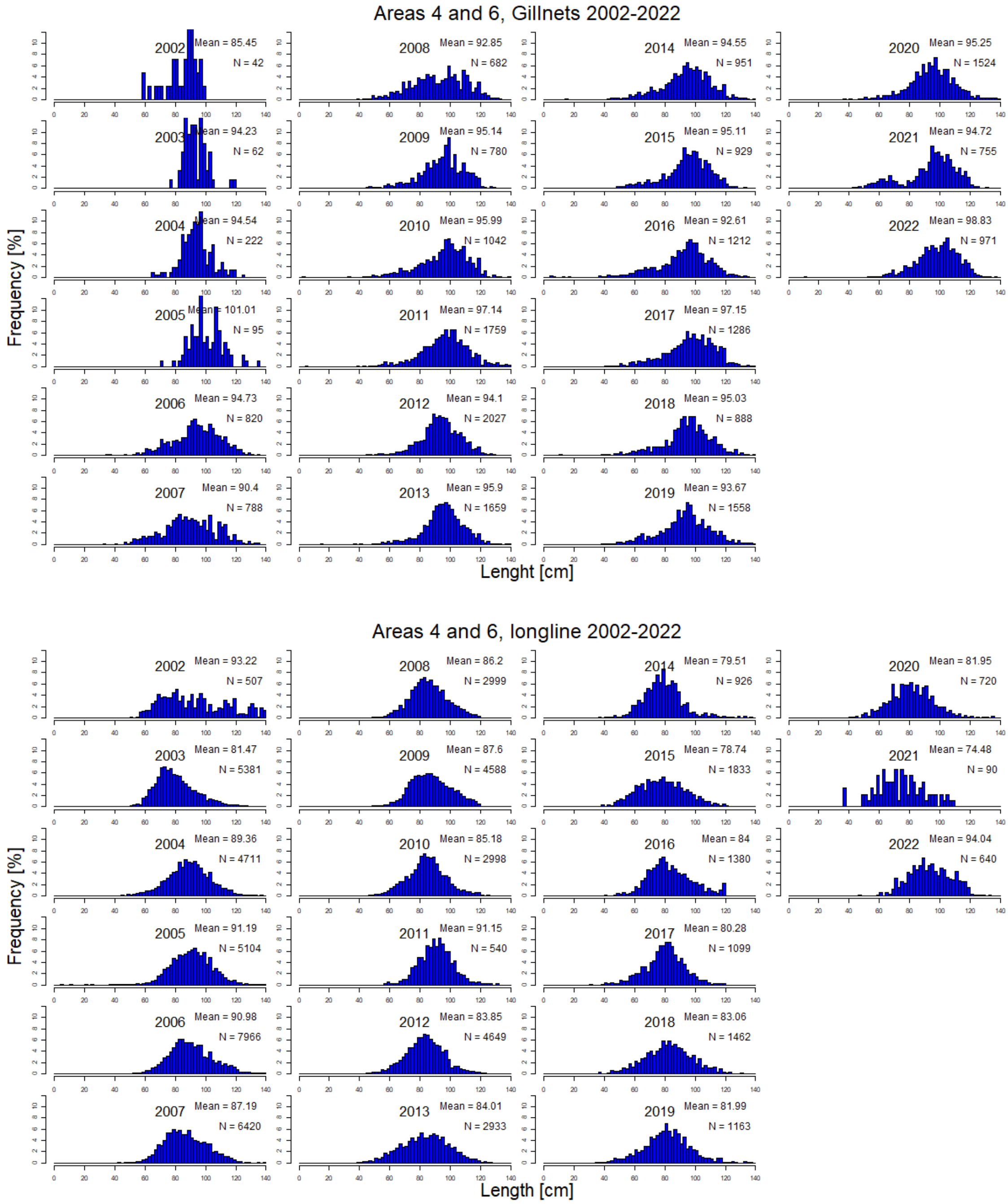

Figure 3.5.5. Ling in subareas 3,4, 6–9, 12, and 14. Length distributions of ling in Areas 3a, 4.a, 6.a and 6.b based on data from the Norwegian reference fleet.

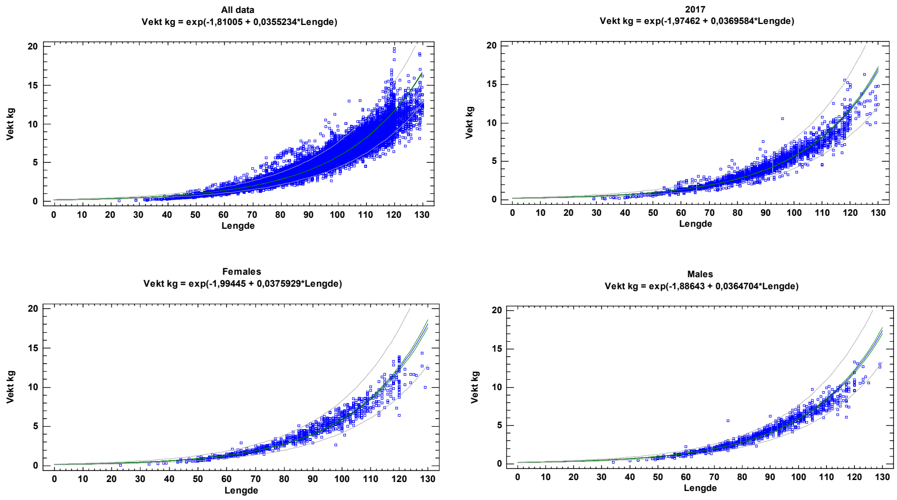

Figure 3.5.6.Ling in subareas 3,4, 6–9, 12, and 14. Weight as a function of length for ling based on all available Norwegian data.

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

The length distribution of catches of ling in the Spanish Porcupine survey, reflect first the declining of number caught in this survey (3.5.7). Further individual remaining in the two last year are small for more information see Ruiz-Pico *et al*. (WD 2023).

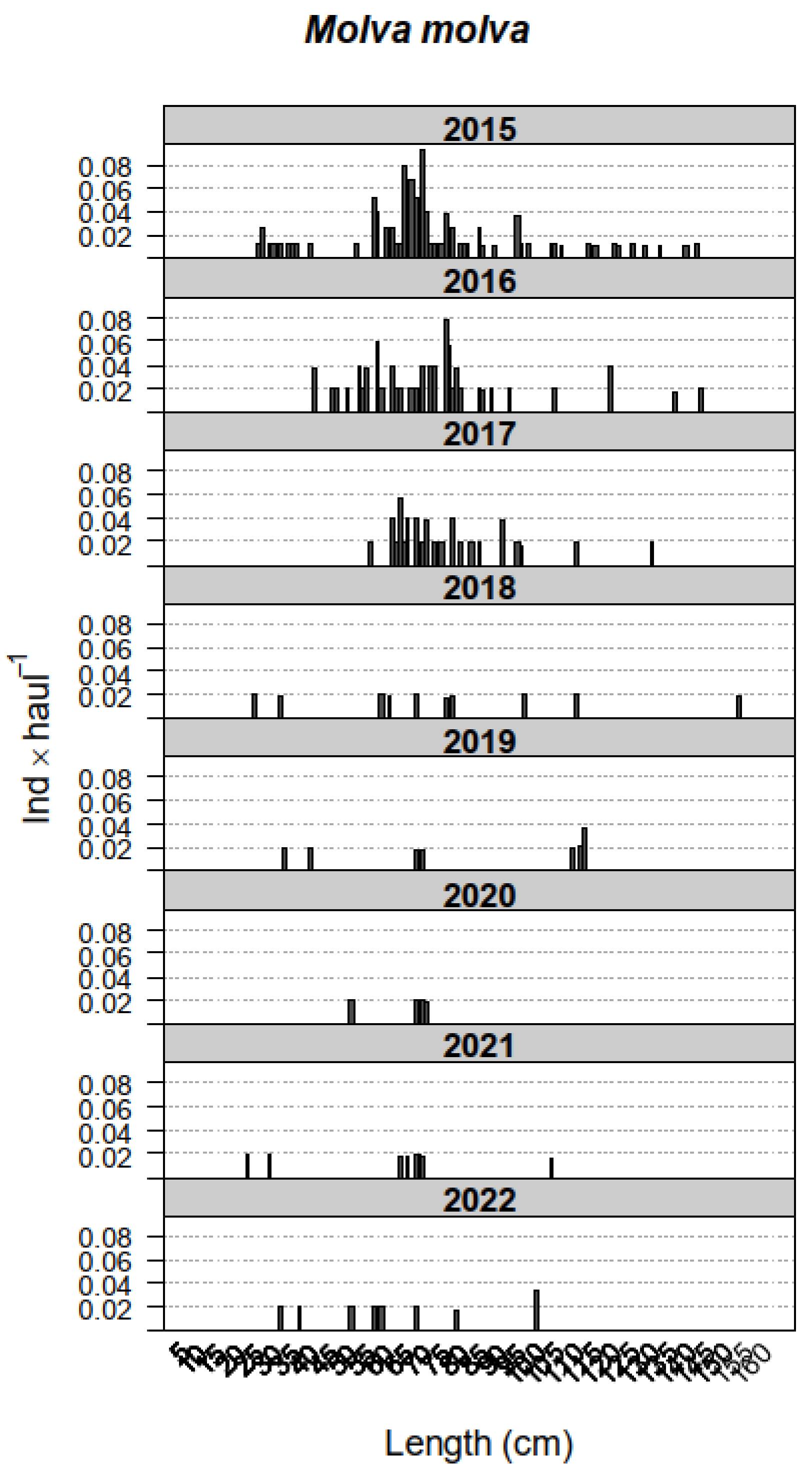

Figure 3.57. Ling in subareas 3,4, 6–9, 12, and 14. Estimated length distributions of ling (*M. molva*) based on the Porcupine Bank Spanish survey in the period 2011–2022.

3.5.5.3 Age compositions

Estimated age distributions for the years 2009–2019 based on data from the Norwegian Reference fleet for all areas combined (Figures 3.5.8) and box and whisker plots for the age composition of the fish taken by longliners and gillnetters in Area 4.a (Figure 3.5.9).

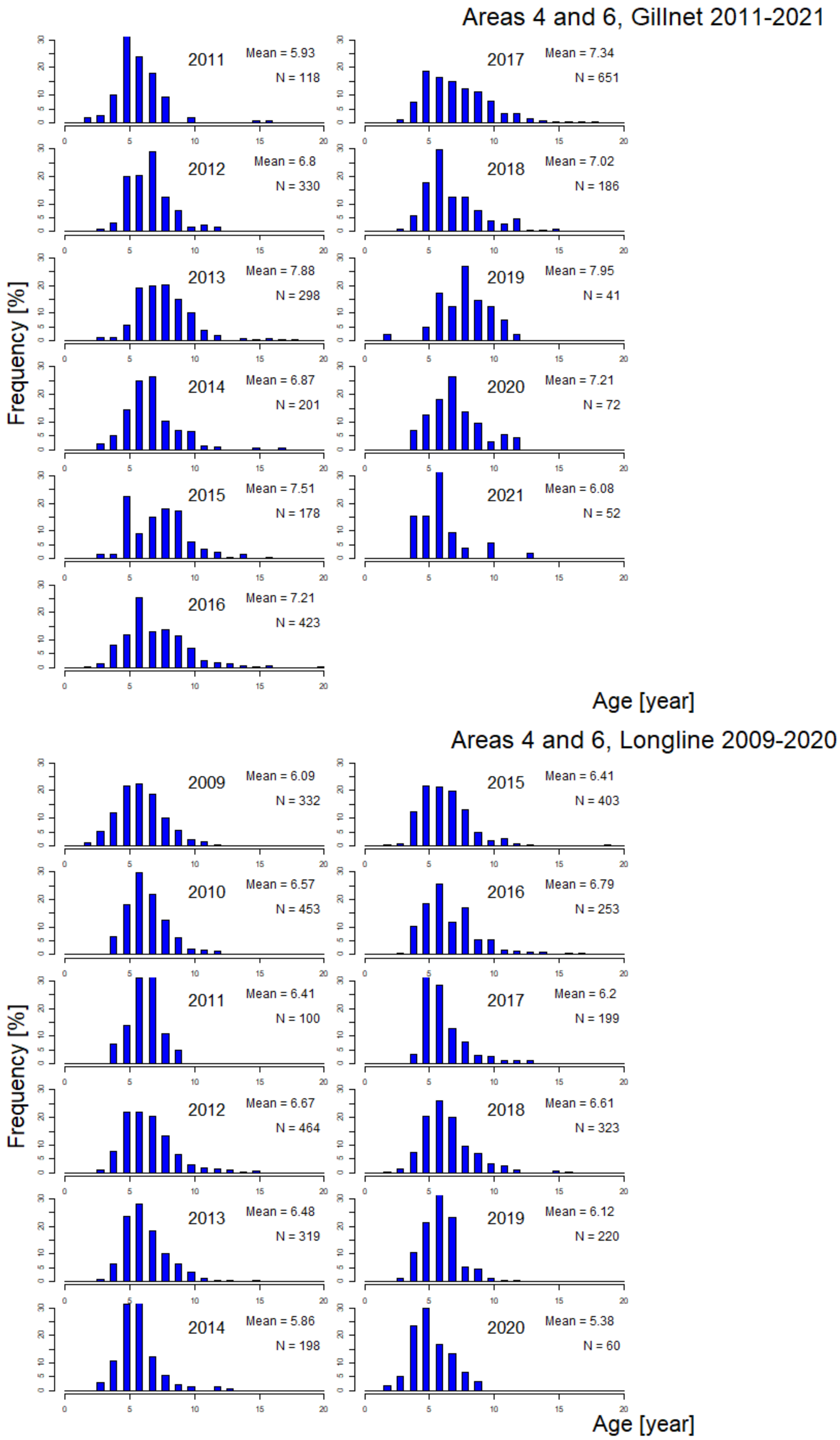

Figure 3.5.8. Ling in subareas 3,4, 6–9, 12, and 14. Age distributions for ling areas combined for all catches taken by longliners and by gillnetters.

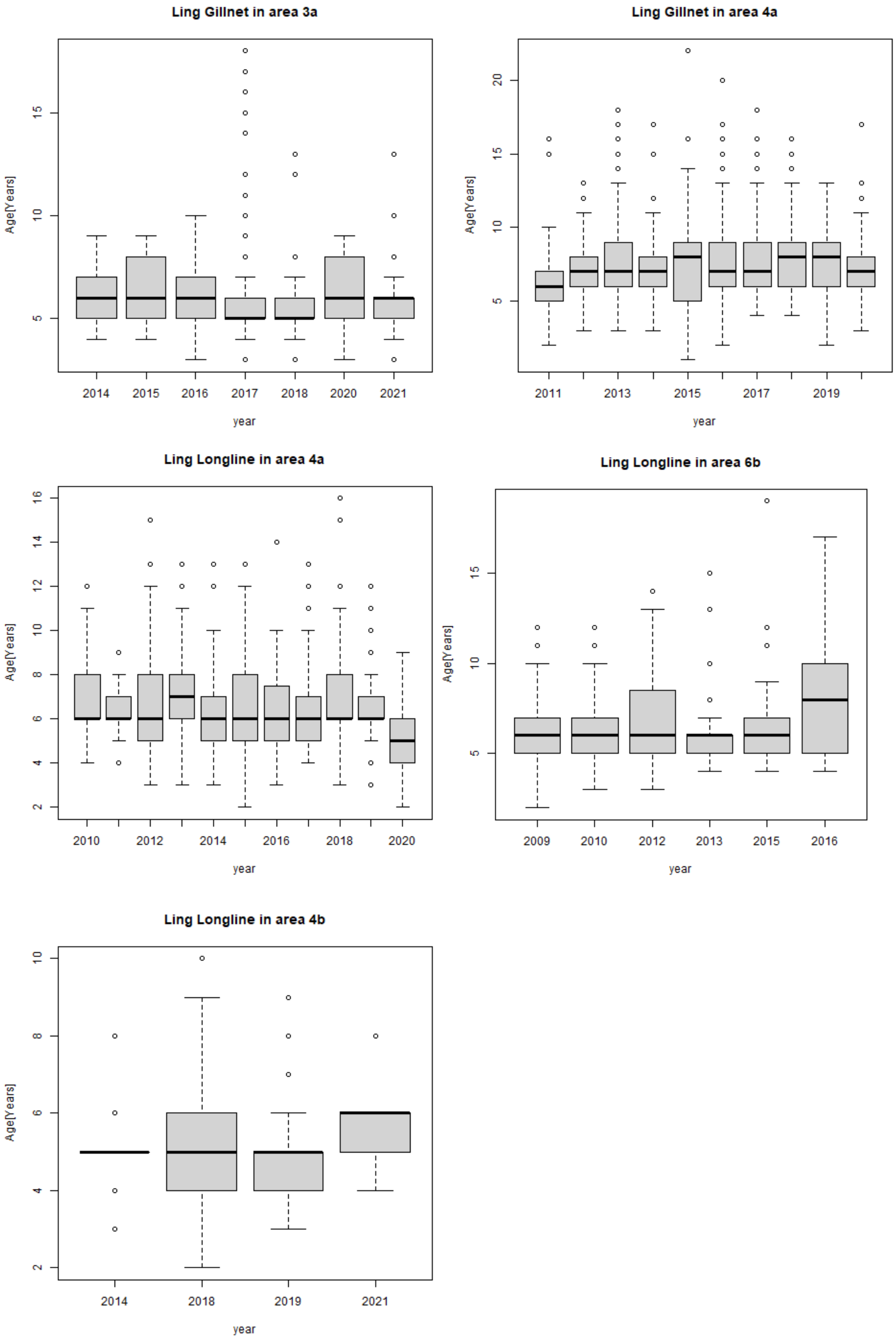

Figure 3.5.9. Ling in subareas 3,4, 6–9, 12, and 14. Average age of ling catches by longliners and gillnetters by area.

3.5.5.4 Weight-at-age

Weight and length at age for all age readings of ling from divisions 4.a and 6.a from 2009 to 2017 sampled from the longliners in the Norwegian reference fleet show quite linear relationships (Figure 3.5.10).

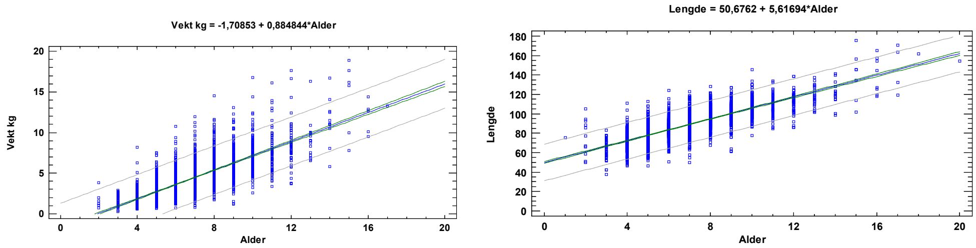

Figure 3.5.10. Ling in subareas 3,4, 6–9, 12, and 14. Weight versus age and length versus age for ling (combined data from 2009 to 2017) for divisions 4.a and 6.a based on the Norwegian longliner reference fleet.

3.5.5.5 Maturity and natural mortality

Similar estimates have been found in other area, e.g. Age at fist maturity around 5–7 years (60–75 cm lengths) with males maturing at a slightly younger age than females (Magnusson *et al.*, 1997).

See stock annex, no new data in 2021.

3.5.5.6 Growth

In 2021, preliminary new estimates of growth of ling were presented for the Celtic Sea, an area with no previous growth estimates for the species (Vieira and Visconti, 2021). The range of growth estimate for the species is wide (Table 3.5.7). The estimate from the Celtic Sea, which is rather average of available estimates for the species and was estimated from Subarea 7, which is rather central in the stock area, was used for the calculation of the rfb rule.

Table 3.5.7. Growth estimated of ling

L∞	k	t0	Area	Reference
119	0.136		Faroe bank	Magnussen (2007)
124	0.163		Faroe	Data from Bergstad and Hareide (1996) in Magnussen (2007)
189	0.080		Northern North Sea	
166	0.103		W. of Scotland	
158	0.087		Rockall	
141	0.143		Norwegian Sea	
266.7	0.047	-0.483	Division 5.b	Stock annex lin.27.5b
	0.1		Subareas 1 and 2	Stock annex lin.27.346-91214 (also in lin.27.1-2)
14.818	0.11	-2.19	7.d-j (Celtic Sea)	Vieira and Visconti (WD 2021)

183	0.118	4.a, 6.ab	Length at age estimated from fish caught by the Norwegian fleet

3.5.5.7 Natural mortality

Natural mortality is also poorly known. For the adjacent stocks in the Faroese and Icelandic ecoregions (lin.27.5a and lin.27.5b) a natural mortality of 0.15 is assumed, the same is used here.

3.5.5.8 Catch, effort and research vessel data

Spanish Porcupine Bottom Trawl Survey

Spanish Porcupine Bottom Trawl Survey (SP-PORC) in 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 these areas (ICES, 2010a; 2010b). The survey provides estimates of biomass and abundance indices. The stratification and location of station is shown in Figure 3.5.11.

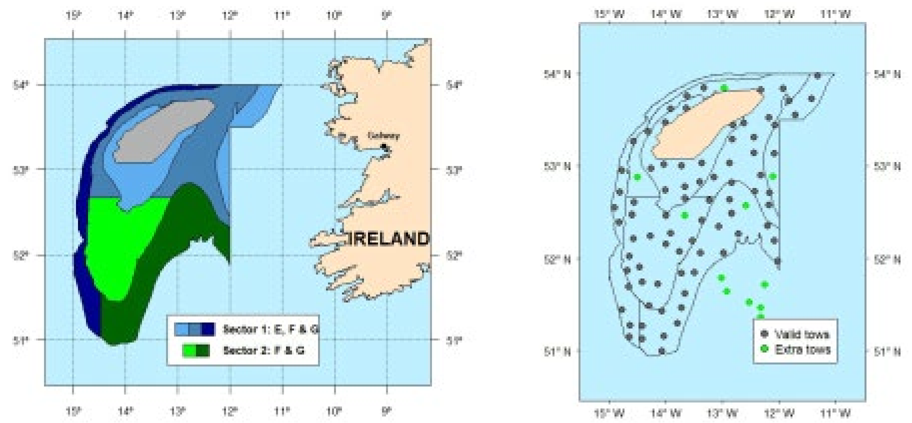

Figure 3.5.11. Ling in subareas 3,4, 6–9, 12, and 14. Left: Stratification design used in the Porcupine surveys starting in 2003: Previous years were re-stratified. Depth strata are: E) shallower than 300 m, F) 301 – 450 m and G) 451 – 800 m. Grey area in the middle of Porcupine bank denotes a large non-trawl able area. Right: distribution of hauls in 2022.

French Southern Atlantic Bottom trawl survey (EVHOE)

Ling are caught in small numbers in the French Southern Atlantic Bottom trawl survey (EVHOE). Population indices (based on swept area for biomass, mean length, etc.) for the Bay and Biscay and Celtic Sea (ICES divisions 7g-k and 8a,b,d) combined were provided for years 1997–2020 (Figure 3.5.15). The survey covers depths from 30 to 600 m and is stratified by depth and latitude.

Commercial cpues

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 2000–2022. Selected vessels were those with a total landed catch of ling, tusk and blue ling of more than 8 t per 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 for 2010 due to changes from paper to electronic logbooks. Since 2011 data quality has improved considerably and data from the entire fleet were availableStandardised cpue series are calculatedusing data from official logbooks starting from 2000 (Helle *et al.*

2015). As the Norwegian fleet had no access to UK waters in 2021, Norwegian landings in 4.a and 6.a were much lesser in 2021 compared to other years, so that 2021 data were unsuitable to calculate the CPUE. Thestandardized time-series of cpue used for assessment is based on the subset of fishing trips where ling make up more than 30% of the total catch. This subset is considered to represent targeted fishing.

3.5.6 Data analyses

Length data analysis

Mean length of the commercial catches by the Norwegian longlining reference fleet fluctuate around 90 cm in Divisions 4a abd 6.a. In Division 6b there may have been a decline in mean length up to 2015 then larger fish were landed in 2016, more recent data are missing. In division 4b, catches are slightly smaller than in 4.a. (Figure 3.5.4). When all data for these areas are combined for longliners and for gill netters the average length is about 10 cm higher for gill netters than for longliners (Figure 3.5.4)

Ling smaller than 50 cm are not caught in significant number in Surveys. The length distributions of ling caught in surveys suggest a disappearance of large fish both on the Porcupine bank (Figure 3.5.7) and in the area covered by the EVHOE survey, divisions 7g-j and 8abd (Figure 3.5.12). For more information, see Ruiz-Pico *et al*., WD 2023.

Ling are caught in small in declining number in EVHOE, with no catch in the two last years (Figure 3.5.12, top left panel). They are however presented (Figure 3.5.12) and their overall trend suggest a clear decline of ling in the survey area.

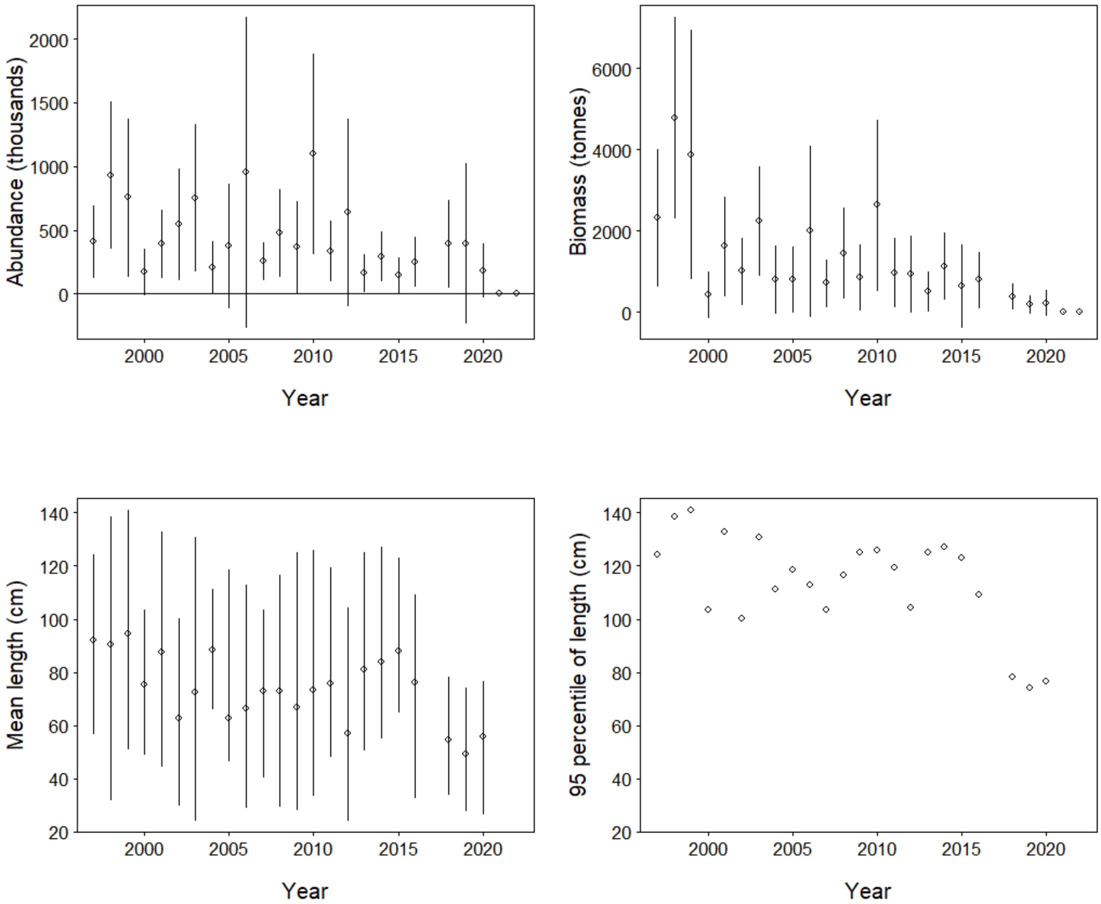

Figure 3.5.12. Ling in subareas 3,4, 6–9, 12, and 14. Population indices (swept area raised abundance and biomass, mean length and 95 percentile of the length distribution) of ling in the Bay and Biscay and Celtic Sea (ICES divisions 7.g,hjk and 8a,b,d) from the French EVHOE survey (W-IBTS-Q4), 1997–2022 (except 2017).

Spanish Porcupine Bank survey

Estimated biomass and abundance indices based on data from the Porcupine Survey for the years 2001–2022 are in Figure 3.5.13. The abundance indices for ling based on the survey were quite stable from 2001–2012. After the peak in 2013 there has been a large decline to a very low level.

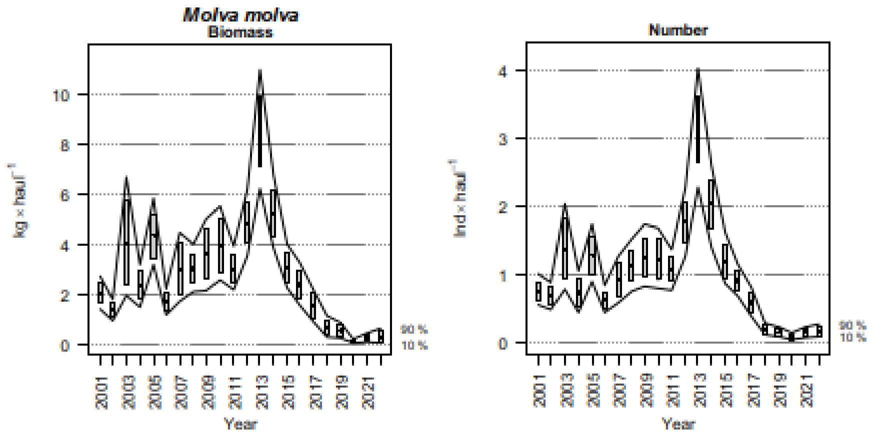

Figure 3.5.13. Ling in subareas 3,4, 6–9, 12, and 14. Estimated biomass and abundance indices based on the Porcupine Survey for the years 2001–2022. Boxes mark the parametric, based standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

Spatial distribution and occurrences from the combination of IBTS surveys

Data from six surveys (NS-IBTS Q1 and Q3 [G1022, G2829], IE-IGFS [G 7212], NIGFS [G7144, G7655], SP-PORC [G5768], FR-EVHOE [G9527] and SCOWCGFS [G4748, G4815] were combined to explore long-term change in the spatial distribution of the species. Only occurrences were plotted. Comparing surveys earlier years, where only data for the North Sea are available to the most recent five years, the species became rarer in the central North Sea (red oval on figure 3.5.14) and occurred in more haul in the Northern North Sea and Skagerrak (green ovals). Surveys data during the last 10-15 years suggest that there was an increase in Northern area (6.a North of Ireland and 4.a, 3.a) and a decrease in Southern Area (Porcupine bank, Celtic Sea, Biscay)

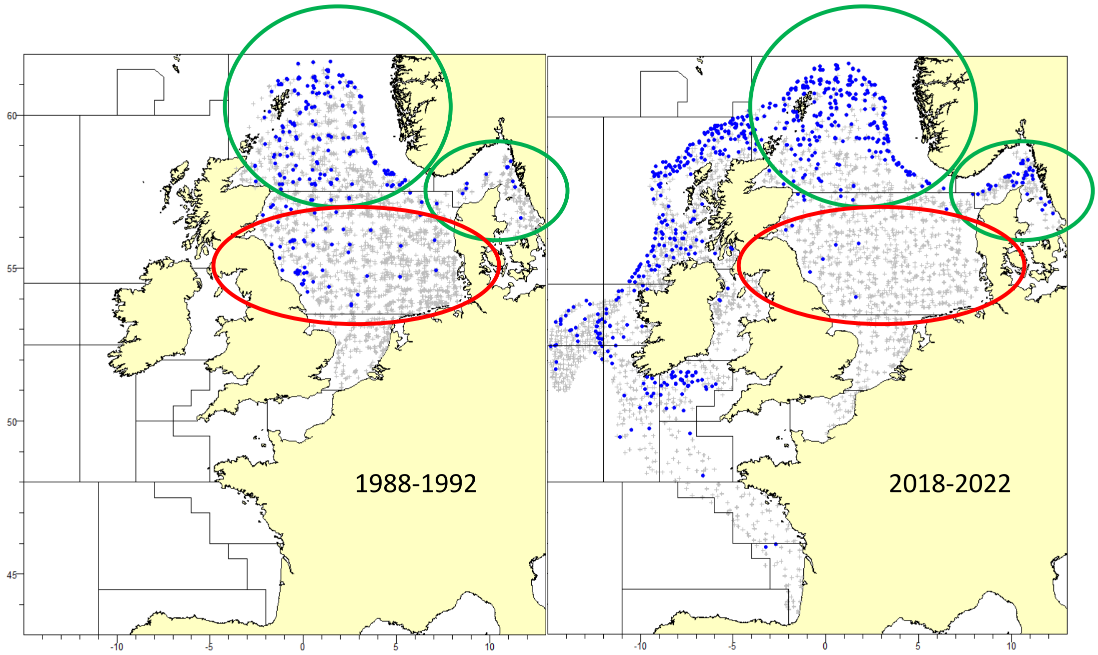

Figure 3.5.14. Ling in subareas 3,4, 6–9, 12, and 14. Occurrence of ling in NS-IBTS surveys during 2 five years periods separated by 30 years.

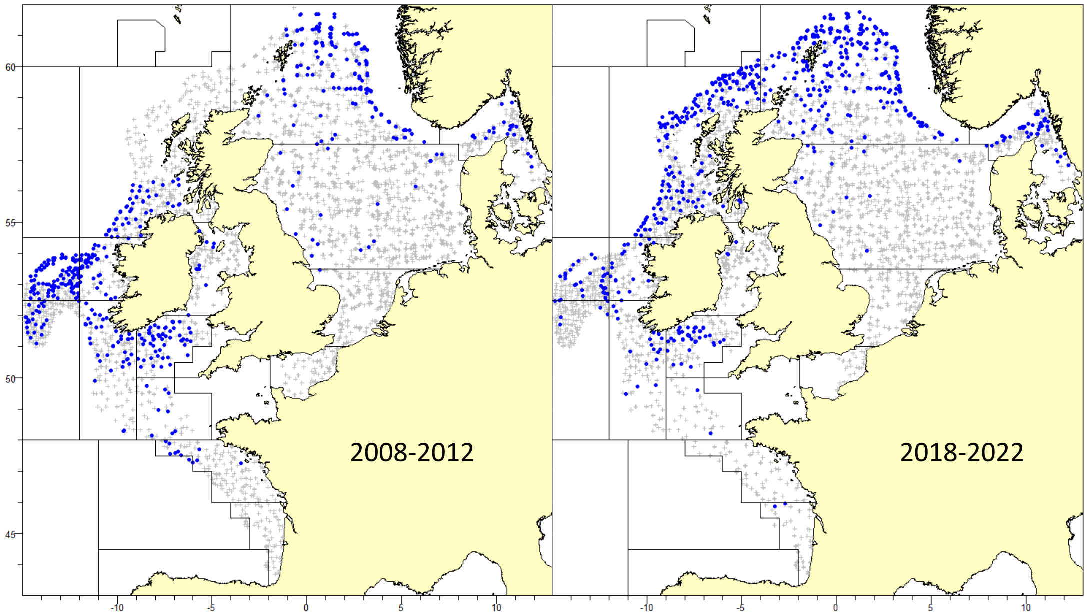

Figure 3.5.15. Ling in subareas 3,4, 6–9, 12, and 14. Occurrence of ling in surveys during 2 five years periods, ten years apart.

Cpue series based on the Norwegian longline fleet

Figure 3.5.14 shows the Norwegian CPUE series from 2000 to 2022. In Division 4a there was a steady increase in CPUE from 2002 until 2016 then a stabilization. In Divisions 6a and 6b there was also an increasing trend from 2002 to 2016 followed by a stabilization in 6.a and a decrease in 6.b. There was no data in 6.b in recent years.

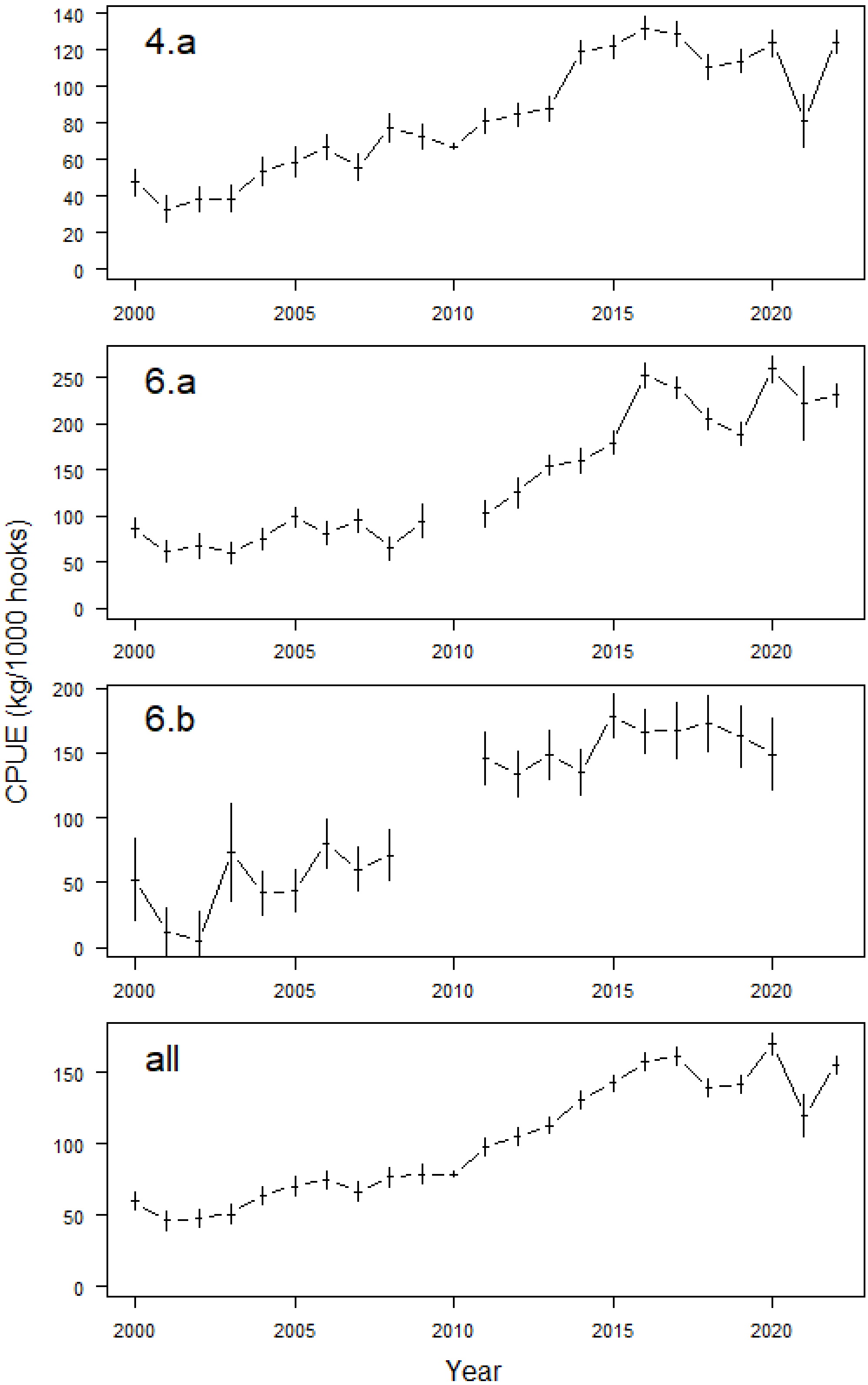

Figure 3.5.14. Ling in subareas 3,4, 6–9, 12, and 14. Cpue series for ling for the period 2000–2022 based on all available data and when ling was targeted. The bars denote the 95% confidence intervals.

The index used for advice on the stock since 2015 is the combination of all data for the 3 divisions (4.a, 6.a and 6.b) when ling was targeted (Figure 3.5.15). Nevertheless, previous' years report showed that the time-series was similar when targeted fishing and all fishing for ling were considered.

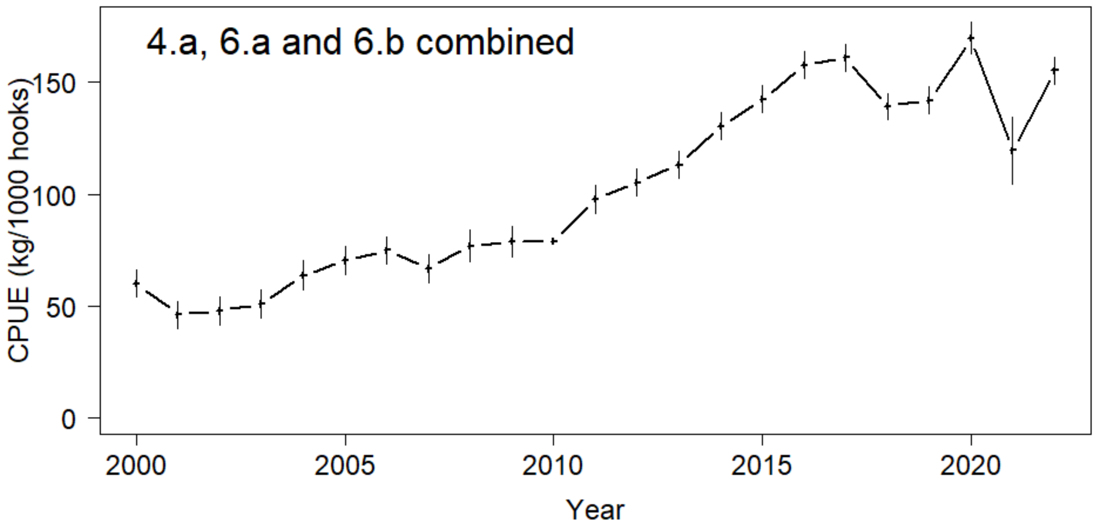

Figure 3.5.15. Ling in subareas 3,4, 6–9, 12, and 14. Cpue series for ling, areas 4a, 4b, 6a and 6b combined, for the period 2000–2022 for target fishing, as used in the assessment . The bars depict the 95% confidence intervals.

3.5.7 Stock assessment

The stock assessment was based on the rfb rule, a number of data analyses were made to check that parameters used in the rfb rule were robust and representative.

The length distribution was taken from InterCatch and included landings and discards data from the main fleets. The length distribution appeared similar for all quarters (Figure 3.5.16) and the mode and *Lc* of the distribution were the same for the landings and discards combined and for landings only.

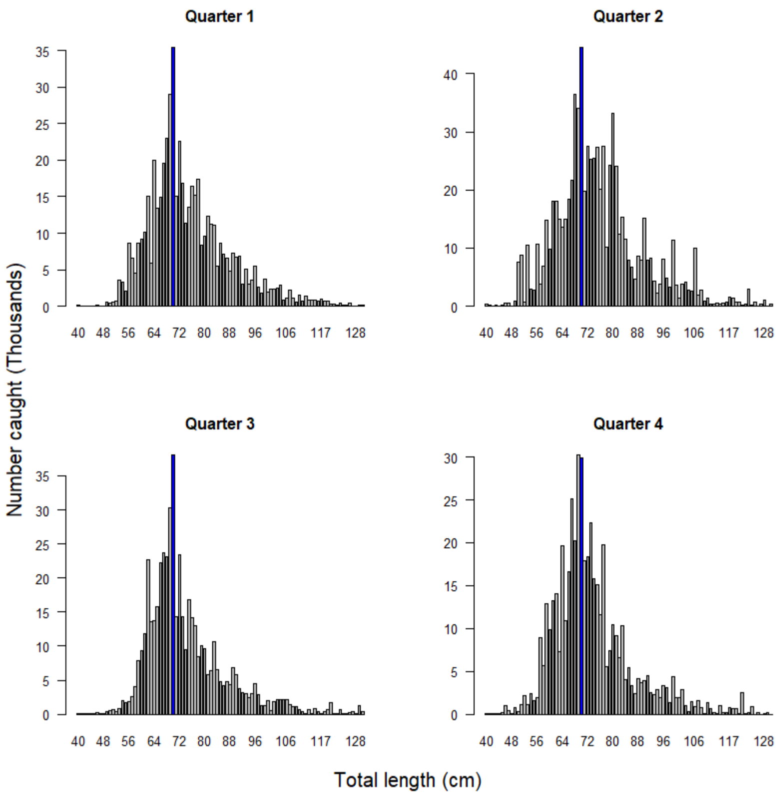

Figure 3.5.16. Ling in subareas 3,4, 6–9, 12, and 14, quarterly length distribution of the catch from InterCatch. The bar for the mode of the length distribution for the whole year is coloured in blue. Small numbers below 40 cm and above 130 cm not shown for legibility.

The effect on the estimated mode and length at first capture (*Lc*) of the bin width used for the length distribution, was explored for bins of 1 to 5 cm (Figure 3.5.17). The large the bin with, the higher the resulting advice for next years (table 3.5.8). The group decide to use 2 cm length bins, which smoothed properly the length distribution. The estimate L infinity from the Celtic Sea, which is rather average of available estimates for the species and was estimated from Subarea 7, which is central in the stock area, was used for the calculation of the rfb rule. The calculation used for advice is in bold in table 3.5.8.

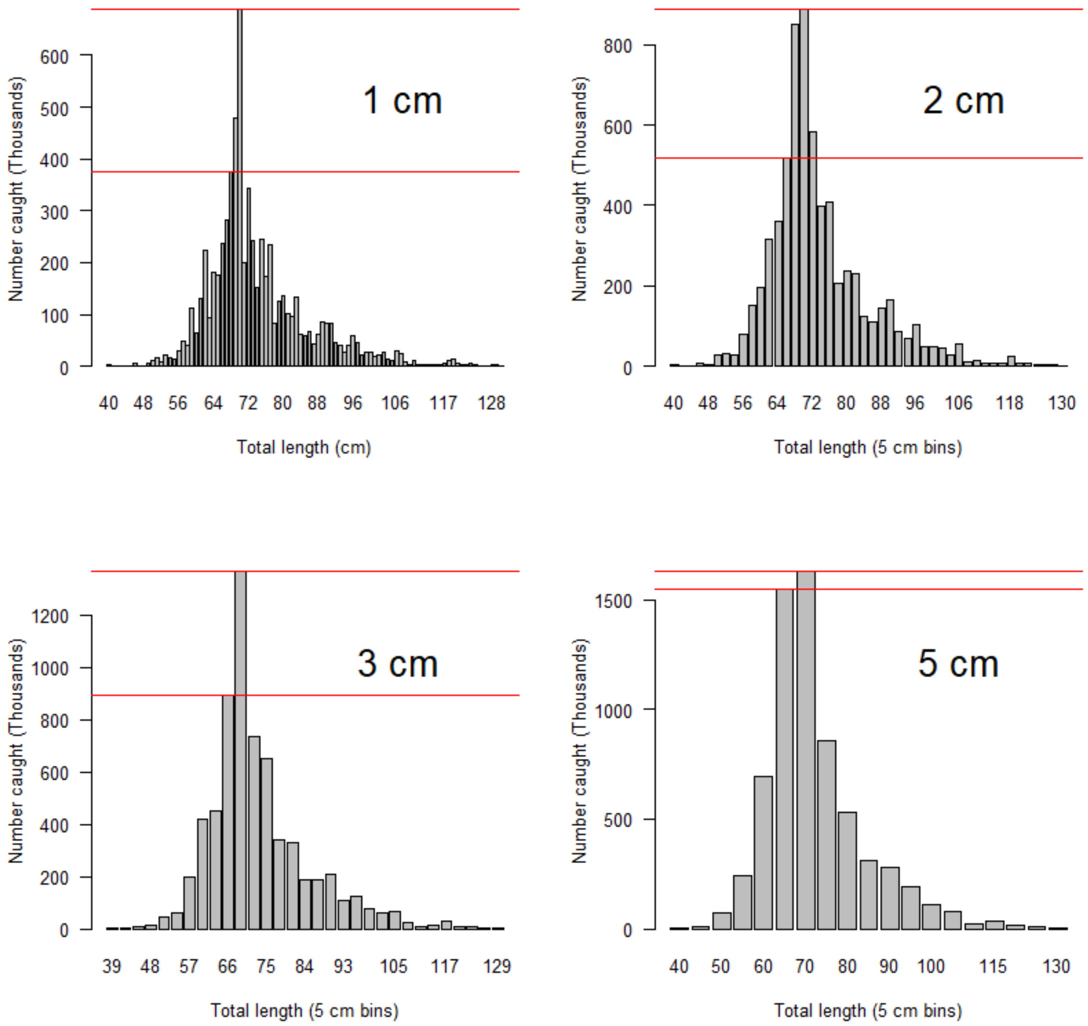

Figure 3.5.17. Ling in subareas 3,4, 6–9, 12, and 14, effect of bins width on the estimated mode and Lc for the length distribution of the whole year. Horizontal lines represent the height of the mode and that of the size class corresponding to Lc.

Table 3.5.8. Ling in subareas 3,4, 6–9, 12, and 14. Application of the rfb rule with a range of L∞ values and bin widths.

L_∞	k	bin	Lc	Lbar	Advice 2023	r	b	m	$L_{F=M}$	f	Advice 2024
119	0.136	1	68.5	79.3419426	15092	1.03285342	1	0.95	81.125	0.97802086	14483
119	0.136	2	67	78.6430894	15092	1.03285342	1	0.95	80	0.98303862	14557
119	0.136	3	67.5	79.5606061	15092	1.03285342	1	0.95	80.375	0.98986757	14658
119	0.136	5	67.5	81.0689782	15092	1.03285342	1	0.95	80.375	1.00863425	14936
148.81	0.11	1	68.5	79.3419426	15092	1.03285342	1	0.95	88.5775	0.89573473	13264
148.81	**0.11**	**2**	**67**	**78.6430894**	**15092**	**1.03285342**	**1**	**0.95**	**87.4525**	**0.89926634**	**13317**
148.81	0.11	3	67.5	79.5606061	15092	1.03285342	1	0.95	87.8275	0.90587351	13415
148.81	0.11	5	67.5	81.0689782	15092	1.03285342	1	0.95	87.8275	0.92304777	13669
160	0.103	1	68.5	79.3419426	15092	1.03285342	1	0.95	91.375	0.86831127	12858
160	0.103	2	67	78.6430894	15092	1.03285342	1	0.95	90.25	0.87139157	12904
160	0.103	3	67.5	79.5606061	15092	1.03285342	1	0.95	90.625	0.87791014	13000
160	0.103	5	67.5	81.0689782	15092	1.03285342	1	0.95	90.625	0.89455424	13247
266.7	0.047	1	68.5	79.3419426	15092	1.03285342	1	0.95	118.05	0.67210455	9953
266.7	0.047	2	67	78.6430894	15092	1.03285342	1	0.95	116.925	0.67259431	9960
266.7	0.047	3	67.5	79.5606061	15092	1.03285342	1	0.95	117.3	0.67826604	10044
266.7	0.047	5	67.5	81.0689782	15092	1.03285342	1	0.95	117.3	0.69112513	10234

Table 3.5.9. Ling in subareas 3,4, 6–9, 12, and 14, rfb rule calculation as presented in the advice

Previous catch advice Ay (2023)		15 092 tonnes
Stock biomass trend		
Index A (2022)		155 kg per 1000 hooks
Index B (2018, 2019, 2020)		150 kg per 1000 hooks
r: Index ratio (A/B)		1.03
Fishing pressure proxy		
Mean catch length ($L_{mean} = L_{2022}$)		79 cm
MSY proxy length ($L_{F=M}$)		87 cm
f: multiplier for relative mean length in catches ($L_{mean}/L_{F=M}$)		0.90
Biomass safeguard		
Last index value (I_{2022})		155 kg hr^{-1}
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)		65 kg hr^{-1}
b: multiplier for index relative to trigger min{$I_{2022}/I_{trigger}$, 1}		1
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.95
RFB calculation**		13 317 tonnes
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Not applied	
Discard rate		4.0 %
Catch advice for 2024 and 2025 (A_y × stability clause)		13 317 tonnes
Projected landings corresponding to advice***		12 785tonnes
% advice change^		-12 %

3.5.8 Comments on the assessment

The rfb rule was applied for assessment in 2023. The *f* factor of the rule was calculated using length distribution data from InterCatch for 2022. For this stock, previously assessed using the 2 over 3 rule, InterCatch data for previous did not include length data so that a time series of the length indicator was no available. Previous LBI estimates using data from Norwegian longliners only, showed that the MSY indicator, $L_{F=M}/L_{mean}$ (inverse of the f multiplier in the rfb rule) indicated overexploitation of the stock in years 2018-2020 (see ICES 2020, 2021), which is in line with the 2023 assessment using data from most fleets and gears.

Surveys data suggest that the species' abundance is decreasing in southern areas (Subareas 7 and 8 in particular), landings data also show a decline in these areas. In contrast, surveys suggest an increasing abundance in subareas 4 and 6. This increasing abundance is consistent with a rather low mean length in the catch, because more abundance implies recruitment of young fish, so that limiting catches for a while should allow for a larger stock of larger fish in the next few years.

. The Norwegian data do not include Subarea 7, were Norwegian vessels do not operate. The Spanish survey on the Porcupine bank showed a stable biomass from 2001- 2012, a peak in 2013 and a sharp downward trend to low levels in 2018-2022 (Figure 3.5.13) In Subarea 7, the landings have decreased from around 11 000 tons in the end of the 1990s to less than 1000 tonnes in recent years. For other areas, the landings have been stable or increasing. The EVHOE survey in the Bay of Biscay (Subarea 8) and Celtic Sea (divisions 7.g-j) shows a monotonous decline trends from 1997 to 2022 with no catch in the two last years.

3.5.9 Management considerations

The 2022 assessment suggests that the stock is exploited beyond MSY limits. Previous exploratory assessments (see ICES, 2020, 2021) indicated the same diagnostic. However, the previous assessment based on the 2 iover 3 rule was more optimistic as the CPUE is increasing.

It is worth noting that surveys in subareas 4 and 6 also suggest an increasing stock. Nevertheless, the increasing CPUE, does not balance the high MSY Fishing pressure proxy ($L_{F=M}$/L_{mean}, inverse of the f multiplier in the rfb rule) so that the 2022 assessment results in an advice for lower catches in 2024 and 2025 compared to the previous advice. Recent catches have been larger the recent advices so that bringing the stock to a better state requires substantial decrease in the catch.

Subareas 6 and 7 suggest different abundance trends than in subareas 4 and 6. The CPUE applies to subareas 4 and 6. The difference between southern subareas 7 and 8 and more northern Subareas 4 (primarily Division 4.a) and 6, suggest that the stock needs being further investigated.

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3.5.10 Tables

Table 3.5.1a. Ling in subareas 3,4, 6–9, 12, and 14. Landings from Subarea 3, data from ICES landings statistics, Intercatch and preliminary catch statistics in recent years.

Year	Belgium	Denmark	Germany	Norway	Sweden	E & W	France	Netherlands	Total
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**
2017		58	1	57	22				**138**
2018		95	1	57	25				**177**
2019		139		38	27			0	**204**
2020		123	0	35	17			4	**179**
2021		144	0	42	14	0	0	0	**200**
2022	0	156	0	39	16	0	0	1	**212**

***Preliminary.**

Table 3.5.1b. Ling in subareas 3,4, 6–9, 12, and 14. Landings from Division 4.a, data from ICES landings statistics, Inter-catch and preliminary catch statistics in recent years.

Year	Belgium	Denmark	Faroes	France	Germany	Neth.	Norway	Sweden[1)]	E&W	N.I.	Scot.	Total
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		6021	5	65		2477	**9740**
2017		1036		308	111		6925	11	78		2761	**11230**
2018		980		842	114	2	6326	14			3270	**11548**
2019	0	1022		926	130	5	6062	16	74		3208	**11443**
2020	0	651		647	93	15	4472	31	34	0	2855	**8798**
2021	0	604	0	896	111	8	1250	35	83	1	3516	**6504**
2022*	0	597	0	888	85	1	6665	60	58	0	3253	**11607**

[(1)] Includes 4b 2001–1993.
***Preliminary**

Table 3.5.1c. Ling in subareas 3,4, 6–9, 12, and 14. Landings from divisions 4.bc, data from ICES landings statistics, Inter-catch and preliminary catch statistics in recent years.

Year	Belgium	Denmark	France	Sweden	Norway	E & W	Scotland	Germany	Netherlands	Total
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**
2017	9	36		9	74	4	9		2	**143**
2018	9	38		8	62		8	36	1	**162**
2019	13	41		12	55	2	6	26	3	**158**
2020	16	37	0	8	31	4	4	14	5	**119**
2021	14	27	0	8	16	2	0	10	4	**81**
2022*	10	29	0	12	17	2	0	6		**76**

***Preliminary.**

Table 3.5.1d. Ling in subareas 3,4, 6–9, 12, and 14. Landings from Divisions 6.a, data from ICES landings statistics, Inter-catch and preliminary catch statistics in recent years.

Year	Belgium	Denmark	Faroes	France	Germany	Ireland	Norway	Spain	E&W	IOM	N.I.	Scot.	Total
2001				774	3	70	1869	142	106			2179	**5143**
2002				402	1	44	973	190	65			2452	**4127**
2003				315	1	88	1477	0	108			1257	**3246**
2004				252	1	96	791	2	8			1619	**2769**
2005			18	423		89	1389	0	1			1108	**3028**
2006			5	499	2	121	998	0	137			811	**2573**
2007			88	626	2	45	1544	0	33			782	**3120**
2008			21	1004	2	49	1265	0	1			608	**2950**
2009			30	418		85	828	116	1			846	**2324**
2010			23	475		164	989	3	0			1377	**3031**
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		156	1313	1109	9			1975	**5659**
2017			5	870		156	1530	1500	3			2244	**6308**
2018				831		156	2185	1560				1922	**6654**
2019				927		142	1616	1689	1			2168	**6543**
2020			22	845		200	1084	1277	3		0	1522	**4953**
2021	0	0	9	878	0	189	0	1007	3	0	0	2220	**4306**
2022*	0	0	7	1015	0	76	1051	1799	2			1741	**5691**

***Preliminary.**

Table 3.5.1e. Ling in subareas 3,4, 6–9, 12, and 14. Landings from Division 6.b, data from ICES landings statistics, Intercatch and preliminary catch statistics in recent years.

Year	Faroes	France)	Germany	Ireland	Norway	Spain	E & W	N.I.	Scotland	Russia	Total
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**
2017	5		2	59	498	7	2		219	1	**793**
2018			2	59	408	6			255		**730**
2019		5	1	102	459	9	1		326	1	**904**
2020		1		106	247	4	0	0	330		**688**
2021	2	6	0	76	0	4	3	3	241	0	**335**
2022*	47	0	0	50	0	3	0		137	NA	**237**

***Preliminary.**

Table 3.5.1f. Ling in subareas 3,4, 6–9, 12, and 14. Landings from Division 7.a, data from ICES landings statistics, Intercatch and preliminary catch statistics in recent years.

Year	Belgium	France	Ireland	E & W	IOM	N.I.	Scotland	Total
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**
2017			9				15	**24**
2018		1	9				8	**18**
2019	2		3				7	**12**
2020	1	0	0	0	0	4	0	**5**
2021	0	0	0	0	0	5	0	**5**
2022*	0		0	0	0	3	0	**3**

***Preliminary.**

Table 3.5.1g. Ling in subareas 3,4, 6–9, 12, and 14. Landings from divisions7.bc, data from ICES landings statistics, Inter-catch and preliminary catch statistics in recent years.

Year	France	Germany	Ireland	Norway	Spain	E & W	Scotland	Total
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**
2017	90		32		133	34	26	**315**
2018	57		39		138	32		**266**
2019	53		0		238	14	8	**313**
2020	47		25	0	67	11	4	**154**
2021	24	0	0	0	94	10	1	**129**
2022*	17	0	0	0	130	8	1	**156**

***Preliminary.**

Table 3.5.1h Ling in subareas 3,4, 6–9, 12, and 14. Landings from divisions 7.de, data from ICES landings statistics, Inter-catch and preliminary catch statistics in recent years.

Year	Belgium	Denmark	France	Ireland	E & W	Scotland	Ch. Islands	Nether-lands	Spain	Total
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
2017	4		104		94					**202**
2018	3		85		32			**1**		**121**
2019	2		54		59			3		**118**
2020	2		49	0	36	0	0	1	0	**88**
2021	2	0	49	0	46	0	0	1	0	**98**
2022*	1		42	0	29	0			0	**72**

***Preliminary.**

Table 3.5.1i. Ling in subareas 3,4, 6–9, 12, and 14. Landings from Divisions 7.f, data from ICES landings statistics, Inter-catch and preliminary catch statistics in recent years.

Year	Belgium	France	Ireland	E & W	Scotland	Total
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**
2017	7	20	1	19		**47**
2018	5	18	1	19		**43**
2019	4	11		11		**26**
2020	6	14	0	13	0	**33**
2021	4	17	0	14	0	**35**
2022*	3	12	0	10	0	**25**

***Preliminary.**

Table 3.5.1j. Ling in subareas 3,4, 6–9, 12, and 14. Landings from divisions 7.g-k, data from ICES landings statistics, Intercatch and preliminary catch statistics in recent years.

Year	Belgium	Denmark	France	Germany	Ireland	Norway	Spain [1]	E&W	UK(N.I.)	Scot.	Total
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**
2017	10		298		392		85	91		12	**888**
2018	6		170		333		76	62			**647**
2019	7		143		212		57	43		3	**465**
2020	8	0	116	0	177		50	34		2	**387**
2021	5	0	133	0	268	0	51	51	1	1	**510**
2022*	7	0	105	0	157	0	30	38	0	3	**340**

***Preliminary. [1] Includes 7.b c until 2011**

Table 3.5.1k. Ling in subareas 3,4, 6–9, 12, and 14. Landings from Subarea 8, data from ICES landings statistics, Inter-catch and preliminary catch statistics in recent years.

Year	Belgium	France	Spain	E & W	Scot.	Ireland	Total
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**
2017		156	43	2			**201**
2018		145	34	4			**183**
2019		139	23			1	**163**
2020		147	15	0	0	0	**162**
2021		133	18				**151**
2022	0	110	23	0			**133**

Table 3.5.1l. Ling in subareas 3,4, 6–9, 12, and 14. Landings from Subarea 9, data from ICES landings statistics, Inter-catch and preliminary catch statistics in recent years.

Year	Spain	Total
2001	0	**0**
2002	0	**0**
2003	0	**0**
2004		
2005		
2006		
2007	1	**1**
2008		
2009		
2010		
2011		
2012	1	**1**
2013-2021(*)	0	**0**
20222	3	**3**

(*) there were no reported landings in 2013-2021

Table 3.5.1m. Ling in subareas 3,4, 6–9, 12, and 14. Landings from Subarea 12, data from ICES landings statistics, Inter-catch and preliminary catch statistics in recent years.

Year	Faroes	France	Norway	E & W	Scotland	Germany	Ireland	Total
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**
2017								**0**
2018								**0**
2019								**0**
2020								**0**
2021	0	0	11	0	0	0	0	**11**
2022	0	0	0	0	0	0	0	**0**

Table 3.5.1n. Ling in subareas 3,4, 6–9, 12, and 14. Landings from Subarea 14, data from ICES landings statistics, Inter-catch and preliminary catch statistics in recent years.

Year	Faroes	Germany	Iceland	Norway	E & W	Scotland	Russia	Green-land	Total
2001	1			35				1	**37**
2002	3			20				0	**23**
2003				83				0	**83**
2004				10				9	**19**
2005								18	**18**
2006								19	**19**
2007				5				2	**7**
2008					1		1	19	**20**
2009	+	3						5	**8**
2010		3						3	**6**
2011	2			1				5	**8**
2012	1		105					5	**111**
2013								2	**2**
2014	1	1	6	1	1			8	**17**
2015								21	**21**
2016	9	1		10			1	15	**35**
2017	1			1			2	5	**7**
2018								5	**5**
2019				128				2	**130**
2020*									
2021									
2022	0	0	0	1	0	0			**1**

***Preliminary.**

Table 3.5.2 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	9	**26 013**
2000	228	9247	384	6909	1879		73	1182	846	218	3578	339	1	7	26	**24 916**
2001	262	7857	284	5143	788		94	1226	807	220	3360	594	0	59	37	**20 720**
2002	263	9152	309	4127	533		126	964	891	453	3526	467	0	8	23	**20 756**
2003	261	6433	234	3246	660		112	524	788	176	2940	436		19	83	**15 912**
2004	236	6306	241	2769	1064		97	640	801	161	2427	492		0	19	**15 240**

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
2005	210	6449	149	3028	1142		61	429	786	184	2053	450		1	18	**14960**
2006	188	6719	144	2573	1411		88	668	687	130	2407	398		1	19	**15433**
2007	174	5858	159	3120	1314		43	358	710	125	1749	312		0	7	**13929**
2008	175	7259	200	2950	1513		15	259	569	187	1541	345		0	20	**15033**
2009	149	7408	314	2324	2635		48	131	363	106	673	186		1	8	**14346**
2010	142	6398	201	3031	2687		44	253	294	69	848	134		0	6	**14107**
2011	140	6508	211	2999	1259		28	208	425	155	936	201		1	8	**13079**
2012	145	7018	192	3655	1390		14	1013	436	167	1520	552	1	4	111	**16218**
2013	130	7197	176	4660	795		30	1010	482	224	1608	459		0	2	**16773**
2014	120	7749	141	4761	774		29	532	605	334	1557	395		0	17	**17014**
2015	125	8069	147	4764	1215		19	560	347	88	1065	337		0	21	**16757**
2016	152	9740	150	5659	1088		24	570	293	114	1172	287			35	**19284**
2017	138	11230	143	6308	793		24	315	202	47	888	201		0	7	**20296**
2018	177	11548	162	6654	730		18	266	121	43	647	183		0	5	**20554**
2019	204	11443	158	6543	904		12	313	118	26	465	163		0	130	**20479**
2020	179	8798	119	4953	688		10	134	88	33	4387	162			1	**15552**
2021	200	6504	81	4306	335		5	129	98	35	510	151	0	11	0	**12365**
2020	212	11607	76	5691	237	0	3	156	72	25	340	133	3	0	1	**18556**

***Preliminary.**

Table 3.5.3. Number of French fishing vessels (otter trawlers, gillnetters and longliners) during the period 2000–2019.

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	28	5	12
2017	32	11	17
2018	28	14	17
2019	32	17	16

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

4.1 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 was supported by differences in length and age structures between areas as well as in growth and maturity. Egg and larvae data from early studies also suggested the existence of many spawning grounds in each of areas of the northern and southern stocks and this was considered as indications of 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 large spatial migrations and therefore limited population structuring. The conclusion is that stock structure of blue ling in the ICES area is uncertain.

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 Subarea 14. All remaining areas (subareas 1, 2, 8, 9 and 12 and divisions 4.a and 3.a) are grouped as in a single stock unit, labelled "Northeast Atlantic" for advice purposes". Historical landing in subareas 1 and 2 and Division 4.a and 3.a have been significant. Whilst landings reported in 8 and 9, where the species does not occur, are now ascribed to the related Spanish ling (*Molva macrophtalma*).

The situation in Subarea 12 is different as this subarea includes part of the Mid-Atlantic Ridge (ICES Divisions 12.a1, 12.a2, 12.a4 and 12.c) and the western slope of the Hatton Bank (ICES Division 12.b). Since 2014, landings from Subarea 12 have been decreasing from 80 to 5 tonnes in 2021, an insignificant level. However, based upon the continuity of bathymetric features and lesser abundance, blue ling from the western Hatton Bank (Division 12.b) is likely to be related to those from the northern Hatton Bank (ICES Division 6.b) and blue ling from other divisions of Subarea 12 is likely to be related to those from Icelandic and east Greenland waters. Following this, the stock Division 12.b would be added to the stock unit bli.27.5b67 and other divisions of 12 would be added to the stock unit bli.5a14. These revised stocks units would be more consistent than currently where the "Northeast Atlantic" unit (bli.27.nea) covers two areas: Subarea 12 (Mid-Atlantic Ridge and Western Hatton Bank), and Subareas 1-4 separated by the two other stock units. Because of theminor landings from Subarea 12 in recent years, current assessments would not be significantly impacted.

Historical total international landings show that blue ling have been exploited for long. Before the start of the time-series considered by WGDEEP, Norway landed 1000–2000t 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 countries have been the Faroe Islands, France, Germany, Iceland and Norway (Figure 4.1.1). 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 7 have had the main contribution to total landings (Figure 4.1.2).

Blue ling forms spawning aggregations, i.e., blue ling is an aggregating species at spawning time. From 1970 to 1990, the bulk of the fisheries for blue ling were seasonal and targeted those aggregations which were thus subject to sequential depletion. Known spawning areas are shown in Figure 4.1.3. In Iceland, the depletion of one spawning aggregation in a few years was documented (Magnússon, 1995). To prevent depletion of adult populations temporal closures have been set in the Icelandic and EU EEZs as well as in the NEAFC RA.

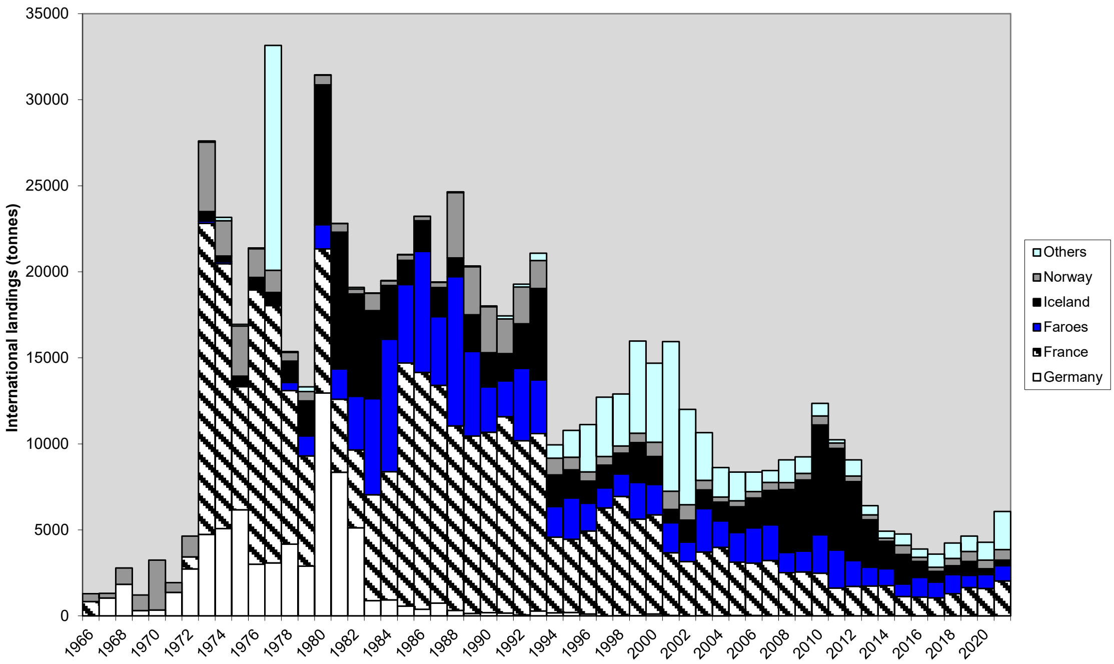

Figure 4.1.1. Total international landings of blue ling in the Northeast Atlantic, by country, 1966–2021.

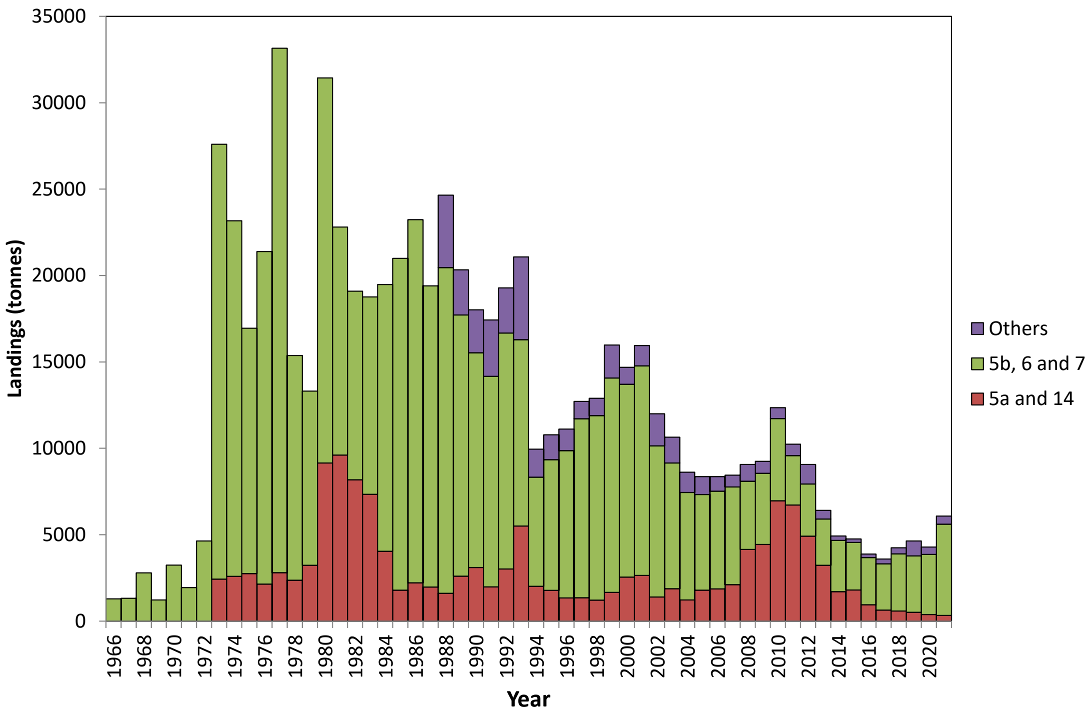

Figure 4.1.2. Total international landings of blue ling in the Northeast Atlantic, by stock unit, 1966–2021.

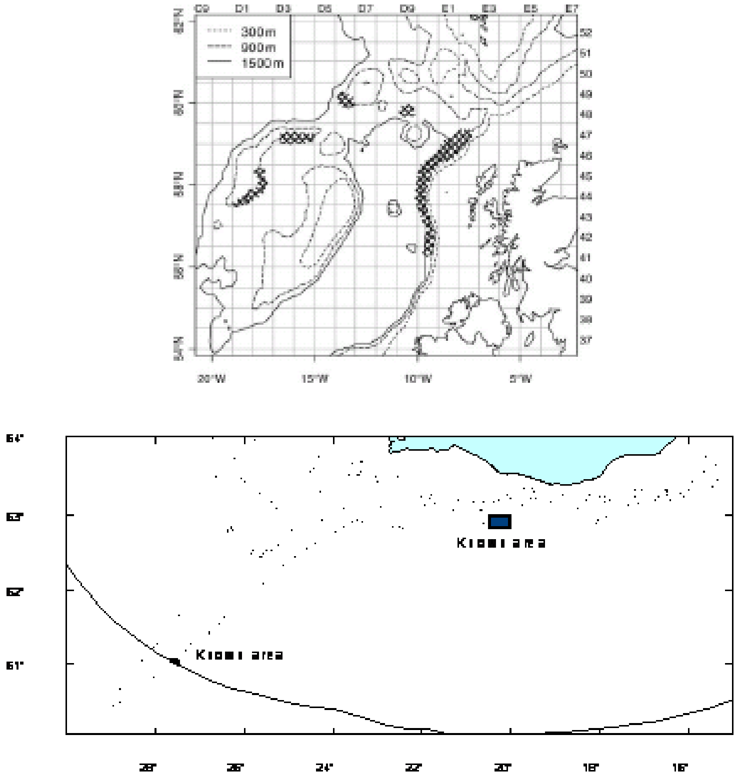

Figure 4.1.3. Known spawning areas of blue ling in Icelandic water (lower panel) and to the West of Scotland (upper panel, from Large *et al.*, 2010).

4.2 Blue ling (*Molva dypterygia*) in 5a and 14

4.2.1 Fishery

The geographical distribution of the Icelandic blue ling fisheries from 2003 to 2023 (Figure 4.2.1 and Figure 4.2.2), indicates an expansion of the fishery of blue ling to north-western waters. This increase may partly be the result of increased availability of blue ling in the north-western area.

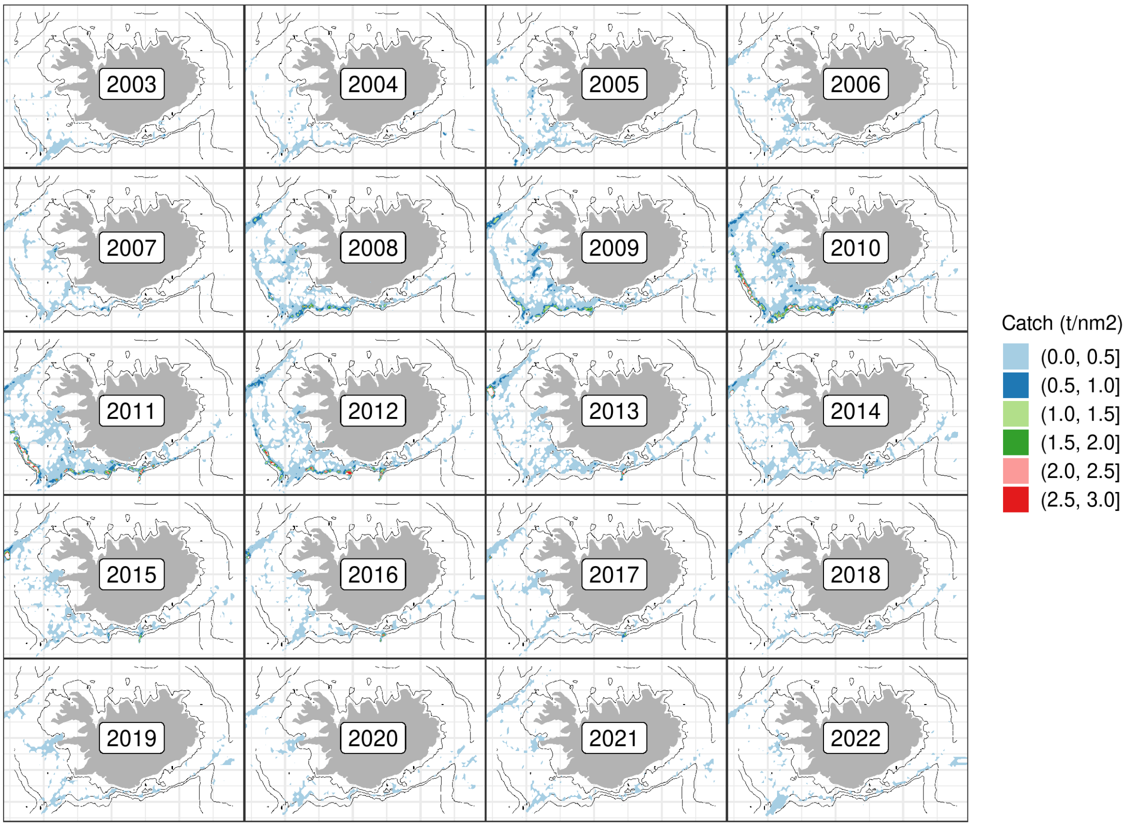

Figure 4.2.1. Blue ling in 5.a and 14. Geographical distribution of the Icelandic blue ling fishery since 2003 as reported in logbooks. All gear types combined.

Before 2008, most blue ling catches were by trawlers, as bycatch in fisheries targeting Greenland halibut, redfish, cod and other demersal species (Table 4.2.2). 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 2008 there was a substantial change in the fishery for blue ling (Table 4.2.2 and Figure 4.2.3). 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.

In 2015–2022, the trend has reversed; the proportion of longline catches decreased to 20–30% and longliners started fishing in shallower waters. From 2008-2014, longline catches were mostly taken at depths greater than 500 Now, the depth distribution resembles the one observed before 2008, or at depths less than 400 m. (Figure 4.2.4).

Historically the fisheries in Subarea 14 have been relatively small but highly variable.

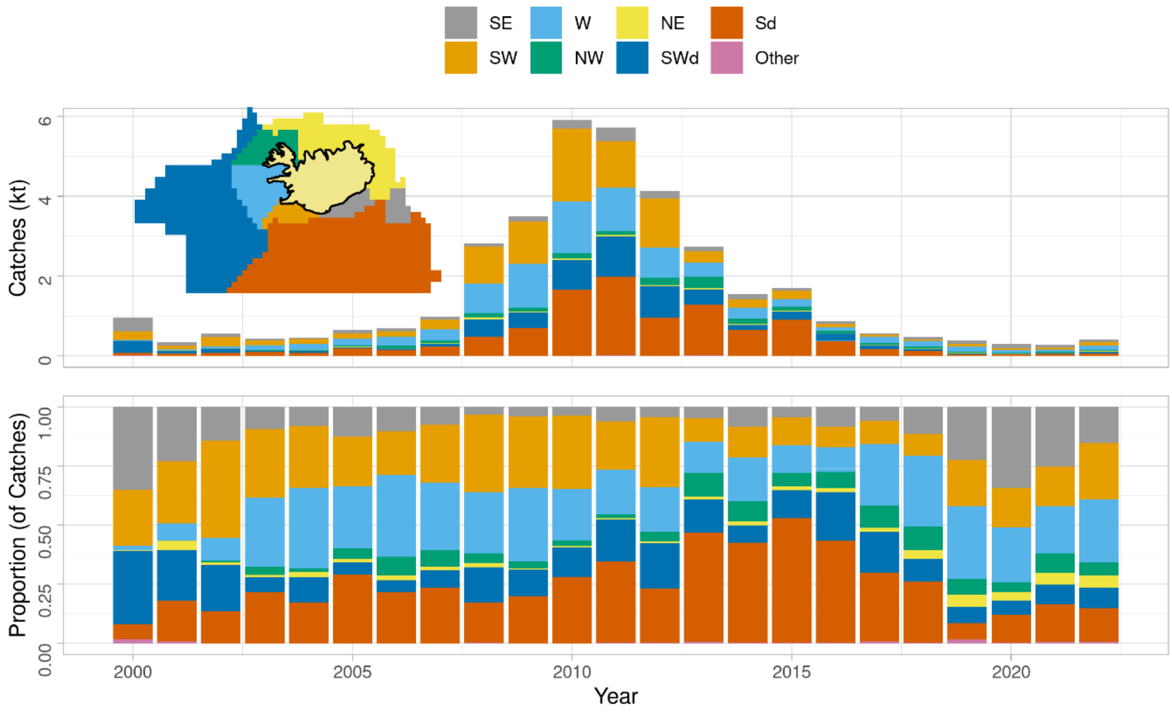

Figure 4.2.2: Blue ling in 5.a and 14. Catch distribution and proportions by area according to logbooks. All gears combined.

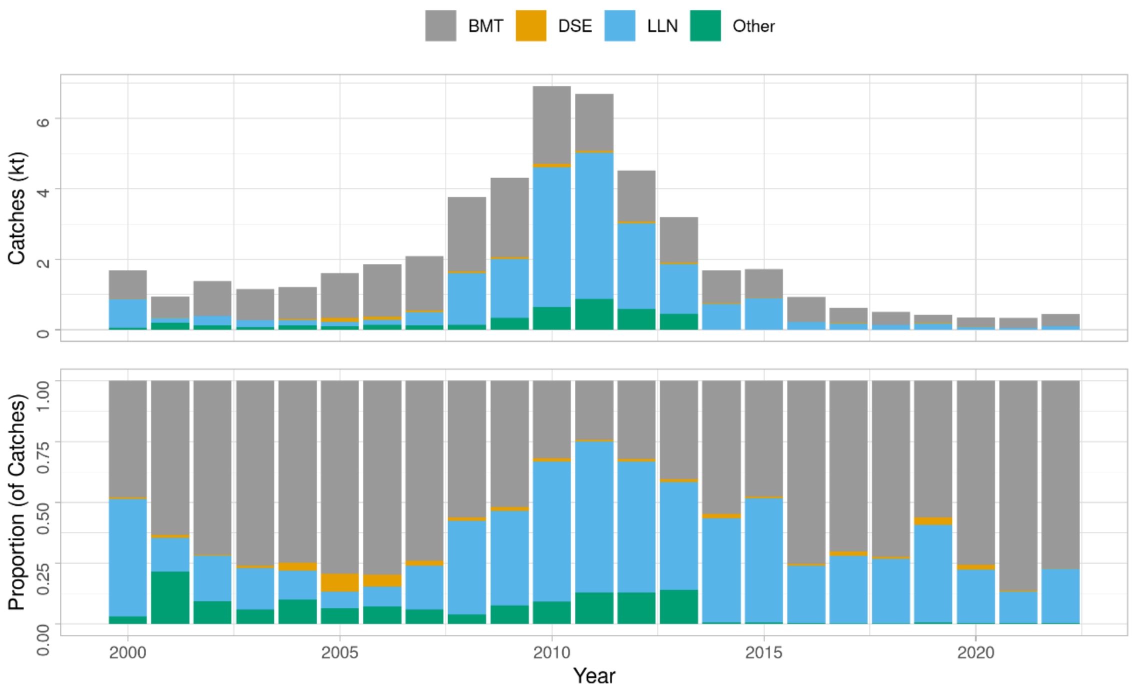

Figure 4.2.3: Blue ling in 5.a and 14. Total catch (landings) and proportion by fishing gear since 2000. according to logbooks.

In 2022, the total landings of the Icelandic fleet were 427 t (Table 4.2.2). Between 2006 and 2010, the catches of blue ling increased by more than 370%; the main part of this increases can be attributed to increased targeting of blue ling by the longline fleet. Since then, catches decreased substantially due to increased management procedures. Now, blue ling is mainly caught as by-catch in the redfish and Greenland halibut fisheries (Table 4.2.2).

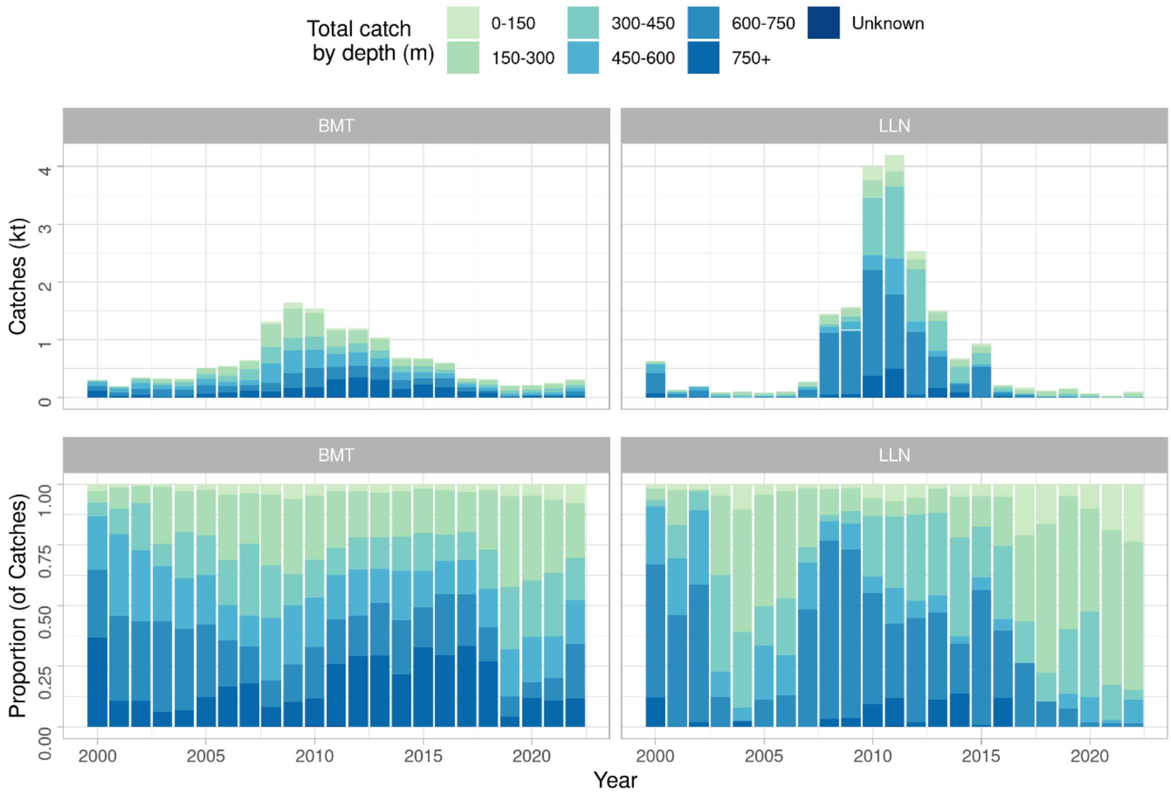

Figure 4.2.4: Blue ling in 5.a and 14. Depth distribution and proportion of longlines (LLN) (right) and trawls (BMT) (left) catches according to logbook entries.

4.2.2 Landings trend

The preliminary total landings in 5.a. in 2022 were 438 t of which the Icelandic fleet caught 427 t. (Table 4.2.2 and Figure 4.2.5). Catches of blue ling in ICES Division 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 ICES Division 5.a decreased substantially due to increased management procedures (Table 4.2.2).

Total international landings from Subarea 14 (Table 4.2.3) 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). Since then, no further information is available on this fishery. The high landing values in Subarea are very occasional, and in most years, total international landings have been between 50 and 200 t. Preliminary landings in 2022 were 34 t.

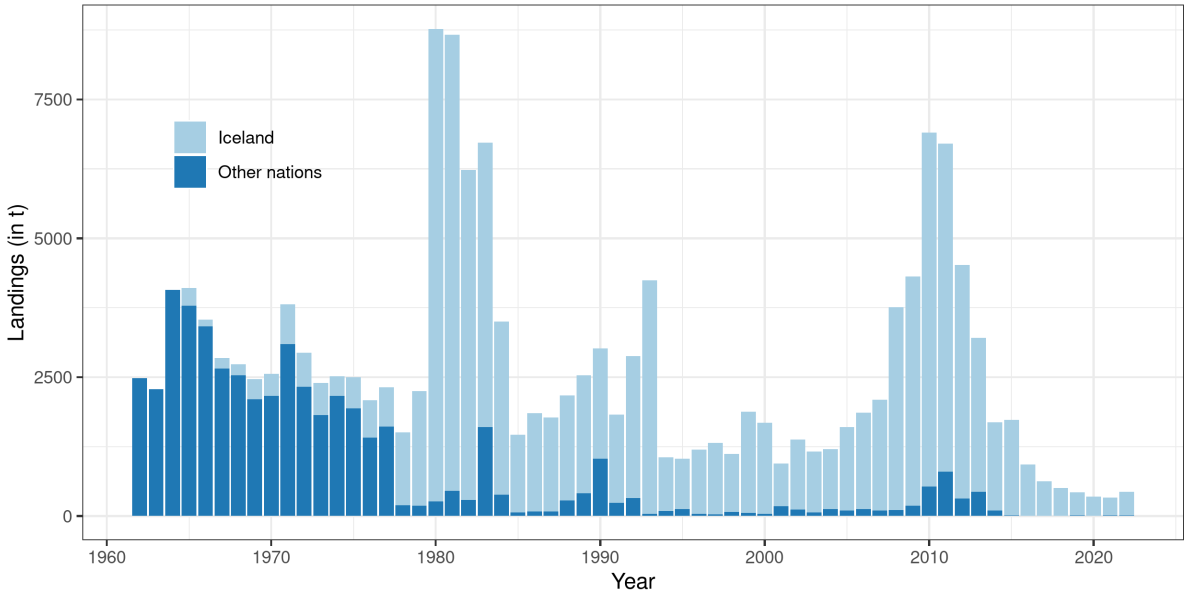

Figure 4.2.5: Blue ling in 5.a and 14. Nominal landings

4.2.3 ICES advice

The assessment is based on ICES rfb-rule for data limited stocks for the first time in 2021, where life history traits, exploitation characteristics and other relevant parameters for data-limited stocks are considered (ICES 2021). The rfb-rule has the following form:

$$A_{y+1} = A_{y-1}\ r\ f\ b\ m$$

where A_{y+1} is the advised catch, A_{y-1} is last years advice, r corresponds to the trend in biomass index (as in the current ICES "2 over 3" rule), f is a proxy for the exploitation (mean catch length divided by an MSY reference length) and b a biomass safeguard (reducing the catch when biomass index drops below a trigger value).

Advice when rfb-rule was applied (2021/2022) was 334 t.

r is the ratio of the mean of the last two survey indices and the mean of the three preceding values or:

$$r = \frac{\sum_{i=y-2}^{y-1} I_1\ /2}{\sum_{i=y-3}^{y-5} I_1\ /3}$$

f is the length-ratio component where:

$$f = \frac{\overline{L}_{y-1}}{L_{F=M}}$$

where $\overline{L}$ is is the mean catch length above $L_{F=M}$. $L_{F=M}$ is calculated as:

$$L_{F=M} = 0.75L_c + 0.25L_\infty$$

where L_c is length at first capture and $L\infty$ is von Bertalanffy $L\infty$.

b is the biomass safeguard and is used to reduce catch advice when index falls below trigger,

$$b = min\left(1, I_y - 1/I_{trigger}\right)$$

where $I_{trigger} = i_{loss\omega}$

m is a multiplier based on stock growth. K for blue ling is < 0.2 and therefore m is 0.95. As the generic simulations on the rfb-rules were based on biennial catch advice, the last years advice (2022/2023) is rolled over to this year´s advice (2023/2024) ICES 2023).

4.2.4 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. In 2021/2022, ither species were transferred to blue ling for the first time since in was regulated into the ITQ system (Figure 4.2.6).

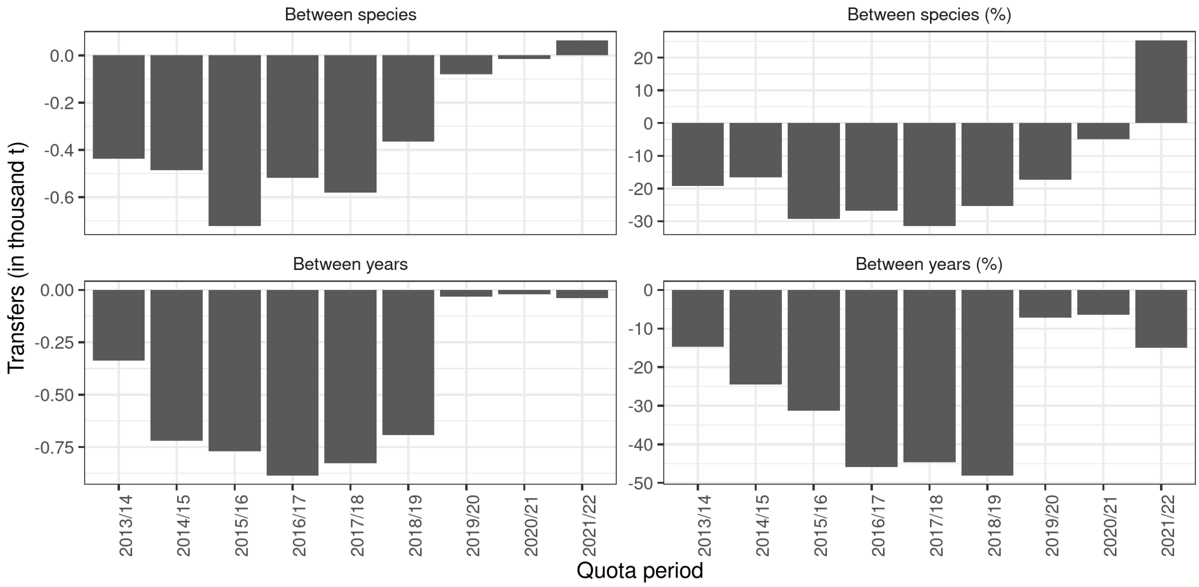

Figure 4.2.6: Blue ling in 5.a and 14. Net transfer of quota, from blue ling to other species and between years, in the Icelandic ITQ system by fishing year.

4.2.5 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).

4.2.5.1 Landings and discards

Landings data are given in Table 4.2.2 and Table 4.2.3. Discarding is banned in the Icelandic fishery. There is no available information on discarding of blue ling. Being a relatively valuable species and not being subjected to TAC constraints prior to 2013/2014 fishing year nor minimum landing size there should be little incentive to discard blue ling.

4.2.5.2 Length composition

Length distributions from the Icelandic trawl and longline catches for the period 2002– 2022 are shown in Figure 4.2.8. No length measures were called for from commercial catches in 2017. In

2022, nine sample were collected from commercial catch i.e three from longlines and six from bottom trawls (Figure 4.2.7).

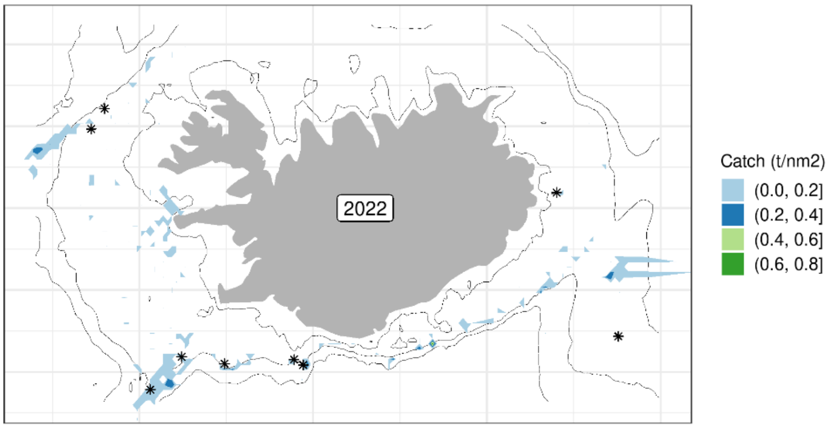

Figure 4.2.7: Blue ling in 5a. Distribution of catches in 2022 and location of samples.

Mean length from catches increased from 79 cm in 2002 to 103 cm in 2018. On average mean length from longlines is higher than from trawls.

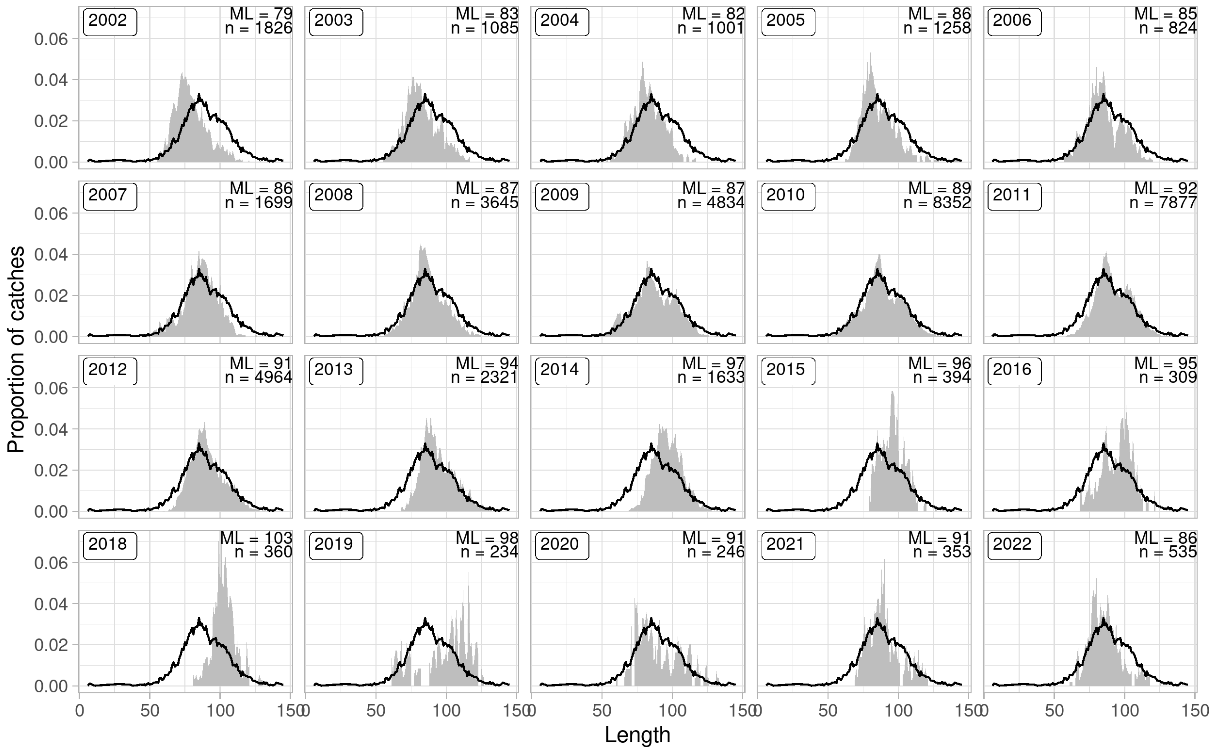

Figure 4.2.8: Blue ling in 5a. Length distribution of blue ling from catch (grey area). Black line is the mean for the period. No data available in 2017.

4.2.5.3 Age composition

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

4.2.5.4 Weight-at-age

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

4.2.5.5 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)

4.2.5.6 Catch, effort and survey data

Catch per unit effort and effort from the Icelandic trawl and longline fleet are given in Figure 4.2.9. 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 and therefore no attempt has been made to standardize the series.

However, looking at fluctuations in CPUE may be informative regarding the development of the fishery. CPUE from longlines was high from 2008 to 2013 but has decreased markedly since then. CPUE from trawls has been gradually decreasing in the period.

Effort from bottom trawls peaked in 2009 but has since then decreased sharply. Effort from longlines peaked in 2011 but has remained relatively stable since. Non-standardised estimates of CPUE and fishing effort from longlines and trawls, based on logbook data where blue ling was recorded in catches. Note that in 2022, no towhours in bottom trawls were recorded and therefore excluded.

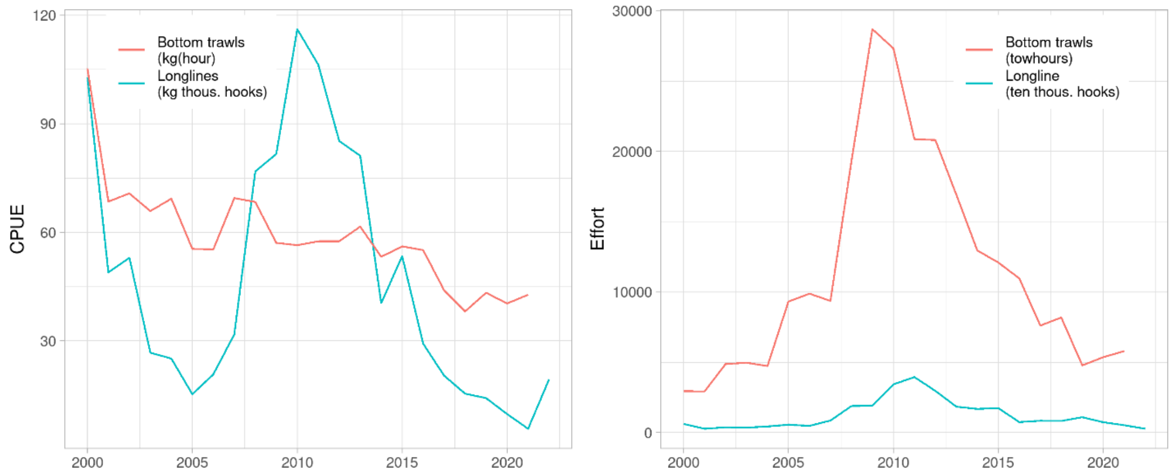

Figure 4.2.9: Blue ling in 5.a and 14. Catch per unit effort (left) and effort (right) from longlines (blue) and trawls (blue) in 5.a based on logbook data where blue ling was recorded in catches.

Time-series stratified abundance and biomass indices from the spring (G3239) and autumn (G4493) trawl surveys are shown in Figure 4.2.10.

The length distributions from the autumn survey and its spatial distribution are presented in Figure 4.2.11 and Figure 4.2.12. 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.

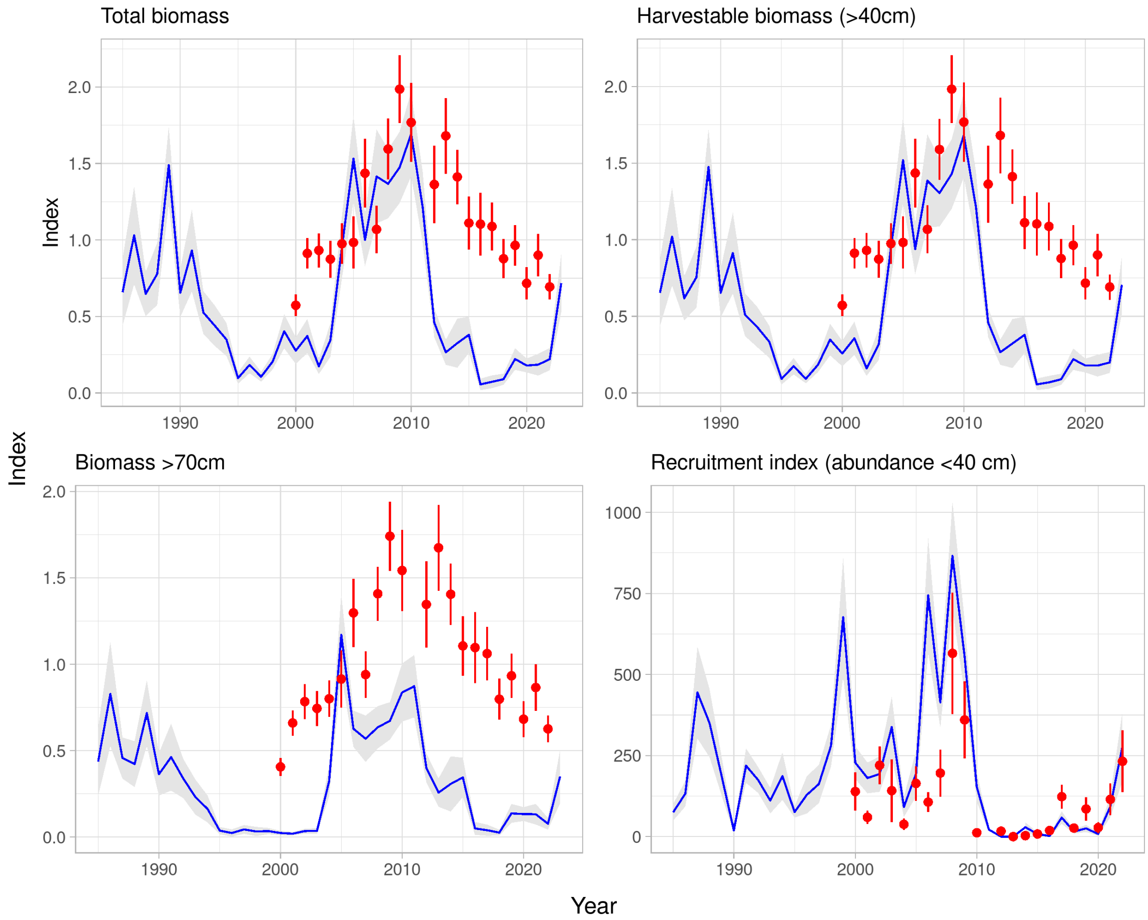

Figure 4.2.10: Blue ling in 5.a and 14. Survey abundance indices for blue ling in the Icelandic autumn survey since 2000 (red points and vertical lines) and the spring survey since 1985 (faded lines and shaded area). Total biomass index (top-left), biomass of 40 cm and larger (top-right), biomass of 70 cm and larger (bottom-left) and abundance - standard error of the estimate. Biomass in thousand tonnes.

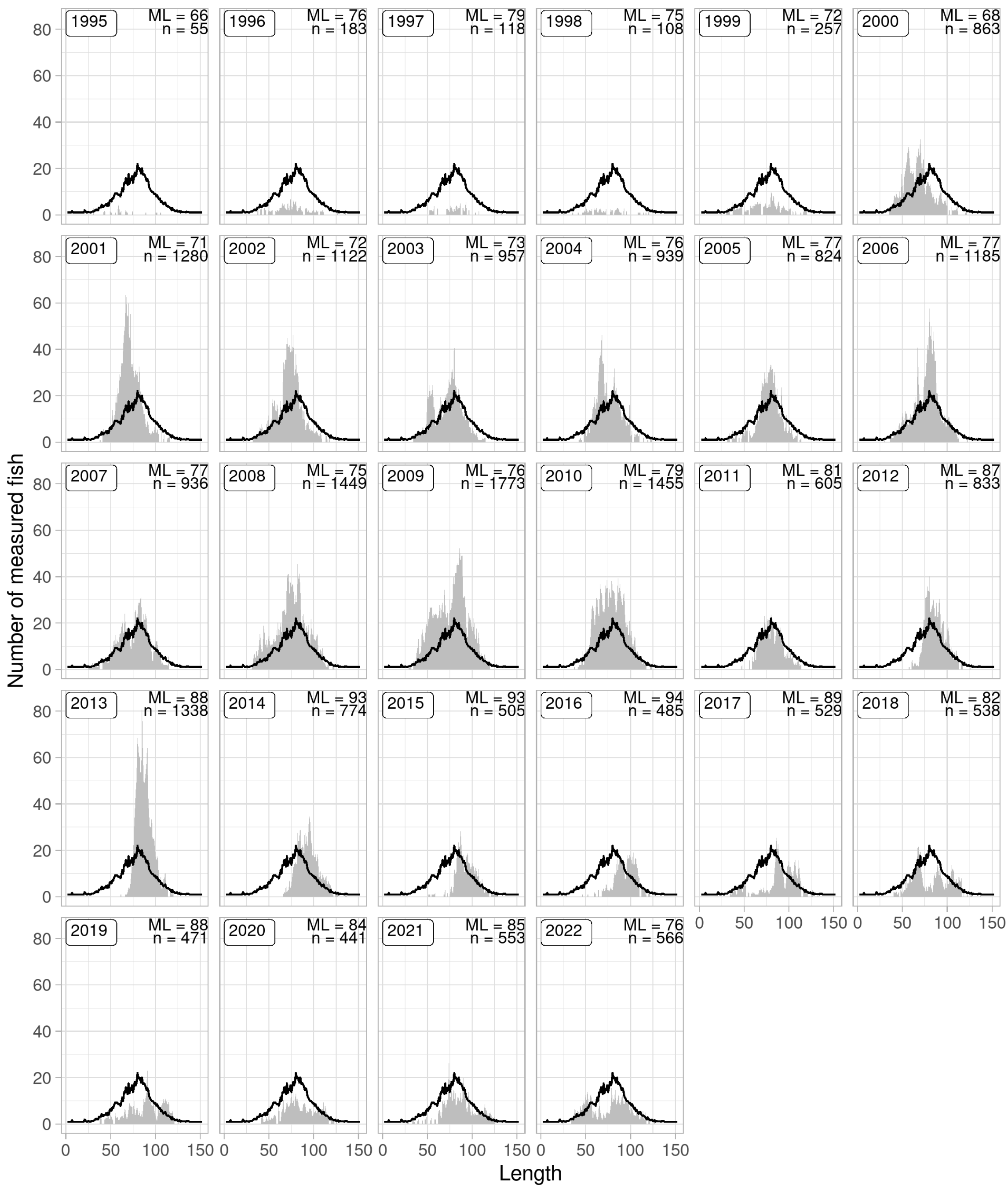

Figure 4.2.11: Blue ling in 5.a and 14. Length distribution from the Icelandic autumn survey since 1995. Black line is the average by length over the displayed period.

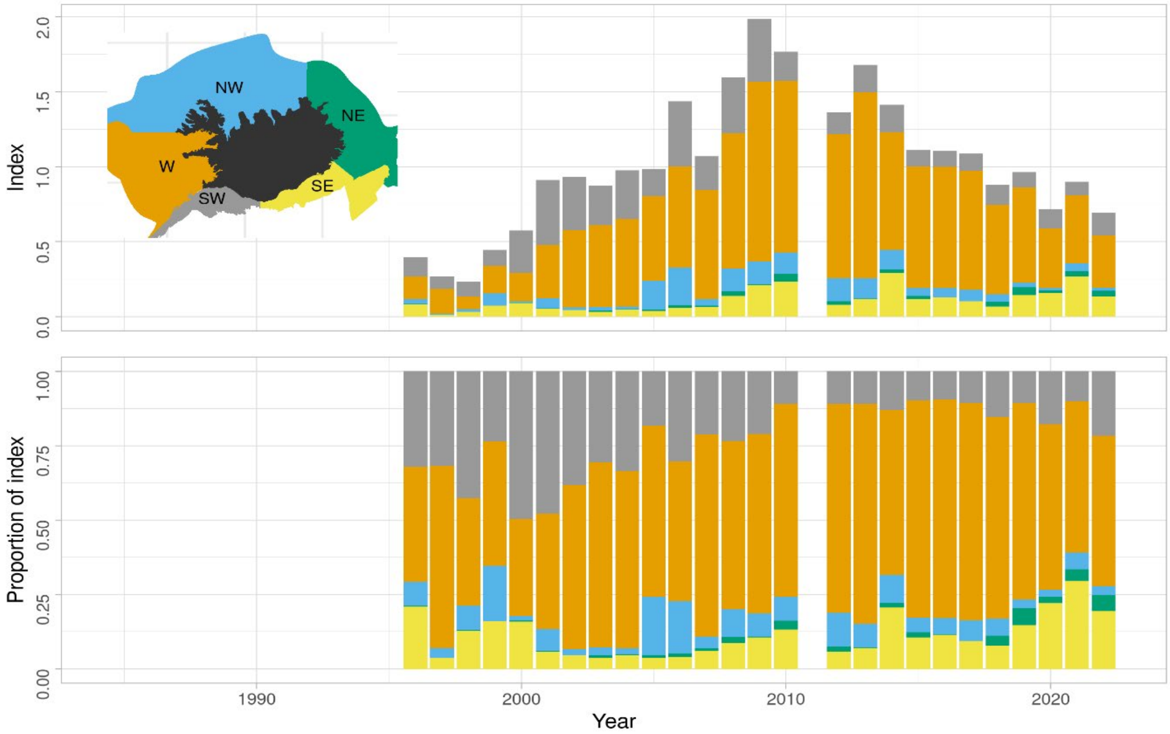

Figure 4.2.12: Blue ling in 5.a and 14. Spatial distribution of biomass index from the Icelandic autumn survey in 1996-2022.

4.2.6 Data analysis

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 (Table 4.2.2).

In 2005 longliners caught 108 tonnes of blue ling when trawlers caught 1261 tonnes or 84% of the total catches (1496 tonnes). In 2011 trawlers caught 1630 tonnes, out of 5904 tonnes or 28%, but longliners 4140 tonnes or 70%. Since then, the proportion taken by longliners has decreased and in 2022 longliners caught 86 t or 20% of the catches, trawls 338 t or 79% and other gear 3 t, or 1%. As longliners take on average larger specimens of blue ling, 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 fishing activity in 2011 and longlines in 2012 and 2013. The expansion of the longline fleet to deeper waters (Figure 4.2.4) may be the result of decreased catch rates in shallower areas.

CPUE and effort: CPUE indices from commercial catches are not considered a reliable index of stock abundance. The rapid CPUE increase 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 4.2.4). 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 4.2.9).

Surveys The spring survey covers only the shallower part of the depth distributional range of blue ling and shows high interannual variance (Figure 4.2.12). Since the spring indices do not cover the depths where the highest abundance of blue ling is found, it is unknown to what extent they reflect actual changes in total blue ling biomass. The shorter autumn survey, which goes to greater depths and is therefore more likely to reflect the true biomass dynamics, does indicate that there was an increase in blue ling biomass 2007-2009 (Figure 4.2.12). Since 2010 the biomass index 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 2010 it had decreased again and remained low until 2022, when an increase was observed (Figure 4.2.11 and Figure 4.2.12). Consequently, the average length recorded in the autumn survey has been greater since 2009 but decreased again in 2022 to levels comparable to those prior to 2010. Note that due to industrial action, only part of the autumn survey was conducted in 2011.

Analytical assessment

Exploratory stock assessment on blue ling using gadget

An exploratory stock assessment of blue ling using the Gadget model was presented at WGDEEP 2012. Updated results of the model were not presented at WGDEEP 2023.

4.2.6.1 Comments on the assessment and advice

The assessment is based on the rfb-rule for ICES category 3 data-limited stocks and last years advise is rolled over to this year as the generic simulations on the rfb-rules were based on a biennial catch advice. The Icelandic autumn trawl survey (IS-SMH) was used as the index for the stock development. The advice is in accordance to $A_{y+1} = A_{y-1}\ r\ f\ b\ m$ or 334 t * 0.833 * 0.977 * 1 * 0.95 which result is advice for 2022/2023 and 2023/2024 set at 259 t for each fishing year (23% reduction from last year's advice). From 2019-2021, the advice was based on the ICES framework for data limited stocks (Category 3.2) where the ratio of the mean of the last two survey indices (Index A) to the mean of the three preceding values (Index B) is multiplied by the last years advice. In 2019, the precautionary buffer was applied and thus, it would have been applied this year, resulting in advice for 223 tonnes (33% reduction) (Table 4.2.1).

Table 4.2.1. Blue ling. Comparison between the *rfb*-rule and the "2 over 3" rule.

Component	Rfb-rule	Old 2 over 3 rule
Previous advice	334	334
Index A	817	817
Index B	980	980
Ratio	0.833	0.833
Length ratio	0.977	-
Biomass safeguard	1	-
Multiplier	0.95	-
Initial advice	258	-
Stability clause applied	0	
Precautionary buffer*	-	0.8

Component	Rfb-rule	Old 2 over 3 rule
Final advice	258	223
Advice change	-23	-33

***Last applied in 2019.**

4.2.6.3 The application of rfb-rule

- r is calculated as the average of last two years values, divided by average of three preceding years values which results in r=0.833 (Figure 4.2.13, Table 4.2.6)

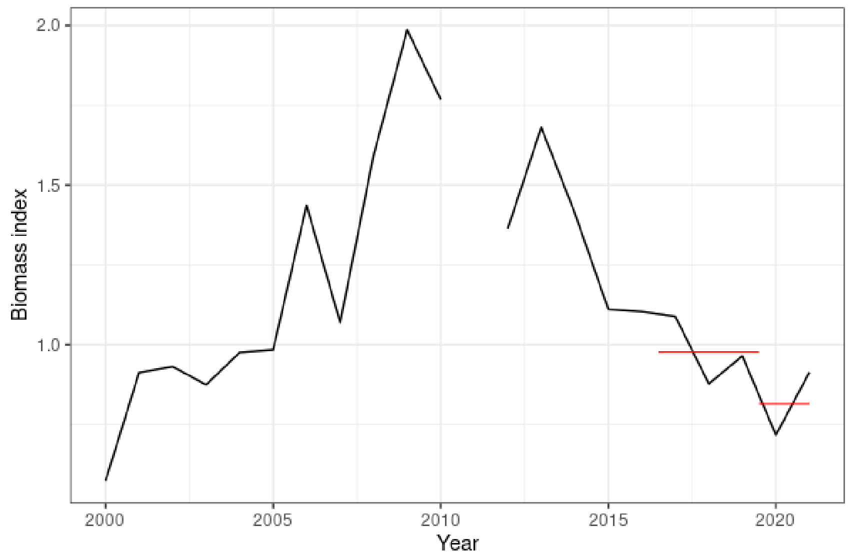

Figure 4.2.13: Blue ling in 5.a and 14. Biomass index since 2000. No index is in the year 2011 (No survey). The red lines show the average of last two years values and the three preceding years.

- *f* is the length-ratio component. The mean length of last years´ catch was 93 cm and the target reference length (L*c* or length at first capture * 0.75 + length ∞ * 0.25) is **95.25** (figure 4.2.14).

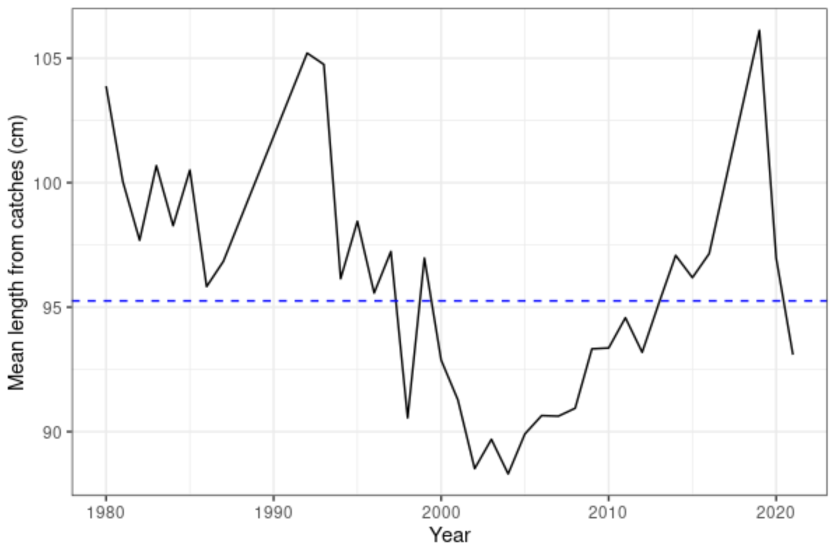

Figure 4.2.14: Blue ling in 5.a and 14. Mean length of blue ling from catches since 1980. The blue dashed line shows the target reference length.

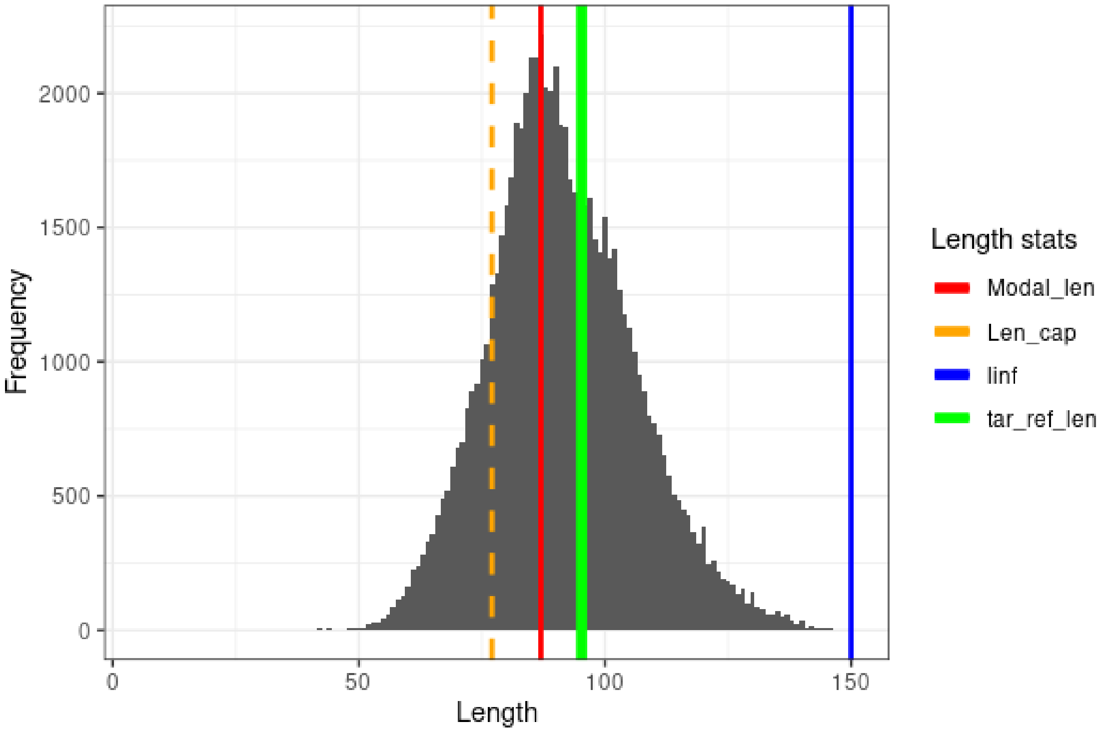

Figure 4.2.15: Blue ling in 5.a and 14. Length frequency distribution from catches. Red line is the length of modal abundance, the orange line is the length at first capture, green line is the target reference length, and the blue line is the L∞.

- *b* is the biomass safeguard and is used to reduce catch advice when index falls below trigger. The lowest index or the I_{loss} for blue ling is 574 and was recorded in the year 2000. $I_{trigger}$ is I_{loss} *1.4 or 803.75 (Figure 4.2.15). Biomass index this year is 915 and above $I_{trigger}$ and *b* is therefore 1.

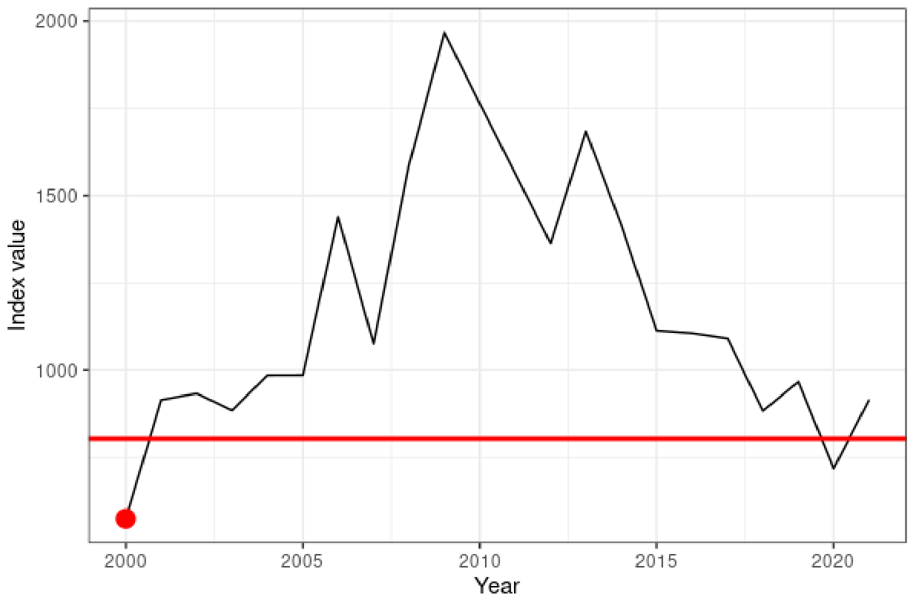

Figure 4.2.16: Blue ling in 5.a and 14. Biomass index values since 2000. The red line is the $I_{trigger}$ and the red dot is the lowest observed value (I_{loss}).

- *m* is the tuning parameter and for slow growing species (with von Bertanlaffy K<0.2), *m* equals to 0.95.

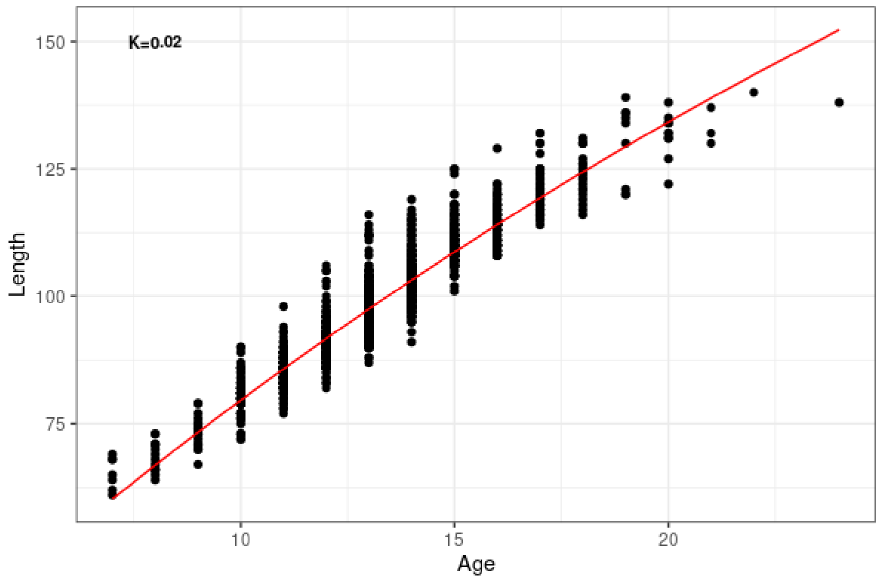

Figure 4.2.17: Blue ling in 5.a and 14. The von Bertalanffy growth curve (red line) fitted to age and length data for blue ling.

4.2.6.4 Exploring sensitivity of *f* with other L∞ values.

The *f* and TAC are sensitive to different *L∞* values (Figure 4.2.18, Table 4.2.2). The L∞ used in the assessment is the maximum length from Icelandic catches. The 99th and 95th percentiles were tested for sensitivity, as well as the *L∞* from fishbase.org. Table 4.2.1 shows how higher *L∞* values decrease *f* by increasing the target reference length. Increased *L∞* values result in lower TAC as it decreases *f*.

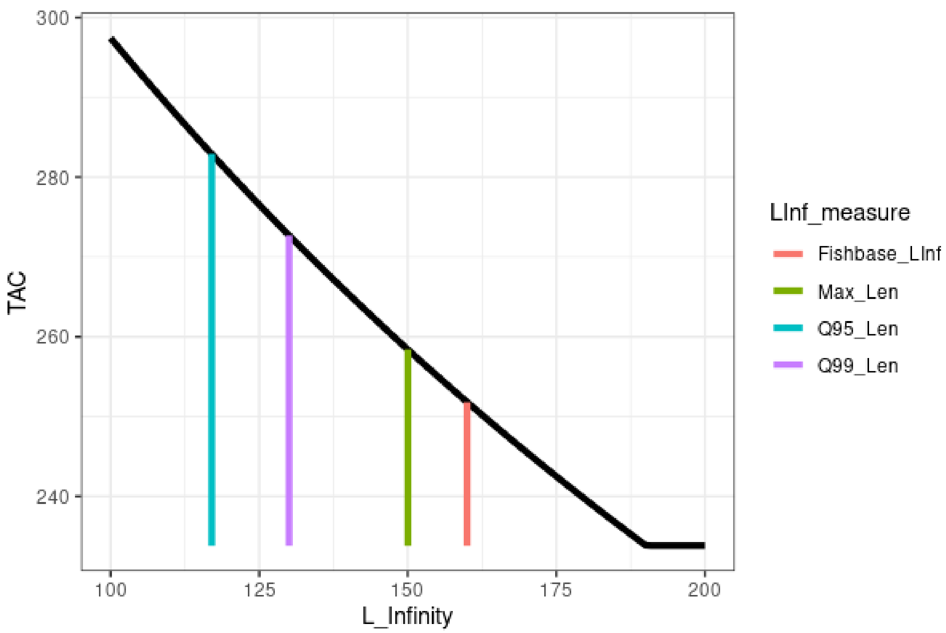

Figure 4.2.18: Blue ling in 5.a and 14. TAC sensitivity to different L∞ values. Blue line shows the 95th percentile to the maximum length value (117 cm), purple line is the 99th percentile to the maximum value (130 cm), green line is the maximum length value (150 cm) and the red line shows the fishbase.org value (160 cm).

Table 4.2.2: Blue ling in 5.a and 14. Parameter sensitivity to different L∞ values. The max length value is 150 cm, the 99th percentile of maximum length value is 130 cm, the 95th percentile is 117 cm and the fishbase.org value is 160 cm.

Component	L∞ (max length)	L∞ (99th percentile)	L∞ (95th percentile)	L∞ (fishbase.org)
Previous advice	334	334	334	334
Index A	817	817	817	817
Index B	980	980	980	980
Ratio	0.833	0.833	0.833	0.833
$L_{F=M}$ (target reference length)	95.25	90.25	87	97.75
f (length ratio)	0.977	1.03	1.07	0.952
Biomass safeguard	0.910	0.91	0.91	0.91
Multiplier	0.95	0.95	0.95	0.95
I_{loss}	574	574	574	574
$I_{trigger}$	804	804	804	804
Initial advice	258	273	283	252
Stability clause applied	0	0	0	0
Final advice	258	273	283	252
Advice change	-23	-18	-15	-25

4.2.7 Management considerations

Landings have decreased considerably in the last year and as blue ling 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 should be maintained and expanded where appropriate.

Table 4.2.3: Blue ling in 5.a and 14. Number of Icelandic boats with blue ling landings and their total landings in 5a.

Year	Bottom trawl (tonnes)	Gill nets (tonnes)	Longlines (tonnes)	Other (tonnes)	Bottom trawl (n boats)	Gill nets (n boats)	Longlines (n boats)	Total catch (tonnes)
2000	801	13	808	13	108	18	44	1634
2001	597	24	131	10	110	28	39	762
2002	986	15	256	8	105	14	41	1264
2003	883	6	197	11	105	14	47	1098
2004	894	5	145	39	112	19	53	1083
2005	1261	8	108	119	106	16	60	1496
2006	1477	13	151	94	105	16	69	1734
2007	1544	22	374	54	97	24	90	1995
2008	2111	28	1454	60	95	25	92	3653
2009	2242	136	1677	75	89	31	87	4129
2010	2201	91	3978	107	85	31	96	6378
2011	1630	76	4140	59	81	24	97	5904
2012	1449	274	2425	58	79	22	78	4207
2013	1300	14	1420	34	75	20	71	2769
2014	923	11	622	32	72	15	73	1588
2015	821	9	868	13	67	18	77	1712
2016	701	3	213	7	66	11	53	925
2017	436	1	169	12	57	8	52	619
2018	363	2	132	5	65	6	59	502
2019	238	3	161	13	58	11	53	415
2020	264	1	70	7	58	9	46	343
2021	286	2	33	2	59	10	40	323
2022	338	2	86	1	55	7	37	427

Table 4.2.4: Blue ling in 5.a and 14. Landing in ICES Division 14. Source: STATLANT database and WD02 (Annex 2).

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	2	4	0	0	889	2	0	898
2001	1	0	1	11	61	0	1631	6	0	1711
2002	0	0	0	11	1	0	0	0	0	12
2003	0	0	3	0	36	0	670	5	0	714
2004	0	0	7	0	1	0	0	7	0	15
2005	2	0	6	0	1	0	176	8	0	193
2006	0	0	6	0	3	1	0	0	0	10
2007	19	0	1	0	1	0	0	0	0	21
2008	1	0	5	0	2	0	381	0	1	390
2009	1	0	5	0	3	0	111	4	0	124
2010	1	0	8	0	9	0	34	0	3	55
2011	0	0	8	0	2	0	0	1	6	17

YEAR	FAROE	GERMANY	GREENLAND	ICELAND	NORWAY	RUSSIA	SPAIN	UK	DENMARK	TOTAL
2012	0	0	13	367	9	0	0	0	3	392
2013	0	0	16	0	0	0	0	3	9	28
2014	0	0	14	0	3	0	0	0	0	17
2015	0	0	66	0	1	0	0	0	5	72
2016	0	0	9	0	0	0	0	0	7	16
2017	0	0	12	0	4	0	0	0	3	19
2018	0	0	34	0	12	0	0	0	5	51
2019	0	7	20	0	36	0	0	0	0	62
2020	0	7	18	0	2	0	0	0	0	27
2021	0	6	1	0	9	0	0	0	0	16
2022	0	0	22	0	7	0	0	0	5	34

Table 4.2.5: Blue ling in 5.a and 14. Advised TAC, national TAC and total landings since the quota year 2013/2014.

Fishing Year	MFRI Advice	National TAC	Iceland	Others	Landings
2013/14	2400	2400	1653	101	1754
2014/15	3100	3100	1898	41	1939
2015/16	2550	2550	1734	90	1828
2016/17	2032	2032	932	23	955
2017/18	1956	1956	554	79	592
2018/19	1520	1520	424	62	424
2019/20	483	483	371	5	376
2020/21	406	406	365	12	377
2021/22	334	334	369	3	327
2022/23	259				

Table 4.2.6: Blue ling in 5.a and 14.: Landings from Icelandic fishing grounds (5a)

Year	Faroe	Germany	Iceland	Norway	UK
2002	28	4	1264	74	10
2003	16	16	1098	6	24
2004	38	9	1083	49	27
2005	24	31	1496	20	26
2006	63	22	1734	27	11
2007	78	0	1995	4	13
2008	88	0	3653	21	0
2009	178	0	4129	5	0
2010	515	0	6378	13	0
2011	797	0	5904	2	0
2012	312	0	4207	2	0
2013	435	0	2769	2	0
2014	71	0	1588	30	0
2015	10	0	1712	4	0
2016	6	0	925	0	0
2017	4	0	619	0	0
2018	28	0	502	0	0
2019	5	0	415	4	0
2020	6	0	343	0.1	0
2021	1	0	323	7	0
2022	1	0	427	10	0

Table 4.2.7: Blue ling in 5.a and 14. Catches along with survey biomass index (larger than 40 cm) from the Icelandic Autumn survey and the calculated Fproxy (Catches in Iceland and Greenland)/Index)

Year	Iceland	Greenland	Index	Fproxy
2000	1635.876	896	574.1	4.41
2001	761.809	1710	914.3	2.70
2002	1264.674	12	933.2	1.37
2003	1098.029	711	884.4	2.04
2004	1089.908	8	985.4	1.11
2005	1502.326	187	985.7	1.71
2006	1736.037	4	1439.2	1.20
2007	1998.092	20	1075.5	1.87
2008	3653.183	385	1586.6	2.54
2009	4129.245	119	1967.2	2.16
2010	6377.866	47	1763.5	3.64
2012	4206.665	379	1363.3	3.36
2013	2769.869	28	1683.9	1.66
2014	1687.642	17	1415.2	1.20
2015	1727.363	72	1113.2	1.62
2016	930.790	16	1105.7	0.89
2017	622.257	19	1090.7	0.59
2018	502.955	17	883.0	0.59
2019	423.983	62	966.7	0.50
2020	349.307	27	718.1	0.52
2021	331.856	16	902.7	0.38
2022	437.831	34	695.0	0.68

4.2.9 References

ICES. 2012. "Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP), 28 March–5 April, 2012, Copenhagen, Denmark. ICES Cm 2012/Acom:17." International Council for the Exploration of the Seas; ICES publishing.

ICES. 2021. Tenth Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE X). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.5985

ICES. 2023. Eleventh Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks(WKLIFE XI). ICES Scientific Reports. 5:21. 74 pp. https://doi.org/10.17895/ices.pub.22140260

4.3 Blue Ling (*Molva dypterygia*) in Division 5.b and subareas 6 and 7

4.3.1 The fishery

In the last decade, the main fisheries have been from French, Faroese and Scottish trawlers. Faroese vessels have been fishing almost exclusively in ICES Division 5.b, French and Scottish vessels have been mostly fishing in in ICES Division 6.a, with a smaller catch in in ICES Division 5.b from French trawlers. Scottish vessels have been catching an increasing proportion of annual international landings and became the main fishing fleet in 2022. The two other countries, which contribute notably to the total catch are Norway and Spain. Total international landings from Subarea 7 have been decreasing since the late 1990s and were less than 0.1% of the total catch in 2022.

Landings by Faroese trawlers are mostly taken in the spawning season. Historically, this was also the case for French trawlers fishing in ICES Division 5.b and 6.a. However, since the 2000s blue ling has been taken round the year together with roundnose grenadier and black scabbardfish, as well as deep-water sharks until 2009. Since 2016 trawling is banned deeper than 800 m, whist blue ling is abundant down to at least 1200 m.

In recent years, an increasing proportion of the catch has been from hooks and lines. Trawlers represented 94 % and 79% of the landings in 2019 and 2022 respectively, whilst the contribution of longliners to total landings increased from 6% to 20% in the same period.. As in previous years, all Norwegian catch were from longliners. The Spanish fleet has a component of longliners, which represented one quarter of Spanish catches in 2019 and increased to 90% in 2021 and 2022. Scottish landings increased from about 720 tonnes in 2018-2020 to 2142 t in 2022, representing 40% of total catch.

4.3.2 Landings trends

See the stock annex for the time-series of landings from 1966 to 1999.Total international landings from Division 5.b (Tables 4.3.1a–f, Figure 4.3.1 and stock annex) peaked in the late 1970s at around 21 000 t and then declined until 2010. Thereafter landings have oscillated between 1000 and 1700 tonnes per year.

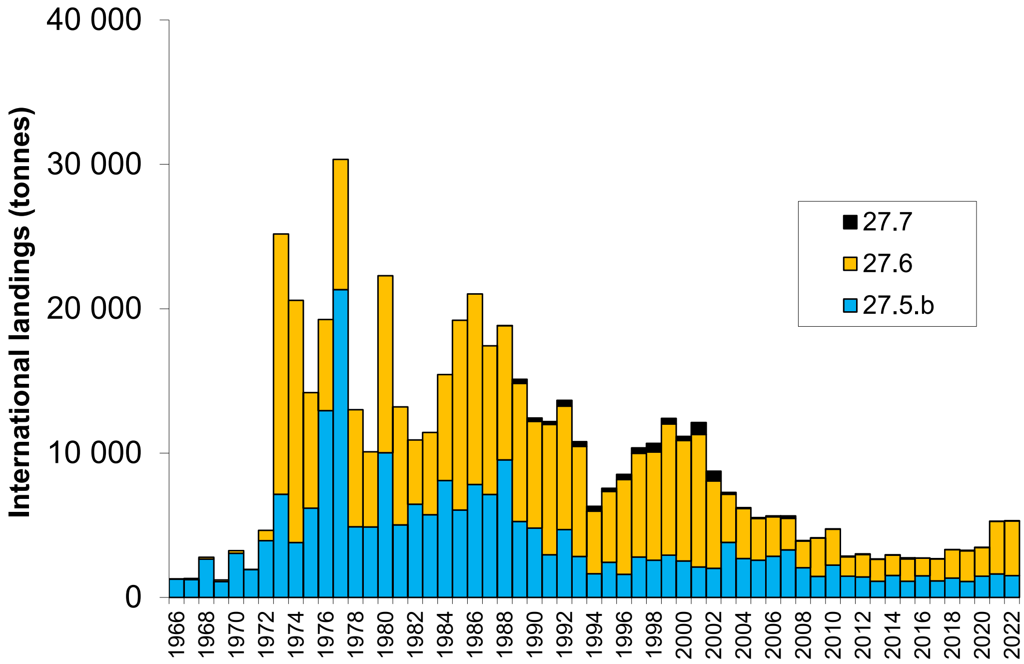

Figure 4.3.1. International landings for bli.27.5b67 in ICES subareas 6 and 7 and Division 5b.

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 2010s, the landings declined to an historical low level of less than 1300 tonnes in 2016 but have increased since to more than 2000 tonnes in 2019 and increased again to near 3800 tonnes in 2022 (Table 4.3.1c). Although significant in the past, landings in Division 6b were minor in the last 10 years and null in the last two years (Table 4.3.1d).

Landings from Subarea 7 are comparatively small, mostly less than 500 t per year in the whole time-series and less than 50 t during the last ten years, except in 2015 when 78 t were landed (Table 4.3.1e).

Landings in 2022 at 5308 increased slightly from 5285 tonnes in 2021 and are the highest record since 2007, but remain well below the advice and TAC levels.

Like in recent years, landings data by country and ICES Division were extracted from InterCatch for all countries, expect for the Faroe Islands for which official Faroese landings were taken from the ICES preliminary statistics.

4.3.3 ICES Advice

The ICES advice for 2023 and 2024 is "when the MSY approach is applied, catches should be no more than 10 952 tonnes in 2023 and no more than 10 972 tonnes in 2024."

4.3.4 Management

This stock is classified as Category 4 in the NEAFC categorization of deep-sea species/stocks which implies that fisheries are primarily restricted to Coastal State exclusive economic zones (EEZs) and therefore management measures are not taken by NEAFC unless complementary to coastal state conservation and management measures.

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 in ICES Division 5.b, and Subareas 6 and 7. TACs are fixed according to bilateral agreements between EU and Faroe Islands and EU and Norway. The EU TAC includes quotas for Norway and the Faroe Islands and the EU has a quota for ling and blue ling in Faroese waters (1885 t in 2019 and 2020). This EU quota in Faroese waters is divided in national quotas between Germany, France and UK.

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

Agreement about TAC between Faroe Islands the United Kingdom of Great Britain and Northern Ireland for 2022: UK stocks for transfer to Faroes ICES area 6, 7 of 500 tonnes blue ling (western) and Faroe stocks for transfer to UK ICES area 5b of 225 tonnes blue ling and ling (Agreed record of fisheries consultations between the Faroe Islands and the United Kingdom of Great Britain and Northern Ireland for 2022, https://lms.cdn.fo/media/16241/semja-millum-f%C3%B8royar-og-bretland-um-s%C3%ADnamillum-fiskir%C3%A6ttindi-fyri-2022.pdf?s=sJM9VkNVqiTh-gFIq6Q2NuMDoaZg).

Year	Area	ICES advice	EU TAC	QUOTA INCLUDED IN EU TAC EU	Norway	Faroe	UK(4)	EU QUOTA IN FAROESE WATERS OF 5.b(1)	INTERNATIONAL 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	2748
2016	5b67	5046	5046	4746	150(2)	150(3)		2100	3043
2017	5b67	11 314	11314	11014	150(2)	150(3)		2000	2669
2018	5b67	10 763	10763	11463	150(2)	150(3)		2000	3322
2019	5b67	11 778	11778	11378	250(2)	150(3)		1885	3218
2020	5b67	11 150	11150	10750	250(2)	150(3)		1885	3478
2021	5b67	11522	11 522	8908	0	0	2614	0	5286
2022	5b67	10 859	10 859	8332	0	0	2527	0	5308
2023	5b67	10 952	10 952	8341	0	0	2611	0	
2024	5b67	10 972							

(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 665 t in 2018.

(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) Since 2021, the share of fishing opportunities agreed between UK and EU are included in the EU regulation

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.

From 2015 to 2023, the EU TAC in EU and international waters was set to the level of the ICES catch advice. As a significant fraction of the catch comes from Faroese waters, setting the EU TAC at the level of the ICES advice implied that the ICES advice could have been overrun without any illegal catch, so creating a risk of exploiting the stock beyond the recommended level.

In 2009, the EU introduced protection areas of spawning aggregations of blue ling on the edge of the Scottish continental shelf (6.a) and at the edge of Rosemary Bank (6.a). Fishing for blue ling is restricted in known spawning areas during 3 months corresponding to the spawning season. 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. This regulation and the coordinate of the prohibited area are included in regulation 2019/1241 of the European parliament and of the Council. Since 2021 and the Brexit, these spawning areas are no longer in EU but in UK waters. In 2013, NEAFC introduced a protection of the spawning area located near the southwest boundary of the Icelandic EEZ, this area is banned to bottom fishing gears from 15 February to 15 April (rec 7:2017, https://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 4.1.3b. The ban of fishing with mobile gears in contact with the seafloor deeper than 800 m included in EU and UK regulations, imply that since 2016 part of depth distribution of blue ling has been devoid of fishing effort from trawlers.

Blue ling has been subject to a minimum conservation reference (MCRS) of 70 cm in EU Northwestern and South-Western waters (EU regulation 2019/124). This regulation also applies to the NEAFC RA. The impact of this MCRS regulation is minor as the proportion of blue ling smaller than 70 cm has always been minor.

4.3.5 Data availability

4.3.5.1 Landings and discards

The time-series of landings was updated (Tables 4.3.1a-f).

As in previous years, landings from the Faroe Islands in 2022 were not uploaded to InterCatch and were taken for ICES preliminary statistics. From all countries, except the Faroe Islands, landings estimates submitted to InterCatch were used..

Data submitted to InterCatch showed that international discards in 2018-22 were less than 1% of landings for countries reporting through InterCatch. Faroese vessels are considered making no discards. This low discarding proportion comes from the absence of catch of small blue ling on most of the fishing grounds. Overall, discarding is well below the maximum level of 5% for considering it negligible in ICES advice. No catch in international waters were reported in 2021 and 2022.

4.3.5.2 Length compositions

Length composition times-series previously used were all updated (see below section 5.3.6 data analyses).

4.3.5.3 Age compositions

Age estimations have been carried out by France since 2009, using a consistent protocol (see stock annex) so even though ageing is not validated for this species, comparable data are now available for 11 years.

4.3.5.4 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. Since the stock was benchmarked in 2014, the length–weight relationship used comes from the Faroese surveys, which cover a wide range of size (see stock annex).

4.3.5.5 Maturity and natural mortality

No new data.

4.3.5.6 Catch, effort and RV data

Catch data were updated, discards data reported to InterCatch were negligible (less than 1% of total catch). Effort data are not used for modelling the stock's dynamics.

Abundance and biomass indices from surveys were all available. Blue ling is sampled in three Faroese surveys and one Scottish survey.

4.3.6 Data analyses

4.3.6.1 Length compositions

Possible recruitment inputs are visible in length compositions of Faroese commercial catches in some years, e.g. 2007–2009, 2015,2018 and 2021 (Figure 4.3.2).

In the sampling of Faroese landings, large numbers of fish have been measured in the last five years, making this data set useful to appraise change in the stock. On the contrary, in years 2000 to 2014, the number of fish measured seemed low.

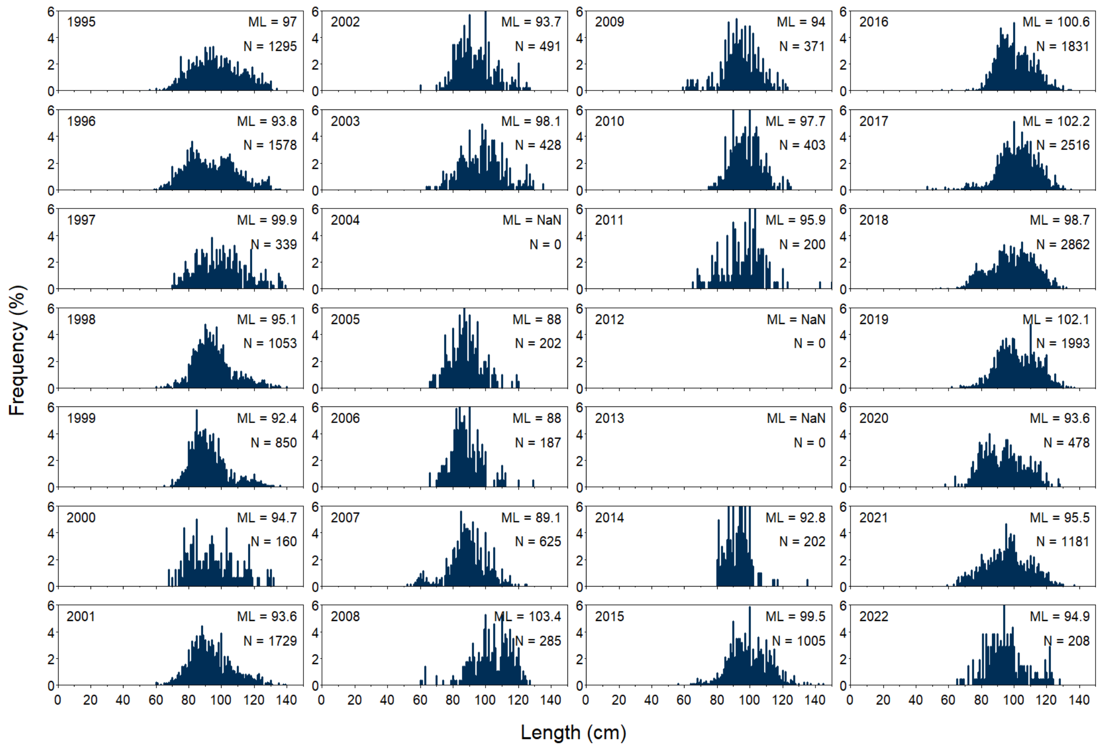

Figure 4.3.2. Length composition of blue ling landings from Faroese otter-board trawlers >1000 HP in Division 5.b from 1995 to 2022.

Small blue ling (between 40 and 60 cm total length) were caught in higher proportion during both surveys in 2017-2019 than during most of the time series (Figures 4.3.3 and 4.3.4). The length distribution of the Faroese deep-water survey initiated in 2014 is shifted to the right compared to the other survey, which is expected as blue ling move to deeper areas with age. Nevertheless, in 2019 the deep-water survey also shows a higher proportion of smaller (60-80 cm) individuals, this proportion was high again in 2022 (Figure 4.3.5).

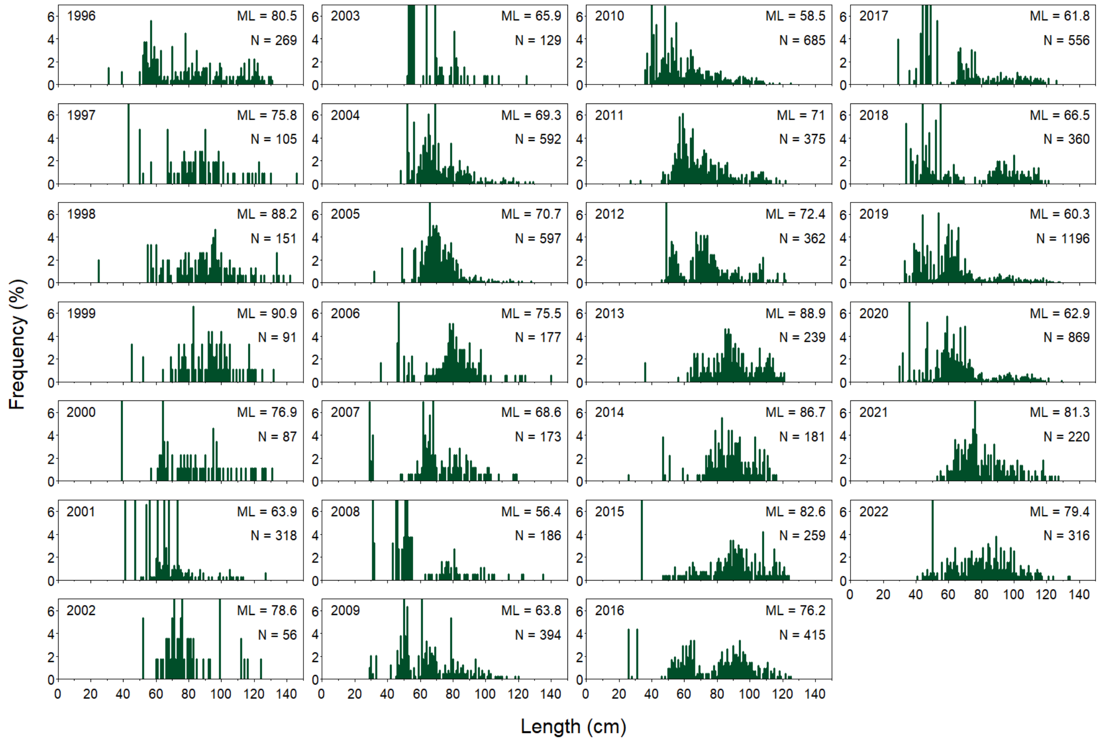

Figure 4.3.3. Length composition of blue ling in the Faroese summer groundfish survey on the Faroe Plateau (1996-2022).

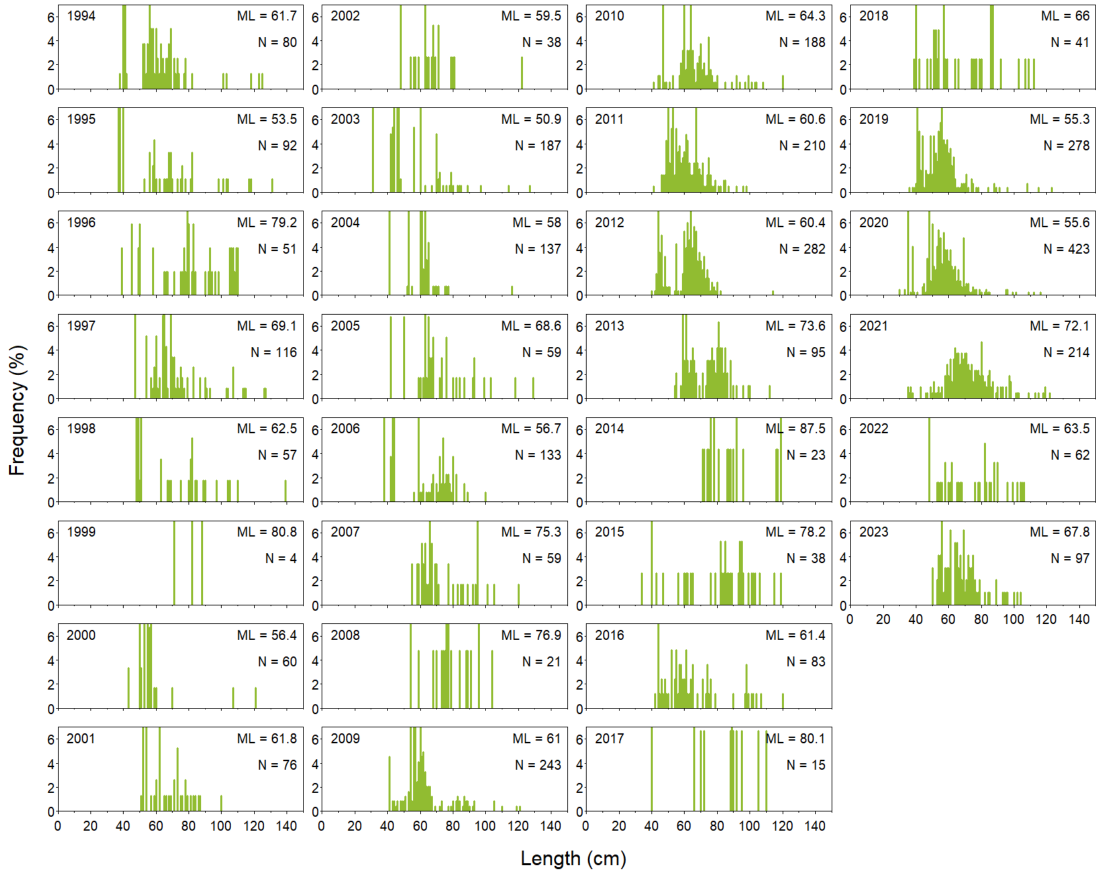

Figure 4.3.4. Length composition of blue ling in the Faroese spring groundfish survey on the Faroe Plateau (1995-2021).

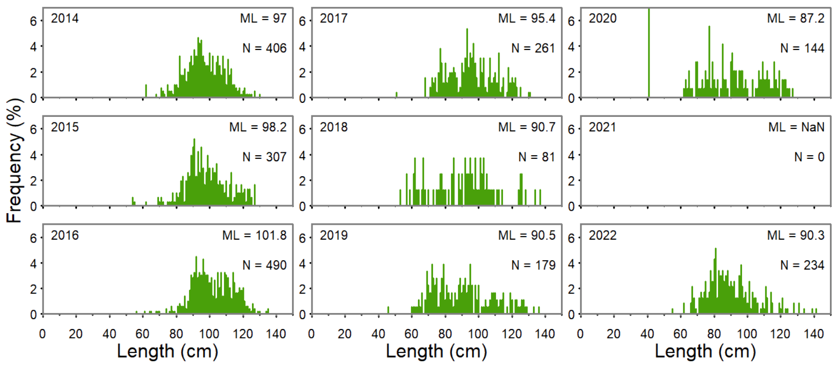

Figure 4.3.5. Length composition of blue ling in the Faroese deep-water survey in Faroese waters (2014-2021). No deep-water survey in 2021

The estimated length composition show an increasing proportion of larger fish from the 2000s to the mid 2010s, followed by a decrease (Figure 4.3.6). The recent decrease reflects a larger income of small fish (recruitment) as in 2014-2018 the stock biomass increased and the fishing mortality was low.

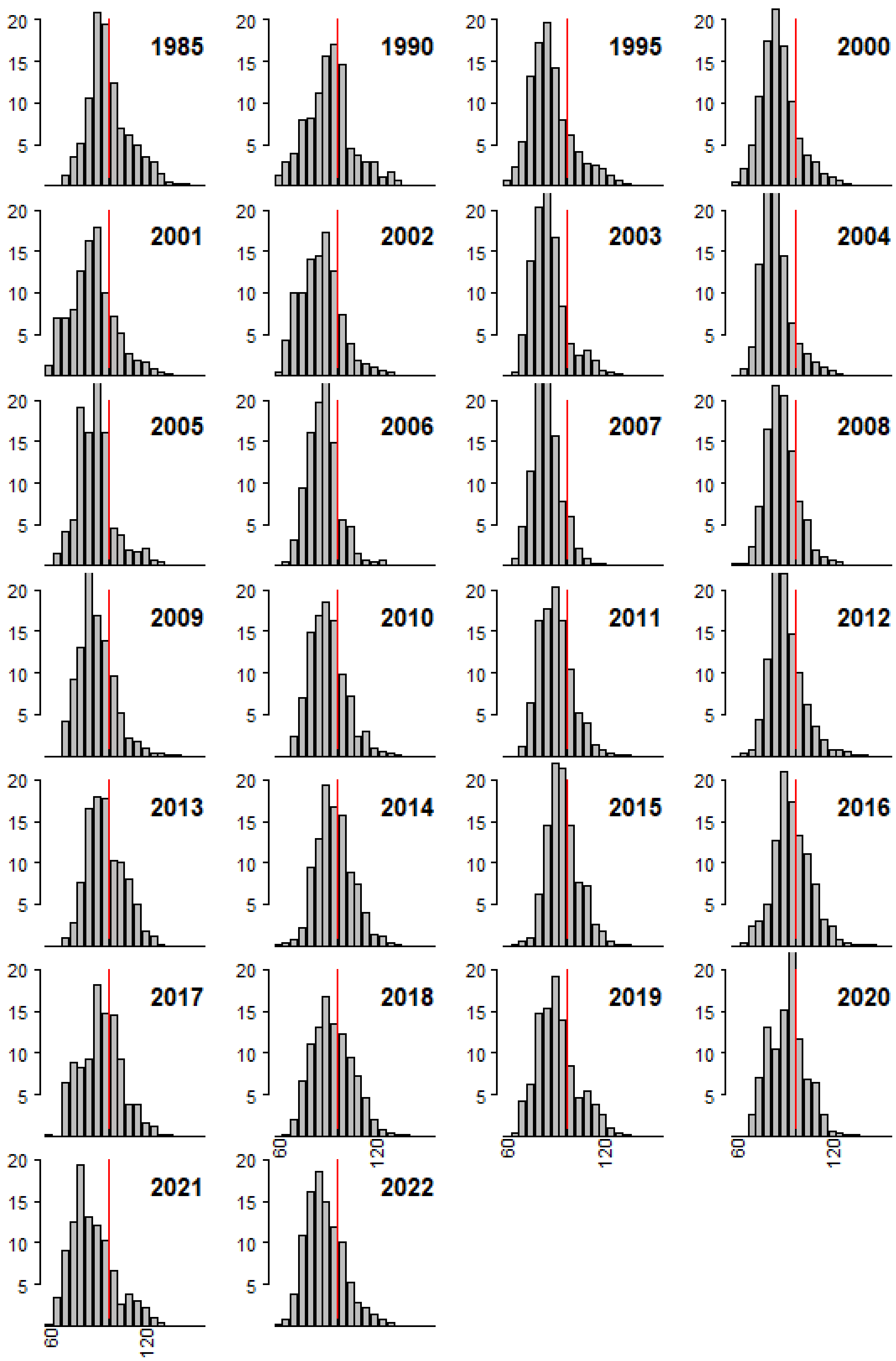

Figure 4.3.6. Length distribution of landings from 1984 to 2022 by 5 cm intervals. The red line represent the 100 cm size class. Length distribution based upon French landings only in 1985-2011,combining French and Faroese length distribution in 2012-2021, using data uploaded to InterCatch data for 2022. Before 2000, only data for every 5th year are shown.

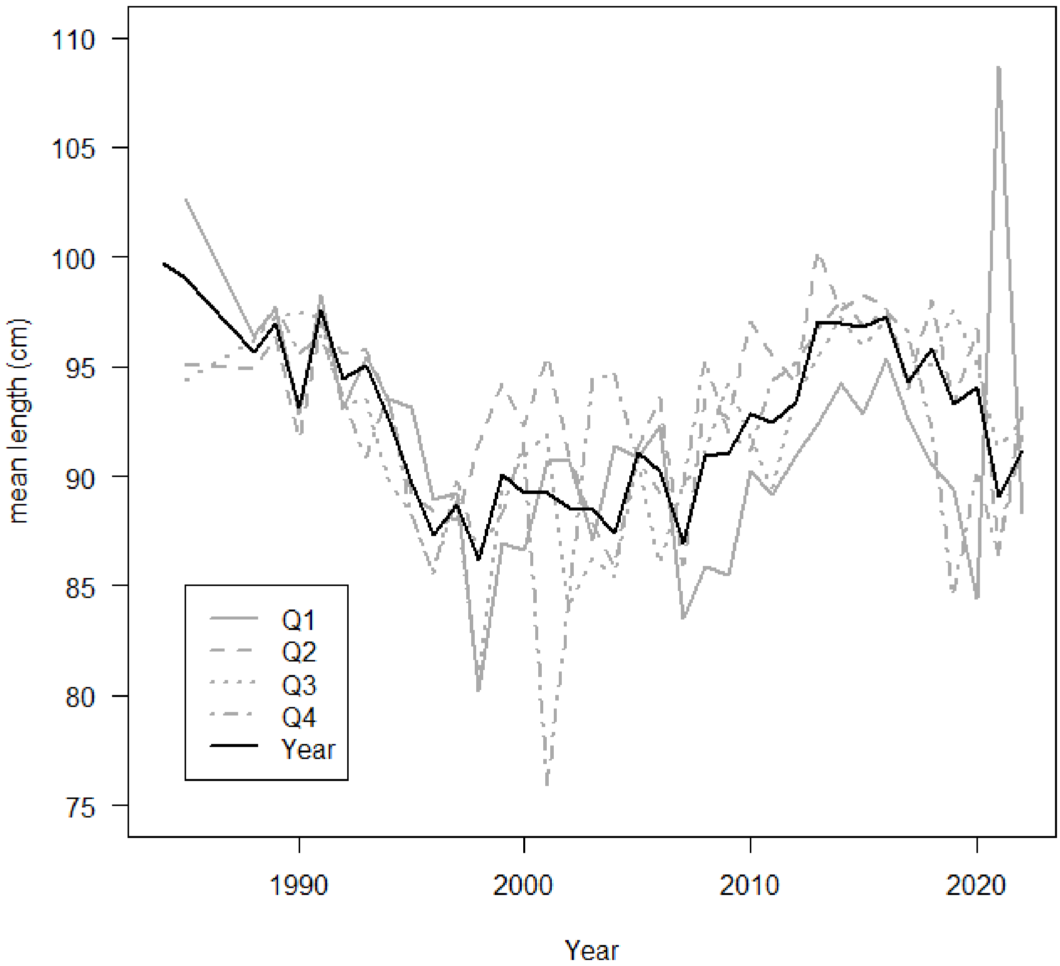

Figure 4.3.7. Quarterly mean length estimated 1984–2022 (no data in 1986-87, some years based upon French data only).

4.3.6.2 Abundance and biomass indices

The previously used indicators of abundance and occurrence of blue ling smaller than 80 cm, also reflect this higher abundance of juveniles in Faroese surveys in 2015-2020, with smaller number in the two last years (Figure 4.3.8).

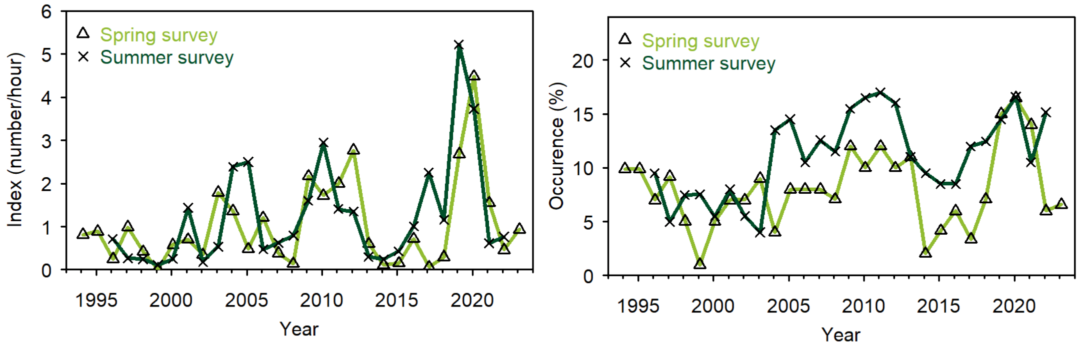

Figure 4.3.8. Juvenile (<80 cm) blue ling caught in groundfish surveys on the Faroe Plateau (left) number per hour and (right) occurrence.

The indices of total biomass from Faroese are uncertain with high values in 2004, 2005 and since 2009 for the summer survey. The spring summer shows a sharp increase after a low level in 2017 (Figure 4.3.9). Over the last decade, the indices from the two surveys did not track each other. The depth range (mostly <500 m) of these surveys do not extend down to the core depth distribution of blue ling. The indices include all hauls and are calculated using a design-based stratification.

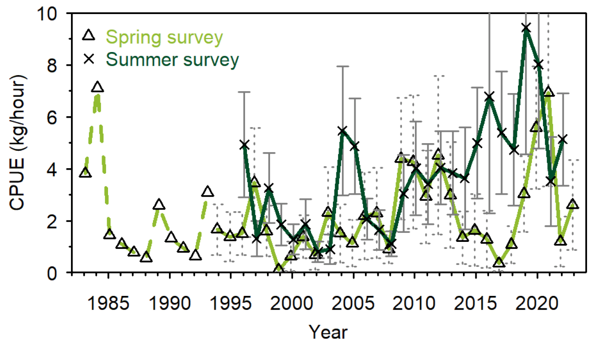

Figure 4.3.9. Biomass indices (kg.hour-1) of blue ling in Faroese surveys.

Indices from the Marine Scotland trawl deepwater survey carried out on the fisheries research survey SCOTIA are uncertain (Figure 4.3.10, Table 4.3.2) probably owing to the small number of hauls per year and the aggregating distribution of blue ling. The indices are averaged numbers and weights caught per haul carried out in the depth range 400 to 1600 m (n = 394 hauls for the whole time-series), which is the core range of the species along the Scottish slope. Only hauls from the Scottish slope are included, excluding data from Rockall and seamounts. The survey was performed biennially since 2013 and annually before (with no surveys in 1999, 2001, 2003 and 2010). The last survey in 2021 was carried out in October/November instead of mostly September in previous years, but the availability of blue ling is not known to change at this late summer/autumn season.

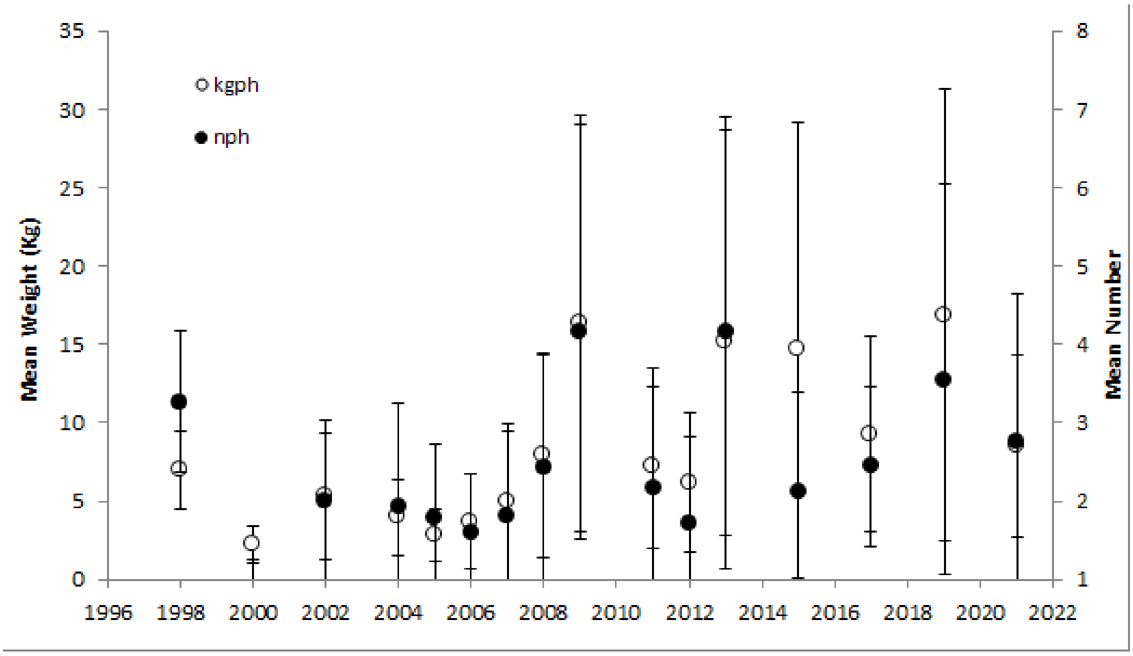

Figure 4. 3.10. Biomass and abundance indices of blue ling from the Marin Scotland deep-water survey.

4.3.7 Stock assessment

No assessment was carried out in 2023 (see last year's report for the most recent assessment).

Reference points

Reference points the stock were defined 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 analysis (ICES 2016). This is because the only input available, at the time was the Stock reduction analysis (SRA) as the MYCC did 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. B_{lim} was set as B_{loss}, the lowest biomass estimate in the time-series (here the time-series of biomass from the SRA estimated in 2014).

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 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 mean of B_{MSY} could not be projected in a projection taking account of recruitment variability.

4.3.8 Management considerations

International landings have been well below the ICES advice for several years. This is the consequence of several factors including:

- in Faroese waters, fleets have other resources available and do not target particularly blue ling,
- in EU waters the major fishing country has been France since the 1970s, the French fleets of large trawlers has reduced and the remaining vessels fish primarily for saithe and hake,
- historically most of the landings were caught in quarter 2 during the spawning season, the fishing for spawning blue ling has been restricted from 2009 in particular in Division 6.a from the EU (COUNCIL REGULATION (EC) No 43/2009
- of 16 January 2009) and since 2021 a similar has been enforced by UK,
- the ban of trawling deeper than 800 m for EU fleets since 2016, reduced the access to the stock which depth distribution extends deeper., this regulation was transcripted to the UK regulation and therefore continues to apply.

4.3.9 References

ICES. 2016. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

Large, P. A., G. Diez, J. Drewery, M. Laurans, G. M. Pilling, D. G. Reid, J. Reinert, A. B. South, and V. I. Vinnichenko. 2010. Spatial and temporal distribution of spawning aggregations of blue ling (*Molva dypterygia*) west and northwest of the British Isles. ICES Journal of Marine Science 67:494–501.

4.3.10 Tables

Table 4.3.1a. Landings of blue ling in Subdivision 5.b.1 (see stock annex for years before 2000).

YEAR	FAROES	FRANCE(1)	GERMANY(1)	NORWAY	UK (E & W) (1)	UK (Scot.)	IRELAND	RUSSIA(1)	TOTAL
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		74	1				1884
2006	1276	839		21	1			16	2153
2007	1220	1166		212	8			36	2642
2008	642	865		35				110	1652
2009	523	325						0	848
2010	840	464		49			0	0	1353
2011	838	312		0			0	0	1150
2012	799	401		8			0	5	1213
2013	440	543		0			0	3	986
2014	730	606		29					1365
2015	621	142	0	140	0		0	0	903
2016	1100	302	0	74	0		0	0	1476
2017	766	267	0	21	0	3	0	0	1057
2018	818	220	0	150	0	0	0	0	1188
2019	573	385		29					987
2020	697	580	0	87		5	0		136é9
2021	651	477	0	212		10			1350
2022	635	502	00	251		59	0	NA	1447

(1) Includes 5.b.2.

Table 4.3.1b. Landings of Blue ling in Subdivision 5.b.2 (see stock annex for years before 2000).

YEAR	FAROES	NORWAY	SCOTLAND	France	TOTAL
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
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
2017	88	9	0	0	97
2018	151	0	0	0	151
2019	64	56	0	0	120
2020	102	0	4	0	106
2021	196	0	88	0	284
2022	4	0	55	1	60

Table 4.3.1c. Landings of blue ling in Division 6.a (see stock annex for years before 2000).

YEAR	FAROES	FRANCE	GERMANY	IRELAND	NORWAY	SPAIN(1)	E & W	SCOTLAND	LITHUANIA	TOTAL
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
2011	10	1136			93	10		74		1323
2012	5	1185			86	6		47		1329
2013	2	1128			132	11		203		1476
2014		1109			18			278		1405
2015	0	920	0	0	127	83	8	371	0	1509
2016	0	776			37	124	0	273	0	1210
2017	0	777	0	0	29	44	0	641	0	1491
2018		1066			87	72		735		1970
2019		1235			67	92		718		2112
2020		985			28	244		710		1967
2021	1	1472	0	0	0	0	367	1797	0	3637
2022	0	1278	0	0	47	389	0	2082	0	3796

Table 4.3.1d. Landings of blue ling in Division 6.b (see stock annex for years before 2000).

YEAR	POLAND	RUSSIA	FAROES	FRANCE	GERMANY	NORWAY	E & W	SCOTLAND	ICELAND	IRELAND	ESTONIA	SPAIN	TOTAL
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				5		3						211	219
2013				9				0				34	43
2014								3				1	4
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
2017	0			0	0	1						21	22
2018				0				1				6	7

YEAR	POLAND	RUSSIA	FAROES	FRANCE	GERMANY	NORWAY	E & W	SCOTLAND	ICELAND	IRELAND	ESTONIA	SPAIN	TOTAL
2019						3		1				5	9
2020	0		0	0	0	0	2	0	0	6	0		8
2021	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	NA	0	0	0	0	0	0	0	0	0	0	0

(1) **Includes unallocated catch.**

Table 4.3.1e. Landings of blue ling in Subarea 7 (see stock annex for years before 2000).

YEAR	FRANCE	GERMANY	SPAIN	NORWAY	E & W	SCOTLAND	IRELAND	TOTAL
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	18	0	21	5	0	0	0	44
2013	35	0	0	0	0	0	0	35
2014	26				3	2		31
2015	11	0	63	0	3	1	0	78
2016	8	0	0	0	0	1	1	10
2017	'	1	0	0	1	0	0	6
2018	4	0	0	0	0	0	0	4
2019	4	0	35	0	0	0	0	39
2020	4	0	0	0	24	0	0	28
2021	6	0		0	8		0	14
2022	0	0	0	4	0	0	0	0

Year	Estonia	Faroes	France(1)	Ger-many(1)	Iceland	Ireland	Lithua-nia(2)	Nor-way(2)	Poland	Russia (1)	Spain	UK (E & W)	UK (Sco)	Total
2000	0	1677	5724	97		89	0	491	0	1	173	588	2320	11160
2001	85	1643	3601	13		819	16	577	0	0	861	493	4019	12127
2002	0	1082	3140	4	0	579	28	629	0	3	327	242	2719	8753
2003	5	2472	3680	1	0	30	29	304	4	2	45	26	677	7275
2004	3	1475	3933	1	0	20	38	52	1	18	19	15	647	6222
2005	0	1655	3072	0	0	13	1	122	0	15	113	11	538	5540
2006	0	1939	2976	0	0	5	2	106	0	16	118	10	478	5650
2007	0	1880	3213	0	0	2	1	253	0	37	85	17	160	5648
2008	0	975	2501	0	0	0	2	110	0	122	16	2	212	3940
2009	0	978	2547	0	0	0	0	83	0	1	166	0	346	4121
2010	0	1539	2453	0	0	0	0	160	0	0	247	0	360	4759
2011	0	1167	1480	0	0	0	0	104	0	0	36	0	74	2861
2012	0	1015	1609	0	0	0	0	102	0	5	238	0	47	3016
2013	0	575	1715	0	0	0	0	132	0	3	45	0	205	2675
2014	0	880	1741	0	0	0	0	53	0	0	1	3	285	2963
2015	0	703	1119	0	0	0	0	366	0	0	177	11	372	2748
2016	0	1113	1086	0	0	1	0	111	0	0	142	0	281	2734
2017	0	854	1048	1	0	0	0	60	0	0	65	1	644	2673

Year	Estonia	Faroes	France(1)	Germany(1)	Iceland	Ireland	Lithuania(2)	Norway(2)	Poland	Russia (1)	Spain	UK (E & W)	UK (Sco)	Total
2018	0	969	1290	0	0	0	0	237	0	0	78	0	736	3310
2019	0	638	1624	0	0	0	0	155	0	0	132	0	719	3268
2020	0	799	1569	0	0	0	0	121	0	0	274	0	715	3478
2021	0	848	1955	0	0	0	0	300	0	0	375	0	1807	5285
2022	0	639	1781	0	0	0	0	353	0	NA	393	0	2142	5308

Table 4.3.1f. Blue ling landings in Division 5.b and subareas 6 and 7 (see stock annex for years before 2000).

YEAR	5.b	6	7	TOTAL
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	2575	2891	74	5540
2006	2850	2733	67	5650
2007	3296	2188	164	5648
2008	2060	1846	34	3940
2009	1461	2649	11	4121
2010	2244	2478	37	4759
2011	1469	1343	49	2861
2012	1424	1548	44	3016
2013	1121	1519	35	2675
2014	1523	1409	31	2963
2015	1128	1542	78	2748
2016	1496	1228	10	2734
2017	1154	1513	6	2673
2018	1339	1967	4	3310
2019	1108	2121	39	3268
2020	1475	1975	28	3478
2021	1634	3637	14	5285
2022	1507	3796	5	5308

Table 4.3.2. Abundance (nb.hour-1) and biomass (kg.h-1) indices from the Scottish deep-water survey in ICES Division 6.a. Lower in upper bounds of 95% confidence intervals of the mean are estimated assuming a normal distribution.

	Number per hour			Weight per hour (kg)			
Year	Lower bound	Mean	Upper bound	Lower bound	Mean	Upper bound	Number of hauls
1998	2.366	3.263	4.160	4.47	7.0	9.48	19
1999							
2000	0.462	0.857	1.252	1.04	2.2	3.45	35
2001							
2002	0.964	2.000	3.036	1.22	5.3	9.39	27
2003							
2004	0.599	1.929	3.258	1.55	4.0	6.43	28
2005	0.820	1.778	2.536	1.16	2.8	4.48	18
2006	0.864	1.607	2.350	0.65	3.7	6.67	28
2007	0.739	1.810	2.880	-0.08	4.9	9.94	21
2008	0.994	2.429	3.863	1.42	7.9	14.39	28
2009	1.524	4.167	6.809	3.07	16.4	29.64	24
2010							
2011	0.641	2.172	3.703	1.96	7.1	12.32	20
2012	0.596	1.711	2.826	1.74	6.2	10.63	27
2013	1.571	4.154	6.738	0.70	15.1	29.51	23
2014							
2015	0.875	2.130	3.386	0.12	14.6	29.14	24
2016							
2017	1.423	2.447	3.471	3.04	9.2	15.46	29
2018							
2019	1.058	3.554	6.049	2.47	16.9	31.23	18
2020							
2021		2.753	4.674	2.692	8.512	14.331	17

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

4.4.1 The fishery

The directed fisheries on spawning aggregations for blue ling on Hatton Bank (ICES Division 12.b) and ICES 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 has represented a significant bycatch of trawl fisheries for mixed deep-water species; especially from Spanish freezer trawlers. In Division 2.a there is a bycatch from the longline and gillnet fisheries on ling, tusk and saithe.

In other ICES subareas blue ling is taken in minor quantities. Small reported landings in Subareas 8 and 9 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.

4.4.2 Landing trends

Landing data are presented in Tables 4.4.0a–f. There are also historical landings from the Norwegian fishery, mainly from Division 2.a, back from 1896 (Figure 4.4.1). During the whole time-series, around 90% or more of the total landings were taken in Subareas 2, 4 and 12 combined. Landings from Subarea 12 which primarily are from the western slope of Hatton Bank (ICES Division 12.b) are now very low. Landings are now reported mostly from ICES Divisions 2a and 4a. In 2021, 98% of the landings came from Subarea 2 and 4 and this was mainly Norwegian landings. In 2019 and from Subarea 1, Iceland has landed 45% of total landings from the whole stock area but there are some uncertainties about this number. In 2020, Iceland had no landings from this area.

For all areas, a continuous decline on landings has been observed after the higher landing levels in the 1988–1993 period and total landings are now 13% of that level. However, the total landings have increased since 2015 which was the lowest level recorded since 1988. As a result of the Icelandic landings from Subarea 1, the total landings from 2018-2019 more than doubled (348-862 tons). For 2020, the total landings are at recent levels.

4.4.3 ICES Advice

The ICES advice for 2020 to 2023 is:

"*ICES advise that when precautionary approach is applied, there should be zero catches in each of the years 2020 to 2023. Closed areas to protect spawning should be maintained*."

4.4.4 Management

A 2022 precautionary TAC for EU vessels in international waters of ICES Subarea 12 was set to 76 tonnes and only applicable to bycatches; no directed fishery for blue ling was allowed in this area. TACs for vessels in EU waters, United Kingdom and international waters of ICES Division 5, and Subareas 6 and 7 were set to 10859 tons; of this a quota for UK vessels was set to 2527 tonnes; for Norway and Faroe Islands, each to be fished in Union waters of ICES Subareas 4, 6 and 7. In United Kingdom and international waters of Subareas 2 and United Kingdom and Union waters of 4, a precautionary TAC for EU vessels was set to 20 tonnes and United Kingdom vessels to 7 tonnes. In European Union and international waters of ICES Division 3.a, a precautionary TAC for EU vessels was set to 4 tonnes.

4.4.5 Data availability

4.4.5.1 Landings and discards

Landings and discards data are presented in Table 4.4.0a–f and 4.4.1 respectively. The discards data from Scotland were revised in 2021 and the Scottish discards were updated in the table for 2015-2020 (Table 4.4.1).

4.4.5.2 Length compositions

Length compositions from the Norwegian longline and gill net fishery from 2002-2021 are available (Figure 4.4.2). Length compositions from the Spanish fishery from 2017 in Stock Annex.

4.4.5.3 Age compositions

No age data are available.

4.4.5.4 Weight-at-age

No weight-at-age data are available.

4.4.5.5 Maturity and natural mortality

No data were available.

4.4.5.6 Catch, effort and research vessel data

For the Norwegian catches there was presented a CPUE from Subareas 1, 2 and 4 and ICES Division 3.a combined (Figure 4.4.3). The CPUE series was calculated for the time period 2000–2021 and is based on longline data from the Norwegian fishery.

4.4.6 Data analyses

The assessment for this stock is based on landing trends (Figures 4.4.4-4.4.6). This is followed by some uncertainties because the trends in landings can be a consequence of changes in effort rather than changes in the stock. However, it is regarded that the situation for the stock is reflected by the landings and it is also thought that discards are minimal since the fishery is exclusively done on larger individuals.

The landings have declined for all areas and the mean landings are now only 13% of the mean landings from the years 1988–1993 (the period with stable landings). There has been however, some fluctuations in landings for some areas.

Landings from Subarea 1 has always been low (less than 5 t for the whole time series). However, for 2019 Iceland landed 389 tons (45% of total landings for the whole stock area) which were assigned to in Subarea 1. For 2020-21 and for Subarea 1, there were no Icelandic landings and the total landings are back on recent, low levels.

The historical Norwegian landings, mainly in ICES Division 2.a 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. Landings in 2015 were lowest on record but have increased since then.

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

The landings in Subarea 4 increased from 2019-2021. This increase came from Norwegian and French landings. French landings for 2021 is 78 t; other landings are low.

An increase on French and Norwegian landings from Subarea 4 was also registered in 2010-2012. The landings then decreased to less than 100 tons and the landings have been stable around this level since 2015. The 2020 level of landings was back to the increased level in 2010-12. The landings for 2021 are again around 100 t. An analyse of the French 2021 landing data by gear type revealed that 60% of the blue ling was taken with bottom trawl and 30% with longlines.

In Subarea 12 and after relative high levels for the period 2001–2005 landings have declined. Spain has for many years been the only country reporting landings from this area; for 2021 there are no Spanish landings from Subarea 12. The reported landings from this Subarea have always been from Division 12b; however, from 2019-20 there was also some landings from Division 12a. For 2021, the landings are from 12.a.4 (Norwegian landings).

Denmark and Scotland report discards from Division 4a. A revision of the Scottish discard data for 2015-2020 was done. The revised values for Scottish discards increased, especially in 2019. Total discards are now less than 3 tonnes.

The Norwegian length compositions from the longline and gill net fishery from 2002-2021 show some years inclusions of smaller fish. It is also possible to follow a dominant group of ages from year to year in some periods (from 2009-2014 and 2015-2021). The mean length varies from 77-100 cm.

The length compositions from Spanish landings from 2017 show lengths from 69-129 cm (See Stock Annex). This is in the same range as seen in length compositions from Faroese catches from areas 5.b, 6 and 7.

The Norwegian CPUE series shows a low level and varies without any trend for the years 2000–2021. Although there is no directed fishery from this area there seems to be no recovery for this part of the stock.

4.4.6.1 Biological reference points

There are not yet suggested methods to estimate biological reference points for category 5 and 6 stocks.

4.4.7 Comments on assessment

Assessment is based on landing trends. Landings have declined since the 90’s (Figure 4.4.7) and are thought to represent stock status. However, there was some concern about the 2020 year increase in Norwegian landings in Subarea 4. In this subarea, blue ling is bycatch in ling and tusk fishery and these bycatch landings may come from a shift to larger proportion of gill nett landings in the fishery for ling. The Norwegian landings from 2021 is now low.

4.4.8 Management considerations

Trends in landings suggest serious depletion in Subarea 2 and perhaps also for the other Subareas. 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 2019 remains appropriate.

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

The bulk of current bycatches of blue ling from subareas and divisions treated in this section are taken within EE (Table 4.4.2).

4.4.9 Tables

Table 4.4.0a. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Subarea 1. (* preliminary).

Year	Iceland	Norway	France	Faroes	Greenland	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

Year	Iceland	Norway	France	Faroes	Greenland	Total
2014				4		4
2015						0
2016		1				1
2017						0
2018	6				16	22
2019	389					389
2020		1				1
2021*		1		+		1

Table 4.4.0b. 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

Year	Faroes	France	Germany	Greenland	Norway	E & W	Scotland	Sweden	Russia	Total
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
2017	57	5			112		3			177
2018	112	4			124	0,105	0,69			241
2019	48	7			321					376
2020		2			237					239
2021*	29	4			289		2			324

Table 4.4.0c. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Division 3a. (* 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

Year	Denmark	Norway	Sweden	FRANCE	Total
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
2017		0.775			1
2018	0.286	0.97	0.085		1
2019	0.885	0.63	0.047		2
2020	0.775	0.948	0.070		2
2021*	1.360	1.259	0.128		3

Table 4.4.0d. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Subarea 4. (* preliminary).

Year	Denmark	Faroes	France	Germany	Norway	E & W	Scotland	Ireland	Swe-den	Neth-er-lands	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

Year	Denmark	Faroes	France	Germany	Norway	E & W	Scotland	Ireland	Swe-den	Neth-er-lands	Total
2015	+		6		74	+	3				83
2016	+		6	+	74		6				87
2017	+		3		65	+	5				73
2018	3		3	+	50	+	3				60
2019	3		12		66	+	4				85
2020	7		21	+	138		10				176
2021*	4		78	+	16	+	29		+	+	127

Table 4.4.0e. Blue ling (*Molva dypterygia*). Working group estimates of landings (tonnes) in Subarea 12. (* preliminary).

Year	Fa-roes	France	Ger-many	Spain	E & W	Scot-land	Nor-way	Ice-land	Po-land	Lithua-nia	Rus-sia	unallo-cated	To-tal
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

Year	Fa-roes	France	Ger-many	Spain	E & W	Scot-land	Nor-way	Ice-land	Po-land	Lithua-nia	Rus-sia	unallo-cated	To-tal
2005		10		657		35				8			710
2006		61		436							4		501
2007	1			353									354
2008				564									564
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
2017				28									28
2018				24									24
2019				10									10
2020				13									13
2021*							5						5

Table 4.4.0f. Blue ling (*Molva dypterygia*). Total landings by Subarea (past reported landings from subareas 8 and 9 are ascribed to *Molva macropthalma* and not included). (* 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

Year	1	2	3	4	12	Total
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	1	87	1	87	29	205
2017	0	177	1	73	28	279
2018	22	241	1	60	24	348
2019	389	376	2	85	10	862
2020	1	239	2	176	13	431
2021*	1	295	3	98	5	402

Table 4.4.1 Blue ling in Subarea 27.nea. Discards from 2015-2021. Discards from Denmark are taken from InterCatch. Discards from Scotland are estimated in 2021.

Year	Denmark	Scotland	Sweden	Total discards	Scotland old[1]
2015		0			
2016		0			
2017	0.808	2.403		3.211	0.117
2018	0.300	0.774		1.074	0.002
2019	0.750	14.110		14.860	0,023
2020	1.448	0		1.448	0
2021	0.051	2.887	0.487	3.425	

[1] **The old InterCatch values for discards from Scotland; revised in 2021. The new values are estimated from 2015-2020.**

Table 4.4.2 Blue ling in Subarea 27.nea. Landings inside and outside the NEAFC Regulatory Area (RA). Landings inside NEAFC area are from 12a and 12b. Weights are in tonnes.

Year	Inside the NEAFC RA	Outside the NEAFC RA	Total landings
2014	80	181	261
2015	12	196	208
2016	29	176	205
2017	28	251	279
2018	24	324	348
2019	10	852	862
2020	13	418	431
2021*	0	402	402

4.4.10 Figures

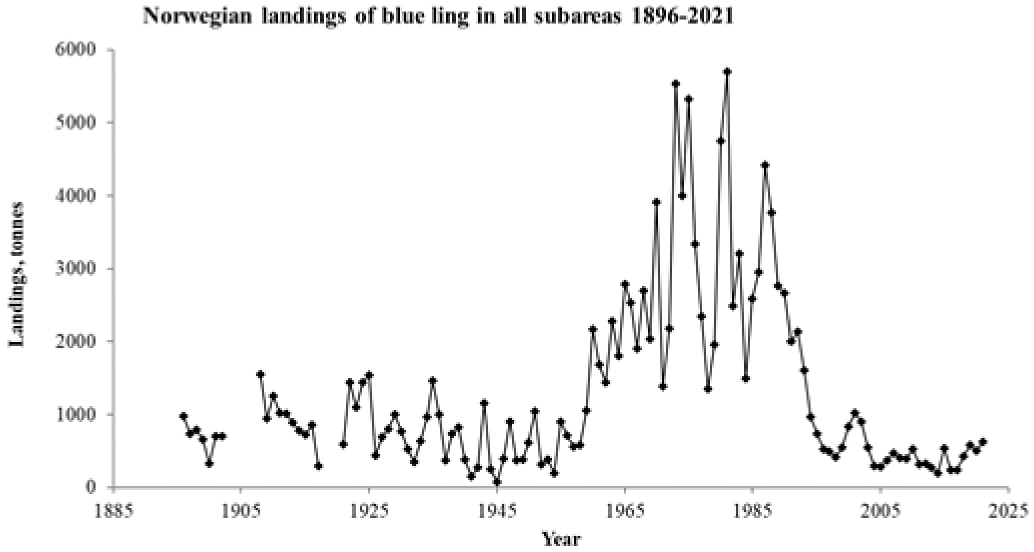

Figure 4.4.1. Reported Norwegian landings on blue ling from 1896–2021.

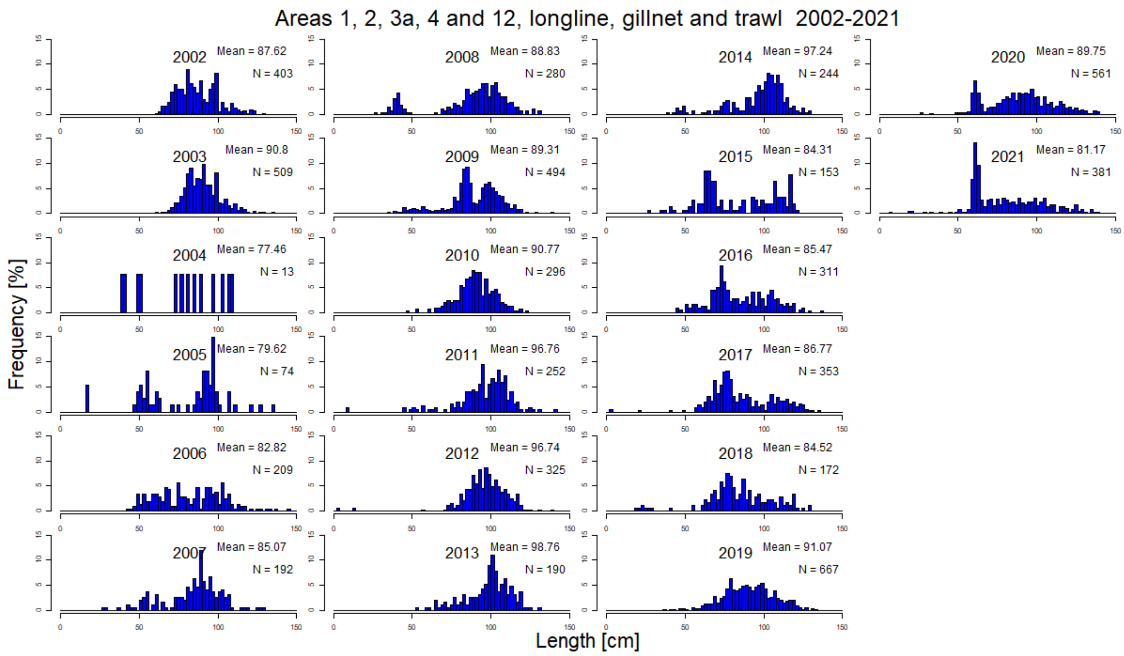

Figure 4.4.2. Length compositions from Norwegian longline and gill net fishery from 2002-2021.

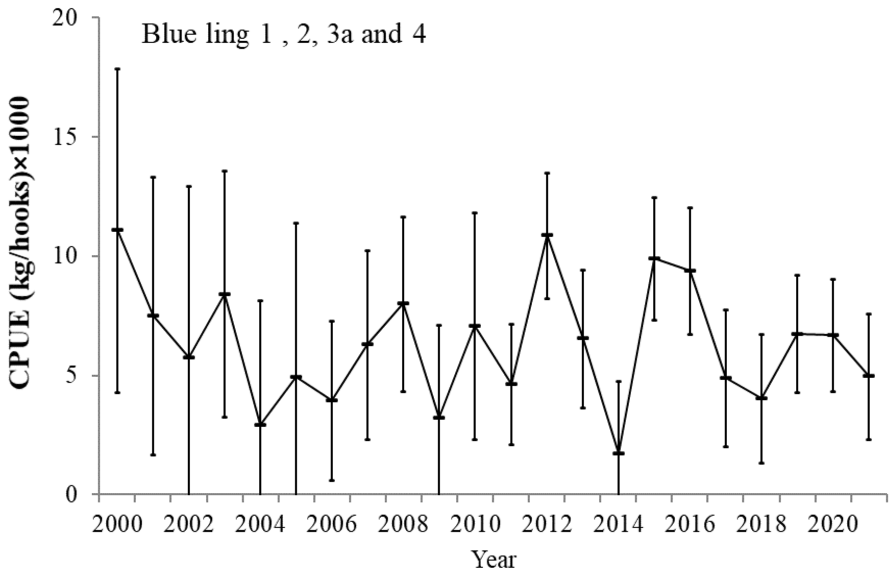

Figure 4.4.3. Norwegian cpue (kg/1000 hooks) from longlines catches in areas 1, 2, 3.a and 4 from 2000–2021.

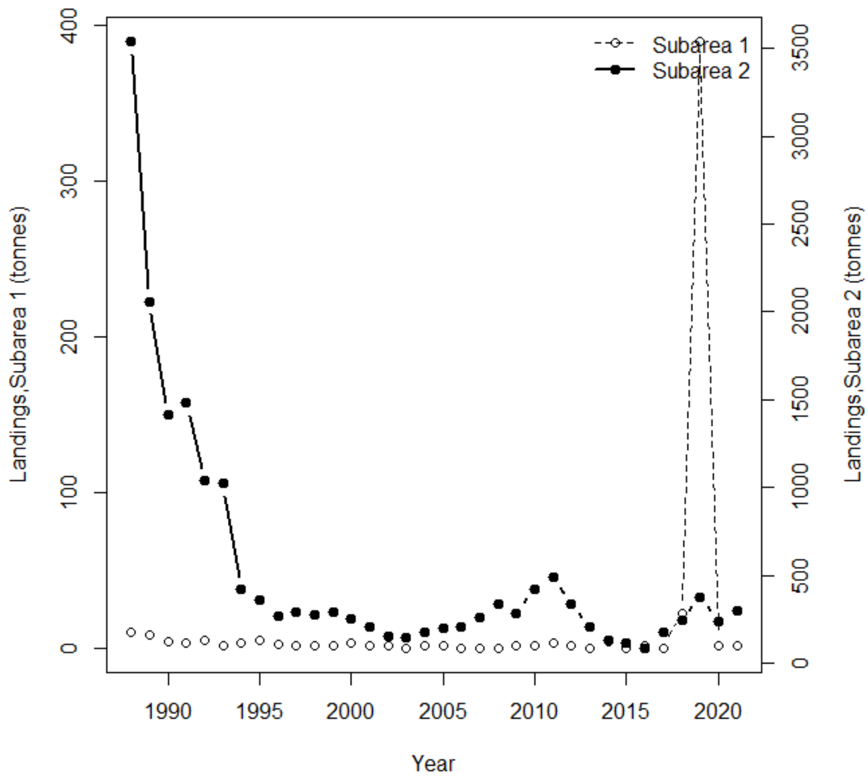

Figure 4.4.4. Landings of blue ling in Subareas 1 and 2 from 1988-2021. Subarea 1: open circles, left axis. Subarea 2: filled circles, right axis.

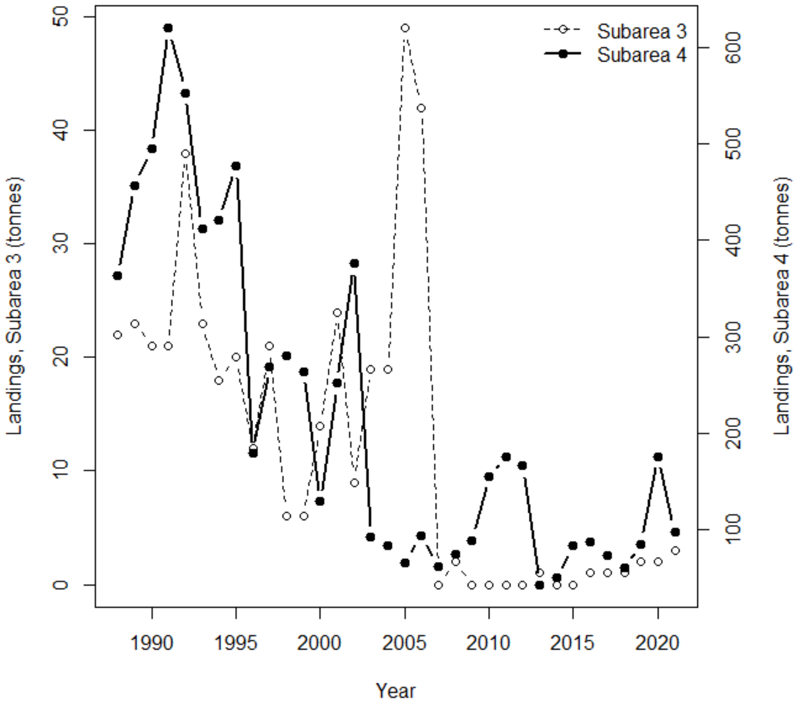

Figure 4.4.5. Landings of blue ling in Subareas 3 and 4 from 1988-2021. Subarea 3: open circles, left axis. Subarea 4: filled circles, right axis.

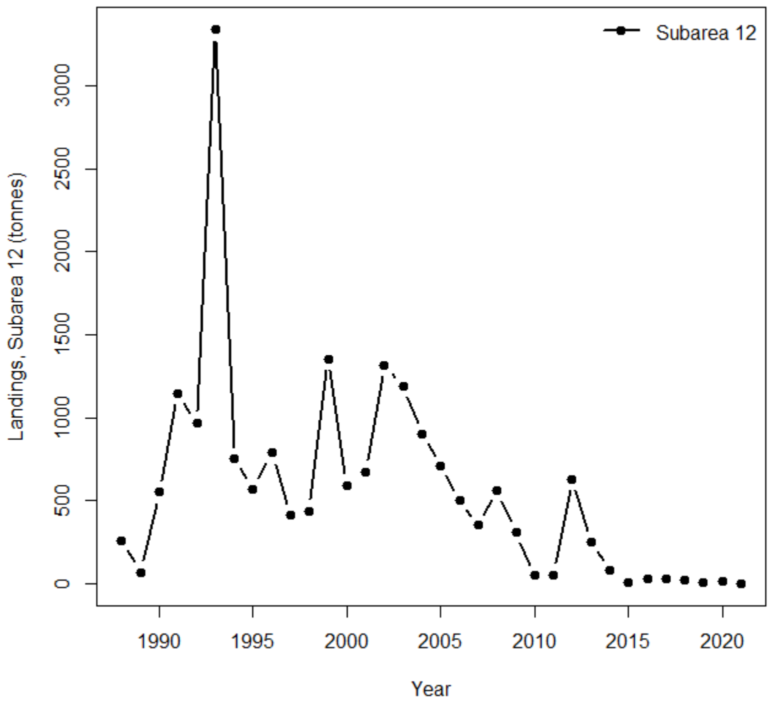

Figure 4.4.6. Landings of blue ling in Subarea 12 from 1988-2021.

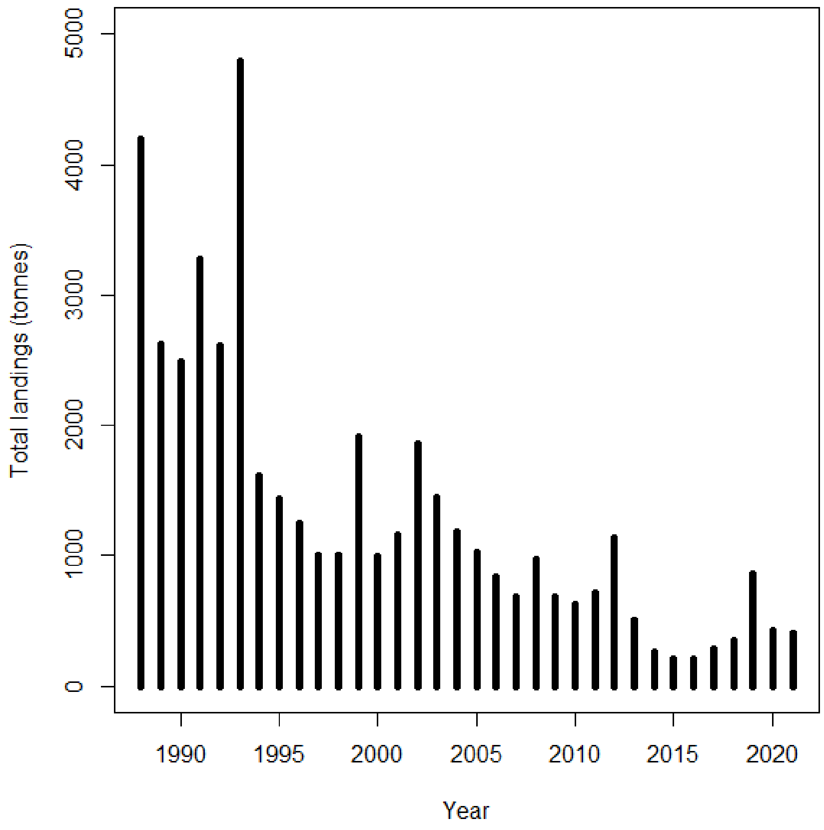

Figure 4.4.7. Total landings of blue ling from stock area 1,2,3a,4 and 12 from 1988-2021.

5 Tusk *(Brosme brosme)*

5.1 Stock description and management units

In 2007, WGDEEP examined the available evidence for separate tusk stocks in the ICES region. Based on genetic investigations, the group suggested the following stock units for tusk:

- Area 5.a and 14;
- Mid-Atlantic Ridge;
- Rockall (6.b);
- Areas 1, 2.

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

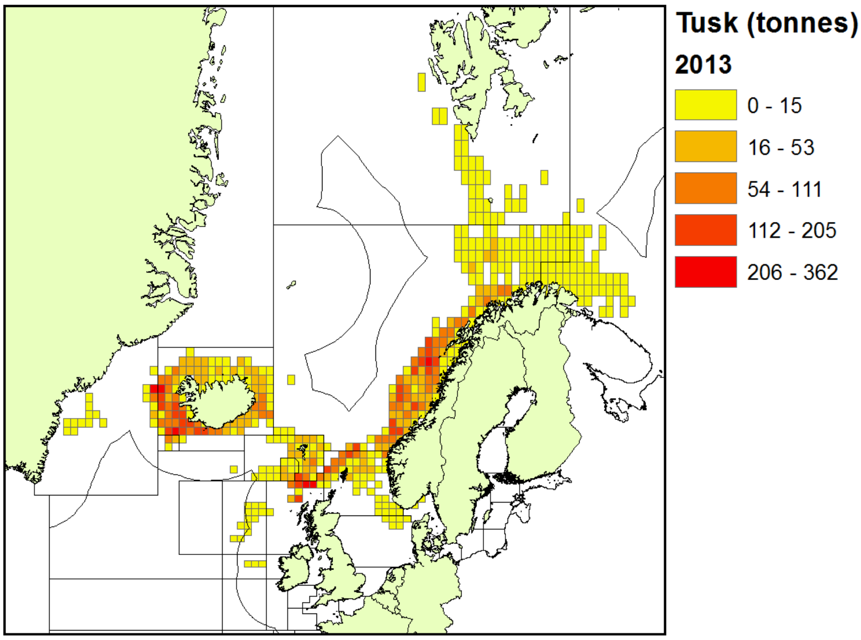

Figure 5.1. Reported landings of tusk in the ICES area by statistical rectangle in 2013. Data are from Norway, Faroes, Iceland, France, UK (England and Wales) and Spain. Landings shown in account for 99% of all reported landings in the ICES area.

5.2 Tusk (*Brosme brosme*) in 5.a and 14

5.2.1 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 ~100 more vessels have small amounts of bycatch landings (Table 5.1.1). Far fewer gillnetters and trawlers participate in the fishery. The number of longliners reporting tusk catches have been continually decreasing in the past few years (Table 5.1.1). Most of tusk in 5.a, around 95% of catches in tonnes, is caught by longlines, and this proportion has been relatively stable since 1992 (Table 5.2.2).

Table 5.2.1. Tusk in 5.a. Number of Icelandic boats with tusk landings in 5.a and total landings in 5.a

	Number of Boats				Catch (Tonnes)			
Year	Bottom trawl	Gill nets	Longlines	Bottom trawl	Gill nets	Longlines	Other	Total catch
2000	120	175	368	100	44	4554	29	5114
2001	108	224	348	87	63	3223	24	4838
2002	103	174	303	88	93	3712	17	5563
2003	97	148	304	65	41	3906	11	5598
2004	90	129	303	92	28	3007	8	4830
2005	87	101	324	115	19	3398	7	5044
2006	85	82	337	100	40	4907	7	6601
2007	74	65	308	104	38	5834	11	7537
2008	75	59	254	126	42	6758	7	8629
2009	75	65	239	115	72	6757	9	8469
2010	70	62	228	97	52	6761	9	8713
2011	63	54	221	72	24	5742	9	7701
2012	65	68	228	64	13	6255	13	7872
2013	66	43	230	76	15	4875	12	6302
2014	62	43	235	87	18	4878	12	6163
2015	55	32	214	71	7	3910	13	4835
2016	59	32	193	61	6	2575	7	3494
2017	52	31	166	48	5	1774	5	2540
2018	55	27	144	83	8	2002	4	2940
2019	49	23	142	103	7	2460	9	3445
2020	55	23	116	108	31	2209	9	3187

	Number of Boats				Catch (Tonnes)			
2021	51	18	111	112	12	1920	5	2779
2022	51	26	97	111	17	1801	4	2577

Most of the tusk caught in 5.a by Icelandic longliners is caught at depths less than 300 meters (Figure 5.2.1). The main fishing grounds for tusk in 5.a as observed from logbooks are on the western and, southwestern part of the Icelandic shelf (Figure 5.2.2 and Figure 5.2.3). The proportional catch in the northwest has increased over the years. Around 50–60% of tusk is caught on the southern and western parts of the shelf (Figure 5.2.3). 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.

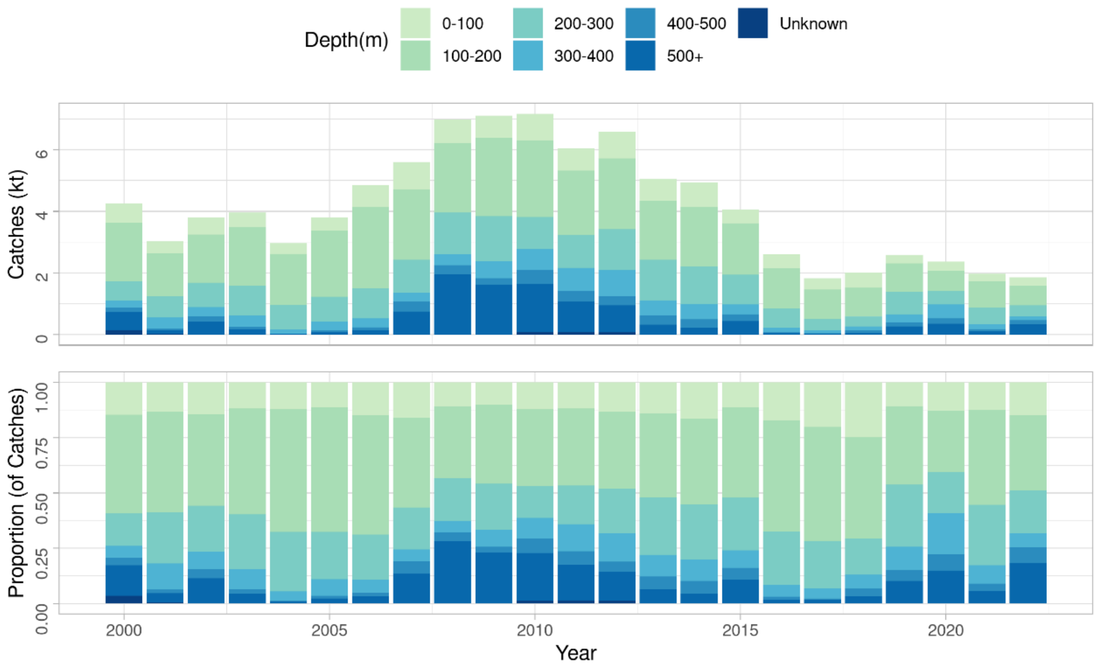

Figure 5.2.1: Tusk in 5.a and 14. Depth distribution of catches in 5.a according to logbooks. All gears combined.

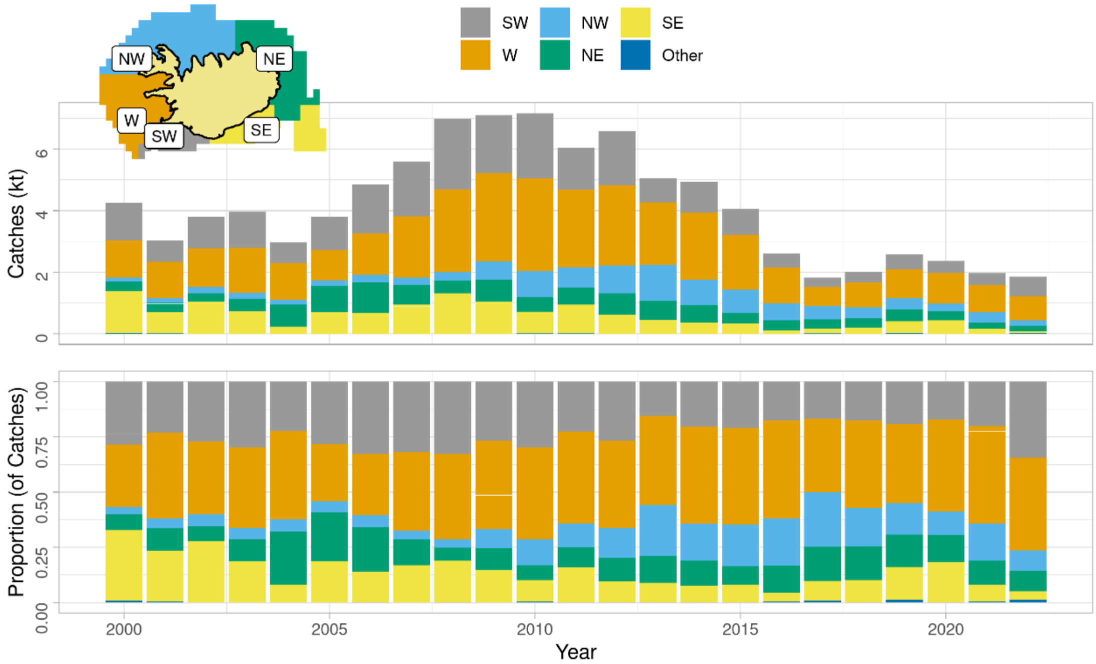

Figure 5.2.2: Tusk in 5.a and 14. Catch distribution and proportions by area according to logbooks. All gears combined.

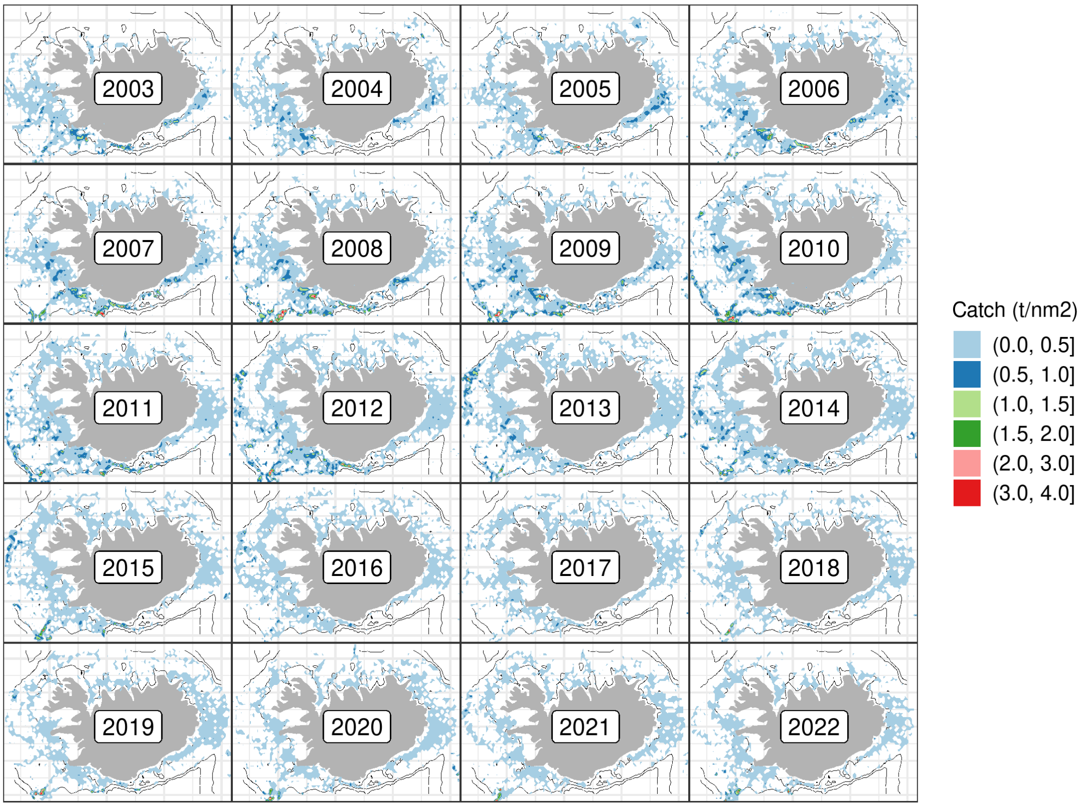

Figure 5.2.3: Tusk in 5.a and 14. Geographical distribution (tonnes) of the Icelandic longline fishery since 2003, as reported in logbooks by the Icelandic fleet.

5.2.2 Landing trends

The total annual landings from ICES Division 5.a were around 2577 tonnes in 2022 (Table 5.2.1), signifying a continuous decrease in landings from 2010. 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 5.2.4).

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, mainly vessels from the Faroe Islands. This proportion reduced to 15–25% until the most recent years in which it increased to closer to 50% due to a reduction in Icelandic catches (Table 5.2.2).

Landings in 14.b have always been low compared to 5.a, rarely exceeding 100 t. However, around 900 tonnes were caught in 2015, after which catches have been consistently substantial. Catch data from section 14 reported by the Greenland Institute of Natural Resources (WD02, Annex to this report) also reflect this trend. Around 566 tonnes in 2019 were caught in the 14.b mainly by Faroese and Greenlandic vessels (Table 5.2.3). This has however increased in 2022 to about 680 tonnes. As the Icelandic TACs were relatively low during this period, this constituted over 20% of the annual catch.

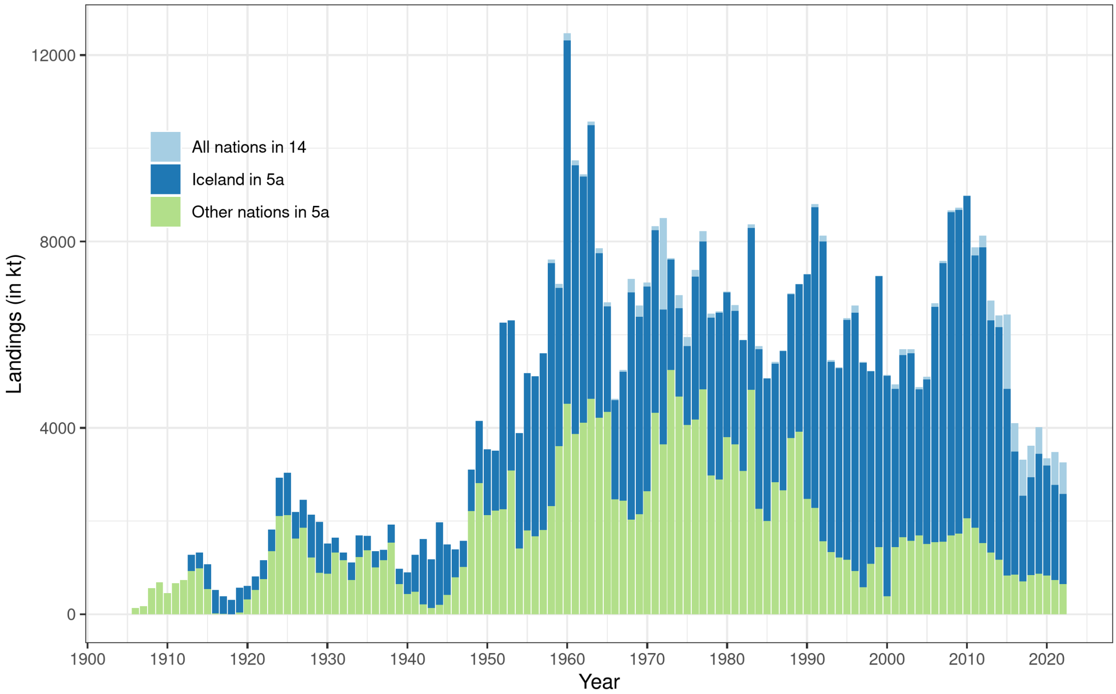

Figure 5.2.4: Tusk in 5.a and 14.Nominal landings within Icelandic waters by Icelandic vessels (light blue) or foreign vessels (dark blue), or within Greenlandic waters (orange). (source for 14: STATLANT).

Table 5.2.2. 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	2987	19	0	5644
1988	3757	0	0	3087	20	0	6864
1989	3908	0	0	3158	10	0	7076
1990	2475	0	0	4821	0	0	7296
1991	2286	0	0	6449	0	0	8735
1992	1567	0	0	6432	0	0	7999
1993	1333	0	0	4086	0	0	5419

YEAR	FAROE	DENMARK	GERMANY	ICELAND	NORWAY	UK	TOTAL
1994	1217	0	0	4065	0	0	5282
1995	1168	0	1	5151	0	0	6320
1996	916	0	1	5540	3	0	6471
1997	579	0	0	4816	0	0	5395
1998	1080	0	1	4130	0	0	5211
1999	1041	0	2	5821	391	2	7257
2000	10	0	0	4727	374	2	5114
2001	1150	0	1	3397	285	5	4838
2002	1279	0	0	3910	372	2	5563
2003	1198	0	1	4024	373	2	5598
2004	1478	0	1	3135	214	2	4830
2005	1157	0	3	3539	303	41	5044
2006	1244	0	2	5054	299	2	6601
2007	1250	0	0	5987	300	1	7538
2008	1398	0	0	6934	298	0	8629
2009	1516	0	0	6953	210	0	8679
2010	1794	0	0	6919	263	0	8976
2011	1655	0	0	5847	198	0	7701
2012	1310	0	0	6344	217	0	7872
2013	1132	0.12	0	4979	192	0	6302
2014	742	0	0	4995	425	0	6163
2015	637	0	0	4001	198	0	4836
2016	543	0	0	2649	302	0	3494
2017	492	0	0	1833	216	0	2541
2018	517	0	0	2097	326	0	2940
2019	549	0	0	2579	316	0	3445
2020	558	0	0	2358	271	0	3187
2021	342	0	0	2049	388	0	2779
2022	288	0	0	1932	357	0	2577

Table 5.2.3. Tusk in 5.a and 14. Nominal landings by nations in 14.

YEAR	FAROE	DEN-MARK	GREEN-LAND	GER-MANY	ICELAND	NOR-WAY	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	17	0	0	0	17
1995	0	0	0	0	0	30	0	0	0	30
1996	0	0	0	0	0	158	0	0	0	158
1997	0	0	0	0	10	9	0	0	0	19
1998	0	0	0	0	0	12	0	0	0	12
1999	0	0	0	0	0	8	0	0	0	8
2000	0	0	0	0	11	11	0	3	0	25
2001	3	0	0	0	20	69	0	0	0	92
2002	4	0	0	0	86	30	0	0	0	120
2003	0	0	0	0	2	88	0	0	0	90
2004	0	0	0	0	0	40	0	0	0	40
2005	7	0	0	0	0	41	8	0	0	56
2006	3	0	0	0	0	19	51	0	0	73

YEAR	FAROE	DEN-MARK	GREEN-LAND	GER-MANY	ICELAND	NOR-WAY	RUSSIA	SPAIN	UK	TOTAL
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	2	0.3	0	0	0	24	0	0	0	427
2014	145	0	0	0	0	35	0	0	0	254
2015	759	0.1	785	0	0	55	0	0	0	1599
2016	243	0	182	0	0	178	0	0	0	606
2017	281	0.38	335	0	0	141	0	0	0	781
2018	345	0	108	0	0	228	0	0	0	681
2019	41	0	66	1	0	458	0	0	0	566
2020	0	0	41	2	0	114	0	0	0	157
2021	260	0	59	2	0	380	0	0	0	701
2022	35	1	87	0	0	558	0	0	0	680

5.2.2.1 Management

The Icelandic Ministry of Food, Agriculture and Fisheries 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 MFRI but thereafter had often been set higher than the advice. One reason is that no formal harvest advisory rule existed for this stock. Up until the fishing year 2011/2012, the landings, by quota year had always exceeded the advised and set TAC by 30-40%. However, since then the overshoot in landings has decreased substantially, apart from 2014/2015 when the overshoot was 34%. In recent years the TACs were not filled, until the past two years when the TAC has been exceptionally low (Table 5.2.4).

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, in recent years managers have to some extent taken into account the foreign catches when setting the national TAC (see below)].

There are bilateral agreements between Iceland, Norway and the Faroe Islands related to fishing activity of foreign vessels in restricted areas within the Icelandic EEZ. Faroese vessels are allowed to fish 5600 t of demersal fish species in Icelandic waters which includes a maximum 1200 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. The tusk advice given by MFRI and ICES for each quota year is, however, for all catches, including foreign catches. Further description of the Icelandic management system can be found in the stock annex.

Figure 5.2.5 shows the net transfers in the Icelandic ITQ-system. During the 2005/2006–2010/2011 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 2015/2016 and 2016/2017 fishing years there was again a small net transfer of other species being changed to tusk quota. In the last four out of five fishing years, 2017/2018-2019/2020, net transfers have been negative again with tusk quota being converted to other species, while 2020/2021 and 2021/2022 shows an overshoot of the quota.

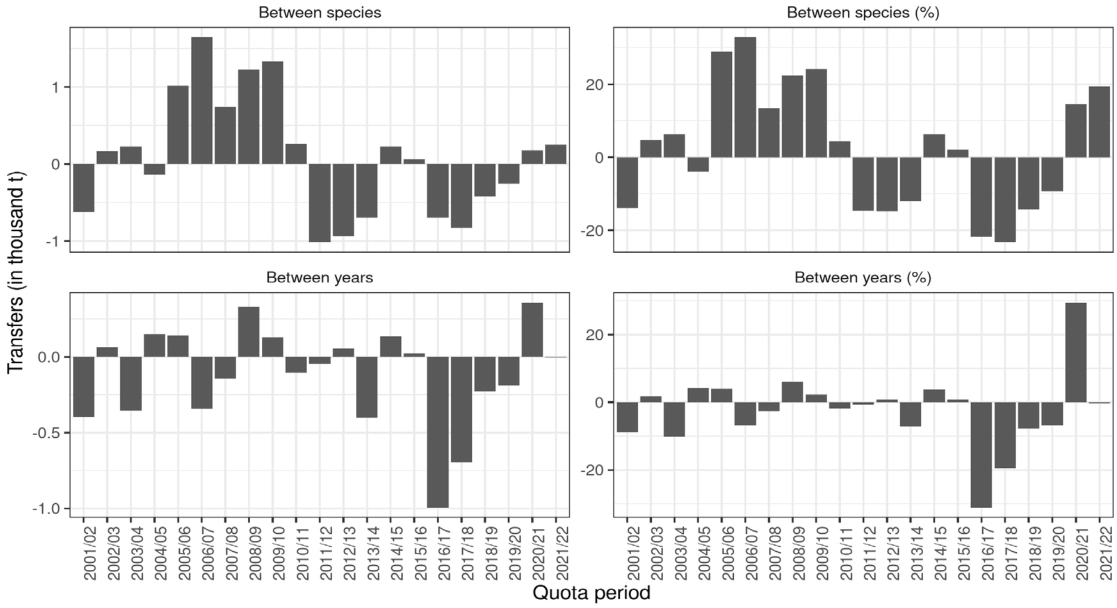

Figure 5.2.5: Tusk in 5.a and 14. Net transfer of quota in the Icelandic ITQ system by fishing year. Between species (upper): Positive values indicate a transfer of other species to tusk, but negative values indicate a transfer of tusk quota to other species. Between years (lower): Net transfer of quota for a given fishing year (may include unused quota).

Table 5.2.4. 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	MFRI Advice	National TAC	Landings
2001/02		4 500	4 876
2002/03	3 500	3 500	5 046
2003/04	3 500	3 500	4 958
2004/05	3 500	3 500	4 901
2005/06	3 500	3 500	5 928
2006/07	5 000	5 000	7 942
2007/08	5 000	5 500	7 279
2008/09	5 000	5 500	8 162

Fishing Year	MFRI Advice	National TAC	Landings
2009/10	5 000	5 500	8 382
2010/11	6 000	6 000	7 777
2011/12	6 900	7 000	7 401
2012/13	6 700	6 400	6 833
2013/14	6 300	5 900	5 881
2014/15	4 000	3 700	4 958
2015/16	3 440	3 000	3 494
2016/17	3 780	3 380	2 407
2017/18	4 370	4 370	3 139
2018/19	3 776	3 100	3 232
2019/20	3 856	3 856	3 241
2020/21	2 289	2 289	2 949
2021/22	2 172	2 172	2 425
2022/23	4 464		

5.2.3 Data available

In general sampling is considered appropriate from commercial catches from the main gear (longlines), although the quantity of samples has decreased substantially in recent years. 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 (ICES (2012)). The sampling coverage by gear in 2021 is shown in Figure 5.2.6.

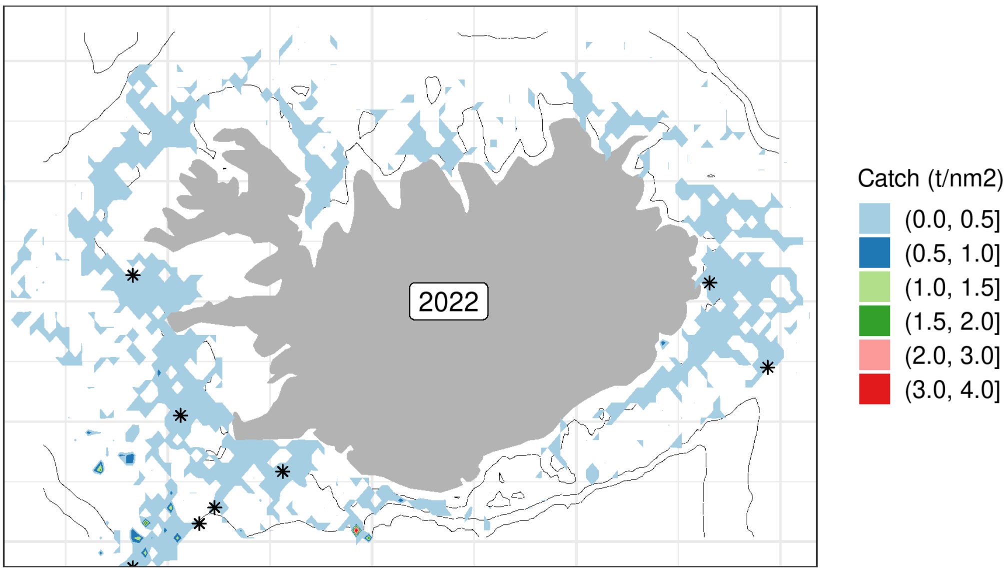

Figure 5.2.6: Tusk in 5.a and 14. Fishing grounds in 2022 as reported by catch in logbooks (tiles) and positions of samples taken from landings (asterisks) by longliners.

5.2.3.1 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, as well as in Norway. Based on limited data, discard rates in the Icelandic longline fishery for tusk are estimated very low (<1% in either numbers or weight) (ICES (2011) :WD02). Measures in the Icelandic management system such as converting quota share from one species to another are used by the Icelandic 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 and Iceland fisheries overview (ICES (2017b) and ICES (2019)). Landings for tusk in Greenlandic waters are obtained from the STATLANT database. Figures reported by the Greenland Institute of Natural Resources (ICES (2014):WD06) are in agreement. No information is available on discards in Greenlandic waters.

5.2.3.2 Length compositions

An overview of available length measurements from 5.a is given in Table 5.2.6. 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 and have remained roughly at that level. Length distributions from the spring survey data and longline fishery are shown in Figures 5.2.7 and 5.2.8 respectively.

No length composition data from commercial catches in Greenlandic waters are available.

Table 5.2.5. Tusk in 5.a and 14. Number of available length measurements from Icelandic (5.a) commercial catches.

Year	Bottom trawl	Demersal seine	Gill net	Long lines	Other
2000	0	0	0	2995	0
2001	0	0	0	3097	151
2002	0	0	0	2843	0
2003	0	0	0	8444	0
2004	150	0	0	3809	0
2005	21	0	0	5820	0
2006	472	0	0	4861	0
2007	150	0	167	11936	0
2008	0	0	0	20963	0
2009	0	0	0	21451	0
2010	0	0	0	9084	0
2011	0	0	0	8158	0
2012	150	0	0	11867	0
2013	0	150	0	6469	0
2014	0	0	0	11748	0

Year	Bottom trawl	Demersal seine	Gill net	Long lines	Other
2015	0	0	0	4821	0
2016	0	0	0	4844	0
2017	0	0	0	1710	0
2018	0	0	0	2781	0
2019	0	0	0	2952	0
2020	1	0	0	2336	0
2021	0	0	0	1499	26
2022	83	0	0	1023	120

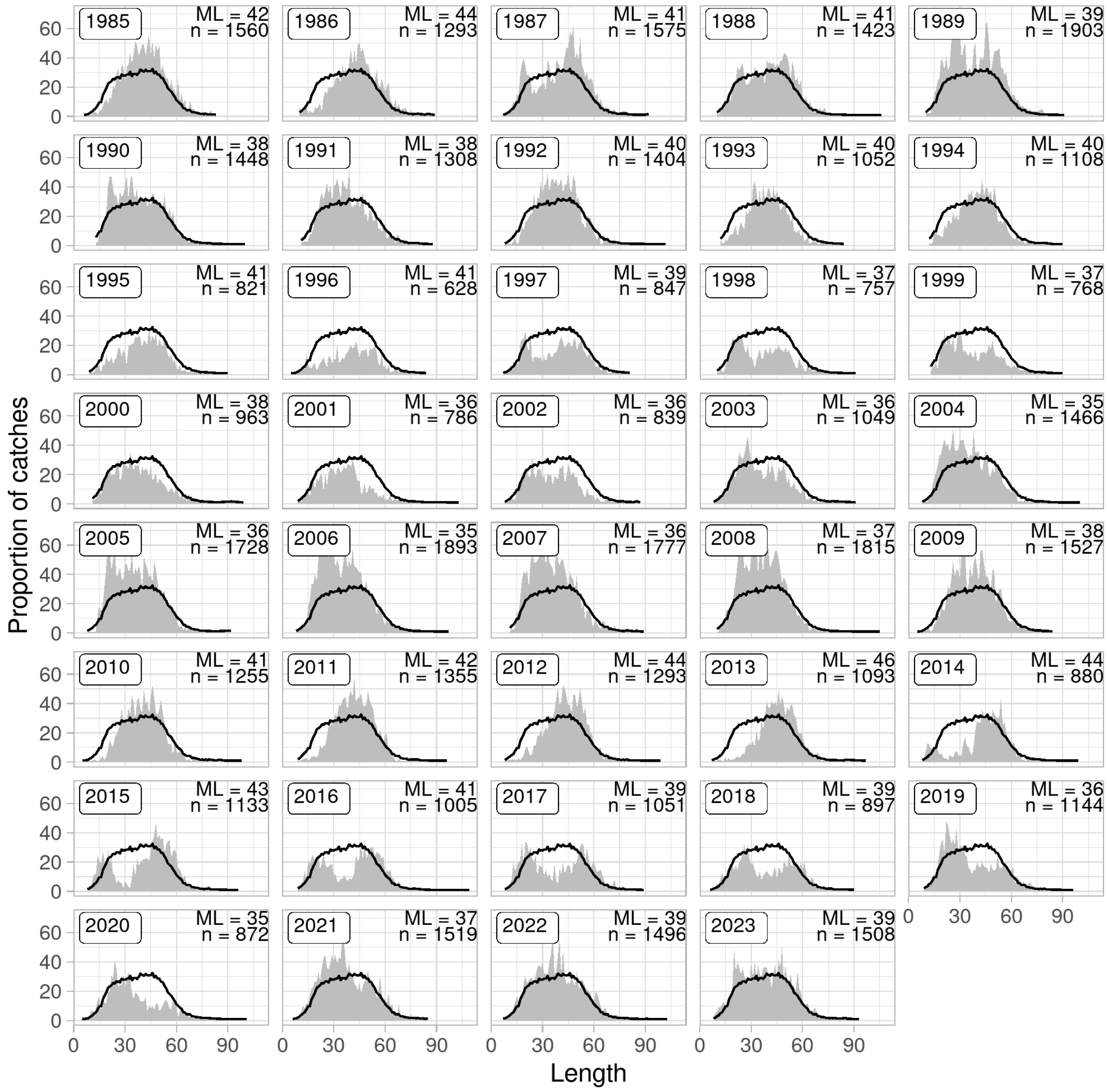

Figure 5.2.7: Tusk in 5.a and 14. Length distributions (4 cm grouping) from the spring survey since 1985. Mean length (ML) and sample sizes (N) are shown.

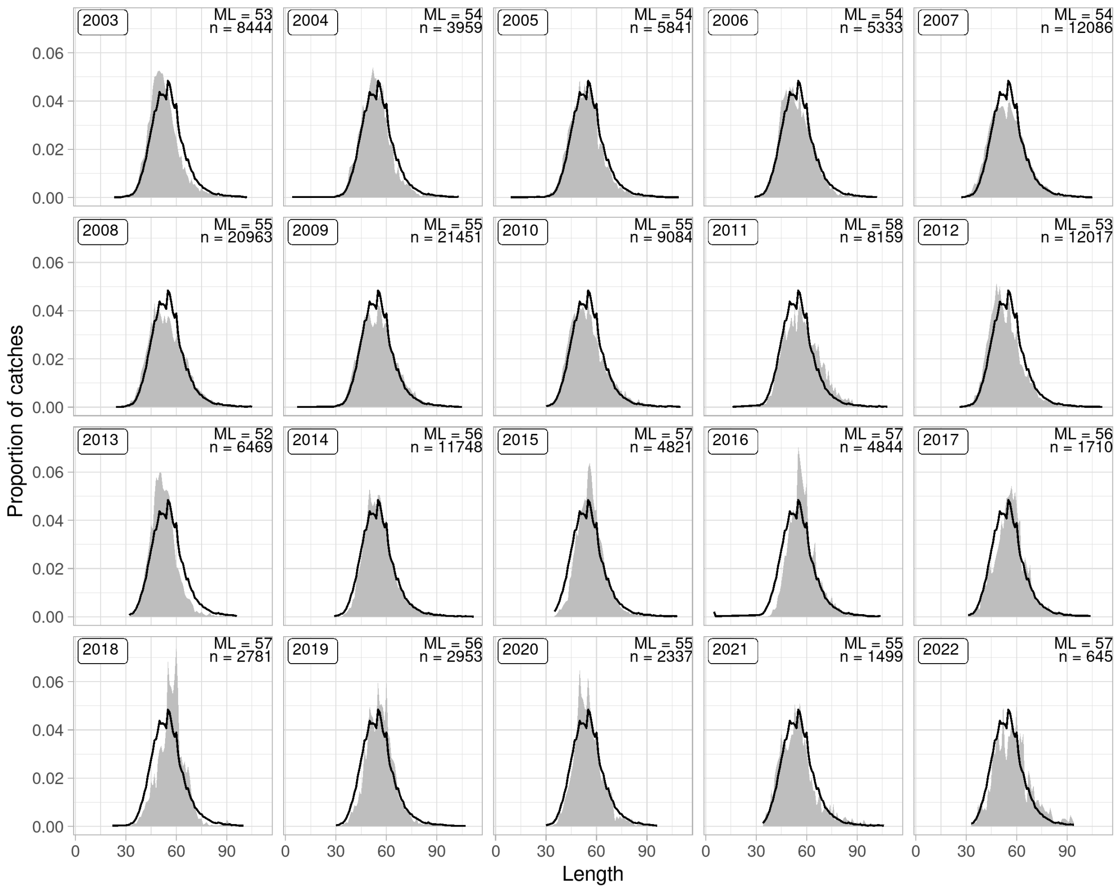

Figure 5.2.8: Tusk in 5.a and 14. Length distributions from Icelandic commercial longline catches.

5.2.3.3 Age compositions

Table 5.2.6 gives an overview of otolith sampling intensity by gear types from 2000 to 2022 in 5.a. Since 2010, considerable effort has been put into ageing tusk otoliths, so now aged otoliths are available from 1984, 1995, 2008–2022. The age data are used as input for the SAM assessment. It is expected that the effort in ageing of tusk will continue.

Table 5.2.6. 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	No. samples (catch)	No. otoliths (catch)	No.samples (survey)	No.aged (survey)
2008	32	1600	282	475
2009	27	1350	277	434
2010	29	1449	241	363
2011	28	1400	270	728
2012	35	1750	285	750
2013	23	1150	275	536
2014	28	620	241	559
2015	26	555	260	573

Year	No. samples (catch)	No. otoliths (catch)	No.samples (survey)	No.aged (survey)
2016	14	290	259	676
2017	8	160	245	571
2018	9	180	247	549
2019	15	330	251	704
2020	14	290	250	647
2021	15	291	278	811
2022	14	287	313	897
2008	32	1600	282	475
2009	27	1350	277	434

5.2.3.4 Weight at age

Weight-at-age data from 5.a are limited to 2008–2022. No data are available from 14.

5.2.3.5 Maturity at age

In recent years, at 54 cm around 34% of tusk in 5.a is mature, at 62 cm 54% of tusk is mature and at 70 cm 50% of tusk is mature based on the spring survey data.

No data are available for 14.

5.2.3.6 Natural mortality

No information is available on natural mortality of tusk in 5.a or 14. For assessment and advisory purpose the natural mortality is set to 0.15 for all age groups.

5.2.3.7 Catch, effort and research vessel data

Catch per unit of effort and effort data from commercial fisheries

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 (ICES division 27.5.a)

Information on abundance and biological parameters from tusk in Icelandic waters is available from two surveys, the Icelandic groundfish survey in the spring and the Icelandic autumn survey. The Icelandic spring groundfish survey, which has been conducted annually in March since 1985, covers the most important distribution area of the tusk fishery. 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 due to labour strikes 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 (ICES (2017b)). Figure 5.2.9 shows a recruitment index and the trends in various biomass indices. No substantial changes in spatial distribution are seen in general although there are spatial gradients in size distribution Figure 5.2.10.

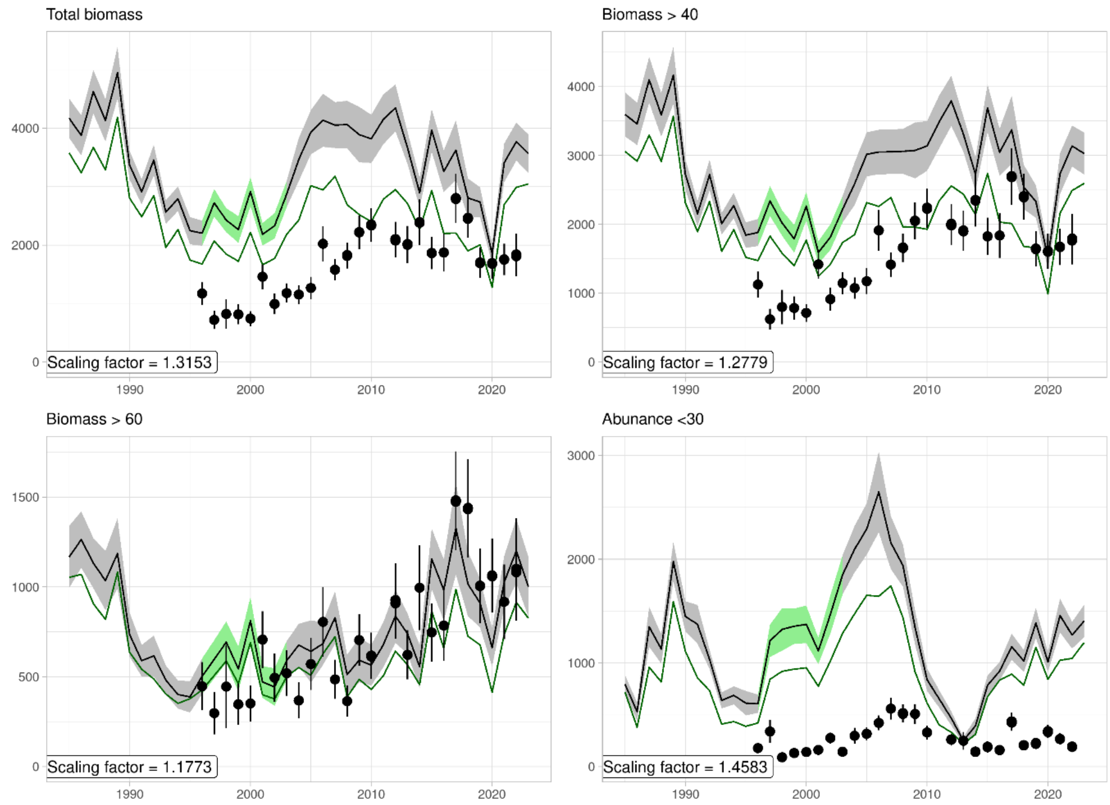

Figure 5.9: Tusk in 5.a and 14. Aa) Total biomass indices, b) biomass indices larger than and including 40 cm, c) biomass indices larger than and including 60 cm and d) abundance indices smaller than and including 30 cm. The lines with shaded areas show the spring survey index from 1985 and the points with the vertical lines show the autumn survey from 1997. The shaded area and vertical lines indicate +/- standard error. Green line is the index excluding the Iceland-Faroe Ridge.

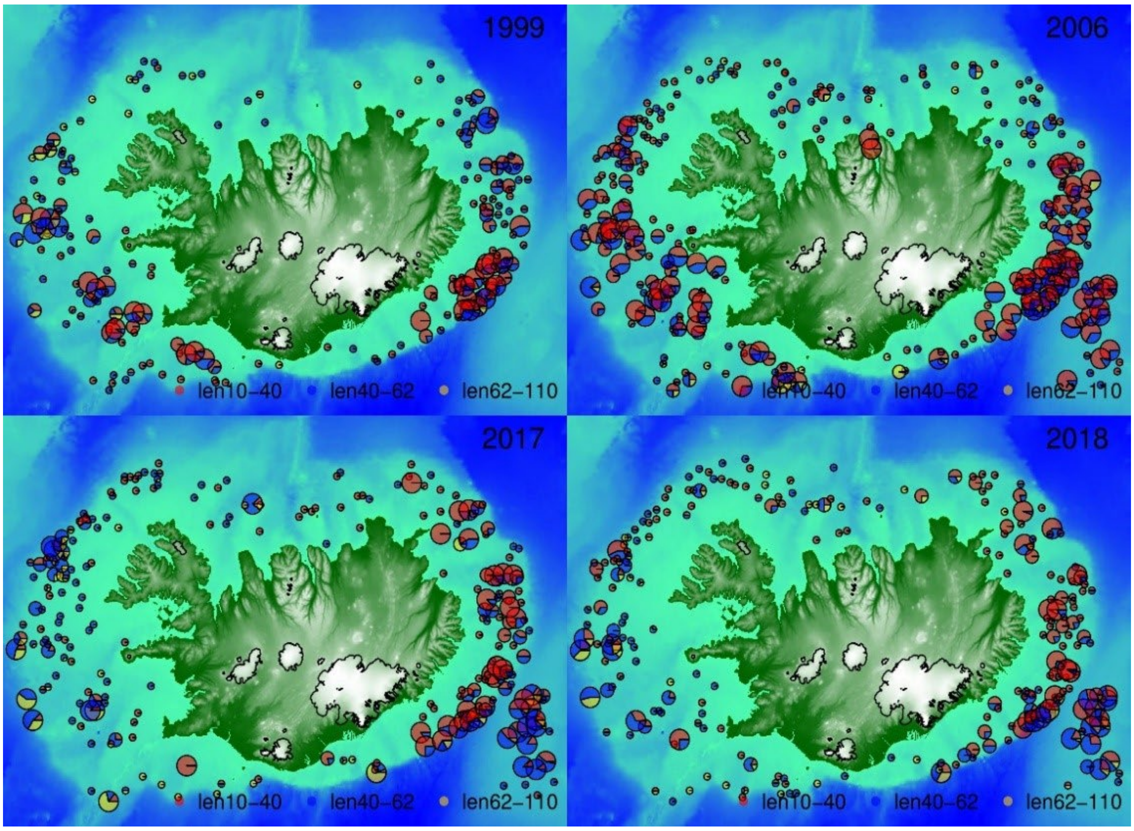

Figure 5.2.10: Tusk in 5.a and 14. Changes in spatial distribution divided by size. Size of pie is indicative of numbers of specimens caught at the tow-station.

German survey data (ICES Subarea 27.14)

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 was 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 5.2.11 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 5.2.12.

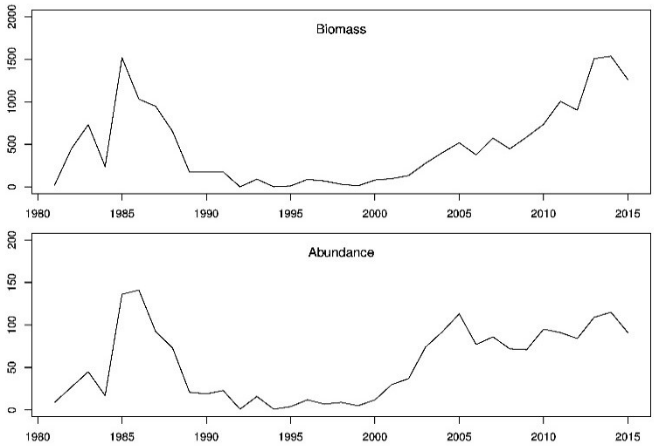

Figure 5.2.11: Biomass and abundance estimates from the Walter Herwig survey in 14. The data are just the total number caught and then converted to weight.

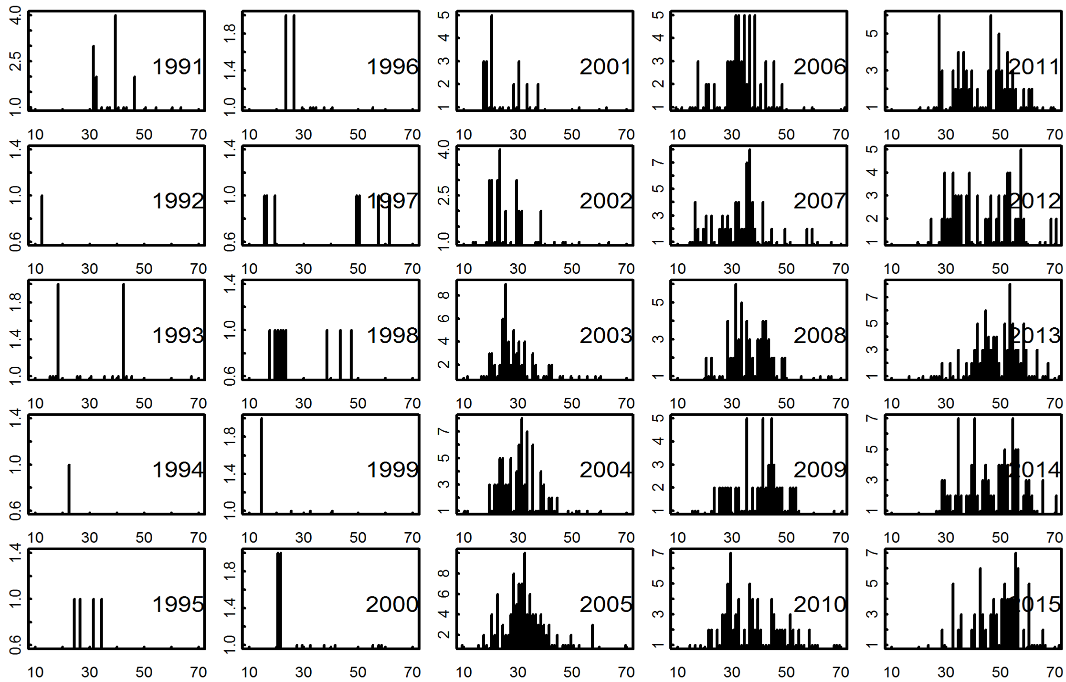

Figure 5.2.12: Length distributions from the Walter Herwig survey in 14.

Greenland survey data (ICES Subarea 27.14)

The Greenland Institute of Natural Resources conducted a stratified bottom trawl survey in East Greenland (ICES 14b) from 1998 to 2016 at depths between 400 to 1500 m (ICES (2019) :WD05). Survey results for tusk show a highly variable but increasing trend over recent years, so results from this survey will be monitored after it resumes in the future as a potential biomass index to be included in the tusk assessment.

5.2.4 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. Catches decreased from around 9000 tonnes in 2010 to 2577 tonnes in 2022. This decrease is mainly because of reductions in landings by the Icelandic longline fleet and to a lesser extent Faroese and Norwegian landings (Table 5.2.2 and Table 5.2.3). This has resulted in less overshoot of landings relative to set TAC (Table 5.2.4) , except in the last two years when the stock has experienced an all-time low. As this all-time low is more likely due to the low recruitment during 2010–2011 rather than overexploitation, so is expected to increase as subsequent higher recruitment levels grow to fishable sizes.

There are no marked changes in the length compositions since 2004, mean length in the catches ranges between 52 and 58 (Figure 5.2.7 and Figure 5.2.8). Length distributions from the spring survey show a distinct large cohort, or series of consecutive cohorts, appearing in 2014, growing through time, and just beginning to reach fished sizes approximately this year 6. This recruitment peak appears to follow a recruitment low that can also be traced through the length distribution from 2014, and can still be observed this year as slightly lower-than-average frequencies of tusk in the 45 - 50 cm range. According to the available length distributions and information on maturity only around 29% of catches in abundance and 44% in biomass are mature. The reason for this is unknown, but given the lack of distinctive cohort structure in the data the first explanation might be a lack of consistency in ageing. Also, tusk have experienced a reduction in fishing mortality over the latter half of this range. 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. The total biomass index and the biomass index for tusk larger than 40 cm (reference biomass) decreased substantially but increased again and has remained at relatively high similar level as in 2011 (Figure 5.2.11). The same holds for the index of tusk larger than 60 cm (spawning–stock biomass index). 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 2014–2017 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 labour strikes in the fishing industry, the autumn survey did not take place in 2011.

When looking at the spatial distribution from the spring survey around 25% of the index is from the SE area. However only around 4% of the catches are caught in this area (Figure 5.2.2 and Figure 5.2.3). The change in juvenile abundance between 2006 and recent years can be clearly seen in Figure 5.2.9 and Figure 5.2.10 where in 2006 juveniles (<40 cm) were all over the southern part of the shelf but can hardly be seen in recent years.

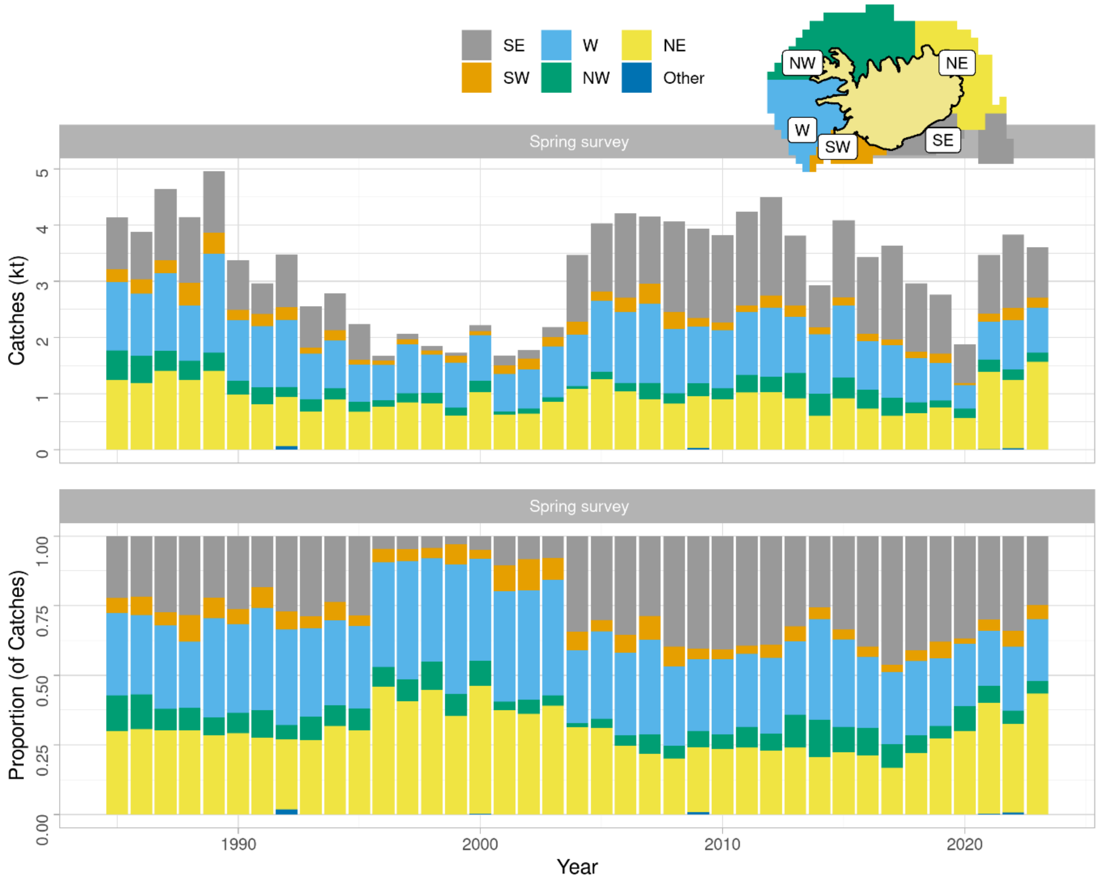

Figure 5.2.13: Tusk in 5.a and 14. Estimated survey biomass in the spring survey by year from different parts of the continental shelf (upper figure) and as proportions of the total (lower figure).

5.2.4.1 Analytical assessment using SAM

Since 2010 the Gadget model (Globally applicable Area Disaggregated General Ecosystem Toolbox, see www.hafro.is/gadget) had 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) and a Gadget model was used for category 1 assessment through 2021. In 2022, Tusk in 5.a and 14 was re-assessed as the previously benchmarked Gadget model had begun to show great instability in retrospective patterns in recent years. As a part of a Harvest Control Evaluation requested by Iceland, the stock was benchmarked (WKICEMSE 2022) which resulted in changes in the assessment method and updated reference points. Model setup and settings are described in the Stock Annex(X).

5.2.4.2 Data used by the assessment and model settings

Data used for tuning and the model configuration are given in the stock annex.

5.2.4.3 Model fit

The model fit to survey indices and catch at age data are shown in Figures 5.2.14 and 5.2.15. Generally, the model closely follows the catch-at-age and spring survey data, which are in good agreeance. The autumn survey is noise but generally follows the same pattern. Fits to the landings (total biomass removals) and April gillnet survey (age 10 abundance) are much noisier.

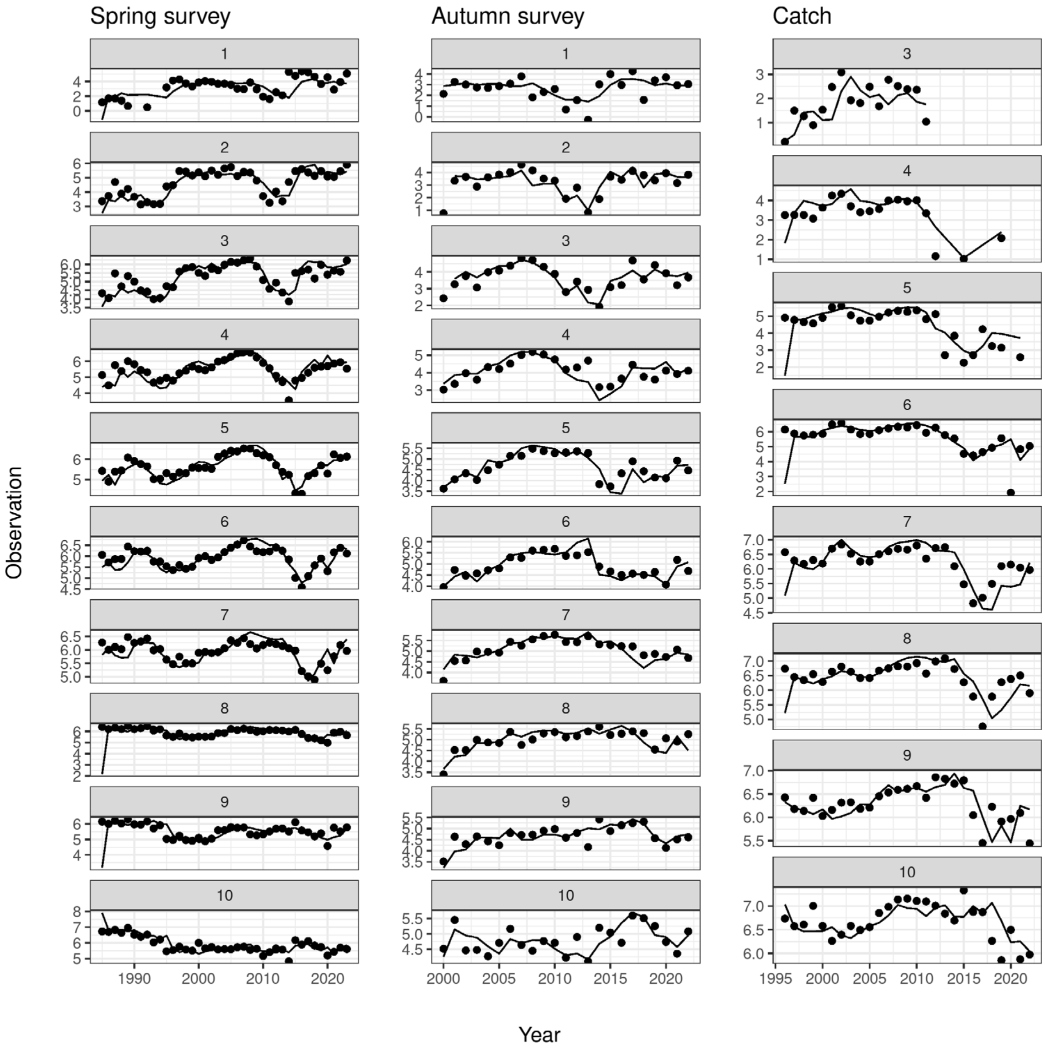

Figure 5.2.14: Tusk in 5.a and 14. Model fit to catches, spring survey and autumn survey indices.

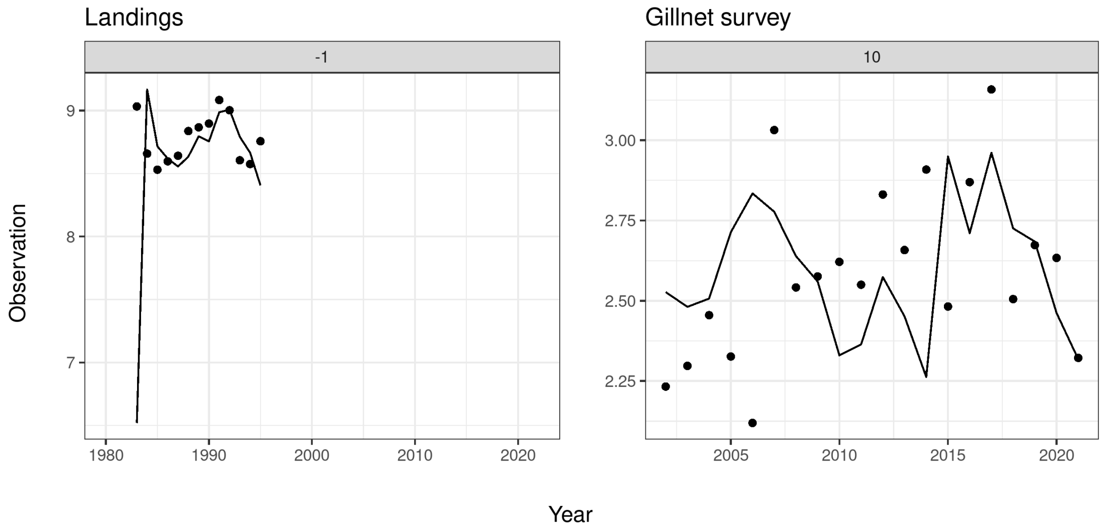

Figure 5.2.15: Tusk in 5.a and 14. Model fit to landings and gillnet indices.

5.2.4.4 Model results

Spawning stock biomass has shown a gradual decline prior to 1995, although prior to 1985 the model is informed by very little data so uncertainty is high. The period 1995 - 2015 was steady, with a gradual decline thereafter that continued until 2022, when biomass levels have started to increase again. This pattern is likely due to a distinctive low point in recruitment in 2011 - 2012, which has since then increased to relatively high levels. Therefore, given moderate fishing levels, spawning stock biomass is expected to increase over the next several years as the newest higher recruitment levels grow into the fishable population. The previous peak in recruitment (2004 - 2005) likely did not increase spawning stock biomass levels substantially during this period due to higher fishing rates and catch values during 2008 - 2010, when these fish would have been entering the fishery (Figure 5.2.16).

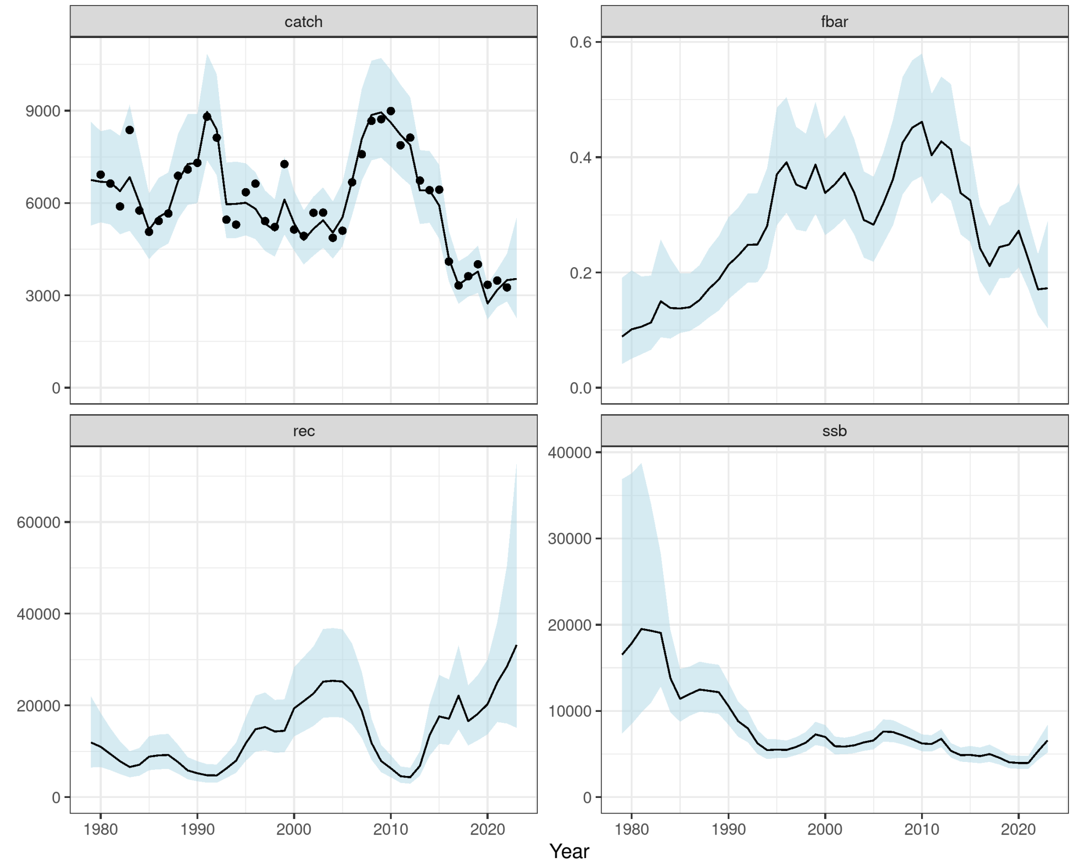

Figure 5.2.16: Tusk in 5.a and 14. Model results of population dynamics overview: estimated catch, average fishing mortality over ages 7 - 10 (Fbar), recruitment (age 1), and spawning stock biomass (SSB).

5.2.4.5 Retrospective analysis

The results of an analytical retrospective analysis are presented (Figure 5.2.17). The analysis indicates generally consistent model results over the 5-year peel. Mohn's rho was estimated to be 0.0327 for SSB, -0.00350 for F, and 0.177 for recruitment. Recruitment indices generally tend to be uncertain as there are few repeated observations at larger sizes with which this influence can be tempered. However, the good fit to survey indices at age 1 (Figure 5.2.14), suggests that recent recruitment estimates from this peak are reliable. In addition, a peak in these sizes of tusk followed by a sharp decline in 2020 are reflected in length distribution data as a rather large but steep peak in proportions of fish that have begun to shift right (to larger sizes) with no obvious new peaks of small sizes taking its place (Figure

5.2.7). Therefore, it is likely that the increase in biomass observed this year will continue in the next year or so.

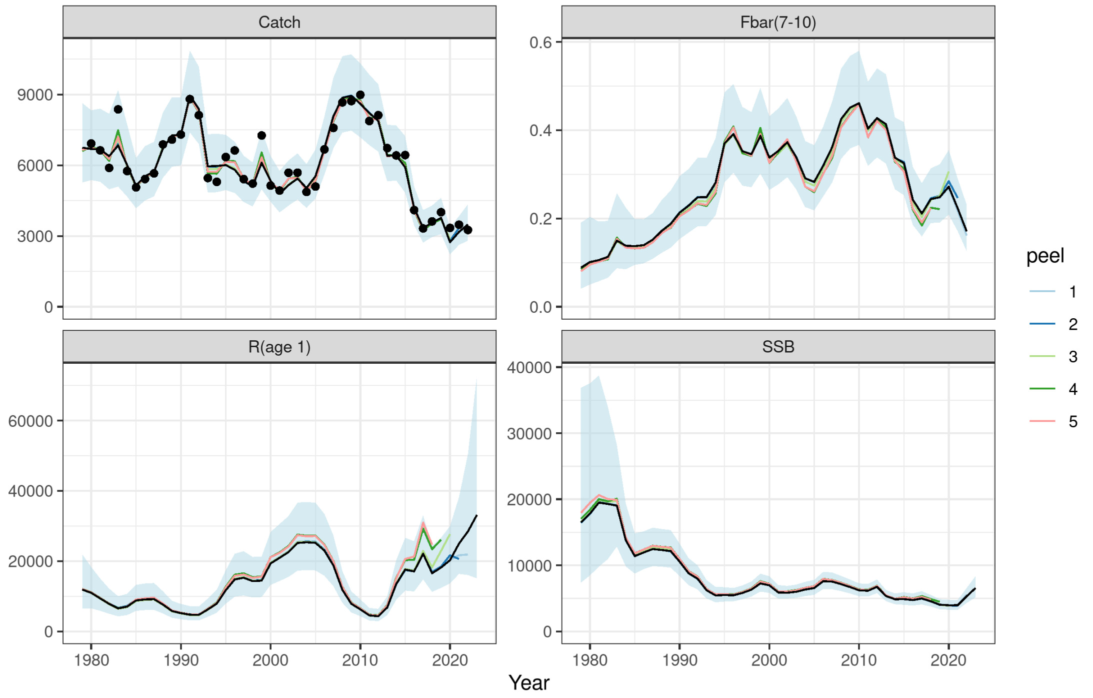

Figure 5.2.17: Tusk in 5.a and 14. Retrospective plots illustrating stability in model estimates over a 5-year 'peel' in data. Results of spawning stock biomass, fishing mortality F, and recruitment (age 3) are shown.

Observation nor process residuals show slight trends in autocorrelation and some blocks of time where the model was consistently over- or underestimating the model. (Figs. 5.2.18 and 5.2.19). However, they a better model configuration could not be found in the benchmark that would remove these patterns, and similar model configurations gave similar model results (WKICEMP 2022).

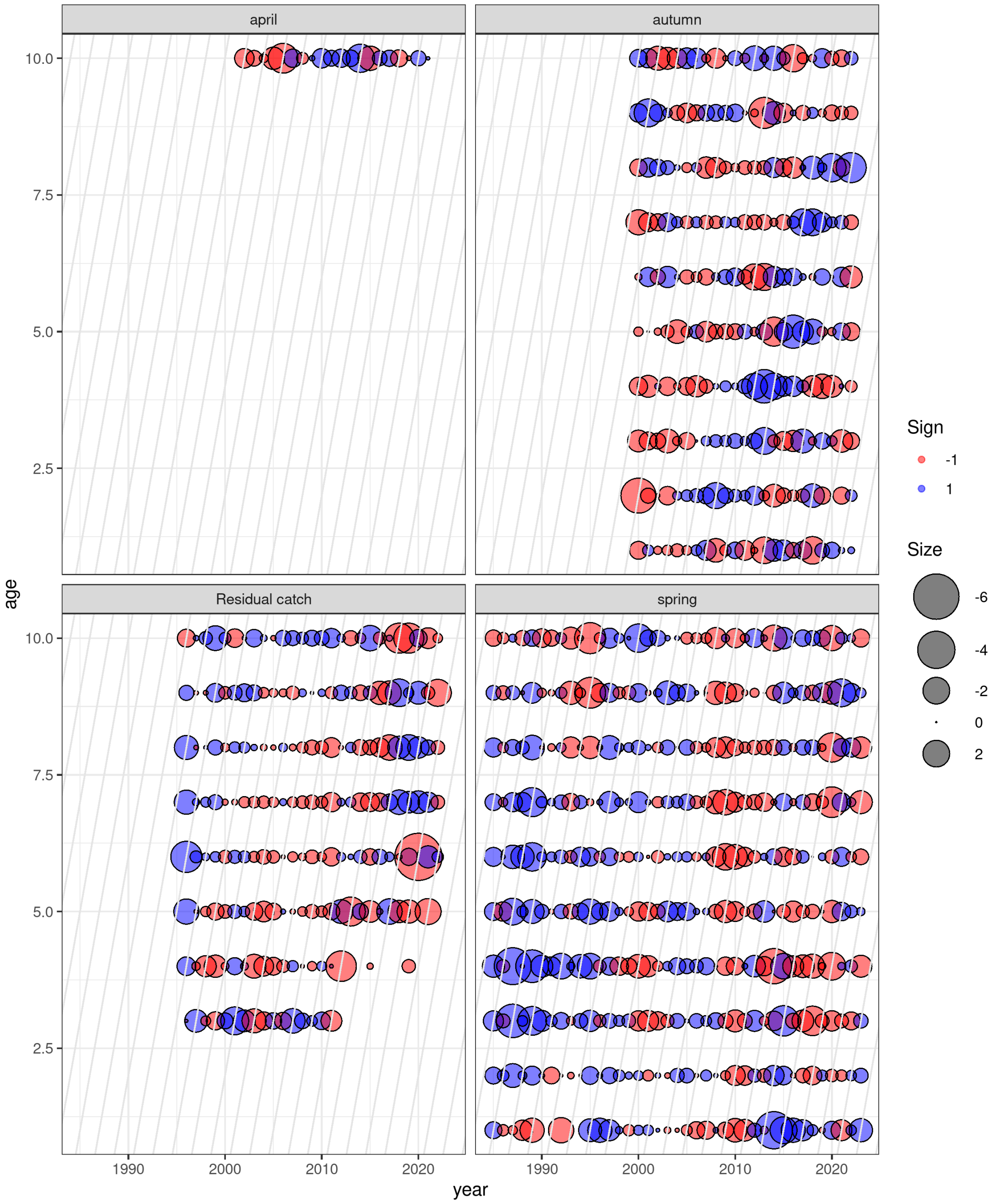

Figure 5.2.18: Tusk in 5.a and 14. Observation error residuals of the SAM model.

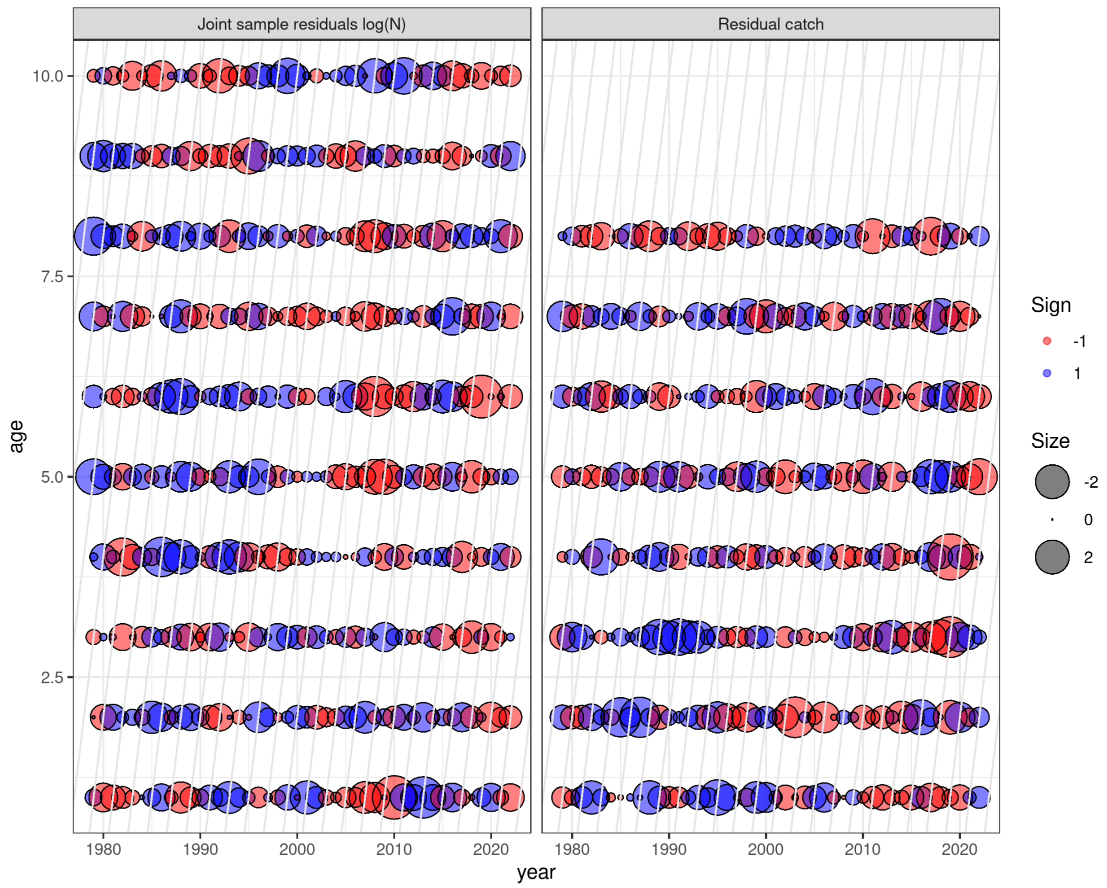

Figure 5.2.19: Tusk in 5.a and 14. Process error residuals of the SAM model.

5.2.4.6 Reference points

In the past, yield-per-recruit-based reference points, estimated as described in the stock annex, were used as proxies for Fmsy. Fmsy from a Y/R analysis is 0.24 and F0.1 is 0.15. WGDEEP 2014 recommended using Fmsy=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 (ICES (2017a)), the following reference points were defined for the stock. The management plan accepted at that time was: The spawning–stock biomass trigger (MGT Btrigger) is defined as 6.24 kt, the reference biomass is defined as the biomass of tusk 40+ cm and the target harvest rate (HRmgt) 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 SSBy is equal or above MGT Btrigger:

TACy/y+1 = HRmgt*BRef,y

When SSBY is below MGT Btrigger:

TACy/y+1 = HRmgt* (SSBy/MGT Btrigger) * Bref,y

WKICEMSE 2017 concluded that the HCR was precautionary and in conformity with the ICES MSY approach, but the model started to show instability in retrospective patterns and was then benchmarked in 2022.

As part of the WKICEMP 2022, HCR evaluations requested by Iceland the following reference points were defined for the stock.

Table 5.2.7: Tusk in 5.a and 14. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	4800	B_{pa}
	F_{MSY}	0.23	Limited by F_{pa}, maximum F at which the probability of SSB falling below B_{lim} is <5%
Precautionary approach	B_{lim}	3400	B_{pa} x $e^{-1.645 * \sigma B}$
	B_{pa}	4800	B_{loss} (SSB in 2016)
	F_{lim}	0.44	Fishing mortality that in stochastic equilibrium will result in median SSB at B_{lim}.
	F_{pa}	0.23	Maximum F at which the probability of SSB falling below B_{lim} is <5%
Management plan	MGT $B_{trigger}$	4800	According to the management plan
	F_{MGT}	0.23	According to the management plan

The management plan proposed by Iceland is:

The proposed HCR for the Icelandic Tusk fishery, which sets a TAC for the fishing year y/y+1 (September 1 of year y to August 31 of year y+1) based on a fishing mortality F_{mgt} of 0.23 applied to ages 7 to 10 modified by the ratio SSB_y/MGT $B_{trigger}$ when SSB_y < MGT $B_{trigger}$, maintains a high yield while being precautionary as it results in lower than 5% probability of SSB < B_{lim} in the medium and long term. WKICEMSE 2022 concluded that the HCR was precautionary and in conformity with the ICES MSY approach.

5.2.5 Management considerations

Increased catches in 14.b, and now 14a also, from less than 100 tonnes in previous years to 900 tonnes in 2015, about 566 tonnes in 2019 are of concern. In 2021, catches were also substantial, close to 700 tonnes, roughly 200 tonnes of which were recorded as originating in 14.a. However, 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 assessment. Recruitment in 5.a shown high levels after a low in 2011. A reduction in fishing mortality has also led to harvestable biomass and SSB that seem to be either stable or slowly increasing. Due to the selectivity of the longline fleet catching tusk in 5.a and the species relatively slow maturation rate, 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 also be maintained and expanded if needed.

5.2.5.1 Ecosystem considerations

Tusk has recently exhibited spatial changes in length distributions (Figure 5.2.12), however, there have been no obvious changes in maturity patterns or growth through time. Demographic patterns of tusk should be monitored as other Icelandic demersal species have exhibited recent changes (e.g., haddock, ling, plaice, wolffish, see WKICEMP). Tusk biomass levels have recently decreased, possibly as a result of increased natural mortality and environmental factors. However, the causes for this, such as multi-species interactions, are unknown and not currently considered in the assessment.

Table 5.2.8. Tusk in 5.a and 14. Estimates of biomass, biomass spawning–stock biomass (SSB) in thousands of tonnes and recruitment at age 1 (millions) and fishing mortality from the SAM model.

YEAR	BIOMASS	SSB	REC3	CATCH	F
1979	39095	16469	11893	6717	0.089
1980	39900	17762	10963	6704	0.102
1981	40053	19407	9388	6670	0.106
1982	39003	19240	7823	6363	0.113
1983	39028	19097	6557	6944	0.152
1984	31889	13847	7040	6005	0.139
1985	28973	11460	8792	5131	0.137
1986	29514	12023	9085	5528	0.139
1987	29817	12539	9172	5719	0.151
1988	29870	12388	7624	6721	0.172
1989	30182	12225	5809	7257	0.187
1990	27324	10605	5193	7306	0.213
1991	24795	8842	4755	8951	0.229
1992	23714	8010	4715	8376	0.247
1993	19339	6261	6246	5919	0.246
1994	17608	5477	7936	5937	0.278
1995	19563	5529	11733	6044	0.372
1996	18589	5483	14819	5846	0.394
1997	19204	5838	15303	5331	0.352
1998	19560	6342	14313	5102	0.344
1999	20959	7299	14446	6151	0.389
2000	19908	7004	19351	5319	0.336
2001	19984	5922	20951	4816	0.352
2002	21045	5876	22600	5197	0.374
2003	22508	6019	25210	5442	0.338
2004	24362	6360	25382	5006	0.289

YEAR	BIOMASS	SSB	REC3	CATCH	F
2005	27626	6601	25197	5502	0.280
2006	30984	7637	22982	6713	0.318
2007	32903	7578	18744	8075	0.359
2008	36377	7181	11810	8876	0.425
2009	35064	6730	7853	8954	0.451
2010	31041	6237	6293	8647	0.462
2011	30000	6171	4567	8187	0.401
2012	30120	6774	4324	7899	0.427
2013	27942	5372	6802	6417	0.414
2014	27448	4883	13506	6406	0.336
2015	23053	4914	17636	5946	0.326
2016	23544	4770	17129	4173	0.240
2017	23044	5017	22144	3328	0.208
2018	21296	4584	16572	3570	0.244
2019	21020	4059	18169	3762	0.248
2020	20637	3979	20280	2740	0.272
2021	22957	3983	24981	3097	0.216
2022	29454	5312	28463	2897	0.142
2023	36901	6665	33123	2990	0.144

Table 3.4.8. Tusk in 5.a and 14. Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Fages 7–10(2023)	0.22	Assuming status quo F (average over the last three years) for the 2023 part of fishing year 2022/2023 and Fmgt for the remainder of 2023
SSB (2024)	6959	Short-term forecast; in tonnes
Rage 1 (2023)	33172	From the assessment; in thousands
Rage 1 (2024)	25020	Resampled from the years 2014–2023; in thousands
Catch (2023)	4487	Results from Fages 7–10 (2023); in tonnes

5.2.6 References

ICES. 2011. “Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP), 2 March–8 March, 2011, Copenhagen, Denmark. ICES Cm 2011/Acom:17.” International Council for the Exploration of the Seas; ICES publishing.

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2017a. “Report of the Workshop on Evaluation of the Adopted Harvest Control Rules for Icelandic Summer Spawning Herring, Ling and Tusk (WKICEMSE), 21–25 April 2017, Copenhagen, Denmark. ICES CM 2017/ACOM:45.” International Council for the Exploration of the Seas; ICES publishing.

2017b. “Tusk in ICES Subarea 14 and Division 5.a.” International Council for the Exploration of the Seas; ICES publishing.

2019. “11.2 Icelandic Waters ecoregion – Fisheries overview.” International Council for the Exploration of the Seas; ICES publishing. https://doi.org/10.17895/ices.advice.5706.

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

5.3.1 The fishery

Tusk is bycatch in the gillnet and longline fisheries in Subdivisions 12.a1 and 14.b1. During 1996 and 1997 Norway also had a fishery in this area.

5.3.2 Landings trends

Landing statistics by nation in the years 1988 to 2021 are shown in Table 5.3.1.

The reported landings are generally very low in these areas. Russia reported some landings of tusk in 2005, 2006, 2007 and 2009 and no landings were reported by the Russians for 2010 and 2011. In 2012 Norway reported 17 tonnes in Area 14.b1 and the Faroe Islands, 1 ton. No landings have been reported in 2013, 2014, 2016 to 2021, while in 2015 Greenland reported 2 tons.

5.3.3 ICES Advice

Advice for **2020 to 2024:** ICES advises that when the precautionary approach is applied, there should be zero catches in each of the years from 2020 to 2024.

5.3.3.1 Management

In 2014 NEAFC (Rec 03 2014) recommends the effort in areas beyond national jurisdiction shall not exceed 65 percent of the highest effort level for deep-water fishing in the past.

5.3.4 Data available

5.3.4.1 Landings and discards

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

5.3.4.2 Length compositions

No length compositions were available.

5.3.4.3 Age compositions

No age compositions were available.

5.3.4.4 Weight-at-age

No data were available.

5.3.4.5 Maturity and natural mortality

No data were available.

5.3.4.6 Catch, effort and research vessel data

No data were available.

5.3.5 Data analyses

There are insufficient data to assess this stock.

5.3.5.1 Biological reference points

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

5.3.6 Comments on the assessment

No assessment was carried out this year.

5.3.7 Management considerations

Tusk is a bycatch in all fisheries. Advice should consider the advice for the targeted species. Life-history traits for tusk do not suggest it is particularly vulnerable.

5.3.8 Tables

Table 5.3.1. 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

Year	Faroes	France	Iceland	Norway	Scotland	Russia	Total
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
2017							0
2018							0
2019							0
2020							0
2021							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
2017							0
2018							0
2019							0
2020							0

2021*	0

Table 5.3.1. (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

Year	12	14.b1	All areas
2015	0	2	2
2016	0		0
2017			0
2018			0
2019			0
2020			0
2021*			0

***Preliminary.**

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

5.4.1 The fishery

Tusk are only caught as bycatch and not targeted in trawl, gillnet, or longline fisheries in Subarea 6.b. Norway has traditionally landed the largest catch of tusk in area 6.b. During the period 1988–2020 Norwegian vessels have reported 70-80% of the total landings. Since January 2007, parts of the Rockall Bank have been closed to fishing which were the traditional areas fished by the Norwegian longline fleet.

The Norwegian longline fishery

The Norwegian longline fleet increased from 36 in 1977 to a peak of 72 in 2000, and afterwards the number decreased and then stabilized around 25-27 since 2014. The number of vessels declined mainly because of changes in the law concerning the quotas for cod. The total number of days the fleet has been fishing in Subarea 6.b per year was a maximun of 464 fishing days in 2002 to 60 days in 2020. In 2021 and 2022, , there was no fishing by Norwegian vessels in Subarea 6.b. (Figure 5.4.1).

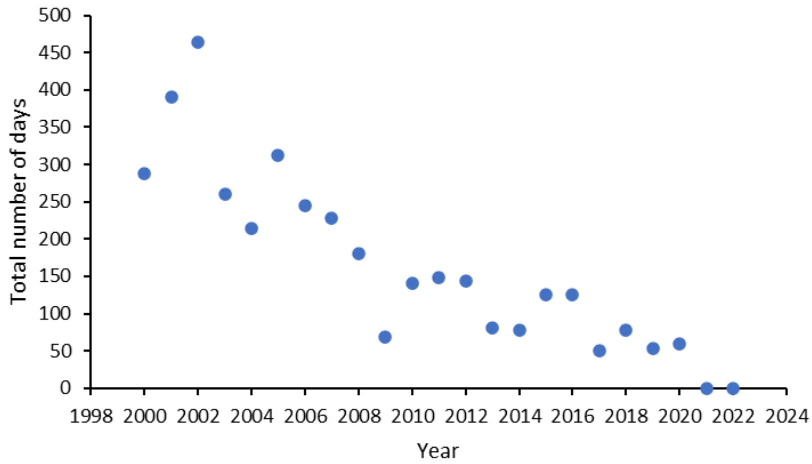

Figure 5.4.1. Estimated total number of days the Norwegian longline fleet fished for tusk (bycatch) during the period 2000 to 2022 based on logbooks.

5.4.2 Landings trends

Landing statistics by nation for the period 1988–2022 are in Table 5.4.1.

Landings varied considerably between 1988 and 2000. Landings peaked at 2344 t in 2000, and since 2000 have been much lower, and declining. In 2014 the catch was 38 tons, an all-time low during this period, while in 2015 the total catch increased to 226 tons, in 2022the landings decreased to 36tons (Figure 5.4.2).

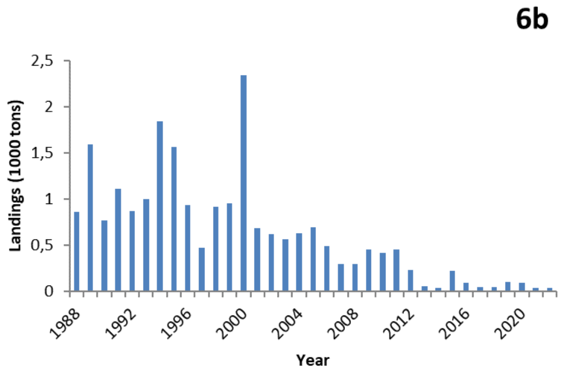

Figure 5.4.2. The international total landings of tusk from Subarea 6.b.

5.4.3 ICES Advice

ICES advises that when the precautionary approach is applied, catches should be no more than 224 tonnes in each of the years **2023 and 2024**. If discard rates do not change from the average of the last three years (2019–2021), this implies landings of no more than 197 tonnes.

5.4.4 Management

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

Norway has a quota in UK waters in area 6 set at 380 t in 2023.

The EU and UK TACs cover Subareas 5, 6, 7 and the EU TAC was in 2023 is set at 3022 t, while the UK TAC was set at 1272t. Total TAC 4297

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 levels in previous years.

5.4.5 Data available

5.4.5.1 Landings and discards

Landings were available for all relevant countries. An overview over landings and discards are shown in Table 5.4.2.

Table 5.4.2. Landings, discards, total catch, and percentage discards of the total catch of tusk in 6.b. since 2016

Year	Landings	Discards	Total catches	% Discards
2016	90	7	97	7
2017	47	14	61	23
2018	47	21	68	31
2019	100	12	112	11
2020	91	24	116	21
2021	40	1	41	2.4

2022	40	0.3	40.3	0.8

5.4.5.2 Length compositions

No new length composition data were available.

5.4.5.3 Age compositions

No new age composition data were available.

5.4.5.4 Weight-at-age

No new data were presented.

5.4.5.5 Maturity and natural mortality

No new data were presented.

5.4.5.6 Catch, effort and research vessel data

Norway began collecting and entering data from official logbooks into an electronic database in 2003, and data are now available for 2000–2020. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 t in each year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day.

5.4.6 Data analyses

No analytical assessments were carried out.

5.4.6.1 Norwegian longline cpue

The CPUE series based on the Norwegian longliners show a decrease from 2000 to 2007. After this the CPUE had been at a low but stable level. No data was available for 2021 and 2022. (Figure 5.4.3).

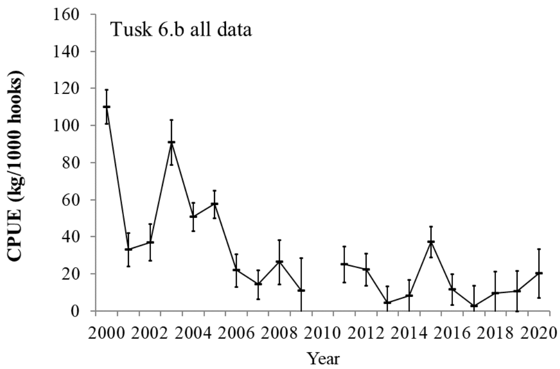

Figure 5.4.3. Estimated cpue (kg/1000 hooks) series for tusk in Subarea 6.b based on skipper's logbooks (during the period 2000–2020). The bars denote the 95% confidence intervals.

5.4.6.2 Biological reference points

No new data were presented.

5.4.7 Comments on the assessment

There are no assessments for tusk in this area.

5.4.8 Management considerations

Landings since 2001 have been low and generally decreasing. Except for 2015, landings have been very low (maximum 100 t per year) since 2013 (Table 5.4.1, Figure 5.4.2).

The decreasing fishing effort in Subarea 6.b. was caused by several factors including; closed areas, increasing fuel costs, and larger quotas of Arcto-Norwegian cod. The total number of days the fleet were fishing in Subarea 6.b per year has decreased from a maximun of 464 fishing days in 2002 to 60 days in 2020, no fishery was carried out by Norway in 2021 and 2022 (Figure 5.4.1).

The CPUE series also shows a decreasing trend until 2007, after which bottom contacting gears were banned in Subarea 6.b. Since 2007, CPUE has been generally low but stable (Figure 5.4.3).

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 that a cpue series, which is based only on commercial catch data, truly tracks abundance.

In general, any assessment method based only on commercial catch data needs to be applied with increased caution. Assessments that use only commercial data are problematic because the relationship between trends in commercial catch rates and population size is normally unknown and probably varies from year to year.

5.4.9 Application of MSY proxy reference points

Length-based indicator method (LBI)

There is not enough length data or other biological data to apply the LBI method. Life history parameters such as L_{mat} have previously been based on tusk caught within Faroese waters. However, Rockall tusk is genetically different from tusk in neighbouring areas (Knutsen *et al*. 2009), and it is very likely that life history parameters like L_{mat} may also be different. Until these values have been established for Subarea 6.b, the use of the LBI method is not considered appropriate. No new length data or other biological data are available for 2022.

5.4.10 References

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Rosenbaum, P.R. 2002. Observational Studies (second ed.), Springer-Verlag, New York, NY (2002) (377 pp.)

Table 5.4.1. 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

Year	Faroes	France	Germany	Ireland	Iceland	Norway	E & W	N.I.	Scot.	Russia	Total
2017				2		37			8		47
2018				2		35			10		47
2019				9		70			21		100
2020				9		51			31		91
2021		1		5					34		40
2022	3			6					31		40

*Preliminary.

Table 5.4.1. (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

Year	6.b	All areas
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
2017	47	47
2018	47	47
2019	100	100
2020	91	91
2021	40	40
2022*	40	40

***Preliminary.**

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

5.5.1 The fishery

Tusk are primarily 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 usually around 85% from longlines, 10% from gillnets and the remainder by other gears. For other nations, tusk is bycatch in trawl and longline fisheries.

Figure 5.5.1 shows the spatial distribution of the total catch by the Norwegian longline fishery in 2021. 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 26 in 2021.. 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 the peak in 2011. During the period 1974 to 2021 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 2021).

Since the total number of hooks per year considers 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 2011–2021 is 40% less than the average effort during the years 2000–2003. It should be noted that the annual fishery covers the entire distribution of tusk in Subareas 1 and 2 (see Figure 5.5.1), so that the catch produced by the applied effort is likely proportional to the actual population.

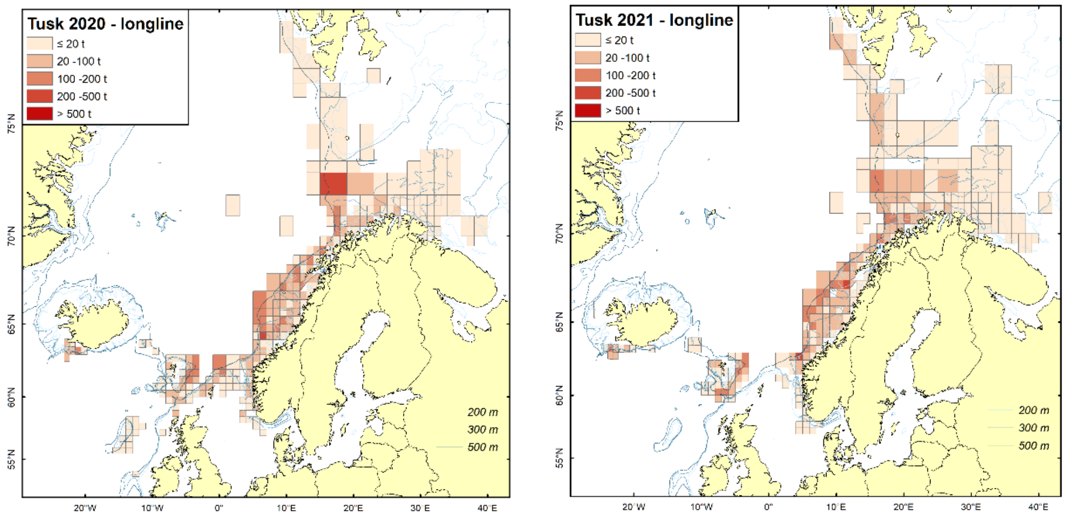


Figure 5. 5.1. Distribution of catches for the Norwegian longline fishery in Subareas 1 and 2 in 2020 and 2021

5.5.2 Landings trends

Landing statistics by nation from 1988 to 2021 are given in Table 5.5.1a–d. Landings declined from 1989 to 2005, afterwards the landings increased and varied around 10.000 t. (Figures 5.5.2 and 5.5.3). The preliminary landings for 2021 are 9 227t.

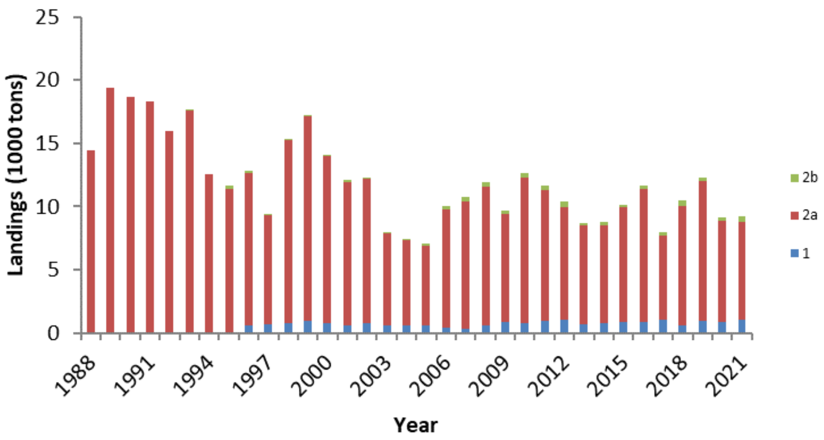


Figure 5.5.2. Total yearly landings of tusk in Areas 1 and 2 for 1988–2021.

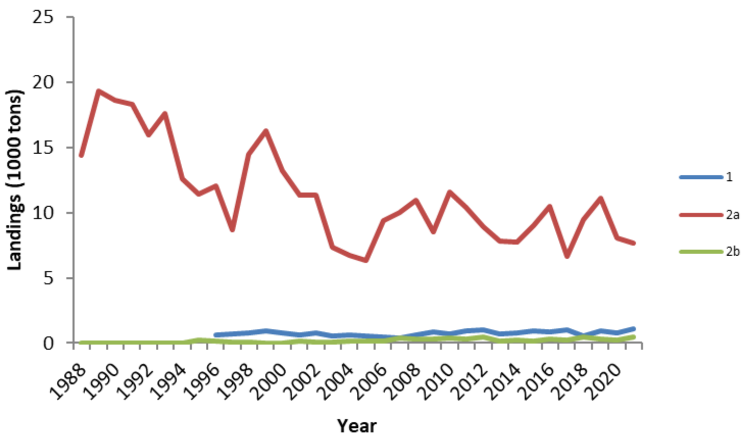


Figure 5.5.3. Total yearly landings of tusk in Areas 1 and 2 for 1988–2021.

5.5.3 ICES Advice

ICES advises that when the precautionary approach is applied, catches should be no more than 8076 tonnes in each of the years **2022 and 2023** Management.

There is no quota 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 length in the Norwegian EEZ.

5.5.4 Data available

5.5.4.1 Landings and discards

The amount landed is 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 small. No discards were reported in 2021. The landings statistics are regarded as being adequate for assessment purposes.

5.5.4.2 Length compositions

Figures 5.5.4 and 5.5.5 show the length distributions and Figure 5.5.6 shows the length–weight relationship for tusk based on data provided by the Norwegian reference fleet for the period 2001–2021.

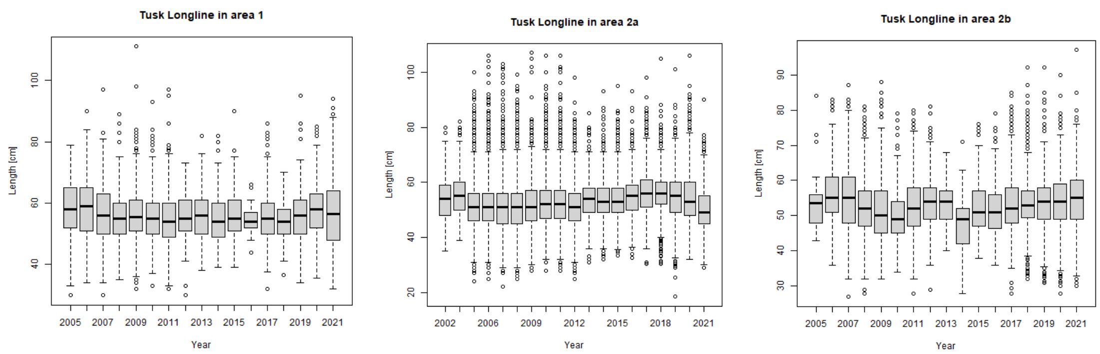
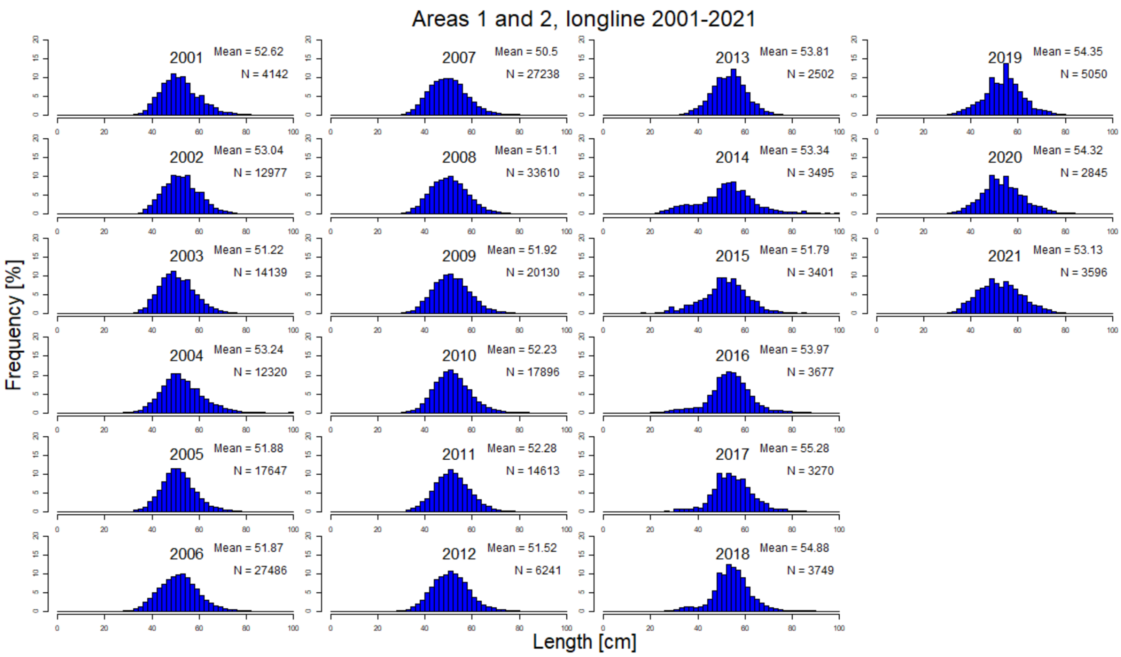
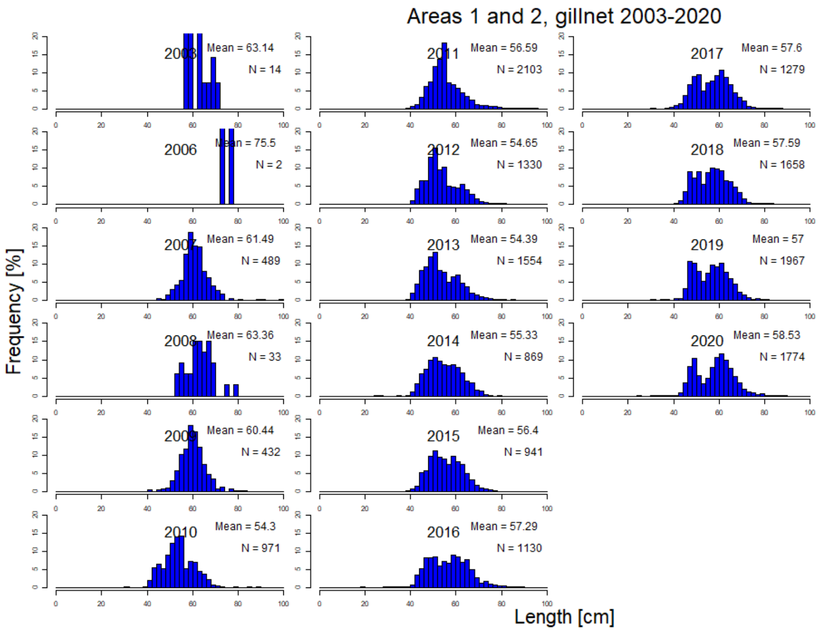


Figure 5.5.4. Box and whisker plots showing the length distribution of tusk. The data were provided by the Norwegian reference fleet for the period 2001–2021.





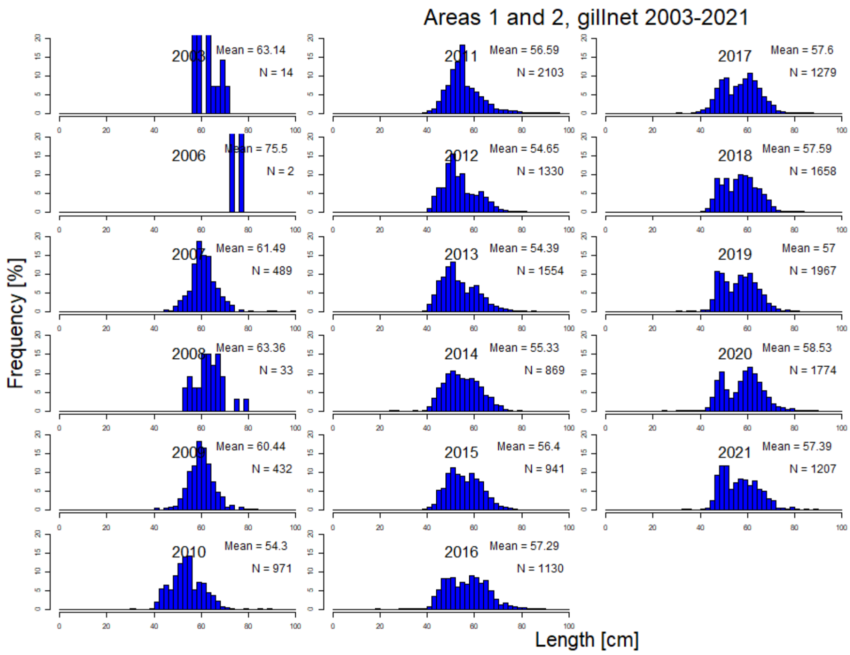


Figure 5.5.5. The estimated length distributions of the catch of tusk by Norwegian longliners and gillnetters combined for the Areas 1, 2.a and 2.b.

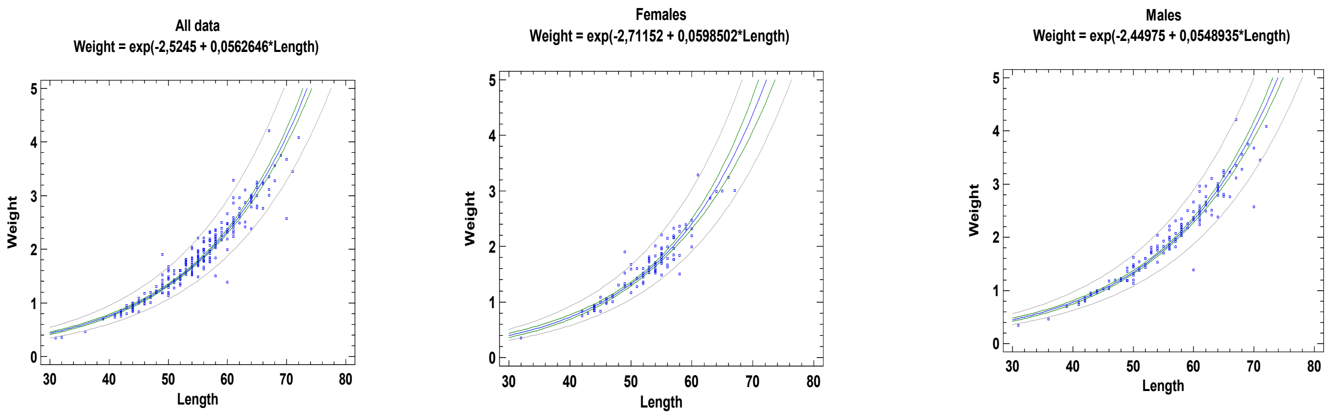


Figure 5.5.6. Length–weight relationship for tusk.

5.5.4.3 Age compositions

No new data are available.

5.5.4.4 Maturity and natural mortality

Maturity ogives for tusk are in Figure 5.5.9 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

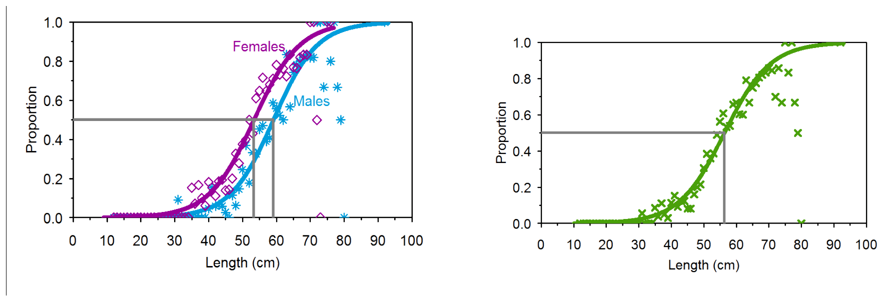


Figure 5.5.7. Tusk Area 1 and 2, Maturity ogive on length for males and females, and all data combined.

5.5.4.5 Catch, effort and research vessel data

Norway began in 2003 to collect and enter data from official logbooks into an electronic database, and these data are now available for the period 2000–2021. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 t each 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, 2021. Two cpue series, one based on all data and one when tusk was targeted were presented (Figure 5.5.8). No research vessel data are available.

5.5.5 Data analyses

Length distribution

In Figures 5.5.4 and 5.5.5 are plots of the length distributions in Area 1 and 2 for 2001 to 2021. It appears that the mean length in Area 1 has varied slightly, while the mean length in Areas 2a and 2b has been very stable. The average length is slightly higher in the gillnet fishery than in the longline fishery. In 2020 the average length was 54.1 cm in the longline fishery and 57.4 cm in the gillnet fishery

Assessment

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

CPUE

Two standardized GLM-based cpue series using all the data and based only when tusk made up more than 30% of the catches are in Figure 5.5.9. Both cpue series have been relative stable since 2011, but with a declining trend the last four years for the targeted fishery (Figure 5.5.8).

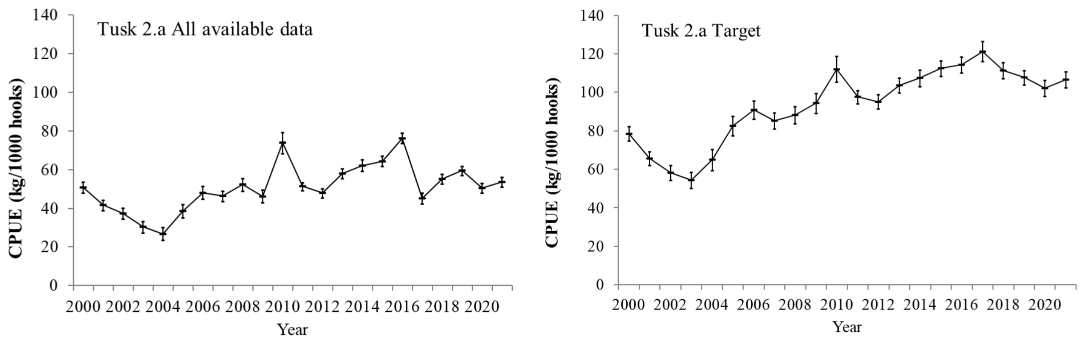


Figure 5.5.8. Estimates of cpue (kg/1000 hooks) of tusk based on skipper's logbook data for 2000–2021. The bars denote the 95% confidence interval.

Biological reference points

No traditional biological reference points are established for tusk. Life history parameters are in Table 5.5.2.

5.5.6 Comments on the assessment

It appears more likely that the cpue series for tusk based only on data from the targeted fishery reflects the population trends than does the series based on all the catch data.

5.5.7 Management considerations

The fishing pressure on tusk has decreased considerably. The number of longline vessels fishing for tusk has decreased by about 65 percent from 2000 to 2018, but with a sharp increase in 2019.

The cod stock in the Barents Sea was very abundant for many years, but now there is a downward trend resulting in lower quotas. Because of lower quotas for cod the fishing pressure on tusk has increased considerably.

As always, it should be emphasized that commercial catch data are 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.

5.5.8 Application of MSY proxy reference points

Summary of SPiCT from benchmark meeting; for tusk in Subareas 1 and 2

It was not possible for the group to recommend or approve a SPiCT assessment for this stock. The reason for this was primarily the construction of the CPUE index; the CPUE index itself was not disregarded but it was not regarded suitable for the SPiCT model. Two points were pointed out as problematic; the targeting effect and technological creep. Especially handling the targeting effect; the spatial-time interactions must be solved before data can be used by SPiCT.

The recommendations from the benchmark were to enhance the standardization of the CPUE and either try an integrated model or try SPiCT again with the new CPUE. The stock should continue to be assessed as category 3 stock.

Input data for tusk arctic was the landings time series with historical landings back to 1908-2020. The abundance index was the CPUE index from the longline fishery from 2000-2020. Two variants of the CPUE index were used; one with all catches and one with only catches with more than 30% tusk.

The model was run with priors on initial depletion level and on the shape of the production curve.

The catch series is almost stable at the end of the series; this together with the very steep increase in the 30% CPUE made the CPUE to drive the model. The increase in all catches CPUE is not as pronounced as the targeted CPUE and that is probably why the model fits better to this scenario.

The very steep increase in CPUE over the short time period is problematic as the model estimate the stock to be 2–4 times BMSY and to have F below FMSY. The very high r (0,3–1,0) seems to be unrealistic as the expected value for r should be 0.12 for tusk (SPMpriors from Fish-Life). The very long catch time series (with low and high catches) and the short CPUE time series by the end of the catch time series period probably entails alternative states that are hidden to current SPiCT runs.

Stock status assessed by SPiCT indicated that B was above BMSY and F below FMSY. Other models were tried that came to contradictory conclusions. The development on B and F from SPiCT were to the assessors not totally unrealistic as the result plots to some extent resembled the history of the fishery and the believed present stock status for tusk in this area. The problem is that F probably was higher in the 1970–1980s than the model estimate. Together with the increase in CPUE this probably makes the results from the SPiCT model to be too optimistic.

The assessments on SPiCT could not be approved according to the uncertainty in the CPUE index and due to the observed inconsistencies described above. Link to the benchmark report: https://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=37488

Results for the LBI, WGDEEP 2021

Information and data

The input parameters and the catch's length distribution for the period 2001-2021 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.

Table 5.5.2 Tusk in arctic waters (1, 2.a, 2.b). Input parameters for LBI.

Data type	Years/Value	Source	Notes
Length frequency distribution	2001-2021	Norwegian long-liners (Reference fleet)	
Length-weight relationship	0.0106* length $^{3.0168}$	Norwegian long-liners (Reference fleet) and survey data.	combined sex
L_{MAT}	56 cm	Norwegian long-liners (Reference fleet) and survey data.	
L_{inf}	119 cm (L_{max})	Norwegian long-liners (Reference fleet) and survey data.	

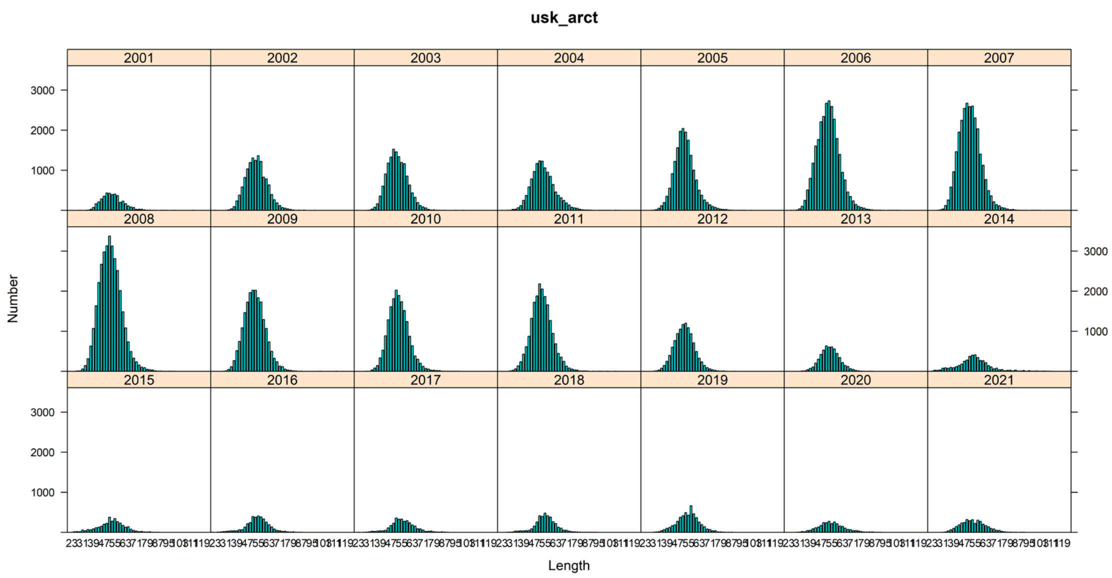


Figure 5.5.9 Tusk in arctic waters (1, 2a, 2b). The length distribution (2 cm length bins) based on data from the Norwegian longline fleet for the period 2001–2021 (sex combined).

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.

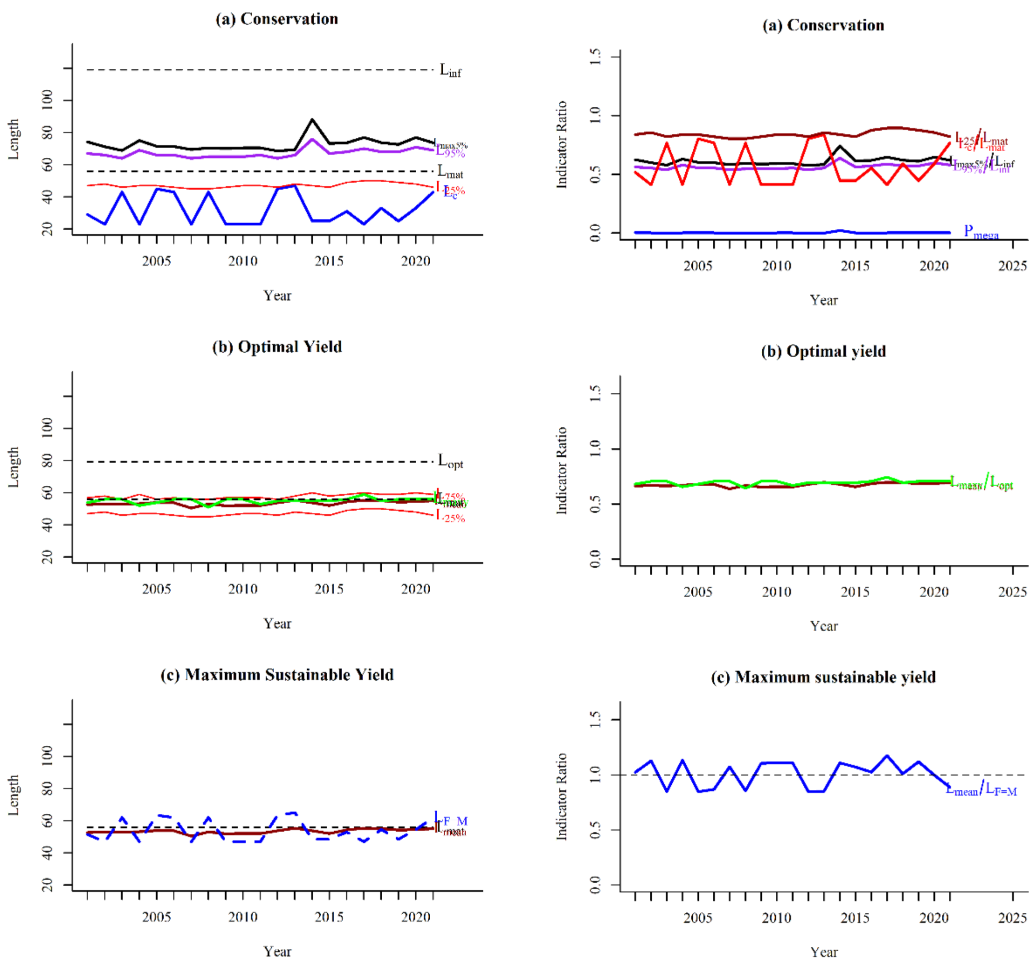


Figure 5.5.10 Tusk in arctic waters (1, 2.a, 2.b). Using length indicators ratios for sex combined to examine three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

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 6.510, Table 6.5.3). 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 between 0.61 and 0.65 in 2019-2021 (Table 6.5.10), 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 ($L_{mean}/L_{F=M}$) is greater than 1 for 2019 and 2020 (Figure 4.3.10), which indicates that tusk in arctic waters is fished sustainably for these years, in 2021 the indicator dropped to under 0.90 which should cause concerns.

Conclusion: The overall perception of the stock during the period 2019–2021 is that tusk in arctic waters seems to be fished sustainably for the years 2019 and 2020, for 2021 there is a drop that may indicate that tusk isn't fished sustainably anymore (Table 6.5.3). However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

Table 5.5.3 Tusk in arctic waters (1, 2.a, 2.b). 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**
2019	0,45	0,88	0,61	0 %	0,68	1,12
2020	0,59	0,86	0,65	0 %	0,69	1,00
2021	0,77	0,82	0,62	0 %	0,69	0,89

Table 5.5.4 Tusk in arctic waters (1, 2.a, 2.b). Stock status inferred from LBI for MSY. Green tick marks for MSY are provided because the $L_{mean}/L_{F=M}$ > 1 in each year. Stock size is unknown as this method only provides exploitation status.

Fishing pressure				
	2019	2020	2021	
MSY (F/F_{MSY})	✔	✔	✖	Fished unsustainably
Stock size				
	2019	2020	2021	
MSY $B_{trigger}$.(B/B_{MSY})	?	?	?	Unknown

5.5.9 References

Helle, K., M. Pennington, N-R. Hareide and I. Fossen. 2015. Selecting a subset of the commercial catch data for estimating catch per unit of effort series for Ling (*Molva molva* L.). Fisheries Research 165: 115–120.

Helle, K. and Pennington, M. 2021. The development of the Norwegian longline fleet's fishery for ling and tusk during the period 2000-2020. Working Document to the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP).21 pp

Pennington, M., and Strømme, T. (1998). Surveys as a research tool for managing dynamic stocks. Fisheries Research 37, 97–106.Rosenbaum, P.R.2002. Observational Studies (second ed.), Springer-Verlag, New York, NY (2002) (377 pp.)

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https://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=37488

5.5.10 Tables

Table 5.5.1 a. Tusk in subarea 1. Official 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
2017	1036	1					1037
2018	555	2					557
2019	944	1		1			946
2020	813	4					817
2021*	1073	9					1082

***Preliminary.**

Table 5.5.1 b. Tusk in Division 2.a. Official landings.

Year	Faroes	France	Ger-many	Green-land	Norway	E & W	Scot-land	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

Year	Faroes	France	Ger-many	Green-land	Norway	E & W	Scot-land	Russia	Ireland	Iceland	Total
2016	61	2	1	2	10332		1	57		3	10459
2017	14	4	2	3	6521		2	106		3	6655
2018	12	2	5	1	8651		1	63		731	9466
2019	13	3	3		10980			70		1	11070
2020	18	1	1	1	7964			92		2	8079
2021*	5	4			7564	3		98			7674

*Preliminary.

(1) Includes 2.b.

Table 5.5.1 c. Tusk in Division 2.b. Official 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

Year	Norway	E & W	Russia	Ireland	France	Total
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
2017	153		81			234
2018	427		37			464
2019	241		53			294
2020	200		26			226
2021*	408		63			471

Table 5.5.1 d. Tusk in subareas 1 and 2. Official landings by Subarea and 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

Year	1	2a	2b	All areas
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	10459	309	11660
2017	1037	6655	234	7926
2018	557	9466	464	10487
2019	946	11070	294	12310
2020	817	8079	226	9122
2021*	1082	7674	471	9227

***Preliminary.**

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

5.6.1 The fishery

Tusk is bycatch in the trawl, gillnet and longline fisheries in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and 12. Norway has traditionally landed the major proportion of the 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 1988–2022, 34% of the landings have been in Area 4, 48% in Division 5.b, and 16% in Area 6.a.

In Division 5.b, tusk was mainly fished by longliners (around 90% of the catch), and the rest of the catch of tusk was taken by large trawlers. The main fishing grounds for tusk are on the slope around the Faroe Plateau and on the Faroe Bank in areas deeper than approximately 200 m. The Norwegian longline fishery decreased from an average 15 days per vessel in 2019 to 8 days per vessel in 2022.

5.6.2 Landings trends

Landing statistics by nation in 1988–2022 are in Table 5.6.1 and are shown by year in Figure 5.6.1.

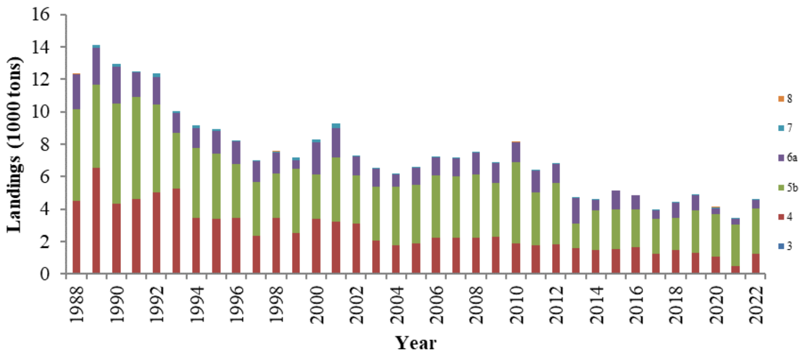
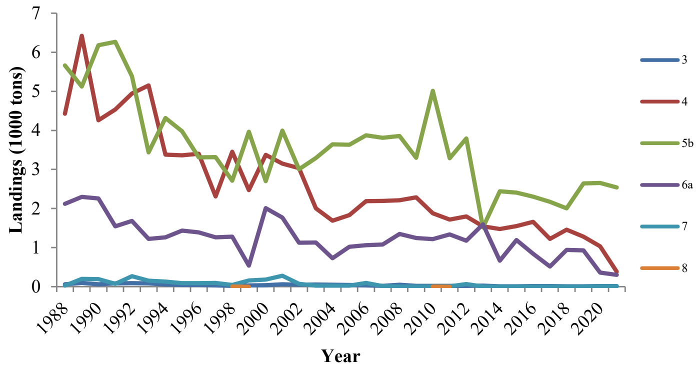


Figure 5.6.1. Landings of tusk per year for 1988–2022.

For all subareas/divisions, the catches were relatively stable from 2002 to 2012, afterwards the total catch declined and stabilized at about 4 500 tons. The total catch was 4550 tons in 2022 (Figures 5.6.1 and 5.6.2).



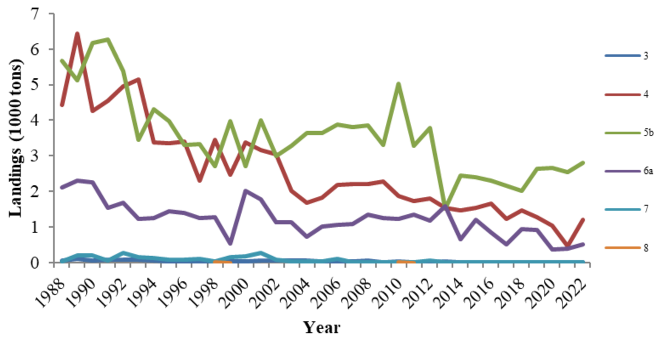


Figure 5.6.2. Landings of tusk by area for 1988–2022.

5.6.3 ICES Advice

Advice for 2022 and 2023: ICES advises that when the precautionary approach is applied, catches should be no more than 7821 tonnes in each of the years 2022 and 2023.

Advice based on the ICES rfb-rule

The assessment is based on ICES rfb-rule for data limited stocks for the first time this year, where life history traits, exploitation characteristics and other relevant parameters for data-limited stocks are considered (ICES 2021). The rfb-rule has the following form:

$$A_{y+1} = A_{y-1}\, r\; f\; b\; m$$

where A_{y+1} is the advised catch, A_{y-1} is last years advice, r corresponds to the trend in biomass index (as in the current ICES "2 over 3" rule), f is a proxy for the exploitation (mean catch length divided by an MSY reference length) and b a biomass safeguard (reducing the catch when biomass index drops below a trigger value).

The former advice when the ICES "2 over 3" rule was set to 7821 tonnes.

r is the ratio of the mean of the last two survey indices and the mean of the three preceding values or:

$$r = \frac{\sum_{i=y-2}^{y-1} I_1 \,/2}{\sum_{i=y-3}^{y-5} I_1 \,/3}$$

f is the length-ratio component where:

$$f = \frac{\overline{L}_{y-1}}{L_{F=M}}$$

where $\overline{L}$ is is the mean catch length above $L_{F=M}$. $L_{F=M}$ is calculated as:

$$L_{F=M} = 0.75L_c + 0.25L_\infty$$

where L_c is length at first capture and $L\infty$ is von Bertalanffy $L\infty$. Tusk in this stock has L_∞ of 77.9 cm

b is the biomass safeguard and is used to reduce catch advice when index falls below trigger,

$$b = min\left(1, I_y - 1/I_{trigger}\right)$$

where $I_{trigger}$ = $i_{loss\omega}$

m is a multiplier based on stock growth. K for tusk is < 0.17 and therefore m is 0.95.

5.6.4 Management

There are a licensing scheme and effort limitation in Division 5.b. The minimum landing length for tusk in Division 5.b is 40 cm. Norway has a bilateral quota with Faroe Islands in 5.b, which is 1500 t tusk for 2023 (sínámillum-fiskiveiðiavtalan-millum-føroyar-og-noreg-fyri-2023.pdf).

In 2023, the Faroese Party will allow 5 Russian vessels to undertake experimental fishing in the Faroese Fishing Zone at depths deeper than 700 meters, provided that a Russian scientific observer is onboard. No more than 3 vessels can simultaneously be operating. 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, if catches in this area do not exceed 500 tonnes of deep-sea species (fiskiveiðiavtala-millum-føroyar-og-russland-fyri-2023.pdf).

There is an agreement between the United Kingdom of Great Britain and Northern Ireland and Faroe Islands for 2023 (sínámillum-fiskiveiðiavtala-millum-føroyar-og-russland-fyri-2023.pdf).

In the North Sea (ICES 4), Norwegian vessels can fish up to 30,000 tons of demersal fish in the UK zone. The quota for the EU in the Norwegian zone (Subarea 4) is set at 75 t, but only three vessels can be operating simultaneously Norwegian vessels have a TAC of 650 tons tusk in ICES 6

EU TACs for 2015-2022 are given in table 5.6.2a and 5.6.2b.

Table 5.6.2.a. TACs tusk in subareas 4 and 7–9, and in divisions 3.a, 5.b, 6.a (Before Brexit). All weights are in tonnes. (2015-2023)

Year	TAC EU Subarea 3	TAC EU Subarea 4 (EU waters)	TAC EU Subarea 4 (Norwegian waters)	TAC EU, Subareas 5,6, 7	TAC Norway2.a and 5.b,4, 6 and 7
2015	29	235	170	937	2923
2016	29	235	170	937	2923
2017	29	235	170	937	2923
2018	31	251	170	1207	2923
2019	31	251	170	1207	2923
2020	31	251	170	1207	2923

Year	TAC EU Subarea 3	TAC EU Subarea 4 (EU waters)	TAC EU Subarea 4 (Norwegian waters)	TAC EU, Subareas 5,6, 7	TAC Norway2.a and 5.b,4, 6 and 7
2021		251	-	4294	-

Table 5.6.2.b. TACs tusk in subareas 4 and 7–9, and in divisions 3.a, 5.b, 6.a. All weights are in tonnes. After Brexit.

Year	TAC EU Sub-area 3	TAC EU Subarea 4 (EU waters)	TAC UK Subarea 4 (UK waters)	TAC EU Subarea 4 (Norwegian waters)	TAC EU, Subareas, 5, 6 ,7	TAC UK Subareas 5, 6 and 7	TAC Norway Subarea 6	TAC UK waters to Norway Subarea 4 (UK waters)
2021	-	149	102	-	3037	1257	-	-
2022	-	136	92	50 (TAC Not relevant)	3029	1265	650	30 000*
2023		136	92		3022	1272	380	30 000*

*** Norwegian vessels can fish up to 30,000 tons of demersal fish in the UK zone Subarea 4**

.NEAFC recommended that in 2009 the effort in areas beyond national jurisdictions should not exceed 65% of the highest level of effort for deep-water fishing used in the past.

5.6.5 Data available

5.6.5.1 Landings and discards

The total landings and discards of tusk were available for all the relevant fleets. The Norwegian and Faroese fleet are not allowed to discard tusk, and incentives for illegal discarding are believed to be low. The landing statistics and logbooks are therefore regarded as being adequate for assessment purposes.

Discards by countries for the years 2013–2022 (Table 5.6.3), and by area and country for 2020 (Table 5.6.4).

Table 5.6.3 Total discards of tusk by country for 2013 to 2022.

	Spain	Ireland	France	UK (Scotland)	Denmark	Germany	Total landings	Total discards	Total catches	% discards
2013	40	12					4673	52	4725	1.1
2014	0	0					4585	0	4585	0.0
2015			6	12			5155	18	5173	0.3
2016			1	152			4820	153	4973	3.1
2017			8	130	5		3916	143	4059	3.5
2018	1	6	4	80		6	4411	96	4507	2.1
2019			5	63		5	4862	73	4931	1.5

	Spain	Ireland	France	UK (Scotland)	Denmark	Germany	Total landings	Total discards	Total catches	% discards
2020		2		67			4065	69	4134	1.7
2021	1		1	71		3	3408	76	3484	2.2
2022	1			51	1	1	4550	54	4604	1.2

Table 5.6.4. Discards of tusk in 2022 by area on country.

Area	Country	Discards
27.4	UK(Scotland)	48
27.4	Germany	1
27.4.a	Denmark	1
27.6.a	UK(Scotland)	3
27.6.a	Spain	1
Total		**54**

5.6.5.2 Length compositions

Norwegian reference fleet data

Figure 5.6.3a and b shows the estimated length distributions of tusk in divisions 4.b, 5.b and 6.a based on data provided by the Norwegian reference fleet for 2001–2022, and Figure 5.6.4 shows the estimated length distributions of the catch of tusk by Norwegian longliners, combined, for divisions 4.a, 5.b and 6.a.

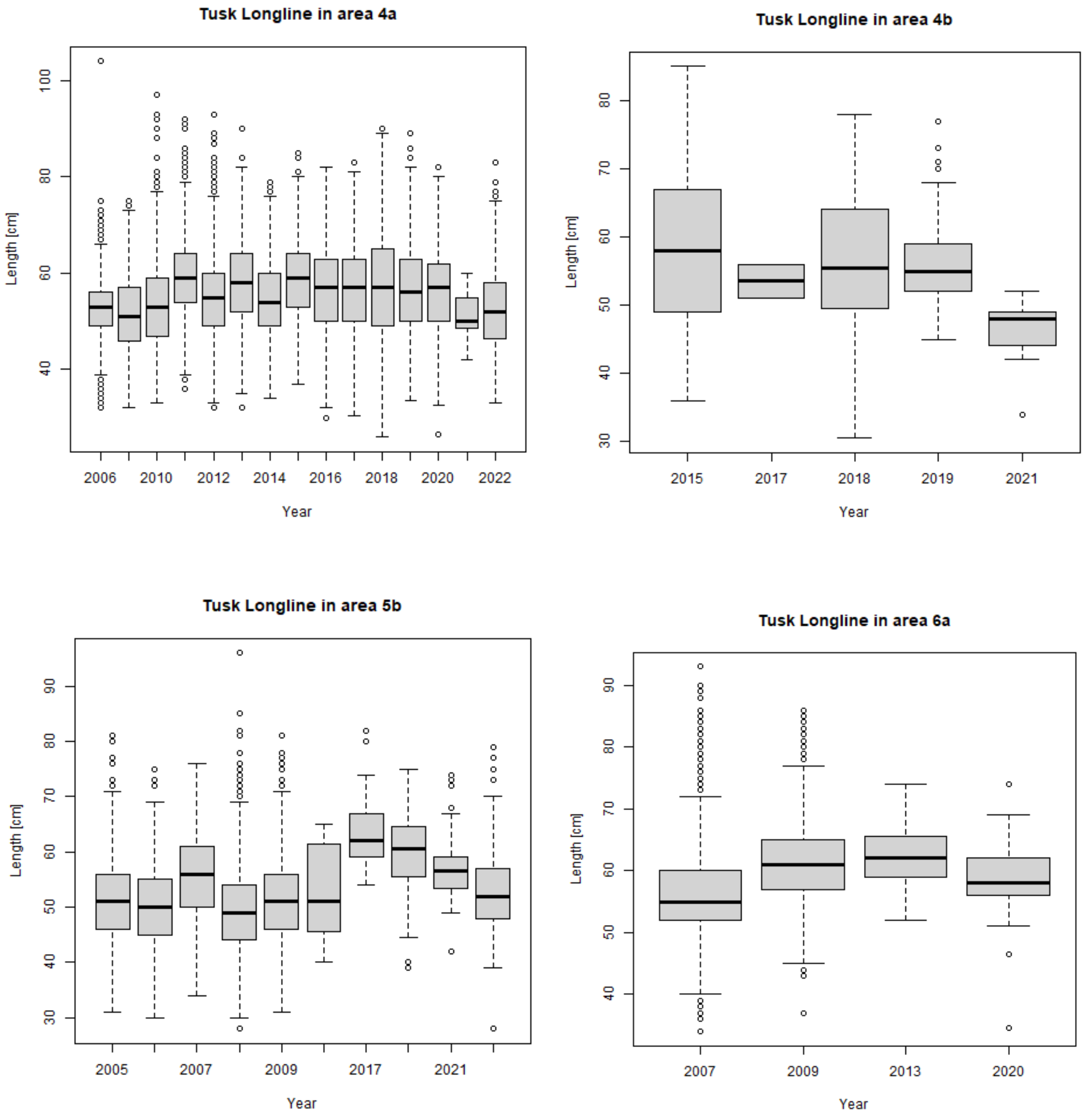


Figure 5.6.3a. Length distributions of tusk in Areas 4.a, 4.b, 5.b and 6.a for 2001–2022, based on longline data from the Norwegian reference fleet.

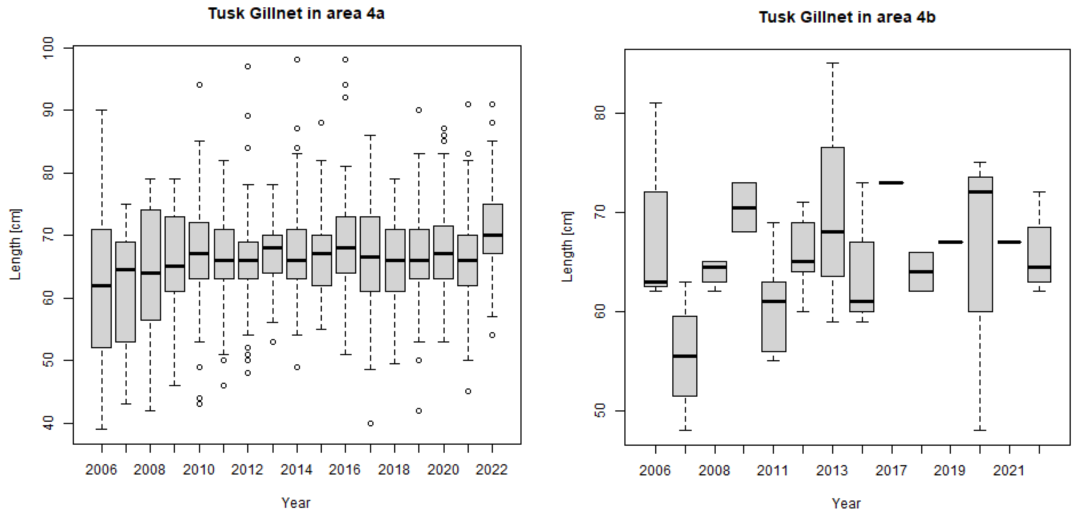


Figure 5.6.3b. Length distributions of tusk in Areas 4.a, 4.b, 5.b and 6.a for 2001–2022, based on gillnet data from the Norwegian reference fleet.

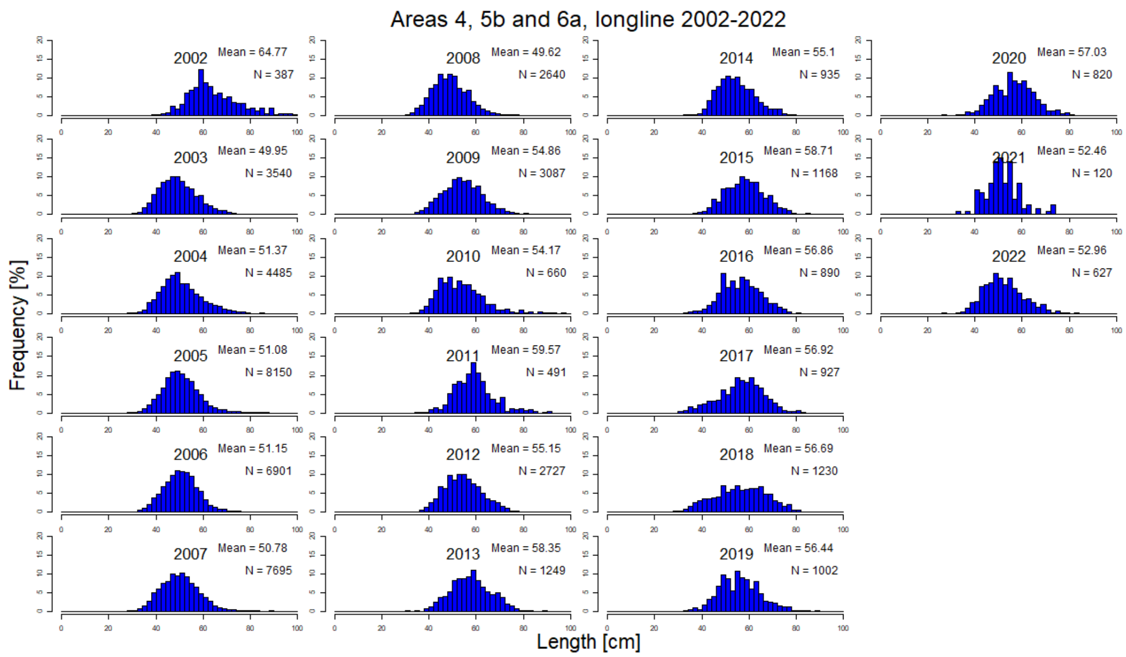


Figure 5.6.4. The estimated length distributions of the catch of tusk by Norwegian longliners, combined, for Areas 4.a, 5.b and 6.a.

Faroese length data

In Division 5.b is the length distributions of tusk based on the commercial catches by Faroese longliners since 1994 are in Figure 5.6.5.

The length data are from the annual spring- and summer groundfish surveys conducted on the Faroe Plateau are presented in Figures 5.6.6 and 5.6.7. In WGDEEP Report 2020 length distributions of tusk caught in other surveys in Division 5.b such as deep water survey (2014- present), Greenland halibut survey (1995- present), redfish trawl survey (2003-2011) and blue ling trawl survey (2000-2003) was presented.

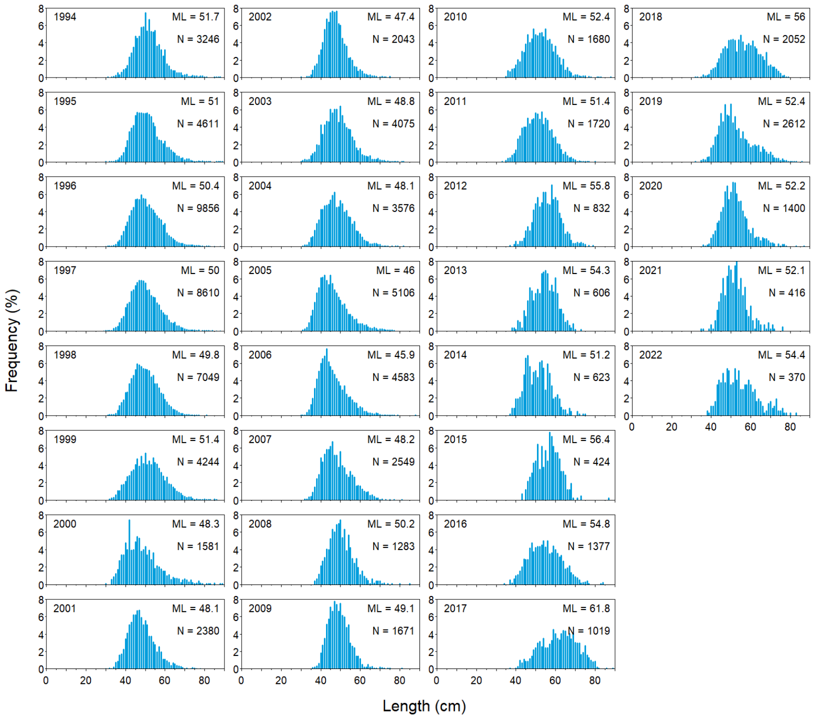


Figure 5.6.5. Length distributions of the catch of tusk by Faroese longliners (>100 BRT) in Division 5.b. ML- mean length in cm, N-number of length measures.

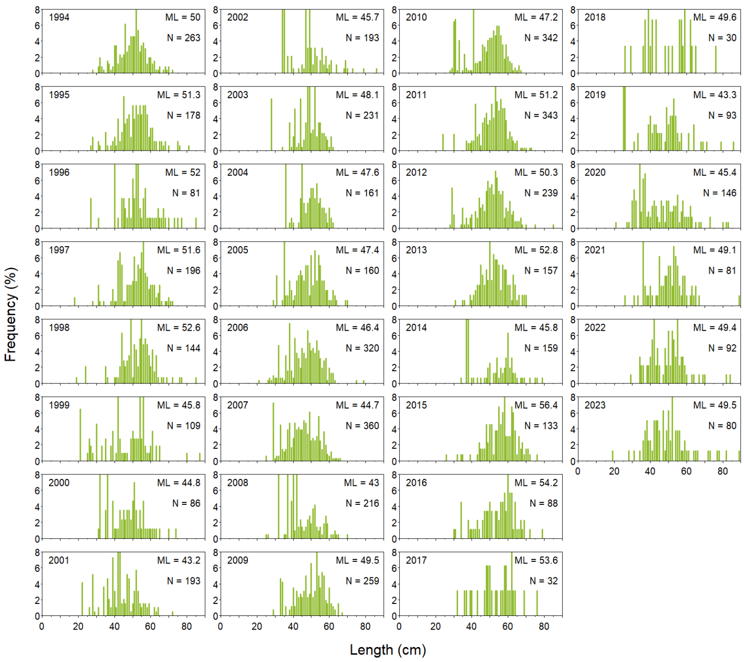


Figure 5.6.6. Length distributions of tusk in Division 5.b based on data from the Faroese spring groundfish surveys. ML- mean length, N- number of calculated length measures. Small tusk are often sampled from a subsample of the total catch, so the values are multiplied to total catch.

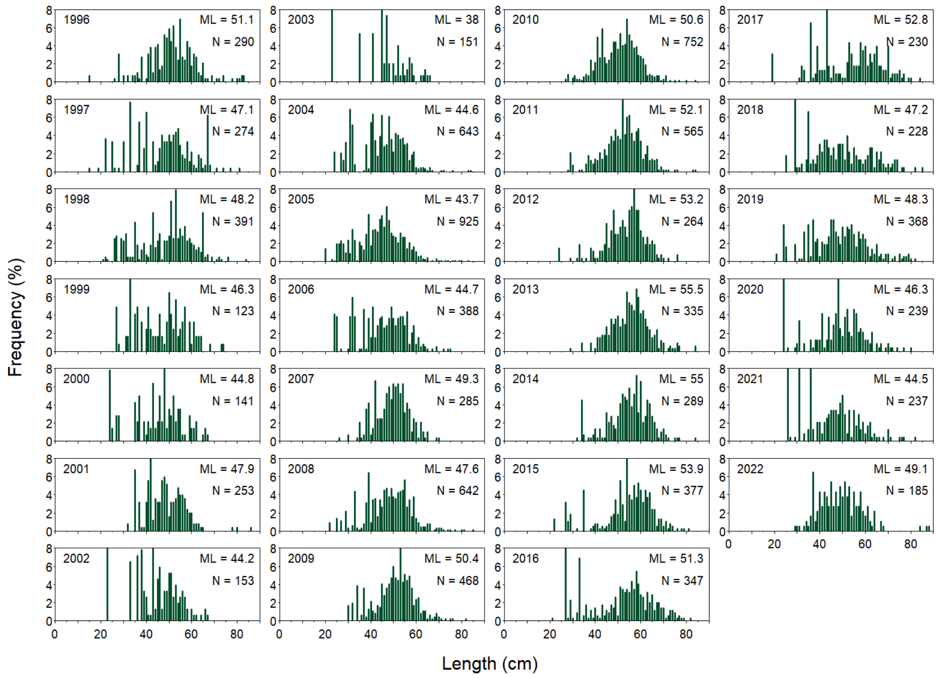


Figure 5.6.7. Length distributions of tusk in Division 5.b based on data from the Faroese summer groundfish surveys. ML- mean length, N- number of calculated length measures. Small tusk are often sampled from a subsample of the total catch, so the values are multiplied to total catch.

5.6.5.3 Age and growth compositions

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

5.6.5.4 Weight-at-age

No new data are available.

5.6.5.5 Maturity and natural mortality

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

5.6.5.6 Catch, effort and research vessel data

Commercial cpue series

Norway started in 2003 to collect and enter data from official logbooks into an electronic database, and data are now available for 2000–2022. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 t in every 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 the switch from paper to electronic logbooks. Since 2011, data quality has improved considerably and data from the entire fleet were available.

The cpue data for tusk 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 cpue series was based on sets where tusk was greater than 30% of the total catch.

Fisheries independent cpue series

Estimates of the cpue series (kg/hour) for tusk are available from two annual Faroese groundfish trawl surveys on the Faroe Plateau that were 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 distributional area (Ofstad, WD WGDEEP 2017). Information on the surveys and standardization of the data are described in the stock annex.

5.6.6 Data analyses

Length distributions

Norwegian length distributions, based on data provided by the longline reference fleet from divisions 4.a, 5.b and 6.a, have varied slightly with no obvious trends (Figures 5.6.3 and 5.6.4). The average length of tusk caught by Norwegian longliners in the combined Areas 4.a, 5.b and 6.a was 56.4 cm in 2019 and 57 cm in 2020.

Faroese length distributions, based on data from Faroese longliners fishing in Division 5.b, varied mainly between 48 and 56 cm (average 51 cm), and there was no downward trend. In 2022, the mean length was 54.4 cm and most of the landings were between 40 and 60 cm (Figure 5.6.5).

The mean length of tusk sampled in the Faroese spring and summer groundfish surveys varied between 43 and 55 cm (Figures 5.6.6 and 5.6.7). The length distributions are noisy, and the reason is that small tusk are often sampled in a subsample of the total catch, so the values are multiplied to total catch. Few tusks smaller than 30 cm are reported to be caught in these surveys.

Cpue trends

4.a

Two cpue series for tusk in Division 4.a based: Norwegian longline data were on all the catches and data when tusk appeared to be the target species. The series based on all the catches indicates at first a stable cpue and then a slightly decreasing trend for the last four years. The series based on the targeted fishery shows a clear and positive upward trend from 2002 until 2013, after 2013 there was a declining trend, this trend is especially clear for the targeted fishery (Figure 5.6.8). Due to late agreement on TAC in area 4a the CPUE for 2021 is based on a low number of fishing days and may therefore not show the correct trend.

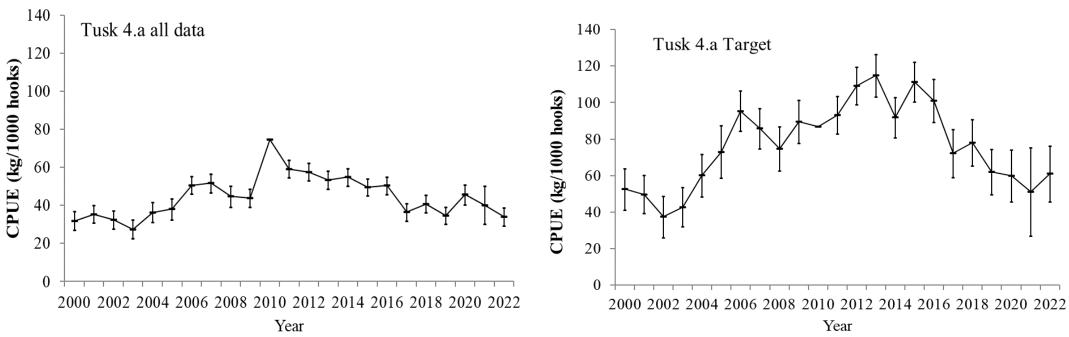
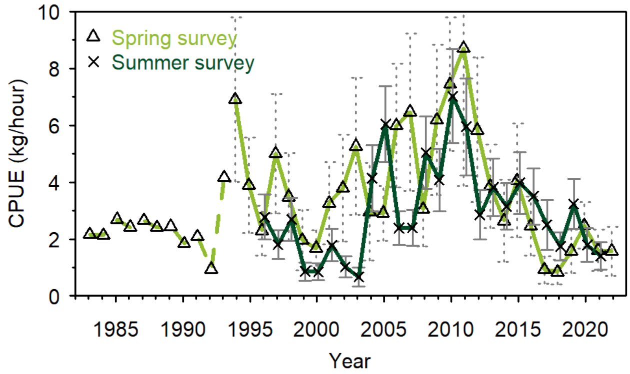


Figure 5.6.8. Tusk cpue series in 4.a for 2000–2022 based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

5.b

The standardized cpue from the annual Faroese groundfish surveys in spring (1994-present) and summer (1996-present) are in Figures 5.6.9.a and 5.6.9.b. In addition, a CPUE series for the spring survey, 1983-1993, based on non-stratified data, are in Figure 5.6.9a. The cpue series for the annual groundfish surveys show a a CPUE of around 2kg/hour in the last years. These surveys are only conducted in waters less than 530 m, so these estimates are not covering the whole distribution area of tusk.

Abundance indices for tusk < 40 cm, generated by the Faroese groundfish survey on the Plateau, are lower than the mean level in the last years (Figure 5.6.10).



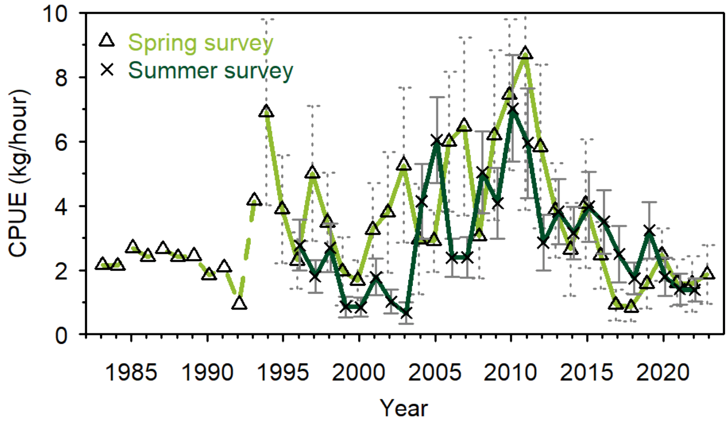


Figure 5.6.9a. Tusk 5.b. Standardized cpue from the annual trawl groundfish surveys. The spring survey data from 1983–1993 are not stratified.

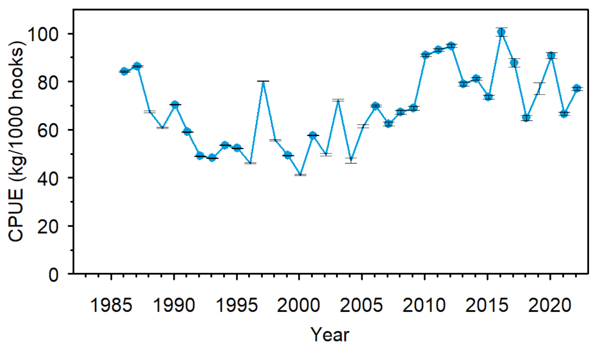


Figure 5.6.9b. Tusk cpue series in 5.b 1986–2022 for Faroese longliners based on tusk >30% of the catch. The bars denote the 95% confidence intervals.

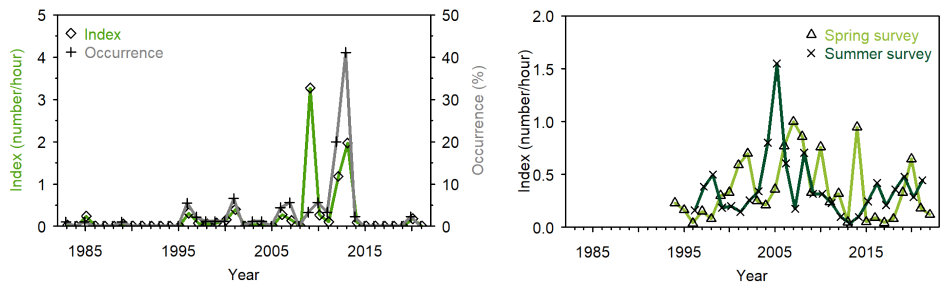


Figure 5.6.10. Tusk 5.b. Abundance index for tusk (2–3 cm in length in number/hour) on the Faroe Plateau based on the 0-group survey (left figure) and abundance index for tusk <40 cm from the annual spring and summer trawl survey on the Faroe Plateau (right figure).

The cpue series based on the Norwegian longline data shows a stable trend from 2000 to 2008, increased until 2012, decreased until 2017, a relatively large increase in 2018 and then decreased in 2019 and 2022(Figure 5.6.11).

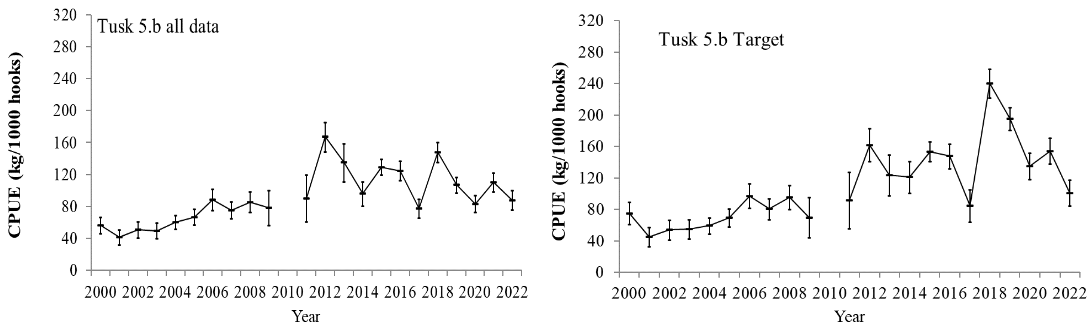


Figure 5.6.11. Tusk cpue series in 5.b for 2000–2022 for the Norwegian longliners based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

6.a

In Division 6.a, a cpue series based on the Norwegian longline data shows an increase in cpue from 2004 to 2008, afterwards it has remained at a high, but slightly increasing level when all data are used (Figure 5.6.12).

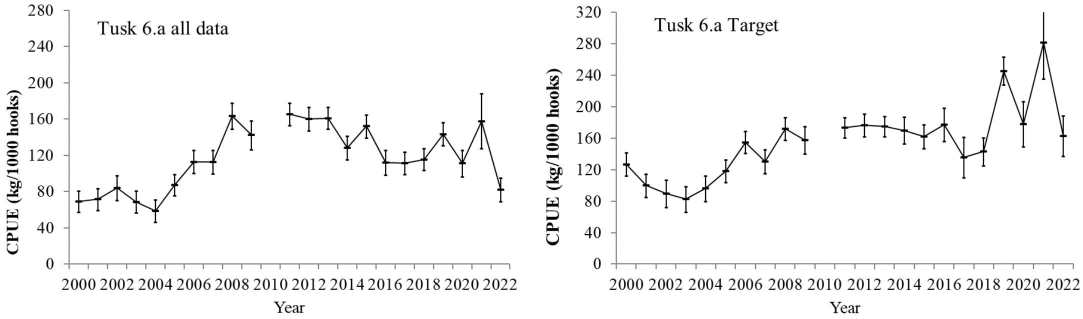


Figure 5.6.12. Two cpue series for tusk in area 6.a from 2000–2022 based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

Combined cpue series for “Tusk areas 4, 5b and 6a”

A cpue series for merging all areas, data from the Norwegian longline fleet was combined with divisions 4.a, 4.b, 5.b and 6.a.

Two cpue series were estimated: based on using all available data and when tusk was targeted (daily catches when tusk made up more than 30% of the total catch, Figure 5.6.13).

The combined Norwegian longline cpue series shows an increasing trend from 2000 to 2010, after 2010 cpue was at a high and stable level (Figure 5.6.13). The CPUE from 2021 is very uncertain due to very limited catch data.

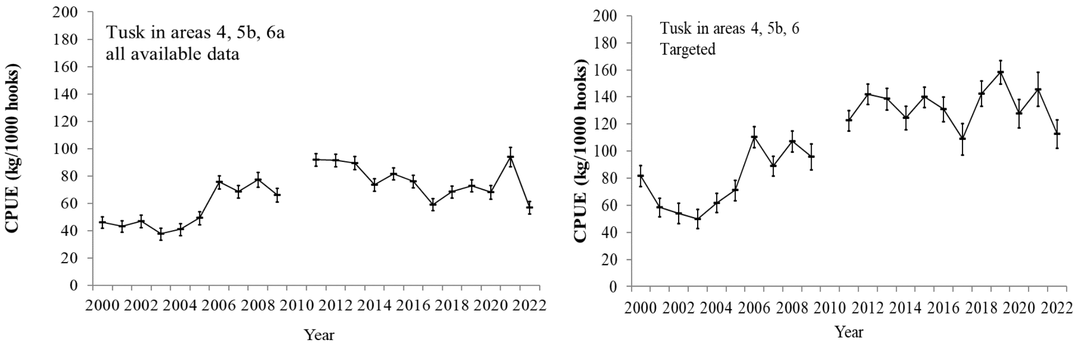


Figure 5.6.13. A combined cpue series for all “other tusk” areas for 2000–2022 based on data from the Norwegian longline fleet when tusk was targeted (>30% of total catch). The bars denote the 95% confidence intervals.

5.6.6.1 Biological reference points

See Section 5.6.9.

5.6.7 Comments on the assessment

The tusk stocks in Areas 3.a, 4, 5b, 6a, 7, 8, 9, 10, 12, 14 are usually best covered by the Norwegian longline fleet and WGDEEP decided that a combined cpue series should be made to give advice for the entire area, and that the data from the targeted fishery should be used. In 2021, there was no agreement on quota sharing between Norway, the UK, and the EU and consequently, there was no fishing by Norwegian vessels in Subarea 6.a. and the UK part of Subarea 4, and hence not enough data calculate a valid CPUE for the entire area.

5.6.8 Management considerations

Tusk landings from all subareas have been relatively stable since 2013. A cpue series, based on the Norwegian longline fishery when all areas are combined, shows a stable or positive trend since 2003. The combined Norwegian longline cpue series shows an increasing trend from 2000 to 2010, after 2010 the cpue series based on targeted catches shows a high and stable level. The two CPUE series show very different trends, and the series will be recalculated. For more information, see section 5.6.9.

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 actual population and/or how accurate the measures of uncertainty associated with the series are (see, for example, Rosenbaum, 2002). Consequently, one must usually hope 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.

5.6.9 The application of the rfb-rule

This is the first year the rfb-rule is applied for tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12. Previously the "3 over 2"-rule has been used. The biomass index is based on the CPUE calculated from logbook data from the Norwegian longline fleet 2000-2022. The length data is from the Norwegian longline reference fleet. To get reliable values for K and Linf has been challenging. There is an ongoing work where these issues are being addressed and linf is set to 77.9, but in lieu of an estimate for k, the estimate from COSEWIC. (2012), where K=0.17 has been used.

Rfb-rule:

- r is calculated as the average of last two years values, divided by average of three preceding years values which results in r=0.90 (Figure 5.6.14, Table xxx)

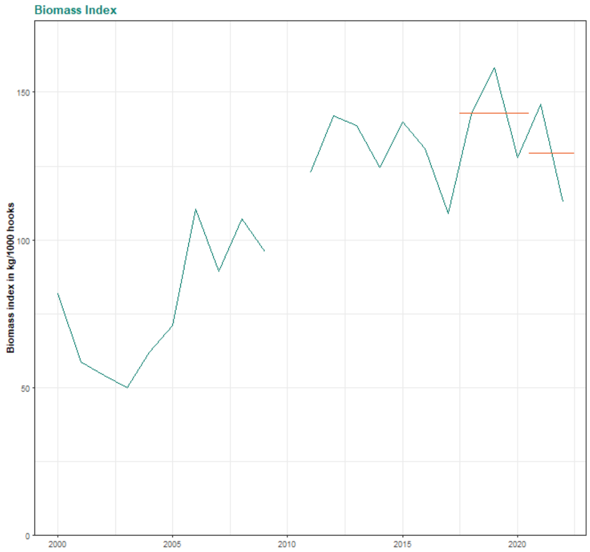


Figure 5.6.14: Tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12. Biomass index since 2000. The red lines show the average of last two years values and the three preceding years.

- *f* is the length-ratio component. The mean length of last years´ catch was 54 cm and the target reference length (L*c* or length at first capture * 0.75 + length ∞ * 0.25) is **52** (figure 5.6.15).

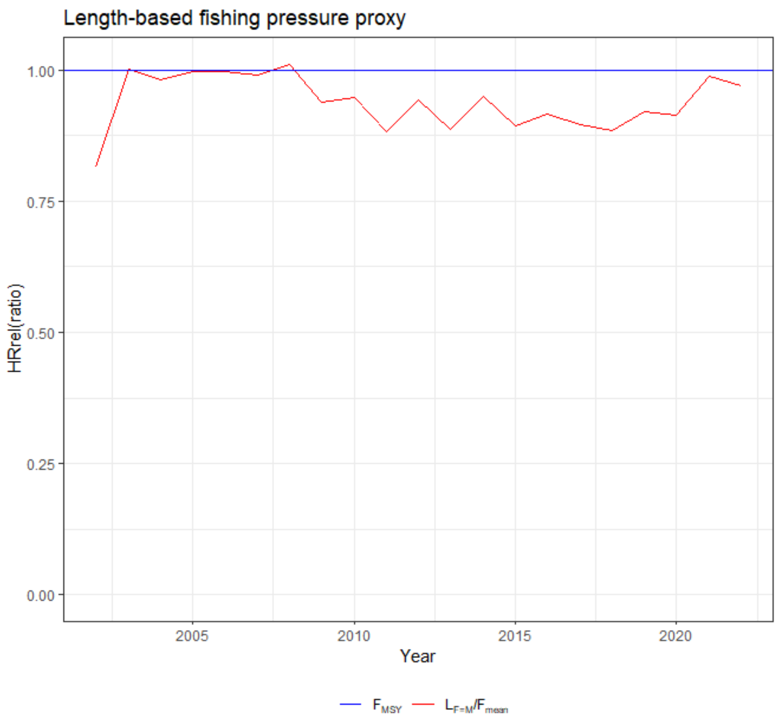


Figure 5.6.15: Tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12. Index ratio of the average length relative to the expected length when fishing mortality equals natural mortality ($L_{mean}/L_{F=M}$) for the Norwegian longline fleet from the length-based indicator method used for the evaluation of the exploitation status. The exploitation status is below the $F_{MSY\ proxy}$ when the index ratio value is higher than 1.

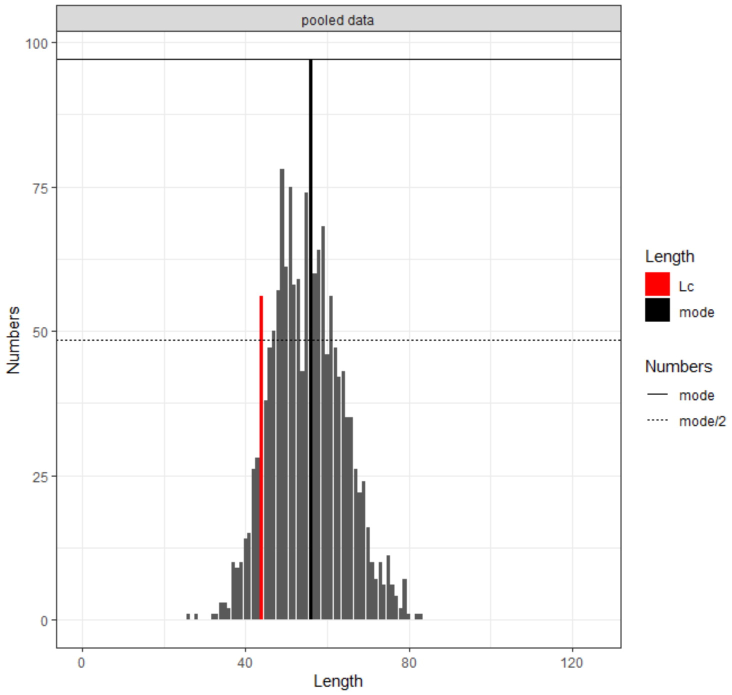


Figure 5.6.16: Tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12. Length frequency distribution from catches. Black line is the length of modal abundance, the red line is the length at first capture.

- *b* is the biomass safeguard and is used to reduce catch advice when index falls below trigger. The lowest index or the I_{loss} for tusk is 50 and was recorded in the year 2003. $I_{trigger}$ is I_{loss} *1.4 or 70 (Figure 5.6.17). Biomass index this year is above $I_{trigger}$ and *b* is therefore 1.

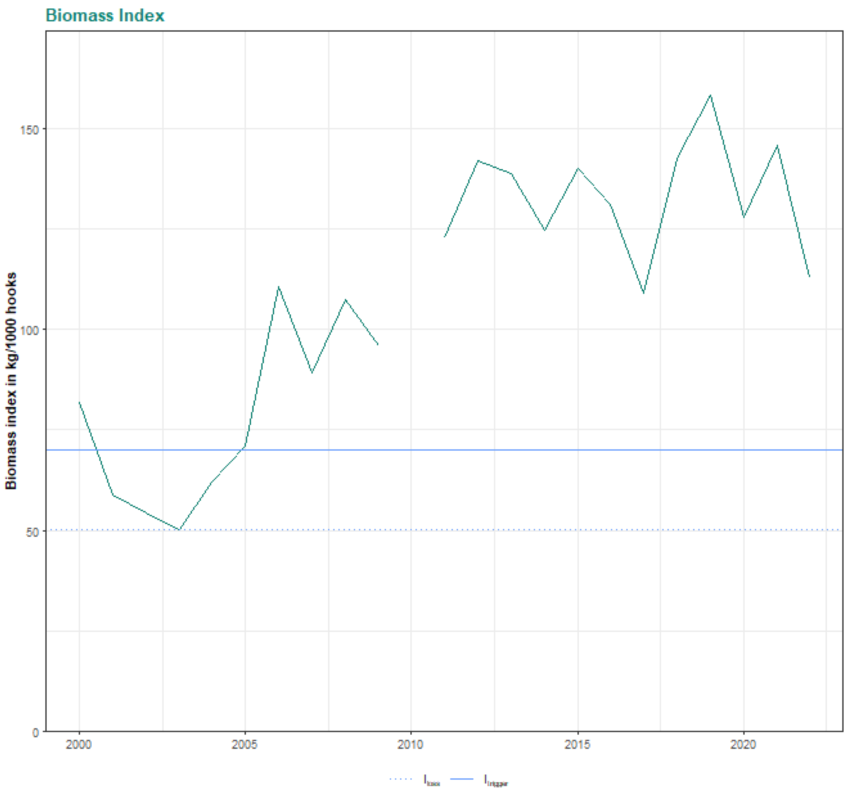


Figure 5.6.17: Tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12.. Biomass index values since 2000. The blue line is the $I_{trigger}$ and the doted is the lowest observed value (I_{loss}).

- *m* is the tuning parameter and for slow growing species (with von Bertanlaffy K<0.2), *m* equals to 0.95.

Table 5.6.5 Tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12. The basis for the catch scenarios^. Catches are in tonnes.*

Previous catch advice A_y		7821 tonnes
Stock biomass trend		
Index A (2021, 2022)		129.28
Index B (2018, 2019, 2020)		142.96
r: stock biomass trend (index ratio A/B)		0.90
Fishing pressure proxy		
Mean catch length ($L_{mean} = L_{2022}$)		54cm
MSY proxy length ($L_{F=M}$)		52 cm
f: fishing pressure proxy relative to MSY proxy ($L_{2022}/L_{F=M}$)		1.03
Biomass safeguard		
Last index value (I_{2022})		113
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)		70
b: index relative to trigger value, min{$I_{2022}/I_{trigger}$, 1}		1
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.95
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Not applied	
Discard rate		0 %
Catch advice for 2024 and 25**		6924 tonnes
% advice change^		-11.5 %

^ The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table.
** Formula [A_y × r × f × b × m]
^ Advice value for 2024/2025 relative to the advice value for 2023 (5 tonnes).

5.6.10 Application of MSY proxy reference points

Summary of SPiCT from benchmark meeting; tusk in Areas 3.a, 4, 5b, 6a, 7, 8, 9, 10, 12, 14

It was not possible for the group to recommend or approve a SPiCT assessment for this stock. The reason for this was primarily the construction of the CPUE index; the CPUE index itself was not disregarded but it was not regarded suitable for the SPiCT model. Two points were pointed out as problematic; the targeting effect and technological creep. Especially handling the targeting effect; the spatial-time interactions must be solved before data can be used by SPiCT.

The recommendations from the benchmark was to enhance the standardization of the CPUE and either try an integrated model or try SPiCT again with the new CPUE. The stock should continue to be assessed as category 3 stock.

The assessments on SPiCT could not be approved according to the uncertainty in the CPUE index and due to the observed inconsistencies described above. Link to the benchmark report: https://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=37488

Results for the LBI, WGDEEP 2023

<u>Information and data</u>

The input parameters and the catch length composition for the period 2002-2022 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.

Table 5.6.6. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Input parameters for LBI.

Data type	Years/Value	Source	Notes
Length frequency distribution	2002–2018	Faroese long-liners fishing in Division 5.b	Data combined from both sources Lengths grouped into 2 cm bins
	2002-2022	Norwegian long-liners fishing in divisions 4.a, 4.b, 5.b, 6.a	
Length-weight relationship	0.0161* length $^{2.9101}$	Norwegian long-liners (Reference fleet) and survey data.	combined sexes
L_{MAT}	51 cm	Faroese survey data	
L_{inf}	77.9 cm (L_{max})	Norwegian long-liners (Reference fleet)	

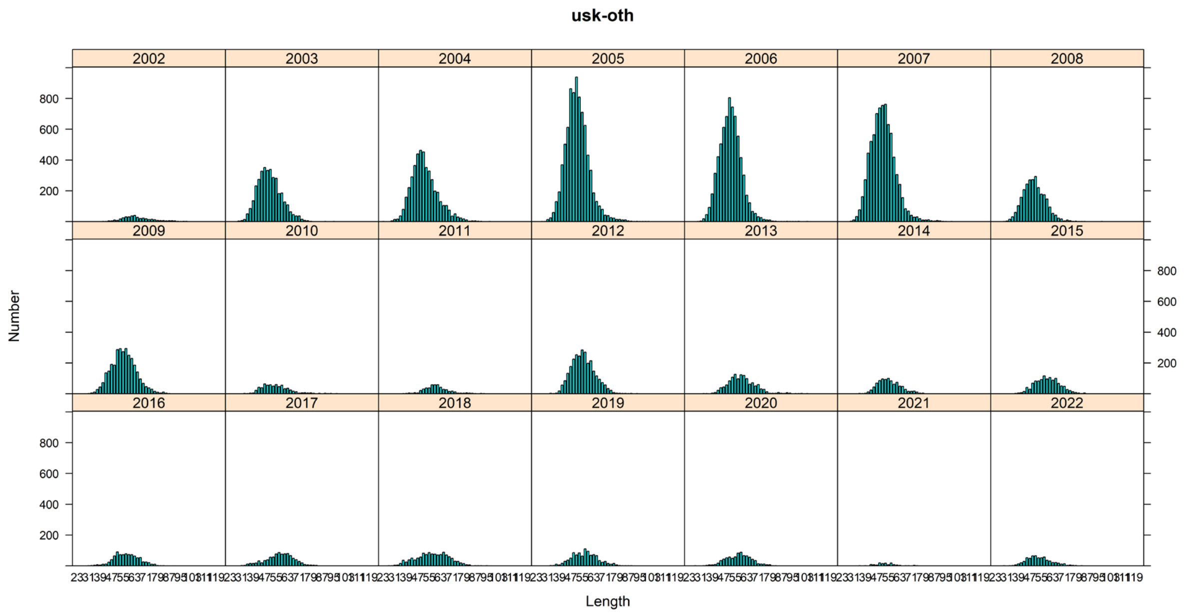


Figure 5.6.18. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Catch length distributions (2 cm bins) have not been raised to total catch for the period 2002–2022 (combined sexes).

<u>Outputs</u>

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 Figure 5.6.15.

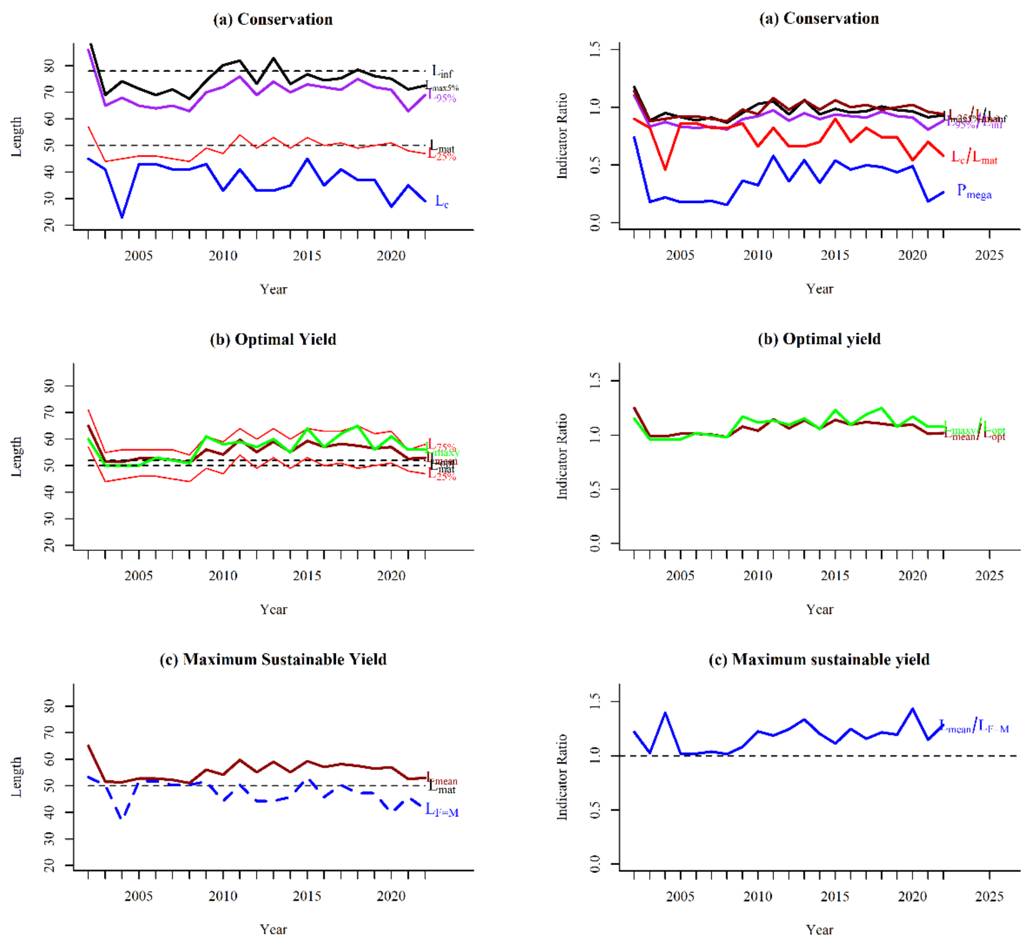


Figure 5.6.19 Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Screening of length indicators ratios for sexes combined under three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

Analysis of results

The conservation model for immature tusk shows that both L_c/L_{mat} and $L_{25\%}/L_{mat}$ is around or above 1 (Figure 5.6.19). In 2020-2022, the ratios were between 0.94 and 1.02 (Table 5.6.7). 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 0.9 for the whole period (Figure 5.6.19), and between 0.57 and 0.60 during the period 2020-2022 (Table 5.6.7), which is above the baseline, 0.8.

The MSY indicator, $L_{mean}/L_{F=M}$, was more than 1 for all three years (Figure 5.6.7), which indicates that tusk in other areas were fished sustainably been fished sustainably.

Table 5.6.7. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). The results based on 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**
2020	0,54	1,02	0,96	49 %	1,10	1,43
2021	0,70	0,96	0,91	18 %	1,01	1,15
2022	0,58	0,94	0,93	26 %	1,02	1,28

Conclusions

The overall perception of the tusk stock in these areas during the period 2020–2022, based on the LBI results, is that tusk seems to have been fished sustainably during the last year (Table 5.6.7.). However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

Table 5.6.8. 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 ($L_{mean}/L_{F=M}$). Stock size is unknown as this method only provides the exploitation status.

	Fishing pressure			
	2020	2021	2022	
MSY (F/F_{MSY})	✓	✓	✓	Fished sustainably
	Stock size			
	2020	2021	2022	
MSY $B_{trigger}$ (B/B_{MSY})	?	?	?	Unknown

Table 5.6.8. Outcomes from the LBI, based on data from the longline fishery provided by the Norwegian reference fleet.

Year	2020	2021	2022
L75	63	56	58
L25	51	48	47
Lmed	57	52	52
L90	68	60	65
L95	71	63	69
Lmean	57.01	52.57	53.00
Lc	27	35	29
LFeM	39.75	45.75	41.25
Lmaxy	61	56	56
Lmat	50	50	50
Lopt	52	52	52
Linf	78	78	78
Lmax5%	75.12	71.17	72.60
Lmean/LFeM	1.43	1.15	1.28
Lc/Lmat	0.54	0.7	0.58
L25/Lmat	1.02	0.96	0.94
Lmean/Lmat	1.14	1.05	1.06
Lmean/Lopt	1.10	1.01	1.02
L95/Linf	0.91	0.81	0.88
Lmaxy/Lopt	1.17	1.08	1.08
Lmax5%/Linf	0.96	0.91	0.93
Pmega	0.49	0.18	0.26
Pmegaref	0.3	0.3	0.3

5.6.11 References

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https://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=37488

5.6.12 Tables

Table 5.6.1. 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

Year	Denmark	Norway	Sweden	Total
2014	1	7	1	9
2015	1	7	1	9
2016	1	12	1	14
2017	1	8	1	10
2018	2	5	1	8
2019	1	7	0	8
2020	1	12	0	13
2021	2	12		14
2022*	1	16		17

*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

Year	Denmark	Faroes	France	Germany	Norway	Sweden[(1)]	E & W	N.I.	Scotland	Ireland	Total
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
2017	37		5	2	1121				41		1206
2018	37		6	1	1341	1			53		1439
2019	46		9	2	1139	1	4		46		1247
2020	46		8		898	5	2		65		1024
2021	26		20		231	4	7		162		450
2022*	22	1	33	2	1069	8	5		73		1212

(1) Includes 4.b 1988–1993.

***Preliminary.**

Table 5.6.1. (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

Year	Denmark	France	Norway	Germany	E & W	Scotland	Ireland	Sweden	Total
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
2017	1		16					1	18
2018	1		15	1					17
2019	1		31	1					33
2020	1		8						9
2021	1		9					1	11
2022			2					1	3

(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

Year	Denmark	Faroes[(4)]	France	Germany	Norway	E & W	Scotland [(1)]	Russia	Total
2015		1338	26		717				2081
2016		1494	17		747		3		2261
2017		1472	18		544		1		2035
2018		1119	14		849		1		1983
2019		1110	13		835		2		1960
2020		1302	18		1139		3		2462
2021		1157	14		830				2001
2022		1679	9		706		7		2401

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 5.6.1. (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

Year	Faroe	Norway	E & W	Scotland (1)	France	Total
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
2017		135				135
2018		21				21
2019	71	611			2	684
2020	161	30				191
2021	235	307				542
2022*	286	113				399

(1)Includes 5.b1.

(2)See 5.b1.

(3)Included in 5.b1.

*Preliminary.

6 Greater silver smelt *(Argentine silus)*

6.1 Stock description and management units

At the WGDEEP 2014, it was suggested that unit arg-oth should be further split into advisory units as fishing grounds are sufficiently isolated (WD10, WGDEEP2014, Figure 6.1.1). This change was implemented at the WGDEEP meeting in 2015. Greater silver smelt is now divided into four management units by ICES areas;

- aru.27.123a4 in ICES areas 1, 2, 3a and 4,
- aru.27.5a14 in ICES areas 5a and 14,
- aru.27.5b6a in ICES areas 5b and 6a,
- aru.27.6b7–1012 in ICES areas 6b, 7-10 and 12

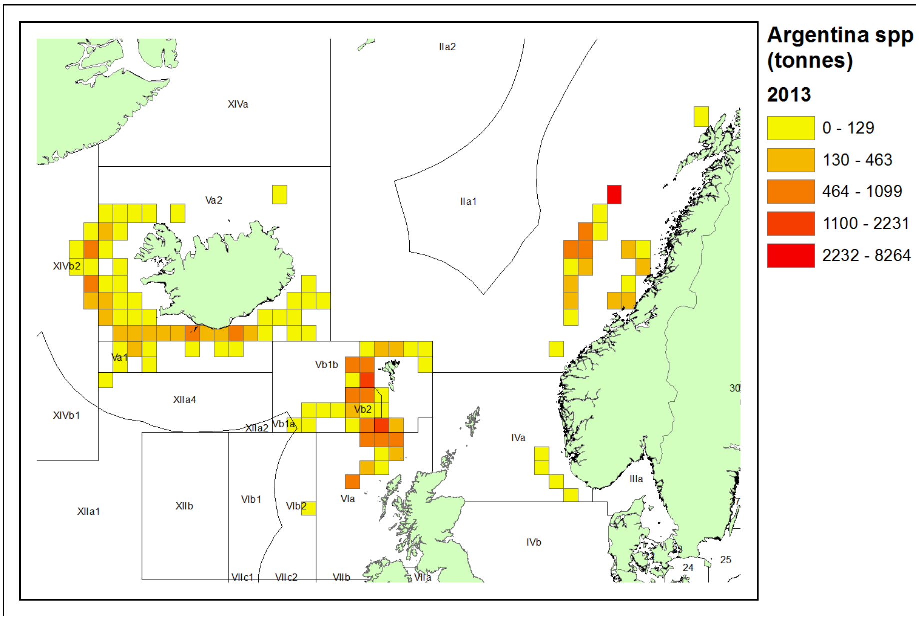

Figure 6.1.1. Catches of greater silver smelt by Iceland, Norway, Faroes and the Netherlands in 2013. Some catches of *A. sphyraena* and *Argentina* unidentified may be included in the Norwegian and Dutch landings.

Stock structure was a subject at the WKGSS 2020 benchmark for greater silver smelt (ICES 2021), where three of these stock units were benchmarked for the first time. The stock in ICES areas 6b, 7-10 and 12 (aru.27.6b7–1012) has not been benchmarked.

Preliminary results from genetic studies presented to the benchmark were not conclusive regarding stock structure (Seljestad et al. 2020, ICES WKGSS WD4). Further genetic investigation should be encouraged to underpin biological segregation of stock units.

6.2 Greater silver smelt (*Argentina silus*) in 1, 2, 3.a and 4

6.2.1 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. Catches in this area increased substantially after 2012 with peak in 2018. While the years 2019-2021 show a declining trend, the catches from this area has increased again in the past year (Figure 6.2.1).

6.2.2 Landing trends

International landings are summarised in Tables 6.2.1–6.2.4, and Figures 6.2.1 and 6.2.2. The variation through the time-series prior to 2014 primarily reflects the developments in the Norwegian target fisheries in Subarea 2. The landings from Division 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. Since 2014 the bycatch in the North Sea (Subarea 4) has been increasing gradually to substantial levels, and in 2020 amounting close to half of the total catch. In the last two years however, the bycatch has decreased and is now less than 40 percent of the total catch.

From peak levels of 10000 t to 11000 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 2001, when landings were 14369 t, the landings remained relatively stable at 6–8000 t until 2003. In 2004 to 2006 landings increased sharply to reach 21685 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 2007–2017 the Norwegian catches in targeted fisheries were around 12000 t per year in accordance with annual TAC regulations reintroduced in 2007. In 2018 the landings increased to 15832 t, while in 2019 the landings were 12501 t. In 2020 these catches are reduced to 8705 t, while for 2021 the catches increased by 1000 t to 9706 t. For 2022 the catches is reduced to 7550 t, which is a record low catch amount for the last 20 years.

Since 2014 a marked increase is observed in catches in subareas 3 and 4, and these have risen in 2018, 2019 and 2020 to substantial 8067 t, 7210 t and 7215 t, respectively. In 2021 these catches have declined to 3733 t, while for 2022 the catches has increased to 4634 t. 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 the end of 2018, 267 samples of Argentines from the industry were identified to either *Argentina silus* or *Argentina sphyraena* using different criteria given in the identification key of Argentines; number of muscle segments, number of pectoral fin rays, number of gill rakes on the lower part of the first gill bow and the size of the eye diameter compared to the snout length (ICES WGDEEP 2019 WD7). Preliminary results show that up to 10% of the individuals sampled might be *A. sphyraena*. In this report, all registered landings are assumed to be greater silver smelt.

In 2020 total landings were 15820 t (Table 6.2.1–6.2.3). Landings from subareas 1 and 2 were 8705 t and the remainder were reported from Subarea 4 and Division 3.a. The total landings were substantially higher than the ICES advice for 2019, primarily due to by-catch landings in the North Sea. In 2021 the total landings were 13271 t, hence landings from subareas 1 and 2 were 9706 t and the remainder were reported from Subarea 4 and Division 3.a. For 2021 the total landings are still higher than the ICES advice given for 2021, however the landings for 2021 are declining compared to 2020. In 2022 the total landings were 12126 t, where landings from subareas 1 and 2 were 7550 t and the remainder from Subarea 4 and Division 3.1. As for 2021, the total landings for 2022 are higher than the ICES advice given for 2022.

6.2.3 ICES Advice

In 2021 ICES advised that, when the precautionary approach is applied, catches should be no more than 10 271 tonnes in each of the years **2022 and 2023**. Discarding is known to take place but is negligible.

6.2.4 Management

For a period after 1983 a Norwegian precautionary unilateral annual TAC was applied in Division 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 12000 t unilateral Norwegian TAC was introduced in 2007 and this TAC was maintained until 2015 when for 2016 it was increased to 13047 t, which also was the TAC for 2017. In 2018 and 2019 the TAC was 13770 t. The TAC in the direct fisheries for 2020 and 2021 is 9033 t. The TAC in the direct fisheries is 7603 t for 2022 and 2023. 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. Usually around 25 trawlers are active in the fishery.

In 2016, RTC-regime (Real Time Closures) was implemented to the direct fisheries in Subarea 2, aimed to limit bycatch of redfish, saithe and haddock. Closing criteria was sat to 1000 kg in combined weight of redfish, saithe and haddock in single catches.

In 2017 a minimum landing size (MLS) in the direct fisheries of 27 cm was implemented in the direct fisheries, with access to 20% mixture of greater silver smelt in numbers under the MLS in single catches. Also, ban on landing greater silver smelt to be processed to fishmeal was repealed in 2017.

In Norway vessels that are not licensed to greater silver smelt fisheries can have up to 10% in weight bycatch of greater silver smelt in single catches and landings. This also applies to vessels that are licenced, but those must subtract the bycatch from their quota.

If the total TAC in the direct fishery is not fished during the year, up to 10% of the total TAC can be transferred to the following year.

There is no Norwegian TAC for fisheries in divisions 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 2020 the EU TAC for subareas 1+2 was 90 t, and for subareas 4 + 3 the TAC was 1234 t. For 2021 the EU TAC for subareas 1+2 was 34 t, while for subareas 4 + 3 the EU TAC was 796 t. For 2022 the EU TAC is 9 t in UK and international waters of 1 and 2, and 199 t in UK and EU waters of 4 and EU waters of 3[1] . For both 2021 and 2022 UK TAC was 25 t in area 1 and 2, and 13 t in 3a and 4c [2]. For years 2023 and 2024 the EU TAC and the UK TAC in subareas 1+2 is 34 t and 25 t, respectively. In subarea 3a and 4c, the EU TAC is 796 t and the UK TAC is 13 t for years 2023 and 2024.[3]

6.2.5 Data available

6.2.5.1 Landings and discards

Landings data are presented by ICES Subareas and Divisions and countries (Tables 6.2.1–6.2.4, Figure 6.2.1–6.2.3). Data from 2014–2021 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 information in InterCatch on very minor discards from non-Norwegian fisheries on this management unit, but bycatches are assumed generally to be landed.

6.2.5.2 Length compositions

Length distributions are presented for target fishery catches from Division 2.a for the period 2009–2022 and for bycatches by Norwegian vessels in Division 4.a for the years 2011, 2013, and 2015-2022 (Figure 6.2.5 and 6.2.6). For each year these distributions are derived by pooling multiple samples from landing sites and samples provided by commercial vessels (Hallfredsson *et al.* 2016, WGDEEP 2016, WD).

Length information is available from the Norwegian slope March/April survey in Division 2.a conducted in 2009 and 2012, and biennially since then (Figure 6.2.7) (Heggebakken *et al.* 2020, WKGSS WD18).

Length information is available from the annual Norwegian shrimp survey in divisions 3.a and 4.a, 1984–2023 (Figure 6.2.8).

Some length distributions from landings and discards from fisheries by Scotland, Sweden and Netherlands are available in InterCatch, but are still to be analysed.

6.2.5.3 Age compositions

Age compositions from Norwegian catches 2013-2020 are presented in Figure 6.2.9. Age distributions from the Norwegian slope survey and the shrimp survey in North Sea/Skagerrak are shown in Figure 6.2.10.

6.2.5.4 Weight-at-age

No new data on weight-at-age were presented to the meeting. Length at age and length-weight relations were scrutinized at the WKGSS 2020 benchmark workshop on greater silver smelt (ICES 2021).

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[1] final-tacs-2022.pdf (europa.eu)

[2] Outcomes of annual negotiations for UK fishing opportunities in 2021 and 2022 (publishing.service.gov.uk)

[3] EU-UK for 2023 (europa.eu)

6.2.5.5 Maturity and natural mortality

No new data on maturity and natural mortality were presented to the meeting, but these were scrutinized at the 2020 benchmark workshop.

6.2.5.6 Catch, effort and research vessel data

A trawl acoustic survey has been conducted in 2009, 2012 and biennially since then, along the continental slope in Norwegian EEZ from 62–74°N (subareas 1 and 2). Additionally, trawl surveys were conducted in Division 2.a in 2003–2005. Acoustic index from this survey is used in the SPiCT assessment.

Surveys were conducted in early 1990-ties in the Norwegian Sea and south–east slope with acoustics, pelagic and bottom trawl (Monstad and Johannessen, 2003), the ones in spring 1990-1992 are used in the SPiCT assessment.

For Subarea 4 and Division 3.a information is available from the Norwegian shrimp survey in years 1984–2023. Stations are in the depth range of 80-660 meters, with around 25% of the stations deeper than 300 meters. The survey has been conducted in different seasons, and this may affect the index for greater silver smelt. The index did not perform well with SPiCT (ICES 2021).

6.2.6 Data analyses

Length and age distributions

In Division 2.a size and age distributions from target fisheries (Figures 6.2.5 and 6.2.9) 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 major changes in the shape of size composition in the recent ten years when the target fishery has been regulated with TACs and other measures.

Age distributions in the Norwegian slope survey are rather even through the years with a mode around age six to eight, while the 2020, 2022 and 2023 age distribution in the North Sea/Skagerrak survey is bimodal with more juveniles of age one to three as well (Figure 6.2.10). The fishery is mainly conducted shallower than 400 m.

The shape of the length distributions in both numbers and biomass in the Norwegian slope survey have varied through the years, but low numbers and biomass are apparent in the 2018 survey while 2020 and 2022 survey shows upward trend (Figure 6.2.7).

In Division 3.a the length distributions throughout the 1984–2023 shrimp survey time-series are bimodal since 2018, as the age distribution in 2020, 2022 and 2023, with marked appearance of larger fish around 30 cm (Figure 6.2.8).

In Division 4.a size distributions from the bycatch (Figure 6.2.6) are to some extent bimodal in years 2015 to 2020 and suggest that the catches comprise rather variable but smaller fish than those in the target fishery landings in Division 2.a. Mean length in 2022 from the target fishery in Division 2.a was 36.45 cm, while mean length from Division 4.a was 17.70 cm in 2022. This probably reflects that the slope of the Norwegian Deep in Division 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 CPUE and survey series

In Subarea 2 biomass estimates based on the acoustic observations show a decreasing trend from 2014-2018, the 2020 estimate shows an increase, while the acoustic estimates for 2022 are at the same level as for 2018 (strata 1A and 2A in Figure 6.2.11). Greater silver smelt spatial distribution shows highest concentrations in approximately 62-70°N (Figure 6.2.12), which agrees to where the direct fisheries are mostly conducted. The index was recalculated using the StoX software at the 2020 benchmark. The 2020 survey was affected by complications related to covid19 restrictions and bad weather conditions. As a result, the area North of 67°N was not covered, being an area with lowest biomass of greater silver smelt in the survey (stratum 3 in Figure 6.2.11) and it is suggested to exclude that area from the index that is used in SPiCT (ICES 2021).

Swept area biomass indices and swept area abundance indices for greater silver smelt from the annual Norwegian shrimp survey in Division 3.a and south-eastern parts of Division 4.a are shown in Figure 6.2.13. The indices are calculated using StoX, which is now the recommended program for calculating survey estimates from acoustic and swept area surveys at IMR (Johnsen *et al.* 2019) (Heggebakken *et al.* 2020, WKGSS WD18). Seasonality of the survey has varied through the years and this may affect the index for greater silver smelt. It was conducted in October 1984-2002, in May 2004-2005, in February 2006-2007 and in January since then.

The indices in terms of numbers and weight from the survey in divisions 3.a and 4.a suggest pronounced variation and trends (Figure 6.2.13). The survey catches rates first declined steadily and then rather abruptly to unprecedented low levels in 2006. After 2010, indices showed an abrupt increase until around 2015 and have been at a relatively high level since then.

A preliminary catch CPUE based on electronic logbook data from the direct fisheries in Division 2.a is shown in Figure 6.2.14. For the pelagic trawls CPUE, year 2013 is the one with highest value, followed by a declining trend until 2016 and a slight increase after that (Heggebakken *et al.* 2020, WKGSS WD18). For the bottom trawls CPUE, the trend is increasing, apart from year 2015 which showed the lowest CPUE for all years. The CPUE series was examined at the 2020 benchmark and considered not applicable to the assessment at present stage. It is foreseeably a labour-intensive task to get the old logbooks digitalized, and a cost-benefit consideration is needed based on further analysis of the electronical logbook data and experience with CPUE series from other areas.

6.2.7 Assessment

LBI was run in 2023 with updated data in a web-based Shiny app (LBIndicator Application (shinyapps.io)). The results show that in the traffic light system (ICES. 2018) all indicators for conservation, optimal yieald and MSY are green (Figure 6.2.15), except for L_c/L_{mat} (=0.96) for conservation of immatures which is slightly below the expected value of >1. Index ratio of the average length relative to the expected length when fishing mortality equals natural mortality ($L_{mean}/L_{F=M}$) from the LBI can be used for evaluation of exploitation status. The exploitation status is below $F_{MSYproxy}$ when this index ratio value for MSY is ≥1. For the stock $L_{mean}/L_{F=M} = 1.09$, which indicates that the exploitation status is within sustainable levels.

SPiCT was run in 2023 and the results are shown in Figure 6.2.16-6.2.20.

According to the recommendations from WKLIFE X, the ICES-rfb rule was applied for a trend-based advice (ICES, 2023) and was calculated in the "cat3advice" R-package (shfischer/cat3advice: An R package to apply the ICES category 3 data-limited harvest control rules (rfb/rb/chr) (github.com)). The relative biomass index from SPiCT was used for the stock development. The advice is based on the recent advised catches (2023), multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard, and a precautionary multiplier. The stability clause was considered and not applied since the change from the previous advice was between +20% or −30%. The discard rate is 0.5% and considered negligible.

The relative biomass index, index A and index B is shown in Figure 6.2.22. The pooled lengths from years 2015-2022 is shown in Figure 6.2.23. The parameters from von Bertalanffys growth function used in the rfb calculations were $L_\infty = 44.65$ cm and $k = 0.12$ yr^{-1}. $I_{trigger}$ used as in rfb-rule decriptions ($I_{trigger} = I_{loss}$ x 1.4) showed an $I_{trigger}$ at 1.2. However, this level is higher than the index has ever been and alternative calculations for $I_{trigger}$ were suggested. In one scenario the $I_{trigger}$ was set as I_{loss} for the relative biomass index, which gave an value of I_{loss} at 0.8539. The other scenario is based on the SPiCT results were $I_{trigger}$ is sat as (B_{MSY}/meanB)/2 which gave an value of 0.4691. Both these scenarios fitted better with the trend of the relative biomass index. However, currently when the rfb-rule is applied the biomass safeguard b becomes 1, since the multiplier index relative to trigger (b) is the minimum value of either 1 or $I_{2022}/I_{trigger}$ and both sceanarios will give values higher than 1. Figure 6.2.24 gives the index and shows both alternatives for $I_{trigger}$, and decision on which alternative to choose will be brought to the ADG to consider. The stock size is above MSY $B_{trigger\ proxy}$ ($I_{trigger}$) (Figure 6.2.24), and the fishing pressure is below $F_{MSY\ proxy}$ (Figure 6.2.25).

The ADGDEEP 2023 rejected use of SPiCT index into the rfb rule, and recommended rather to use acoustic index from the Norwegian Slope survey with intropolated values for missing years (figure 6.2.26), as input to the rfb rule.

6.2.8 Comments on the assessment

The assessment is in accordance to the WKGSS 2020 benchmark workshop (ICES 2021) and the recommendations from WKLIFE X, regarding applying ICES-rfb rule (ICES, 2023).

Due to covid19 complications, the 2020 Norwegian slope survey in subareas 1 and 2 did not cover the northernmost survey area (stratum 3). The biomass estimates for this stratum has been minor compared to stratum 1A and 2A (Figure 6.2.11). Thus, the SPiCT analysis was run with summed biomass estimates for stratum 1A and 2A, leaving out stratum 3. The SPiCT analysis for 2022 are run with the acoustic index from the Norwegian slope survey conducted in 2022.

Existing abundance, length and age data series for this stock are rather short compared to potential life span of the species (approx. 30 years). However, if the time-series are maintained they may support more analytical assessment in a near future. CPUE from the fisheries is the only known source of data that potentially can give information on historical development of the stock back in time to around 2009. Electronic logbooks were introduced in the Norwegian fisheries in 2011 but are not available digitally for earlier years. Before 2011 the fishing vessels were obliged to keep logbooks, and have them available in case of inspection, but not to deliver them to the government. Thus, it is foreseeably a labour-intensive task to get the old logbooks digitalized, and a cost-benefit consideration is needed based on further analysis of the electronic logbook data and experience with CPUE series from other areas. It is currently unknown if the CPUE reliably will reflect the dynamics in the population.

6.2.9 Management considerations

Advice is given every second year for this stock and the 2023 advice applies for 2024 and 2025.

The bycatch in Subarea 4 (North Sea) has increased rapidly since 2012 and total catch in this area reached levels of around 7 to 8 thousand tonnes. In 2020 the catches in Subarea 4 were 7115 t, reaching levels not far from to the catches in the direct fisheries in subareas 1 and 2 (8705 t). This is an alarming level as the bycatches are not well regulated. There are uncertainties in how this bycatch is estimated in this fishery, 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 for the most part they are greater silver smelt catches (Hallfredsson and Heggebakken 2019, ICES WGDEEP 2019 WD7).

6.2.10 References

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6.2.11 Tables

Table 6.2.1. Greater Silver Smelt in 1, 2, 3.a and 4 by countries. WG estimates of landings in tonnes. ICES official statistics. Landings from 1966-2018 are shown in Stock Annex. * Preliminary landings.

year	Denmark	Sweden	Ireland	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Lithua-nia	Iceland	SUM
1988	1062	0	0	1	0	13014	5	14	0	0	0	0	0	14096
1989	1322	0	0	0	335	10495	0	23	1	0	0	0	0	12176
1990	737	0	0	13	5	10686	0	0	0	0	0	0	0	11441
1991	1421	0	0	0	3	8864	0	0	6	1	0	0	0	10295
1992	3564	0	0	1	70	8932	0	0	101	0	0	0	0	12668
1993	2353	0	0	0	298	8481	0	0	56	0	0	0	0	11188
1994	1118	0	0	0	0	6221	0	0	614	0	0	0	0	7953
1995	1061	0	0	357	0	6419	0	0	20	0	0	0	0	7857
1996	1446	0	0	0	0	6817	0	0	0	0	0	0	0	8263
1997	1455	542	0	1	0	5167	0	0	0	0	0	0	0	7165
1998	748	428	0	169	277	8655	0	0	0	0	0	0	0	10277
1999	1420	0	0	0	7	7151	0	0	18	0	0	0	0	8596
2000	1039	273	10	0	3	6107	0	195	18	9	0	0	0	7654
2001	907	1011	3	0	0	14360	0	7	233	28	0	0	0	16549
2002	614	484	4	0	0	7406	0	0	164	0	0	0	0	8672

year	Denmark	Sweden	Ireland	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Lithua-nia	Iceland	SUM
2003	918	42	0	4	617	8351	0	7	22	4	4	0	0	9969
2004	910	0	36	4	4277	11574	0	4	12	0	0	0	0	16817
2005	470	0	0	1	28	17066	0	16	0	0	14	0	0	17595
2006	335	0	0	6	0	25149	0	4	2	0	0	0	0	25496
2007	0	0	0	0	0	16373	0	1	0	0	0	0	0	16374
2008	0	0	0	0	0	13424	0	0	0	0	0	0	0	13424
2009	0	0	0	0	0	13495	0	0	0	0	0	0	0	13495
2010	0	0	0	0	0	12865	0	0	33	0	0	0	0	12898
2011	0	0	0	0	0	12060	0	0	0.4	4	0	0	0	12064
2012	0	0	0	0	0	12352	0	0	0	1.2	114	0	18	12485
2013	0	0	0	0	0	13227	0	0	0	2.3	0	0	0	13229
2014	40	1	0	204	345	14471	0	0	0	1	0	0	0	15062
2015	0	1	0	0	0	15235	0	0	0	0	0	0	0	15236
2016	0	1	0	38	11	18835	0	7	0	1.4	0	0	0	18893
2017	0	1	0	0	10	17788	0	35	0	0	0	0	0	17835
2018	18	4	0	67	152	23609	0	9	0	0	0	0	0	23859
2019	0	0	0	143	349	19172	0	8	0	0	0	0	0	19672
2020	309	0	0	0	222	15534	21	8	0	0	0	35	0	16129

year	Denmark	Sweden	Ireland	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Lithua-nia	Iceland	SUM
2021	0	0	0	439	24	12804	4	0	0	0	0	0	0	13271
2022*	0	0	0	0	2	12124	0	0	0	0	0	0	0	12126

Table 6.2.2. Greater Silver Smelt in 1 and 2. WG estimates of landings in tonnes. *Preliminary landings.

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

Year	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Iceland	TOTAL
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
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
2017		10	12277		35					12322
2018	0.2	0.4	15823		8.5					15832

Year	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Iceland	TOTAL
2019			12493		8					12501
2020			8697		8					8705
2021			9706							9706
2022*		1.5	7548			0.4				7550

Table 6.2.3. Greater Silver Smelt in 3. WG estimates of landings in tonnes. Figures in parentheses are discards as recorded in InterCatch. Landings from 1966-2018 are shown in Stock Annex. *Preliminary landings.

Year	Denmark	Germany	Norway	Sweden	TOTAL
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

Year	Denmark	Germany	Norway	Sweden	TOTAL
2005	470				470
2006	324				324
2007					0
2008					0
2009					0
2010					0
2011					0
2012					0
2013					0
2014			2	1	3
2015			22	1	23
2016			101	1	102
2017			3	(1)	3(1)
2018				(3.6)	(3.6)
2019				(66)	(66)
2020	7(4)				7(4)
2021				(1.4)	(1.4)
2022*				(0.2)	(0.2)

Table 6.2.4. Greater Silver Smelt in 4. WG estimates of landings in tonnes. Figures in parentheses are discards as recorded in InterCatch. Landings from 1970-2018 are shown in Stock Annex. *Preliminary landings.

Year	Denmark	France	Germany	Netherlands	Norway	Scotland	Ireland	Russia	Lithuania	Poland	TOTAL
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

Year	Denmark	France	Germany	Netherlands	Norway	Scotland	Ireland	Russia	Lithuania	Poland	TOTAL
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
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	(24)					5669(24)
2017					5508	(388)					5508(388)
2018	17(1)		67	152	7786	(38)		6			8028(39)
2019			143	349	6679	(39)					7171(39)
2020	302(15)			222	6837	(100)			35	21	7417(115)
2021			439	24	3098	(168)				4	3565(168)
2022*					4576	(58)					4576(58)

6.2.12 Figures

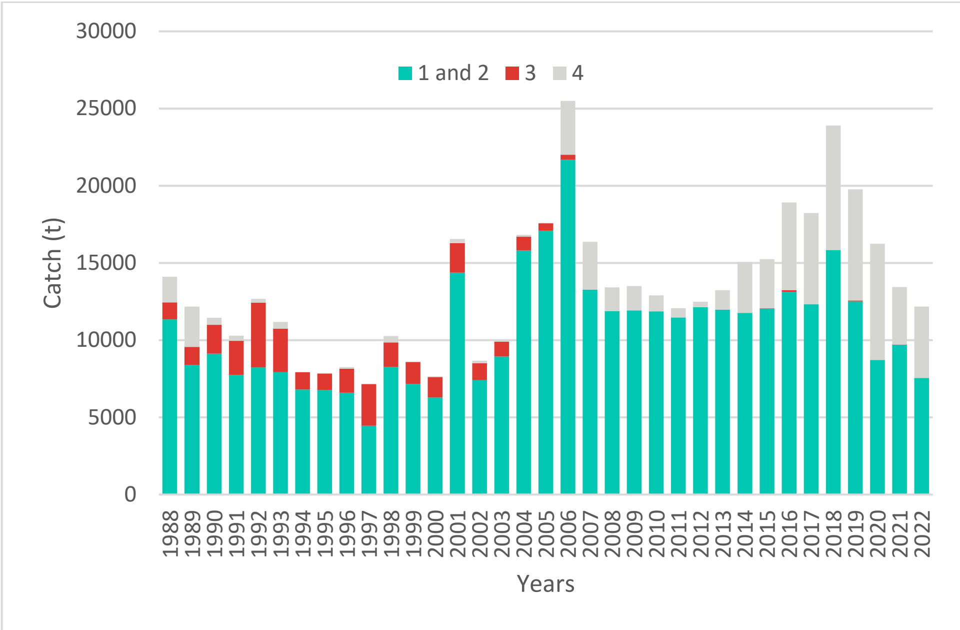


Figure 6.2.1. Total catch of greater silver smelt in subareas 1, 2, 3 and 4.

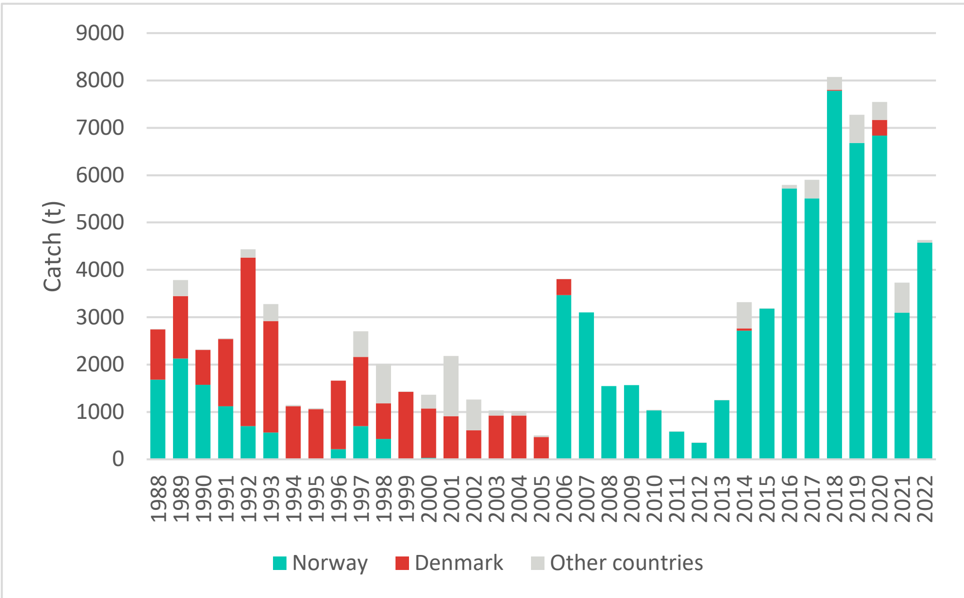


Figure 6.2.2. Total catch of greater silver smelt in subareas 3 and 4, by countries.

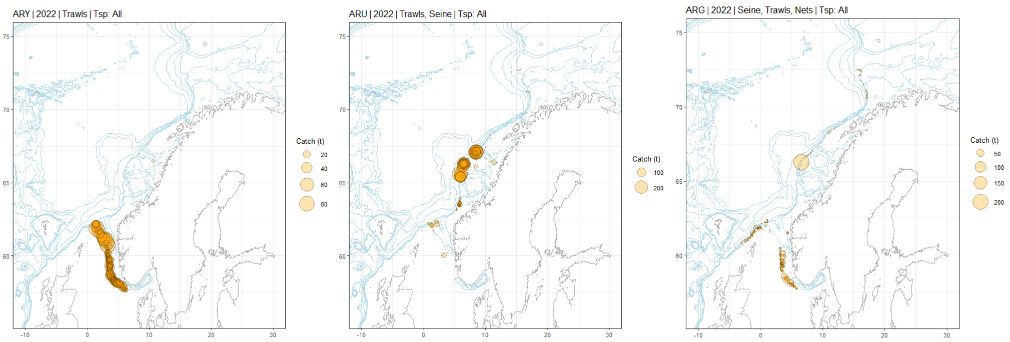


Figure 6.2.3. Norwegian catches in 2022 based on logbooks, including bycatch. Left, middle and right panels show catches registered as lesser silver smelt, greater silver smelt and mix of both species, respectively. Bubble sizes reflect sizes of single catches. NB: Catch representing max bubble size varies between panels.

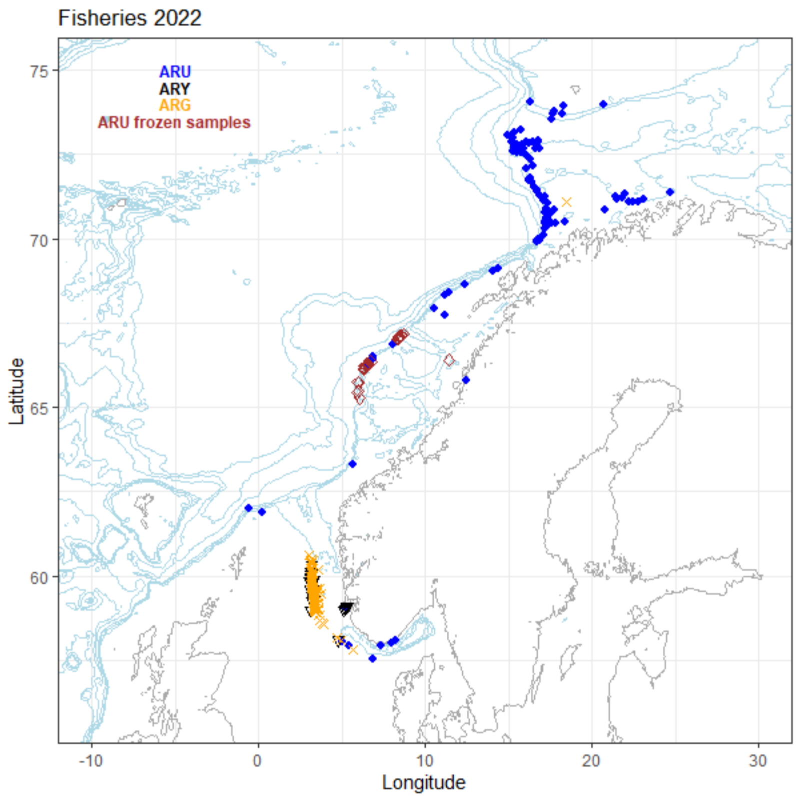


Figure 6.2.4. Positions from the fisheries for 2022 with length measurement landed as GSS, LSS, GSS/LSS and frozen samples.

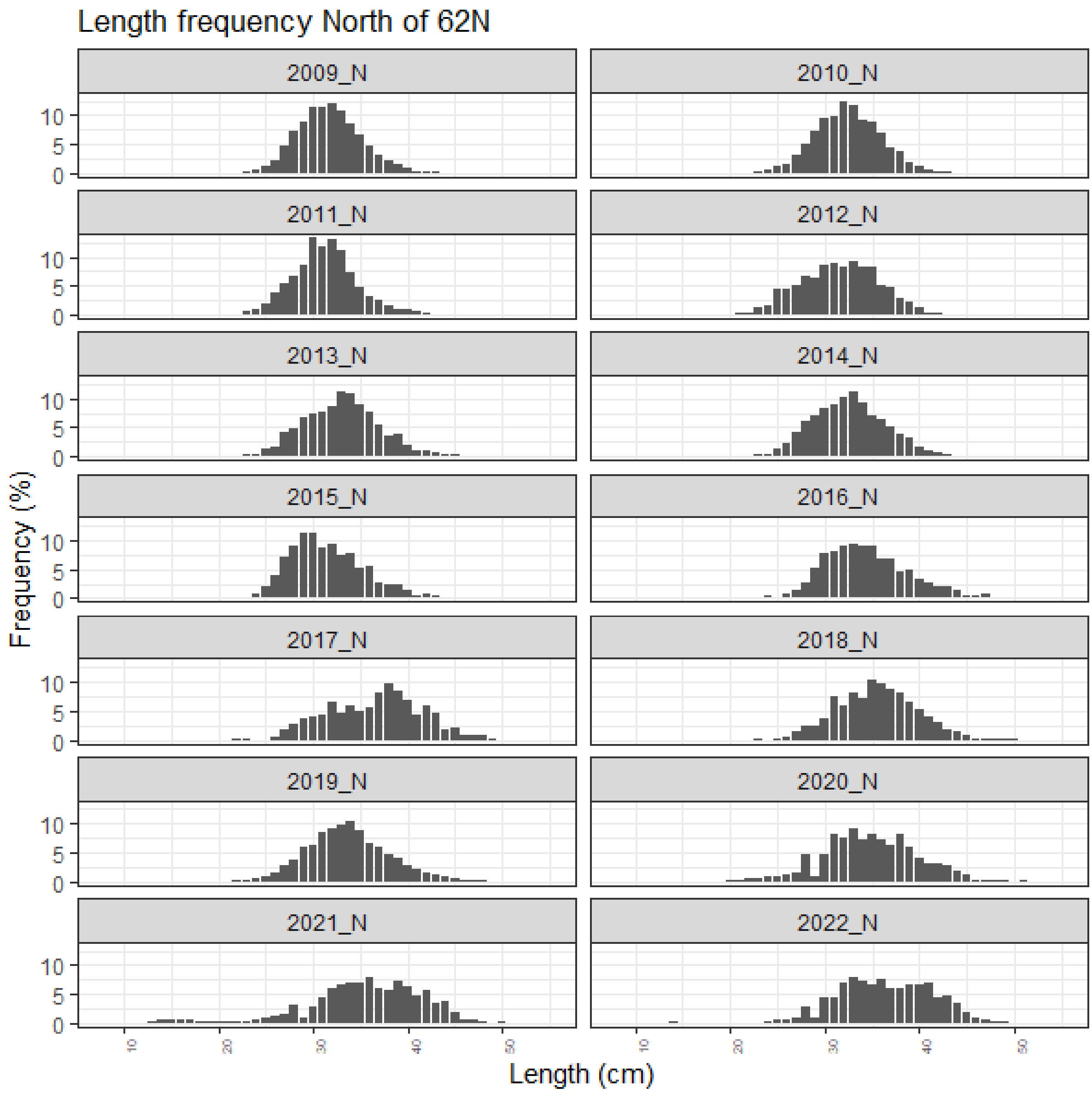


Figure 6.2.5. Greater silver smelt in subareas 1, 2, and 4 and Division 3.a. Length distributions (% numbers) from the target fisheries in 2009–2022 north of 62°N (approximately subareas 1 and 2).

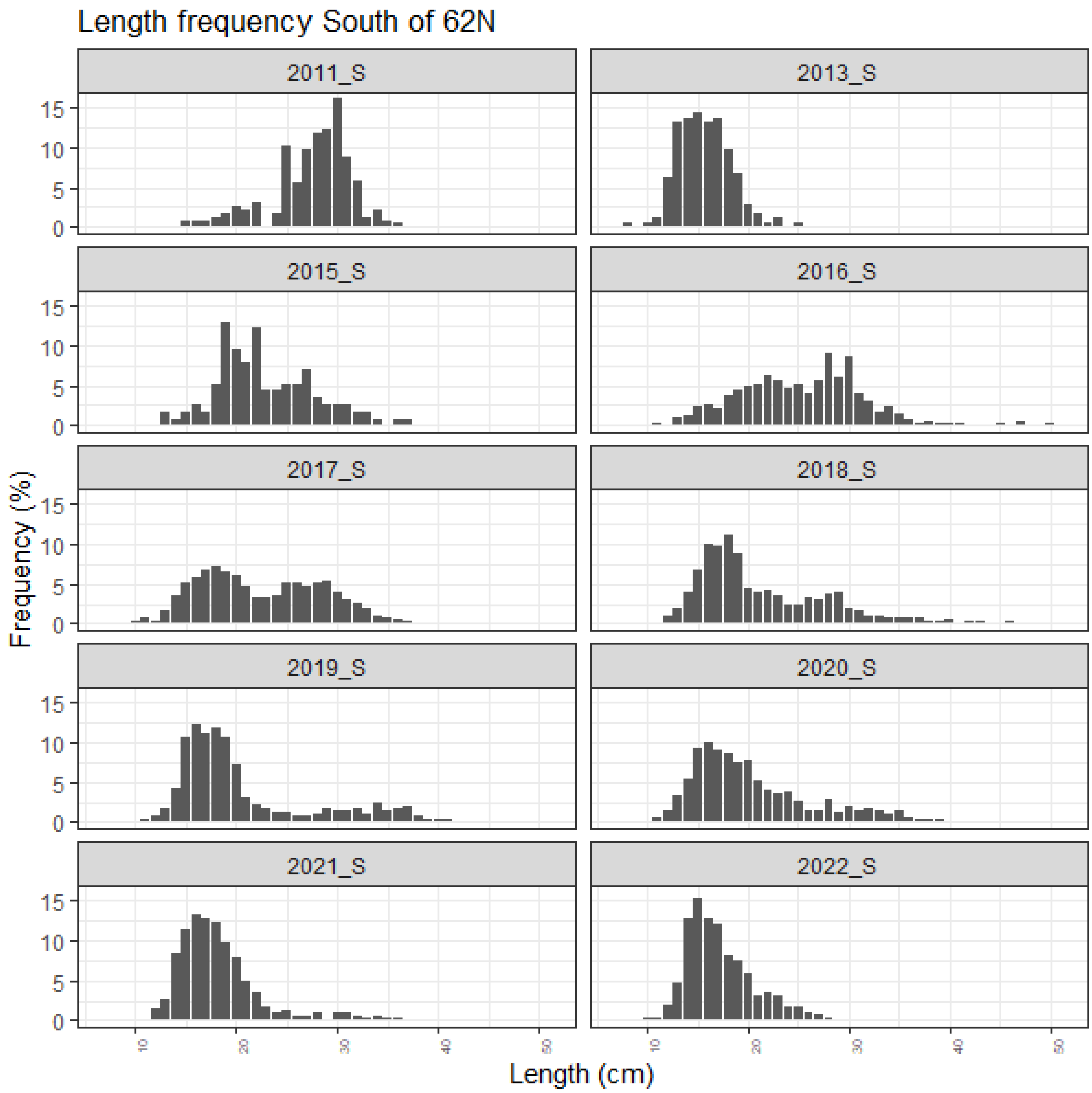


Figure 6.2.6. Greater silver smelt in 1, 2, 3.a and 4. Length distributions in annual samples from Norwegian bycatches south of 62°N (approximately subareas 3 and 4).

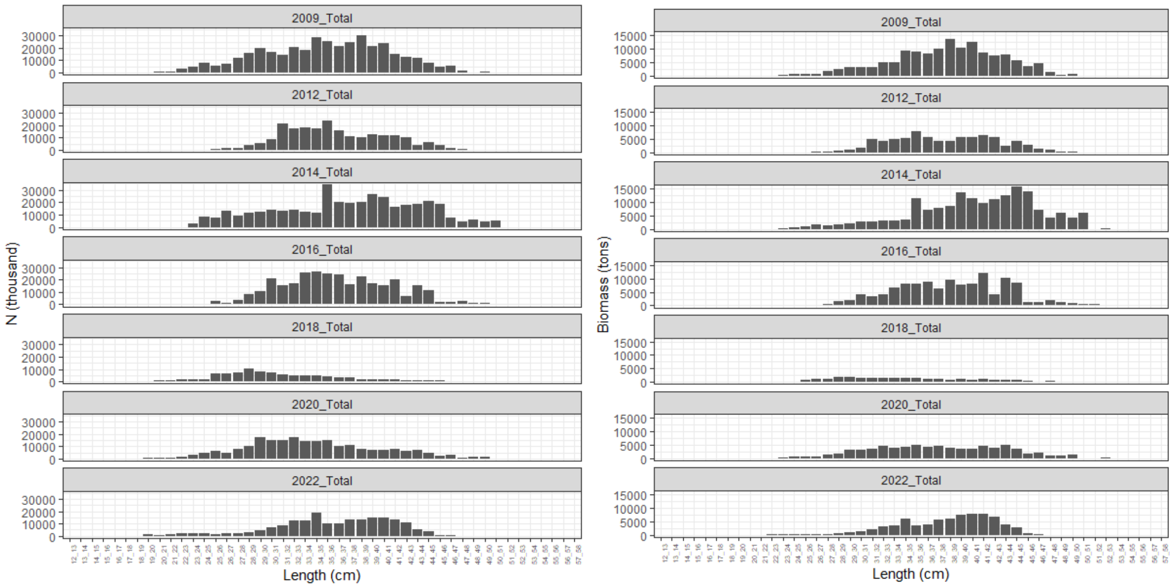


Figure 6.2.7. Length distributions in numbers (left panels) and biomass (tons) (right panels) for greater silver smelt in the Norwegian Sea south-east slope survey in 2009, 2012, 2014, 2016, 2018, 2020 and 2022. Swept area estimates from StoX.

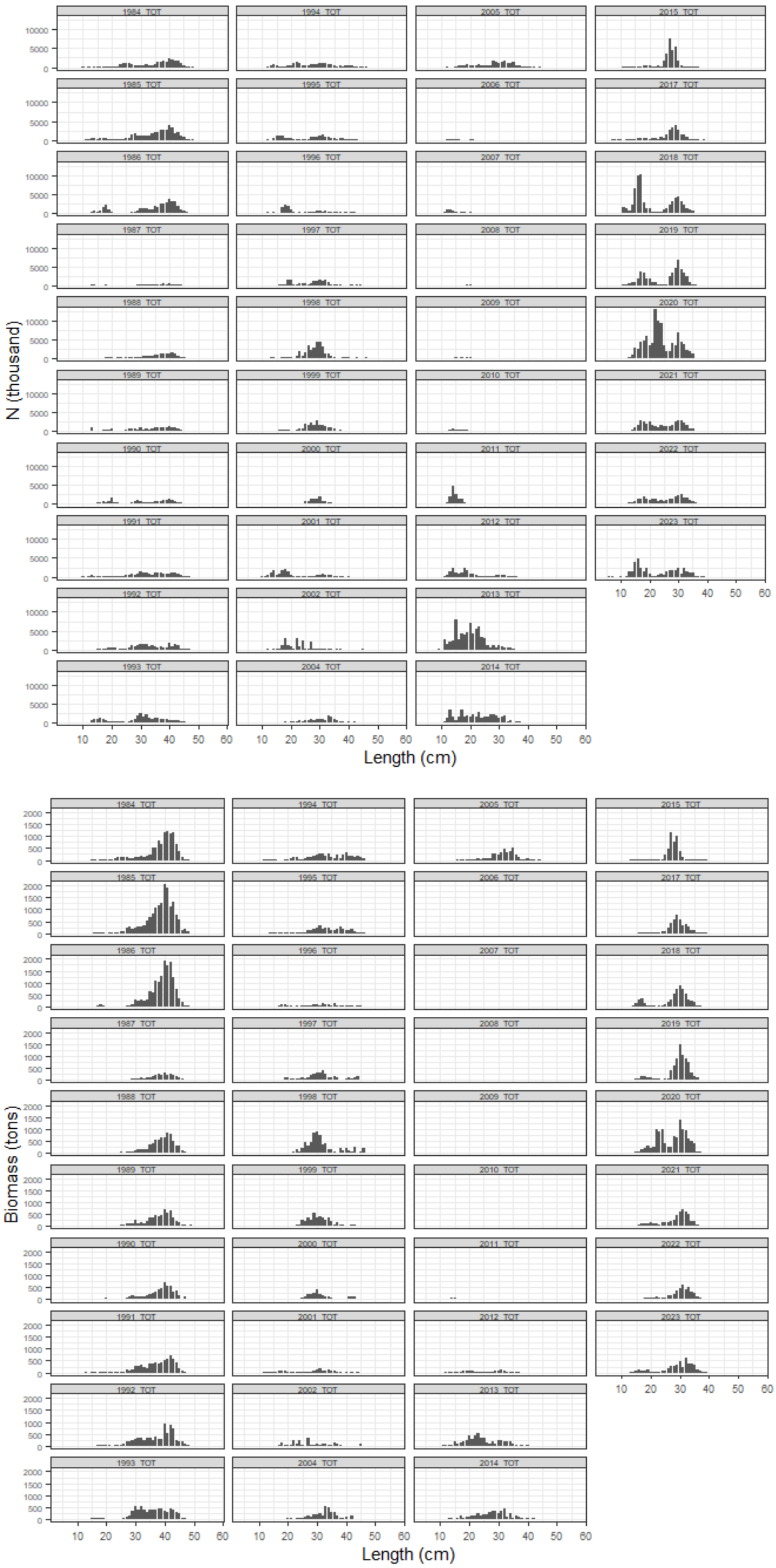


Figure 6.2.8. Length distributions in numbers (upper panels) and biomass (lower panels) for greater silver smelt in the North Sea/Skagerrak survey.

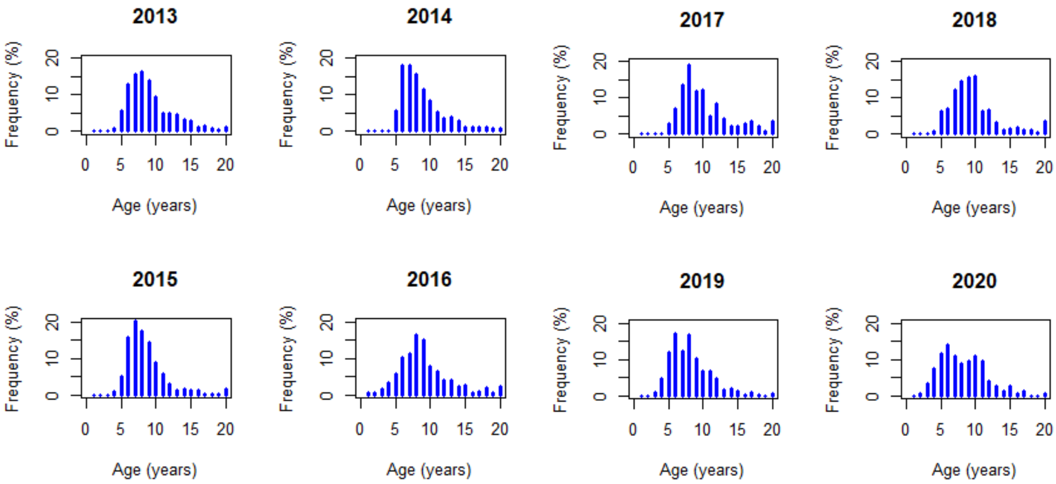


Figure 6.2.9. Greater silver smelt in 1, 2, 3, and 4. Age composition of Norwegian landings samples, 2013-2020.

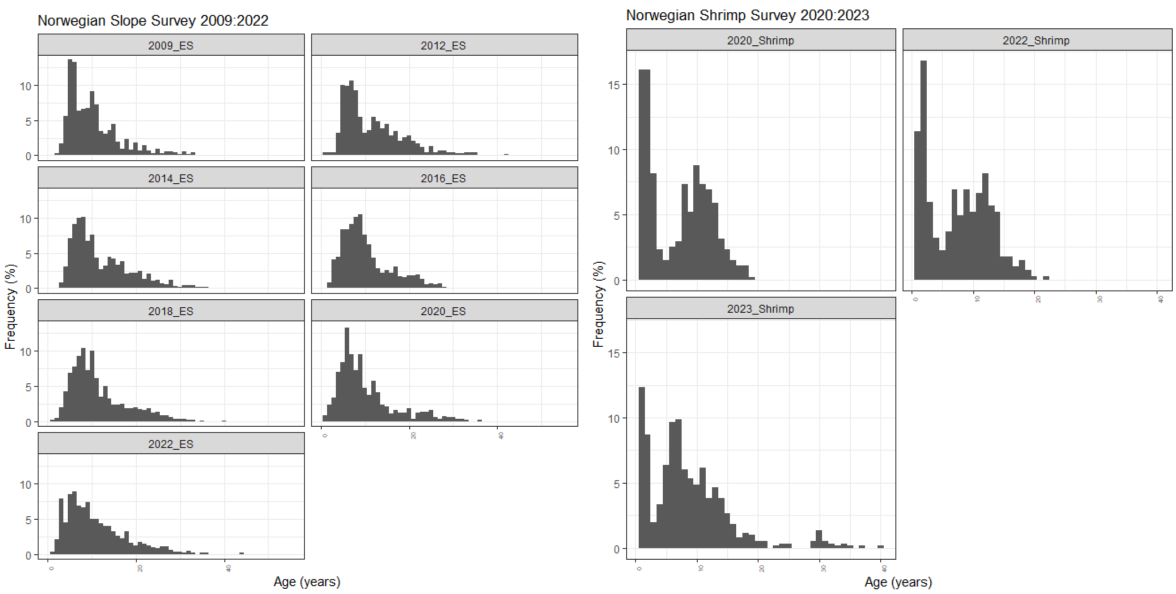


Figure 6.2.10. Age distributions of greater silver smelt from the Norwegian slope survey 2009-2022 (left panels) and the Norwegian Shrimp survey in North Sea/Skagerrak 2020, 2022 and 2023 (right panels).

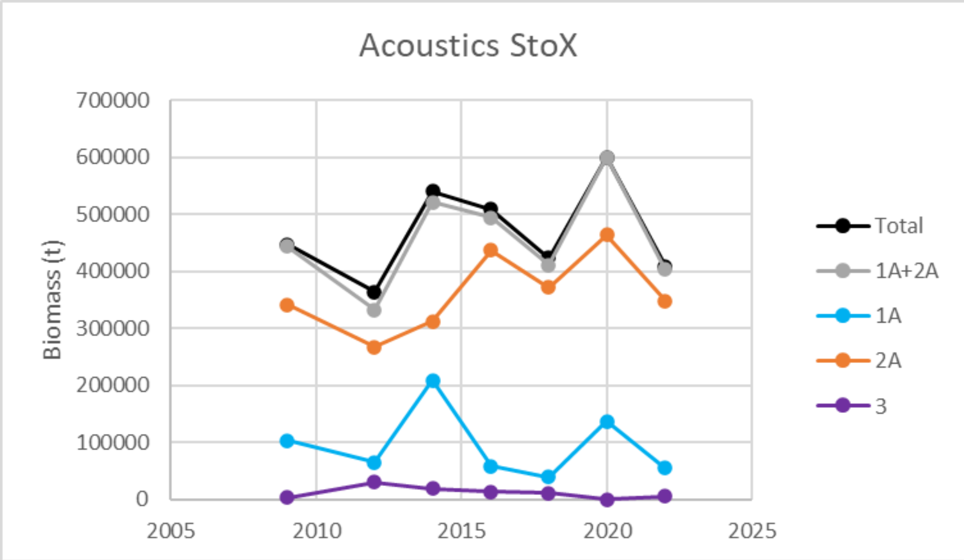


Figure 6.2.11. Acoustic index from the Norwegian Slope survey in subareas 1 and 2. Biomass estimates for different strata (1A, 2A and 3) in the survey are shown, as well as summed estimates for 1A and 2A and total for all strata. Stratum 3 was not covered in 2020 due to covid19 complications in the conduct of the survey.

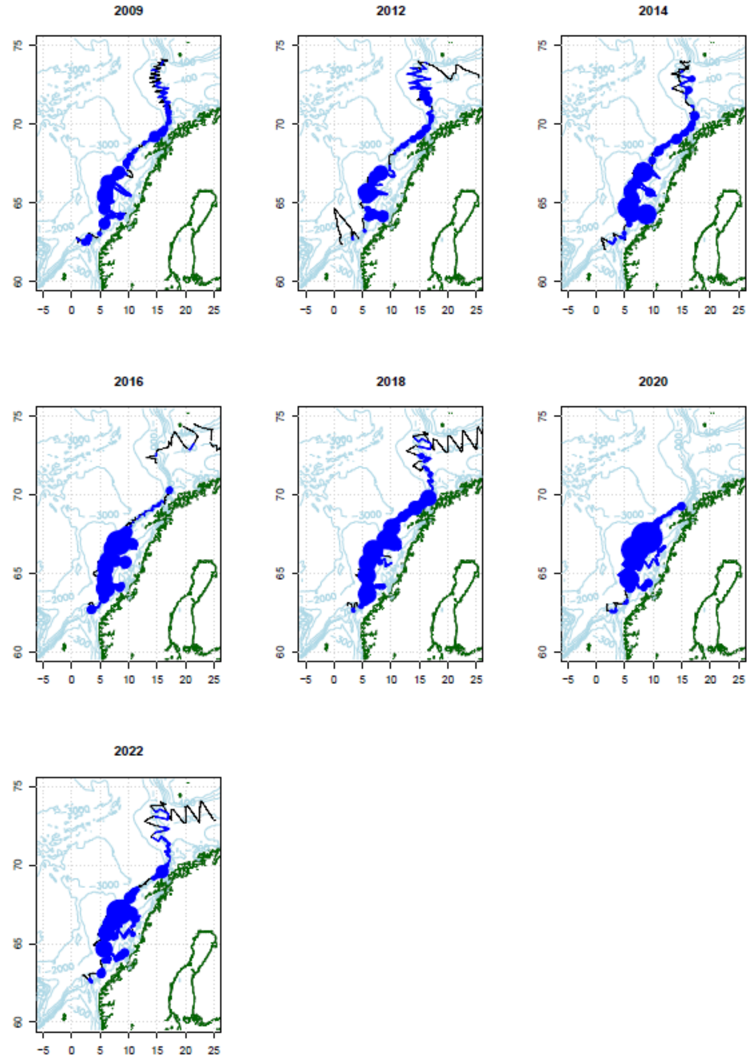


Figure 6.2.12. Greater silver smelt in Division 2.a. Acoustic backscattering strength estimates (SA-values) in Norwegian continental shelf and slope surveys March–April 2009, 2012, 2014, 2016, 2018, 2020 and 2022.

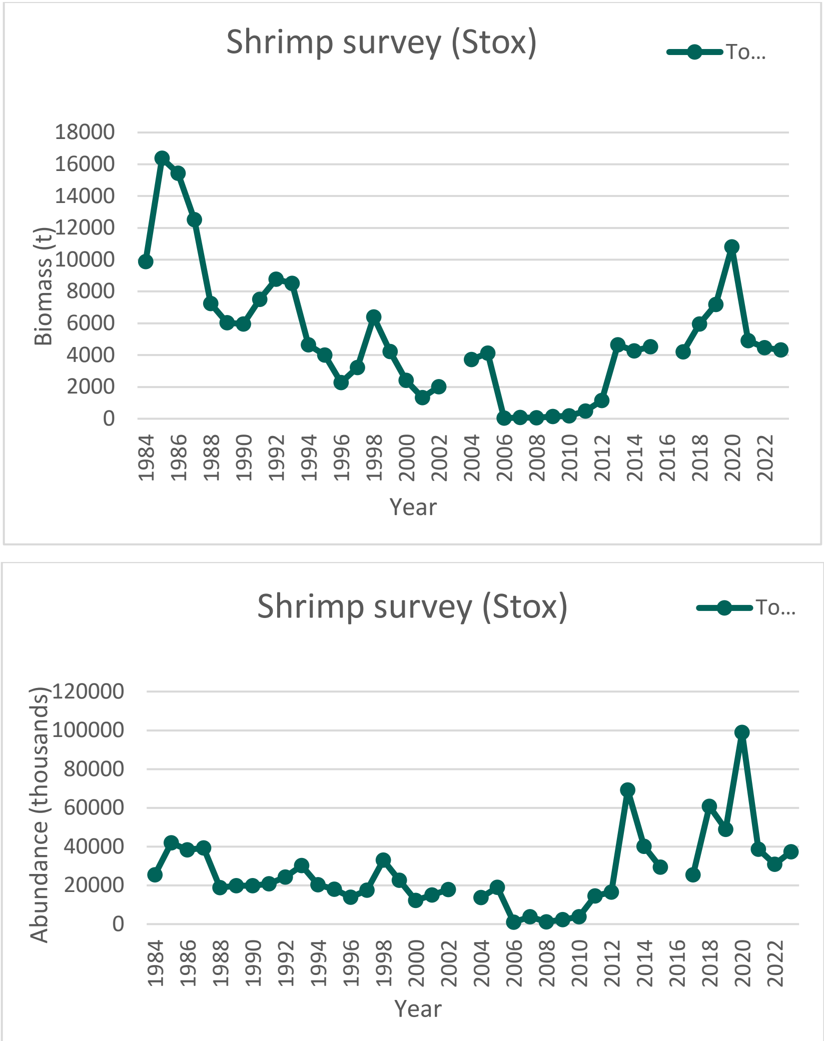


Figure 6.2.13. Swept area total biomass index (upper panel) and swept area total abundance index (lower panel) for greater silver smelt in the shrimp survey in North Sea/Skagerrak. Seasonality of the survey has varied through the years. It was conducted in October 1984-2002, May 2004-2005, February 2006-2007 and in January since then.

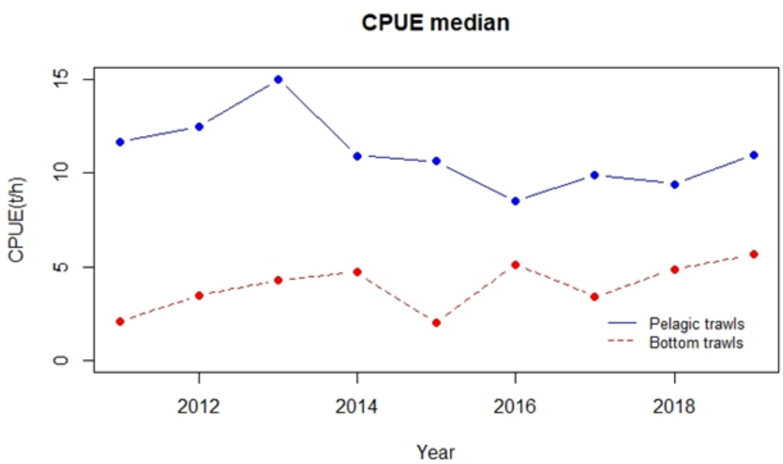
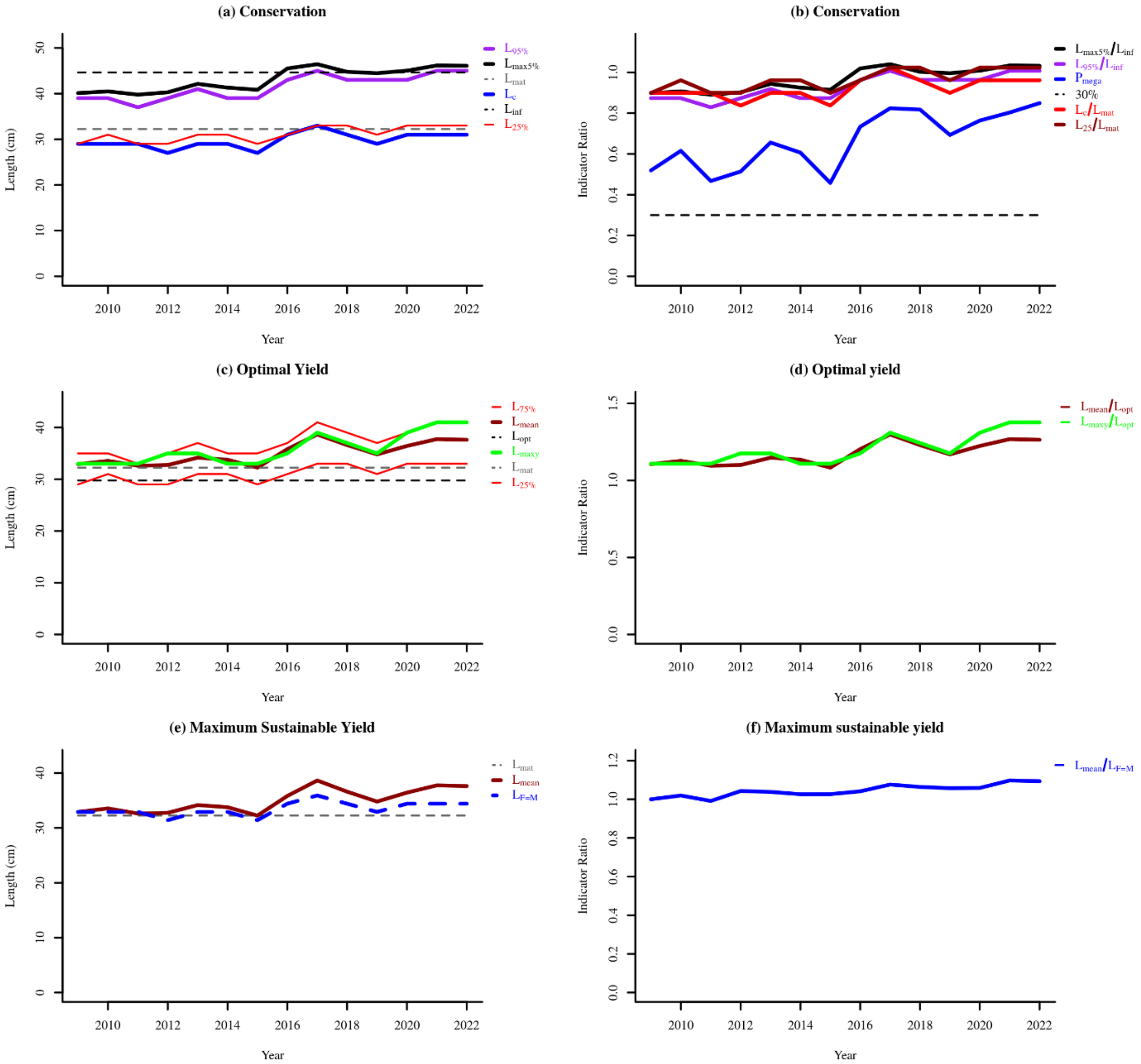


Figure 6.2.14. CPUE from the Norwegian direct fisheries on greater silver smelt in Division 2.a, based on electronic logbooks 2011-2019.



Indicator status for the most recent three years

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%}$ / L_{mat}	$L_{max\ 5}$ / L_{inf}	P_{mega}	L_{mean} / L_{opt}	L_{mean} / $L_{F=M}$
2020	0.96	1.02	1.01	0.76	1.22	1.06
2021	0.96	1.02	1.03	0.80	1.27	1.10
2022	0.96	1.02	1.03	0.85	1.26	1.09

Figure 6.2.15. Results from the length-based indicator method (LBI) used for the evaluation of the exploitation status in subareas 1 and 2 run in 2023. Panels a to f show status of conservation, optimising yield, and MSY for all years with length distributions available from the fisheries, and the traffic light system (ICES 2018) table below shows the same in more detail for the last three years.

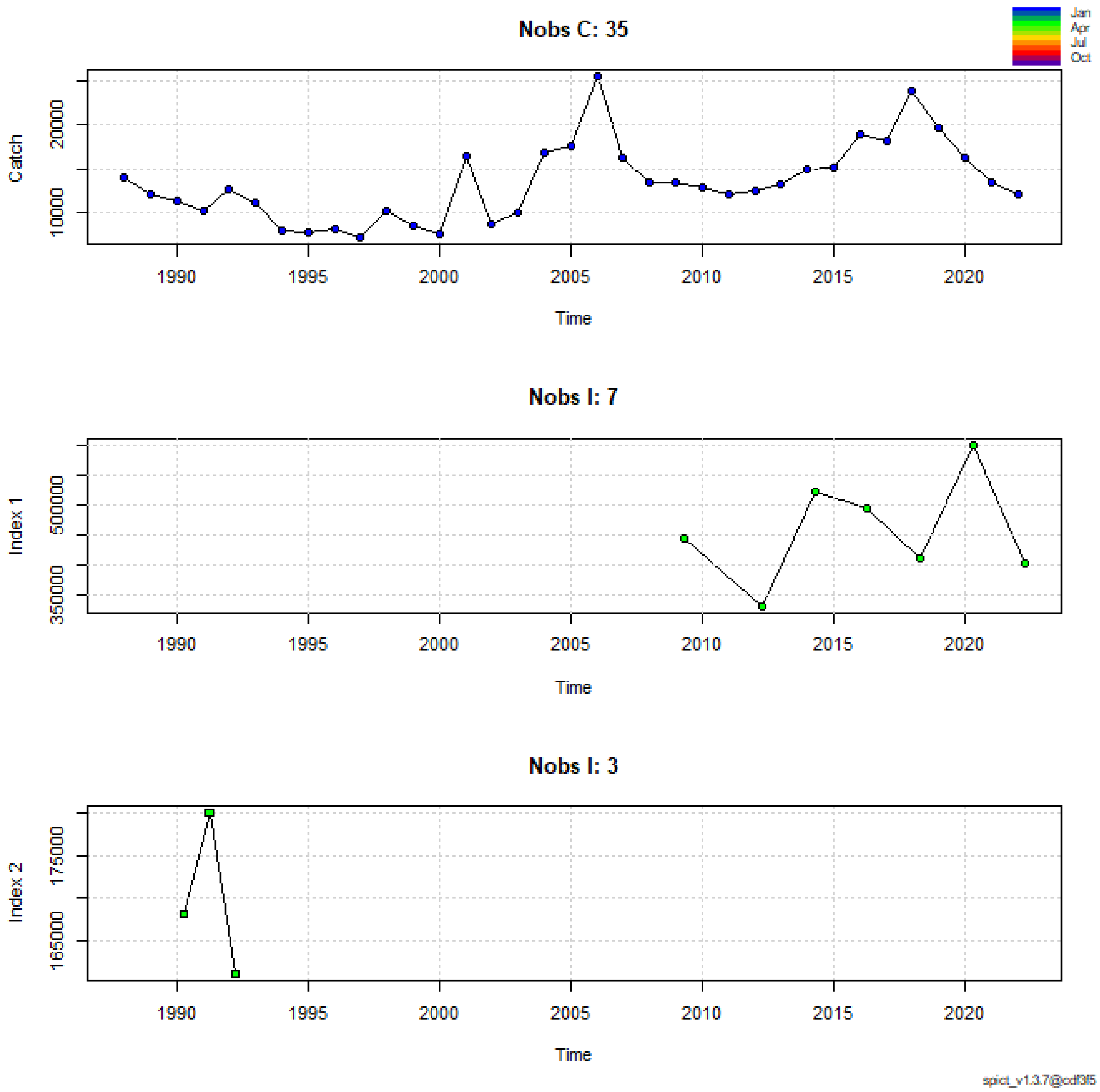


Figure 6.2.16. Input data to the SPiCT analysis. Uppermost panel is catch in tonnes, midpanel is acoustic index from the Norwegian slope survey and lowest panel is acoustic index from surveys at the slope in the 1990s.

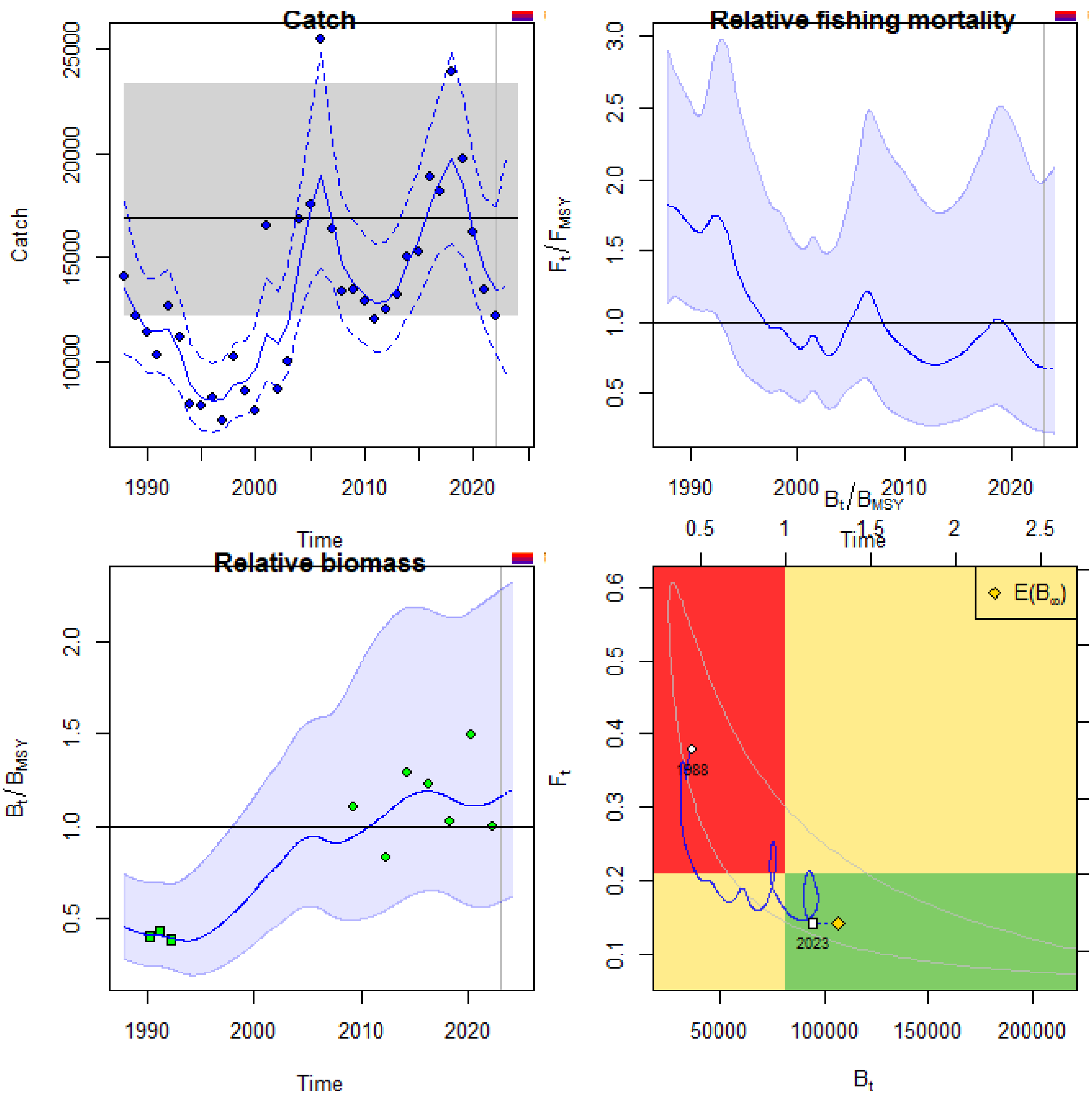


Figure 6.2.17. Results from the SPiCT analysis.

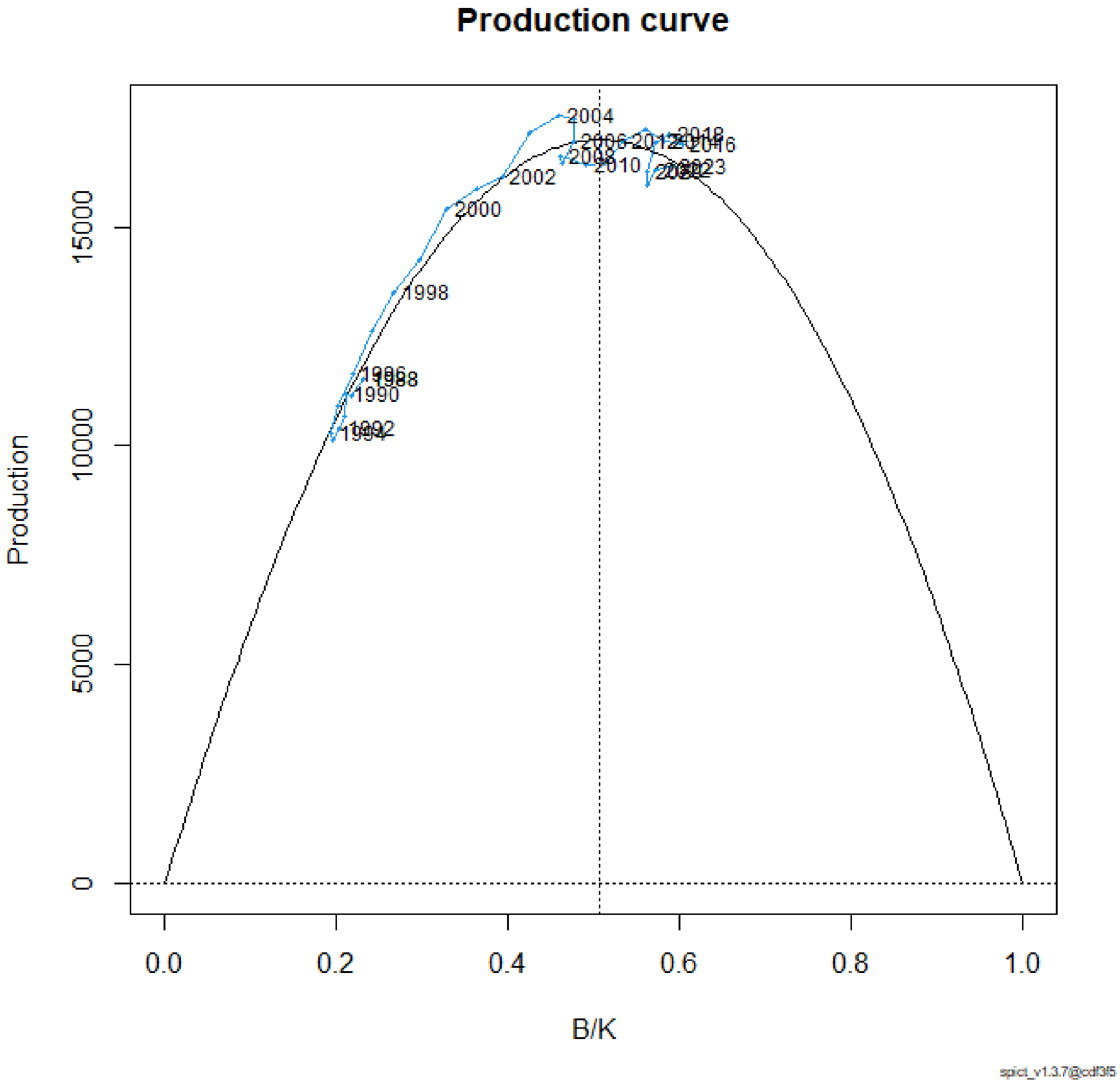


Figure 6.2.18 Production curve from the SPiCT analysis.

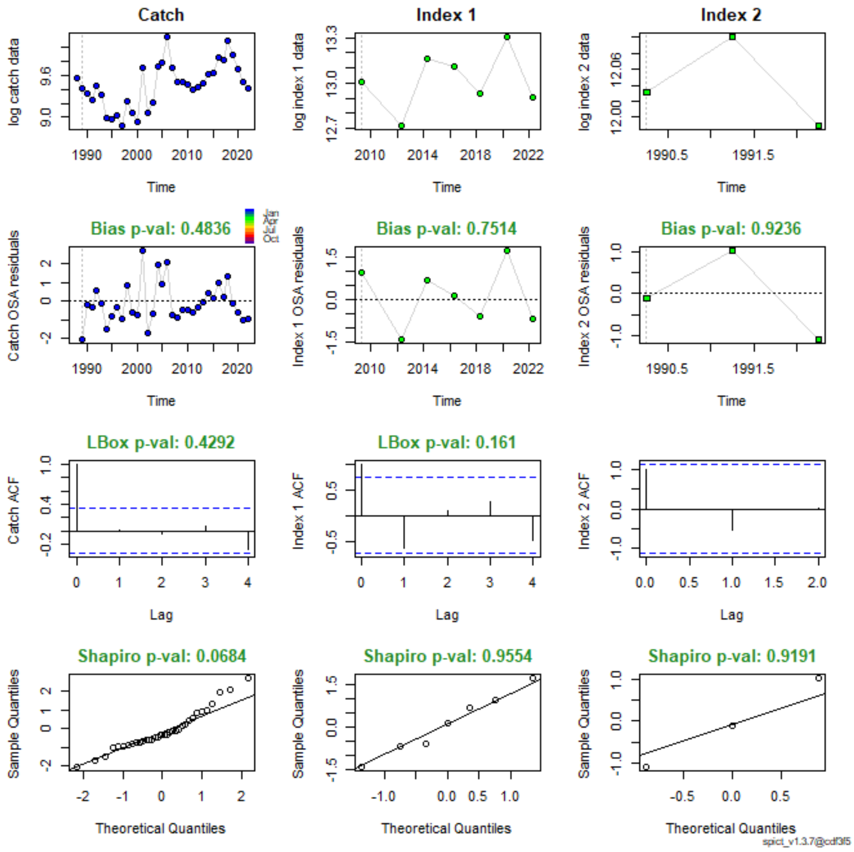


Figure 6.2.19. Diagnostics from the SPiCT analysis.

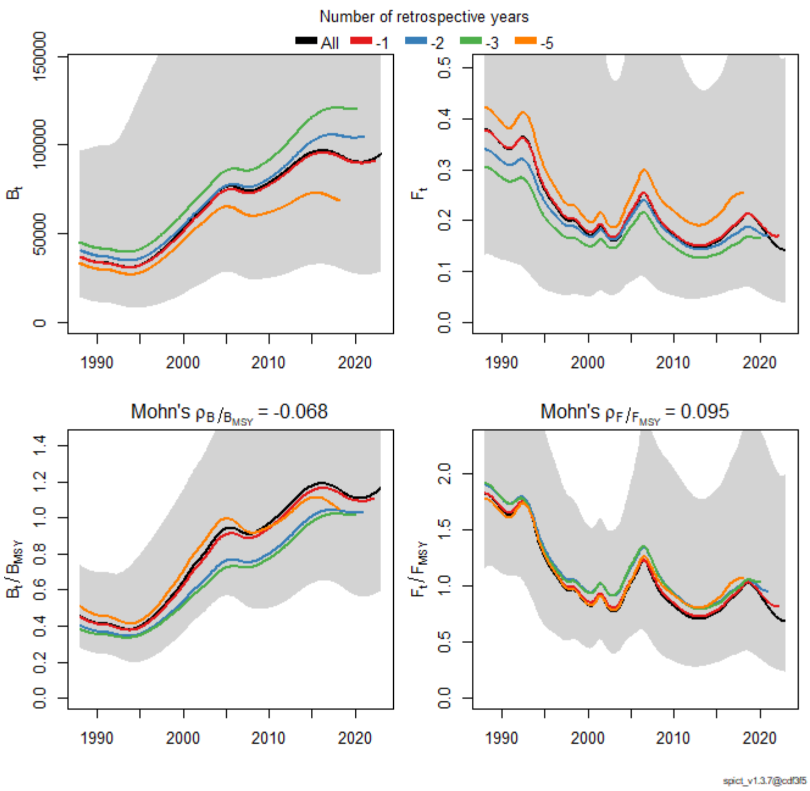


Figure 6.2.20. Retrospective analysis from the SPiCT analysis.

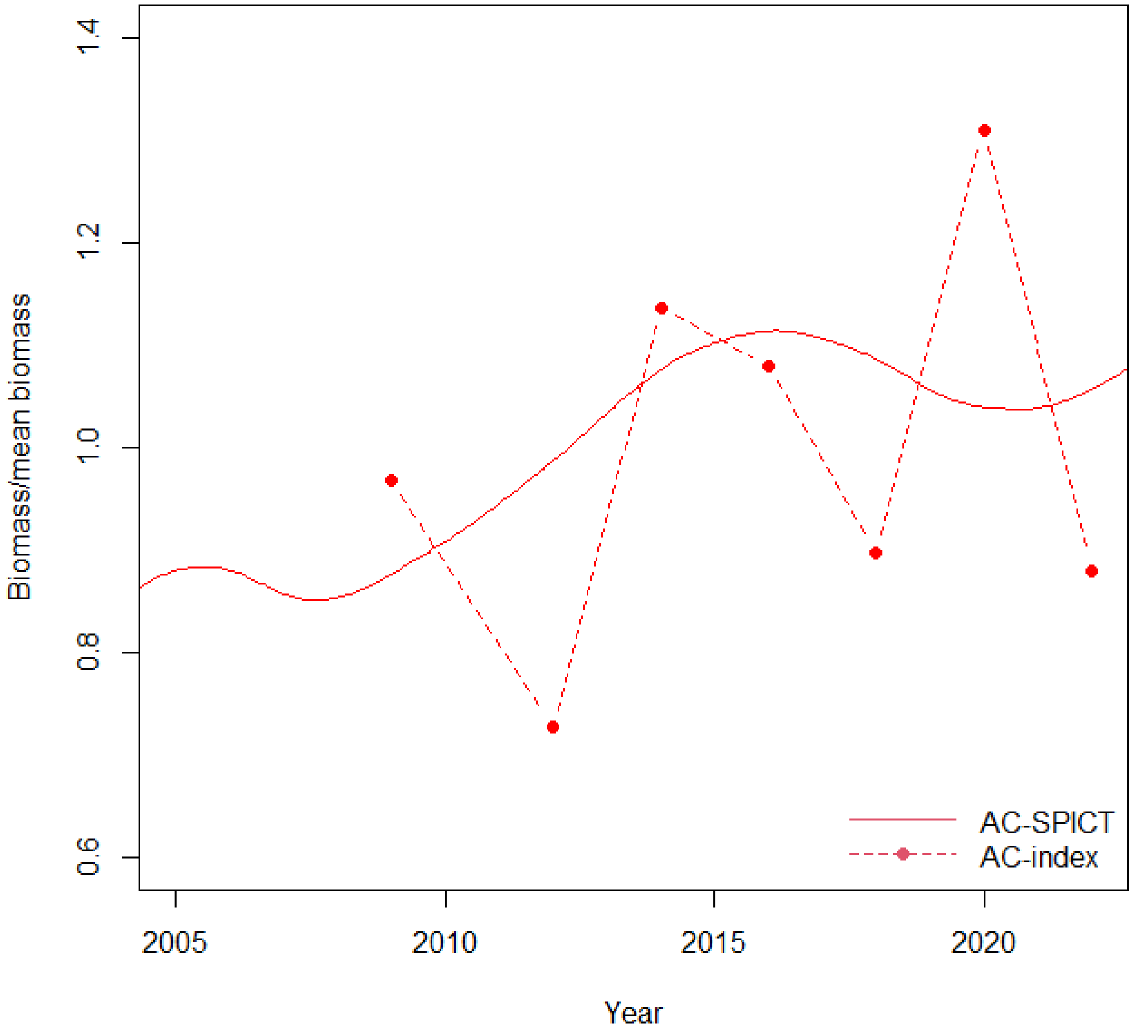


Figure 6.2.21. Relative biomass (estimated biomass/mean) from the SPiCT analysis with the acoustic index from the Norwegian slope survey.

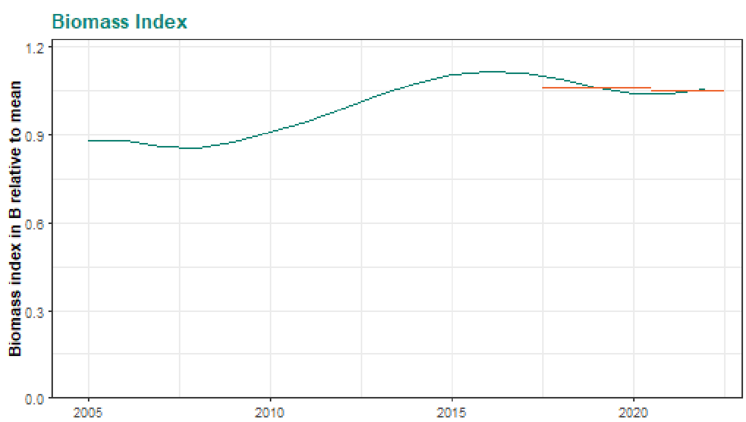


Figure 6.2.22. Relative biomass (estimated biomass/mean) used in rfb-rule, index A and index B.

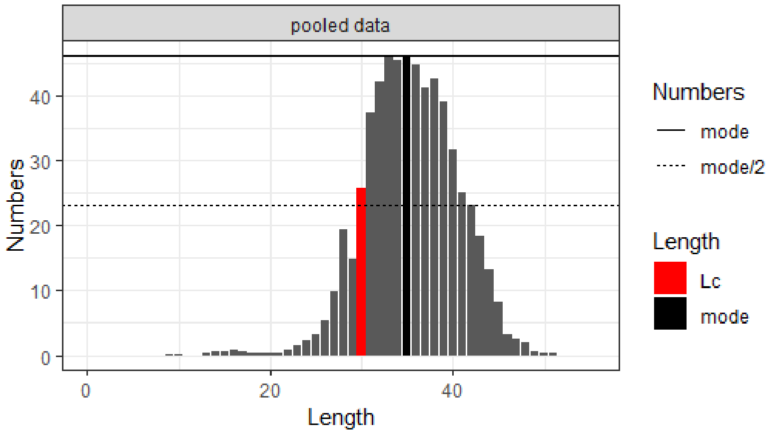


Figure 6.2.23. Pooled length distributions (year 2015-2022), including Lc and mode length.

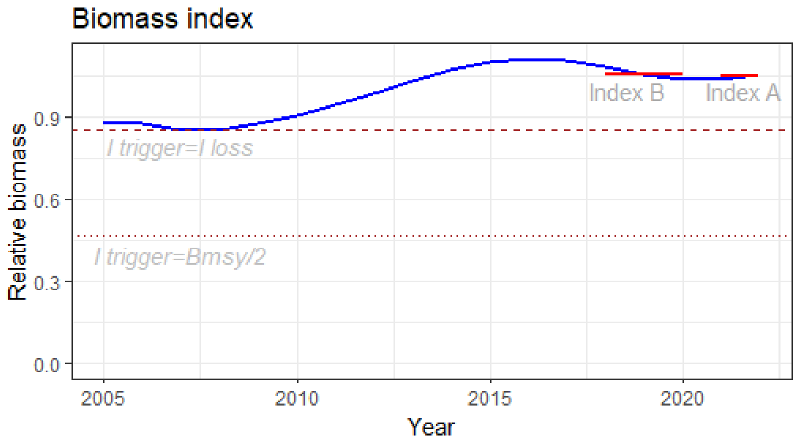


Figure 6.2.24. Relative biomass used in rfb-rule, including lines showing index A, index B, $I_{trigger}$ = I_{loss}, and $I_{trigger}$ = B_{MSY}/2.

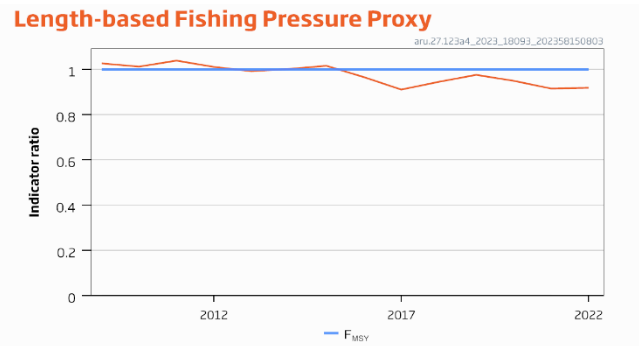


Figure 6.2.25. Length-based fishing pressure proxy. Indicator ratio LF= M/Lmean (inverse of the indicator ratio, f) from the length-based indicator (LBI) method is used for the evaluation of the exploitation status. The proxy fishing pressure is less than that corresponding to the FMSY proxy (LF= M) when the indicator ratio value is lower than 1 (shown by the horizontal blue line).

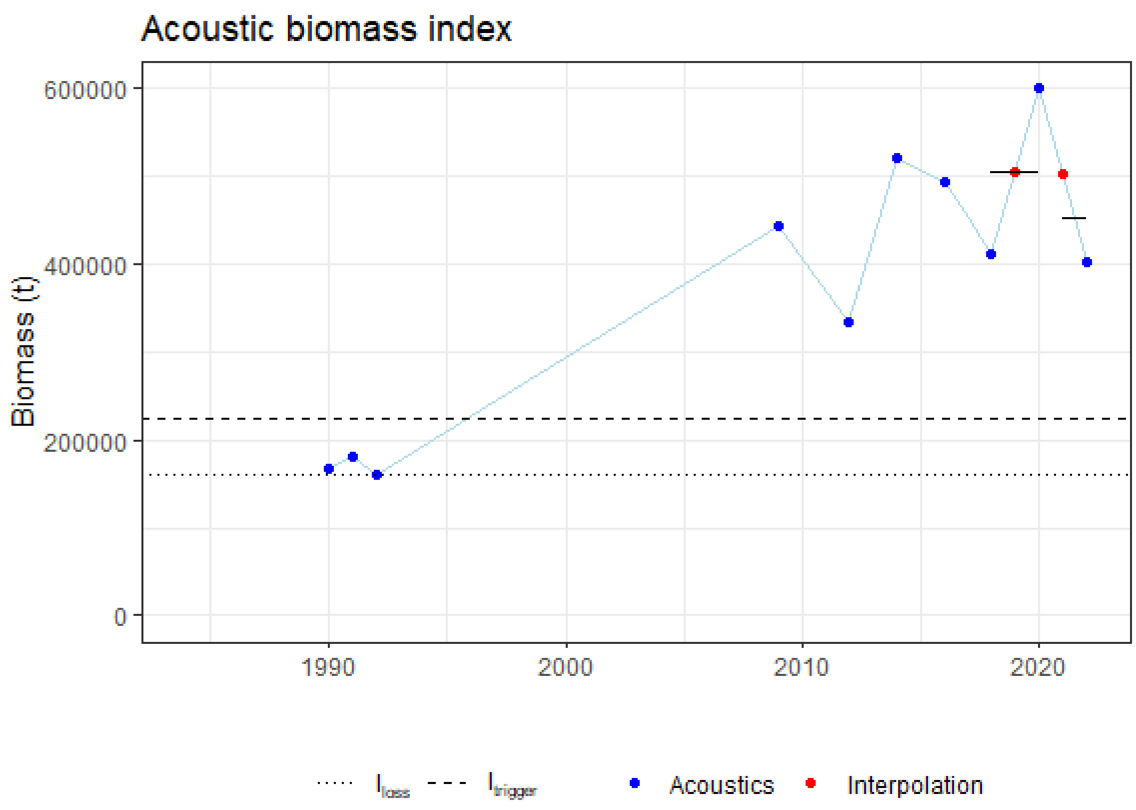


Figure 6.2.26. Acoustic biomass used in rfb-rule Reference valus I_{loss} and $I_{trigger}$ are shown, and index value A and B (blak solid lines).

6.3 Greater silver smelt (*Argentina silus*) in 5.a and 14

6.3.1 The fishery

Greater silver smelt is mostly fished along the south and southwest coast of Iceland, at depths between 500 and 800 m, as targeted fishing is only allowed at depths greater than 400 m (Figure 6.3.1). 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. This caused the landings to increase significantly in the past with the highest amount recorded in 2010, despite relatively low recent levels (Table 6.3.1).

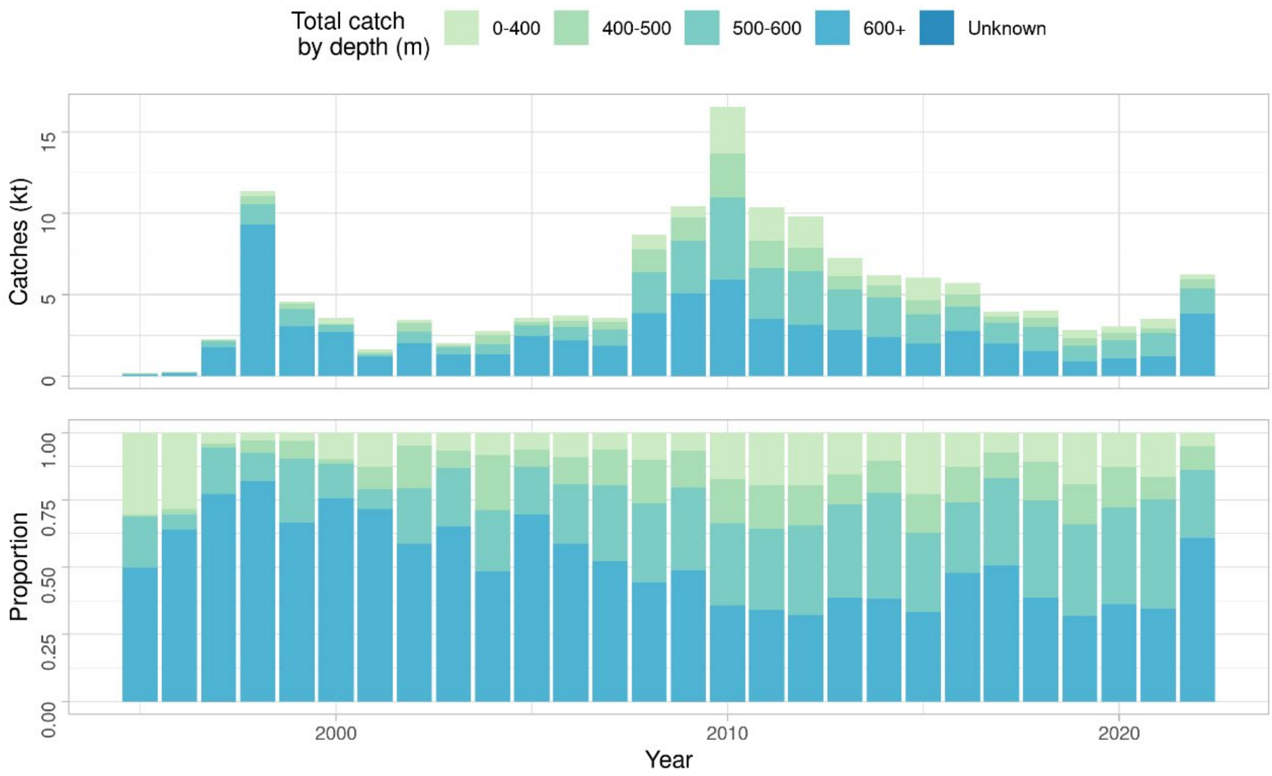


Figure 6.3.1: Greater silver smelt in 5.a and 14. Depth distribution of catches in 5.a according to Icelandic logbooks. All gear combined.

Table. 6.3.1. Greater silver smelt in 5.a and 14. Landings (tonnes) records from the Icelandic directorate of Fisheries and Greenland (WD05, annexed to this report).

Year	Inside the NEAFC RA	Outside the NEAFC RA		Landings (tonnes)
		Section 5.a	Section 14.b	
1988				240
1989				8
1990				113
1991				246
1992				657
1993				1526
1994				756
1995				586
1996				881
1997				3935
1998				15242

Year	Inside the NEAFC RA	Outside the NEAFC RA		Landings (tonnes)
		Section 5.a	Section 14.b	
1999				6681
2000				5657
2001				3043
2002				4960
2003				2680
2004				3645
2005				4482
2006				4769
2007				4227
2008				8778
2009				10828
2010				16428
2011				10516
2012				9289
2013	0	7155		7155
2014	0	6344	4	6348
2015	0	6058	12	6070
2016	0	5646	16	5662
2017	0	4344	666	5010
2018	0	4035	425	4460
2019	0	3208-9	1	3210
2020	0	3775	22	3797
2021	0	4140	15	4155
2022	0	6886	28	6914

6.3.2 Fleets

Since 1996 between 20 and 40 trawlers have annually reported catches of greater silver smelt in 5.a (WGDEEP 2019, Table 6.3.2). The trawlers participating in the greater silver smelt fishery also target redfish (*Sebastes marinus* and *S. mentella*) and to a lesser extent Greenland halibut and blue ling. The number of hauls peaked in 2010, but the number of hauls have decreased since then in line with lower total catches. In most years, over 50% of the greater silver smelt catches were taken in hauls where the species composed more than 50% of the catch (Table 6.3.2).

Table 6.3.2: Greater silver smelt in 5.a. Information on the fleet reporting catches of greater silver smelt.

Year	Number of trawlers	Number of hauls	Reported catch (kg)	No. hauls which GSS > 50% of catch	Proportion of reported catch in hauls where GSS > 50%
1987	1	14	4740	3	0.6751055
1988	2	146	224700	50	0.5718736
1990	1	24	46350	10	0.6256742
1991	13	114	74210	7	0.2641153
1992	23	275	230782	16	0.2032221
1993	25	317	772031	98	0.7282091
1994	16	151	304550	52	0.7832868
1995	24	200	180736	21	0.4039040
1996	22	307	259660	29	0.4039898
1997	26	874	2281654	355	0.8216162
1998	40	2683	11388707	1991	0.9465763
1999	25	1509	4563652	810	0.8485031
2000	23	1301	3549812	608	0.7971971
2001	26	794	1606420	245	0.6920637
2002	32	1160	3158313	468	0.7440289
2003	30	1176	2005477	213	0.4732091
2004	27	1052	2732879	292	0.6527805
2005	30	1388	3557625	335	0.7069759
2006	31	1554	3735916	355	0.6897529
2007	27	1275	3469927	416	0.7179114
2008	31	3256	8568592	848	0.6478629
2009	34	3555	10425146	1010	0.6804055
2010	36	4846	16499826	1821	0.7271470
2011	34	3309	10237373	961	0.7151100
2012	31	3395	9775676	988	0.7103783

Year	Number of trawlers	Number of hauls	Reported catch (kg)	No. hauls which GSS > 50% of catch	Proportion of reported catch in hauls where GSS > 50%
2013	31	2743	7246715	609	0.6418890
2014	24	2363	6195337	487	0.6076312
2015	24	2195	5835439	356	0.5735490
2016	26	2096	5718623	385	0.5926304
2017	21	1363	3894310	236	0.5844221
2018	20	1440	3892702	215	0.4785869
2019	28	1169	2569762	143	0.5063064
2020	25	1170	2968000	174	0.4750000
2021	27	1166	3438890	189	0.6629520
2022	18	782	2802636	223	0.7358009

6.3.3 Targeting and mixed fisheries issues in the Greater Silver Smelt fishery in 5.a

6.3.3.1 Mixed fisheries issues: species composition in the fishery

Redfish spp. (*Sebastus marinus* and *S. mentella*) are the main bycatch species in the mixed fishery encompassing 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 (ICES 2021).

6.3.3.2 Spatial distribution of catches through time

Spatial distribution of catches (5.a and 14) in 2000– 2021 is presented in Figure 6.3.2 and Figure 6.3.3. Most of the catches have been from the southern edge of the Icelandic shelf. However, since 1993, there has been a gradual increase in the proportion caught in the western area and even in the north western area. The likely reason for this is that the fleet focusing on redfish and Greenland halibut in more northern regions also takes a few hauls of greater silver smelt in the area (Figure 6.3.2).

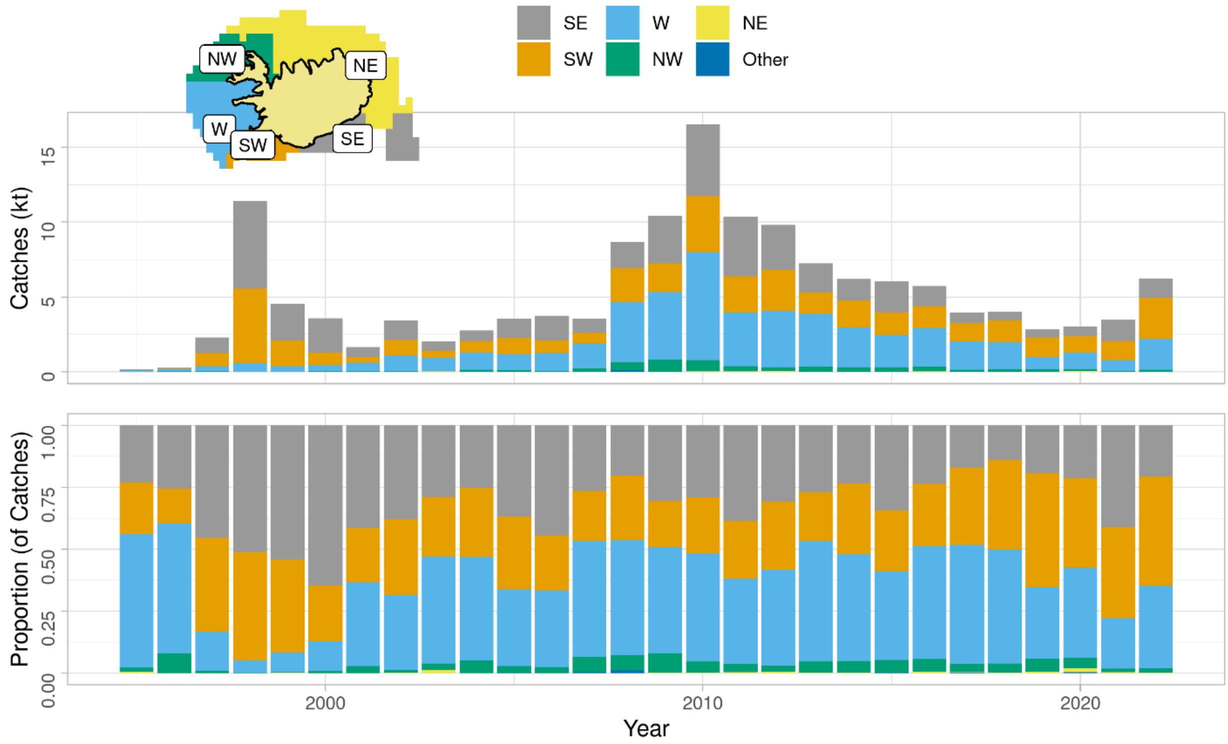


Figure 6.3.2: Greater silver smelt in 5.a and 14. Spatial distribution of catches defined by regions deeper than 400 m by year (See stock annex for details). Above are the catches on absolute scale and below in proportions. All gears combined.

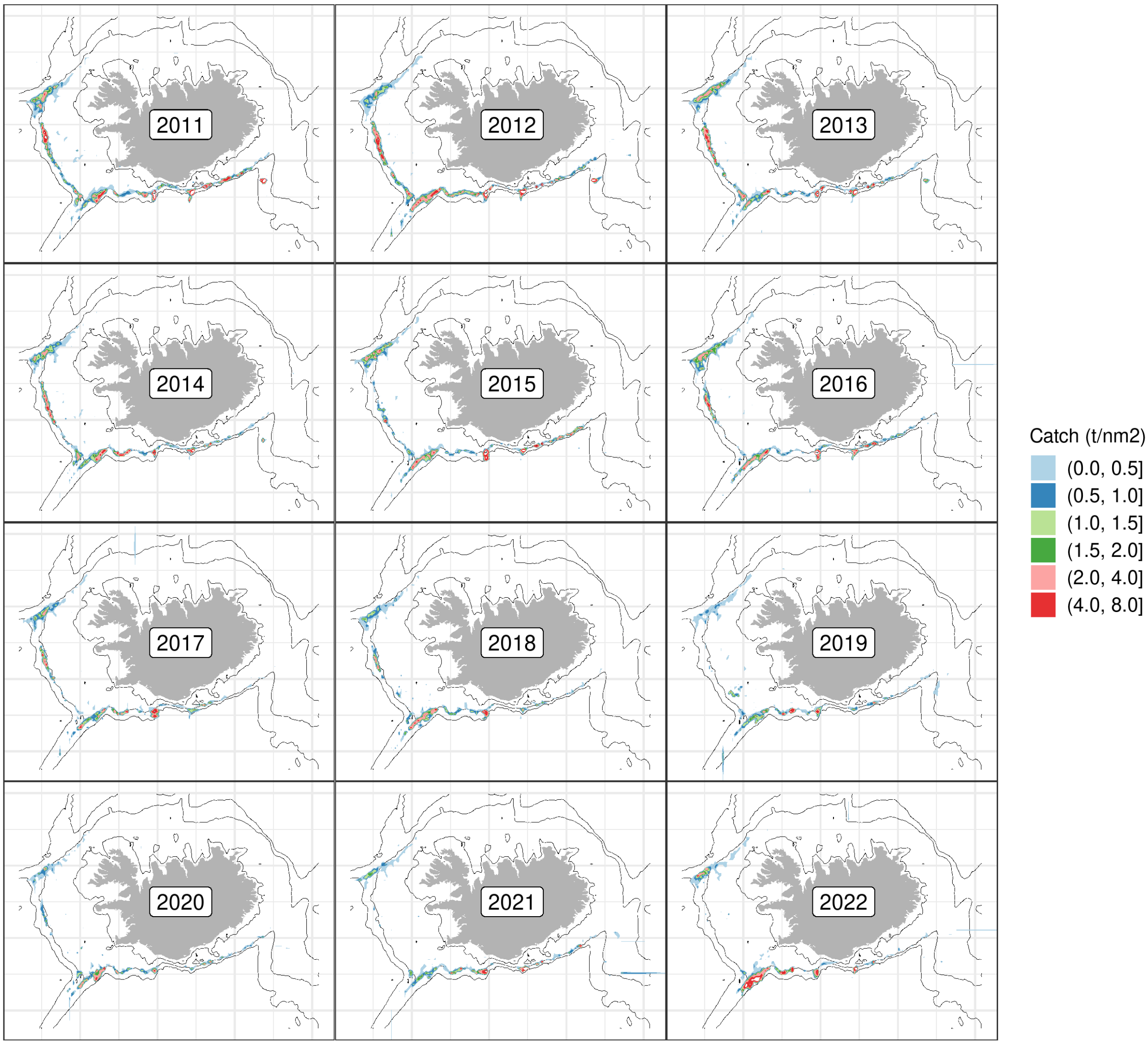


Figure 6.3.3: Greater silver smelt in 5.a and 14. Spatial distribution of the Icelandic fishery catches as reported in logbooks. All gears combined.

6.3.4 Landing trends

Landings of Greater Silver Smelt are presented in Table 6.3.1 and Figure 6.3.4. 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 2 600 to 6 700 t. After 2007 landings increased substantially, from 4 200 t in 2007 to almost 16 500 t in 2010. In 2011 landings started to decrease due to increased management actions, and landings in 2022 amounted to 6914 tonnes in 14 and 5.a. Substantial landings were reported in Greenlandic waters in 2017 and 2018; however, these exploratory directed fisheries appear to have ceased in 2019 but should be monitored for reappearance.

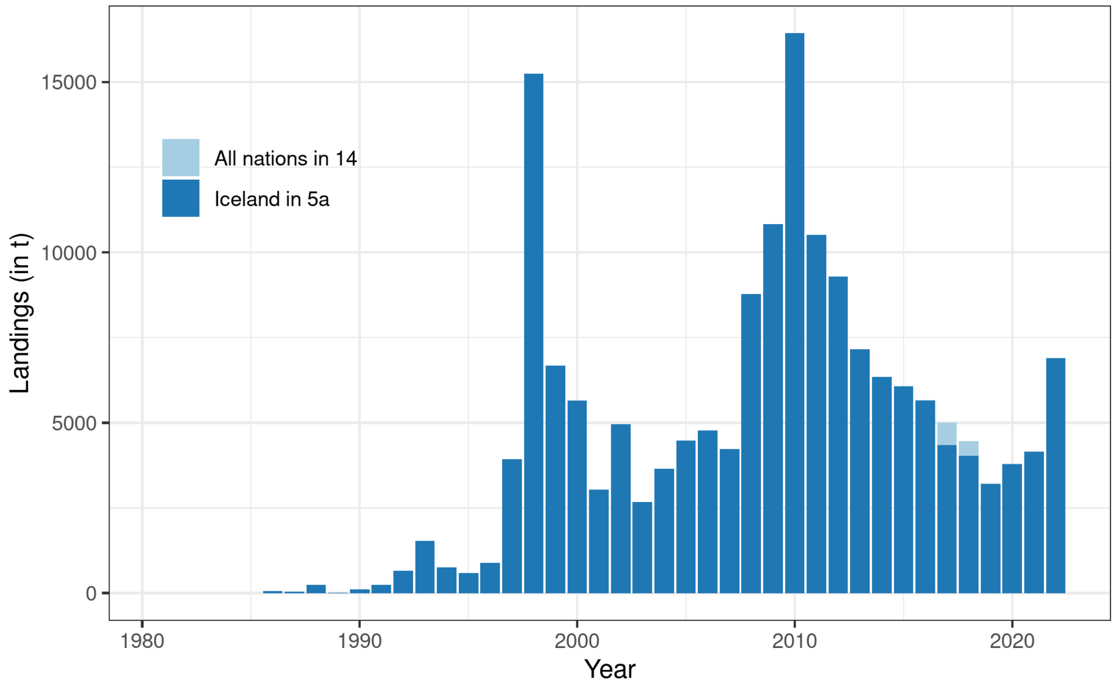


Figure 6.3.4: Greater silver smelt in 5.a and 14. Nominal landings. 23 tonnes were landed by foreign vessels (England and Wales) in 1999, which is the only year of catches reported by foreign vessels.

6.3.5 Data available

In general sampling is considered representative from commercial catches, as one of the requirements of owning a fishing license for greater silver smelt is the retention of scientific samples (Table 6.3.3). Samples were only obtained from bottom trawls. The sampling does seem to cover the spatial and temporal distribution of catches. The sampling coverage in 2020 is shown in Figure 6.3.5. However, recent years have experienced a large decline in sampling. No age data were collected in 2019.

Table 6.3.3: Greater silver smelt in 5.a. Summary of sampling intensity and overview of available data.

Year	No. length samples	No. length measurements	No. otolith samples	No. otoliths	No. otoliths aged
1997	48	4991	31	1447	1059
1998	148	15557	114	6966	889
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	
2004	34	996	7	225	84
2005	49	3708	14	772	
2006	29	4186	13	616	525
2007	14	2158	8	285	272

Year	No. length samples	No. length measurements	No. otolith samples	No. otoliths	No. otoliths aged
2008	44	3726	39	1768	1387
2009	53	5701	36	1746	1574
2010	134	16351	68	3370	3120
2011	63	6866	40	1953	1774
2012	43	4440	31	1492	603
2013	47	4925	34	710	704
2014	39	4709	16	350	340
2015	11	1275	8	221	217
2016	45	5879	13	285	283
2017	29	3466	21	430	416
2018	12	1437	9	185	181
2019	8	1010	0	40	40
2020	8	1566	2	130	130
2021	13	1205	4	195	194
2022	4	381	2	105	105

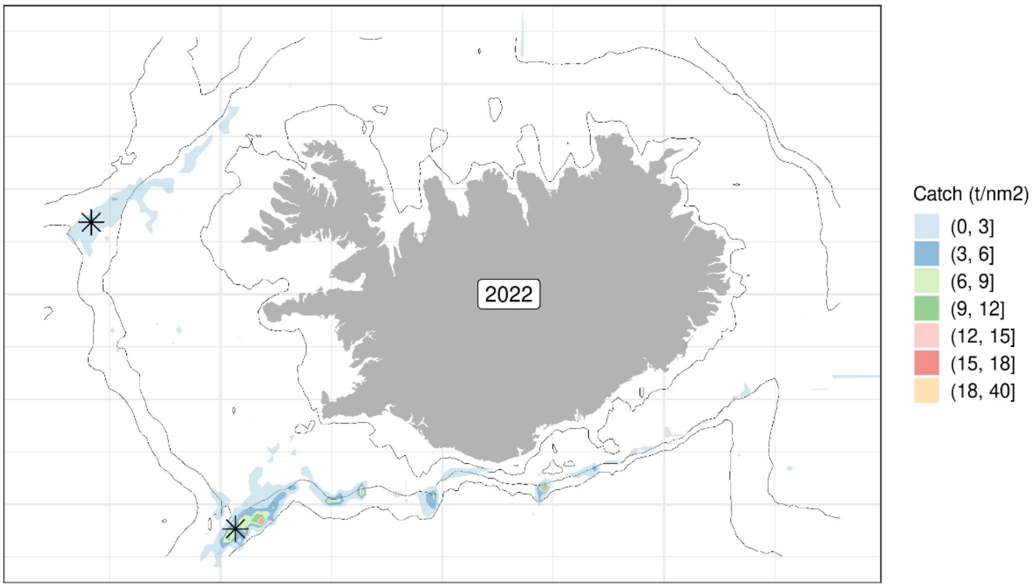


Figure 6.3.5: Greater silver smelt in 5.a and 14. Fishing grounds in 2022 as catches reported in logbooks (tiles) and positions of samples taken from landings (asterisks).

6.3.6 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.

6.3.7 Catch, effort and research vessel data

6.3.7.1 Catch per unit of effort and effort data from commercial fisheries

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.

6.3.7.2 Icelandic survey data

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. The survey may be indicative of recruitment; however, the data have not been explored in sufficient detail to be used for this purpose. 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, as it covers deeper waters where larger greater silver smelt are found and fished (> 400 m, due to a regulation requiring this). Figure 6.3.6 gives trends in biomass density and juvenile density (numbers) for the spring survey in 1985 to 2022 and for the autumn survey to 2021. Figure 6.3.7 gives the most recent catch quantities and locations of surveys. 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 because 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. For example, survey indices in 1999, 2014, 2021 and 2022 are especially high in comparison with survey indices from adjacent years (Figure 6.3.6). For this reason, winsorisation has been done in the past to reduce the effects of these hauls. However, winsorisation is not necessary for the gadget model and has not been used since 2020. No substantial changes in proportional catch by area is seen in general (Figure 6.3.8).

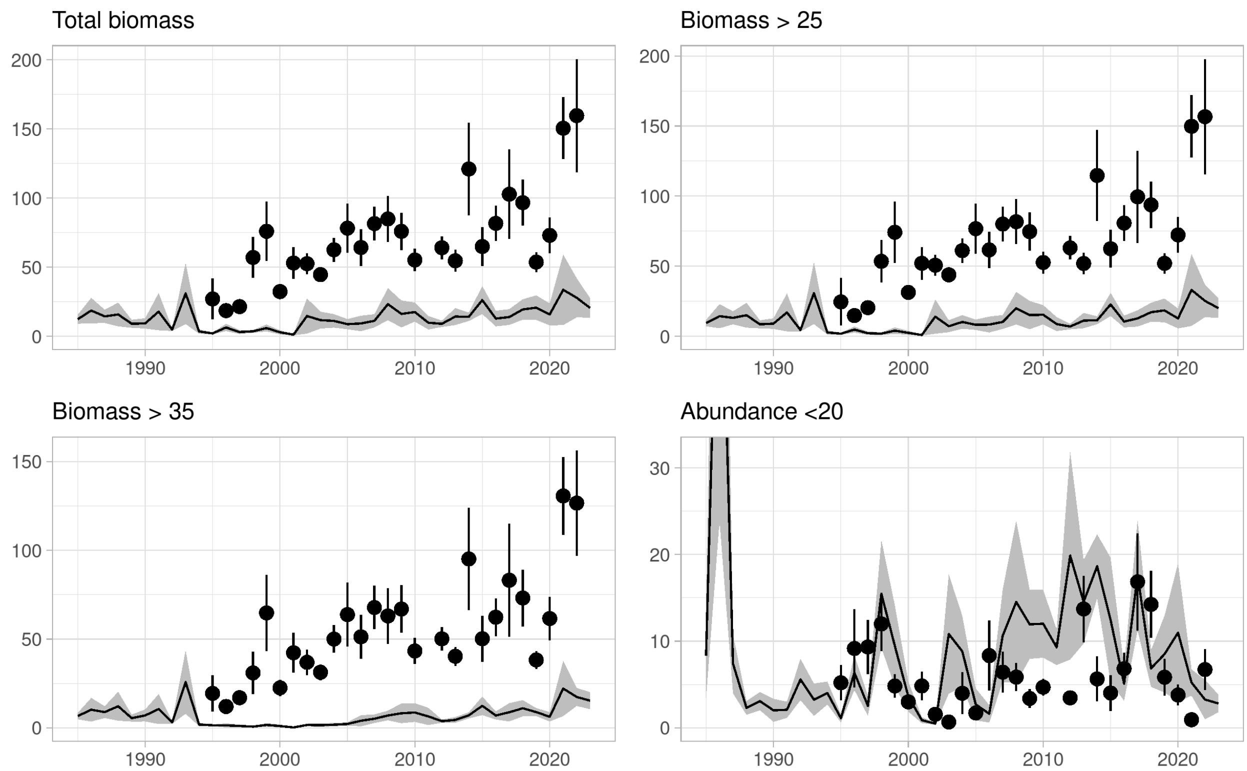


Figure 6.3.6. Greater silver smelt in 5.a and 14. Indices calculated from the Icelandic spring survey (black lines and shaded area) and from the autumn survey (dots and vertical lines). Vertical lines and shaded area represent +/- 1 standard error.

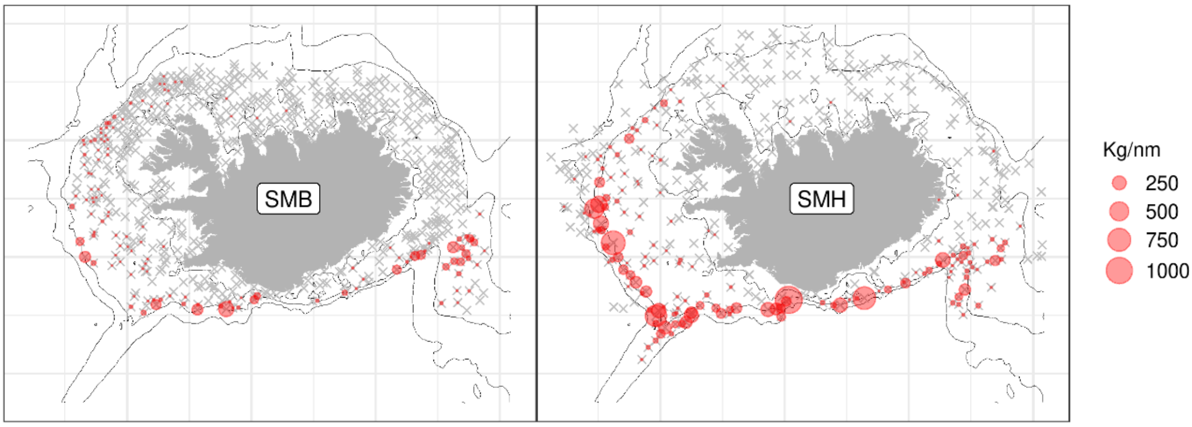


Figure 6.3.7: Greater silver smelt in 5.a and 14. Abundance and distribution of greater silver smelt in the spring survey (SMB) in 2023 and in the autumn survey (SMH) in 2022.

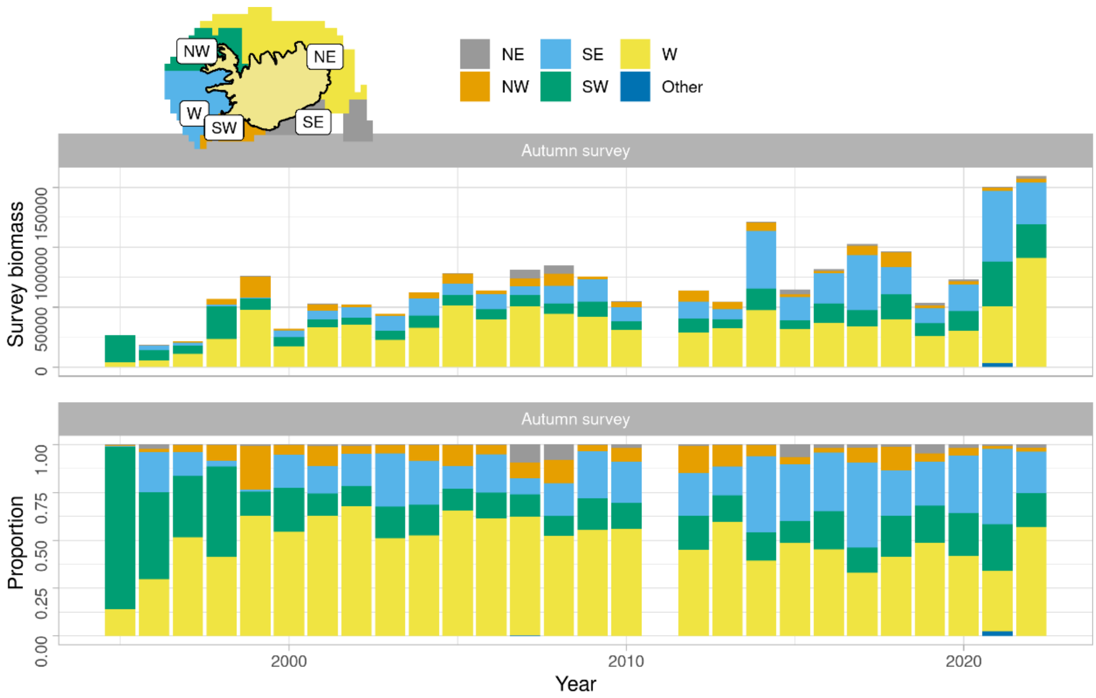


Figure 6.3.8: Greater silver smelt in 5.a and 14. Estimated survey biomass in the autumn survey by year from different parts of the continental shelf (upper panel) and as a proportion of the total (lower panel).

6.3.7.3 Length compositions

Table 6.3.2 gives the number of samples and measurements available for calculations of catch in numbers of Greater Silver Smelt in 5.a. Length distributions from autumn survey and commercial samples are presented in Figure 6.3.9 and Figure 6.3.10 respectively. Length distributions from the autumn survey are rather stable, with 2022 being close to the long-term average (Figure 6.3.9).

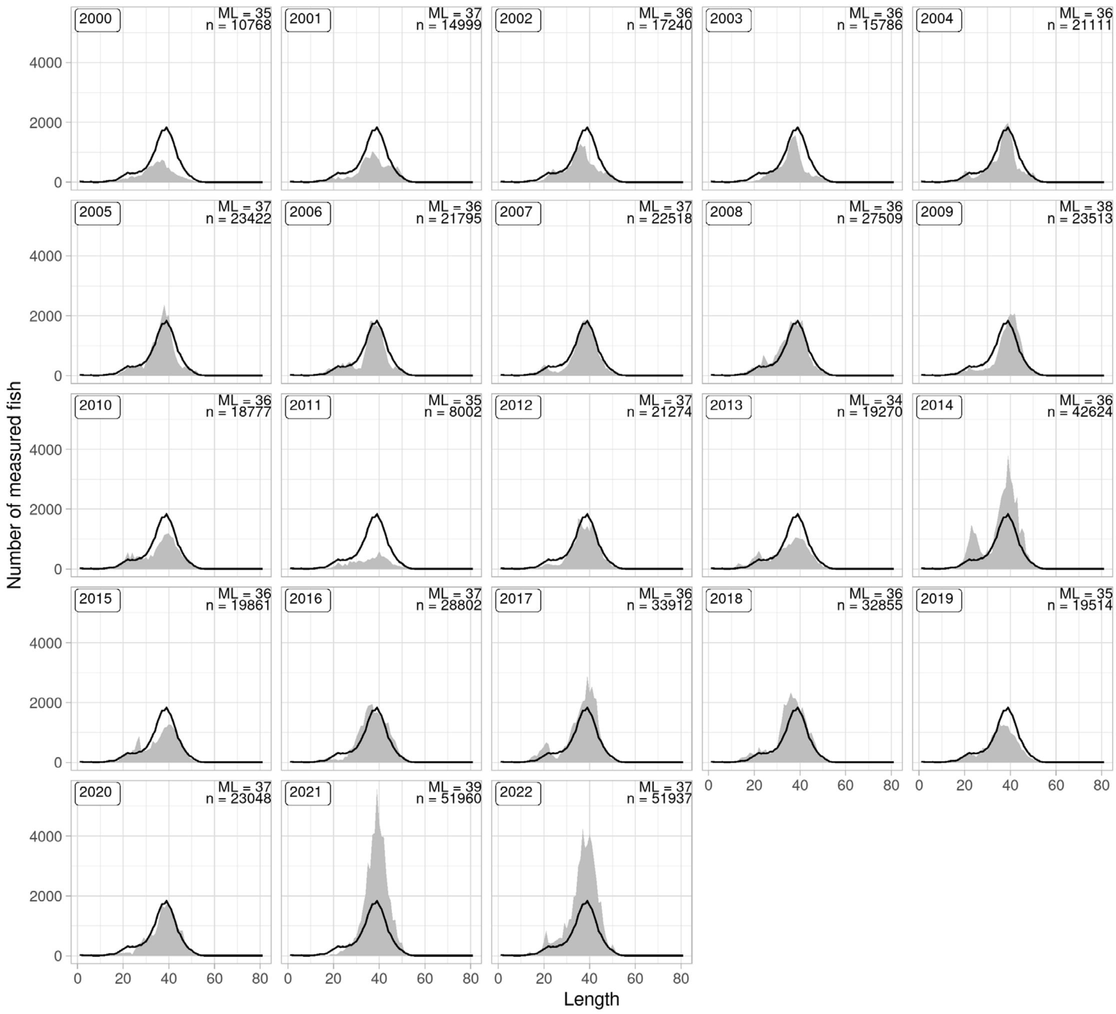


Figure 6.3.9: Greater silver smelt in 5.a and 14. Length distribution from the autumn survey. The black line shows the mean for all years.

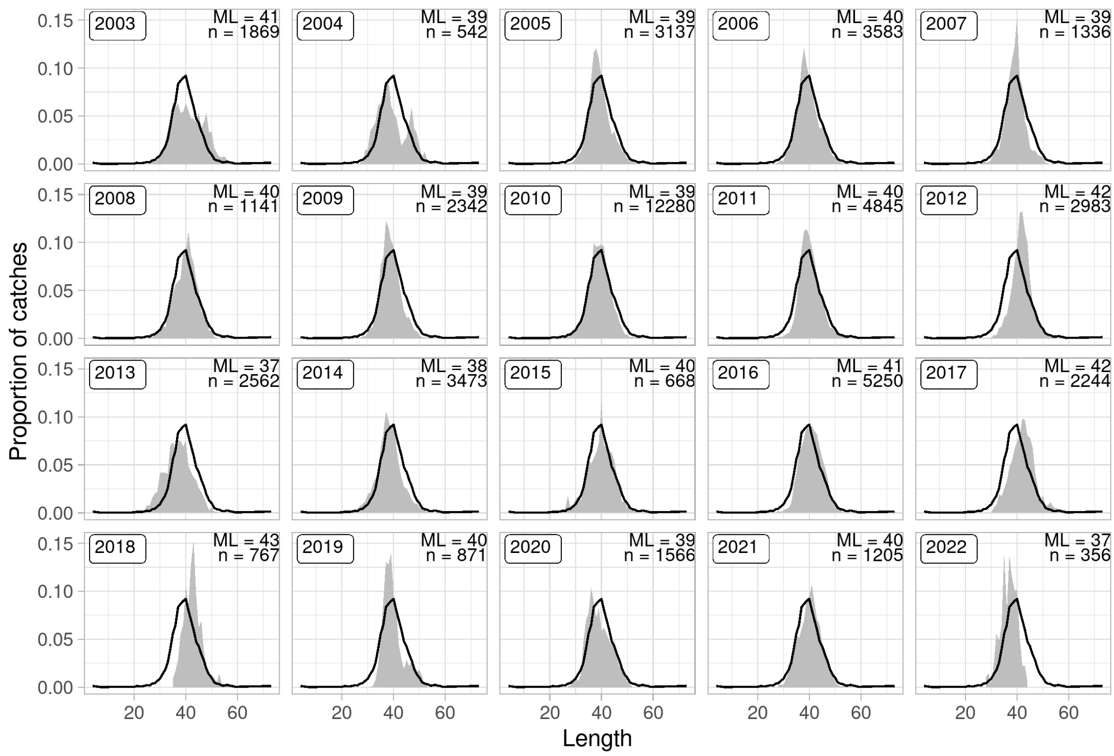


Figure 6.3.10: Greater silver smelt in 5.a and 14. Length distributions from commercial catches.

6.3.7.4 Age compositions

Table 6.3.2 gives the number of samples and measurements available for calculations of catch in numbers of greater silver smelt in 5.a. Age distributions estimated as catch in numbers are given in Figure 6.3.11 & 6.3.12.

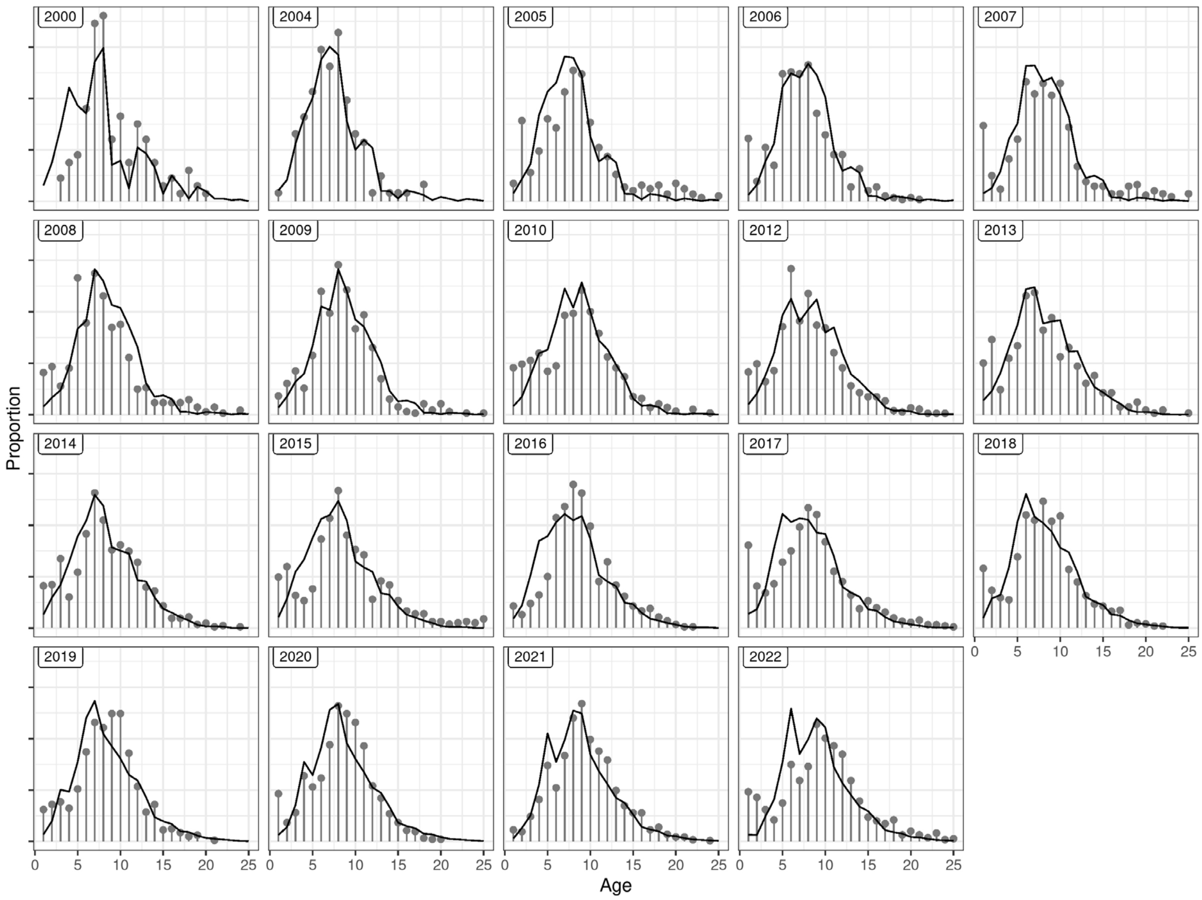


Figure 6.3.11: Greater silver smelt in 5.a and 14. Age distributions in proportions in 5.a from the Icelandic autumn survey.

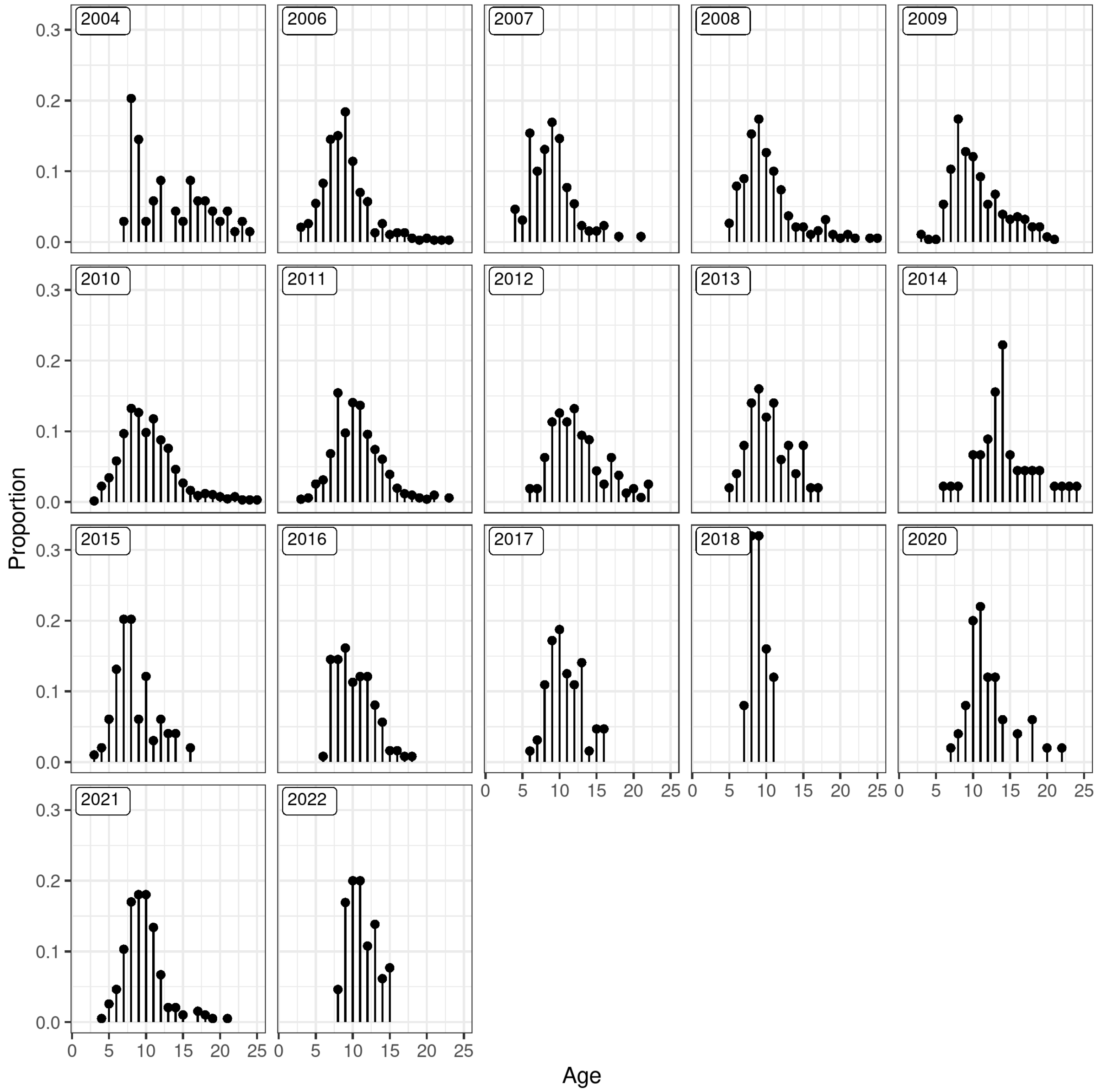


Figure 6.3.12: Greater silver smelt in 5.a and 14. Catch in numbers at age. Estimates for 2002 are based on limited number of aged otoliths. No age data are available for 2019.

6.3.7.5 Weight at age

Biological data from spring, fall, and commercial data were combined to analyse growth. Von Bertalanffy growth curves were fitted and plotted within a series of time periods, including 2016–2019, 2011–2015, 2006–2010, 2001–2005, 1994–2000, and prior to 1994 to increase sample sizes for estimating each curve. The exponential length–weight relationship is extremely consistent across periods. In general, there is very little variation between periods, although females can be seen to grow to larger sizes than males.

6.3.7.6 Maturity at age and natural mortality

Estimates of maturity ogives of greater silver smelt in 5.a were presented at the WKGSS 2020 meeting for both age and length (WKGSS 2020) 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.

6.3.8 Data analyses

6.3.8.1 Landings and sampling

Spatial distribution of catches in 5.a did not change markedly between 2015 and 2016 and fishing for greater silver smelt in the NW area seems to have stopped (Figure 6.3.2 and Figure 6.3.3). 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 6889 tonnes in 2022 (Figure 6.3.4 and Table 6.3.1). 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 which can also be seen in recent years (Figure 6.3.10). 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. However, as is the case for mean length, mean age in catches in 2012 increased, and is estimated closer to 11 years in the most recent years (Figure 6.3.12). The reason for this change is not known as there is no marked difference in the spatial distribution of the fishery; however, reduced fishing pressure may be a factor.

6.3.9 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 (without stratification). 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 2022 are at a higher level than in 1994–2001. The juvenile index (spring survey) has a very high peak in 1986 but then hardly any juveniles are detected in the survey in 1987 to 1995. Since 1998 there have been several small spikes in the recruitment index (Figure 6.3.6).

The observed trends in the biomass indices from the autumn survey have a considerably different trend than those observed in the spring survey (Figure 6.3.6). 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 a high value, and thereafter has been relatively stable but with high variability. In 2021, the index peaked and in 2022, the highest value in the timeseries was observed.

There is a clear gradient in mean length of greater silver smelt with depth, larger fish being in deeper water, and therefore no abundance index is presented for the spring survey. 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 and is used in the advice procedure.

6.3.9.1 Analytical assessment using Gadget

In 2020 a model of greater silver smelt in Icelandic and Greenlandic waters developed in the Gadget framework (see http://www.hafro.is/gadget for further details) was benchmarked for the use in assessment (WKGSS 2020). In 2022, Gadget version 3 was used instead of Gadget 2 which was used in the benchmark. Gadget 3 is the same in every way, except that it uses template model builder (TMB), which allows it to utilize TMB's automatic differentiation procedures. This way it produces models that can be optimized faster by using R optimisers (rather than gadget 2 which only has inbuilt optimisers). Further comparison between Gadget 2 and 3 can be found in working document nr 14.

6.3.9.2 Data used and model settings

Data used for tuning and model settings used in the Gadget model are described in more detail in the stock annex (ICES 2020).

6.3.9.3 Diagnostics

6.3.9.4 Observed and predicted proportions by fleet

Overall fit to the predicted proportional length and age–length distributions is close to the observed distributions, with the exception of a small peak of small-sized fish (Figures 6.3.14, 6.3.15, 6.3.16, 6.3.17). This peak does not shift from year to year and therefore is considered to exist because of high catchability in aggregations of small fish rather than cohorts in recruitment peaks. These peaks are likely absent from commercial data due to the requirement of fishing at > 400 m depth.

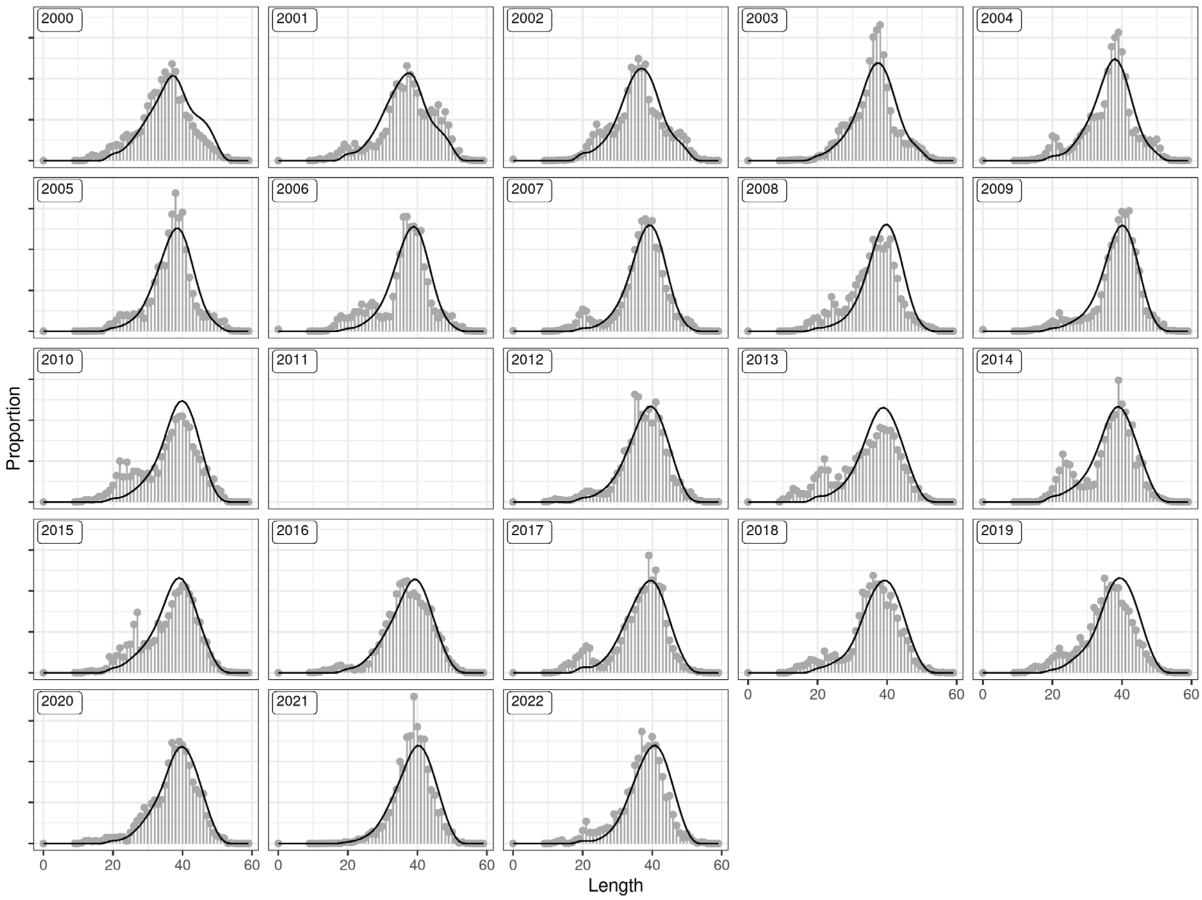


Figure 6.3.14: Greater silver smelt in 5.a. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions in the autumn survey (grey lines and points)

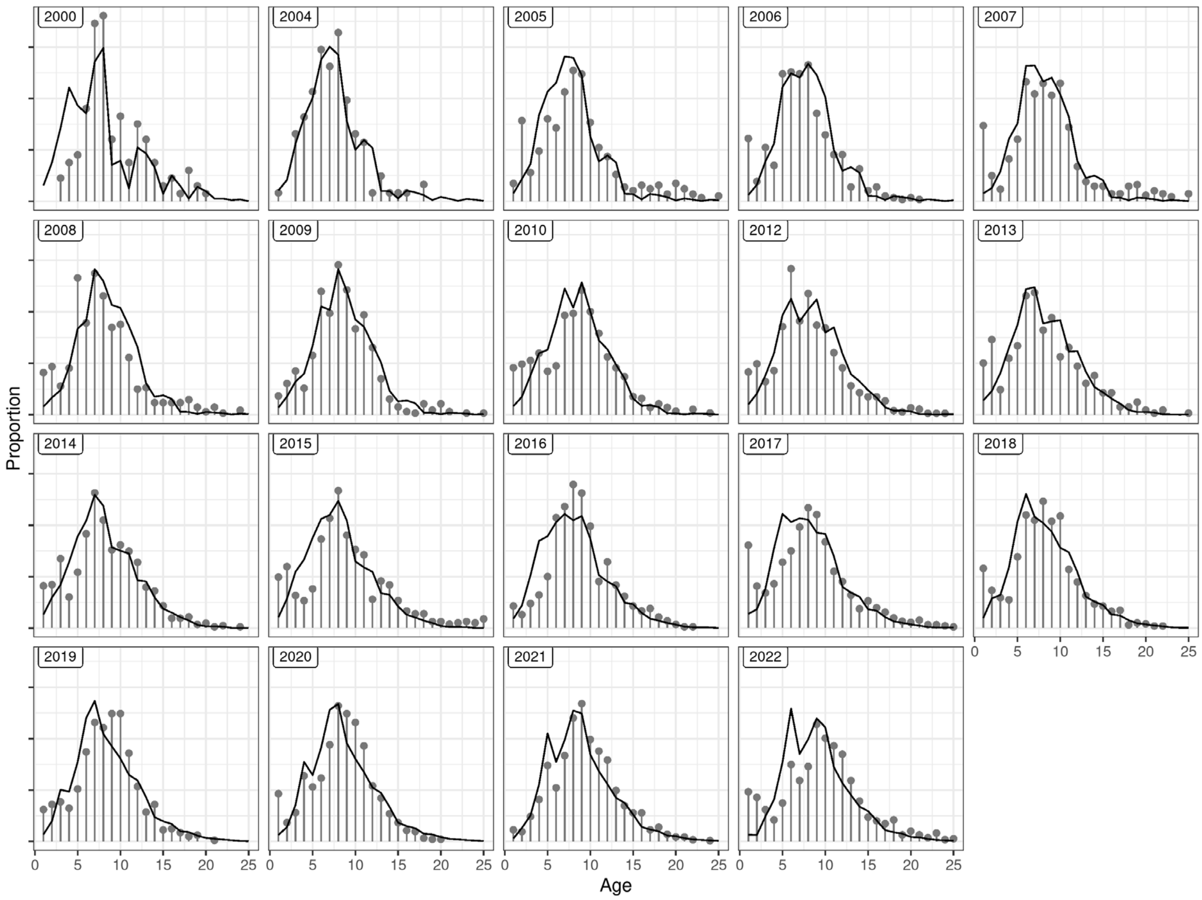


Figure 6.3.15: Greater silver smelt in 5.a. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions in the autumn survey catches (grey lines and points).

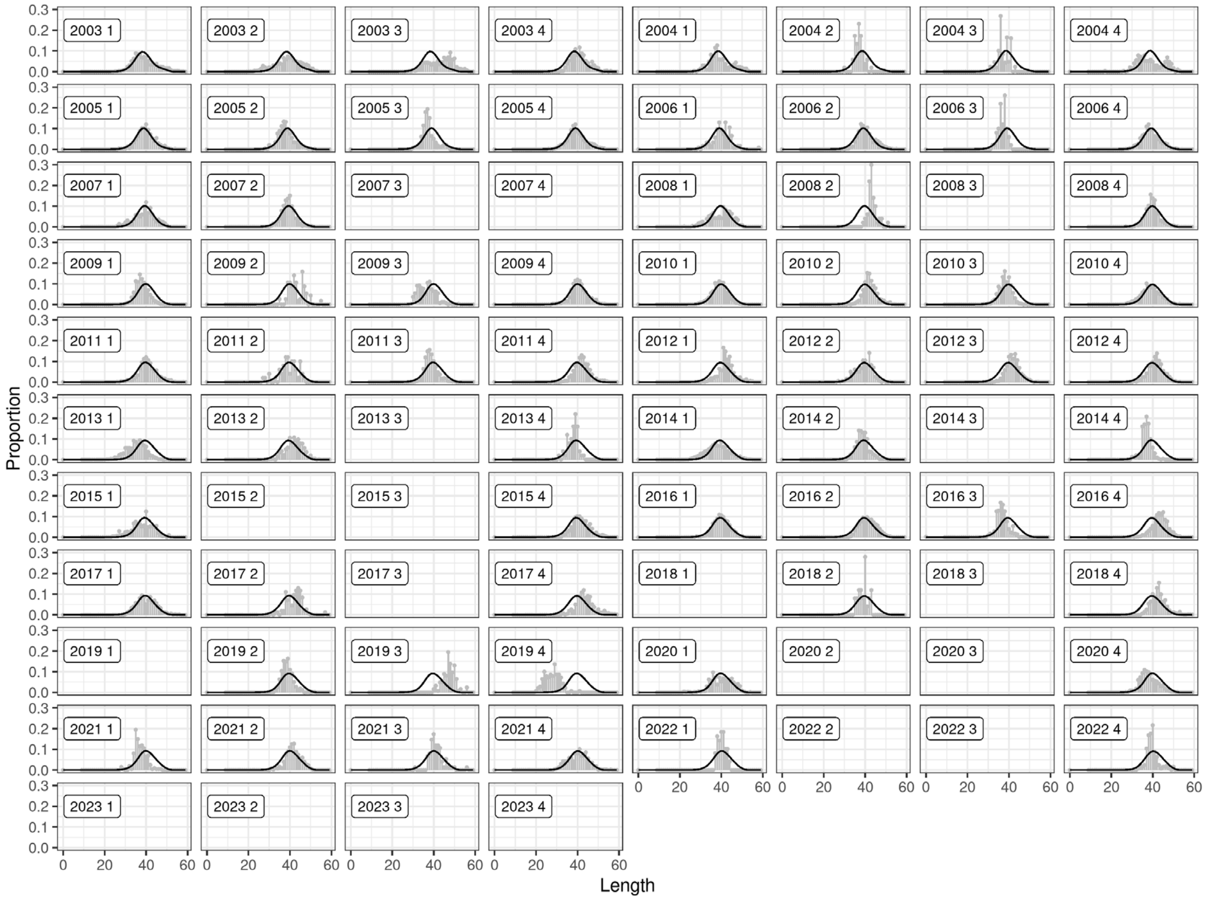


Figure 6.3.16: Greater silver smelt in 5.a. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions from commercial catches (grey lines and points).

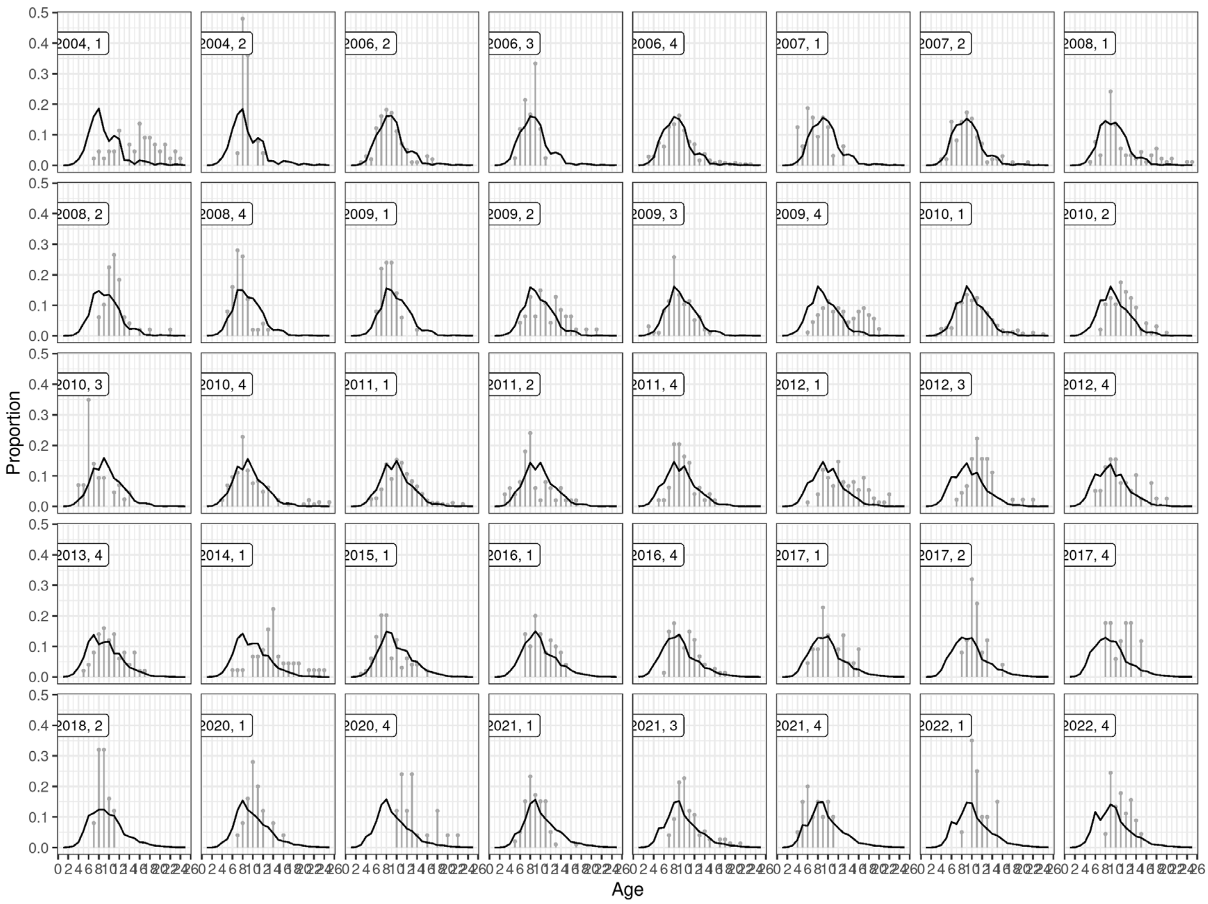


Figure 6.3.17: Greater silver smelt in 5.a. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions in commercial catches (grey lines and points).

6.3.9.5 Model fit

Figure 6.3.18 shows the overall fit to the survey indices described in the stock annex. In general, the model appears to follow the stock trends historically. In previous category 3 assessments of this stock, the autumn survey was winsorized due to high variability in the survey index, which can also be seen here, as survey indices are not winsorized or standardized before being used. The peak observed in the two smallest size classes (10-25 and 25-30) are likely due to selectivity and aggregation and not cohort dynamics. The terminal estimate has a large overestimation indicating the potential for overestimation of biomass However, this year's indices for large-sized fish are at a historical high, indicating that last year's values were more likely to be relatively accurate. These high values may be the result of high variability in the survey index numbers in general, however. If survey indices are lower again next year, the model fit is likely to experience a correction to lower predicted index values.

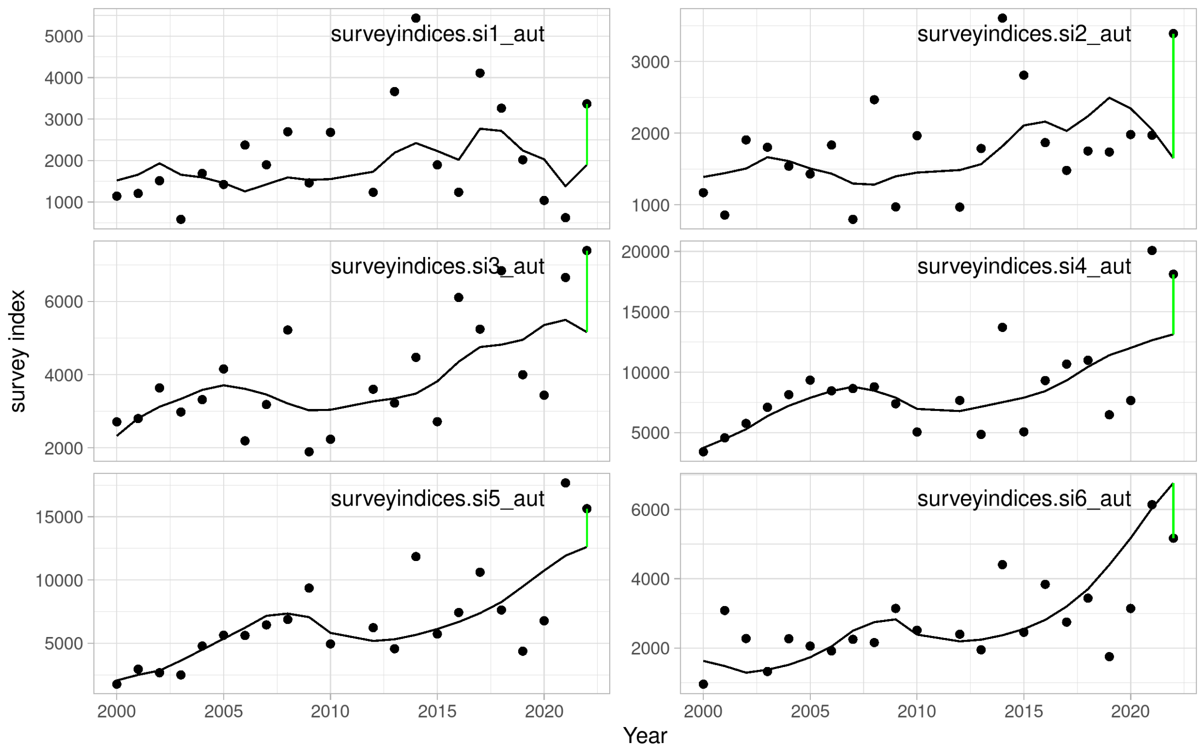


Figure 6.3.18: Greater silver smelt in 5.a. Fitted autumn survey index by length group from the Gadget model (black line) and the observed number of greater silver smelt caught in the survey (points). The green line indicates the difference between the terminal fit and the observations.

6.3.10 Results

The results are presented in Table 6.3.4 and Figure 6.3.19. Recruitment has been increasing over the past decade, but the most recent very high estimate in 2021 may be the result of recent high variability in survey indices, and are therefore likely to be revised downwards in the next few years. Spawning–stock biomass has increased since 2012 and reached the highest SSB estimate in 2021 after a slight decrease in 2020. Fishing mortality for greater silver smelt (age 6–14) has decreased from around 0.2 in 2010 to 0.04 over the past several years, due to greater regulation of the fishery as well as reduced commercial interest. Uncertainty was estimated by spatially bootstrapping the data and refitting the assessment model to resampled data. The spatial bootstrap entails refitting the model to 100 sets of data resampled by spatial areas to maintain spatial correlation in the data (see the stock annex). The base model assessment results appear unbiased as it corresponds well with the median of results (Figure 6.3.19) Asymmetry in the confidence intervals is likely to be the result of a small number of model runs with a set of resampled data that are a poor representation of the actual data. For this reason, it was suggested by WGDEEP to improve the spatial bootstrap methods so that they better represent variation in the data.

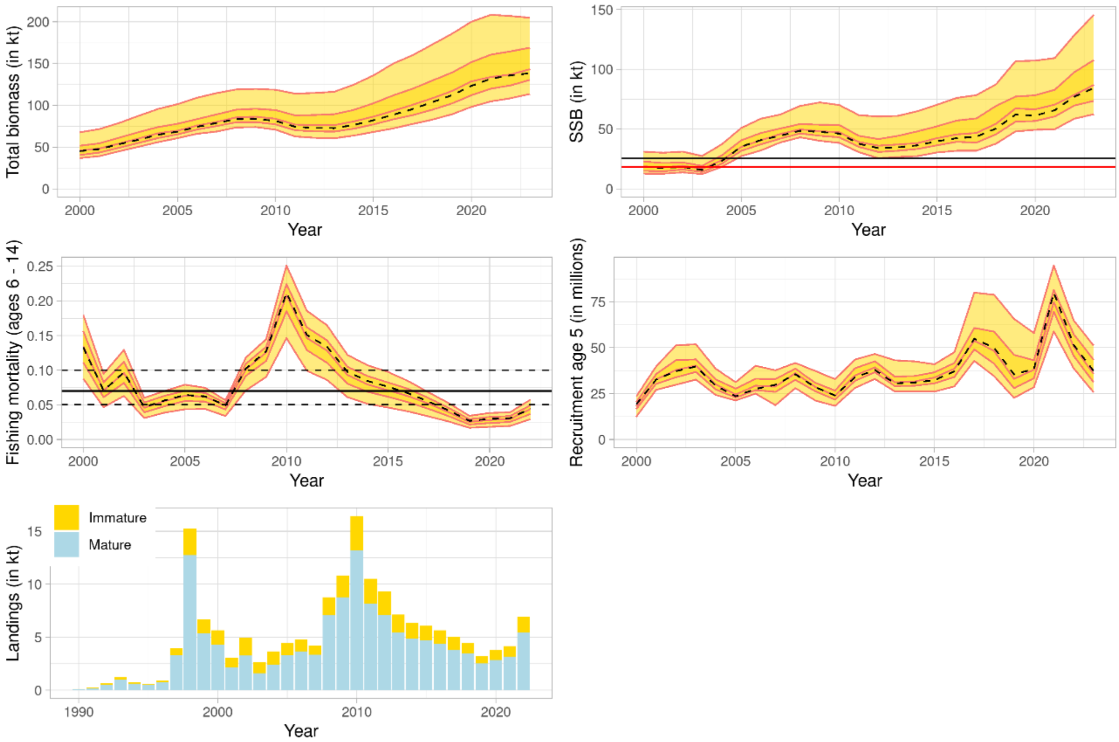


Figure 6.3.19: Greater silver smelt in 5.a and 14. Estimated biomass, spawning stock biomass (SSB), fishing mortality for fully selected fishes, recruitment and total catches. The black solid line in the SSB plot represents Bpa and the solid red line indicates Blim. The horizontal solid line in the fishing mortality plot indicates the fishing mortality used in the ICES MSY advice rule, whereas the horizontal dashed lines indicate the bounds of the realized fishing mortality resulting from the advice rule given the uncertainty in the assessment. Uncertainty was estimated by spatially bootstrapping the data and refitting the assessment model to resampled data. Outer yellow ribbons with red borders indicate 90% interquantile ranges, whereas inner yellow ribbons indicate 50% interquantile ranges. The central red line indicates the median, and the dashed red line is the base model run for the assessment upon which advice is based.

Table 6.3.4: Greater silver smelt in 5.a. Gadget assessment model results including input catch values (tonnes), estimated spawning stock biomass (SSB, tonnes), recruitment (Rec., age 5 in millions), and fishing mortality (age 5). Projections are given in the last year. All values in 2023 result from projections, as well as F and Catch values from 2022.

Year	Total Biomass	Catch	SSB	Rec.	F
2000	45118	5.657	18382	19.08215	0.133
2001	47556	3.043	17527	32.64511	0.07
2002	53394	4.961	18352	37.19779	0.097
2003	58708	2.68	15731	39.75649	0.047
2004	64762	3.645	23181	29.21376	0.056
2005	68392	4.482	35361	23.52586	0.064
2006	74260	4.769	40766	27.52963	0.062
2007	78868	4.227	44515	29.77001	0.049
2008	83431	8.778	48580	35.50917	0.102
2009	83704	10.828	47648	28.45587	0.127
2010	81310	16.428	46220	23.96504	0.211

Year	Total Biomass	Catch	SSB	Rec.	F
2011	74263	10.516	37651	33.78942	0.151
2012	72964	9.289	34076	37.84254	0.134
2013	72678	7.155	34690	30.54237	0.097
2014	76439	6.348	36379	31.05902	0.084
2015	82088	6.07	39812	32.26439	0.076
2016	88663	5.662	42368	37.11361	0.067
2017	95443	5.011	43544	54.86462	0.055
2018	103717	4.46	50414	49.92427	0.042
2019	112007	3.21	62072	35.40619	0.027
2020	123221	3.797	61228	38.40801	0.03
2021	131900	4.156	65763	79.98619	0.031
2022	135830	6.914	77111	51.55442	0.044
2023	138445	9.188	84291	36.54049	0.071

6.3.10.1 Retrospective analysis

An analytical retrospective analysis is presented. The analysis indicates that there were downward revisions of biomass over the first four years of the 5-year peel followed by a upward revision of biomass (SSB) over the last year. As a result, there was an upward then downward revision of F. Estimates of recruitment are decently stable.

Mohn's rho was estimated to be 0.062 for SSB, -0.032 for F, and 0.016 for recruitment.

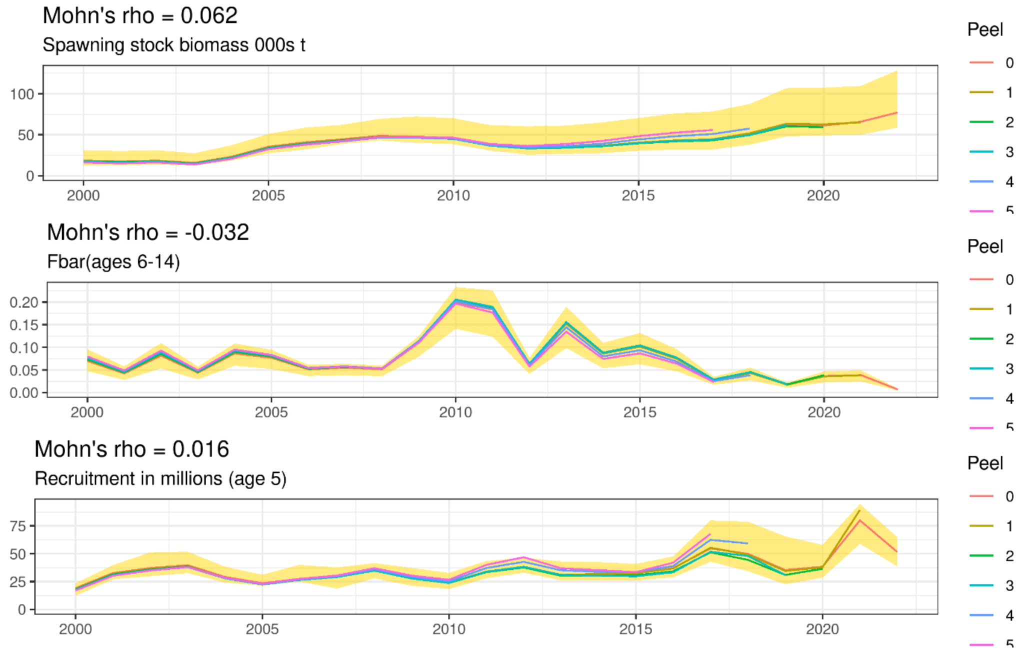


Figure 6.3.20: Greater silver smelt in 5.a and 14. Retrospective plots illustrating stability in model estimates over a 5-year 'peel' in data. Results of spawning stock biomass, fishing mortality F, and recruitment (age 5) are shown.

6.3.11 ICES advice

In 2020 this stock was benchmarked (WKGSS 2020) and a length- and age-based assessment was accepted as a category 1 assessment method. The ICES MSY advice rule is applied for this stock in 2021/2022 advice. Last year's advice amounted to 11520 tonnes.

6.3.12 Management

The Icelandic Ministry of Industries and Innovation 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. Before the 2013/2014 fishing year the Icelandic fishery was managed as an exploratory fishery subject to licensing since 1997. A detailed description of regulations on the fishery of greater silver smelt in 5.a is given in the stock annex (ICES 2016).

The TAC for the 2013/2014 fishing year was set at 8 000 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 8 000 t. For the fishing year 2015/2016 it was also maintained at 8 000 t, but was 7 885 t for 2016/2017, 9 310 t for 2017/2018, 7 603 t for 2018/2019, 9 142 t for 2019/20, 8729 for 2020/21, and 9244 for 2021/22 (Table 6.3.5). Flexibility is built into the Icelandic fisheries management system in which quota is automatically transformed for use for constraining species when it is available. As this stock is consistently caught at levels lower than the TAC in recent years, it has been a source of quota that may be used to fish other species (Table 6.3.5).

Table 6.3.5: Greater silver smelt in 5.a. TAC recommended for greater silver smelt in 5.a by the Marine and Fisheries Research Institute, national TAC and total landings.

Fishing Year	MFRI Advice	National TAC	Landings
2010/11	8 000		12 091
2011/12	8 000		8 410
2012/13	8 000		11 038
2013/14	8 000	8 000	7 243
2014/15	8 000	8 000	6 849
2015/16	8 000	8 000	6 018
2016/17	7 885	7 885	3 570
2017/18	9 310	9 310	5 159
2018/19	7 603	7 603	2 807
2019/20	9 124	9124	3775
2020/21	8729	8729	4282
2021/22	9244	9244	6550
2022/23	11520	11520	

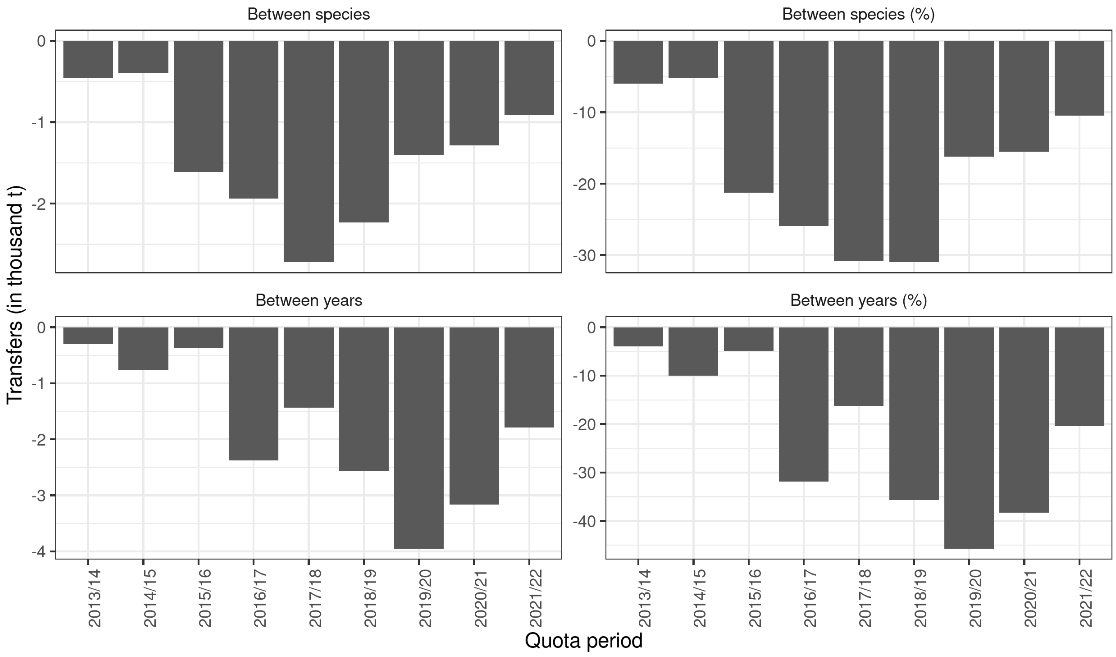


Figure 6.3.21: Greater silver smelt in 5.a and 14. An overview of the net transfers of quota between years and species transformations in the fishery in 5.a.

6.3.13 Current advisory framework

As a part of the WKGSS 2020 benchmark proceedings (WKGSS 2020), the following reference points were defined for the stock:

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	25.44 kt	B_{pa}
-	F_{msy}	0.14	Median F that maximises the median long-term catch in stochastic simulations with 7-year block-bootstrapped recruitment, scaled according to a hockey stick recruitment function with the breakpoint set to B_{lim}.
-	$F_{p.05}$	0.07	The fishing mortality that has an annual 5% probability of of SSB < B_{lim}.
Precautionary approach	B_{lim}	18.3 kt	SSB(2003), corresponding to B_{loss} as the fishing level in relation to F_{msy} is unclear and model uncertainty high
-	B_{pa}	25.44 kt	$B_{lim} * e^{1.645*\sigma}$ where $\sigma = 0.2$
-	F_{lim}	0.24	F corresponding to 50% long-term probability of SSB > B_{lim}
-	F_{pa}	0.16	$F_{lim}/e^{1.645*\sigma}$ where $\sigma = 0.25$
MSY advice rule	F_{msy}	0.07	F such that $F \leq F_{msy}$, $F \leq F_{pa}$, and $F \leq F_{0.05}$, long-term yield is consistent with MSY while leading to high stock biomass
-	MSY $B_{trigger}$	25.44	Set as B_{pa}

Figure 6.3.22: Greater silver smelt in 5.a and 14. Reference points.

The ICES MSY advice rule is applied for this stock. The decision which allocates catches to the fleets requires 1) an expected quantity of catch to be removed that will complete total catch removals for the current fishing season, 2) a 1-year projection to determine the amount of biomass available to fish, and 3) application of projected fishing effort according to F_{msy} to determine the expected catch from fishing at this level. Advised catch is set to this value while $SSB_y > B_{trigger}$, scaled by $\frac{SSB_y}{B_{trigger}}$ while while $B_{lim} \leq SSB_y < B_{trigger}$, and set to 0 while $SSB_y \leq B_{lim}$. Further information on how these reference points were generated and the model setting for short-term projections can be found in WKGSS 2020 report (WKGSS 2020).

The current intermediate year assumption regarding catch is set equal to the TAC during the fishing season (last quarter of year y and quarters 1 – 3 in year y + 1) and projections for the following year run at a selected harvest rate. However, the recommended TAC in recent years has been much higher than recorded landings. Therefore, for sensitivity analysis, projections were also run using intermediate year catch assumptions which are more indicative of recorded landings than TAC. Catches were previously assumed to be *status quo*, calculated as the average of the previous three years, but catches in 2022 were much higher than in previous years. The average of the previous three years is, hence, not representative of the current year. Catches were calculated by summing up the first quarter of 2023 with quarter 2 and 3 in 2021 and forecast catches at F_{mgt} in the fourth quarter.

Age 1 recruitment estimates are highly uncertain from the most recent three years. Therefore, in forecasts, it is proposed to use the geometric mean of the three years previous to these values (e.g. for 2023, this would be the geometric mean of age 1 recruitment estimates from years 2020–2022). The projected recruitment reported from the model output is for age 5 because recruitment estimated for ages 1-4 are highly uncertain.

6.3.14 Management considerations

Exploitation of greater silver smelt has been reduced in recent years, coming down from relatively high levels in 1998 and 2010, to levels lower than the average exploitation rate in the reference period.

6.3.14.1 Ecosystem considerations for management

Shorter periods of reduced biomass due to high fishing rates are observed in the history of greater silver smelt fishing in Iceland. However, there has been a general trend since the mid-1990s of a decrease in biomass levels from the mid-1980s to the mid-1990s, during which catch records are unreliable so the general reduction cannot directly be attributed to fishing, followed by a general increase in biomass in the past two decades. It is likely that a combination of lower fishing rates and favourable environmental conditions have led to high recruitment levels over the past decade.

6.3.15 References

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6.4 Greater silver smelt (*Argentina silus*) in 5 b and 6 a

6.4.1 The fishery

The fishery on greater silver smelt in Divisions 5.b and 6.a is mainly conducted by Faroese and European trawlers. In 2022, catches in 5.b were mainly taken by two pairs of Faroese pair trawlers deploying bentho-pelagic trawls (98%) while catches in 6.a were mostly taken by European trawlers (68%) and the remainder mainly by previously mentioned Faroese trawlers (24%, inside the Faroese EEZ) (Table 6.4.1 and Figure 6.4.1).

Historically, greater silver smelt was caught as bycatch in the shelf-edge deep-water fisheries and either discarded or landed in small quantities. The fishery for greater silver smelt in Faroese waters in 5.b did not develop until the mid-1990s and for 6.a in the early 1990s.

Fishing grounds for greater silver smelt in Faroese waters were located north and west on the Faroe Plateau and around the banks southwest of Faroe Plateau mainly at depths between 300 and 700 meters (mid-1990s to 2007). Since 2008 the Faroese fishery has extended fishing activities to include areas on the Wyville-Thomson Ridge south of the Faroe Plateau. Around 50% of the Faroese catches are caught on the Wyville-Thomson Ridge (in Divisions 5.b and 6.a, inside the Faroese EEZ) since 2012.

European fishery on silver smelt takes place mostly on the shelf edge within Divisions 6.a, 5.b and 4.a. Information from the self-sampling program carried out by the European fisheries (Pelagic Freezer-trawler Association, PFA) has been presented since 2018. The self-sampling program consists of historical information derived from skipper's notes (2002 - present) and new information collected as part of the research program within the PFA. An overview of catch rates of silver smelt (*Argentina spp.*) from both the Faroese and European fisheries is shown in Figure 6.4.2.

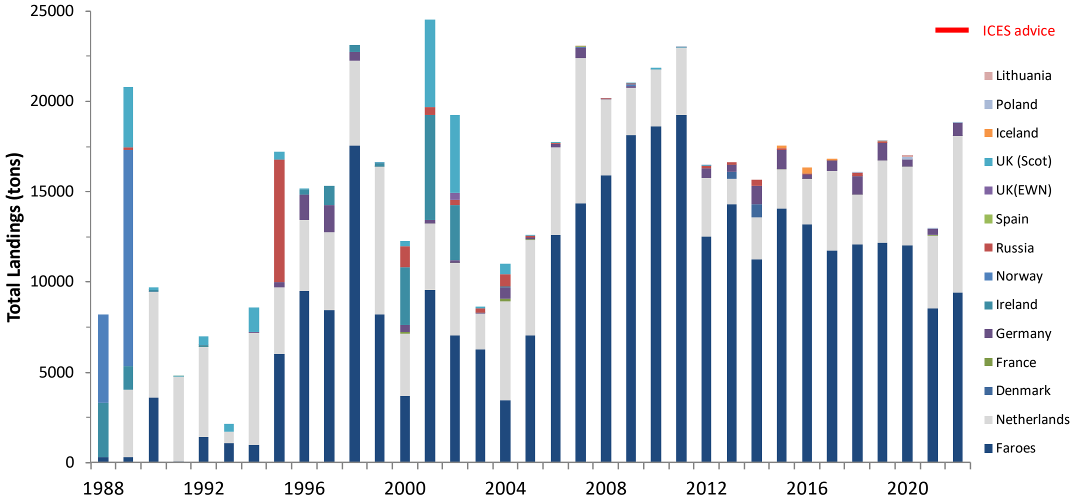

Figure 6.4.1. Greater silver smelt in 5.b and 6.a. Total landings of greater silver smelt in 5.b and 6.a by countries since 1988.

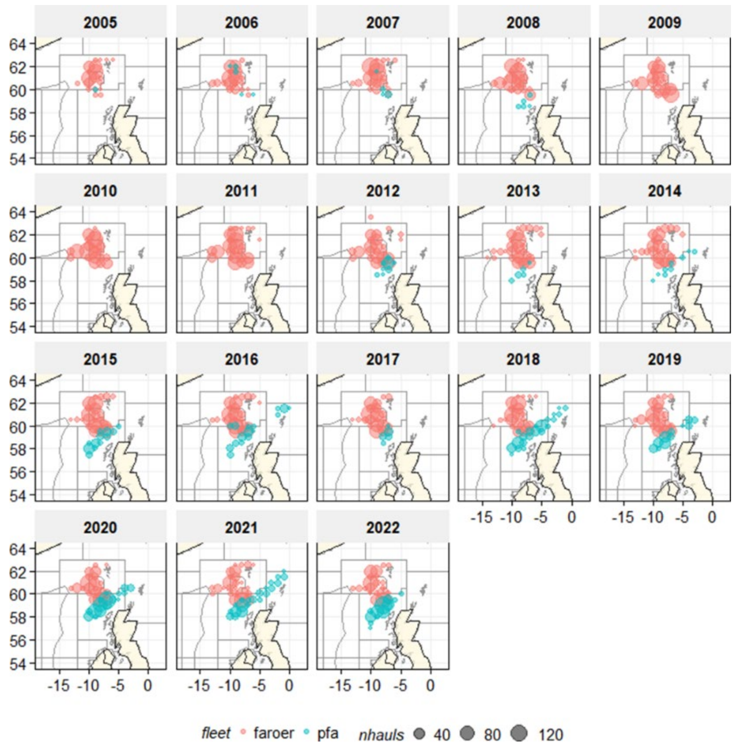

Figure 6.4.2. Greater silver smelt in 5.b and 6.a. Effort (number of hauls) of commercial fisheries available for standardized CPUE calculation in Faroese fishery (red circles) and PFA fishery (blue circles) since 2005.

6.4.1.1 Landing trends

Landings in Division 5.b increased rapidly from 2004 (5300 tonnes) to 2006 (12 500 tonnes) and further increased in 2011 to 15 600 tonnes (Table 6.4.2). Landings have oscillated between 10 000 to 13 000 tonnes since 2012. The reduction of catches in 5.b since 2012 was probably due to several factors, e.g., the introduction of quotas for greater silver smelt in Faroese waters, a shift for mackerel and the relocation of effort to the Wyville-Thomson Ridge.

Landings in Division 6.a have been fairly stable at around six to eight thousand tonnes but for two peaks in 1989 (20 581 tonnes) and 2001 (14 466 tonnes). Landings have ranged between 5000 and 7500 tonnes since 2004.

Catches in 2022 were 6383 tonnes in Division 5.b and 12467 tonnes in Division 6.a.

6.4.2 ICES Advice

ICES advises that when the MSY approach is applied, catches in **2023** should be no more than 17 695 tonnes.

6.4.3 Management

The EU introduced total allowable catch (TAC) management for greater silver smelt in 2003 setting a TAC quota for the EU fishery in Subareas 5, 6 and 7 (separate EU TACs exist for greater silver smelt in areas 1 and 2, and in areas 3.a and 4). TAC quotas for the EU fishery in Subareas 5, 6 and 7 since 2014 are presented in the Table 6.4.3.

Since 2021 (Brexit) the UK has set a species-specific TAC quota for greater silver smelt in Subareas 5, 6 and 7. The TAC quotas for the UK fishery in Subareas 5, 6 and 7 since 2021 are also presented in the Table 6.4.3.

From 2010 to 2013, the Faroese greater silver smelt fishery was managed by an agreement between the Faroese fleet and the management authorities that the total annual landings should not exceed 18 000 tonnes in the Faroese EEZ. This management was based on scientific advice from the Faroe Marine Research Institute (FAMRI) on the Faroese “stock” component. The management of the fishery was regulated by fishing days for the trawler fleet. There are also other technical limitations such as minimum size, bycatch, mesh size and area restrictions.

In 2014, the Faroese authorities introduced a species-specific TAC quota for greater silver smelt for Faroese trawlers (6 vessels) within the Faroese EEZ. Faroese TACs are presented in Table 6.4.3 too. A decrease in the biomass index as estimated by the age-based exploratory assessment resulted in a decline of TAC from 2014 to 2017.

ICES advice, TACs issued by UK, EU and Faroese authorities are summarised in Table 6.4.3.

The ICES advised catch for 2022 was nearly three times as high as the last catch advice issued in 2019 for 2020 and 2021. The advice in 2019 was based on a category 3 trend-based assessment and has now been upgraded to an analytical assessment; advice is provided following the MSY approach.

6.4.4 Data available

Data on length, round weight and age are available for greater silver smelt from Faroese and European landings. Catch and effort data from Faroese trawler logbooks and from the PFA fisheries in the Northeast Atlantic are also available (WGDEEP 2021, WD02).

Fishery-independent biological data is available from the annual ground fish summer survey on the Faroe Plateau since 1995. The survey targets cod, haddock and saithe. In addition, a deepwater survey has been conducted since 2014 covering the fishery distribution within the Faroese EEZ.

Acottish deepwater survey (MSS Deepwater Slope Survey) is also included in the SAM assessment as a biomass index. The survey covers the distribution of the European fishery in 6.a (Campbell 2020, WD01 WKGSS).

6.4.4.1 Landings and discards

The landings statistics are regarded as being adequate for assessment purposes. Landing data for all relevant fleets disaggregated by area and country is presented in Tables 6.4.1 and 6.4.2, and Figure 6.4.1.

Discarding is prohibited within the Faroese EEZ. All catches are assumed to be landed. A landing obligation in the European Union for pelagic fisheries was implemented in 2015. Catches of all species in the pelagic fishery are to be landed, except for protected species which are to be immediately released after capture. The EU landing obligation was applied to demersal fisheries in 2019.

Discards from foreign nations are reported to ICES (Table 6.4.4). Bycatches are assumed to be landed.

Substantial levels of discards occur in the trawl fishery conducted in Subareas 6 and 7 on the continental slope at depths of 300 to 700 m (Girard and Biseau, WD 2004). Discards reported by Spain in 2012 and 2013 were revised downwards. No discards from Spain were reported in Subarea 6 in 2014 - 2018.

Based upon on-board observations from the EU data collection framework (DCF) sampling, the catch composition in the French mixed trawl fisheries for 2011 in 5.b, 6 and 7 include 5.3% of greater silver smelt representing 25.3% of the discards in that fishery (Dubé *et al.*, 2012). Most of the discards in Division 6.a were reported in the French and Scottish deep-water fisheries since 2014 (data from ICES) (Table 6.4.4). Discard data reported to ICES represent on average 3.0% of the total catches since 2014.

6.4.4.2 Length compositions

Commercial length frequency distributions are available from the Faroese pairtrawler fleet in 5.b and 6.a (Figure 6.4.3) and from PFA fisheries in Divisions 4a, 5b and 6a (Figure 6.4.4).

Fishery-independent length compositions data is obtained from the Faroese summer ground fish survey on the Faroe Plateau in Division 5.b are presented in Figures 6.4.5. Length distributions from the Faroese deep water survey are presented in Figure 6.4.6.

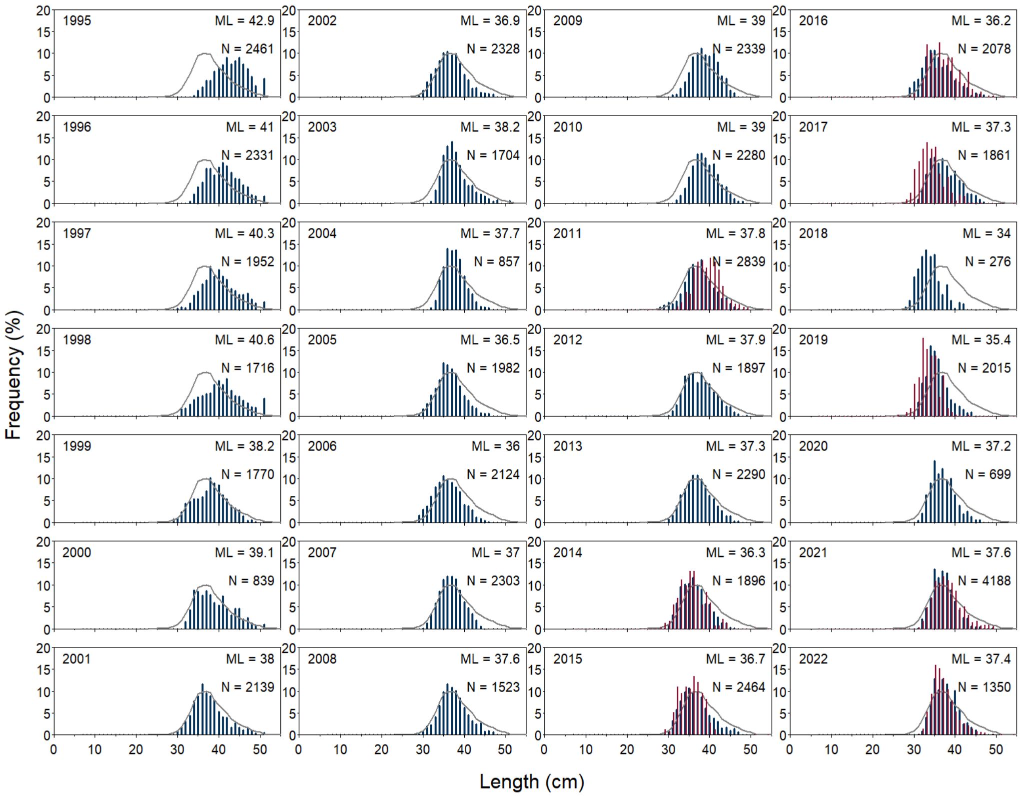

Figure 6.4.3. Greater silver smelt in 5.b. Length frequencies of greater silver smelt in the Faroese catches from 1995 to present. Blue bars are catches within area 5b and red bars are catches within area 6a. Curves are the average over whole time frame. ML= mean length (cm) and N= number of length measurements.

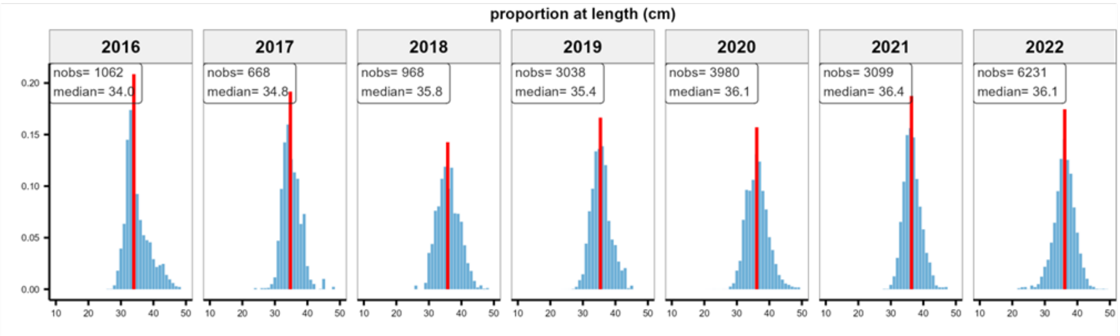

Figure 6.4.4. Silver smelt (*Argentine spp.)* in 5.b and 6.a. Relative length frequencies in PFA self-sampled fisheries in division 4a, 5b and 6a from 2016 to present. Number of length measurement (nobs) and median length (cm, red) in top left.

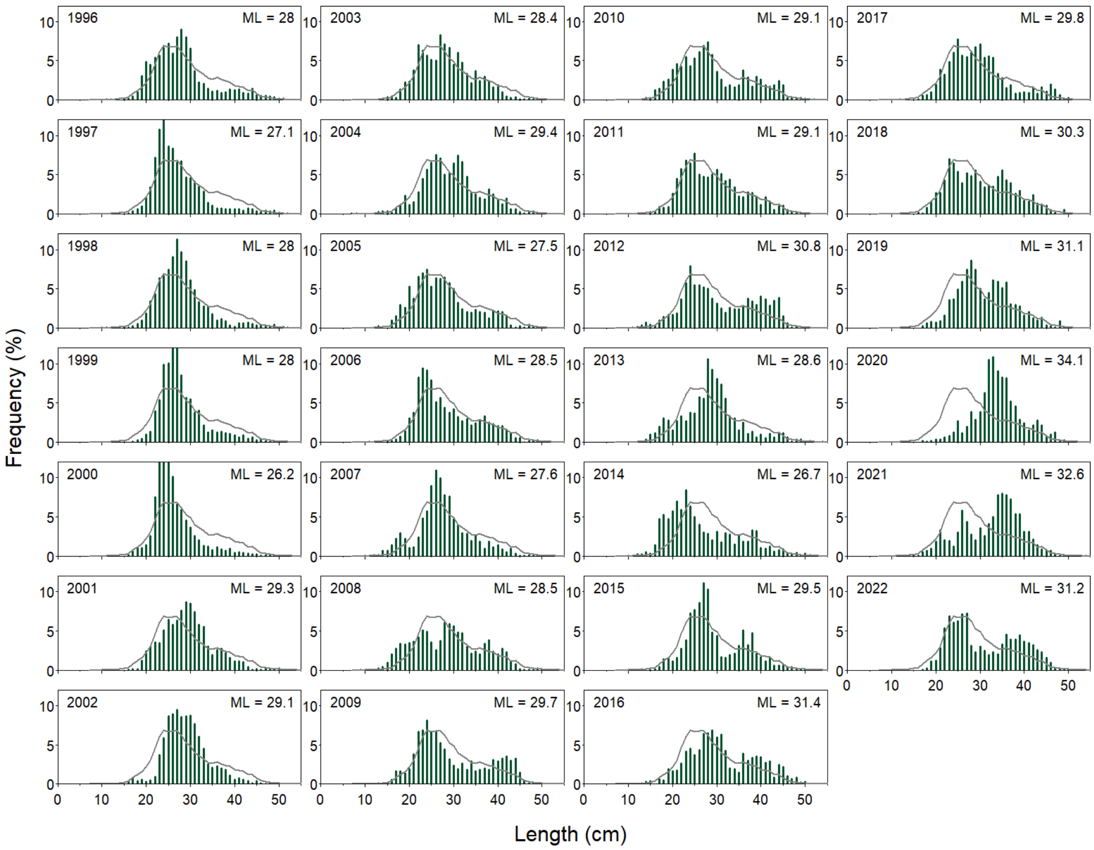

Figure 6.4.5. Greater silver smelt in 5.b. Length frequencies from Faroese ground fish summer survey from 1996 to present. Greater silver smelt is sub sampled of the total catch i.e., the values of greater silver smelt are scaled to reflect total catch. ML= mean length.

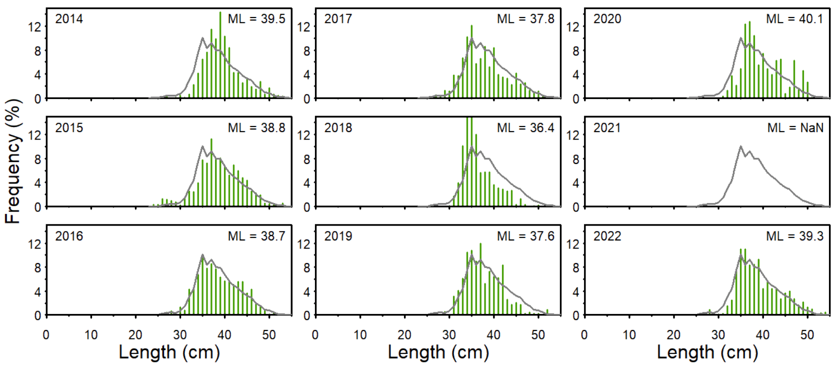

Figure 6.4.6. Greater silver smelt in 5.b. Length frequencies from the Faroese deep water survey from 2014 to present, excluding 2021 when the deepwater survey was not conducted .. ML = mean length.

6.4.4.3 Catch at age (CAA)

Catch at age compiled in InterCatch framework is presented in Figure 6.4.7 and Table 6.4.5. These data are used in the age-based state-space fish stock assessment SAM. Additional data from the Netherland and Scottish fishery in Division 6.a is also used in the compilation of the catch at age. The computation of the catch at age is described in detail in the stock annex.

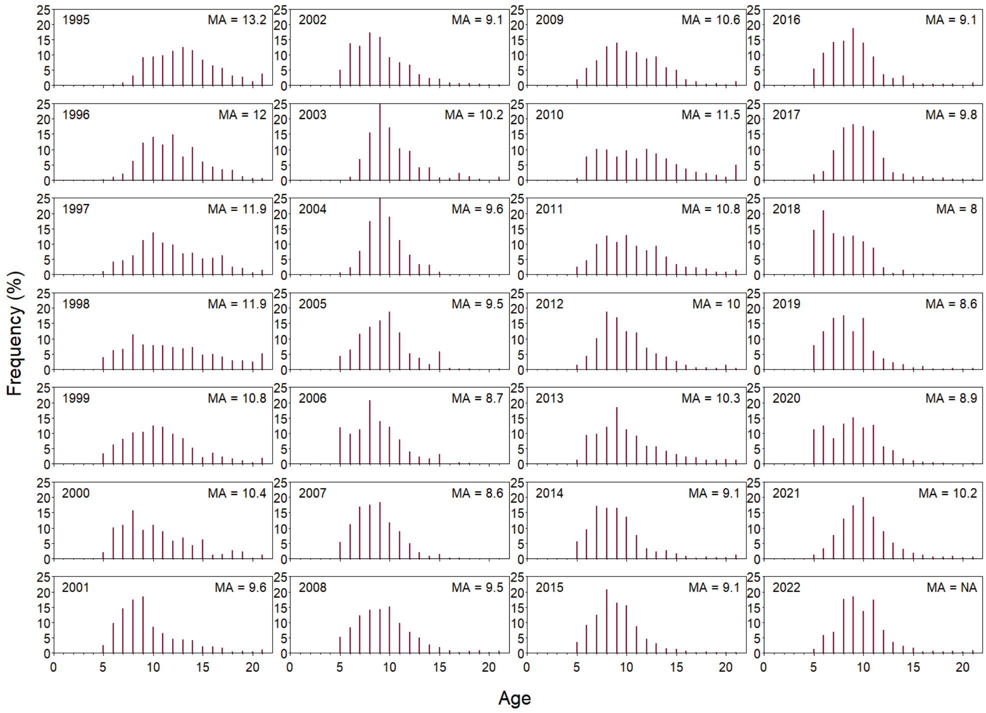

Figure 6.4.7. Greater silver smelt in 5.b and 6.a. Catch at Age (CAA) used in the SAM assessment in 1995 to present. Prior to 2005 only CAA from the Faroese data has been used. From 2005 to present the combined CAA from Faroese and EU data have been used (compiled in InterCatch). MA= mean age.

6.4.4.4 Weight-at-age

Catch weight at age is compiled in InterCatch framework (Figure 6.4.8 and Table 6.4.6). Data from 1995 to 2005 is only available from the Faroese fishery in Division 5.b. The low weight at age values of greater silver smelt older than 15 years in 2019 are potentially due to the low age sample size of old fish (Figure 6.4.8). Stock weights are assumed to be equal to catch weight.

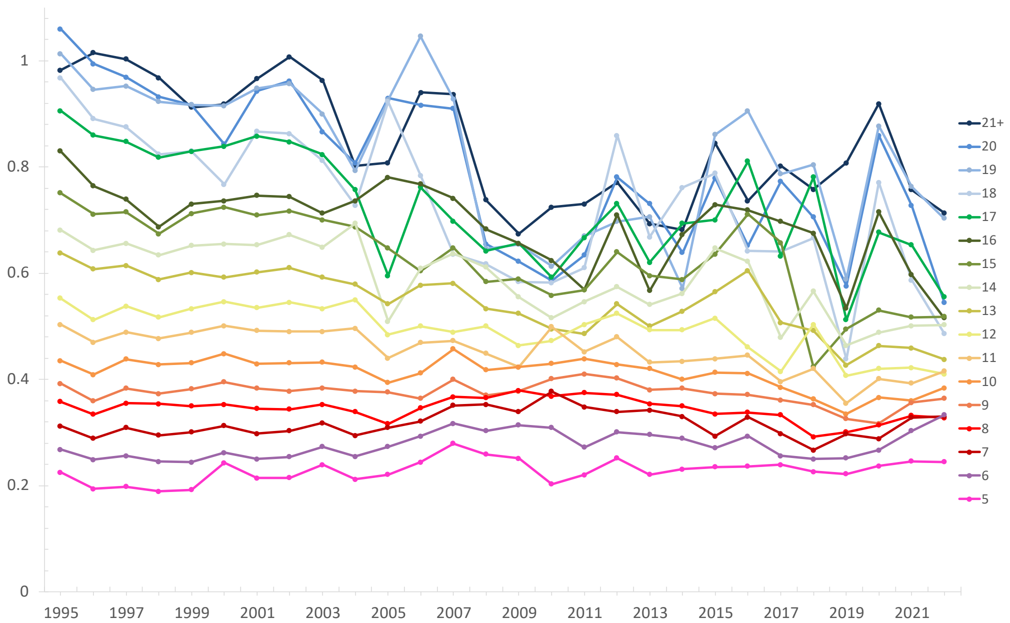

Figure 6.4.8. Greater silver smelt 5.b and 6a. Mean weight-at-age of greater silver smelt in the commercial catch within 5.b and 6.a.

6.4.4.5 Maturity and natural mortality

The composition of the commercial catches consists mostly of mature individuals in Division 5.b (ICES, 2021).

Maturity at age is estimated from the Faroese surveys for the period 2000-2019 and it is fixed for the whole assessment period (Table 6.4.7).

Natural mortality is set to 0.15 (ICES, 2021).

6.4.4.6 Catch, effort and research vessel data

Fishery-dependent data is available from Faroese trawler logbooks (1995-2021) and the PFA self-sampling program (2005-2008, 2012-2021). The catch from Faroese trawlers accounts for more than 80% of the total Faroese landings since 2005. Therefore, the period 2005-2021 was chosen for calculating a CPUE index. The PFA self-sampling logbooks account for varying percentages of the total registered catch by Germany and Netherland in Division 5.b and 6.a.

The Faroese summer groundfish survey is used as a tuning series for the assessment. The survey is carried annually on the Faroe Plateau since 1996 (Figure 6.4.9; ICES, 2023, Stock annex). It has to be noted that the summer survey has very few stations deeper than 500 m and are therefore likely to only cover the greater silver smelt juveniles adequately. The adult part of the population is not fully covered by the survey and they may not necessarily reflect correctly the temporal variation of the biomass of the stock that is better covered by the Faroese deep water survey. The spring survey series, conducted in February/March since 1994, needs closer investigation before it can be used as a tuning series because of large interannual variations.

The Faroese deep-water trawl survey has been conducted in September since 2014, covering the slope and banks including the fishing grounds for greater silver smelt in the Faroese EEZ (5.b and 6.a) (ICES, 2023, Stock annex). No Faroese deep water survey was conducted in 2021. The standardized index is presented in Figure 6.4.9.

The Scottish MSS Deepwater slope survey covers the fish community in the deep waters to the northwest of Scotland and has been conducted irregularly since 1998. It has shown that greater silver smelt are found at depths between 400m and 750m (Campbell, WD Nov. 2019). A CPUE from this survey has been standardized (Figure 6.4.9) and the number of hauls per year where greater silver smelt is encountered is generally around 10 (ICES, 2023, stock annex).

At the benchmark meeting in 2020, another standardized combined CPUE series for the Faroese and European (PFA) fisheries was presented using a GLM model that incorporates year, week and depth category as explanatory variables (Figure 6.4.9; WKGSS 2020, WD03; WGDEEP 2021, WD01). A single fleet analysis is also routinely carried out to assess the year trends in CPUE for the data by Faroese and PFA fisheries separately. This indicates that the variability is substantially higher in the PFA series compared to the Faroese series (See stock annex). Parameter estimates for explanatory variables are routinely checked and described in WD04, WGDEEP 2023. Commercial CPUE may be influenced by changes in greater silver smelt quotas and fishing season/market factors but these influences were regarded as minor in comparison to variations in stock biomass. A review of the commercial CPUE index was conducted at WGDEEP 2023, see detailed results in section 6.4.5.2.1.3.

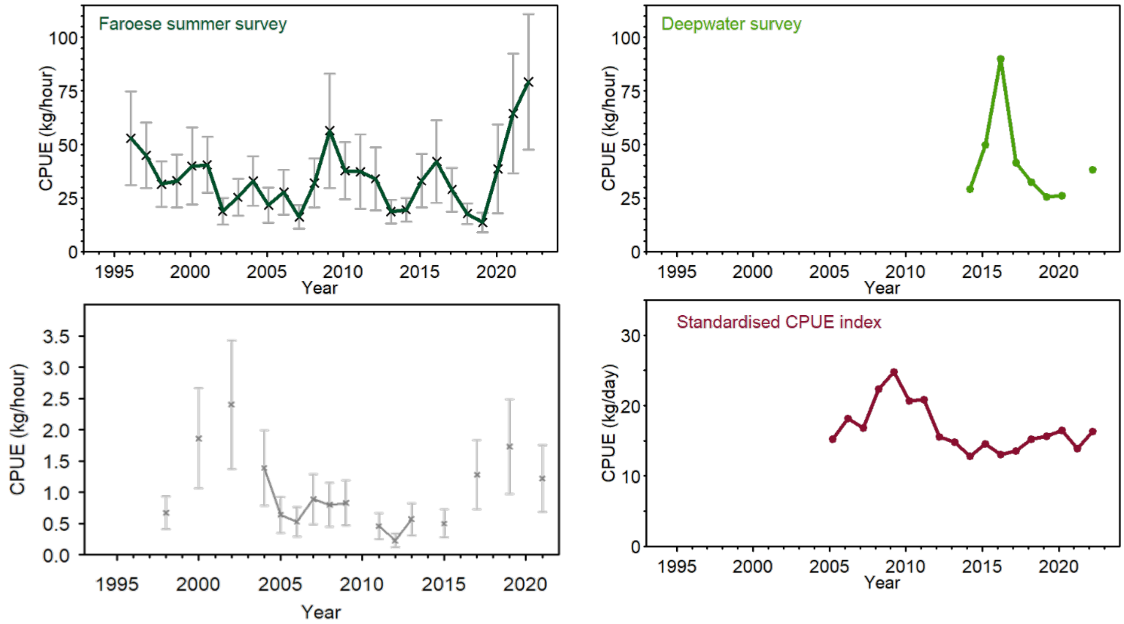

Figure 6.4.9. Survey indices with confidence intervals from 1) the Faroese summer survey (since 1995) top left, 2) Faroese deepwater survey (since 2014, excluding 2021) top right, 3) MSS Slope Deep Water (since 1998, irregularly) bottom left, and 4) combined standardized CPUE with confidence intervals from Faroese and EU fisheries from 2005 to last data year

6.4.5 Data analyses

6.4.5.1 Length and age distributions

In Division 5.b the mean length and age of greater silver smelt in the Faroese landings decreased from 1994 to 2000 and have been stable since then (Figures 6.4.3, 6.4.10). This trend probably reflects 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 recent years could be due to different depths sampled in the various areas as the size of greater silver smelt is known to increase with increasing depth as reported in WKGSS 2020. Generally, the Faroese bottom surveys catch individuals with length less than 30 cm at depths shallower than 350 m whereas larger individuals (35–40 cm) are found deeper.

Mean landing size from the Netherland is around 34-38 cm (Figure 6.4.10).

Since 2003, mean length of greater silver smelt from Faroese and Netherland trawlers is very similar, around 36–39 cm (Figure 6.4.10). The low mean lengths observed in the Netherlands fishery (1996, 1999, 2002) could be due to the catch being a mixture of *Argentina silus* and *A. spyraena* or due to the Netherland trawlers operating in shallower waters. Another explanation could be that the data are from discard not landings.

Mean length in the catch from the fishery in the Faroes, PFA and Netherland as well as from the Faroese deepwater survey are comparable allowing the use of Faroese age-length data in the age-based assessment. The Faroese summer survey on the other hand has a lower mean length which is due to the shallow waters covered in the summer survey (Figure 6.4.10). However, this survey covers the distribution of juveniles which the other indices do not.

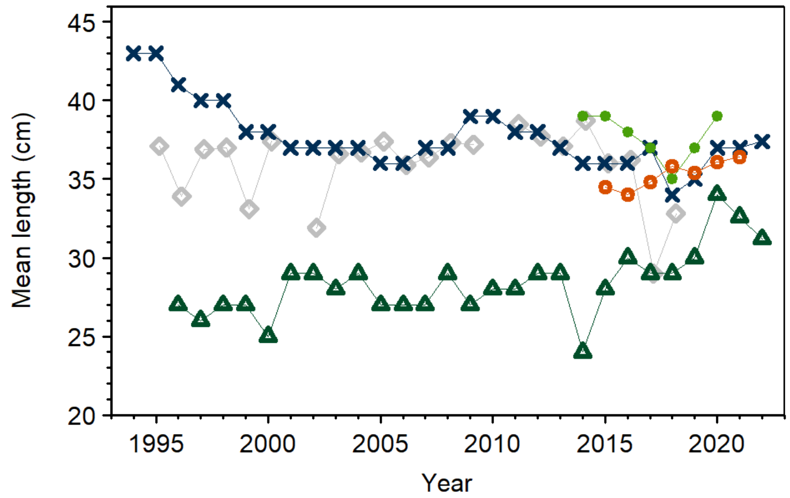

Figure 6.4.10. Greater silver smelt in 5.b and 6.a. Comparison of median lengths at year from Faroese catches (Blue crosses), PFA (open orange circles) and Netherland (grey diamonds) catches and from the Faroese summer (dark green triangles) and deep-water surveys (green filled circles).

6.4.5.2 Stock assessment

The SAM model is based on catch at age for ages 5 to 21+ and initiated in 1995 (Table 6.4.5). Catch at age data from 1995 to 2004 is derived from Faroese sampling raised to international catches. Catch at age data since is derived from InterCatch whereby the age-based data is only contributed by Faroe Islands and the Netherlands. Age classes of 5-year-old and older are used in the assessment. However, information on younger age groups (2-4) is available in InterCatch.

Maturity at age is fixed for the assessment period and natural mortality is set to 0.15 for all ages and years (ICES, 2021)

The age-disaggregated tuning series were the Faroese summer survey, ages 5 to 12 years (since 1997, Table 6.4.8) and the Faroese deepwater survey, ages 5 to 14 years (2014-2020, Table 6.4.9).

The Scottish deepwater slope survey (since 1998, irregular, Table 6.4.10) and the combined commercial Faroese and EU trawlers catch per unit effort (since 2005, Table 6.4.10) were used as biomass indices in the tuning of the assessment.

The model configuration has a correlated error structure for the age-based survey information (Faroese summer survey, Faroese deepwater survey). The model configuration required 23 estimated parameters (Table 6.4.11).

Other details regarding the age based state-space fish stock assessment (SAM) can be found in the Stock annex.

6.4.5.2.1 __**Preliminary analyses**__

In preparation for the WGDEEP meeting several preliminary analyses were undertaken to investigate four different elements:

1. The impact of replacing missing catch-weights at ages 19-21+ in years 2005-2007 and 2018 with 10-year averages
2. The impact of changing the parameter binding for the F-process to numerical order
3. The impact of adding a fleet effect to the CPUE standardisation for the combined Faroese – PFA fleet
4. The impact of changing the model configuration to estimate catch more accurately

6.4.5.2.1.1 Replacing missing catch-weights

The catch weight at age matrix contained -1 values for ages 19-21+ in 2005-2007 and 2018. SAM cannot estimate these missing values in its current formulation although SAM can estimate missing catch numbers at age. These missing weights were replaced by an average from the 10 previous years. The impact is minor and only leads to subtle changes in SSB for these years. Figure 6.4.11 shows the impact of changing the stock weights.

6.4.5.2.1.2 Changing the order of F-process parameters

In SAM, the number of F processes to be estimated is set in the configuration file by listing parameter numbers per age. For this stock, separate F processes are estimated for ages 5-10 and the same F process is estimated for ages 11+. The numerical order for these parameters followed 0-4,6,5,5,5,… rather than 0-6,6,6,6,… This aspects was likely overlooked at the benchmark and has a minor impact on the assessment but does affect the estimation of the F processes as these are correlated between ages. In the original case, the F process of age 11+ was correlated with the F process of age 9 with a lag of 1 rather than a lag of 2 (etc for the other ages but with higher lags).

6.4.5.2.1.3 Adding a fleet effect in the CPUE standardisation for the Faroese and PFA vessels

During preparation of the standardized CPUE time series for WGDEEP 2023, it was noticed that the generalized linear model treats data from both fleets the same, i.e., it does not differentiate the different fleets by including a fleet effect (or alike). Upon investigation it was found that introducing a fleet effect was highly significant. There are several reasons why this is relevant: (a) the fleets do not overlap in space, both fleets fish in a different area (see WD04), (b) the time-series for both fleets start at a different moment in time; notably at 2005 for the Faroese fleet and from 2015 onwards there is broad coverage in the catch per day information from the PFA fleet although data from years before that period are available as well. This leads to a data unbalance in the CPUE calculation which has not been taken into account. During the benchmark, the scientists involved considered including a fleet effect but found that it was insignificant at that time. Upon further investigation, the scientists had included a latitudinal effect at the same time as the fleet effect. A latitudinal effect has a similar effect as a fleet effect in this instance as the fleets are more or less separated by the ~59° latitudional line. As latitude was not included in the model either an effect to include fleet differentiation is required for appropriate model fitting.

The impact of including a fleet effect is described in WD04 and is substantial as it changes the trajectory of the CPUE mainly from 2015 onwards. It shows a much lower increase in relative biomass than would be the case for the model excluding a fleet effect. This change is more in line with the development of the Faroese CPUE that has remained more or less stable since 2012. As the assessment fits the CPUE well, this change downscales SSB, increases F and decreases the estimates of R for the period from 2015 onwards.

The experts investigated whether fitting a GAM rather than a GLM would be appropriate but this led to minor differences although the number of parameters reduced greatly through the use of smoother functions for the co-variates of depth and week. To remain as close as possible to the stock annex, experts decided to prefer the GLM model over the GAM model.

6.4.5.2.1.4 Estimating catch more accurately

Preliminary analyses were undertaken to find a model configuration that would fit the ICES estimated catch better within the assessment model. The main driver for the misfitting of catch in the model is the lack of process error at age 6+. This value was changed in last years assessment from log(0.0001) and is now set to log(0.01) to have the assessment model converge as the cohort data is likely not good enough to inform the assessment model sufficiently to estimate this parameter value. Setting the value this low means that there is almost no deviation in cohort signal compared to the assumed survivor equation.

As the model assumes catches up to the age of 21, any incorrect estimation of cohort size at a young age can have a long-lasting effect up to older ages. Allowing for more process error to take place leads to an overly uncertain stock assessment and retrospective patterns. It requires extensive explorations to see if other model configurations can be used to minimize the impact on parameter uncertainty and retrospective pattern.

6.4.5.2.2 Final model

The working group accepted changes 1-3 as mentioned above which results in SSB, F and Rec estimates as shown below.

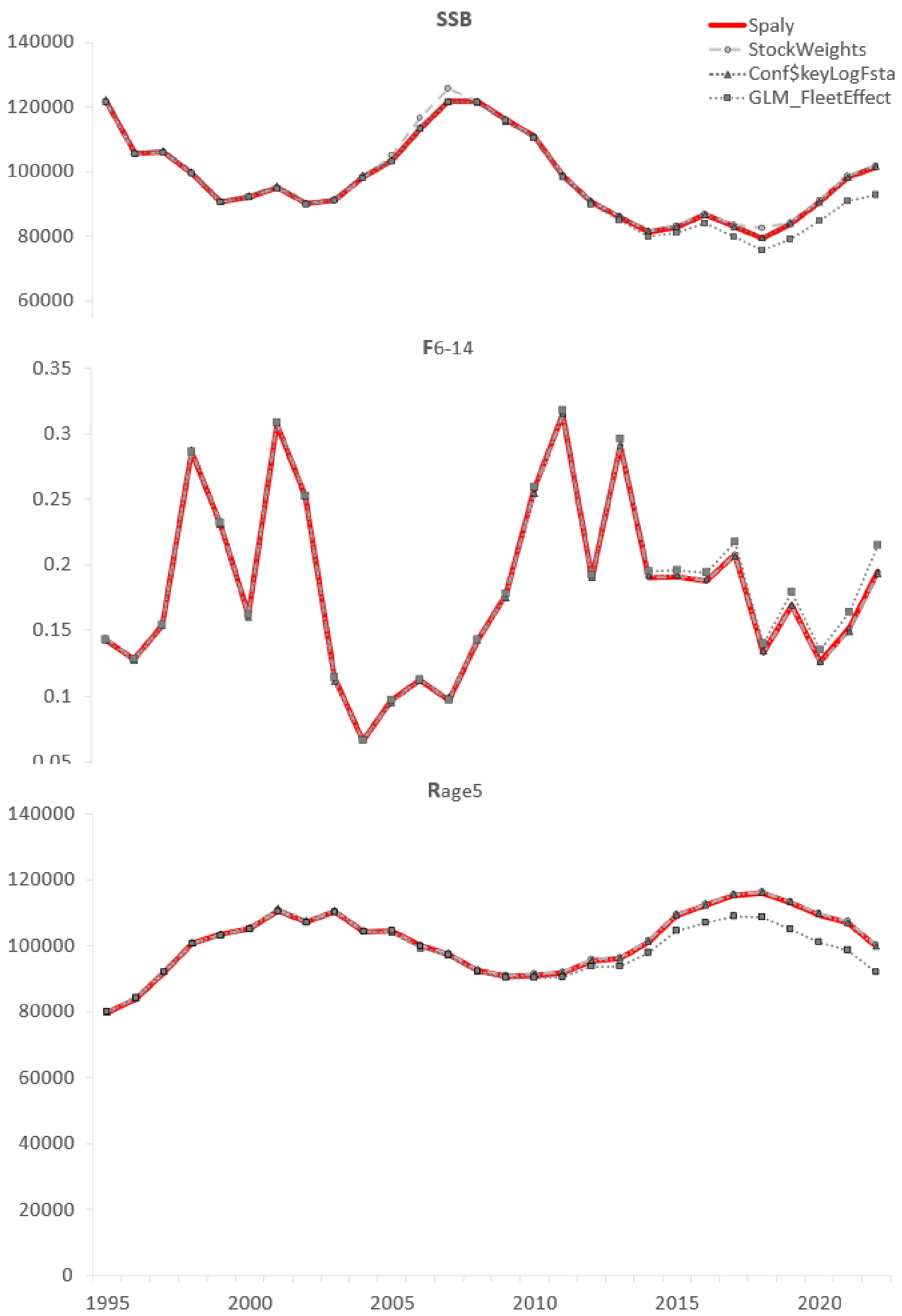

Figure 6.4.11 Greater silver smelt in 5.b and 6.a. Impact on SSB, F and R for changes in catch and stock weights, changing the F-process binding and the impact of adding a fleet effect to the CPUE standardisation.

Diagnostics and results of the SAM model ARU _27.5b6a_WGDEEP2023 @ stockassessment.org are shown in the Figures and Tables below:

- Model fits to the data (Figures 6.4.12-6.4.13)
- Standardized one-step-ahead residuals (Figure 6.4.14)
- Leave-one-out analysis (Figure 6.4.15)
- Retrospective analysis (Figure 6.4.16)
- Estimated correlations between age groups for each fleet (Figure 6.4.17)

- Comparison of SSB, Fbar, Recruitment and Catch between last years and present year SAM runs(Figure 6.4.18 and Table 6.4.13)
- Parameter estimates (Figure 6.4.19, Table 6.4.12)
- Selectivity patterns by pentad (Figure 6.4.20)

In order to minimize systematic year effects, the final SAM model included correlated errors across ages (Figure 6.4.19). Residuals were more randomly distributed after the correlated errors were taken into account.

The retrospective pattern shows that recruitment has been underestimated (Figure 6.4.16). All the retrospective runs fall within the confidence intervals of the final assessment. Mohn's rho parameters are estimated at -4%, 4% and -11% for the spawning stock biomass, F and recruitment, respectively.

The results from SAM shows that the spawning stock biomass (SSB) currently around 93 000 tonnes (Figure 6.4.18, Tables 6.4.13, 6.4.15) which is above B_{pa} and $MSYB_{trigger}$. The fishing mortality ($F_{6\text{-}14}$) has varied but has been below F_{MSY} since 2014 (Figure 6.4.18, Tables 6.4.13, 6.4.14). The model-estimated catch in the years since 2014 has been lower than the observed catch except in 2021.

Parameter estimates of the model are in the Table 6.4.12 and compared with the previous assessment in the Figure 6.4.19. Overall, parameter estimates are highly comparable between years.

The estimated selectivity by year is shown in Figure 6.4.20, organized by pentad. The estimated selectivities are highly variable between years and show large variations in estimated selectivities, especially at the older ages. This has impacts on the short term forecast that is based on the most recent selectivity taken forward.

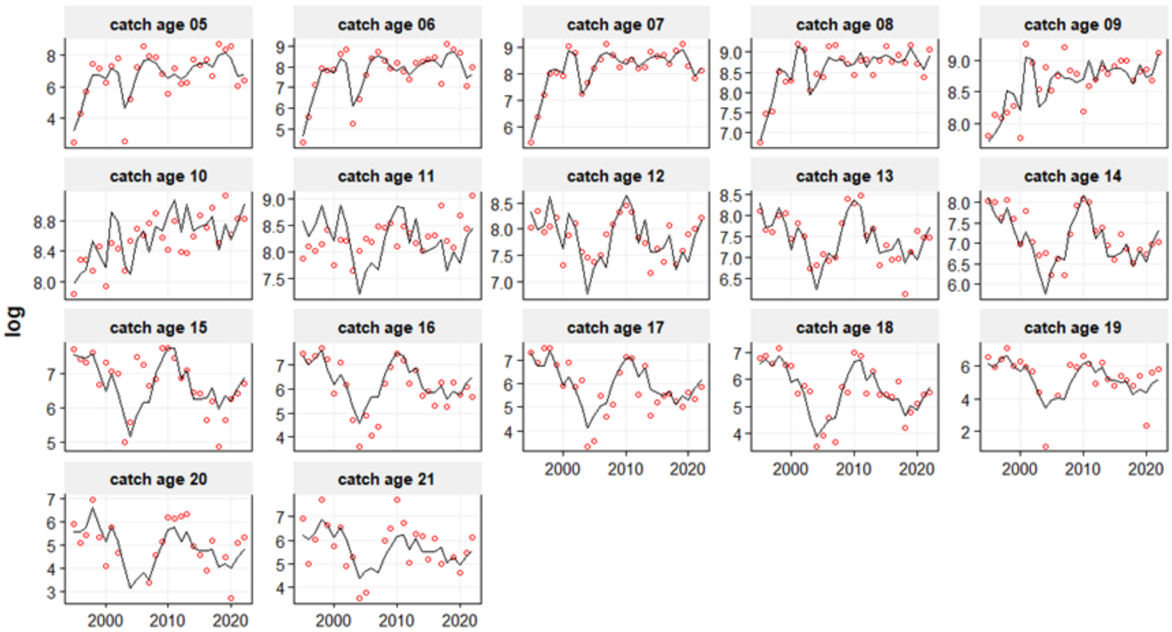

Figure 6.4.12. Greater silver smelt in 5.b and 6.a. Fit of the assessment model to the catches at age.

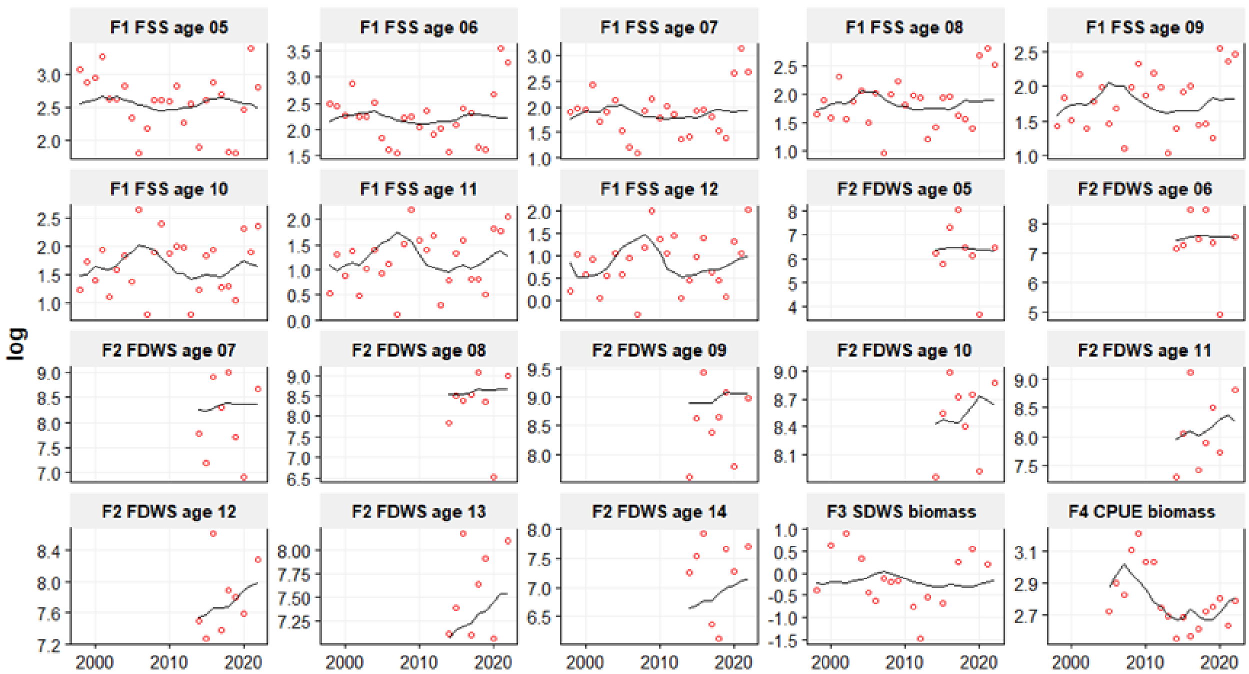

Figure 6.4.13. Greater silver smelt in 5.b and 6.a. Fit of the assessment model to the Faroese summer survey (F1 FSS), the Faroese deepwater survey (F2 FDWS), the MSS Deepwater slope survey (F3 SDWS) and the Faroese-EU standardized CPUE series (F4 CPUE).

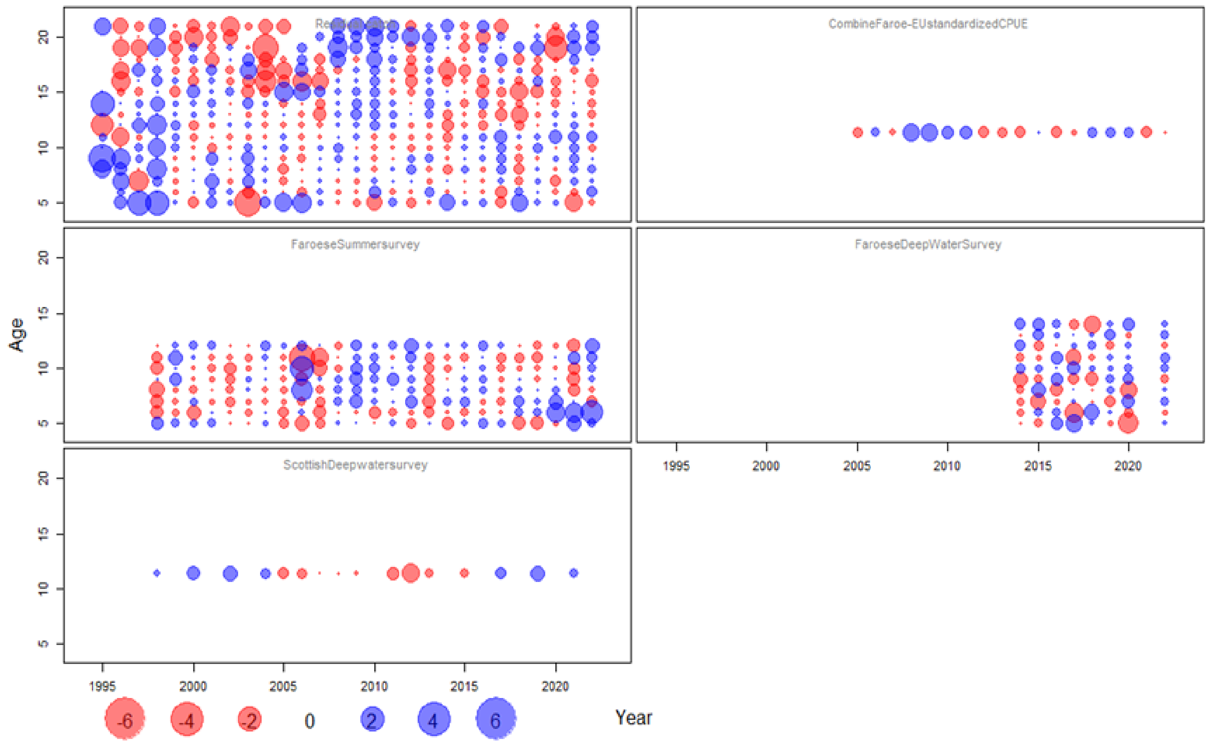

Figure 6.4.14. Greater silver smelt in 5b and 6a. Standardized one-step-ahead residuals from the SAM model.

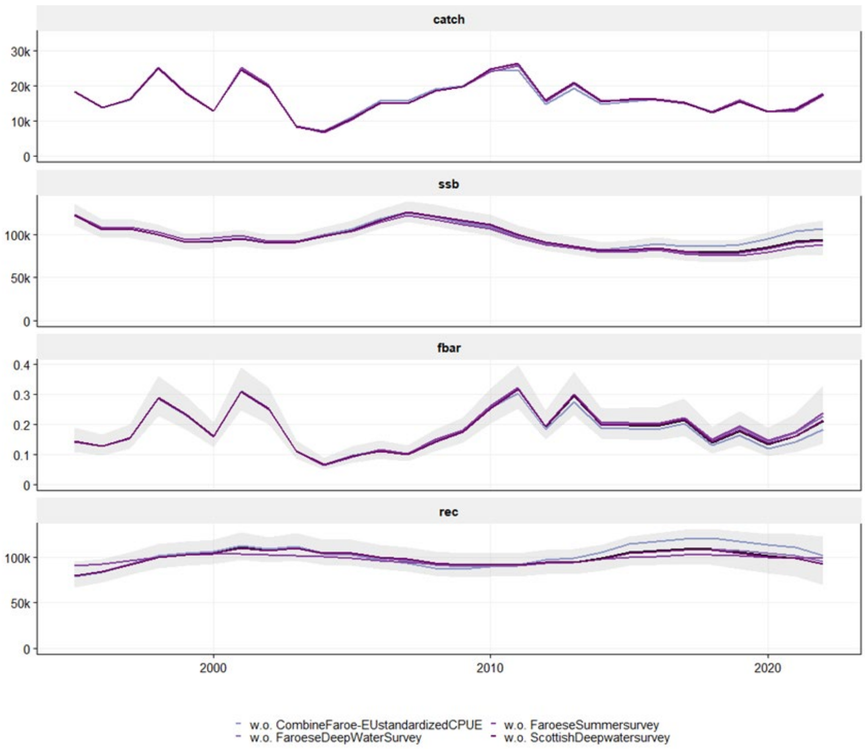

Figure 6.4.15. Greater silver smelt in 5b and 6a. Leave-one-out analysis of Catch (1st), SSB (2nd), fishing mortality (3rd), recruitment (4th). Black line and grey band indicated the final assessment with 95th percentiles.

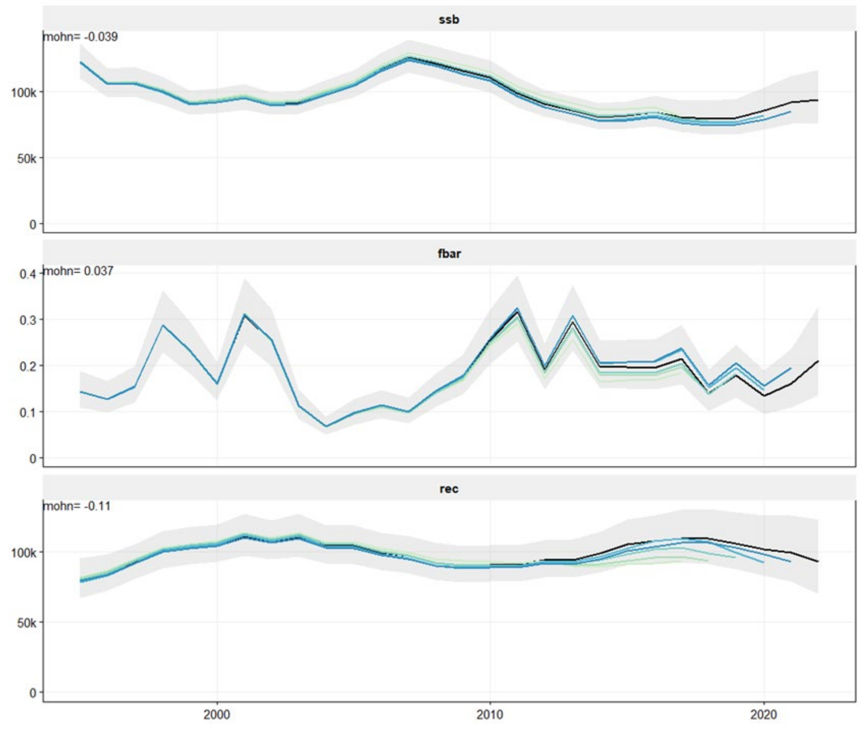

Figure 6.4.16. Greater silver smelt in 5b and 6a. Retrospective analysis with 5 peels in SSB (upper), fishing mortality (middle), recruitment (lower). Mohn's rho value indicated in top left of each panel.

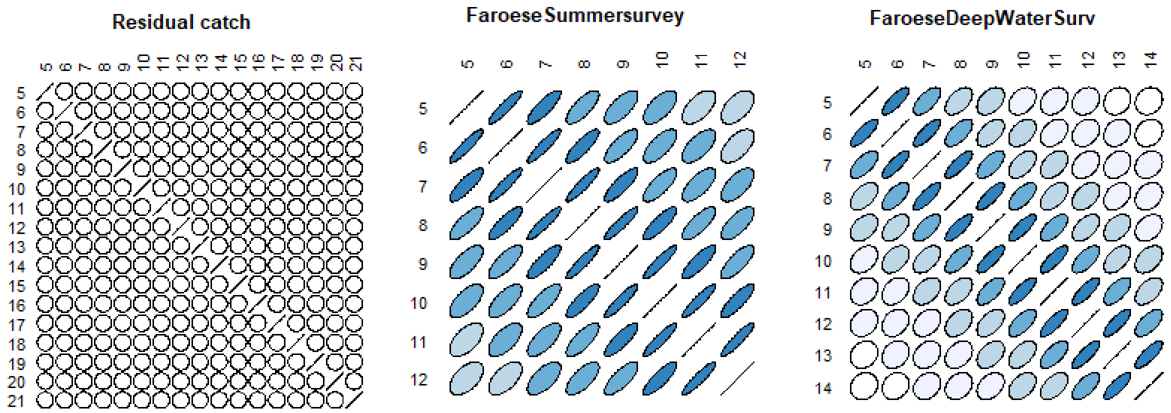

Figure 6.4.17. Greater silver smelt in 5b and 6a. Estimated correlations between age groups for catch (left), Faroese summer survey (middle) and Faroese deepwater survey (right).

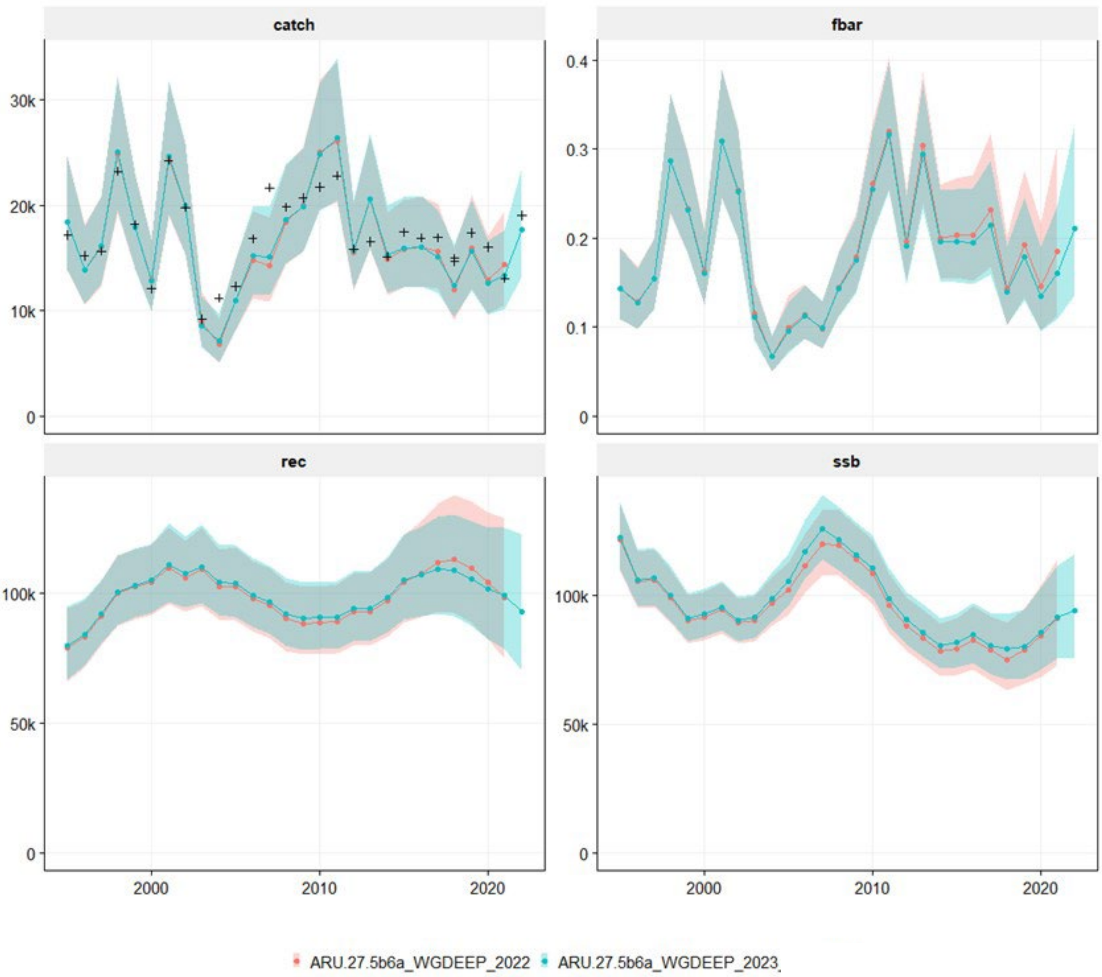

Figure 6.4.18. Greater silver smelt in 5.b and 6.a. Comparisons of present assessment (green blue) and previous assessment (red). Catch in tonnes (upper left), fishing mortality (upper right), recruitment (lower left) and SSB (lower right).

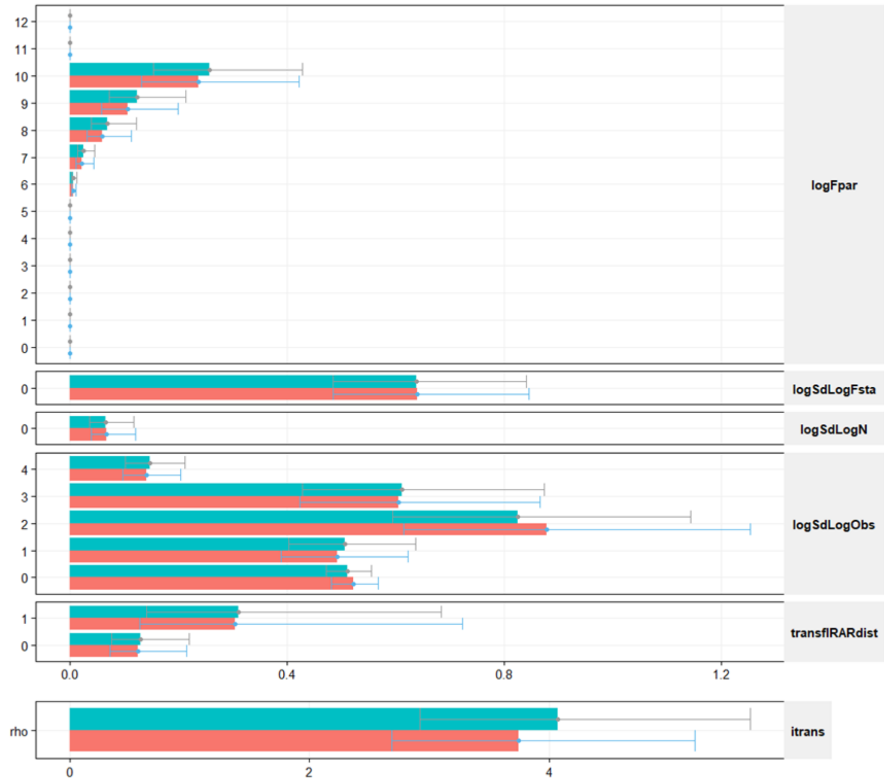

Figure 6.4.19. Greater silver smelt in 5.b and 6.a. Comparison of parameter estimates from present assessment (green blue) and previous assessment (red).

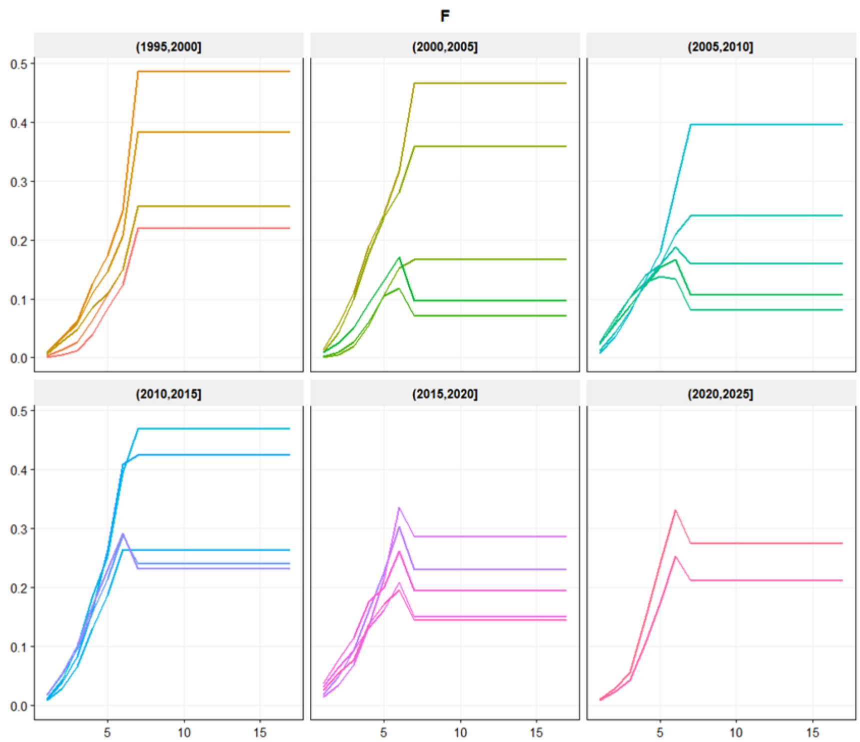

Figure 6.4.20. Greater silver smelt in 5.b and 6.a. Selectivities from the SAM model by year, organized by pentad of 5 years.

6.4.6 Quality of the assessment

The assessment of greater silver smelt was benchmarked in 2020 (ICES, 2021), where the assessment was upgraded from a trend-based to a SAM state-space model using catch at age information and four indexes. A comparison of parameter estimates between the previous assessment and present assessment indicates that the model results are largely comparable, although both F and recruitment are estimated somewhat higher than in the 2023 assessment (Figure 6.4.20). The Mohn's rho values from the retrospective analysis are below the required thresholds.

In the 2021 assessment, a substantial discrepancy was discovered between the calculated catch in tonnes from InterCatch and the SAM estimated catch in tonnes. The discrepancy mostly occurred in the period from 2015 to 2020. Part of the discrepancy derives from the truncation of the age-range used in the assessment model where only age 5 and up have been used whereas in InterCatch catch at age information is available from age 2 onwards. A comparison of the catch in tonnes that is and that is not included in the assessment explains part of the discrepancy between observed catch and modelled catch, but still a noticeable discrepancy remains (WGDEEP2021). This could potentially be due to a mismatch between the catch at age information from InterCatch and the SAM model configuration. Unfortunately, this issue has not been resolved prior to WGDEEP 2023 but will be explored further for next assessment.

6.4.7 Short term forecast

A short-term forecast was carried out using the forecast options on stockassessment.org. Recruitment was based on a 10-year geometric mean recruitment (2010-2019) and mean weights was based on 5 year averages. Stock numbers and selectivity were taken from the final year.

A particular challenge in the forecast of this stock is the way to deal with the discrepancy between the SAM estimates of catch and the InterCatch estimated catch. At the 2022 assessment several forecast options were explored and a catch constraint based on the ratio of TAC to catch since 2010 on the intermediate year was introduced. The working group developed a method to estimate uptake of the quota in the interim year. The process calculates the uptake of the TAC as a ratio of ICES landings over summed TAC of the Faroes, EU and UK TACs for the years since 2010. It then fits a linear model on the ΣTAC-uptake datapoints and uses this relationship to predict the expected uptake given the agreed TAC in the interim year. This results in an expected catch in the interim year. Results are shown in figure 6.4.21 and table 6.4.21.

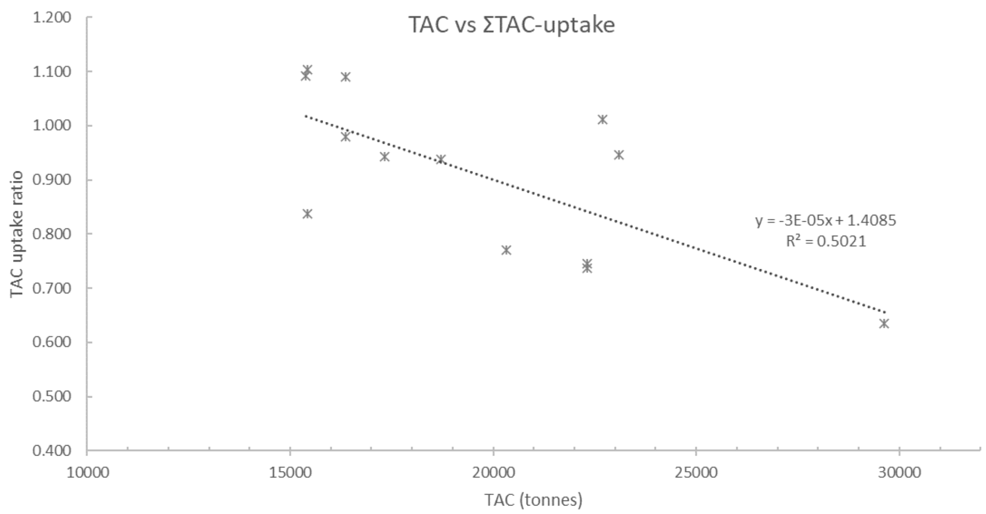

Figure 6.4.21. Greater silver smelt in 5.b and 6.a. Estimated F-at-age in the WGDEEP 2022 and 2023 final assessments as well as the ratio between these F estimates.

6.4.8 Reference points

Reference points for this stock were estimated at the benchmark meeting WKGSS 2020 (ICES, 2021). Two types of reference points are referred to when giving advice for Category 1 stocks: precautionary approach (PA) reference points and maximum sustainable yield (MSY) reference points.

With the updated technical guidelines on reference points (ICES (2021). 16.4.3.1. ICES fisheries management reference points for category 1 and 2 stocks. ICES Advice Technical Guidelines.), the procedure for estimating fishing mortality reference points have changed. F_{pa} is now set at $F_{p0.5}$ = 0.33. The previously estimated F_{lim} (=0.29) is no longer considered relevant, as it is lower than the new F_{pa}. F_{MSY} is estimated at F=0.24 (Table 6.4.18).

6.4.8.1 Impact of changes in stock assessment configuration on the reference points

Due to the changes made in the assessment model, one could argue that reference points need to be updates as well. The working group suggests to retain the current reference points as these are still considered precautionary.

The working group considered two aspects of the model to justify this approach. (1) the change in selection at age and (2) the change in productivity of the stock.

The selection pattern of the fleet under the 2023 adjusted assessment settings results in a decline in selection of older ages and increase in a selection of younger individuals (Figure 6.4.22). This change has a positive impact on the estimate of F_{msy} and hence leaves the current estimate of F_{msy} to be more precautionary compared to an updated value. It should furthermore be noted that this assessment has substantial retrospective patterns in F and therefore will estimations of F reference points vary based on the most recent assessment anyhow.

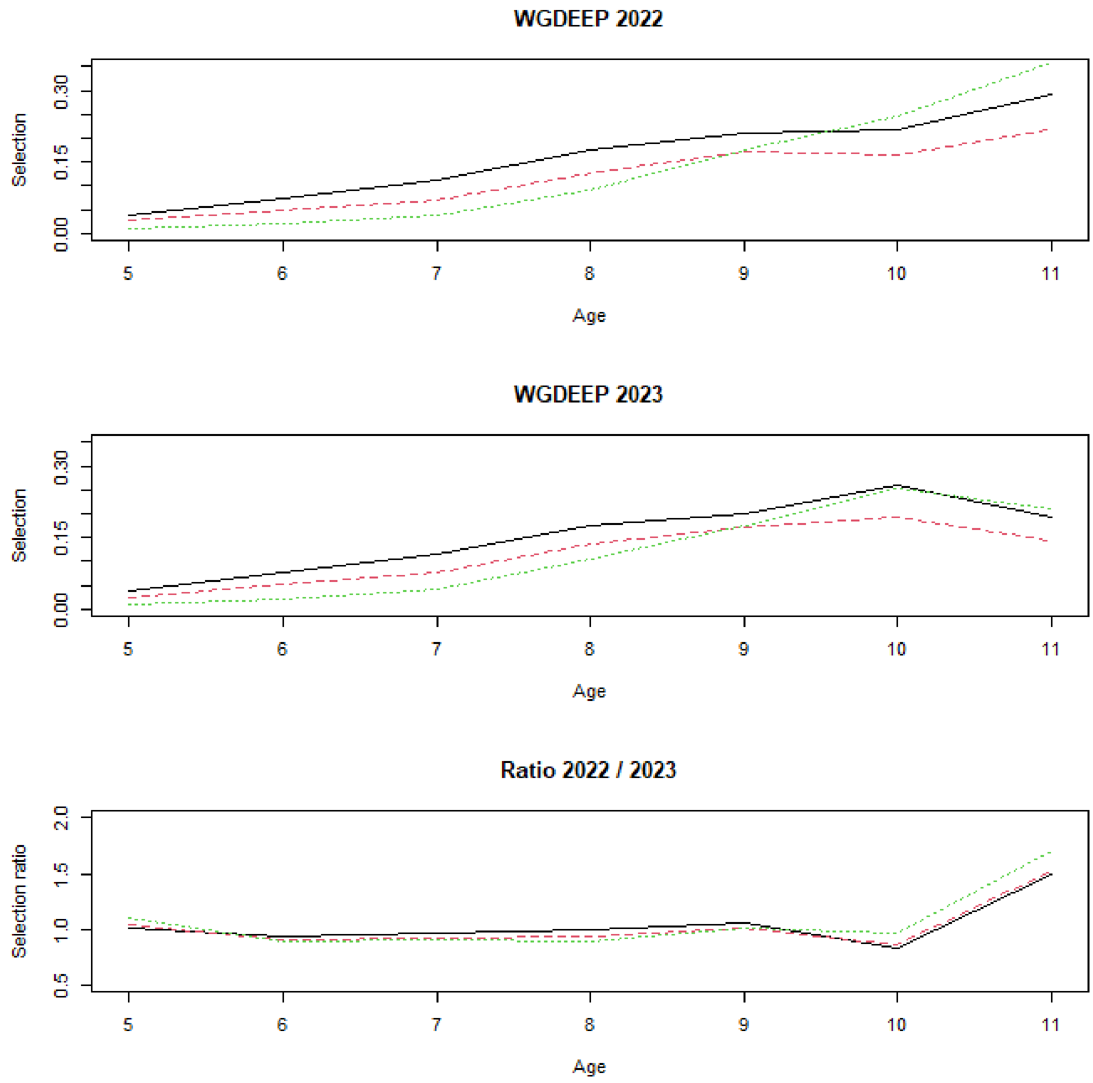

Figure 6.4.22. Greater silver smelt in 5.b and 6.a. Estimated F-at-age in the WGDEEP 2022 and 2023 final assessments as well as the ratio between these F estimates. Lines represent the estimates for the years 2019-2021 (black, red and green respectively).

When considering the second (2) point, the working group noticed only a marginal change in recruitment over SSB (Figure 6.4.22). There is however a shift visible in the SR-pairs with a shift to lower SSB values. As B_{lim} and B_{pa} are derived from the lowest observed biomass levels, retaining the current biomass reference points will be considered to be more precautionary than when these values would be updated. It should furthermore be noted that this assessment has substantial retrospective patterns in SSB and therefore estimates of biomass reference points will vary based on the most recent assessment regardless.

6.4.9 Management considerations

The quota of greater silver smelt in the Faroese EEZ has been reduced from 16 000 tonnes (2014) to 11 700 in 2018 and 2019 (Table 6.4.3). The reason for this was the decrease in the spawning–stock biomass index from the exploratory assessment in 2018.

The TACs by the European Union for areas 5, 6 and 7 are set for the European fisheries only. This TAC mostly applies to the fishery in Divisions 5.b and 6.a where the bulk of the catches are taken.

No bilateral agreement between the UK, EU and the Faroe Islands exists to set an overall TAC of greater silver smelt in 5.b and 6a. The sum of quotas of the Faroe Islands, UK and EU has exceeded the scientific ICES advice since 2016, except for in 2022 (Table 6.4.3).

6.4.10 Future research and data requirements

The WG recommends that work be done to further explore the assessment and forecast issues that have been identified for this stock. Based upon the new ICES Benchmark guidelines and outcome of these analyses, potential solutions could be presented for the working group at next WGDEEP. The most pressing issues are:

- Revisit the whole time series of catch at age and weight at age in order to resolve the discrepancy between modelled catch and observed catch. Special attention should be devoted to the allocation criteria for assigning catch at age proportions to unsampled strata. Furthermore, the catch weight at age estimates need attention as the lack of samples of fish older than 15 years, in some years, highlights the need to combine catch at age and weight at age samples in the allocation process that is currently handled separately in Division 5b and 6a.
- Review the short-term forecast assumptions and method in the light of the discrepancy between the SAM estimates of catch and the InterCatch estimated catch and revisiting the catch at age and weight at age matrices.
- Revisit, if needed, the biological reference points in the light of the new guidelines from ACOM.
- Investigate the model's sensitivity to catches in the most recent years which is showing quite a large variability in the selectivity at age over the years. The change in the selectivity estimated in the model driving the difference in the forecast (Figure 6.4.20) should be investigated too.

6.4.11 Tables

Table 6.4.1. Greater Silver Smelt 5.b and 6.a. WG estimates of landings in tonnes. *preliminary data

Division 5.b Year	Den-mark	Faroes	France	Germany	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	UK(E&W)	UK (Scot)	Russia	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	12286
1996		9495										3		9498
1997		8433												8433
1998		17570												17570
1999		8186	5								23	15		8229
2000		3713	64									247	1185	5209
2001		9572					1					94	414	10081
2002		7058						5				144	264	7471
2003		6261						51				1	245	6558
2004		3441						1125				42	702	5310
2005		6939						15					59	7013
2006		12554											35	12589
2007		14085						441	32				8	14566
2008		14930							3				19	14952
2009		14200											28	14228
2010		15567										40	2	15609
2011		15578											8	15586
2012		9744											110	9854
2013		11109											114	11223

Division 5.b Year	Den-mark	Faroes	France	Germany	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	UK(E&W)	UK (Scot)	Russia	TOTAL
2014		9747		110									339	10196
2015		13025	0	40		132							115	13312
2016		11129		38		345		31				0	13	11557
2017		9424		1		63		2					6	9496
2018		10114	0							1			150	10265
2019	0	9194		2		6				4			87	9292
2020	0	8416								0			22	8438
2021	0	5411												5411
2022*		6368												6368

Table 6.4.1 (Continued).

Division 6.a Year	Den-mark	Faroes	France	Germany	Ireland	Lithuania	Netherlands	Norway	Poland	UK (E&W)	UK (Scot)	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		4309							6894
1998				464	405		4696							5565
1999				24	168		8188			5				8385
2000			19	403	3178		3436							7036
2001			7	189	5838		3654				4777			14465
2002			1	150	3035		4009			424	4136			11755
2003				26	1		1958				80			2065

Division 6.a Year	Den-mark	Faroes	France	Germany	Ireland	Lithuania	Netherlands	Norway	Poland	UK (E&W)	UK (Scot)	Russia	Spain	Total
2004			147	652	46		4335				507			5687
2005		103	10	125	18		5276				61			5593
2006		52		213			4841				3		1	5110
2007		254		589			7621	3					2	8469
2008		991		10			4186	3						5190
2009		3923		115			2616	83			6	36		6779
2010		3060					3139	7			20	11		6237
2011		3655					3724			2	2			7383
2012		2781		538			3248			5	5	1		6578
2013	388	3197		417	0		1380					13		5395
2014	711	1495		908			2332					21		5467
2015		1055		1027			2154	0						4236
2016		2050	0	228			2495							4773
2017		2304		599			4405	2						7310
2018		1974	8	1001			2763	5				18		5769
2019		2980	4	953	6		4540		29			28	0	8538
2020		3629	8	384	0	114	4330		111				0	8576
2021		3141	17	336	0		4019		1		3		0	7514
2022*	4	3040	1	728	4		8664	0	21					12461

Table 6.4.2. Greater silver smelt (*Argentina silus*) (5.b and 6.a). *preliminary data

Year	5.b	6.a	Total Landings	Discard 5.b	Discard 6.a	Total catches
1988	287	7924	8211			8211
1989	227	20581	20808			20808
1990	2888	6795	9683			9683
1991	60	4726	4786			4786
1992	1443	5531	6974			6974
1993	1063	1069	2132			2132
1994	960	7635	8595			8595

Year	5.b	6.a	Total Landings	Discard 5.b	Discard 6.a	Total catches
1995	12286	4938	17224			17224
1996	9498	5632	15130			15130
1997	8433	6894	15327			15327
1998	17570	5565	23135			23135
1999	8229	8385	16614			16614
2000	5209	7036	12245			12245
2001	10081	14465	24546			24546
2002	7471	11755	19226			19226
2003	6558	2065	8623			8623
2004	5310	5687	10997			10997
2005	7013	5593	12606			12606
2006	12589	5110	17699			17699
2007	14566	8469	23035			23035
2008	14952	5190	20142			20142
2009	14228	6779	21007			21007
2010	15609	6237	21846			21846
2011	15586	7383	22969			22969
2012	9854	6578	16432			16432
2013	11223	5395	16618			16618
2014	10196	5467	15663	28	1553	17244
2015	13312	4236	17548		270	17818
2016	11557	4773	16330	12	1651	17993
2017	9496	7310	16806	31	239	17076
2018	10265	5769	16033	2	185	16220
2019	9292	8538	17830		86	17916
2020	8438	8576	17014	0	127	17141
2021	5411	7514	12925		157	13081
2022*	6368	12461	18829		243	19071

Table 6.4.3. Greater silver smelt in 5.b and 6.a. Overview of ICES advice and TACs set by the Faroese authorities and the European Union for greater silver smelt in area 5.b and 6.a.

Year/Area	ICES advise (5.b and 6.a)	Faroe Islands Quota (5.b and 6.a)	EU Quota ˆ (5, 6, 7)	UK Quota (5, 6, 7)	TACs Summed
2014	-	16000	4316	-	20316
2015	-	14400	4316	-	18716
2016	10030	13000	4316	-	17316
2017	10030	11500	3884	-	15384
2018	12036	11700	4661	-	16361
2019	12036	11700	4661	-	16361
2020	7703	11700	3729	-	15429
2021	7703	11700	3521	208	15429
2022	24493	18000	10976	650	29626
2023	17078	12700	7670	454	20824

ˆ The EU TAC applies to all of areas 5, 6 and 7. However, only minor catches have been taken outside of divisions 5.b and 6.a.

Table 6.4.4. Greater silver smelt in 5.b and 6.a. Discards of greater silver smelt in tons per country per area from 2014 to last data year along with discard percentage of combined annual catch. *preliminary data

Year	Area 5.b				Area 6.a					Areas combined 5.b and 6.a	
	France	Germany	Netherlands	UK(Scotland)	France	Germany	Netherlands	Spain	UK(Scotland)	Total	% of catches
2014		28			808	92			653	1581	9.2
2015					161				109	270	1.5
2016	12				200				1451	1663	9.2
2017	31		0		217		9		14	270	1.6
2018	2				118				67	187	1.2
2019					13			9	64	86	0.5
2020				0				2	124	127	0.7
2021								0	156	157	1.2
2022*								83	159	243	1.3

6.5 Greater silver smelt (*Argentina silus*) in 6.b, 7, 8, 9,10 and 12

6.5.1 The fishery

The fisheries in this area are very minor and there are no directed fisheries.

6.5.2 Landing trends

Landings from this area are reported from 1966–2022. Landings increased until 2002 to 4662 tons then declined again to low levels of less than a ton in 2016. Landings from 2006 until 2022 have been less than 50 tons, except for 76 t in 2020. The main landings have been from Division 6b and Subarea 7 where Ireland was fishing for some years between 2000 and 2003.

Landings in Division 6.b and subareas 7–10 and 12 are small. Considerable discarding is known to occur in some fisheries in the Porcupine Bank outer shelf and upper slope fisheries for demersal and deep-water fish. These fisheries do not land greater silver smelt. Targeted fisheries for greater silver smelt that existed prior to 2006 have not operated significantly in these areas since then. It is considered more likely that variations in landings over time reflect market opportunities rather than fish abundance.

6.5.3 ICES Advice

Advice is given every other year. The 2021 advice for area 6b, 7, 8, 9, 10 and 12, stated "ICES advises that catches should be no more than 124 tonnes in each of the years **2022 and 2023**. The precautionary approach was applied for the advice given in 2021. ICES previously gave advice on landings for this stock. Because discard data are now available, the present advice is provided for catch.

6.5.4 Management

The EU introduced TAC management in 2003. For 2023 and 2024, the EU TAC is 7670 t whilst the UK TAC is 454 t in Subareas 5, 6 and 7 [4]. Catches of blue whiting may include unavoidable by-catches of greater silver smelt in the area.

6.5.5 Data available

6.5.5.1 Landings and discards

Landings data are presented by area and countries (Tables 6.5.1–6.5.5, Figure 6.5.1). Discards data from the eight last years are presented in Table 6.5.6. Discards from 2015 to 2019 and from 2021 to 2022 are mainly from the Spanish fishery and from Subarea 7 while for 2020 the discards were around 50 t from both the Spanish fishery and the Scottish fishery. For previous years, the discards were very high compared to the landings. In 2020 this shifted, with Dutch landings of 62 t from Subarea 7. However, for the last two years the landings have declined again and are now, respectively, approximately 35 and 14 percent of the total catch.

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 6.5.7). 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

[4] EU-UK for 2023 (europa.eu)

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.

ICES considers that the high landings of silver smelt seen in the early 2000s (Table 6.5.1 and 6.5.2, and Figure 6.5.1.) may have resulted from misreporting of fish species other than silver smelt. There is currently no directed fishery and bycatches of greater silver smelt are discarded in fisheries for other species (primarily hake, monkfish, and megrim).

6.5.5.2 Length compositions

The size compositions of *Argentina* spp. from Porcupine survey since 2012 is presented in Figure 6.5.2.

Length distribution from discards is available in InterCatch for 2015 (Scotland), 2016 (Scotland and Spain), 2017 (Spain and Scotland), 2018 (Spain and Scotland), 2019 (Spain), 2020 (Scotland and Spain), 2021 (Spain) and 2022 (Spain). Length distributions from discards is presented in Figure 6.5.7. For landings, length distributions are available from 2020 (Netherland). Comparison of length distributions from landings and discards from 2020 is shown in Figure 6.5.8.

6.5.5.3 Age compositions

No new data on age composition were presented.

6.5.5.4 Weight-at-age

No new data on weight-at-age were presented.

6.5.5.5 Maturity and natural mortality

No new data on maturity and natural mortality were presented.

6.5.5.6 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* (Table 6.5.8 and Figures 6.5.2 - 6.5.6). Abundance and biomass indices from survey catches of mixed *A. silus* and *A. sphyraena* is presented in Figure 6.5.4. The Spanish survey only covers depths to 400 m and is unlikely to fully cover the depth range of greater silver smelt.

6.5.6 Data analyses

Length and age distributions

In previous years, the size compositions from Porcupine Bank in Subarea 7 have not shown any obvious trend towards smaller fish, but these data may be disturbed by the relative species composition of *A. silus* and *A. sphyreana* (Figure 6.5.2 and 6.5.5). In 2019, however, despite the low abundance per size of *A. silus* from the last survey, small specimens (around 17 cm) were found. For *A. silus*, this shows the highest amount of small specimens in the last ten years. A second small mode was found around 28 cm. For 2020, the length composition from the survey for *A. silus* shows that the mode around 22 cm increased greatly. The survey conducted in 2021 did not show any trends regarding the length composition as the amount of *A. silus* was low. For 2022, the length composition still shows a bi-modal distribution. However, the number of specimens is considerably lower than showed in 2020. For, *A. sphyraena,* a single mode is showed around 22 cm since 2017 (Figure 6.5.2).

Commercial and survey cpue series

For Subarea 7, abundance and biomass indices from the Spanish porcupine survey showed a decreasing trend from 2002 until 2011, were rising from 2012 until 2016 but have had a downward trend since then (Figure 6.5.4). The index has decreased for *A. silus* since 2016 with the exception of relatively high estimates in 2020 (Figure 6.5.3). However, the survey is unlikely to cover all the exploitable biomass of the stock as it only covers depth down to 400 meters. In 2019, the biomass of both species of *Argentina* continued decreasing whereas the abundance increased slightly (Table 6.5.8 and Figure 6.5.4). *A. silus*, the most contributing species in the overall percentage of silver smelt, followed the downward trend of the previous years whereas *A. sphyraena* increased abruptly both regarding biomass and abundance (Table 6.5.8 and Figure 6.5.3). However, the index from the survey conducted in 2020 shows that both the biomass and the number of *A. silus* increased considerably, breaking the downward trend of recent years, and staying in the medium-high values of historical series. *A. sphyraena*, by contrast, decreased sharply, getting medium-low values of the time series. For 2021 the trend for *A. sphyraena* continued at 2020 values, while both the biomass and abundance of *A. silus* declined to a historical low level. For 2022 the trend for both species, considering biomass and abundance, increased.

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) at WGDEEP 2017, but it did not converge. SPiCT was also run before WGDEEP 2023 on the catch dataseries (1966-2022) and the biomass index series from Porcupine Bank (2001-2022), but either this time did SPiCT converge.

6.5.7 Assessment

According to the recommendations from WKLIFE X, the ICES-rfb rule was applied for a trend-based advice (ICES, 2023). The Spanish Porcupine bank survey greater silver smelt index (Table 6.5.8 and Figure 6.5.3) was used for the stock development. The advice is based on the recent advised catches (2023), multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard, and a precautionary multiplier. The stability clause was considered and applied to limit the decrease in catch advice to 30%. The discard rate (mean 2015–2022) was 82%. The biomass index, index A and index B is shown in Figure 6.5.9. The pooled lengths from years 2015-2022 is shown in Figure 6.5.10. Note that the pooled lengths are from discards, hence the Lc, length at first capture, is not representative for landings. Age data were not available for this stock and growth parameters from the nearby greater silver smelt stock in Faroes waters and west of Scotland (ICES areas 5b and 6a) were applied. The parameters from von Bertalanffys growth function used in the rfb calculations were L_{∞} = 48 cm and k = 0.225 yr^{-1}. $L_{trigger}$ is 40 kg $haul^{-1}$. The stock size is above MSY $B_{trigger\ proxy}$ ($I_{trigger}$) (Figure 6.5.9), and the fishing pressure is above $F_{MSY\ proxy}$ (Figure 6.5.11).

6.5.8 Comments on the assessment

Advice is given every other year for this stock and last advice applies for 2024 and 2025.

It should be noted that lesser silver smelt (*A. 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 6.5.2, and 6.5.6). 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.

A SPiCT model with the Spanish Porcupine survey as a biomass index was explored before the meeting but did not converge. This indicates that a production model is not appliable to the stock with the currently available data. Thus, in accordance with ICES guidelines (ICES, 2023) a trend-based rfb rule assessment is applied.

6.5.9 Management considerations

The trends for Porcupine bank survey biomass indices for *Argentina* species have increased in 2015 and 2016, declined in 2017, 2018 and 2019, increasing again in 2020 before declining to a historical low level in 2021 before increasing again in 2022.

6.5.10 References

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6.5.11 Tables

Table 6.5.1. Greater Silver Smelt in 6.b. WG estimates of landings in tonnes. *landings in 2022 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

Year	Faroes	Germany	Ireland	Netherlands	Scotland	Russia	Spain	TOTAL
2006								
2007								
2008						1	8	9
2009								
2010								
2011								
2012								
2013								
2014						20.5		20.5
2015								0
2016								0
2017								0
2018								0
2019						1		1
2020						11		11
2021								0
2022*								0

Table 6.5.2. Greater Silver Smelt in 7. WG estimates of landings in tonnes. *landings in 2022 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										

Year	France	Germany	Ireland	Netherlands	Scotland	Norway	Poland	Spain	UK E/W	TOTAL
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

Year	France	Germany	Ireland	Netherlands	Scotland	Norway	Poland	Spain	UK E/W	TOTAL
2011		4			8					12
2012		2			1					3
2013				1						1
2014				1						1
2015				5						5
2016	0			0				0		0
2017				8						8
2018				31				1		32
2019			0	5						5
2020			1	62						63
2021				34						34
2022*				16						16

Table 6.5.3. Greater Silver Smelt in 8. WG estimates of landings in tonnes. *landings in 2022 are preliminary.

Year	Netherlands	Spain	Ireland	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

Year	Netherlands	Spain	Ireland	TOTAL
2017		0		0
2018		3.9		3.9
2019		1.6	0.5	2.1
2020		1.6		1.6
2021		0.3		0.3
2022*	1.5			1.5

Table 6.5.4. Greater Silver Smelt 9. WG estimates of landings in tonnes. *landings in 2022 are preliminary.

Year	Netherlands	Spain	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
2017				0
2018		0.1		0.1
2019				0
2020				0
2021				0
2022*		0.06		0.06

Table 6.5.5. Greater Silver Smelt 12. WG estimates of landings in tonnes. *landings in 2022 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

Year	Faroes	Iceland	Russia	Netherlands	TOTAL
2016					0
2017					0
2018					0
2019					0
2020					0
2021					0
2022*					0

Table 6.5.6. Discard data from 2015-2021 from Subarea 6b, 7-1012. *discards in 2022 are preliminary

Year	Spain				UK (Scotland)	TOTAL
	6b	7	8	9	6b	
2015	0.7	28			0.5	29.2
2016		237	2	1		240
2017	1.82	148.8			0.3	151
2018	2.3	97.9	1.8	0.8	10	112.8
2019	5	146	0.2	0.1	0.29	152
2020	2	44.6	7.4	2.9	50	107
2021	2	59.1	0.4	0.2	0.033	62
2022*	2.1	98.7	5.5	2.3	0.2	108.8

Table 6.5.7. Discards by Spain and Netherlands from before the redefinition of the stock area (Subarea 6,7 and 8) from 2003–2014.

Year	Spain	Denmark	Germany	Sweden	Netherland	Total
2003	2807				1247	4053
2004	3075				300	3375
2005	2438				0	2438
2006	1250				149	1399
2007	2038				45	2083
2008	3060				58	3118
2009	4109				74	4183
2010	2006				23	2029
2011	2050				6	2056
2012	177				26	203
2013	91			21	20	133
2014	160	6	120	1	111	398

Table 6.5.8. Greater silver smelt in subareas 7–10 and 12, and in Division 6.b. Assessment summary. Biomass index from the Spanish Porcupine Bank survey for both greater and lesser silver smelt. Also given is the biomass index for *A. silus* only and the proportion between the two species. High and low refer to standard errors.

Year	*Argentina sp.*			*Argentina silus*			Proportion of *A. silus/A. sphyrena* in the survey
	kg haul^{-1}	Low	High	kg haul^{-1}	Low	High	
2001	133.17	72.76	193.57				
2002	143.72	62.36	225.08				
2003	141.33	82.19	200.47				
2004	142.76	68.42	217.09				
2005	111.15	59.60	162.69				
2006	98.05	36.29	159.81				
2007	79.03	43.71	114.35				
2008	82.16	32.93	131.40				
2009	79.74	43.65	115.83	72.95	37.69	108.21	0.91
2010	97.39	41.19	153.59	89.97	34.02	145.91	0.92
2011	57.57	32.38	82.75	50.32	25.85	74.78	0.87
2012	93.52	51.51	135.53	83.02	42.52	123.53	0.89
2013	135.63	76.35	194.91	121.50	66.25	176.75	0.90
2014	75.59	48.41	102.77	59.57	35.53	83.61	0.79
2015	92.80	53.82	131.79	72.56	41.95	103.18	0.78
2016	199.00	109.49	288.51	172.94	92.32	253.55	0.87
2017	159.31	89.22	229.41	129.63	73.41	185.86	0.81
2018	112.36	38.57	186.16	98.72	25.44	172.00	0.88
2019	92.59	70.69	114.49	67.60	48.07	87.13	0.73
2020	125.34	87.95	162.72	109.81	75.28	144.34	0.88
2021	43.40	33.05	53.75	28.59	22.39	34.78	0.66
2022	96.54	74.66	118.42	71.04	54.58	87.51	0.74

6.5.12 Figures

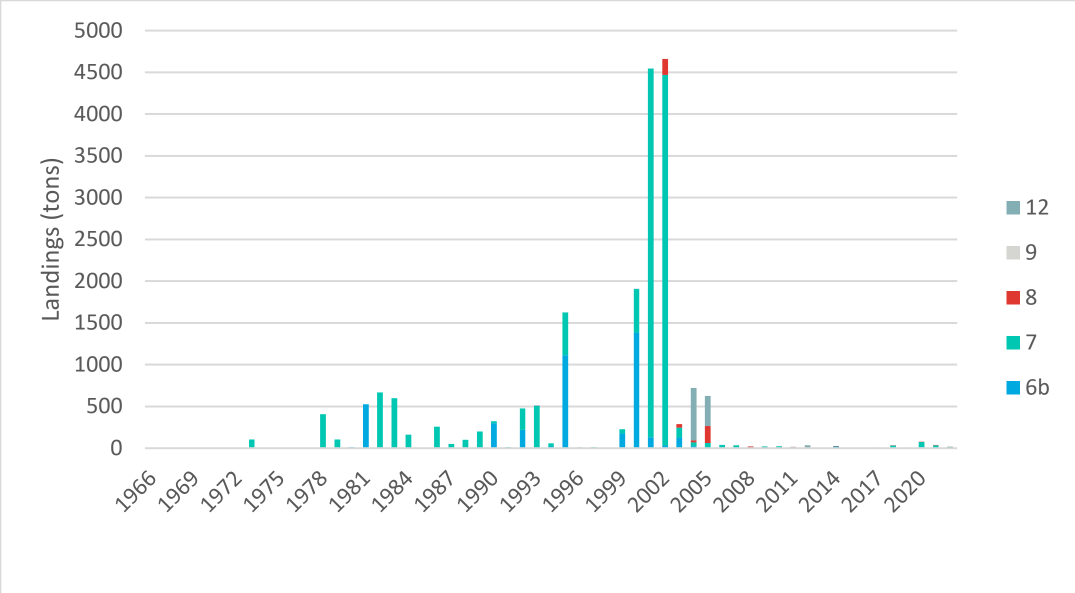


Figure 6.5.1. Total landings from 1966–2022 of greater silver smelt in 6.b, 7, 8, 9, 10 and 12.

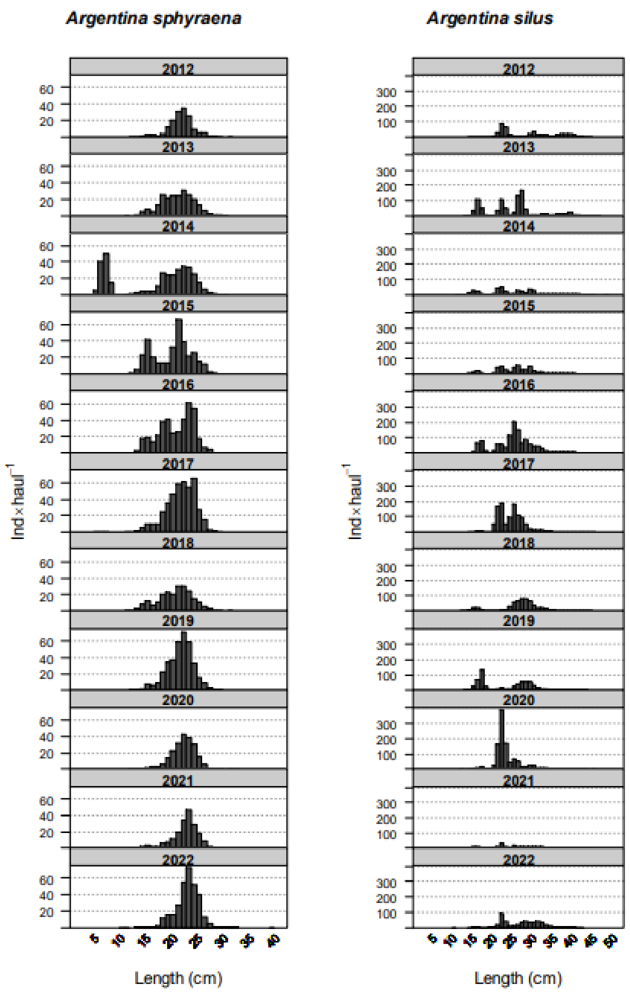


Figure 6.5.2. Mean stratified length distributions of *Argentina* spp. in Spanish Porcupine surveys from 2012–2022. Note different range in the y-axis values between species.

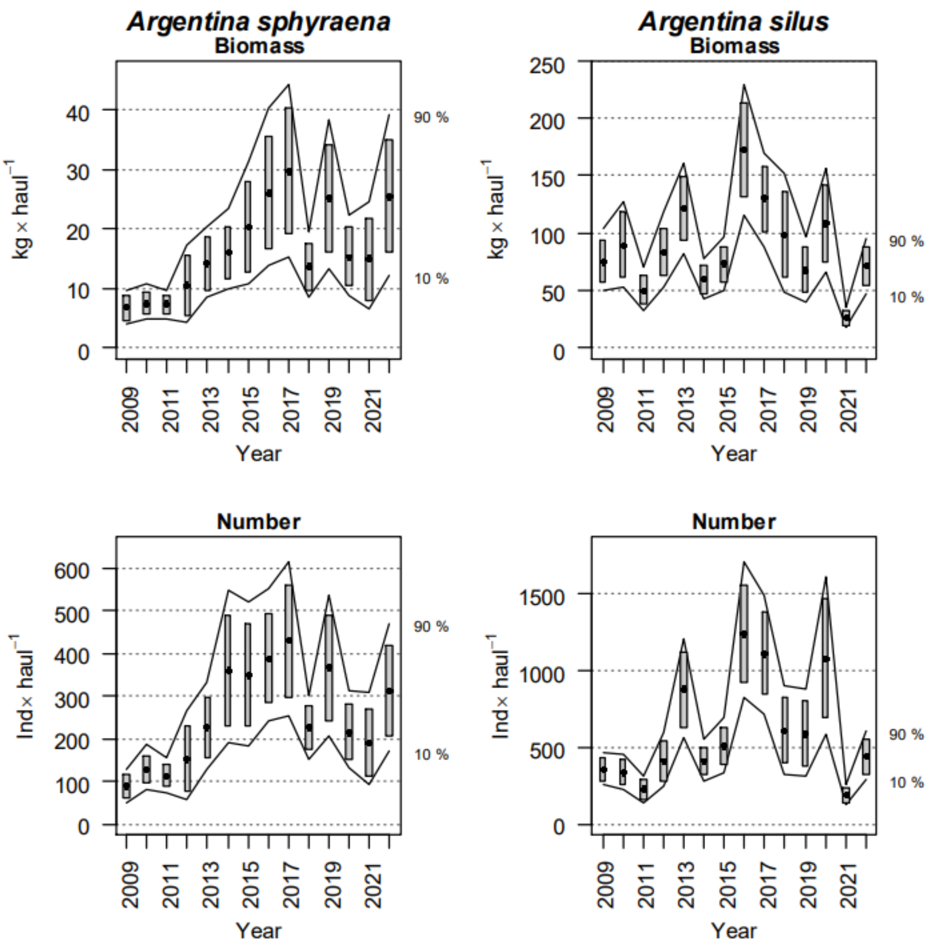


Figure 6.5.3. *Argentina sphyraena* and *Argentina silus* biomass and abundance indices in Porcupine surveys (2009–2022). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a=0.80, bootstrap iterations=1000).

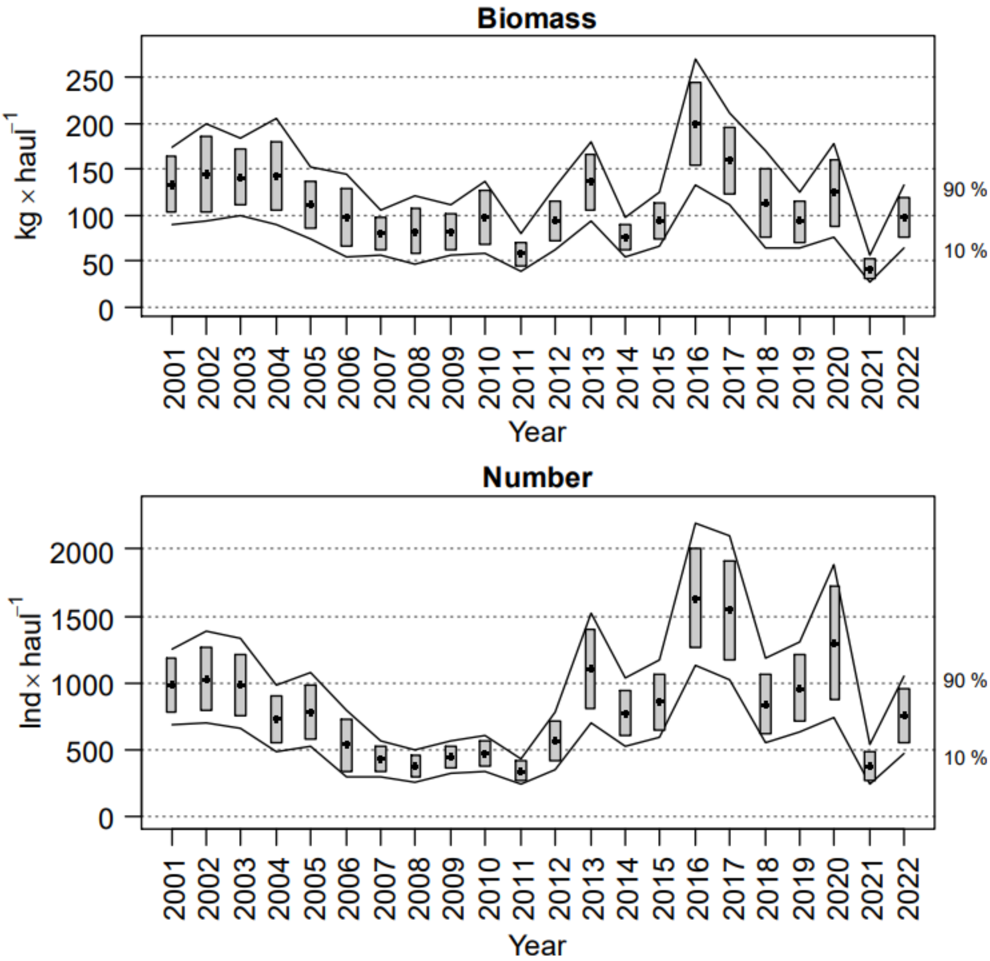


Figure 6.5.4. Argentina spp. (mainly Argentina silus) biomass and abundance indices in Porcupine surveys (2001-2022). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

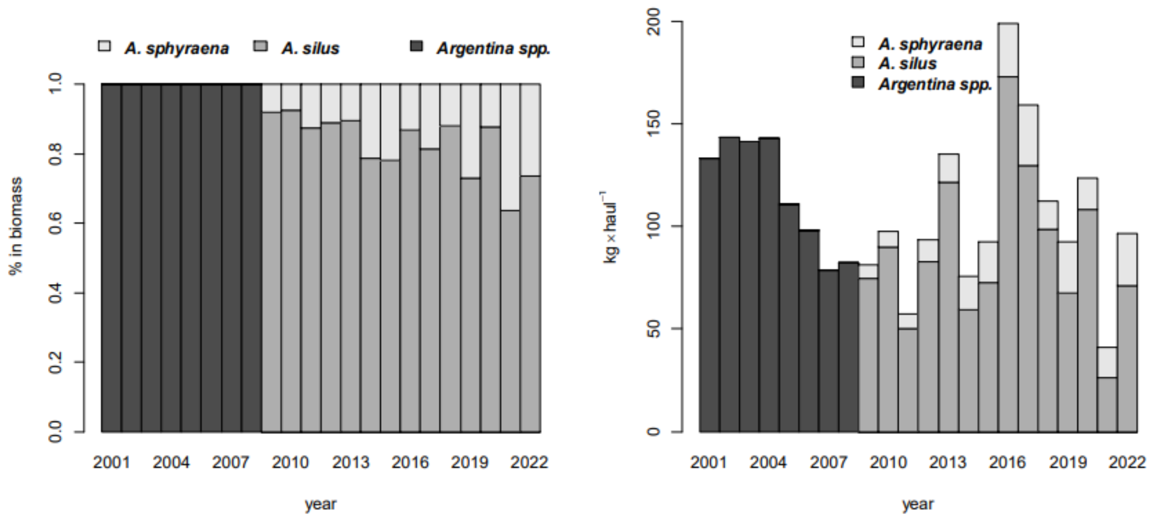


Figure 6.5.5. Share and abundance of Argentine species in Porcupine Bank surveys (2001–2022).

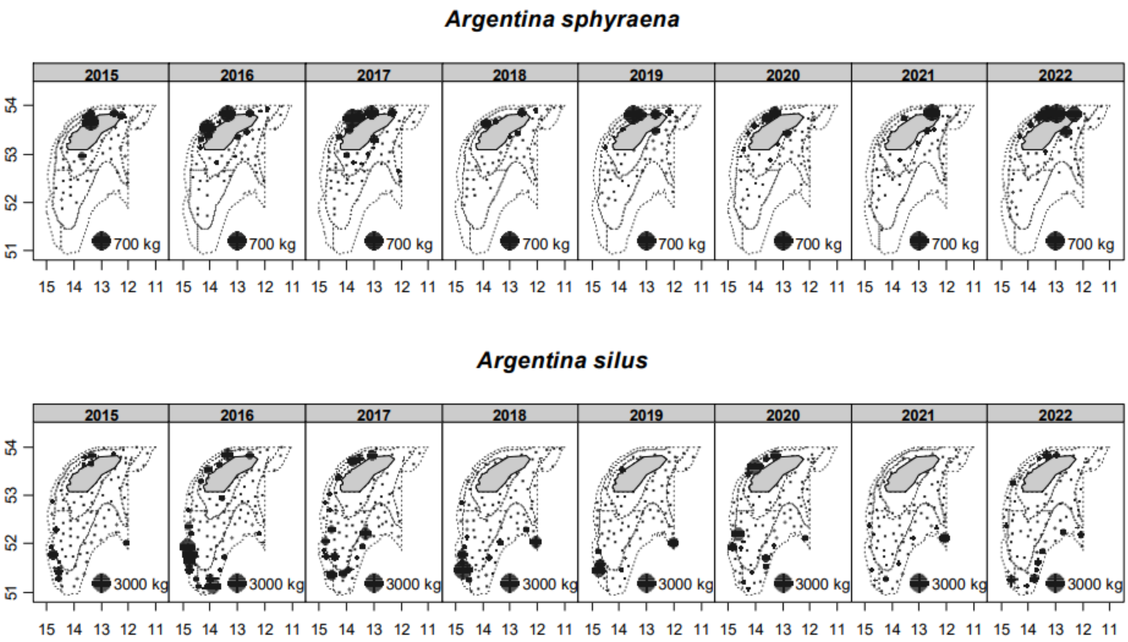


Figure 6.5.6. Geographic distribution of *Argentina sphyraena* and *Argentina silus* catches (kg/30 min haul) in Porcupine surveys (2015 - 2022)

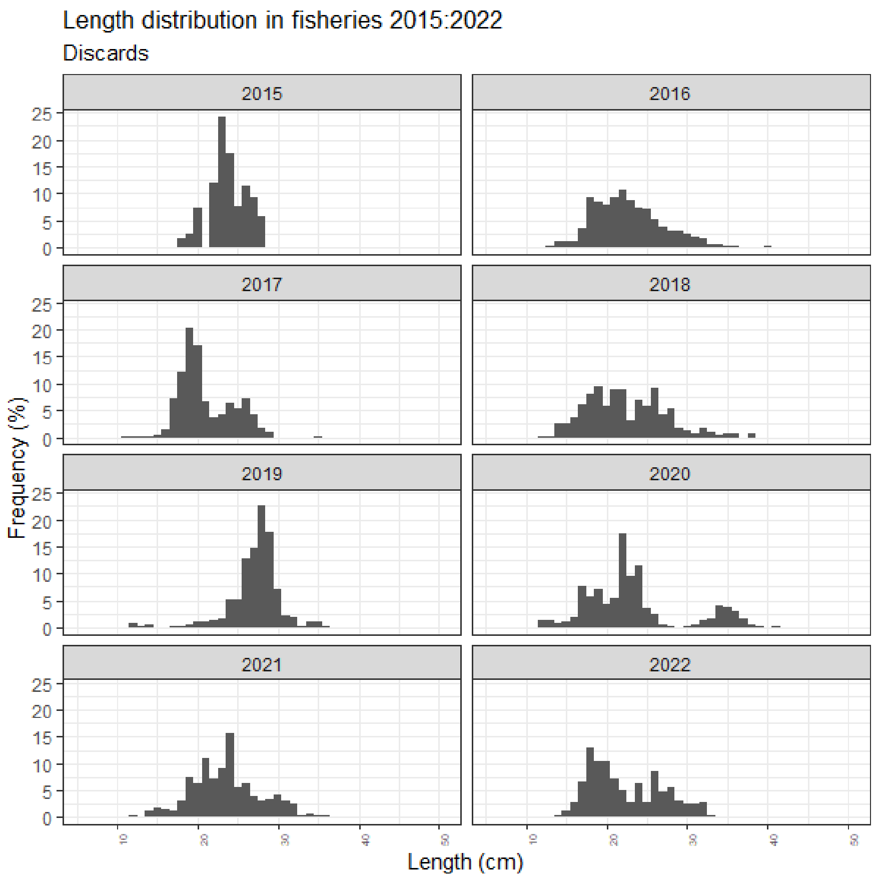


Figure 6.5.7. Length distribution from discard 2015-2022, all areas **combined.**

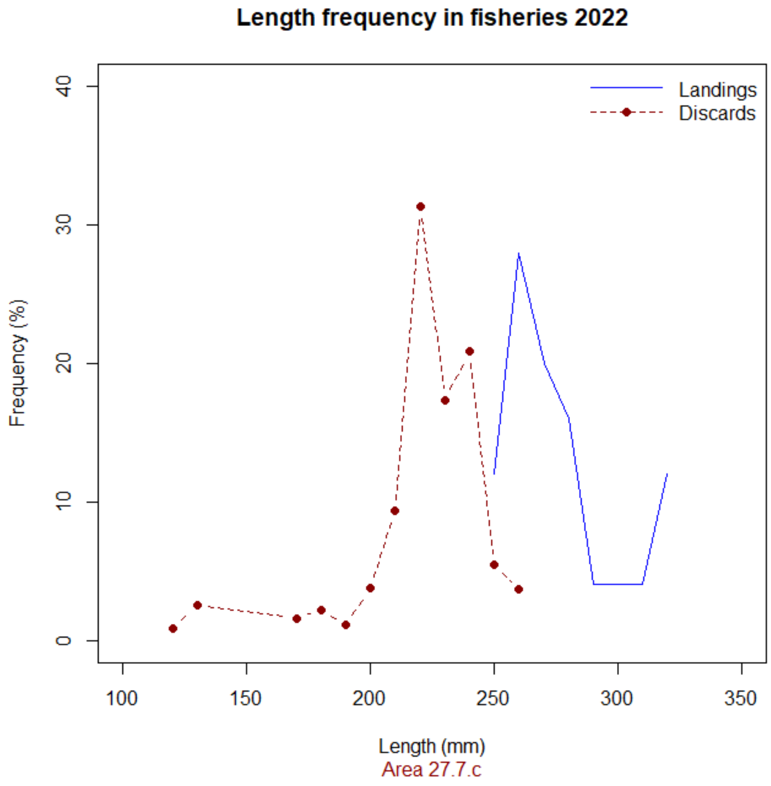


Figure 6.5.8. Length distribution from discard and landings from area 27.7.c in 2020.

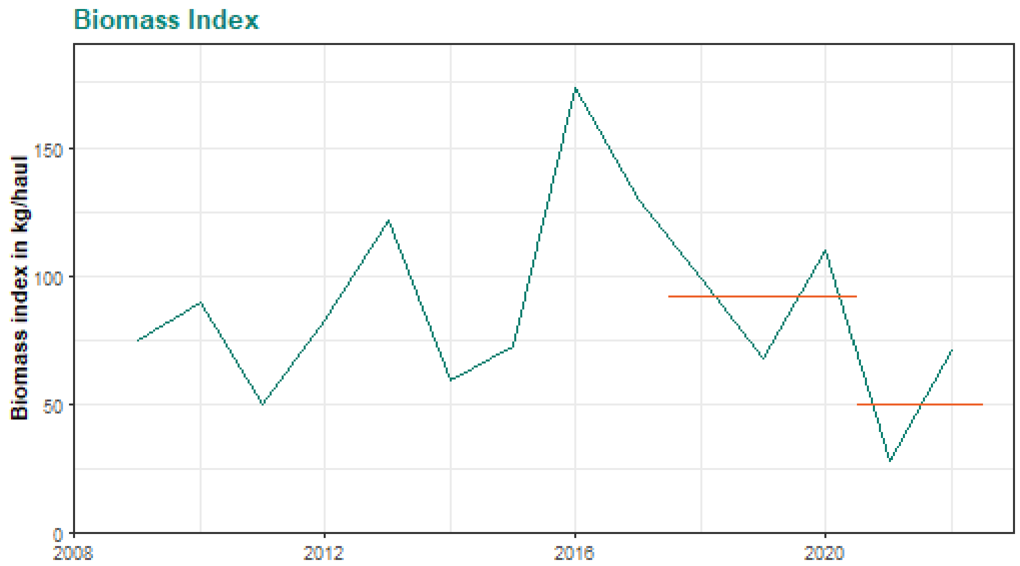


Figure 6.5.9. Biomass index year 2009-2022. Red horizontally lines indicating Index A (2021 and 2022) and index B (2018-2020).

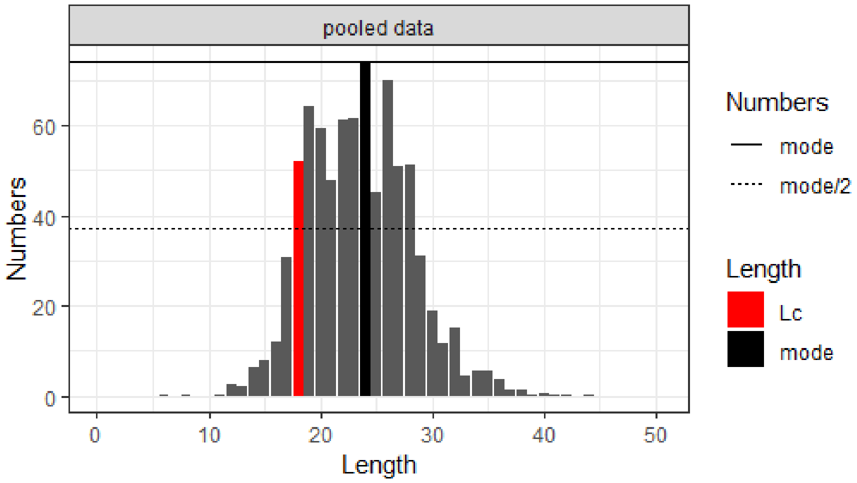


Figure 6.5.10. Pooled length distribution (years 2015-2022), including Lc and mode length.

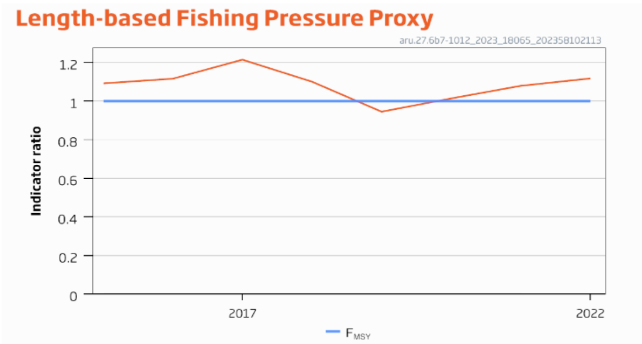


Figure 6.5.11. Length-based fishing pressure proxy. Indicator ratio LF= M/Lmean (inverse of the indicator ratio, f) from the length-based indicator (LBI) method is used for the evaluation of the exploitation status. The proxy fishing pressure is less than that corresponding to the FMSY proxy (LF= M) when the indicator ratio value is lower than 1 (shown by the horizontal blue line).

7 Orange roughy (*Hoplostethus atlanticus*) in the Northeast Atlantic

7.1 Stock description and management units

The stock structure of this species is unknown. The information available is insufficient to admit the existence of separate populations of orange roughy in the North Atlantic.

For assessment purposes, ICES considers three assessment units along ICES area:

- Subarea 6;
- Subarea 7;
- Orange roughy in all other areas.

Given the scarcity of spatial fisheries data, biological and genetics data, WGDEEP have not altered these assessment units.

Orange roughy is an aggregating species and the spatial scale of current management units would not prevent sequential depletion of local aggregations. Such local aggregations may not represent different biological populations, i.e. a biological population may comprise several local aggregations. However, the sequential depletion of local aggregations could lead to depletion at stock level. Therefore, ICES has recommended that where the small-scale distribution is known, this should be used to define smaller and more meaningful management units. In other words, where aggregations are known, their biomass should be estimated to derive small-scale catch levels that can be sustained at aggregation level. Nevertheless, the methodology to do that is hardly available.

7.2 Orange roughy (*Hoplostethus Atlanticus*) in Subarea 6

7.2.1 The fishery

There was a French target fishery, centred on spawning aggregations around the Hebrides Terrace Seamount in the early 1990s. Irish vessels exploited aggregations further south in divisions 7c and 7k in the early 2000, but directed fisheries had ceased by 2006. No fishing and no catch were reported for years 2017-2021. From 2017, following the ban of trawling deeper than 800 m in EU waters and for EU vessels in international waters (EU regulation 2016/2336 of 14 December 2016), catch by EU vessels are expected to be negligible or none.

7.2.2 Landings trends

Table 7.2.1 and Figure 7.2.1 show the landings (ICES estimates) data for orange roughy for ICES Subarea 6 as reported to ICES or as reported to the WGDEEP. In recent years, only a small landing, 700 kg rounded to 1 tonne (Table 7.2.1) was landed by the Faroe Islands in 2016. The cumulative landings in Subarea 6 since 1988 were 7188 tonnes. There were no landings in 2017–2022.

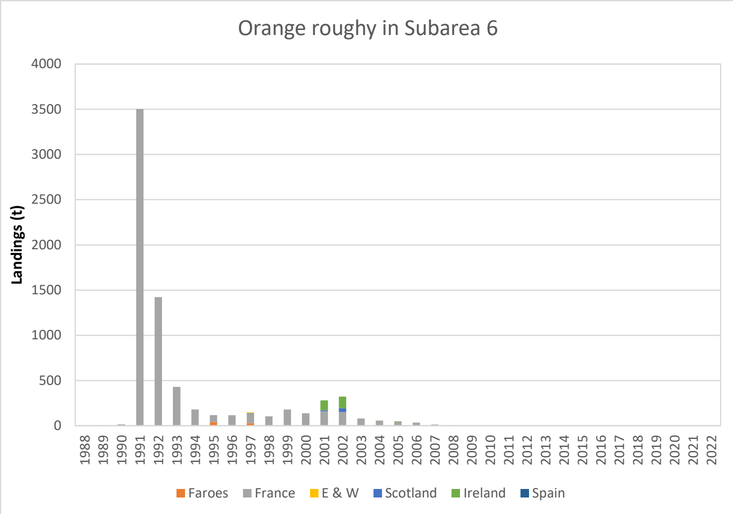


Figure 7.2.1. Time-series of orange roughy landings by country in ICES Subarea 6.

7.2.3 ICES Advice

The ICES advice was published in 2020 for **2021–2024**. It applies to orange roughy in the North-east Atlantic and states that when the precautionary approach is applied, there should be zero catches in each of the years 2021–2024.

7.2.4 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 EU vessels in Area 6 was reduced annually between 2007 and 2009. Zero TACs have been set for orange roughy in all EU waters since 2010. In recent years, the species is prohibited in all EU waters.

Landings in relation to TAC are displayed in Table 7.2.2.

Table 7.2.2. EU TACs and landings in EU and international waters of 6.

		Landing (t)	
Year	TAC (t)	EU 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

	Landing (t)		
2011	0	0	0
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	0	1
2017	0	0	0
2018	0	0	0
2019	0	0	0
2020	0	0	0
2021	0	0	0
2022	0	0	0

7.2.5 Data available

7.2.5.1 Landings and discards

Landings are in Table 7.2.1.

Raised discard weights were not available for 2014 and 2015. For 2016 and 2017, discards were estimated to 0 (zero). In 2018-2022 there was no reported landings nor discards to ICES.

7.2.5.2 Length compositions

Length distributions are available from historical observer programmes and current deep-water surveys. Available information can be found in the stock annex.

7.2.5.3 Age compositions

No new information. Available information can be found in the stock annex.

7.2.5.4 Weight-at-age

No information.

7.2.5.5 Maturity and natural mortality

No new information. Available information can be found in the stock annex.

7.2.5.6 Catch, effort and research vessel data

No new information. Available information can be found in the stock annex.

7.2.6 Data analyses

No new analysis was performed in 2023.

7.2.7 Management considerations

A zero TAC without allowing a bycatch can potentially lead to discarding if existing fisheries overlap with the distribution of orange roughy. However, since the ban of trawling deeper than 800 m the overlap between existing fisheries and the distribution of orange roughy might be minimal in EU waters of Subarea 6.

Due to the closure of the fishery in subareas 6 and 7 and trawling ban deeper than 800 m there are no fishery-dependent data to evaluate the status of the stocks.

PSA assessment of the susceptibility of orange roughy populations in Subareas 6 and 7 to current and deep-water trawl fisheries (see WGDEEP 2014, Section 7.3) has shown a strong reduction in risk over time when fisheries directed targeting practices stopped and continued with mixed deep-water trawl fisheries. Before the ban of trawling deeper than 800 m, some spatial overlap between the species and fisheries remained, 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. Following the application of the ban of bottom trawling deeper than 800 m (EU regulation 2016/2336) this bycatch might be minor in EU fisheries because the fraction of orange rough biomass occurring shallower than 800 m is minor or inexistent.

Table 7.2.1. Orange roughy catch in Subarea 6.

Year	Faroes	France	E & W	Scotland	Ireland	Spain	Total
1988	-	-	-	-	-	-	0
1989	-	5	-	-	-	-	5
1990	-	15	-	-	-	-	15
1991	-	3502	-	-	-	-	3502
1992	-	1422	-	-	-	-	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

Year	Faroes	France	E & W	Scotland	Ireland	Spain	Total
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
2017							0
2018							0
2019							0
2020							0
2021							0
2022							0

7.3 Orange roughy (*Hoplostethus atlanticus*) in Subarea 7

7.3.1 The fishery

After the first few years (1991–93) of the fishery in Subarea 6, the main fishery for orange roughy in the northern hemisphere was in Subarea 7. 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.

7.3.2 Landings trends

Table 7.3.1 and Figure 7.3.1 show the landings data for orange roughy as reported to ICES or as reported to the Working Group.

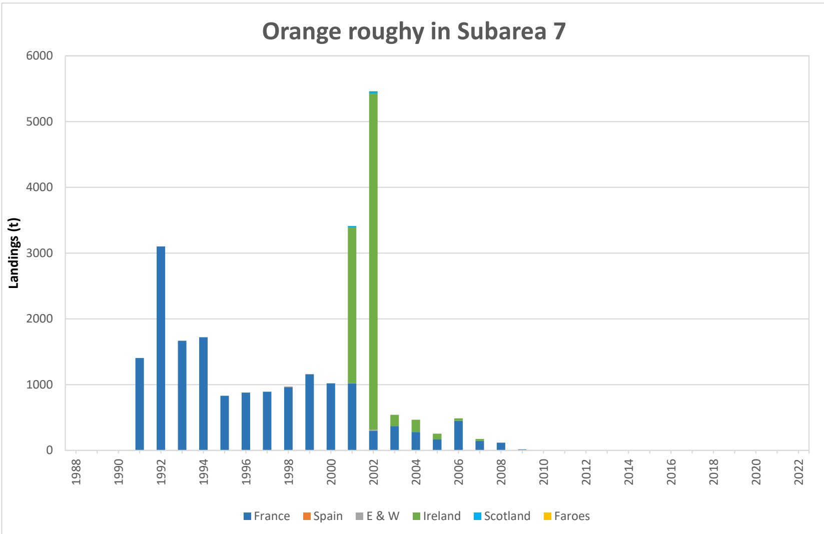


Figure 7.3.1. Time-series of orange roughy landings by country in ICES Subarea 7.

7.3.3 ICES Advice

The ICES advice was published in 2020 for **2021–2024**. 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 2021–2024.

7.3.4 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 7.3.2. EU TACs and landings in EU and international waters of Subarea 7.

		Landing (t)	
Year	TAC (t)	EU 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
2017	0	0	0
2018	0	0	0
2019	0	0	0
2020	0	0	0
2021	0	0	0
2022	0	0	0

The TAC for orange roughy in Subarea 7 was set to 0 t for 2022. No catch was reported.

7.3.5 Data available

7.3.5.1 Landings and discards

Landings are shown are in Table 7.3.1.

There were no landings since 2010 until 2021 where 0.003 tonnes were reported from France in InterCatch from Division 7.e, which should be considered as an error in landings statistics as orange roughy does not occur in 7.e, which does not include depth suitable to the species. 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. More recent discards are lesser because the main depth range of the species is no longer accessible to bottom trawlers in EU and UK waters.

7.3.5.2 Length compositions

No new information available. Historic information can be found in the stock annex.

7.3.5.3 Age compositions

No new information available. Historic information can be found in the stock annex.

7.3.5.4 Weight-at-age

No data.

7.3.5.5 Maturity and natural mortality

No new information available. Historic information can be found in the stock annex.

7.3.5.6 Catch, effort and research vessel data

No new information. Available information can be found in the stock annex.

7.3.6 Management considerations

See section 6.1.1. Management considerations.

Table 7.3.1. 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

Year	France	Spain	E & W	Ireland	Scotland	Faroes	Total
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

7.4 Orange Roughy (*Hoplostethus atlanticus*) in subareas 1, 2, 4, 5, 8, 9, 10, 12 and 14 and Division 3.a

7.4.1 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. Since 2010, fisheries are mainly occurring in subareas 10 and 12, with sporadic catches in 5.a, 5.b and 9. In the period 2011-2019, one Faroese trawler operated a small directed fishery in ICES Subareas 10 and 12 (Ofstad, 2020). In recent years, Iceland had catches in 5a.

7.4.2 Landing trends

Table 7.4.0 and Figure 7.4.1 show ICES estimates of landings of orange roughy from ICES subareas 1, 2, 4, 5, 8, 9, 10, 12 and 14 and Division 3.a. Landings from the single trawler fishing in subareas 10 and 12 were between 50 and 150 tonnes per year in 2014 to 2019. They amounted to 150 tonnes in 2017. There were no catch of orange roughy in 2020. In 2021, around 4 tonnes were landed, mainly in Subdivision 5a and in 2022 this increased to 19 tonnes landed in 5a.

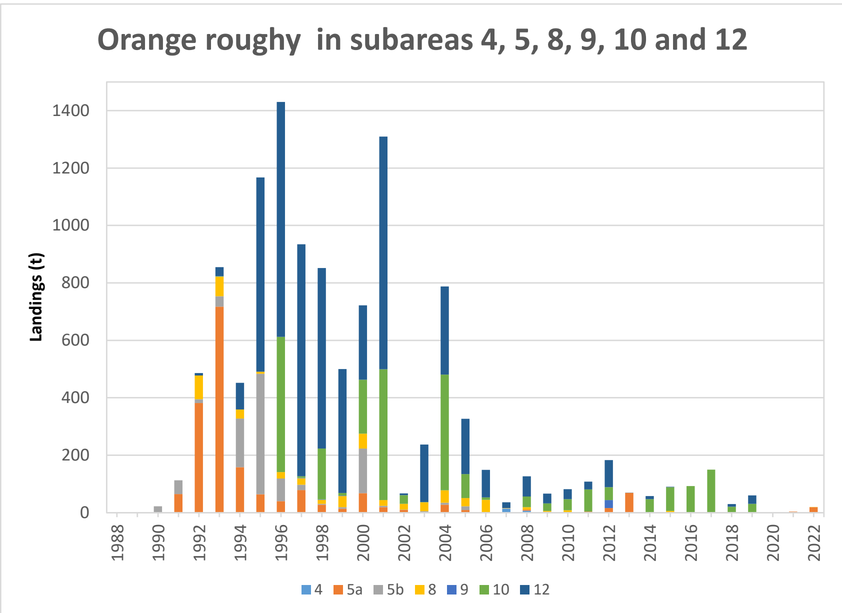


Figure 7.4.1. Time-series of orange roughy landings by subarea in all ICES areas (except subareas 6 and 7).

7.4.3 ICES Advice

The ICES advice was published in 2020 for **2021–2024.** 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 2021–2024.

7.4.4 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 7.4.1.

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 bycatch (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 7.4.1. 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	EU TAC (t)	EU 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	0	0
2017	0	0	0
2018	0	0	0
2019	0	0	0
2020	0	0	0
2021	0	0	0
2022	0	0	0

7.4.5 Data available

7.4.5.1 Landings and discards

Landings are in Table 7.4.0. In recent years, Iceland had a fishery for orange roughy in 5a. No Faroese fishery in Subarea 10 since 2019. The Faroese catches were 93 and 150 tonnes in Subarea 10, respectively in 2016 and 2017. In 2016 and 2017, small discards were reported by Spain in divisions 8.c and 9.a, 500 and 225 kg respectively in 2016 and 2017. In 2018 reported discards were 120 kg by Spain from Division 8.c. The Faroese catches were 21 tons in Subarea 10 and 9 tons in Subarea 12 in 2018 and 31 tons in area 10 and 29 tons in Subarea 12 in 2019. There were no catch of orange roughy in 2020. In 2021, 0.070 tonnes were reported from Scotland for Subdivision 4a and 3.587 tonnes from Iceland for Subdivision 5a. In 2022, 19 tonnes were reported from Iceland in 5a, 0.0034 tonnes from ES in 8c and 0.026 tonnes from France in 8b.

7.4.5.2 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. The length distribution of the catch is between 50–70 cm total length (Figure 7.4.1), 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 2011–2019 compared with the results from the experimental fishery in 1992–1998 (Thomsen, 1998) (Table 7.4.2). In 2019, only length measurements were taken, no sex or weight measurements were available. There was no new information on length composition since 2019.

Table 7.4.2. Mean length and weight by sex and combined (comb.). From sampling by trained crew members on board the single Faroese fishing vessel targeting orange roughy. [a] Thomsen, 1998.

Year	Area	Month	Average length (cm)			Average weight (kg)	
			Female	Male	Comb.	Female	Male
1992-1998[a]	Faroe Islands		61.4	58.6		4.4	3.7
1992-1998[a]	Hatton Bank		64.6	62.8		4.9	4.3
1992-1998[a]	Reykjanes ridge		58.9	56.4		3.6	3.0
1992-1998[a]	North of Azores		60.6	59.7		3.9	3.7
2011	27.10b	Feb., Mar.	61.4	60.5	60.9	3.5	3.2
2012	27.10b	Feb.	61.4	60.8	61.0	3.5	3.2
2013	27.10b	Jan.	60.9	57.7	59.6	4.3	3.8
2014	27.10b	Jun., Jul.	62.1	58.4	60.5	4.2	3.7
2015	27.10b	Jul., Aug.	59.0	58.3	58.6	3.7	3.5
2016	27.10b	Jun., Oct., Nov.	61.4	58.7	60.1	4.3	3.7
2017	27.10b	Nov.	60.6	57.5	58.7	3.9	3.4
2018	27.10b, 27.12c	Feb.	63.4	60.1	61.5	4.2	3.8
2019	27.10b, 27.12cd	Feb., Mar.			61.4		

7.4.5.3 Age composition

No data.

7.4.5.4 Weight-at-age

No data.

7.4.5.5 Maturity and natural mortality

No data.

7.4.5.6 Catch, effort and research vessel data

Catch and effort data were collected on a haul-by-haul basis in the Faroese fishery.

Orange roughy is caught occasionally in the stratified bottom trawl survey in East Greenland (Division 14.b) (Nielsen et. al., 2019). The species was only caught in 2008, 2013, 2014 and 2015 (Figure 7.4.2). In 2014 and 2015, estimated biomass was 1.7 t and 1.1 t, respectively, and all other years it was zero or very close to. No length distributions are calculated because of too few specimens (N<20) has been caught.

There was no information available of orange roughy in ICES division 14.b in the period 1999-2019 (Nilsen, 2020).

7.4.6 Data analysis

No data analysis was carried out in 2022.

7.4.7 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.

The zero EU TAC implies that no EU fishing for the species is allowed. The application of the EU regulation 2016/2336, establishing specific conditions for fishing for deep-sea stocks in the north-east Atlantic implies that bycatch in EU trawl fisheries might be minor as a consequence of the ban of fishing deeper than 800 m with trawls in this regulation. Possible bycatch should be minor because the fraction of orange rough biomass occurring shallower than 800 m is minor or inexistent. With the exception of the black scabbardfish fishery in Subarea 9.a, where bycatch of orange roughy are not known to occur, there are no EU longline fisheries at depth where orange roughy occurs.

Concerns were raised at the WGDEEP 2020 about potential sequential depletion of orange roughy at seamounts. It was recommended to perform an analysis of available VMS-data and investigate the fishing grounds exploited by this fishery.

In 2015–2019 all landings from the stock were caught in the NEAFC RA.

7.4.8 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.

Nilsen, J., Nogueira, A., and Christensen, H.T. 2019. Survey results of roughhead grenadier, roundnose grenadier, greater silver smelt, blue ling, tusk, black scabbardfish, ling, and orange roughy in ICES subdivision 14.b.2 in the period 1998-2016. WD05 WGDEEP 2019.

Nilsen, J. 2019. Commercial catches of roundnose grenadier, roughhead grenadier, greater silver smelt, blue ling, tusk, black scabbard fish, ling and orange roughy in ICES division 14b in the period 1999-2019. WD02 WGDEEP 2020.

Ofstad, L.H. 2020. Faroese fishery of orange roughy in ICES areas 10 and 12. WD01 WGDEEP 2020.

Thomsen, B. 1998. Faroese quest of orange roughy in the North Atlantic. Copenhagen (Denmark), ICES.

7.4.9 Tables and Figures

Table 7.4.0a. Working Group estimates of landings in tonnes 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

Year	Iceland	Total
2014	0	0
2015	0	0
2016	0	0
2017	0	0
2018	0	0
2019	0	0
2020	0	0
2021	4	4
2022	19	19

Table 7.4.0b. Working Group estimates of landings in tonnes 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

Year	Faroes	France	Total
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
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	0	0	0
2020	0	0	0
2021			0
2022			0

Table 7.4.0c. Working Group estimates of landings in tonnes of orange roughy, *Hoplostethus atlanticus*, in Subarea 8.

Year	France	Spain	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

Year	France	Spain	E & W	Total
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
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
2021				0
2022	0		0	0

Table 7.4.0d. Working Group estimates of landings in tonnes of orange roughy, *Hoplostethus atlanticus*, in Subarea 9.

Year	Portugal	Spain(1)	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
2017			0

Year	Portugal	Spain(1)	Total
2018			0
2019	0	0	0
2020			0
2021			0
2022			0

Included in landings from Subarea 9 until 2002

Table 7.4.0e. Working Group estimates of landings in tonnes 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

Year	Faroes	France	Norway	E & W	Portugal	Ireland	Total
2009	26						26
2010	39						39
2011	77						77
2012	45						45
2013	0						0
2014	47 (1)						47
2015	83 (1)						83
2016	93 (1)						93
2017	150 (1)						150
2018	21 (1)						21
2019	31 (1)						31
2020							0
2021							0
2022							0

(1) Landings 2014–2019 were from Division 10.b

Table 7.4.0f. Working Group estimates of landings in tonnes 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

Year	Faroes	France	Iceland	Spain	E & W	Ireland	New Zealand	Russia	Total
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	0								0
2017	0								0
2018	9								9
2019	29								29
2020									0
2021									0
2022									0

Table 7.4.0g. Orange roughy total international landings in tonnes 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

Year	4	5.a	5.b	8	9	10	12	All areas
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						93		93
2017						150		150
2018						21	9	30
2019						31	29	60
2020								0

Year	4	5.a	5.b	8	9	10	12	All areas
2021	0	4						4
2022		19		0				19

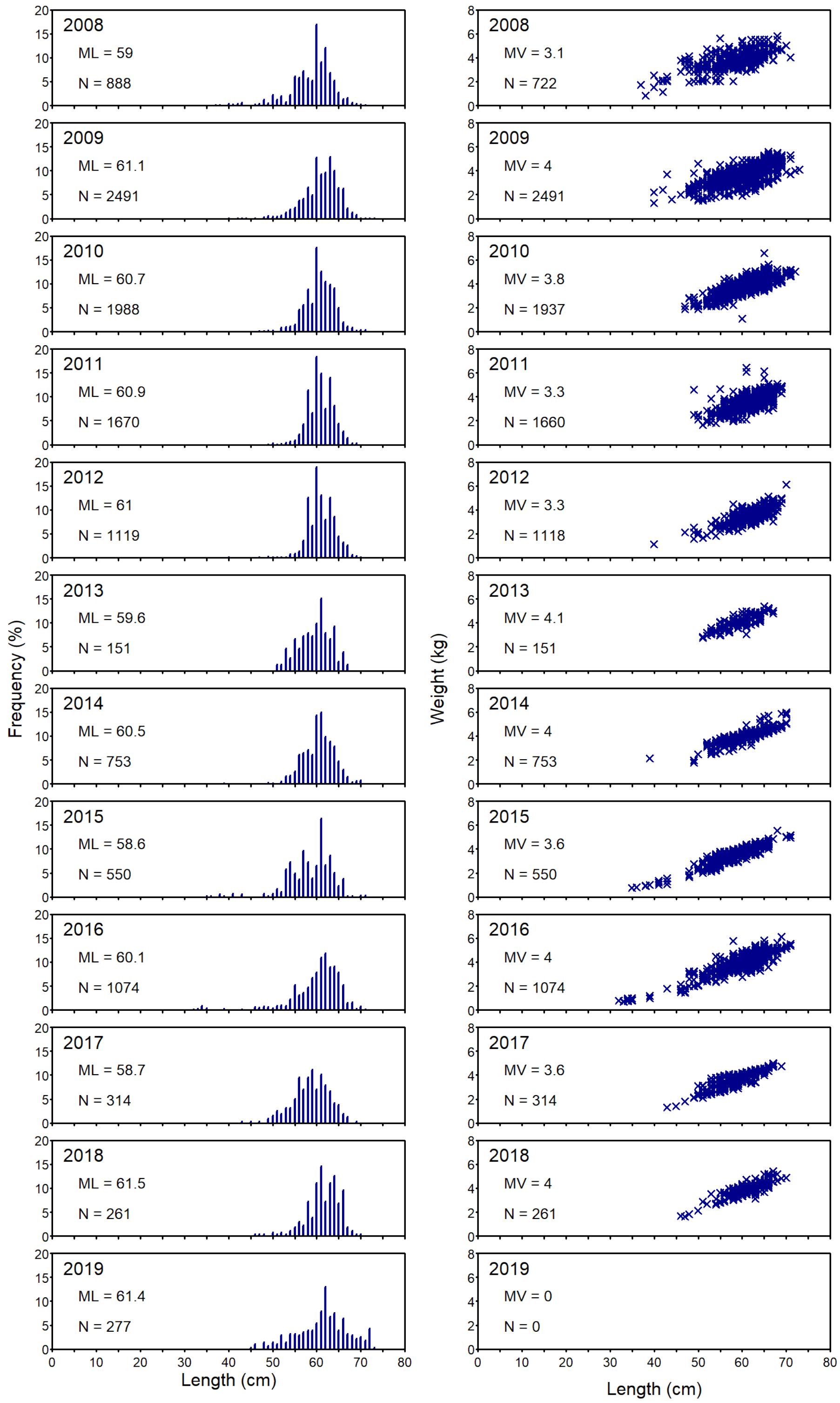


Figure 7.4.1. Length composition and length–weight relation of orange roughy in Faroese catches 2008–2019. There were no weight measurements of orange roughy in 2019. No catches since 2019.

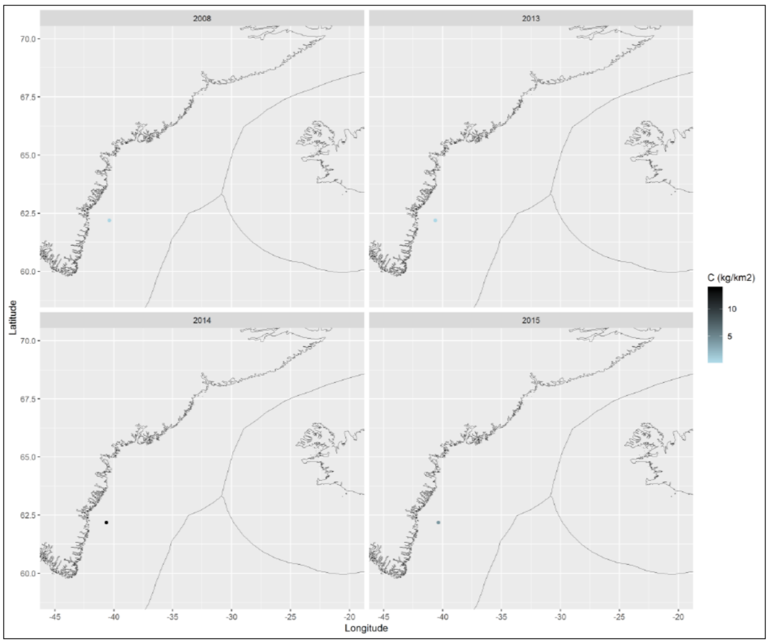


Figure 7.4.2. Distribution of survey catches of orange roughy at East Greenland in 1998–2016. No survey in 2001, 2017.

8 Roundnose grenadier (*Coryphaenoides rupestris*)

8.1 Stock description and management units

ICES WGDEEP has in the past proposed four assessment units of roundnose grenadier in the Northeast Atlantic:

- Skagerrak (Division 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.

In the 2010s, genetic analyses have brought forward information regarding the 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. Knutsen *et al.* (2012) covered a larger geographic range including East and West Atlantic as well as Artic areas and found significant genetic structure. Parts of this structure, notably in peripheral (Canada) and bathymetrically isolated basins (Skaggerak and Trondheimsleia (off Norway)), was found to represent distinct biological populations with limited present connectivity with central Atlantic and West European slope. Off the British Isles (Irish slope, Rockall, and Rosemary Bank), the magnitude of genetic structure was found weak. This lack of definition could reflect that samples from this area represent a single, widespread population. On the other hand, a 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 for grenadier. These sites may therefore represent distinct demographical populations, where there is a sufficient gene flow to maintain genetic similarity in terms of allele frequency but the demography is driven by local/regional recruitment and growth with a minor contribution of large scale migrations of juveniles and adults or transport of larvae.

The current stock units are consistent with the study from Knutsen *et al.* (2012) except that the unit covering subareas 1, 2, 4, 8, and 9, Division 14.a, and subdivisions 14.b.2 and 5.a.2, should not be considered as a demographic stock or a genetic population because it includes Artic and Atlantic areas in which roundnose grenadier was found to be genetically different. This unit might be only considered as an aggregations of areas where roundnose grenadier occurs at low to moderate density and is not subject to significant continuous exploitation.

8.2 Roundnose Grenadier (*Coryphaenoides rupestris*) in Division 5.b and 12.b, Subareas 6 and 7

8.2.1 The fishery

The majority of landings of roundnose grenadier from this area have historically been 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.

8.2.2 Landings trends

Over the past two decades, landings from Division 5.b, 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. Since then, landings have continued to gradually decreased. In the period 2011-2021, landings in 5.b were exclusively from French and Faroese trawlers (Table 8.2.0a), with 33 t in 2020, 22 t in 2021 and less than 8 t in 2022.

In Subarea 6, the highest landings were observed in 2001 (close to 15 000 t) and then decreased progressively to around 513 t in 2018, 202 t in 2019 and 318 t in 2020. Most of these landings were traditionally caught by French and Spanish trawlers (Table 8.2.0b), with small amounts from Scotland. Landings in 2021 were 116 t almost exclusively from French trawlers. In 2022, provisional total catches indicate similar level of catches, around 119 t, being the 87% captured by France, with small catches from Norway and Scotland.

In Subarea 7, landings close to 2000 t were recorded in 1993–1994, although recent annual landings are much lower (from 200-400 t/year in 2005–2007, to around 10 t in 2014-15). Only 2 t were reported in 2018 and less than 1t in 2019, increasing slightly to 5 in 2020. Landings in 2021 were 2.5 t exclusively from France, and for 2022, provisional landings are below 1 t, also exclusively from French trawlers (Table 8.2.0c).

In ICES Division 12.b, the recent landings are exclusively from Spanish trawlers. After a peak to more than 12 700 t in 2004, reported landings have decreased to about 5300 t in 2009, 2900 t in 2011 and 992 t in 2014. In 2015 the landings went down to 363 t and then increased again slightly until the 632 t in 2016 and around 1000 in 2017 and 2018. In 2019, the landings decreased again to around 50% of the previous year (460t), and have been continue to decrease drastically since then, with 268t in 2020 and 0t in 2021 and 2022 (Table 8.2.0d).

In the mid-1990s Faroese landings were significant, but this fishery ended in the 2000s and now only few tonnes were landed. In 2004 French fisheries have landed up to 1700 t but since 2007 almost no landings were registered.

Official landings have been revised for 2021 and are preliminary for 2022.

8.2.3 ICES Advice

ICES advises that when the precautionary approach is applied, catches should be no more than 3177 tonnes in each of the years 2023 and 2024. All catches are assumed to be landed.

8.2.4 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 639 t for 2021 and 639 t for 2022. The TAC since EC regulation 1367/2014 was a combined value for roundnose grenadier and roughhead grenadier (*Macrourus berglax*). Since 2019, this TAC set by EC regulation 2018/2025 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. Based on those considerations, ICES advises that there should be no directed fisheries for roughhead grenadier and that by-catches 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 for 2021 was set at 572 t and 572 t for 2022. 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		7, 9, 10, 12, 14		Total international Landings 5.b, 6, 7, 12.b	ICES predicted
esti-mates	EU TAC	EU Land-ings	EU TAC	EU Landings 12.b		catch corresp. to advice
2005	5253	5777	7190	8782	14558	-
2006	5253	4535	7190	4361	8896	-
2007	4600	3880	6114	4258	8138	< 6000
2008	4600	2980	6114	2432	5412	< 6000
2009	3910	2566	5197	6377	8943	< 6000
2010	3324	1421	5197	2910	4332	< 6000
2011	2924	790	4573	2905	3695	< 6000
2012	2546	546	3979	1343	1889	< 6000

	5.b, 6, 7		7, 9, 10, 12, 14		Total international Landings 5.b, 6, 7, 12.b	ICES predicted
esti-mates	EU TAC	EU Land-ings	EU TAC	EU Landings 12.b		catch corresp. to advice
2013	4297	760	3581	991	1752	< 6000
2014	4297	558	3223	988	1546	< 6000
2015**	4010	744	3644	363	707	< 5433
2016**	4078	732	3279	623	1005	< 5511
2017**	3052	633	2623	1001	1634	≤ 3897
2018**	3120	521	2099	998	1519	≤ 3971
2019	2558	232	2281	457	689	≤ 3971
2020	2558	356	2281	268	624	≤ 3971
2021	639	140	572	0	140	≤ 3177
2022*	639	127	572	0	127	≤ 3177

*** provisional.**

**** combined TAC for roundnose grenadier and roughhead grenadier.**

After the introduction of TACs in 2003 and 2005, the reported landings have decreased.

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 Faroese waters, the catch of roundnose grenadier is subject to a minimum size of 40 cm total length.

The fishery of this species was affected by the EU regulation 2016/2336 establishing specific conditions for fishing for deep-sea stocks, namely a ban for bottom trawling at depths > 800 m.

8.2.5 Data available

Landings and discards

Landings time-series data per ICES areas are presented in Tables 8.2.0a-e.

Landings data by ICES area were available for France, Norway and UK (England, Wales and Scotland) since 2005 and for Spain since 2010. 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 in years prior to 2010.

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 2004 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. Between 2014 and 2018, discards rates decreased, ranging between 3-6% of the catch in weight and 8-17% in number. In 2019 and 2020, reported discard rates were almost negligible, with around 0.7% and 0.6% in weight respectively, and in 2021 and 2022 the reported discard rate is close to 0 (around 0.5 in 2022).

The reduction of discards is related to:

1. a change of depth of the French fleet towards shallower waters
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. Discards data for 2011 were not presented as they are considered to be inaccurate but provided again for 2012 and onwards. Although in the period 1996–2015 the discards occasionally reached 26% of the total observed weight catch, they were negligible in most sampled months. Annual average discards were around 7% (range 0–21%) in weight in both Divisions 6.b and 12.b (range 0–26%) for that period. These discards, however, correspond to undersized individuals.

In 2017, in area 6.b and 12.b, the discard rate is around 4.7% in weight (5.05% in 6.b and 4.6% in 12.b). In 2018, the discard rate is estimated to be around 2.5% (1.6% in 6.b and 3% in 12.b), and around 0.32% in 2019 (0.39% in 6.b.1 and 0.26% in 12.b). The sampling programs were suspended in most of 2020, due notably to administrative problems and to a lesser extend to covid-19, so there is no new discard information for 2020. In 2021 and 2022 there were no fishing effort in the area by the Spanish fleet.

Length composition of the landings and discards

Length composition of landings and discards were available for France and Spain covering different periods and areas (Figures 8.2.1–8.2.5).

8.2.5.1 Age composition

No new data.

8.2.5.2 Weight-at-age

No new data.

8.2.5.3 Maturity and natural mortality

No new data.

8.2.5.4 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 2020. Last survey occurred in 2021.

LPUE from the French trawl fishery to the west of the British Isles

In 2022 no new information was presented as the fishing effort has been greatly reduced. Historical standardized LPUE information based on haul by haul data from French skipper’s personal tallybooks is included in the Stock annex.

LPUE from the Faroese commercial fleet

In 2022 no new information was presented as the fishing effort has been greatly reduced and more recent landings were at about 1t. Historical standardized LPUE information can be consulted in the stock annex.

CPUE from the Spanish commercial fleet.

CPUE series were calculated from commercial trawlers operating in 6.b.1 and 12.b areas, with effort being the total applied in each area in Kw-day, and the catches only those with any presence of roundnose grenadier in the total catch.

An updated revision of the available data for the period 2010-2020 was included for analysis. A general linear model (GLM) was used to standardize all the CPUE (kg/effort unit) series for the Spanish commercial fleet where the independent variables were the following: year, vessel and fishing area (6.b.1, 12.b). The dependent variable was the log-transformed kg per day measure for variable, which was back-transformed prior to use.

The standardized CPUE time series aims to serve as an approximation for the evolution of the stock in this period, but should be taken with caution, due to the limited number of years currently available and the fact that it only represents the area where the Spanish fleet has a higher presence, and not the whole stock area. In addition, the continuous reduction of the effort applied to this stock by all the commercial fleets, could pose an added difficulty to improving the quality of this series in coming years.

8.2.6 Data analyses

Trends from length distribution and individual weight

For France, the modal discarded length has remained constant (Figure 8.2.1) 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 since 2011. There is an increasing trend in the landings since then. The mean pre-anal length for landings was around 15 cm in 2018-2019, 16.3 cm in 2020 reaching 17.3 in 2021 (Figure 8.2.4).

Modal length for landings in 12.b and 6.b1 shows some differences, being in general those from 12.b smaller (Figures 8.2.2 and 8.2.3). Size–frequency data provided by Spain for the period 2001–2019 in 6.b.1 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 8.2.5). The modal length of discards is around 9.5 cm. Over the period 2001–2019, 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 2009–2020, in both 6.b.1 and 12.b, the mean length in landings has increased by two centimetres for both males and females in 2010–2014, with a tendency to decrease after 2015. 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 0.75 kg in

2017, 0.5 kg in 2019 and 0.6 in 2021, but with very wide confidence intervals in most of the cases (Figure 8.2.6).

Trends in abundance indices

Marine Scotland Deep-water Science survey (MSDSS)

Data on Marine Scotland Deep-water Science survey was available for WGDEEP2022. There is an increasing trend of abundance over the period 2011–2013. Since 2015, there is however, a decrease and the index were close to the long term average of the series. (Figure 8.2.7).

Lpue from the Faroese commercial fleet

In 2021 no new information was presented and the CPUE series available for the Faroese commercial fleet ended in 2014. The historical CPUE time series can be found in the stock annex.

CPUE from the Spanish commercial fleet in 12.b

CPUE indices based on revised catches for the period 2010-2020 were estimated for the Spanish fleet in order to include the 12.b landings into the assessment. The CPUE has declined from 2010 to 2014 with a peak in 2017 followed by a decline in 2018. Preliminary data shows and a slight increase in 2019(Figure 8.2.8). The general tendency of the total catches has been variable previous to 2010, with a general tendency to decrease since 2004, since there seems to be a change in the fishing habits, with a growing tendency for vessels to use this area as a stopover, either on the way out or on the way back, of other fishing grounds, mainly to the NAFO area.

LPUE from the French tallybooks

In 2021 no new information was presented. Stock annex includes the historical CPUE time series, which was available from 2010 to 2015.

Stock assessment

The advice on this stock is based on the framework for advice for ICES category 5 stocks for the entire stock since 2018.

In 2016, it was possible to provide advice on stock as category 1 advice for the part of the stock in subareas 6 and 7 and Division 5.b, but while the advice for the part of the stock occurring in Division 12.b was a catch-only assessment (category 5).

LPUE data from haul-by-haul data provided by French trawlers were used in previous assessments for subareas 6 and 7 and Division 5.b. The decrease in activity and number of boats now prevents the use of those indices in the assessment.

In 2020, an exploratory model using a new index available up to 2019 (Marine Scotland Deep-water Survey) was examined. However, this model formulation and the use of this survey as a biomass indicator was not benchmarked yet.

Discard data are available back to 1996. Discards have not been included in the assessment as it was considered that sorting patterns of discards and landings in earlier years may have been different.

The ICES framework for category 5 stocks was applied for the 2018-2022 advice. ICES considers that a precautionary reduction of catches should be implemented unless there is sufficient data to access the current level of exploitation of the stock.

The precautionary buffer (20% reduction in landings) was applied in 2016 and later in 2020 advice so it was not applied in 2022. Therefore, ICES advises that when the precautionary approach is applied, catches should be no more than 3177 tonnes in each of the years 2023 and 2024. All catches are assumed to be landed.

ICES cannot assess the stock and exploitation status relative to MSY and PA reference points because the reference points are undefined.

This stock is classified as Category **1** in the NEAFC categorization of deep-sea species/stocks which implies that NEAFC requires stock-specific management measures since the entire or a significant proportion of the catch is taken in the NEAFC regulatory area.

Previous stock assessment issues

This stock was 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.

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 past assessments and the impact of this is unknown. The reconstruction of a time-series of discard rates is required for the whole time-series. No new information has been available since then. Prior estimates of discards can only be addressed at the moment through assumptions to be tested.

Additionally, some issues regarding model requires more studies

- Estimates of r (intrinsic growth rates of the surplus production model) was possibly too high in regards of stock dynamics. This should be explored from modelling and data exploration. The lack of contrast between indices from observation and those predicted using estimates of r is a concern as trends from the model seem to increasingly differ over the years.
- A workaround to the problem above would be to use another model taking account additional information that are not currently taken account by the model such as length distributions and giving more value to recent information from survey indices.
- The French tallybooks, due to the decrease of effort and number of vessels in the deep-water French fisheries are no longer representative to derive abundance indices. The Marine Scotland Science Deep-water survey is available on a biannual basis in line with advisory years and a sufficient time-series has been integrated into the assessment over the last years. However, comparisons with the French tallybooks showed some strong differences of biomass, which leaves some doubt on biomass estimates. The reason for those differences have to be investigated.
- Spanish CPUE based on data from commercial fleet has been also calculated and tested as input for the assessment, combined with French and Scottish indices. The model shows discrepancies between the indices, with strong negative correlations between all of them.
- Multi Year Catch Curves are no longer available. Other indicator of stock status may be considered using for example, length or individual weight.

8.2.7 Management considerations

Previous simulations suggest that fishing mortality is below F_{MSY}.

8.2.8 Benchmark preparation

At this moment, there is no planned benchmark for this stock. In the current state, more work is needed to investigate what is the most appropriate approach to try to integrate the available information and develop a model that represents the dynamics of the stock.

Table 8.2.0a. Working Group estimates of landings (t) of roundnose grenadier from Division 5.b.

Year	Faroes	France	Nor way	Germ any	Russia/ USSR	UK (E+W)	UK (Scot)	TOTAL
1988	0	0	0	1	0	0	0	1
1989	20	181	0	5	52	0	0	258
1990	75	1470	0	4	0	0	0	1549
1991	22	2281	7	1	0	0	0	2311
1992	551	3259	1	6	0	0	0	3817
1993	339	1328	0	14	0	0	0	1681
1994	286	381	0	1	0	0	0	668
1995	405	818	0	0	0	0	0	1223
1996	93	983	0	2	0	0	0	1078
1997	53	1059	0	0	0	0	0	1112
1998	50	1617	0	0	0	0	0	1667
1999	104	1861	2	0	0	29	0	1996
2000	48	1699	0	1	0	43	0	1791
2001	84	1932	0	0	0	0	0	2016
2002	176	774	0	0	0	81	0	1031
2003	490	1032	0	0	0	10	0	1532
2004	508	985	0	0	6	0	76	1575
2005	903	884	1	0	1	0	48	1837
2006	900	875	0	0	0	0	0	1775
2007	838	862	0	0	0	0	0	1700
2008	665	447	0	0	0	0	0	1112
2009	322	122	0	0	0	0	2	446
2010	229	381	0	0	0	0	1	611
2011	63	11	0	0	0	0	0	74

Year	Faroes	France	Nor way	Germ any	Russia/ USSR	UK (E+W)	UK (Scot)	TOTAL
2012	16	28	0	0	0	0	0	44
2013	24	36	0	0	0	0	0	60
2014	33	44	0	0	0	0	0	77
2015	24	28	0	0	0	0	0	52
2016	30	7	0	0	0	0	0	38
2017	9	21	0	0	0	0	0	30
2018	0	6	0	0	0	0	0	6
2019	19	11	0	0	0	0	0	30
2020	20	13	0	0	0	0	0	33
2021	12	10	0	0	0	0	0	22
2022*	1	6	<1	0	0	0	<1	8

*Provisional.

Table 8.2.0b. Working Group estimates of landings (t) of roundnose grenadier from Subarea 6.

Year	Esto-nia	Fa-roes	France	Ger-many	Ire-land	Lithua-nia	Nor-way	Po-land	Rus-sia	Spain	UK (E+W)	UK (Scot)	TOTAL
1988	0	27	0	4	0	0	0	0	0	0	1	0	32
1989	0	2	2211	3	0	0	0	0	0	0	0	2	2218
1990	0	29	5484	2	0	0	0	0	0	0	0	0	5515
1991	0	0	7297	7	0	0	0	0	0	0	0	0	7304
1992	0	99	6422	142	0	0	5	0	0	0	2	112	6782
1993	0	263	7940	1	0	0	0	0	0	0	0	1	8205
1994	0	0	5898	15	14	0	0	0	0	0	0	11	5938
1995	0	0	6329	2	59	0	0	0	0	0	0	82	6472
1996	0	0	5888	0	0	0	0	0	0	0	0	156	6044
1997	0	15	5795	0	4	0	0	0	0	0	0	218	6032
1998	0	13	5170	0	0	0	21	0	0	3	0	0	5207
1999	0	0	5637	3	1	0	0	0	0	1	0	0	5642
2000	0	0	7478	0	41	0	1	0	0	1002	1	433	8956
2001	680	11	5897	6	31	137	32	58	3	6942	21	955	14773

Year	Estonia	Faroes	France	Germany	Ireland	Lithuania	Norway	Poland	Russia	Spain	UK (E+W)	UK (Scot)	TOTAL
2002	821	0	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
2010	0	13	1271	0	0	0	2	0	0	769	1.2	23	2079
2011	0	4	1112	0	0	0	0	0	0	682	0	8	1806
2012	0	0	1088	0	0	0	0	0	0	454	2	0	1544
2013	0	0	934	0	0	0	0	0	0	661	6	0	1601
2014	0	0	630	0	0	0	0	0	0	471	0	0	1101
2015	0	0	364	0	0	0	0	0	0	282	0	0	646
2016	0	0	422	0	0	0	0	0	0	330	0	5.5	757
2017	0	0	99	0	0.5	0	0	0	0	496	0	8	602
2018	0	0	184	0	0	0	0	0	0	323	0	6	513
2019	0	0	128	0	0	0	0	0	0	68	0	6	202
2020	0	0	204	0	0	0	0	0	0	108	0	5.5	318
2021	0	1	106	0	0	0	0	0	0	0	0	9	116
2022*	0	0	104	0	0	0	<1	0	0	0	0	15	119

*** Provisional.**

Table 8.2.0c. Working Group estimates of landings (t) of roundnose grenadier from Subarea 7.

Year	Faroes	France	Ireland	Spain	UK (Scot)	TOTAL
1988	0	0	0	0	0	0
1989	0	222	0	0	0	222
1990	0	215	0	0	0	215
1991	0	489	0	0	0	489

Year	Faroes	France	Ireland	Spain	UK (Scot)	TOTAL
1992	0	1556	0	0	0	1556
1993	0	1916	0	0	0	1916
1994	0	1922	0	0	0	1922
1995	0	1295	0	0	0	1295
1996	0	1051	0	0	0	1051
1997	0	1033	0	5	0	1038
1998	0	1146	0	11	0	1157
1999	0	892	0	4	0	896
2000	0	859	0	0	0	859
2001	0	938	416	0	0	1354
2002	1	449	605	0	3	1058
2003	0	373	213	0	1	587
2004	0	248	320	0	0	568
2005	0	191	55	0	0	246
2006	0	248	138	0	0	386
2007	0	207	20	0	0	227
2008	0	27	0	0	0	27
2009	0	59	0	0	0	59
2010	0	41	0	0	0	41
2011	0	34	0	0	0	34
2012	0	48	0	0.2	0	48
2013	0	40	0	0	0	40
2014	0	11	0	0	0	11
2015	0	10	0	0	0	10
2016	0	4	0	0	0	4
2017	0	0	0	0	0	0
2018	0	2	0	0	0	2
2019	0	0.8	0	0	0	0.8
2020	0	5	0	0	0	5

Year	Faroes	France	Ireland	Spain	UK (Scot)	TOTAL
2021	0	2.5	0	0	0	2.5
2022*	0	0.5	0	0	0	0.5

*** provisional.**

Table 8.2.0d. Working Group estimates of landings (t) of roundnose grenadier from Subarea 12.b

Year	Esto-nia	Fa-roes	France ***	Ger-many	Ice-land	Ire-land	Lithua-nia	Spain	USSR/Russia	UK (E+W)	UK (Scotl.)	Nor-way	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
2009								5335					5335
2010			1					2910					2911

Year	Esto-nia	Fa-roes	France ***	Ger-many	Ice-land	Ire-land	Lithua-nia	Spain	USSR/Russia	UK (E+W)	UK (Scotl.)	Nor-way	Total
2011		3						2905					2908
2012		9						1343					1352
2013								991					991
2014		3.6						988					992
2015								363					363
2016								632					632
2017								1001					1001
2018								998.53					999
2019		3						454					457
2020	0	0	0	0	0	0	0	268	0	0	0	0	268
2021	0	0	0	0	0	0	0	0	0	0	0	0	0
2022*	0	0	0	0	0	0	0	0	0	0	0	0	0

*** Preliminary.**

Table 8.2.0e. Working Group estimates of landings (t) of roundnose grenadier unallocated landings in 5.b, 6 and 12.

Year	Unallocated
1988	0
1989	0
1990	0
1991	0
1992	0
1993	0
1994	0
1995	0
1996	0
1997	0
1998	0
1999	0
2000	0

Year	Unallocated
2001	208
2002	504
2003	952
2004	0
2005	0
2006	0
2007	0
2008	0
2009	0
2010	0
2011	0
2012	0
2013	0
2014	0
2015	0
2016	0
2017	0
2108	0
2019	0
2020	0
2021	0
2022*	0

*** Provisional.**

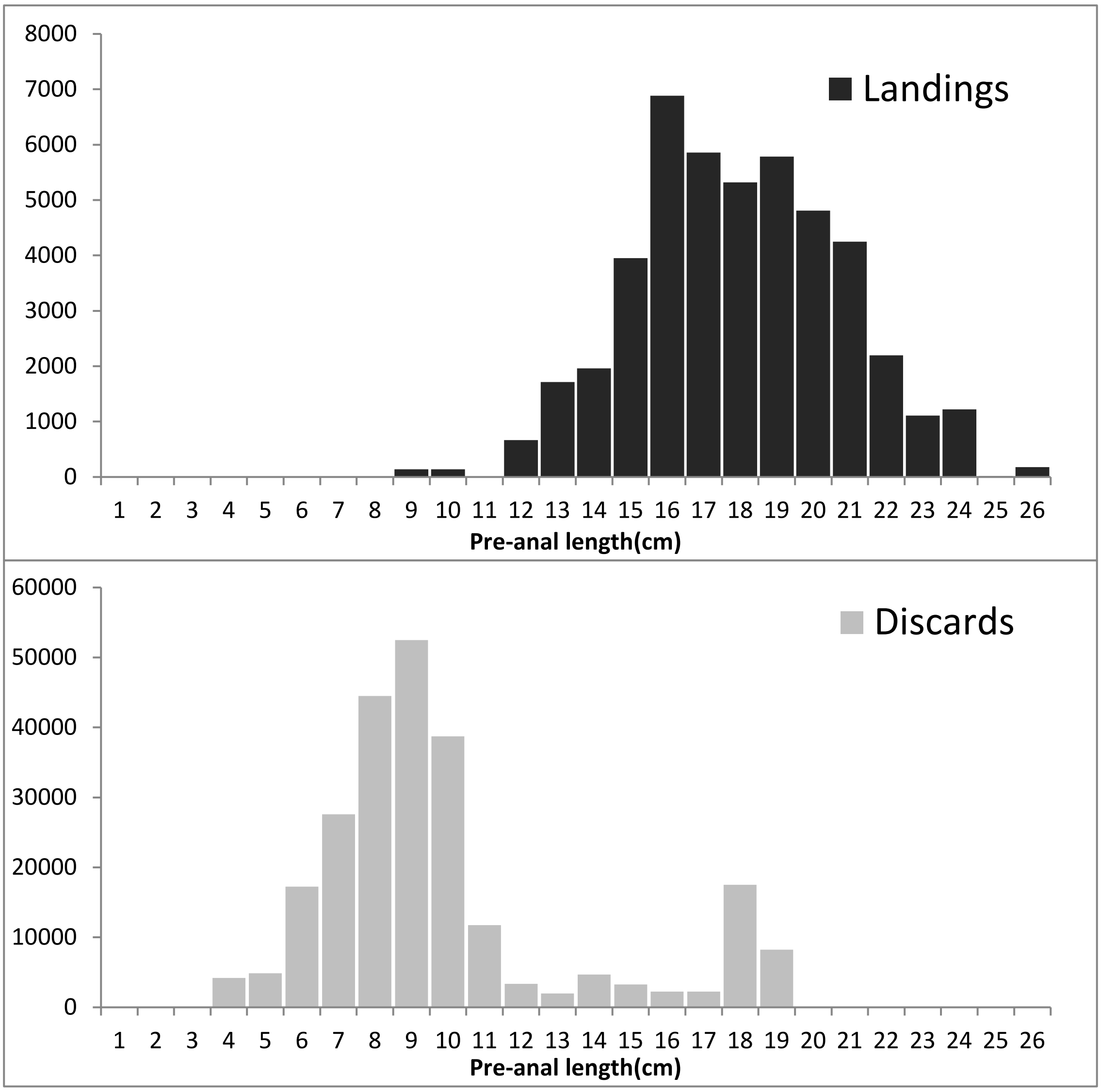
Table 8.2.0f. Working Group estimates of landings (t) of roundnose grenadier 5.b, 6, 7 and 12.b.

Year	5.b	6	7	12.b	Unallocated	5.b,6,7	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

Year	5.b	6	7	12.b	Unallocated	5.b,6,7	Overall total
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	2079**	41	2911**	0	2731**	5643**
2011	74	1805**	34	2907**	0	1914**	4822**
2012	44	1542**	48	1352**	0**	1634**	2986**
2013	60	1601**	40	991**	0**	1701**	2692**
2014	77	1100**	11	992**	0**	1188**	2180**
2015	52	646**	10	363**	0	708**	1071**
2016	38	777**	4	632**	0	819**	1452**
2017	30	603**	0	1001	0	633**	1634**
2018	6	513	2	998	0	521	1519
2019	30	202	1	457	0	233	689
2020	33	318	5	268	0	356	624

Year	5.b	6	7	12.b	Unallocated	5.b,6,7	Overall total
2021	22	116	2	0	0	140	140
2022*	8	119	0.5	0	0	128	128

*** Preliminary. ** Revised catches, updated in 2020.**



Figures 8.2.1. Length distribution of the landings and discards of the French fleet in Division 5.b, 6, 7 based from on-board observations. Figures reflect data from 2022.

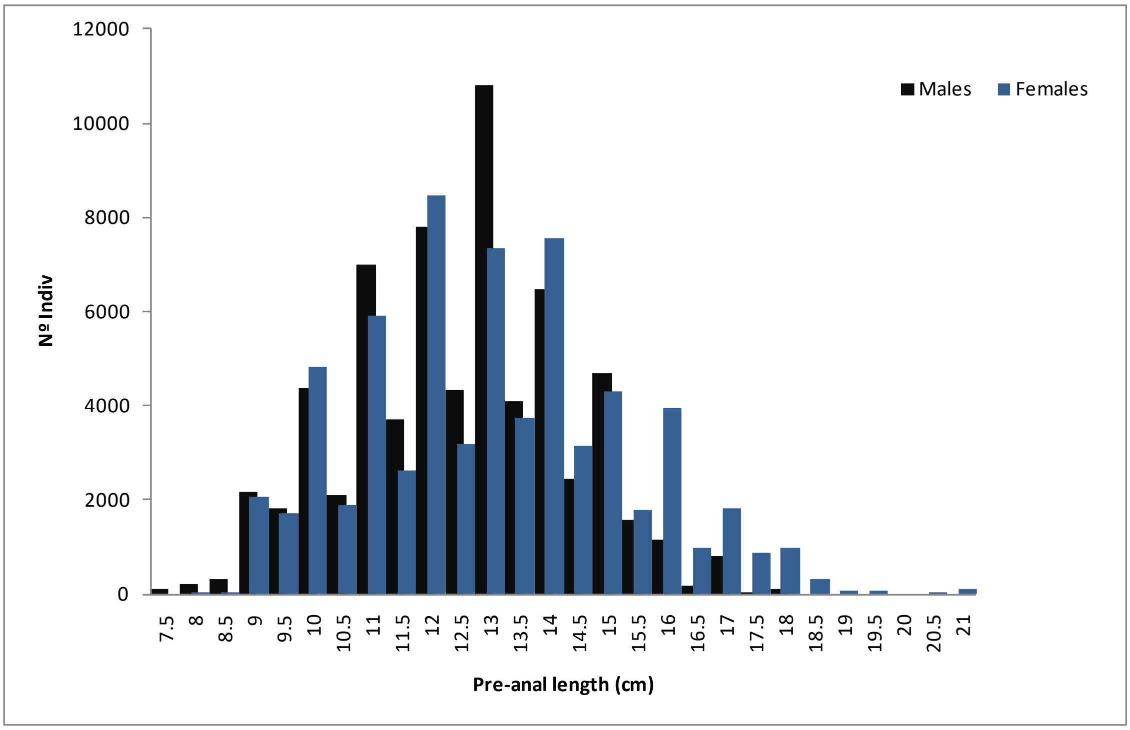


Figure 8.2.2. Length distribution of the landings of the Spanish fleet in Division 6.b.1 based from on-board observations in 2019. No new information was available in 2020-2022.

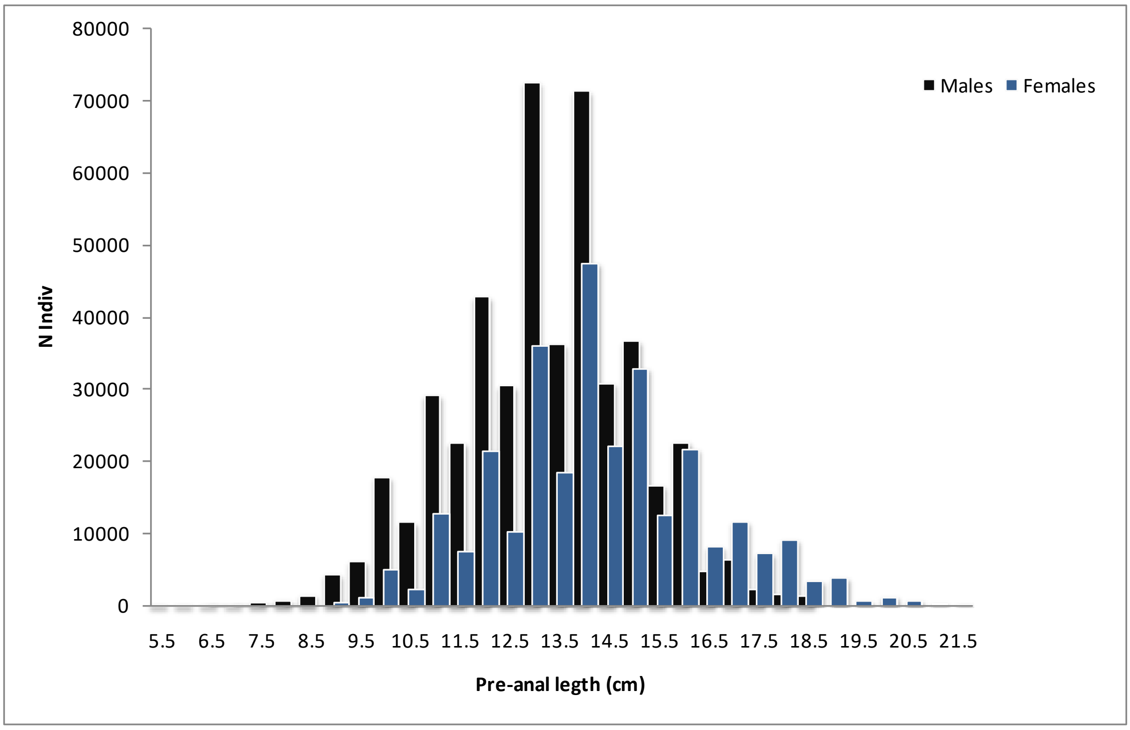


Figure 8.2.3. Length distribution of the landings of the Spanish fleet in Division 12.b based from on-board observations in 2019. No new information was available in 2020-2022.

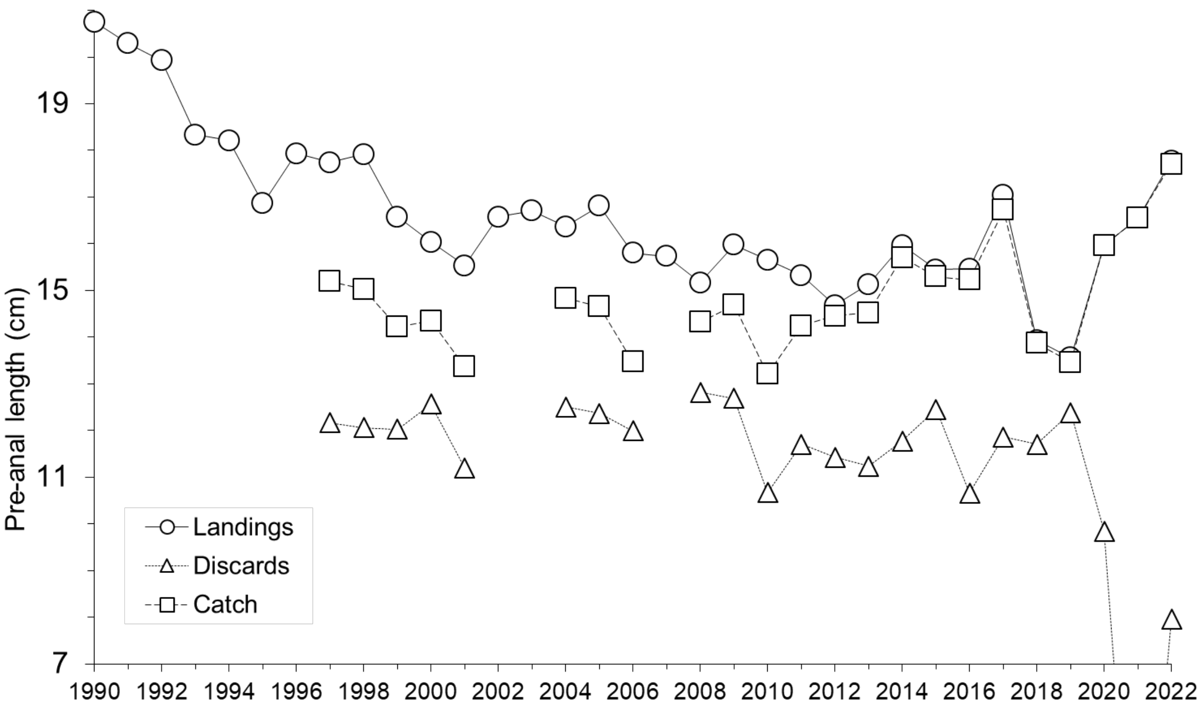


Figure 8.2.4. Evolution of the pre-anal length of roundnose grenadier in the French landings, catch and discards, 1990–2022. No information was available on discards for 2021.

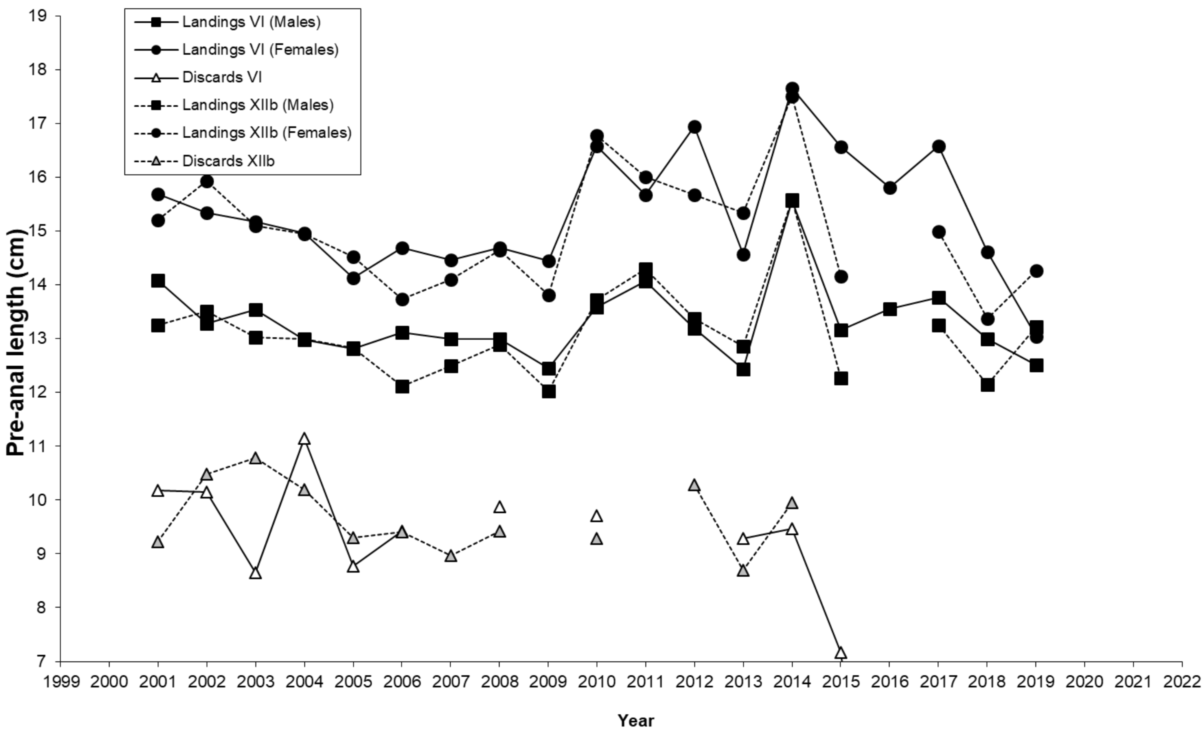


Figure 8.2.5. Evolution of the pre-anal length of roundnose grenadier in the Spanish landings and discards in Divisions 6.b and 12.b, 2001–2019. No new discard or landings length distribution information in 2020-22.

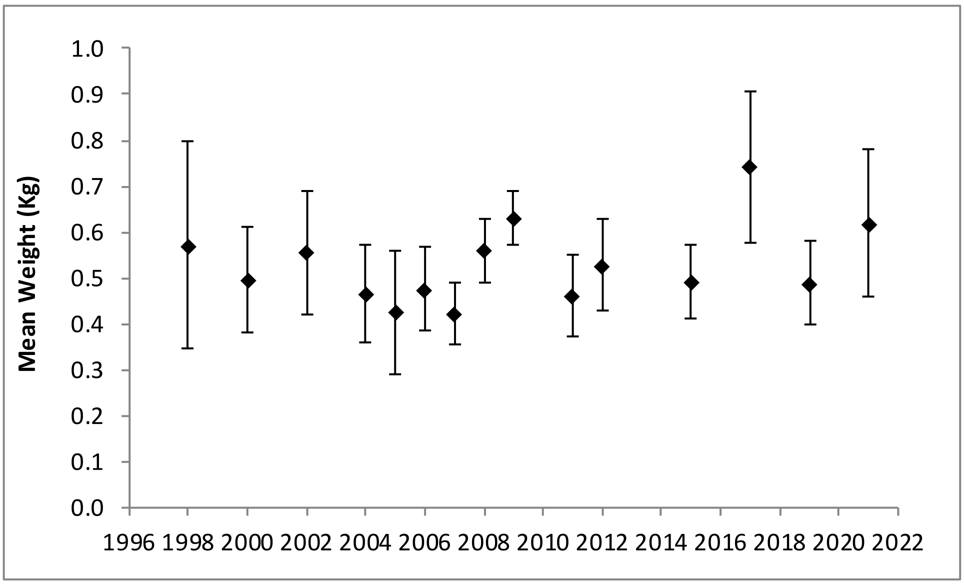


Figure 8.2.6. Mean individual weight of roundnose grenadier according to Marine Scotland deep-water science survey in 6.a.

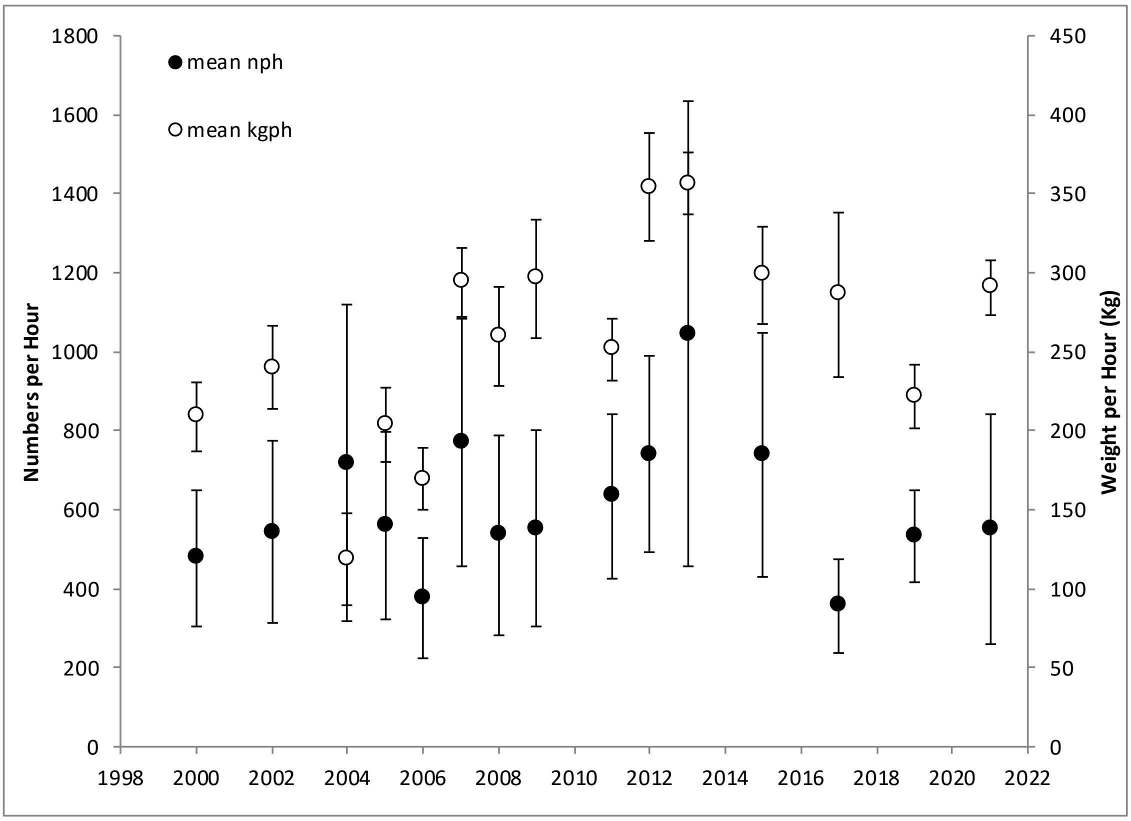


Figure 8.2.7. Abundance indices of roundnose grenadier according to Marine Scotland deep-water science survey in 6.a.

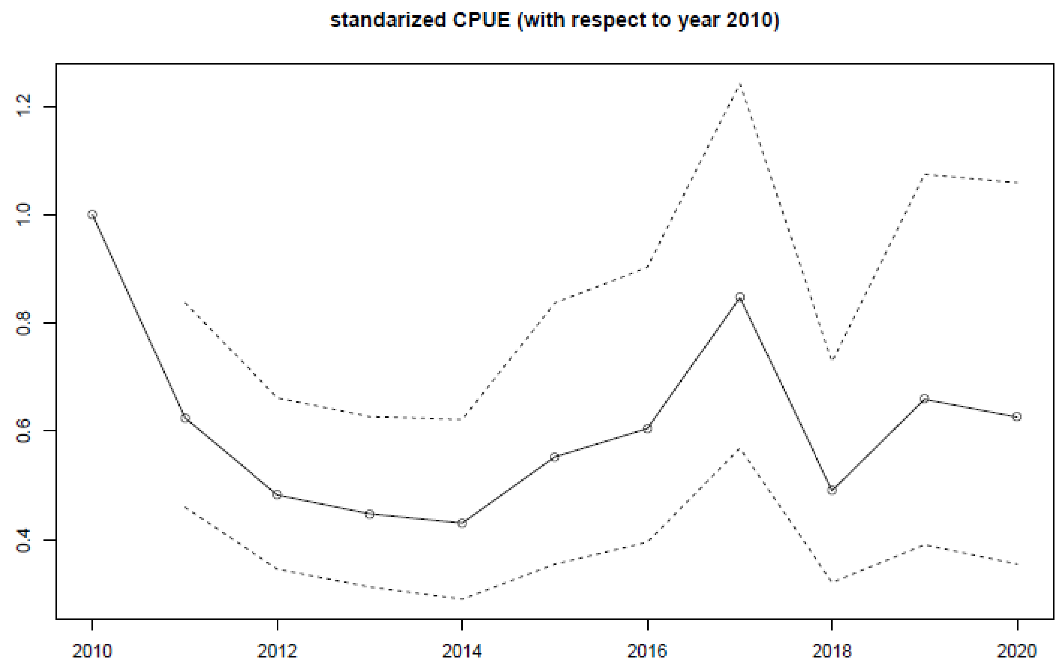


Figure 8.2.8. CPUE from the Spanish commercial fleet operating in 6.b.1 and 12.b. Dotted lines represent the confidence intervals.

8.3 Roundnose grenadier (*Coryphaenoides rupestris*) in Division 3.a

8.3.1 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.

8.3.2 Landing trends

The total landings by all countries from 1988–2022 are shown in Table 8.3.0 and Figure 8.3.0.

The landings from the directed Danish fishery ceased in 2007 and the total landings have since been minor (<2 tonnes). The landings are now by-catches from other fisheries.

8.3.3 ICES Advice

The 2023 and 2024 advice for rng.3a is: "ICES advices that when the precautionary approach is applied, there should be zero catch in each of the years 2023 and 2024".

8.3.4 Management

The directed fishery for roundnose grenadier was stopped in April 2006 based on agreements between Norway and the EU. The directed fishery has then been prohibited since 2006. 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 2023/194 of 30 January 2023, fixing for 2023 and 2024 the fishing opportunities for EU vessels for fish stocks of certain deep-sea fish species, a precautionary TAC was set to 2 tons for each year, 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. There is no TAC for Norwegian vessels in Norwegian waters but the agreed regulation between EU and Norway apply for this area.

8.3.5 Data available

8.3.5.1 Landings and discards

Landings data from 1988-2022 are presented in Table 8.3.0. Discards have been reported from both the Swedish and Danish fishery since 2014 (Table 8.3.2).

8.3.5.2 Length compositions

Since the Danish 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 (see stock annex for further details).

Updated information on size distribution from the Norwegian shrimp survey is provided in Figure 8.3.1. Length measurements are given in pre anal fin length (PAFL) in cm.

8.3.5.3 Age composition

Age data are available from a deep-sea species survey in 1987 and from the Norwegian shrimp survey in 2007-2023 (Table 8.3.3).

Age data were derived using age determination by transverse sections of sagittal otoliths and reading method with broken reading axis as developed by Bergstad (1990).

These age data are presented in Bergstad *et al*., 2014.

8.3.5.4 Bycatch effort and cpue

Data from the Norwegian reference fleet have been analysed from 2013-2019 to estimate the catch of roundnose grenadier in the shrimp fishery (Table 8.3.5).

8.3.5.5 Survey indices

The Norwegian annual shrimp survey conducted since 1984 samples deeper parts of the Skagerrak and north-eastern 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 8.3.1. The survey indices from the shrimp survey were updated with new information from 2023 (Table 8.3.4 and Figure 8.3.2). The indices are given as biomass (kg/h) and abundance (number/h).

8.3.6 Data analyses

An earlier study analysed the time-series of abundance of roundnose 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 8.3.2). 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 pre anal fin length (PAFL), illustrating variation in recruitment.

8.3.6.1 Trends in landings, effort and estimated bycatches

Collated information on landings and estimates of bycatch from the Norwegian Reference fleet suggest that the removals of roundnose grenadier are now at low levels in Division 3.a. Discard has been reported since 2014. Although the discards from the fishery in this area from recent years was reported to be at the same level as the landings for some years, the level on reported total catch was still low and in the range of what it has been since 2007. However, Denmark reported 21 tons of discards from 2022.

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 status nor stock development for the time of the directed fishery, which ceased in mid–2006.

Landings and discards have been insignificant and have been represented as bycatches from other fisheries. Data from the Norwegian reference fleet show that catches of roundnose grenadier in the Norwegian shrimp fishery is low (Table 8.3.5). However, discards from Denmark for 2022 was 21 tons and represents an increase compared with earlier years.

8.3.6.2 Size compositions

The recent length distributions from the Norwegian shrimp survey data contrasts with the 1991–2004 distributions by not having a distinct mode of small fish as seen in the early 1990s (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 (PAFL) through several years.

8.3.6.3 Biomass and abundances indices from survey

The survey catch rate 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. The index for 2023 show a small increase since the lowest record in 2017. 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 are very low compared to the levels before 2000.

8.3.6.4 Age data

The age frequency distributions from recent years contrast with distributions from the 1980s (Bergstad, 1990b) in terms of proportions of old fish (e.g. >20 years) (Table 8.3.3). 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 1984–2023, perhaps only a single major year class. This event rejuvenated the stock and enhanced abundance in subsequent years.

8.3.7 Comments on assessment

In 2022, the rb-rule was used for the assessment. This rule was chosen when lacking a SPiCT assessment and length measurements from the fisheries.

$I_{trigger}$ is calculated as I_{loss}×1.4 and I_{loss} was defined as the lowest value in the Norwegian shrimp survey index in the period before the collapse (1990) (I_{loss}=49.82), giving $I_{trigger}$ = 69.73 kg/h. The r would be the ”2 over 3 rule” giving 1.25, the multiplier m = 0.5

In 2018, the stock was upgraded to a 3.2 category stock using the biomass index from the Norwegian shrimp survey, derived from the relevant depth range of the species in this area.

8.3.8 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 to be overall low, the potential for recovery of the roundnose grenadier in Skagerrak may be good. Abundance levels has declined since 2004 and in 2017 it was the lowest recorded during the survey period 1984–2022. However, there has been a small increase in the index since 2017 but still at very low levels. Rejuvenation and growth of the population would at present seem unlikely due to low recruitment during the recent decade.

8.3.9 References

Bergstad, O.A. 1990b. Distribution, population structure, growth and reproduction of the roundnose grenadier *Coryphaenoides rupestris* (Pisces:Macrouridae) in the deep waters of the Skagerrak. *Marine Biology* 107: 25–39.

Bergstad, O.A., H.Ø. Hansen and T. Jørgensen. 2014. Intermittent recruitment and exploitation pulse underlying temporal variability in a demersal deep-water fish population. ICES Journal of Marine Science, 71: 2088–2100.

8.3.10 Tables and Figures

Table 8.3.0. 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

Year	Denmark	Norway	Sweden	TOTAL
2015	0.6	+	+	0.6
2016	1.1	0.3	0.01	1.4
2017	0.7	0.03	0.03	0.76
2018	0.3	0.06		0.36
2019	0.9	0.09	+	1
2020	0.4	0.8	+	1.2
2021	0.4	0.5	+	0.9
2022	0.9	0.7	+	1.6

*** Preliminary data.**

Table 8.3.1. Summary of data on bottom-trawl survey series from the Norwegian shrimp survey, 1984-2022. 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 2022 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	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

YEAR	Survey month	Vessel	IMR Gear code	Additional gear info.	No. trawls >300m	No. trawls >400m	No. trawls survey
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
2018	JAN	KB	3271	Campelen 1800 20mm/40, Rg and strapping**	27	8	111
2019	JAN	KB	3296	Campelen 1800 20mm/40, Rg and strapping***	27	8	119
2020	JAN	KB	3296	""	26	7	106
2021	JAN	KB	3296	""	27	8	113
2022	JAN	KB	3296	""	28	8	119
2023	JAN	KB	3296	"	29	8	116

*** Path width of the tow constrained by a 10 m rope connecting the warps, 200 m in front of otter boards. ** Path width of the tow constrained to a 15 m rope connecting the warps, 100 m in front of the otter boards. *** Same trawl and strapping but from 2019 there are inserted several floaters on the trawl to lighten the trawl (Nordsjørigging).**

Table 8.3.2. Discards (tons) reported for roundnose grenadier in 3a from 2014-2021.

Year	Denmark	Sweden	Norway	TOTAL
2014		0.4		0.4
2015	1			1
2016	0.1	0.9		1
2017		1.6		1.6
2018	2.9	0.01		2.9
2019	0.5	0.08		0.6
2020	0	0		0
2021	0	0		0
2022	21.7	2.2		23.9

Table 8.3.3. Cumulative percentages (%) for selected ages from the deep-sea species survey in 1987 and from the Norwegian shrimp survey in 2007-2023

			Age		
Year	5	10	20	30	50
1987	9	21	45	75	96
2007	10	23	83	94	96
2008	22	40	92	99	100
2009	14	30	88	93	100
2010	12	29	71	96	99
2011	6	23	65	94	99
2012	10	28	48	96	100
2013	14	28	56	92	99
2014					
2015	7	17	48	95	100
2016					
2017	14	52	81	94	99
2018	23	50	77	99	100
2019	8	37	64	92	100
2020	40	64	83	97	100

	Age				
Year	5	10	20	30	50
2021	20	55	83	97	100
2022	33	53	81	95	99
2023	22	50	79	92	100

Table 8.3.4. Mean biomass index and mean abundance index from the Norwegian shrimp survey 1984-2023. Missing data are from surveys that are not representable according to roundnose grenadier catches (less stations > 300 m). Data from 2016 are considered unreliable according to gear inconsistencies.

Number stations>300m (n) Mean biomass (kg/h), Mean abundance (n/h), Number (n) and Standard error (SE)					
Year	n	(kg/h)	SE(kg/h)	(n/h)	SE(n/h)
1984	10				
1985	21	108.12	38.32	149.95	49.43
1986	24	83.75	32.16	117.83	46.99
1987	35	76.15	13.56	125.80	24.60
1988	31	72.14	13.92	105.19	21.22
1989	31	122.69	43.48	195.94	73.07
1990	26	49.81	18.20	72.66	27.55
1991	28	107.14	22.27	176.86	38.75
1992	27	188.54	67.53	698.52	337.67
1993	30	58.59	19.42	190.33	74.15
1994	27	87.19	21.21	372.96	143.56
1995	29	118.30	32.36	440.62	144.41
1996	27	99.63	31.68	268.01	116.92
1997	25	113.86	66.47	362.72	222.08
1998	23	255.54	87.80	812.82	336.85
1999	27	149.30	42.85	388.83	122.54
2000	25	129.27	30.39	389.06	107.71
2001	18	105.33	51.84	272.99	151.99
2002	24	174.77	66.27	371.70	129.97
2003	13				
2004	17	324.38	125.48	1143.35	487.33

Number stations>300m (n) Mean biomass (kg/h), Mean abundance (n/h), Number (n) and Standard error (SE)					
Year	**n**	**(kg/h)**	**SE(kg/h)**	**(n/h)**	**SE(n/h)**
2005	23	193.65	93.81	550.42	260.94
2006	10				
2007	11				
2008	18	95.58	65.81	259.10	208.53
2009	25	72.72	39.81	207.41	121.84
2010	24	33.24	21.47	77.21	54.81
2011	22	26.84	12.61	54.76	27.05
2012	20	16.69	11.97	34.40	23.83
2013	28	11.48	4.92	35.06	16.90
2014	16	25.62	15.76	49.56	28.69
2015	28	7.28	4.59	21.19	12.14
2016	28				
2017	30	6.64	2.41	15.74	6.73
2018	27	12.88	6.60	41.91	26.13
2019	27	14.59	5.77	40.09	18.05
2020	26	18.72	11.48	63.02	38.07
2021	27	9.59	5.03	26.14	14.19
2022	28	23.87	10.94	75.20	35.61
2023	29	19.24	8.89	38.81	19.10

Table 8.3.5. Proportion of tows with shrimp trawl that caught roundnose grenadier. Data from Norwegian Reference fleet

Year	Total number of shrimp trawl	Number of trawl hauls that caught roundnose grenadier	Catch of roundnose grenadier (kg)	% of the total catch
2013	243	0		0
2014	288	2		0.69
2015	1489	14		0.94
2016	4811	23		0.48
2017	3798	20	29	0.53
2018	2849	19		0.67

2019	1233	4	80	0.32

Table 8.3.6. Mean average catch (kg/km²) from the Swedish bottom trawl survey 2018-2021.

Year	nHauls>=300 m	nHauls with catch	mean	var	sd	se
2018	15	11	114.6	24921.9	157.9	40.8
2019	10	4	128.2	157271.1	396.6	125.4
2020	14	11	381.3	223687.7	473.0	126.4
2021	7	2	272.6	114841.2	338.9	128.1

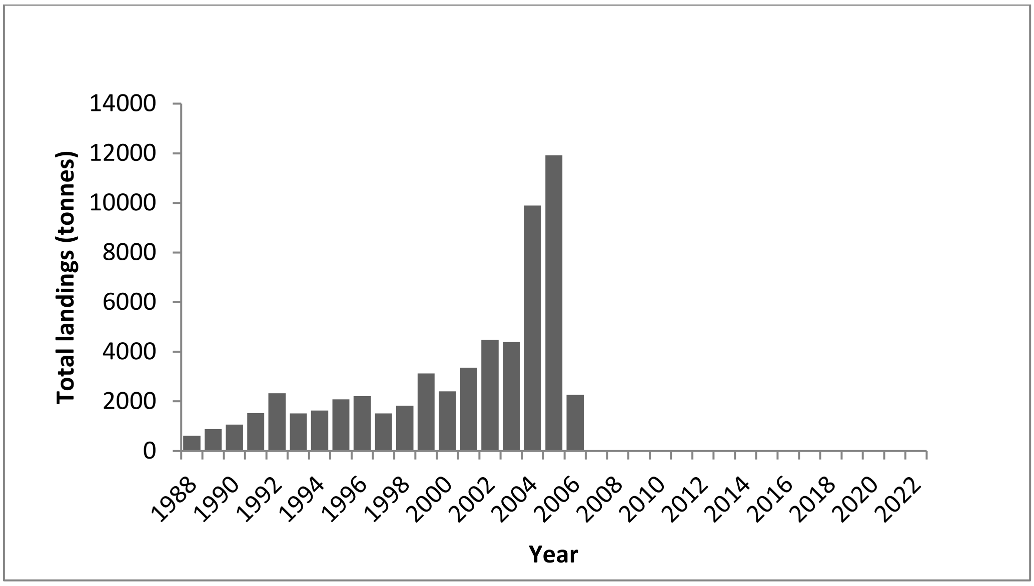


Figure 8.3.0. Landings of roundnose grenadier from Division 3.a. Landings from 2007–2022 are insignificant.

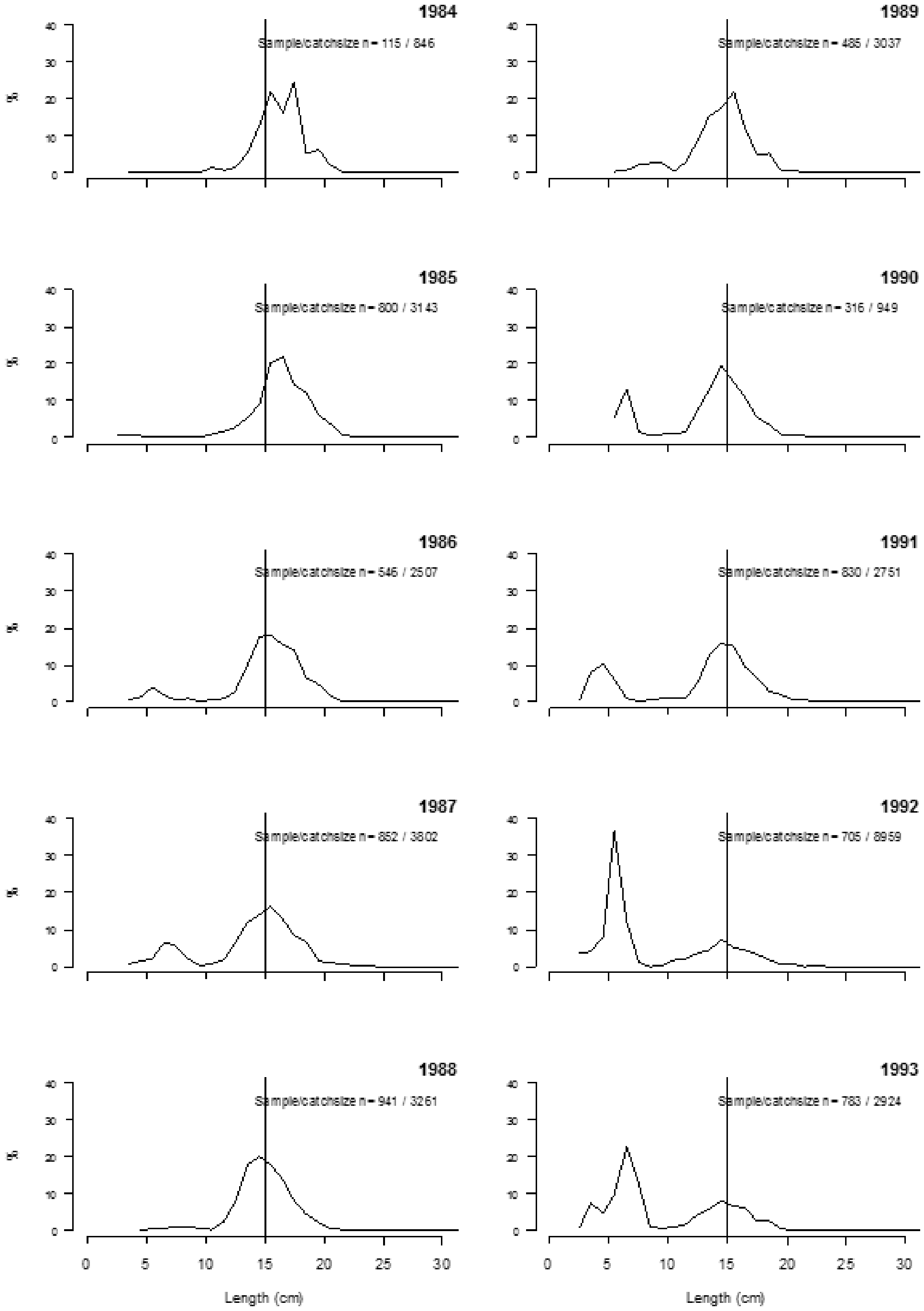


Figure 8.3.1. Length–frequency distributions for roundnose grenadier, 1984–2023. Data from Norwegian shrimp survey, all catches deeper than 300 m. Length is measured as pre-anal fin length in cm (PAFL). The distributions are calculated as percent number of fish in each cm length interval standardized to total catch number and trawling distance for each station each year.

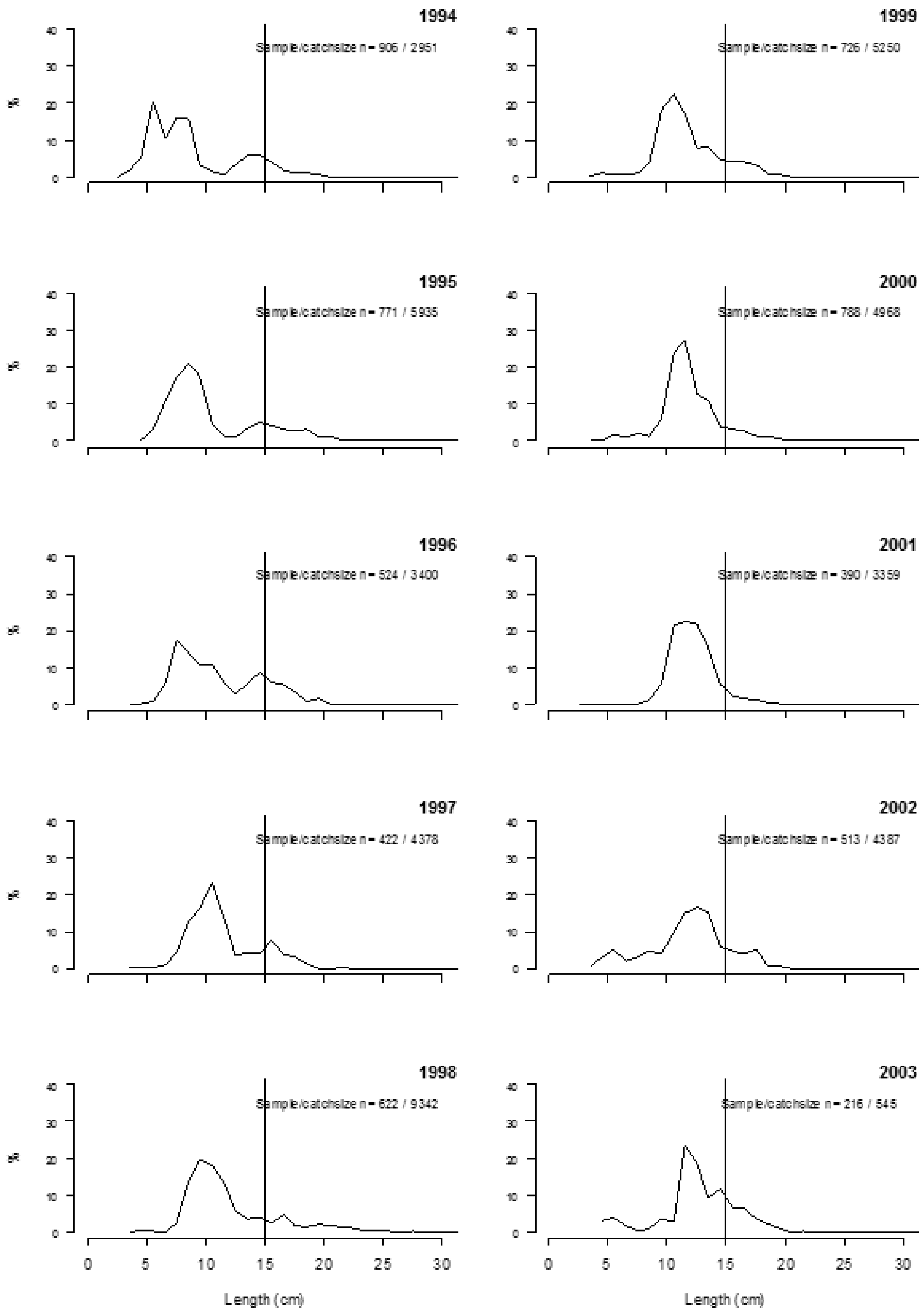


Figure 8.3.1. (Con't).

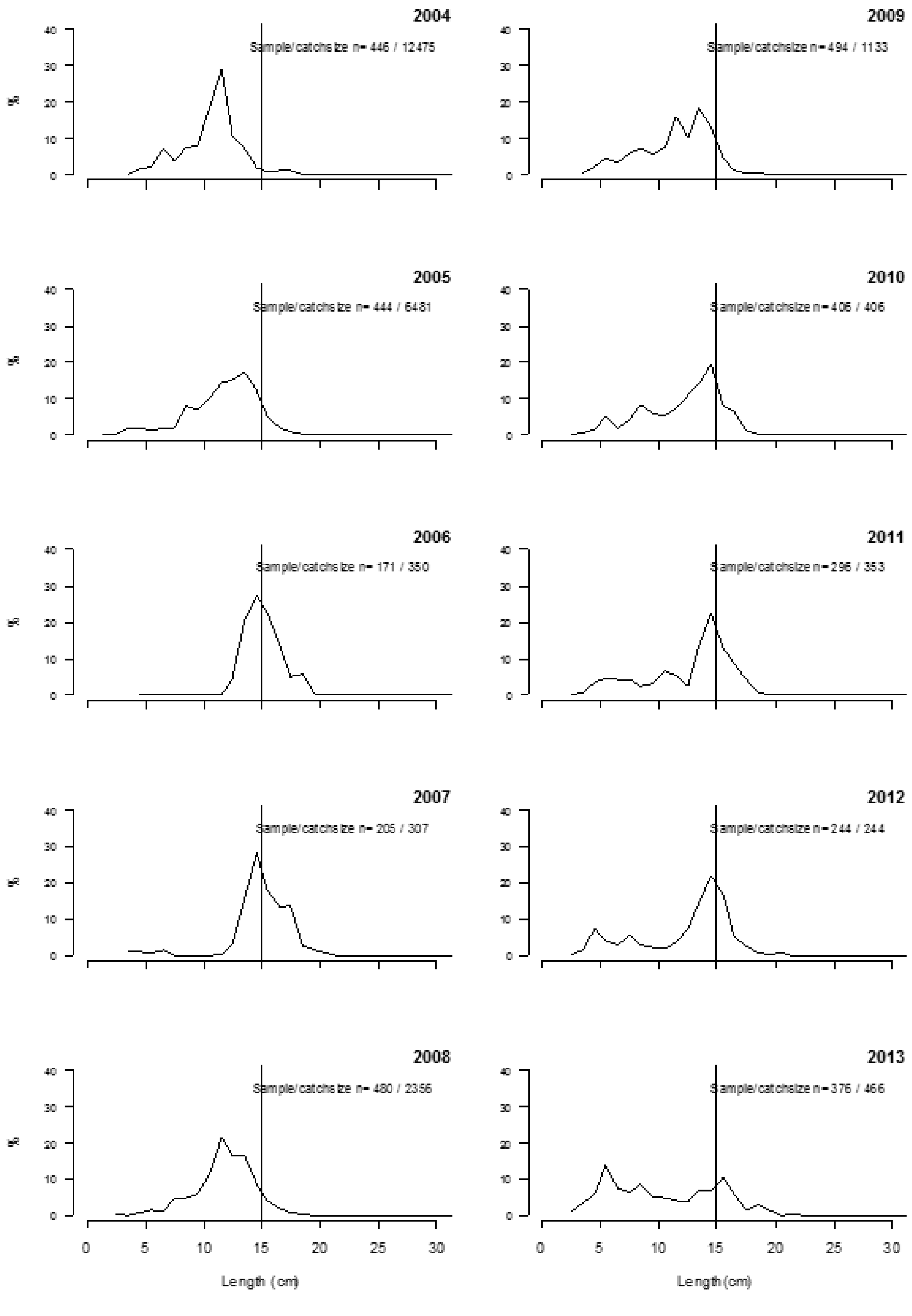


Figure 8.3.1. (Con't).

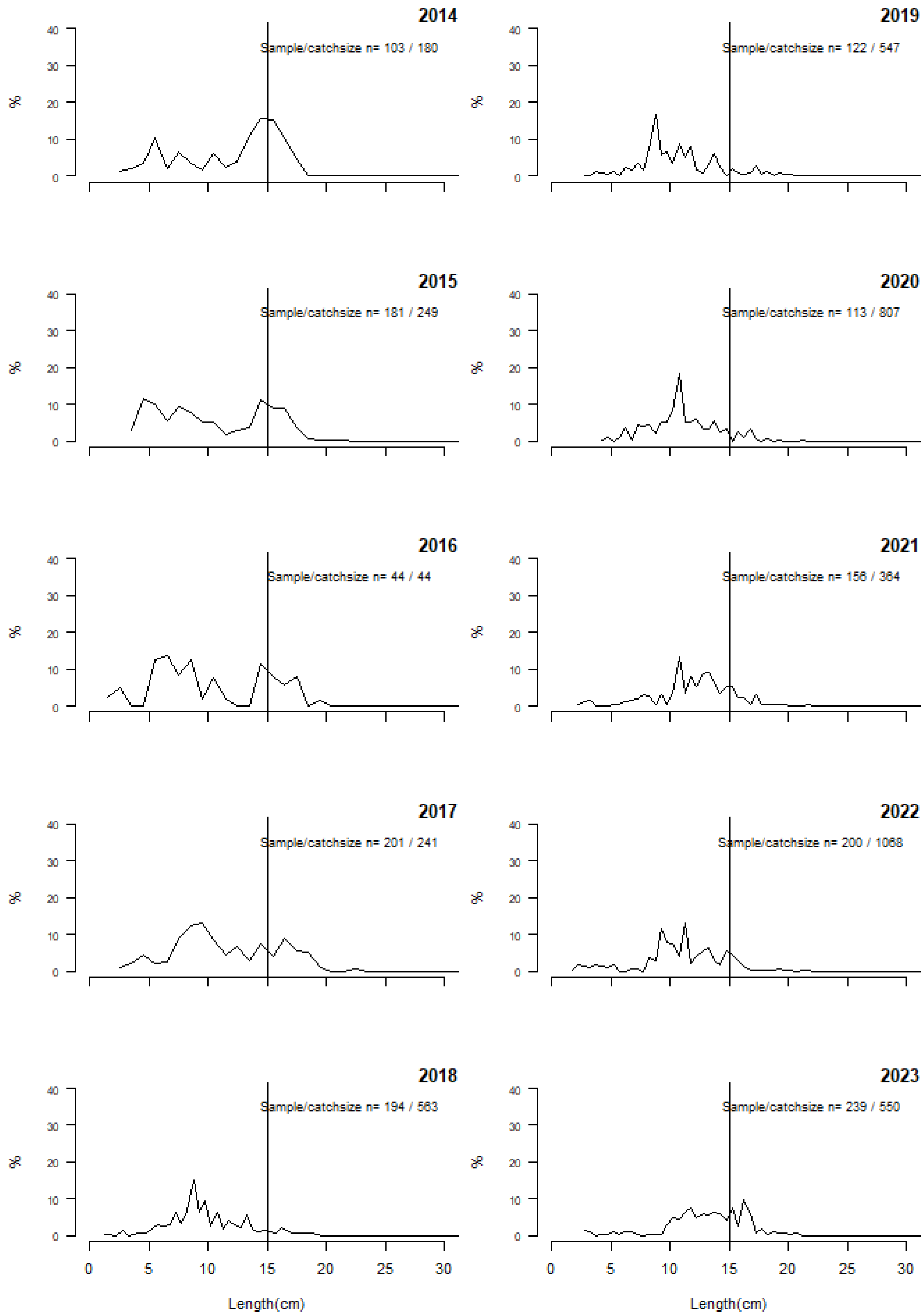


Figure 8.3.1. (Con't).

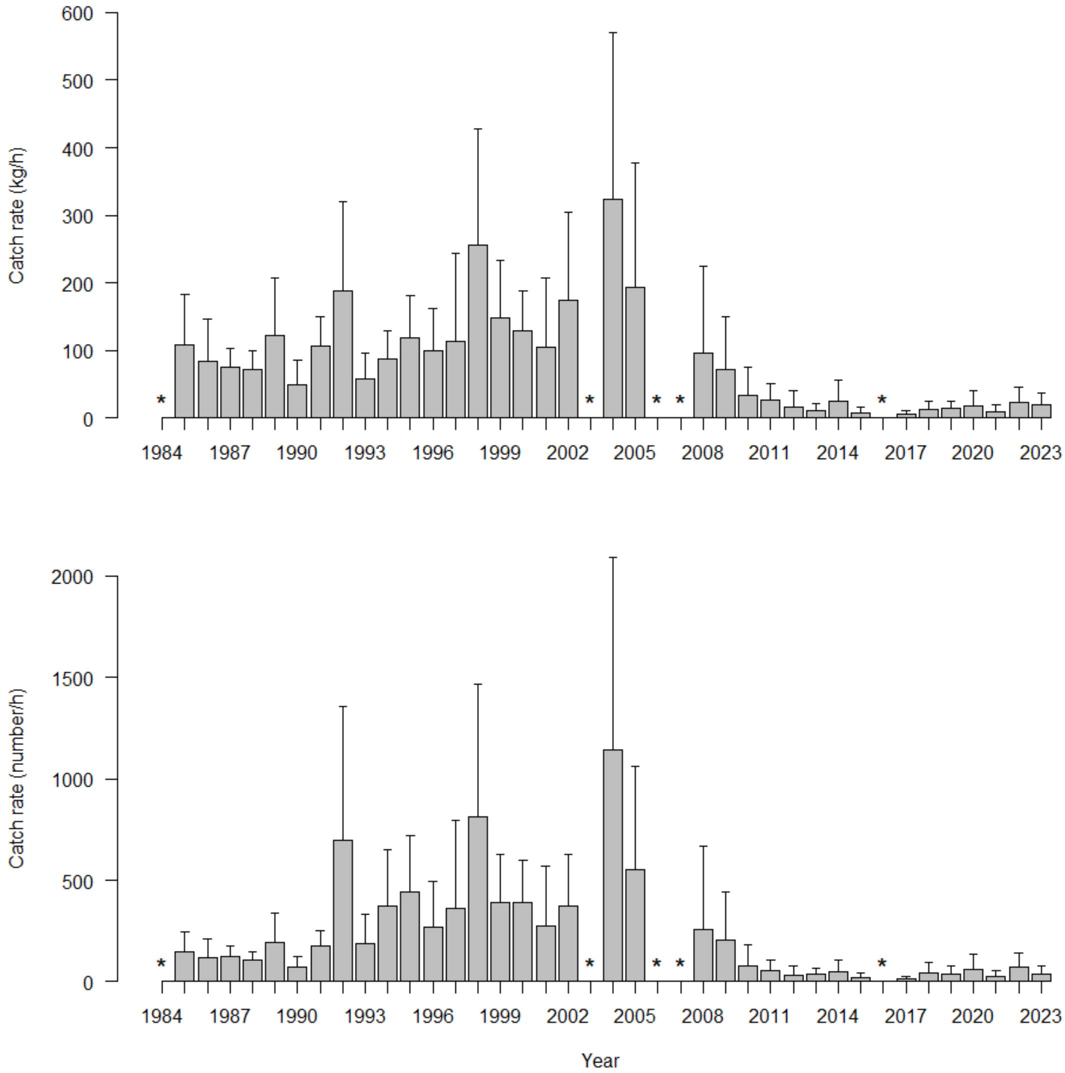


Figure 8.3.2. Survey catch rates in biomass (kg/h) and abundance (nos/h) of grenadier 1984–2023 in the Norwegian shrimp survey. Note: in 1984, 2003, 2006, and 2007 only a single or no trawls were made deeper than 400 m, thus the primary grenadier habitat was not sampled for those years. For 2016 data from the shrimp survey is regarded as unreliable due to inconsistencies with trawling gear and data from that year should be excluded. 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).

8.4 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)

8.4.1 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. Since 2010, Russian fleets abandoned the fishery, which is almost exclusively exploited by Spain in recent years.

8.4.1.1 Landings trends

The highest annual catch (almost 30 000 t) was taken by the Soviet Union in 1975 (Figure 9.4.1, see Stock Annex for detailed information) and in subsequent years the Soviet catch varied from 2800 to 22 800 tonnes 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 multispecies 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.

In 2008, the Spanish fleet targeting redfish on the MAR reported landings of roundnose grenadier in 14.b.1 totalling 1722 tonnes. Since 2010, roundnose grenadier became a target species. In 2011 official landings in 14.b.1 increased to 2239 tonnes. In subsequent years total estimated landings amounted to of 1860, 1790 and 2065 t in 2012, 2013 and 2014 respectively (Table 9.4.2). To these figures an unallocated catch in 14.b.1 of 1098 and 1015 t must be added in 2012 and 2014, respectively. The 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. Catches have been reported only by Spain since 2015. In 2015 total Spanish catch was declared as 862 t (533 and 329 tonnes in 14.b.1 and 12.a.1 respectively; Table 9.4.3). In 2016 the landings were estimated as 660 tonnes. In 2017 and 2018, preliminary official landings were considerably low, not exceeding 84 tonnes. In 2019 the landings increased to 215 tonnes and in 2020 decreased to 131 tonnes, all in Division 12.a.1. (Table 9.4.1 and 9.4.3). In 2021, zero tonnes were reported.

There has been uncertainty in the number of Spanish landings in 2015-2016, and previous report include different figures. Additionally, most landings of roundnose grenadier from the NEAFC Regulatory Area are caught in Division 12.b and 6.b.1, which are part of another stock (rng.27.5b6712b). The current report only includes data for 2021 based on preliminary official landings from InterCatch.

8.4.1.2 ICES Advice

ICES advice applicable to 2020–2023

"ICES advises that when the precautionary approach is applied, landings should be no more than 574 tonnes in each of the years 2020 and 2023. ICES cannot quantify the corresponding catches.".

8.4.1.3 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). The EU TAC combined ICES advices on catch for 2 stocks: the roundnose grenadier in divisions 10.b and 12.c, and in subdivisions 12.a.1, 14.b.1, and 5.a.1 and the roundnose grenadier in subareas 6 and 7, and divisions 5.b and 12.b. This allows for the realization of the full amount of TAC in any of these areas. For 2021, NEAFC recommendation (Rec. 5:2021) on the conservation and management of roundnose grenadier (*Coryphaenoides rupestris*) and other grenadiers in the NEAFC Regulatory Area (Divisions 10.b and 12.c, and Subdivisions 12.a.1 and 14.b.1) specifies:

1. *A total allowable catch limitation of 574 tonnes of roundnose grenadier is established.*
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. Catches should be reported by species. Unidentified grenadiers should be recorded as Macrouridae.*

8.4.2 Data available

8.4.2.1 Landings and discards

From earlier years data are WGDEEP estimates based on national submissions to ICES which are not fully included in InterCatch. Landings are given in Tables 9.4.1–9.4.3. The information on landings have been variable and at a considerably lower level down to insignificant in 2017 and 2018 but have increased to about 215 tonnes in 2019 and reached 131 tonnes in 2020. In 2021, zero tonnes were reported. Landings from the 1970s to the 1990s were reported to be mostly from pelagic trawling. In the 2000s there has been pelagic trawling in Division 14 and bottom trawling in Division 12. There were no discards of roundnose grenadier on Russian trawlers where smallest fish and waste were used for fishmeal processing. The information on discards is very limited. An assessment of discards was conducted in 2014, when the discards on Spanish target fishery estimated by scientific observers was at level of 386 tonnes (Tables 9.4.2). No discards have been reported from 2015-2021. Discards of roundnose grenadier in other fisheries have declined and this can be attributed to the decline of the deep-water fishery overall.

8.4.2.2 Length compositions

No new data on length compositions were presented.

8.4.2.3 Age compositions

No new data on age compositions were presented.

8.4.2.4 Weight-at-age

No new weight-at-age data are available.

8.4.2.5 Maturity and natural mortality

No new data on natural mortality are available.

8.4.2.6 Catch, effort and research vessel data

Catch and CPUE data are given in the Stock Annex. 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 for each subareas and divisions are available for Russian fleet in 2003–2009. Effort data for Spanish fleet is available for 2010–2020, but information remains very uncertain.

8.4.3 Data analyses

Substantial landings were recorded in the 1970s and 1980s. Since then, landings have been variable and have decreased considerably to around 27 tonnes in 2018. In 2019, landings reached 215 tonnes, all in Subdivision 27.12.a.1. Provisional landings are 131 tonnes in 2020 and zero tonnes in 2021. ICES cannot quantify the corresponding catches.

Since 2010 the official Spanish CPUE and effort data are available (see Stock Annex). 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 debilitated by the lack of standardisation of fleet and vessel type. The Spanish CPUE in Subdivisions 14.b.1 were on maximum historical levels in 2011. In 2012–2013 the CPUE declined and was stable in 2014–2015. The time-series of the CPUE for Subdivisions 12.a.1 is very limited.

8.4.4 Stock assessment

The ICES framework for category 5 stocks was applied for the 2020–2023 advice (ICES, 2019). ICES considers that a precautionary reduction of catches should be implemented unless there is sufficient data to access the current level of exploitation of the stock.

The precautionary buffer (20% reduction in landings) was applied in the 2015 advice and the available new data (catch statistics) do not change the assessment of the stock. There is no data on abundance trends but in the absence of fishing, the stock is expected to rebuild from the past depletion state caused by exploitation before the 2000s. Therefore, ICES advises that when the precautionary approach is applied, landings should be no more than 717 tonnes in each of the years 2020 to 2023. ICES cannot assess the stock and exploitation status relative to MSY and PA reference points because the reference points are undefined.

This stock is classified as Category 4 in the NEAFC categorization of deep-sea species/stocks which implies that fisheries are primarily restricted to Coastal State exclusive economic zones (EEZs) and therefore management measures are not taken by NEAFC unless complementary to coastal state conservation and management measures.

8.4.5 Biological reference points

No attempt was made to propose reference points for this stock.

8.4.6 Comments on the assessment

No analytical assessments were carried out.

8.4.7 Management considerations

Active roundnose grenadier fishery was resumed in 2010, but the current status is unknown due to insufficient data. The landings series is very limited and the CPUE data are very uncertain. The CPUE can be use as indicator of the state of stock in future.

8.4.8 References

ICES. 2019. Advice basis. In Report of the ICES Advisory Committee, 2019. ICES Advice 2019, section 1.2. https://doi.org/10.17895/ices.advice. 5757

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.

8.4.9 Tables and Figures

Table 9.4.1. Working group estimates of catch for roundnose grenadier from Subareas 12.a.1 and 12.c, between 2012 and 2021 (data from 1973-2011 is shown in the Stock Annex)

Year	USSR/Russia	Poland	Latvia	Faroes	Spain	Lithuanian	Total
2012					864	4	868
2013					118		118
2014				4			4
2015					329		329
2016					289		289
2017					16*		16
2018					27*		27
2019					215*		215
2020[1]					131*		131
2021[1]					0		0

[1]–preliminary statistics. * Subareas 12.a.1 only

Table 9.4.2. Working group estimates of catch for roundnose grenadier 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			239
2003		272			272
2004	201				201
2005					

Year	USSR/Russia	Spain	Unallocated	Discards	Total
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		371			371
2017		68			68
2018	0	0	0	0	0
2019	0	0	0	0	0
2020[1]	0	0	0	0	0
2021[1]	0	0	0	0	0

[1]–preliminary statistics.

Table 9.4.3. Working group estimates of catch of roundnose grenadier 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

Year	5.a.1	10.b	12.a.1 and 12.c	14.b.1	Total
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

Year	5.a.1	10.b	12.a.1 and 12.c	14.b.1	Total
2011	0	0	0	2239	2239
2012	0	0	868	2958	3826
2013	0	0	118	1790	1908
2014	0	0	4	3466	3470
2015	0	0	329	533	862
2016	0	0	289	371	660
2017	0	0	16*	68	84
2018	0	0	27*	0	27
2019	0	0	215*	0	215
2020[1]	0	0	131*	0	131
2021[1]	0	0	0	0	0

[1]–preliminary statistics. * Subareas 12.a.1 only.

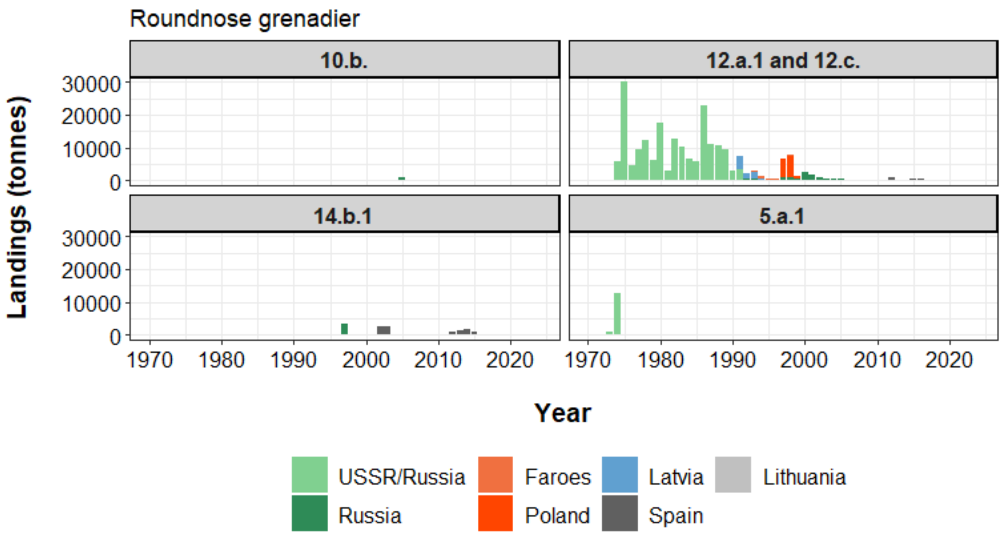


Figure 9.4.1. Landings of roundnose grenadier in ICES Divisions 10.b, 12.c and Subdivisions 5.a.1, 12.a.1, 14.b.1 in 1973–2021.

8.5 Roundnose grenadier (*Coryphaenoides rupestris*) in subareas 1, 2, 4, 8, and 9, Division 14.a, and in subdivisions 5.a.2 and 14.b.2 (Northeast Atlantic and Arctic Ocean)

8.5.1 The fishery

Areas of the main fisheries for roundnose grenadier are covered in the other sections of this chapter. Landings of roundnose grenadier in subareas 1, 2, 4, 8, and 9, Division 14.a, and in subdivisions 14.b.2 and 5.a.2 are mostly bycatch of trawl and longline fisheries for other species.

Most landings between 2000-2015 were from divisions 5.a.2 and 14.b.2. Since 2015, most landings are from subareas 1 and 2 and Subdivision 14.b.2 Landings from other areas have been minor in recent years. Trends in landings may reflect changes in fishing activity in other fisheries rather than in stock abundance.

8.5.1.1 Landings trends

Landing statistics by countries in the period 1990–2022 are presented in Tables 9.5.1–9.5.5.

In the subareas 1 and 2 the catch of roundnose grenadier in 2022 was 37 t In recent year, the species was partly taken as bycatch in the trawl and longline fisheries targeting other deep-water species. Since 1990, landings ranged from 0 t to 101 t in 1997, showing a significative decline since 1998 (Table 9.5.1). In subareas 1 and 2, the major contribution to the total catch was made by Norway. This is assumed to be from the bottom longline fishery targeting Greenland halibut in Division 2.a.. 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. Therefore, it is assumed that there are no French landings for roundnose grenadier from subareas 1 and 2 or account for minor bycatch from other fisheries that are considered to be negligent.

In Subarea 4, the minor catches of roundnose grenadier were reported in 2022 from ICES Division 4.a, amounting for less than 0.5 t. Negligible catches were also reported by Norway in gillnet and seine fisheries. Between 1990–2022 total landings in this area ranged between 0 and 372 t (Table 9.5.2). Unusually high landings were reported by the Danish fleet in 2004. Similar to French landings in Subareas 1 and 2, earlier landings of roundnose grenadier in Subarea 4 likely correspond to roughhead grenadier but since 2014 landings are correctly assigned.

For the period 1990–2022, landings of roundnose grenadier within Icelandic waters (Division 5.a) varied 3 to 398 t, mostly by Iceland (Table 9.5.3). Maximum landings were recorded in 1992–1999 when 120–398 t were caught annually as bycatch in mixed deep-water fisheries. However, it should be noted that catches may include other grenadier species until 1990. In recent years (2010-2022), landings of roundnose grenadier ranged between 3 to 84 t were taken in Icelandic waters as bycatch in trawl fisheries for Greenland halibut and redfish. Reported landings have increased from 5 tonnes on average between 2016-2020 to 27 tonnes (2021-2022).Between 1990 and 2022, landings of roundnose grenadier from subareas 8 and 9 ranged between 0 to 28 t annually. Since 2009, reported landings from this area are negligible (Table 9.5.4).

Landings from Division 14.a and Subdivision 14.b.2 (Greenland and Icelandic waters) in 1990–2022 varied from 15 to 262 t (Table 9.5.5). There is no directed fishery for roundnose grenadier in these areas. Most of the landings is taken as bycatch of the Greenland halibut bottom-trawl fisheries by Greenland and Germany. In 2022 landings were 136 t, corresponding to 113 t from

Subdivision 14.b.2 and 23 t from Division 14.a, mostly by Norway and Greenland. In 2020, by-catch of roundnose grenadier reported by Greenland reached the lowest levels in more than 10 years, 11 t. No catches by Icelandic vessels from Subdivision 14.b.2 are reported since the year 1993.

Between 2001 and 2003 unallocated landings were assigned to subareas 1, 2, 4, 8, 9 and Division 5.a.2 and 14.b.2 (Table 9.5.6).

8.5.1.2 ICES advice

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."

ICES advice applicable to 2018 and 2019

"ICES advises that when the precautionary approach is applied, landings should be no more than 65 tonnes in each of the years 2018 and 2019. ICES cannot quantify the corresponding catches."

ICES advice applicable to 2020 and 2023

"ICES advises that when the precautionary approach is applied, landings should be no more than 131 tonnes in each of the years from 2020 to 2023. ICES cannot quantify the corresponding catches."

8.5.1.3 Management

This stock is classified as Category 4 in the NEAFC categorization of deep-sea species/stocks which implies that fisheries are primarily restricted to Coastal State exclusive economic zones (EEZs) and therefore management measures are not taken by NEAFC unless complementary to coastal state conservation and management measures (NEAFC, 2016).

Management measures adopted by NEAFC established a total allowable catch limitation of 574 tonnes of roundnose grenadier in 2021 and no direct fisheries for roughhead grenadier and roughsnout grenadier should be authorised in NEAFC Regulatory Area. Since then, NEAFC did not renew specific measures for grenadiers. ICES WGDEEP understands that measures are now just covered by the Recommendation 7: 2018 on Deep-Sea Fisheries within the NEAFC Regulatory Area.

In eastern Greenland, main fishing operations are in Subdivision 14.b.2 and here, a combined annual TAC for roundnose and roughhead grenadiers has been 1000 tonnes since 2010.

There are also a range of other management measures covering this roundnose grenadier stock, including a TAC in Subareas 8, 9, 10, 12, and 14 (RNG/8X14-) for EU and UK vessels in EU and UK waters and for EU and UK vessels in international waters, and a TAC for grenadiers for EU and Norway in Greenland waters of 5 and 14 (GRV/514GRN)[1].

There are other management measures that afford protection to deep-water fishery resources in the North-east Atlantic including depth limits on bottom trawling and netting (Regulation (EU) 2016/2336[2]), spatial management (e.g., MPAs) and specific requirements for the protection of Vulnerable Marine Ecosystems (Regulation (EU) 2016/2336 and Regulation (EU) 2022/1614[3]). In terms of current depth limits in EU and UK waters, and for EU and UK vessels in international waters, bottom set gillnets may be deployed to depths less than 600 m, whilst bottom trawling is prohibited at depths greater than 800 m (Regulation (EU) 2019/1241[4].

The TAC for roundnose grenadier in the European Union and international waters of 1, 2 and 4 (RNG/124-) was last fixed in 2018.

There may be other management measures that WGDEEP experts may not be aware of.

8.5.2 Data available

8.5.2.1 Landings and discards

From earlier years data are WG estimates based on national submissions to ICES, which are not fully included in InterCatch.

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 1 t in subsequent years. In 2020, Spain reported discards data from divisions 8.c (3 t) and 9.a (1 t); zero discards from Spanish vessels were reported in 2021. No discards were reported from the Portuguese bottom otter trawl fisheries in Division 27.9.a since 2020. Discard data from subareas 8 and 9 for the year 2022 was not available to WGDEEP at the time of the writing of this report.

National catch statistics of Greenland are available for 14.b.2 from 1999 to 2022. These may include both landings from Greenland and other countries vessels, wherefore it was unclear whether this implies double count with landings reported by other countries. A potential misreporting is suspected for roundnose grenadier, as fisheries-independent data have revealed that roughhead grenadier is much more common than roundnose grenadier in ICES Subarea 14.b.2.

[1] Regulation (EU) 2023/194 fixing for 2023 the fishing opportunities for certain fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, as well as fixing for 2023 and 2024 such fishing opportunities for certain deep-sea fish stocks.

[2] Regulation (EU) 2016/2336 of the European Parliament and of the Council of 14 December 2016 establishing specific conditions for fishing for deep-sea stocks in the north-east Atlantic and provisions for fishing in international waters of the north-east Atlantic and repealing Council Regulation (EC) No 2347/2002. http://data.europa.eu/eli/reg/2016/2336/oj/eng

[3] EU. 2022. Commission implementing regulation (EU) 2022/1614 of 15 September 2022 determining the existing deep-sea fishing areas and establishing a list of areas where vulnerable marine ecosystems are known to occur or are likely to occur. http://data.europa.eu/eli/reg_impl/2022/1614/oj

[4] Regulation (EU) 2019/1241 of the European Parliament and of the Council of 20 June 2019 on the conservation of fishery resources and the protection of marine ecosystems through technical measures, amending Council Regulations (EC) No 1967/2006, (EC) No 1224/2009 and Regulations (EU) No 1380/2013, (EU) 2016/1139, (EU) 2018/973, (EU) 2019/472 and (EU) 2019/1022 of the European Parliament and of the Council, and repealing Council Regulations (EC) No 894/97, (EC) No 850/98, (EC) No 2549/2000, (EC) No 254/2002, (EC) No 812/2004 and (EC) No 2187/2005

– while roundnose grenadier is more abundant in reported catches from the same area (WGDEEP 2023: WD06).

Bycatches from Norway are assumed to be from the bottom longline fleet. The proportion of roundnose grenadier catch from the longline fishery is questionable, since this species is unlikely to be caught by hooks (Hareide, 1995). These records are likely to be roughhead grenadier, but WGDEEP is not able to validate this assumption.

There remains some uncertainty on historical landings and discards, which have not been always accurate or provided by all countries. Additionally, there is a discrepancy between reported catches in Greenland waters, the origin of which had not been resolved at the time of writing this report. Therefore, available data needs to be reviewed to provide robust estimations.

Landings of roundnose grenadier inside and outside the NEAFC Regulatory Area are provided in table 9.5.7.

8.5.2.2 Length compositions

No new data.

8.5.2.3 Age compositions

No new data.

8.5.2.4 Weight-at-age

No new data.

8.5.2.5 Maturity and natural mortality

No new data.

8.5.2.6 Catch, effort and research vessel data

Greenland's annual bottom trawl survey is the main source for fishery-independent data for roundnose grenadier in Subarea 14 (Greenland waters).

Greenland carried out a bottom buffered bottom trawl fishery-independent survey from 1998 to 2017 (no survey in 2001) on board R/V Paamiut using an Alfredo III bottom trawl. The survey was resumed in 2022, starting a new index survey series, after interruption since 2017, covering areas within the Greenland waters of subarea 14.b.2 (Greenland waters). The survey in 2022 has a new fix station allocation design. The survey is depth stratified and covers the slope and shelf (400-1500 m) between the 3 nm line (baseline) and the 200 nm (Exclusive Economic Zone) or middle line to Iceland. A new research vessel, RV Tarajoq and a new trawl gear, Bacalao 476, with a mesh size of 136 mm and a 30-mm mesh-liner in the cod-end were used. Towing speed is between 2.5-3.0 knots and is estimated from the start and end positions of the haul, with a 30-min bottom time (tows of at least 15 min are accepted). Detailed information is provided in the Working Document available to WGDEEP (Nogueira and Christiansen, 2023; WD6).

8.5.3 Data analyses

Fisheries-independent data

During the 2022 bottom trawl survey in East Greenland, roundnose grenadier was caught in 18 of the 73 hauls. Catches were generally low and were only found in Q2 at 1001-1500 and Q5 between depth of 601 to 1500 m. The total biomass estimates for roundnose grenadier in 2022 was 84 t (S.E. = 17), lower than previous estimates (Figure 9.5.1). The majority of the fish were found in 800–1000 m depth strata (Nogueira and Christiansen, 2023; WD6). In 2022, there was a mode in the length distribution around 3 cm (Figure 9.5.2), but changes in survey design and effects of gear selectivity in observed changes in length distributions cannot be excluded.

Fisheries-dependent data

Yearly and monthly logbook information, and CPUE distribution from 1999 to 2022 for roundnose grenadier were presented to WGDEEP (Nogueira and Christiansen, 2023; WD7). Data presented are a mix of targeted catches and bycatch of the Greenland halibut fishery in East Greenland.

Catches of roundnose grenadier have fluctuated throughout the evaluated time period (1999 to 2022) ranging from 129.3 tons (1999) to 29.2 tons (2008). Catches in 2022 within the Greenland waters of Subdivision 14.b.2 were 113 t, most caught during the months of June and July (68.3 % of the total reported catch).

Data from deep waters surveys conducted in East Greenland (1998-2016 and 2022) is suggestive that roughhead grenadier is more abundant than roundnose grenadier. Therefore, it is likely that there is misidentification of grenadier species confounding the logbook data of roundnose grenadier and roughhead grenadier.

Biological reference points

There are no reference points for this stock.

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.

8.5.4 Comments on the assessment

No assessment was carried out for this stock.

8.5.5 Management considerations

This is a bycatch fishery and advice for other stocks and fisheries should take into account advice on this stock. Trends in landings may reflect changes in activity in other fisheries rather than in stock abundance. Most landings since 2000 are from subdivisions 5.a.2 and 14.b.2, and have been relatively stable. Since 2016, it is noticeable a decrease in landings from Subdivision 5.a.2 and increase from subareas 1 and 2. Landings from other areas were negligible since 2016. There are no reported catches inside the NEAFC Regulatory Area.

The current stock units are consistent with the study from Knutsen et al. (2012) except that the unit covering subareas 1, 2, 4, 8, and 9, Division 14.a, and subdivisions 14.b.2 and 5.a.2, should not be considered as a demographic stock or a genetic population because it includes areas of the Arctic and Atlantic oceans in which roundnose grenadier was found to be genetically distinct. This unit might be only considered as an aggregation of areas where roundnose grenadier occurs at low to moderate density and is not subject to significant continuous exploitation.

Given the bathymetric distribution of roundnose grenadier in the Northeast Atlantic, the fishery for this species may be affected by the recent EU regulation for the protection of Vulnerable Marine Ecosystems (Regulation (EU) 2022/1614). In terms of depth limits in EU and UK waters, and for EU and UK vessels in international waters, bottom set gillnets may be deployed to depths less than 600 m, whilst bottom trawling is prohibited at depths greater than 800 m (Regulation (EU) 2016/2336 and Regulation (EU) 2019/1241).

WGDEEP is aware of Norwegian regulations for fisheries in Norwegian EEZ, and in Jan Mayer and Svalbard (ICES Subarea 2), that define seabed deeper than 1000 m as vulnerable and ban the deployment of bottom-contact gears.

8.5.6 References

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Nogueira, A., Christensen, H. 2023. Commercial catches of roughhead grenadier, roundnose grenadier, greater argentine, tusk, blue ling, black scabbardfish, ling, and orange roughy in ICES Division 14.b in the period 1999-2022. WD6 WGDEEP 2023.

8.5.7 Tables and Figures

Table 9.5.1. Working group estimates of landings of roundnose grenadier from Subareas 1 and 2.

Year	Faroes	Denmark	Germany	Norway	Russia/USSR	UK (E+W)	France	TOTAL
1990			5		12			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

Year	Faroes	Denmark	Germany	Norway	Russia/USSR	UK (E+W)	France	TOTAL
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				11				11
2016				2			0	2
2017				4			< 1	4
2018				21			< 1	21
2019	0	0	0	35	0	0	< 0.1	35
2020	0	< 0.01	0.1	25	0	0	0	25
2021	0	0	0	44			< 0.1	45
2022*	0	0	0	37	0	< 0.1	0	37

*** 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

Year	Germany	Norway	UK (Scot)	Denmark	France	TOTAL
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		1	1
2017		< 1			< 1	< 1
2018		< 0.5			< 1	< 1
2019	0	< 0.5	0	0	0	1
2020	0.1	< 0.1	0	0	2	2
2021	0	< 0.5	0	0	< 0.5	1

Year	Germany	Norway	UK (Scot)	Denmark	France	TOTAL
2022*	0	< 0.5	< 0.1	0	< 0.5	< 0.5

*Preliminary data.

Table 9.5.3. Working group estimates of landings of roundnose grenadier from Division 5.a.2.

Year	Faroes	Iceland**	Norway	UK (E+W)	Denmark	Greenland	Germany	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						80
2013		84						84
2014		36						36

Year	Faroes	Iceland**	Norway	UK (E+W)	Denmark	Greenland	Germany	TOTAL
2015		22			2			24
2016		51						51
2017		18				0		18
2018		13	0					13
2019		2					1	3
2020		6				3		9
2021		6	26					32
2022*		20***				< 0.5	< 0.5	21

*** Preliminary data. ** includes other grenadiers from 1990 to 1996. *** Catch from Iceland is reported for Subarea 5.a and it is assumed to be within Division 5.a.2.**

Table 9.5.4. Working group estimates of landings of roundnose grenadier from Subareas 8 and 9.

Year	France	Spain	Portugal	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

Year	France	Spain	Portugal	TOTAL
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
2017	0	0		0
2018	0	0		0
2019	< 0.5	0	0	< 0.5
2020	0.1	0	0	0.1
2021	< 0.1	0	0	< 0.1
2022*	0	0	0	0

*** Preliminary data.**

Table 9.5.5. Working group estimates of landings of roundnose grenadier from Division 14.a and Subdivision 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	138		19					262
2000		41	96		5					153

Year	Faroes	Germany	Greenland	Iceland	Norway	UK (E+ W)	UK (Scot)	Russia	Estonia	TOTAL
2001		11	75		7	2	72			172
2002		25	56		15	1	1			103
2003			55		5	1				76
2004		27	107							137
2005			62		6	1				76
2006		35	79		17					131
2007	1		43		1					45
2008			31					12		43
2009			45		2					47
2010		33	61		7					101
2011		32	138		4					174
2012			126		1					127
2013			129		2					131
2014	0		100		7				4*	111
2015			141							179
2016			64							79
2017			93							119
2018		59	127		1					217
2019	0	35	27	0	92	0	0	3	0	157
2020	0	28	12	0	2	0	0	3	0	44
2021	1	31	34	0	78	0	0		0	143
2022*	0	14	13	0	103	0	0	5	0	136

*** Preliminary data. ** Estonian landings in 2014 not reflected in ICES catch statistics.**

Table 9.5.6. Working group estimates of landings of roundnose grenadier from 1, 2, 4, 5.a.2, 8, 9, 14.a and 14.b.2.

Year	1+2	4	5.a.2	8+9	14.b.2	14.a	Unallocated	Total
1990	17	2	7	5	47			78
1991	31	4	48	1	29			113
1992	30	5	210	12	31			288

Year	1+2	4	5.a.2	8+9	14.b.2	14.a	Unallocated	Total
1993	2	4	276	18	26			326
1994	12	27	210	5	15			269
1995	0	16	398	0	27			441
1996	0	12	140	1	25			178
1997	101	10	198	0	59			368
1998	100	0	120	20	126			366
1999	46	5	129	16	262			458
2000	0	0	54	4	142			200
2001	2	17	40	7	167		208	441
2002	12	27	60	3	98		504	704
2003	4	12	57	2	61		952	1088
2004	27	372	181	2	134			716
2005	12	2	76	8	69			167
2006	8	4	62	28	131			233
2007	12	1	16	10	45			84
2008	10	0	29	8	43			90
2009	8	0	46	1	47			102
2010	23	2	59	1	101			186
2011	16	0	62	1	174			253
2012	5	1	80	0	127			213
2013	17	0	84	0	131			232
2014	4	3	36	0	111			154
2015	11	2	24	1	141			179
2016	2	1	51	0	62	2		118
2017	4	< 1	18	0	93			115
2018	21	< 1	13	0	185	2		221
2019	35	1	3	< 0.5	157	0		196
2020	25	2	9	0.1	45	0		81
2021	45	1	32	< 0.1	143	1		222

Year	1+2	4	5.a.2	8+9	14.b.2	14.a	Unallocated	Total
2022*	37	< 0.5	21	0	112	23		193

*** Preliminary data.**

Table 9.5.7. Roundnose grenadier in the Northeast Atlantic. Landings inside and outside the NEAFC Regulatory Area (RA) as estimated by ICES. Landings in tonnes.

Year	Inside the NEAFC RA	Outside the NEAFC RA	Total landings	Proportion inside the NEAFC RA (%)
2017	0	115	115	0
2018	0	221	221	0
2019	0	196	196	0
2020	0	81	81	0
2021	0	222	222	0
2022*	0	193	193	0

*** Preliminary data.**

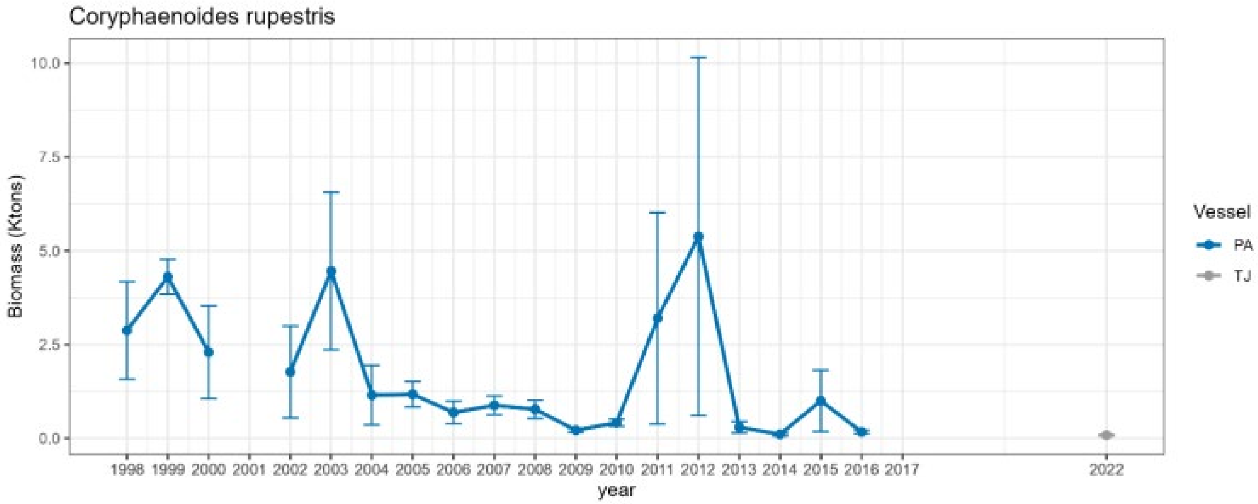


Figure 9.5.1. Roundnose grenadier (RNG) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut (PA) and on board R/V Tarajoq (TJ) in 2022 (Nogueira and Christiansen, 2023; WD6).

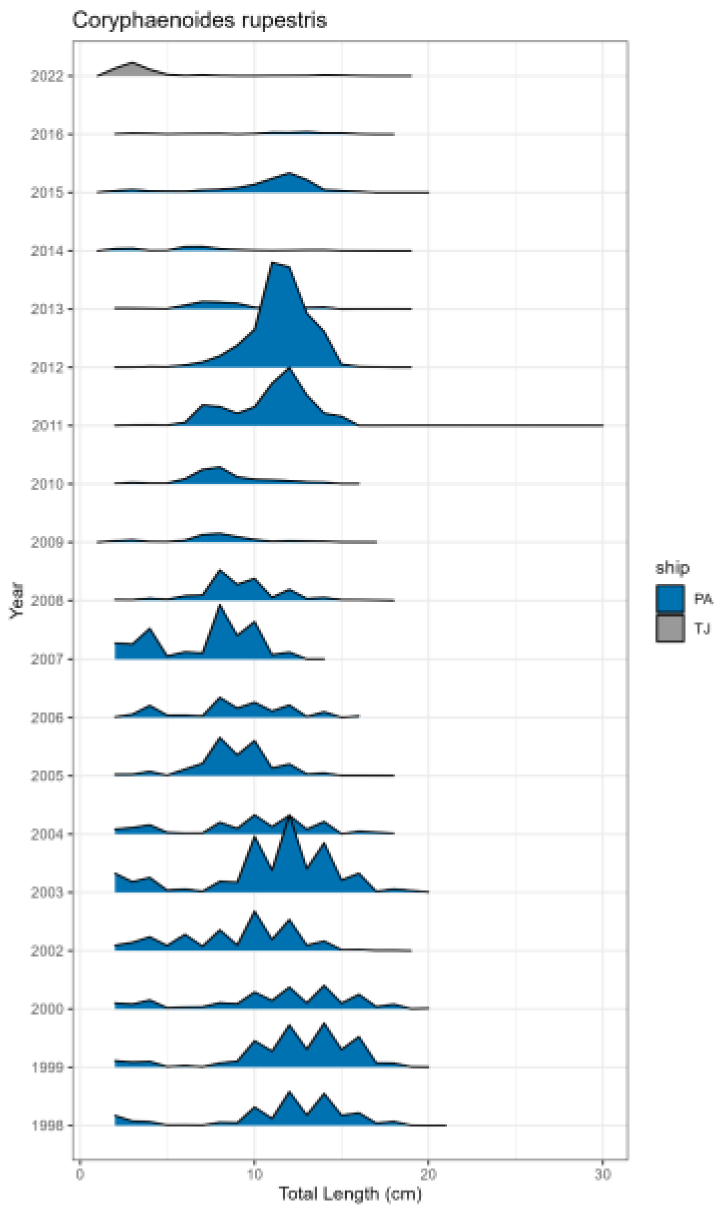


Figure 9.5.2. Length frequency distribution of roundnose grenadier sampled in ICES subarea14.b.2, onboard the R/V Paamiut (PA) between 1998-2016, and onboard R/V Tarajoq (TJ) in 2022.. No survey was carried out in 2001, and between 2017-2021 (Nogueira and Christiansen, 2023; WD6).

9 Black scabbardfish (*Aphanopus carbo*) in the Northeast Atlantic

9.1 Stock description and management units

The species is distributed on both sides of the North Atlantic and on seamounts and ridges, from the Strait of Denmark, southwards to about 30°N (Nakamura & Parin, 1993). Juveniles are mesopelagic and adults benthopelagic. The life cycle of the species is not completed in just one area and large-scale migrations occur seasonally.

All available evidences suggest one single stock doing a clockwise migration between Northern European waters (ICES subareas 5, 6 and 7 and Division 27.12.b) and southern European waters (subareas 8 and 9) down to Madeira in the CECAF area, where spawning occurs (Farias *et al.*, 2013). The connexions between the Northern and Southern components and other areas, in particular Azorean waters and the mid-Atlantic Ridge is less clear. However, ICES considers one single assessment unit in the Northeast Atlantic.

Two different species, the black scabbardfish (*Aphanopus carbo*) and the intermediate scabbardfish (*A. intermedius)*, coexist in Azorean waters (Subarea 10), Madeira, and the Canaries (Stefanni & Knutsen, 2007; Stefanni *et al.*, 2009; Biscoito *et al.*, 2011; Besugo *et al.*, 2014 WD). This latter species is not subject to assessment by ICES.

Because of the different characteristics of fisheries and life stage occurring in each area, the report is organised in four sections treating fisheries in northern, southern, other areas, and CECAF. WGDEEP does not assess fisheries in Madeira (Eastern Central Atlantic area, CECAF) or in other areas outside the ICES area.

Section 9.2 "Black scabbardfish (*Aphanopus carbo*) in subareas 27.5, 27.6 and 27.7 and Division 27.12.b" presents data and analyses on fisheries and catches in the Northern component of the ICES areas. In these areas the bulk of the catch is by trawlers.

Section 9.3 "Black scabbardfish (*Aphanopus carbo*) in subareas 27.8 and 27.9" presents data and analyses where the main fishery is from deep-water longliners in Division 27.9.a, which represents the Southern component of the ICES areas, as well as results of the model for the overall stock. The modelling relies on a state-space dynamic population model benchmarked at WKDEEP 2014 (ICES, 2015).

Section 9.4 " Black scabbardfish (*Aphanopus carbo*) in other areas" presents data and analyses for other areas, namely Division 27.3.a and subareas 27.1, 27.2, 27.4, 27.10, and 27.14. Data are mostly about longline fisheries. Since, 2010 the overall landings from these areas were globally much lower than at the other two management units.

Section 9.5 " Black scabbardfish (*Aphanopus carbo*) in CECAF area" presents data and analysis of fisheries and landings in CECAF area 34.1.2, where a directed bottom longline fishery operates. Although ICES does not asses this fishery, it is admitted that the incorporation of reliable CECAF data could provide a wider perception of the stock dynamics.

9.2 Black scabbardfish (*Aphanopus carbo*) in subareas 27.5, 27.6 and 27.7 and Division 27.12.b

In this section, fisheries, landings trends, and applicable management are presented for divisions 27.5.a, 27.5.b, and 27.12.b and subareas 27.6 and 27.7, but the stock assessment data analyses and management considerations apply to these areas and ICES subareas 27.8 and divisions 27.9.a.

ICES Division 27.5.a, initially included in "Other areas", has been included in the Northern Component since 2016, both for stock assessment analyses and for management considerations.

9.2.1 The fishery

The fishing effort from EU vessels in the Northern Component area has been greatly reduced due to the EU Regulation 2016/2336 of 14 December 2016 (EU, 2016) that bans fishing with bottom trawls at a depth below 800 metres, with impacts on the French bottom deep-water fishery that catches the black scabbardfish.

In Division 27.5.b, black scabbardfish was initially fished by large trawlers that operated on the slope around the Faroe Bank and on the Wyville-Thomsen ridge close to the southernmost Faroese EEZ boarder. In Faroese waters, the black scabbardfish fishery is managed through a fishing licencing scheme and since 2013, only one trawler has had licence to fish black scabbardfish as a targeted species.

Faroese commercial trawlers use a star trawl with 486 meshes, 160 mm with a net mesh size of 80 mm. Black scabbardfish is usually fished at depths from 600 to 1000 m and the haul duration varies from 6 to 8h, but may last less in case of large catch (Ofstad, 2023 WD).

9.2.2 Landings trends

The historic landing trends on this assessment unit are described in the stock annex.

Total landings from the ICES Division 27.12.b and subareas 27.5, 27.6, and 27.7 show a markedly increasing trend from 1999 to 2002 followed by a decreasing until 2005 (Figure 9.2.1). The peak in landings was registered in 2002 and came mainly from landings in ICES subareas 27.6 and 27.7. The 2002 peak appears to be mainly driven as a response to the EU TAC management (Figure 9.2.1). From 2009 until 2016, landings have been stable, fluctuating around about 3000 tonnes per year. Since 2017, the landings have been decreasing.

Since 2010, Icelandic landings in ICES Division 27.5.a have increased, remaining stable around 300 t between 2012 and 2017, and decreasing since then (Table 9.2.4f).

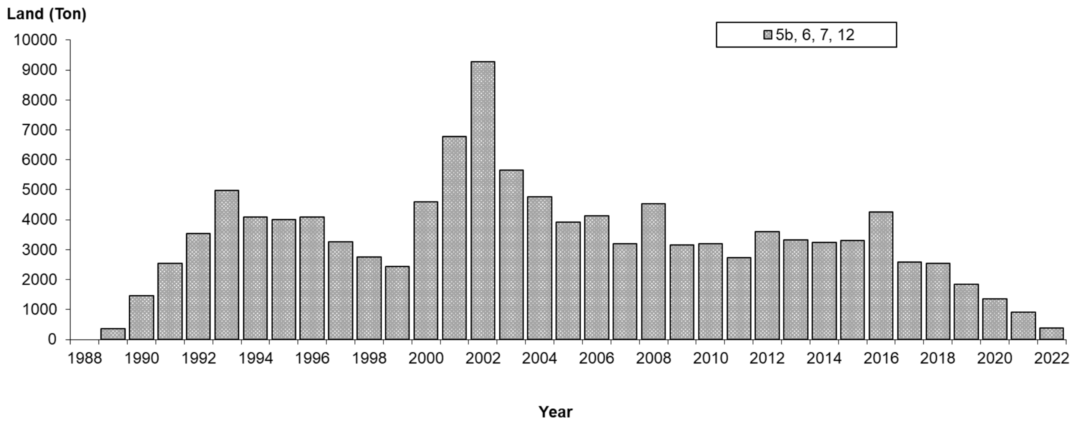


Figure 9.2.1. bsf.27.nea Northern component annual landings time-series for ICES subareas 27.5, 27.6, 27.7, and 27.12.

In early years, French landings represented more than 75% of the Northern component total landings, but in 2002 and 2006 they just represented about 50%. The relative importance of French landings, particularly at ICES Subarea 27.6, had an increasing trend from 2009 to 2012, a decreasing trend until 2017, decreasing from 2017 to 2020 to increase again until 2022. From 2013 to 2018, Spanish landings of black scabbardfish showed a slight increased, decreasing from 2018 onwards, whereas Faroese landings increased from 2017 to 2020, which resulted on a rise in their relative contribution, but decreased in the last years (Figure 9.2.2).

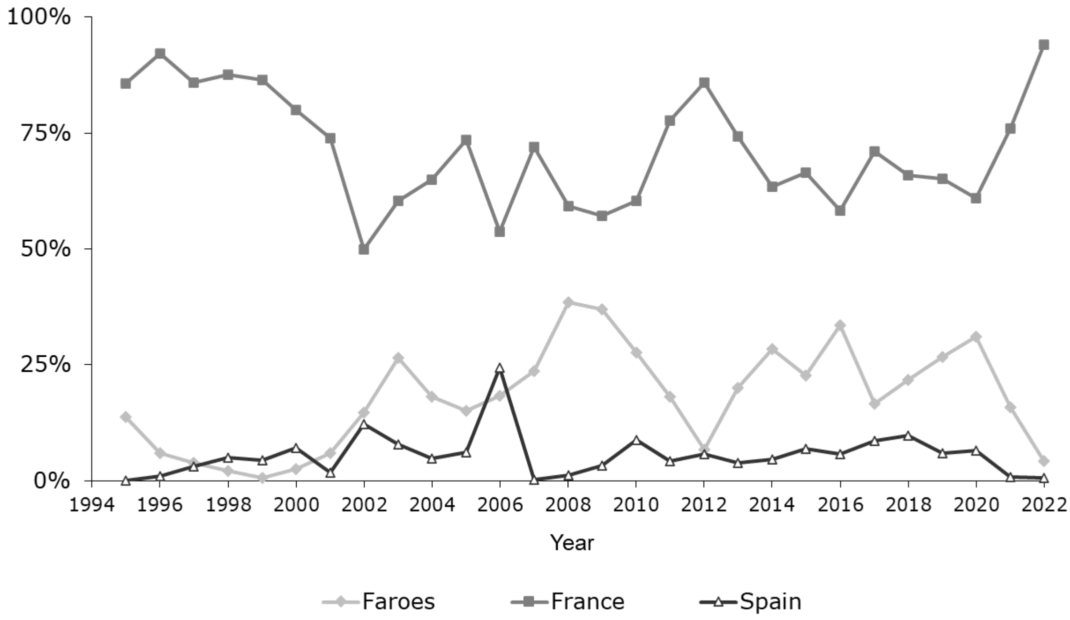


Figure 9.2.2 bsf.27.nea Northern component French, Spanish and Faroese relative contribution to the annual landings for the Northern component.

9.2.3 ICES Advice

The latest ICES advice, in 2022, was: "*ICES advises that when the precautionary approach is applied, catches should be no more than 4214 tonnes in each of the years 2023 and 2024.*"

9.2.4 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 27.5, 27.6, 27.7, and 27.12, from 2006 to 2020, are presented in Table 9.2.1. The difference between the TAC and landings may not necessarily be regarded as TAC overshoot as some catches occur in waters under the jurisdiction of third countries and are therefore not covered by the EU TAC.

Given the EU Regulation 2016/2336 of the European Parliament and of the Council of 14 December 2016 (EU, 2016), "No fishing authorisation shall be issued for the purpose of fishing with bottom trawls at a depth below 800 metres", black scabbardfish catches from trawl fishing grounds deeper than 800 meters are null for EU vessels since 2017.

Table 9.2.1. Black scabbardfish TACs and total landings of EU vessels in ICES subareas 27.5, 27.6, 27.7, and 27.12 from 2006 to 2021.

Year	EU TAC 27.5, 27.6, 27.7 & 27.12	Landings 27.5, 27.6, 27.7 and 27.12
2006	3042	4150
2007	3042	3194
2008	3042	4533
2009	2738	3159
2010	2547	3421
2011	2356	2900
2012	2179	2408
2013	3051	3229
2014	3966	3599
2015	3649	3567
2016	3357	4597
2017	2954	2886
2018	2600	2686
2019	2470	1903
2020	2470	1453
2021	583	938
2022	0	453
2023	1710	

9.2.5 Data available

9.2.5.1 Landings and discards

In 2021, updated landing data were made available for the major fishing countries operating in ICES subareas 27.5, 27.6, 27.7, and 27.12 (Table 9.2.4).

Updated discard data were also provided for major fishing countries operating at the Northern component area. Based on the discard data available for this component, it is concluded that discards of black scabbardfish are negligible.

9.2.5.2 Research vessel data

Since September 2014, a Faroese deep-water survey has been conducted to investigate bottom fishes at deep waters and other areas than those the annual Faroese groundfish surveys covers (Ofstad, 2019 WD). The main species studied are tusk, blue ling, greater silver smelt, black scabbardfish, roundnose grenadier, deep-water redfish and Greenland halibut.

Faroese deep-water surveys are held onboard the research vessel "Magnus Heinason". The trawl gear used is a star trawl with 40 mm mesh size in the cod-end. Rockhopper ground gear, 120 m bridles and Thyborøn-trawl doors. Fishing hauls have a mean duration of one hour, but the fishing haul duration (i.e. the time interval between the time when the gear reaches the bottom till it is hauled up from the bottom) may vary. The adopted sampling procedure is the same as those adopted for Faroese annual groundfish surveys. After each fishing haul the total catch is sorted by species and total weight is determined for each species. Further samples are also collected with the aim of obtaining data on specimens´ length and weight. For the main species, subsamples are also collected to determination of sex, maturity and age.

In Faroese waters, black scabbardfish is mainly distributed on the slope north of the Faroe Bank and on the Wyville-Thomsen ridge (Figure 9.2.3), which correspond to the main Faroese fishing areas. A closer look shows that the black scabbardfish is only caught in the area north-west of the Faroes and never caught on the Faroe Plateau (Figure 9.2.4). In 2020, only 31 out of the 75 hauls planned for the survey were performed due to the weather conditions and problems with the vessel.

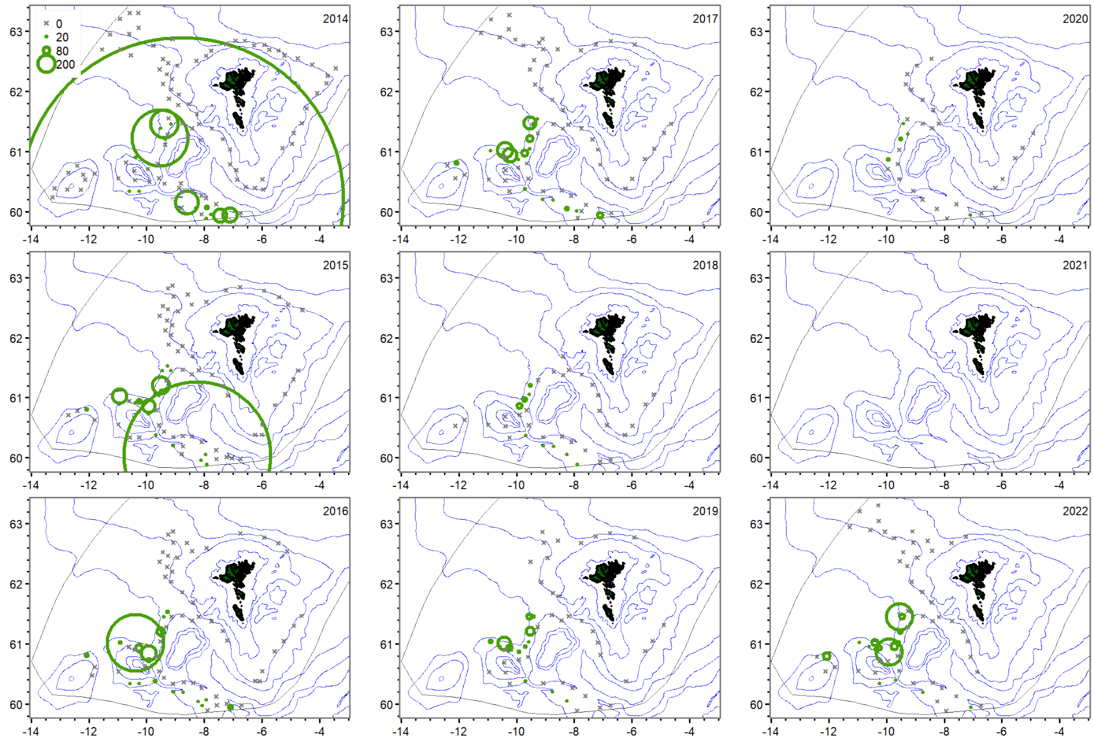


Figure 9.2.3. bsf.27.nea Northern component. Black scabbardfish in Division 27.5.b. Spatial distribution of CPUE (kg/h) from the deep-water surveys in 2014- 2022. No survey in 2021. (Source: Ofstad, 2023, WD;).

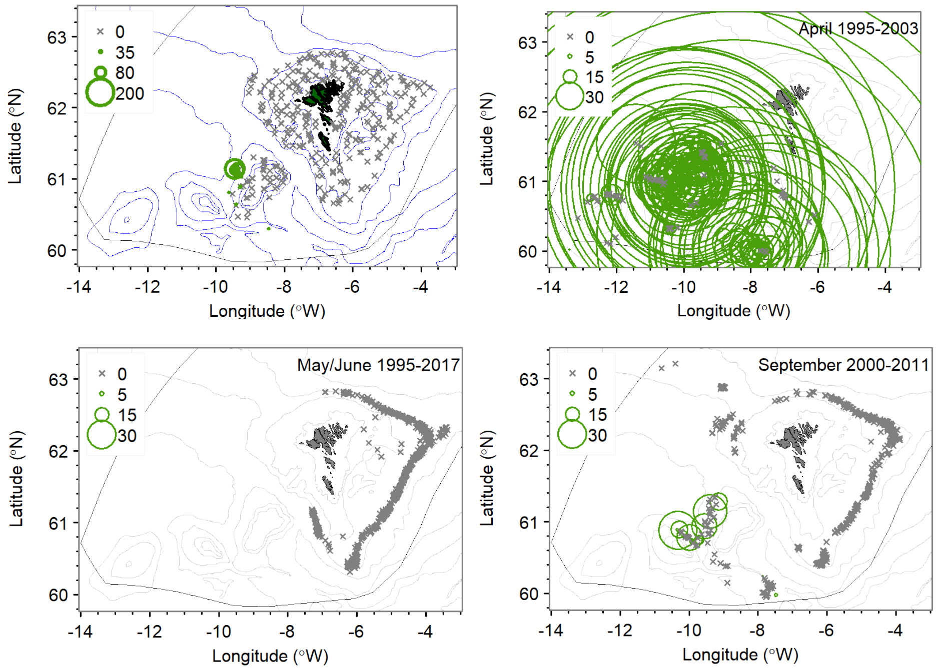


Figure 9.2.4. bsf.27.nea Northern component. Spatial distribution, CPUE (kg/h), from different surveys. Annual groundfish surveys, August 1996-2017 (upper left), Blue ling surveys, April 1995-2003 (upper right), Greenland halibut surveys, May/June 1995–2017 (lower left) and Redfish surveys, September 2000-2011 (lower right). (Source: Ofstad, 2019, WD)

Oceanographic data collected in Faroese surveys indicate that the species occurs at depths below 500 m, in waters with temperature higher than 6°C (Figure 9.2.5). These two conditions are registered at the oceanic Faroese waters (Figure 9.2.6).

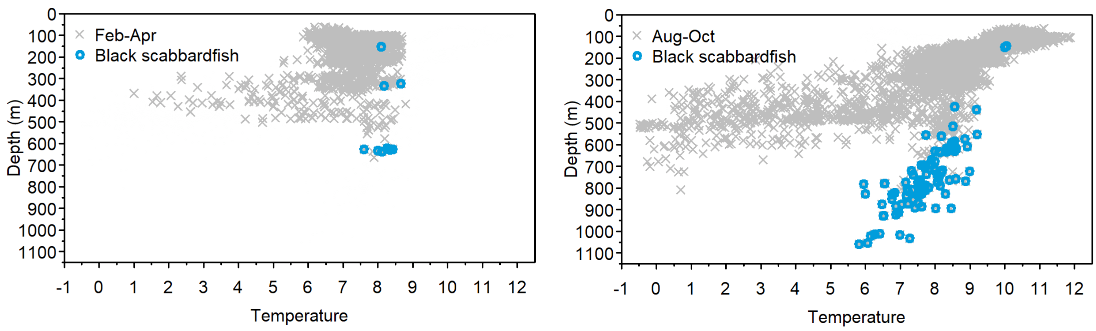


Figure 9.2.5 bsf.27.nea Northern component. Temperature and depth distribution of black scabbardfish (blue dots) and catch with no black scabbardfish (grey crosses) in February-April (left) and August-October (right). (Source: Ofstad 2019, WD).

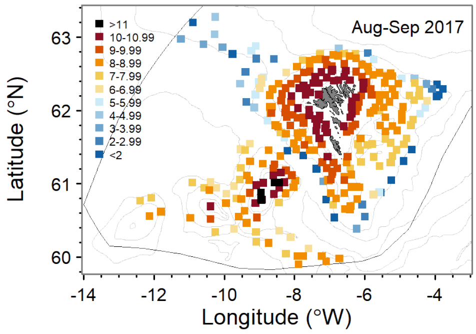


Figure 9.2.6. Temperature and depth distribution in Faroese waters August-September 2017. (Source: Ofstad, 2019, WD)

9.2.5.3 Length compositions

The annual length frequency distributions, based on French on-board observer data, for the period 2004-2022 are presented in Figure 9.2.7. The length frequency distribution is similar between years and reflects a predominance of immature individuals, i.e. specimens with less than 103 cm total length.

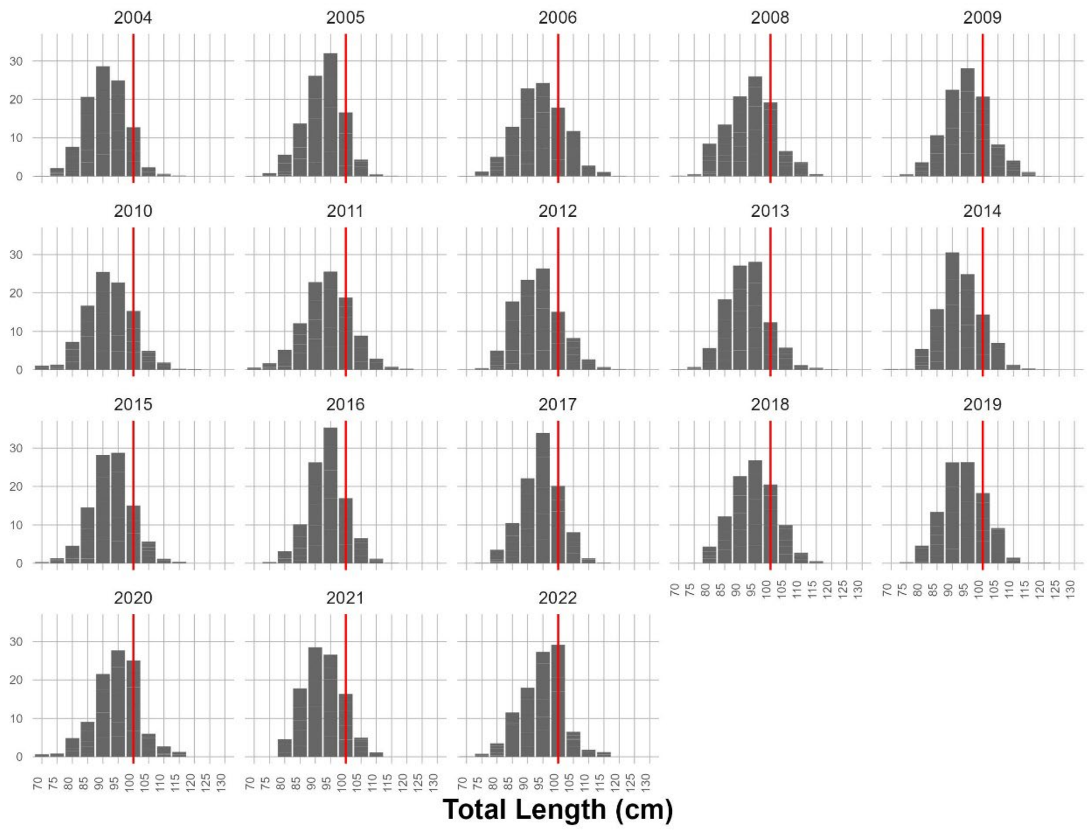


Figure 9.2.7. bsf.27.nea Northern component. Annual frequency length distribution of black scabbardfish based on French observer data collected on-board commercial vessels (2004–2022). The red vertical line indicates the length of 1st maturity of the species.

For the period 2004–2022, the temporal evolution of the mean length shows no trend (Figure 9.2.8), reflecting a stability on the length structure of the exploited population. In quarter 4, the lower mean length values were registered in 2010 and 2020, which may be associated with a high recruitment signal.

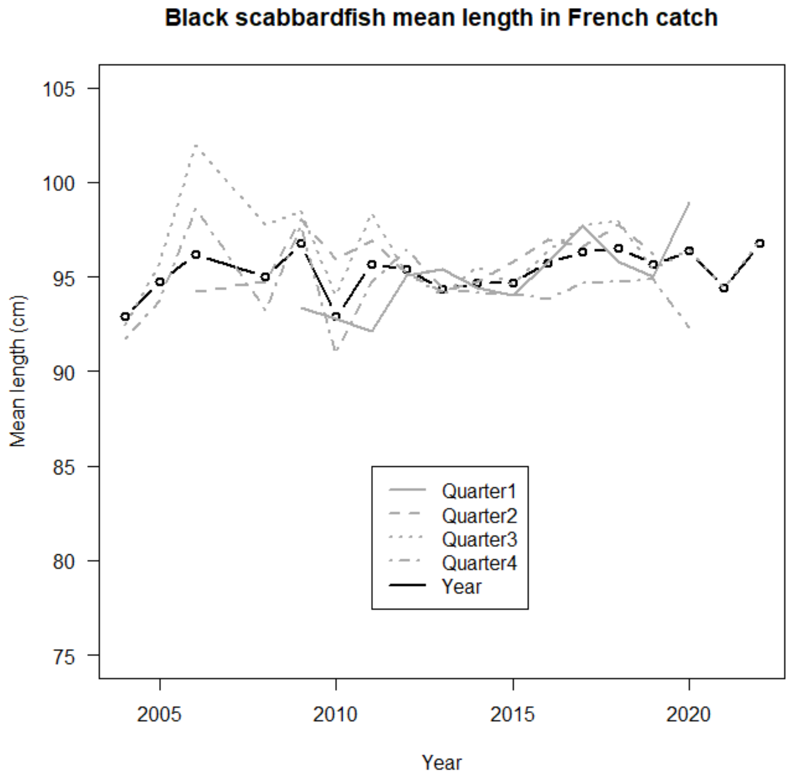


Figure 9.2.8. bsf.27.nea Northern component. Mean length estimates of black scabbardfish by quarter for the period 2004-2022. Data were collected under the French on-board observer program.

For the period 2014–2022, the annual length-frequency distributions based on samples collected at Faroese landings and Faroese deep-water surveys are presented in Figure 9.2.9. The mean length of the exploited population is around 90-92 cm, which is about the same mean length registered at the deep-water survey. In 2020, the Faroese survey length distribution includes specimens with length between 20 and 40 cm which were not registered before. Also, in 2020, the upper limit of the length range is lower than those from the previous years. The length frequency distribution for 2020 is not considered representative as it is based on 91 specimens and in the survey only 31 out of the 75 hauls planned were performed, due to the weather conditions and problems with the vessel.

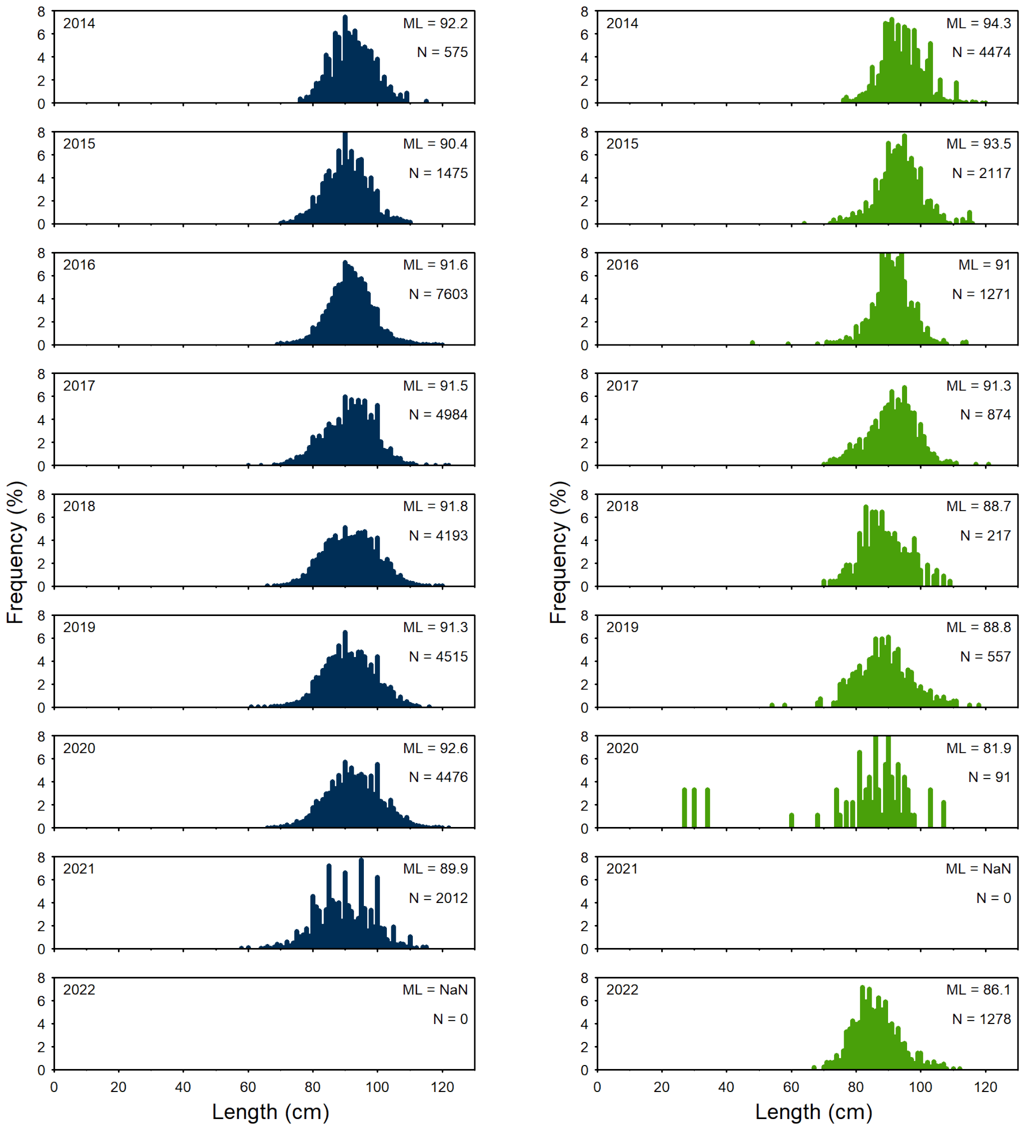


Figure 9.2.9. bsf.27.nea Northern component. Length-frequency distribution from the landings (no samples in 2022) (left) and the deep-water survey (no survey in 2021) (right) in 2014-2022. (Source: Ofstad, 2023 WD)

In 2023, no new length information was provided by Spain for ICES Division 27.6.b and ICES Subarea 27.12. For 2014 and 2015, the annual length frequency distributions for ICES Division 27.6.b and ICES Subarea 27.12 were constructed based on the length data collected under Spanish on-board observer program (Figure 9.2.10).

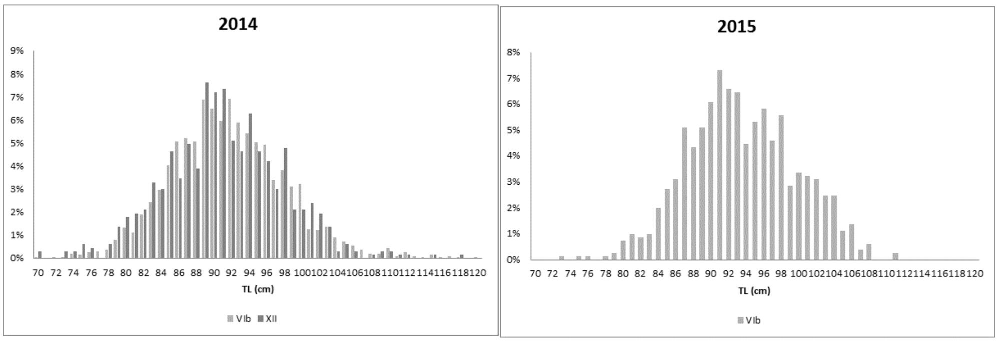


Figure 9.2.10. bsf.27.nea Northern component. Length frequency distribution based on Spanish on-board observations in 2014 (a) and in 2015 (b) in Division 6.b and Subarea 12.

Length frequency distributions for ICES Division 27.5.a based on the Icelandic Autumn surveys for the period 2000–2022 are presented in Figure 9.2.11.

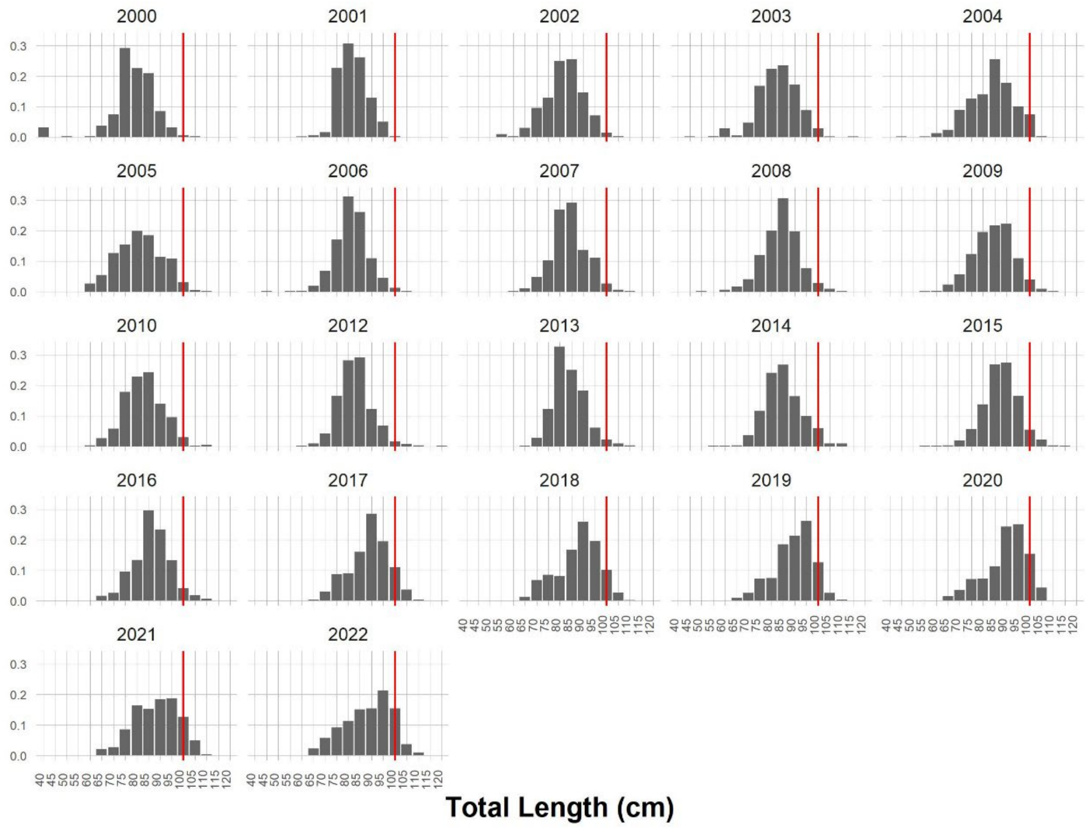


Figure 9.2.11. bsf.27.nea Northern component. Black scabbardfish in Division 27.5.a: length distribution from the Icelandic Autumn survey, from 2000 to 2022. The red vertical line indicates the length of 1st maturity of the species.

The length data available for the Northern component suggests a similar length structure of the exploited population between the different fishing fleets and specimens with total length smaller than 103 cm predominate.

The longest length data time series is from France and because of that French data is used to calculate the total catches, in number, grouped by the two length classes considered in the assessment model (the two length classes are: C2, which includes specimens from 70 to 103 cm TL (total length), and C3, which are specimens larger than 103 cm TL).

The total catch in weight (ton) and in number by length class, C2 and C3, for the period 1999-2021 used in the last advice in 2022 is presented in Table 9.2.2. A six-month time period is adopted as the time unit in the model and defined as: SEM1 = months 3-8 of the year; SEM2 = month 9–12 of the year plus months 1 and 2 of the following year.

Table 9.2.2. bsf.27.nea Northern component. Total catch estimates (in ton) and total catch estimates (in number) in length group C2 and C3 by SEM1 (3-8 of the year) and SEM 2 (month 9-12 of the year plus months 1 and 2 of the following year) for the years 1999–2021.

	Catch (in ton)		Catch (in number) C2		Catch (in number) C3	
Year	**Sem 1**	**Sem 2**	**Sem 1**	**Sem 2**	**Sem 1**	**Sem 2**
1999		1553		1264092		197321
2000	2044	3053	1555358	2485582	242786	387991
2001	2759	3758	2098661	3059087	327594	477514
2002	3720	4362	2830256	3550670	441794	554248
2003	2442	2775	1857504	2258718	289950	352578
2004	2143	2119	1740128	1928011	153435	95913
2005	1860	2040	1406337	1582422	182697	161474
2006	2801	1919	2152433	1512990	243934	172945
2007	1682	1930	1164611	1527070	209447	174555
2008	1874	2616	1160752	2069458	301462	236553
2009	2202	1740	1357278	1159152	352502	263009
2010	1843	1569	1327905	1166053	186787	167764
2011	1671	1653	965970	1135256	287668	167927
2012	1475	1283	985407	631463	189141	155895
2013	1879	1651	1382488	1056923	174340	138409
2014	2134	1726	1454066	1181859	233393	147308
2015	2059	1551	1580797	1268657	164558	83647
2016	2206	1514	1545847	1187905	226667	106955
2017	1565	1301	1066746	977950	179999	116263
2018	1560	994	982492	728921	231759	99391
2019	1101	658	795869	424424	124839	89909
2020	819	559	477750	483812	118433	20912
2021*	609		475707		44050	

* incomplete SEM 2 since January and February 2022 were not available

9.2.5.4 Age compositions

The exploited population is not structured by age because the assessment approach followed to assess the stock is a stage-based model, with stages defined according to length.

9.2.5.5 Weight-at-age

No data on weight-at-age are available.

9.2.5.6 Maturity and natural mortality

The information available for ICES Subareas 27.5.b, 27.6, 27.7, and 27.12 consistently points out to the predominance of small and immature specimens.

9.2.5.7 Catch, effort and research vessel data

The standardised French CPUE series covering the period 1998–2021 is presented in Figure 9.2.12. Estimates were made for one vessel in each ICES rectangle, for the mean fishing depth by rectangle, and determined by averaging over rectangles by area. CPUE was estimated by six-month time periods as: SEM1= months 3–8 of the year; SEM 2=month 9–12 of the year, plus months 1 and 2 of the next year. The use of an index by semester instead of a yearly index was driven by a clear seasonal pattern in CPUE with higher catch rates in autumn-winter.

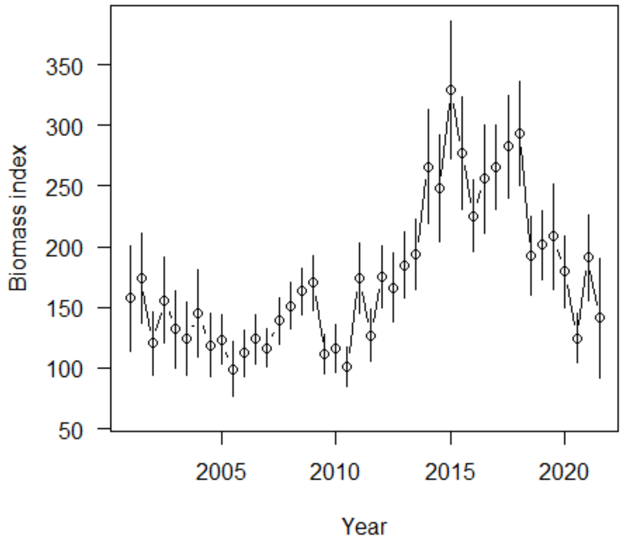


Figure 9.2.12. bsf.27.nea Northern component. CPUE by new semesters, i.e., SEM1= months 3-8 of the year and SEM2=month 9-12 of the year, plus months 1 and 2 of the next year.

For the period from 2006 to 2021, the monotonic trend in the standardised fishing effort time series for the Northern component was tested using the Kendall rank correlation test. The time series plot with LOWESS smooth indicates a downward trend (Figure 9.2.13) and the autocorrelation in this data is not significant (Fig 10.2.14). The Mann-Kendall trend test (tau = -0.784; 2-sided p-value =1.3118e-09) confirms the downward trend in fishing effort for the Northern component.

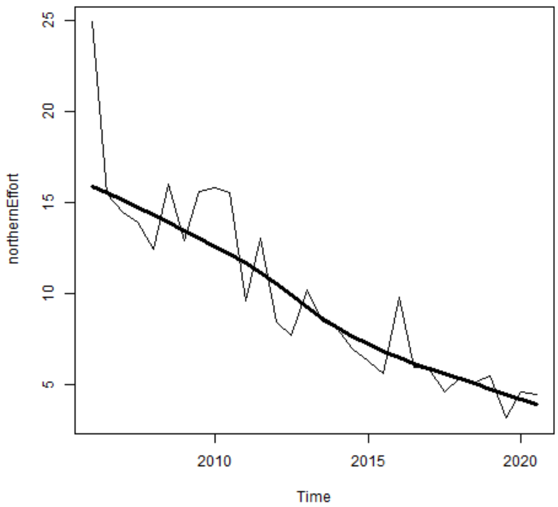


Figure 9.2.13. bsf.27.nea Northern component. Standardised effort by new semesters, i.e., SEM1= months 3-8 of the year and SEM2=month 9-12 of the year, plus months 1 and 2 of the next year.

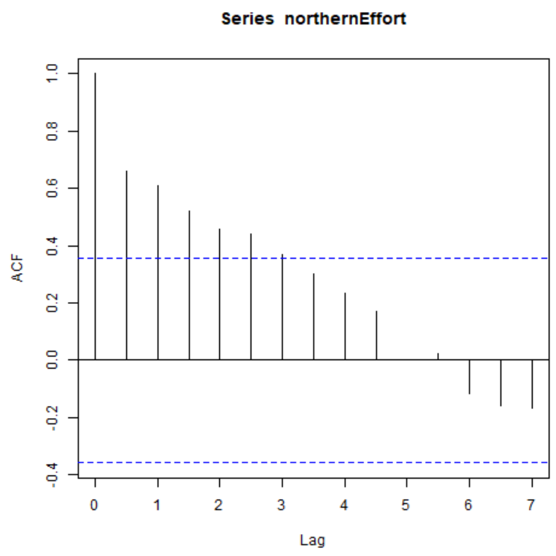


Figure 9.2.14. bsf.27.nea Northern component. Standardised fishing effort time series autocorrelation.

Scottish research survey data have been provided to WGDEEP. The survey takes place every two years. The annual biomass and abundance index estimates (kg per hour and mean numbers per hour of trawling for each haul with 95 % confidence intervals) obtained for hauls deeper than 500 and shallower than 1600 m are presented in Figure 9.2.15 (Campbell, 2022, pers. comm.). After 2012, both the annual biomass and annual abundance indices are at higher levels, with an increasing trend between 2015 and 2021, indicating that the population at the Northern component has been increasing.

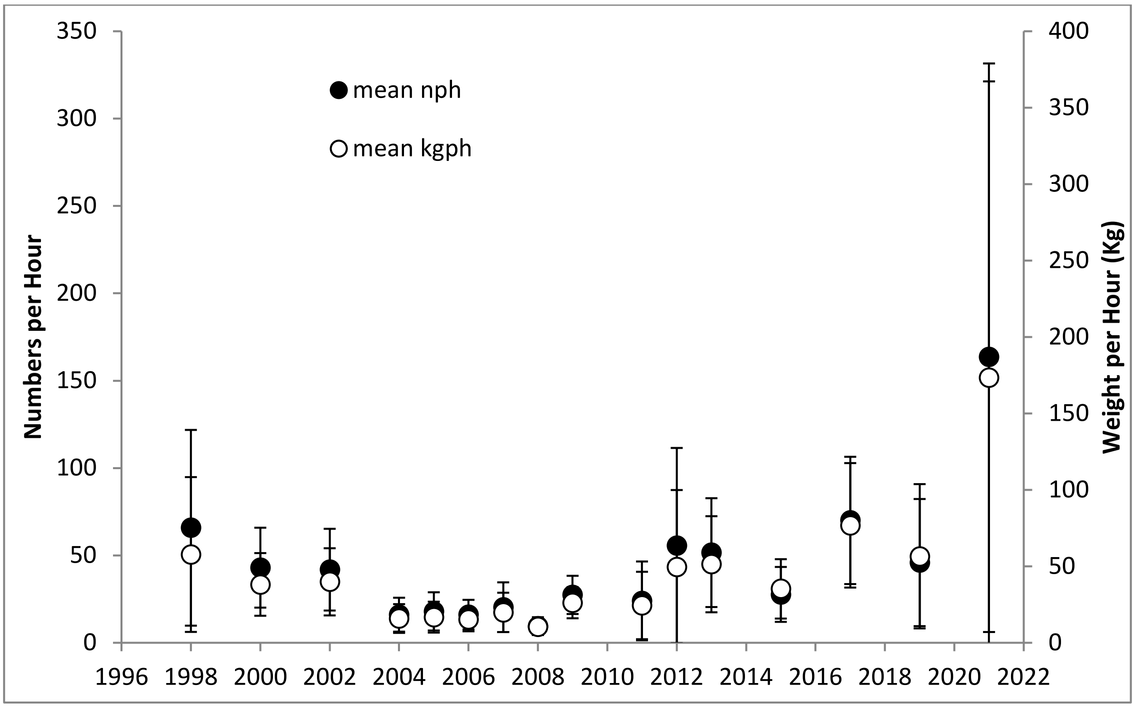


Figure 9.2.15. bsf.27.nea Northern component. Annual biomass and abundance indices of black scabbardfish estimated for depths deeper than 500 m and shallower than 1600 m, from 1998 to 2021. Seamounts/Rockall not included. (Source: Campbell, N., 2022, pers. comm.)

In ICES Division 27.5.a, the Icelandic Autumn survey biomass index series for all sizes (Total biomass) and specimens larger than 90 cm are at the higher level of the whole series are presented for the period between 2000 and 2019 (Figure 9.2.16). Black scabbardfish abundance index from Icelandic Autumn survey shows an overall decreasing trend since 2013 however it is at higher levels than those registered at the beginning of the series (Figure 9.2.17).

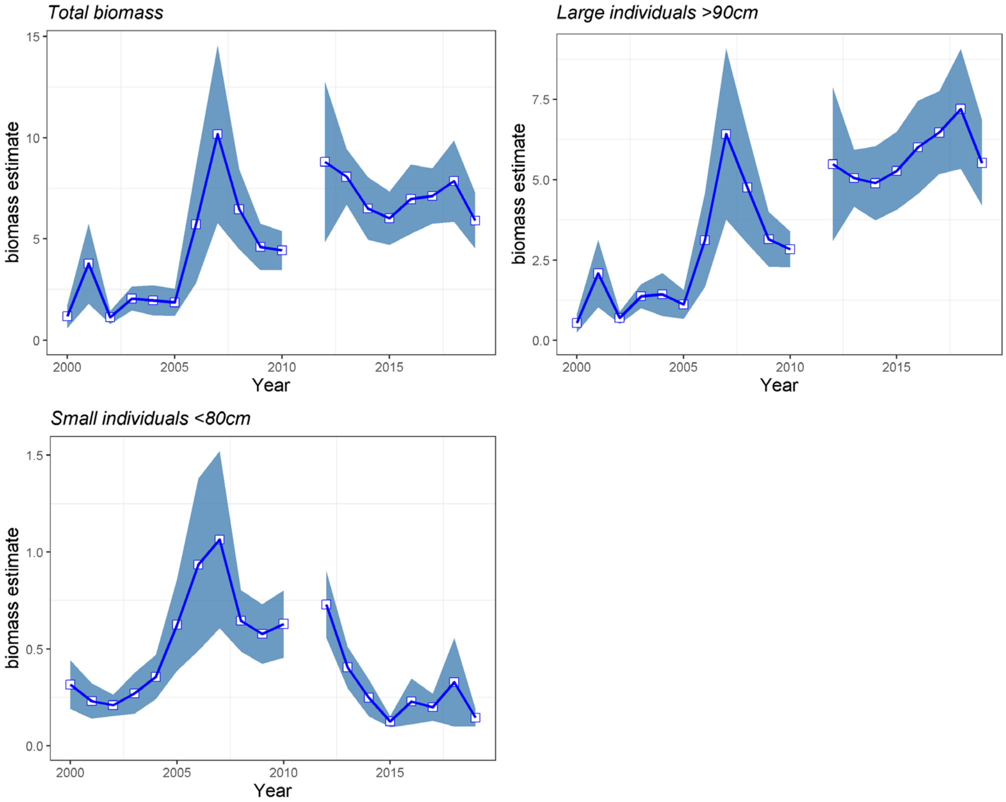


Figure 9.2.16. bsf.27.nea Northern component. Black scabbardfish biomass index with 95% confidence interval from the Icelandic Autumn survey from 2000 to 2019 for all sizes (Total biomass, upper left); specimens larger than 90 cm (Large individuals >90 cm, upper right); specimens smaller than 80 cm (Small individuals <80 cm, lower left).

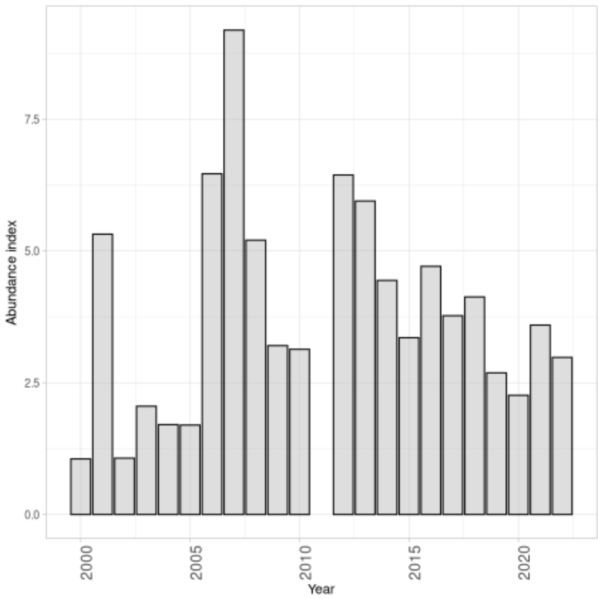


Figure 9.2.17. bsf.27.nea Northern component. Abundance of black scabbardfish from Icelandic Autumn survey from 2000 to 2020.

Regarding the Scottish survey data, the recent abundance and biomass indices are at similar levels when comparing with the beginning of the time-series (1998) and higher than in the mid-

2000's, whereas for the Icelandic survey the abundance and biomass indices are at higher levels than at the beginning of the time-series (2000).

The trends in the abundance or biomass in recent years for the French fleet are different from both the Scottish and the Icelandic surveys. The lower French CPUE values in recent years reflect the spatial displacement of fishing effort to lower depths as a consequence of the bottom trawl ban for waters deeper than 800 m. In fact, based on Scottish surveys, black scabbardfish in Northern areas appear to be more frequent at depths between 800 and 1000 m.

Faroese commercial CPUE, between 2000 and 2020, calculated using fishery data from large Faroese trawlers and restricted to fishing hauls where black scabbardfish represents more than 30% of the total catch and for fishing haul with a duration larger than 2 hours is presented in Figure 9.2.18. The mean CPUE for the whole period was 250 kg/h and from 2013 to 2015 the CPUE was twice the overall mean value, about 508 kg/hour. Since 2016, the CPUE has been slightly decreasing probably related with an increased targeting of the fishery for blue ling. In 2022, the CPUE-data are not presented because the only commercial trawler that had a fishery licence for black scabbardfish was sold, having only 8 black scabbardfish hauls in that year (Ofstad, 2023, WD).

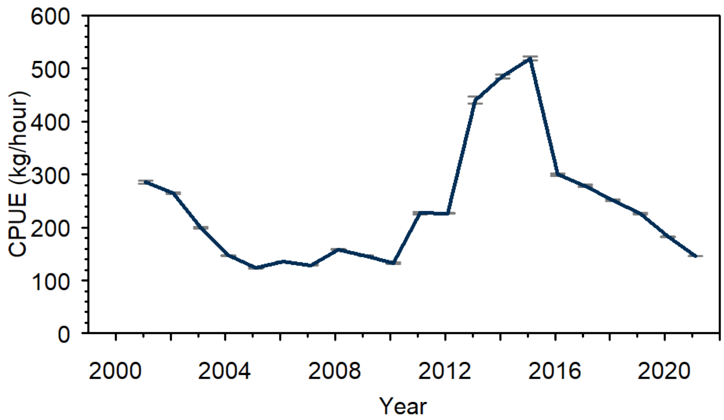


Figure 9.2.18. bsf.27.nea Northern component. Standardised CPUE (kg/hour) from Faroese commercial trawlers (> 1000 HK). Criteria: black scabbardfish >30% of total catch and effort > 2 hours per haul. (Source: Ofstad, L., 2022, pers. comm.).

9.2.6 Data analyses

For the major fishing countries exploiting the northern and southern stock components in the ICES area, the landing data are considered reliable and discards are minor. For stock assessment purposes the catches in weight are converted into numbers and aggregated by six-month time periods defined as: SEM1= months 3-8 of the year; SEM 2=month 9-12 of the year plus months 1 and 2 of the next year. Worth to remark that the adopted assessment model includes a parameter that accommodates for the uncertainty on the input catch data.

In the model, the standardised French CPUE series is adopted for the Northern component and the standardised Portuguese CPUE series is used for the Southern component.

The CPUE series and the catch weights from each component are used to derive the standardised fishing effort. Standardised fishing effort for the Northern and Southern components are calculated for each time periods, i.e., SEM1 and SEM2. These estimates are obtained by dividing the catch weight data by the corresponding standardised CPUE. Within the assessment model a full recruitment model with log-normal error linking the fishing effort estimate by SEM with the catchability coefficient is used to define the prior distribution of the parameter - survivorship to fishing.

Furthermore, the distribution of the parameter related to emigration to the Northern component (recruitment) is unknown since survey data available is insufficient to derive a prior distribution for this parameter. The Scottish survey is held every two years and at a time period out of the migration season. So, the information available does not allow inferring the index of C2 elements entering in the Northern area in SEM2 each year. Due to the lack of a reliable recruitment index, a non-informative prior distribution is adopted in the model.

As 2023 is not an assessment year for this stock, the model subsequent analyses were not performed.

MSY proxy reference points

Length-based indicators (LBIs) proposed by ICES for stocks in categories 3 and 6 were applied to the exploited population in the whole ICES area, that corresponds to the combined overall length frequency distribution of black scabbardfish from French length sampling in the Northern component (divisions 27.5.b, 27.6.a, and 27.6.b.1) and Portuguese length sampling in the Southern component (Division 27.9.a) for the period between 2014 and 2022. The length frequency distributions of 1 cm interval class were used. The life history parameters used for calculating the reference points, were L_{mat} = 103 cm (Figueiredo et al, 2003) and L_{inf} = 159 cm (Vieira *et al.*, 2009).

The following traffic light table presents the final results from the combined length distribution of black scabbardfish in the Northern and Southern components for the period from 2014 to 2022 (Table 9.2.3).

Table 9.2.3. bsf.27.nea Northern and Southern components. LBI screening method ratios between 2014 and 2022.

		Conservation						Optimizing Yield	MSY
		L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{95\%}/L_{inf}$	L_{maxy}/L_{opt}	$L_{max5\%}/L_{inf}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
Year	Ref.	> 1	> 1	> 0.8	≈ 1	> 0.8	>30 %	≈ 1 (>0.9)	≥ 1
2014		0.63	0.90	0.73	1.00	0.75	4%	0.94	1.13
2015		0.66	0.92	0.73	0.93	0.75	4%	0.95	1.11
2016		0.76	0.93	0.73	0.97	0.75	3%	0.95	1.02
2017		0.62	0.93	0.71	0.97	0.74	2%	0.95	1.16
2018		0.61	0.92	0.72	1.02	0.74	3%	0.95	1.16
2019		0.74	0.95	0.73	1.01	0.75	4%	0.97	1.06
2020		0.65	1.00	0.74	1.03	0.76	6%	1.00	1.19
2021		0.74	1.02	0.75	1.05	0.76	8%	1.03	1.12
2022		0.66	1.00	0.75	1.04	0.77	9%	1.01	1.19

The length at first catch was smaller than the length at first maturity in all years. Most indicators of conservation state of the stock are below the desirable levels because they are based on length frequency analysis, which is shunt to lower lengths in the Northern component. These indicators are considered less informative given the available knowledge on species length-structure which are closely related to the tail of the frequency distribution. For this species, it should be possible to provide stock status by expert judgement, using indicators based on scientific knowledge on the species and the fishery.

The MSY indicator ($L_{mean}/L_{F=M}$) was above 1 in all years, and the optimizing yield indicator (L_{mean}/L_{opt}) is close to 1 in all analysed years.

LBI results show that the stock is at an adequate status as the exploitation levels are above the length-based indicator of MSY.

9.2.7 Management considerations

Available information does not unequivocally support the assumption of a single stock for the whole NE Atlantic area, however most available evidences support it. In face of these evidences, catches from ICES Division 27.5.a were included in the Northern component in the assessment of the stock.

The analysis of the annual relative fishing effort by depth strata (Figure 9.2.19, in relation to total fishing effort) indicates changes on the fishing depth by the French trawlers. This change might have an impact on catchability and a deeper scrutiny on depth of the French fishing grounds by year is required to incorporate those changes in the assessment model. In recent years the fishing effort on black scabbardfish indicates that the fishing operations are mainly performed at depth strata shallower than 800m, possible as a response to the EU Regulation trawl ban (EU, 2016).

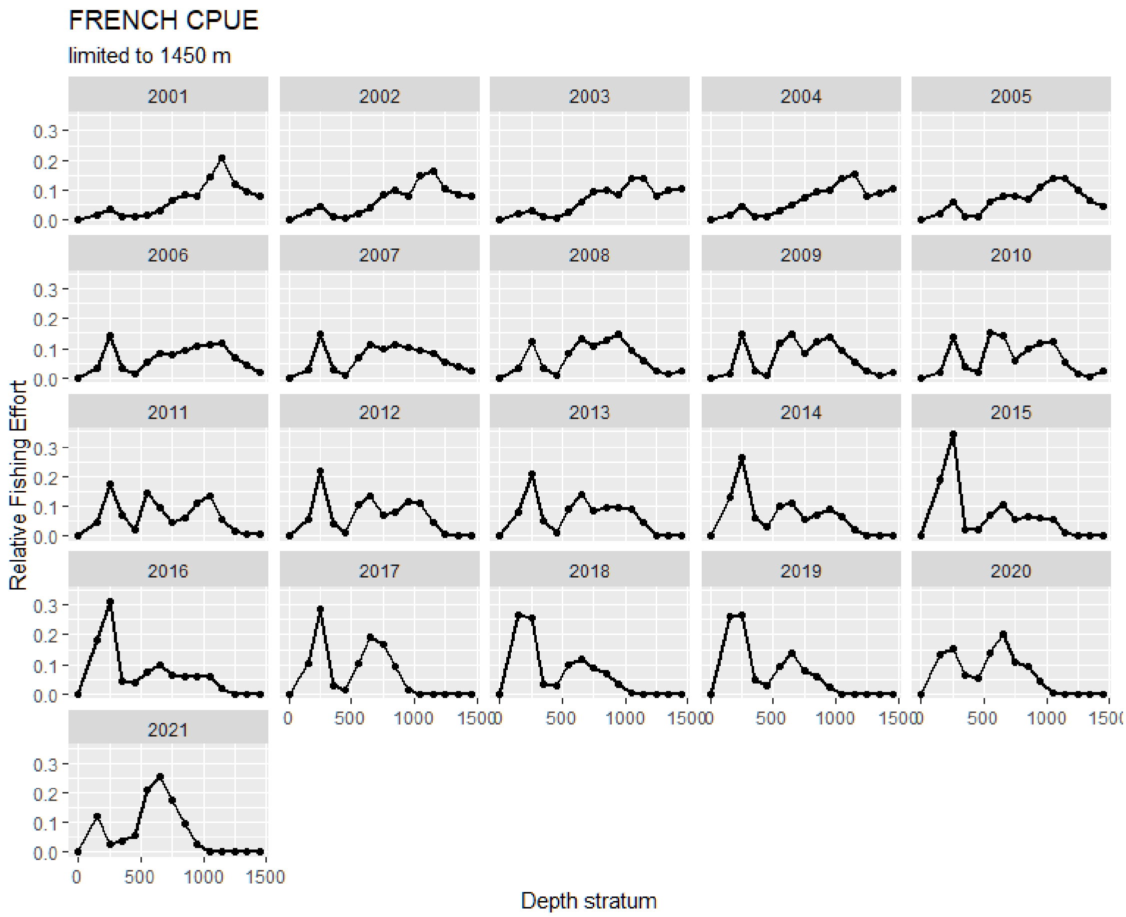


Figure 9.2.19. bsf.27.nea Northern component. French fleet annual relative fishing effort by depth strata, in relation to total fishing effort).

9.2.8 Tables

Table 9.2.4a. Landings of black scabbardfish from Division 27.5.b. Working Group estimates. E&W&NI is England, Wales and Northern Ireland.

Year	Faroes			France	Germany*		Scotland	E&W&NI	Russia**	Total
	27.5.b.1	27.5.b.2	27.5.b	27.5.b	27.5.b.1	27.5.b	27.5.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**

Year	Faroes			France	Germany*		Scotland	E&W&NI	Russia**	Total
	27.5.b.1	27.5.b.2	27.5.b	27.5.b	27.5.b.1	27.5.b	27.5.b			
2014	400	181	143	0	0	0	0	0	1	**725**
2015	549	181	0	211			1			**941**
2016			712	52						**765**
2017	285	14		112			0			**412**
2018	324	229		41			-			**594**
2019	395	93		52						**540**
2020	317	102		21			0			**440**
2021	41	101		17			-	-		**159**
2022	3	13		6			-	-		**22**

***STATLAND data from 1988 to 2011.**

****STATLAND data.**

Table 9.2.4b. Landings of black scabbardfish from Division 27.12. Working Group estimates. E&W&NI is England, Wales and Northern Ireland.

Year	Faroes	France	Scotland	Spain	Germany*	E&W&NI	Ireland	Total
1988					.			**0**
1989		0			.			**0**
1990		0			.			**0**
1991		2			-			**2**
1992		7			-			**7**
1993	1051	24			93			**1168**
1994	779	9			45			**833**
1995	301	8						**309**
1996	187	7		41				**235**
1997	102	1		98				**201**
1998	20	324		134				**478**
1999		1	0	109				**109**
2000	1	5		237				**243**
2001		3		115				**118**
2002		0	1	1117		0		**1119**

Year	Faroes	France	Scotland	Spain	Germany*	E&W&NI	Ireland	Total
2003		7		444			1	**452**
2004	95	10	1	230				**337**
2005	127	14		239			0	**380**
2006	8	0		1009				**1017**
2007	0		0	9			0	**9**
2008	1		0	53			0	**54**
2009	156			103		0	0	**259**
2010	27	1		180		0	0	**208**
2011	24	1		113				**138**
2012				47				**47**
2013	1			50				**51**
2014				149				**149**
2015				51				**51**
2016				82				**82**
2017	0			68				**68**
2018				125				**125**
2019	0			46				**46**
2020				25				**25**
2021				0				**0**
2022								**0**

***STATLAND data from 1988 to 2011.**

Table 9.2.4b. Continued.

Year	Iceland*	Poland*	Russia**	Lithuania*	Estonia	Unallocated	Total
1988		-	.	.	.		**0**
1989		-	.	.	.		**0**
1990		-	.	.	.		**0**
1991		-	.	.	-		**0**
1992		-	.	-	-		**0**
1993		-	.	-	-		**0**

Year	Iceland*	Poland*	Russia**	Lithuania*	Estonia	Unallocated	Total
1994		-	.	-	-		**0**
1995		-	.	-			**0**
1996	0	-	.				**0**
1997							**0**
1998							**0**
1999							**0**
2000							**0**
2001							**0**
2002							**0**
2003		1		1			**2**
2004				1			**1**
2005					1		**1**
2006					2		**2**
2007					7		**7**
2008			4				**4**
2009							**0**
2010							**0**
2011							**0**
2012						907	**907**
2013						289	**289**
2014							**0**
2015							**0**
2016							**0**
2017							**0**
2018							**0**
2019							**0**
2020							**0**
2021							**0**
2022							**0**

***STATLAND data from 1988 to 2011.**

****STATLAND data.**

Table 9.2.4c. Landings of black scabbardfish from Subarea 27.6. Working group estimates.

Year	France			Faroes	Germany		Ireland		Scotland		Spain		Total
	27.6	27.6.a	27.6.b	27.6.a	27.6.a	27.6.b	27	27.6.a	27.6.a	27.6.b	27.6.a	27.6.b	
1988					.	.							**0**
1989		138	0	46	.	.			-	-			**184**
1990		971	53		.	.			-	-			**1023**
1991		2244	62		-	-			-	-			**2307**
1992		2998	113	3	-	-			-	-			**3113**
1993		2857	87		48	-	62		-	-			**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			**1809**
2000		2971	27						333	41			**3371**
2001		3791	29				3		486	145			**4454**
2002		3833	156	2					603	300			**4894**
2003		2934	67	45					78	9			**3132**
2004		2637	99	59					100	24			**2919**
2005	3	2533	59	38					18	62			**2714**
2006	-	1713	36	59				1	63	0			**1872**
2007	-	1991	4	44			37	0	53	0			**2129**
2008	-	2348	0	37			0	0	26	0			**2412**
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			**1546**
2013		1799	9	6					57				**1871**
2014	0	1902	0	4	0		2		110				**2018**

Year	France			Faroes	Germany			Ireland	Scotland		Spain		Total
	27.6	27.6.a	27.6.b	27.6.a	27.6.a	27.6.b	27	27.6.a	27.6.a	27.6.b	27.6.a	27.6.b	
2015		1870		1					124		10	172	**2280**
2016		2336							96		9	163	**2669**
2017		1714		64					101		3	153	**1970**
2018		1601		-			-		65	0	0	124	**1791**
2019		1124							45		1	52	**1222**
2020		769							20			57	**846**
2021		651		1					34	0			**686**
2022		349							5			0	**354**

Table 9.2.4c. Continued.

Year	E&W&NI**	Netherlands **			Lithuania**	Estonia**	Poland**	Russia**	Unallocated	Total
	27.6.a	27.6.a	27.6.b	27.6	27.6.a	27.6.b	27.6.b	27.6.b		
1988		-	-		.	.		.		**0**
1989		-	-		.	.	-	.		**0**
1990		-	-		.	.	-	.		**0**
1991		-	-		.	-	-	-		**0**
1992		-	-		-	-	-	-		**0**
1993		-	-		-	-	-	-		**48**
1994		-	-		-	-	-	-		**30**
1995		-	-		-	-	-	-		**0**
1996		-	-		-	-	-	-		**0**
1997		-	-		-	-	-	-		**0**
1998		-	-		-	-	-	-		**0**
1999		11	-		-	-	-	-		**11**
2000		7	-		-	-	-	-		**7**
2001		-	-		3	225	-	226		**454**
2002		21	2		9		2			**34**
2003			2		12	7	2	7		**30**
2004					85	5		5		**95**
2005					5	11		11		**27**

Year	E&W&NI**	Netherlands **			Lithuania**	Estonia**	Poland**	Russia**	Unallocated	Total
	27.6.a	27.6.a	27.6.b	27.6	27.6.a	27.6.b	27.6.b	27.6.b		
2006					1	3		3		**7**
2007										**0**
2008		14						1		**15**
2009										**0**
2010										**0**
2011										**0**
2012									690	**690**
2013									189	**189**
2014		3	0		0	0	0	0	0	**3**
2015				5						**5**
2016				1						**1**
2017				0						**0**
2018										**0**
2019										**0**
2020										**0**
2021	34									**34**
2022										**0**

***STATLAND data from 1988 to 2011.**

****STATLAND data.**

Table 9.2.4d. Landings of black scabbardfish from Division 27.7. Working group estimates. E&W&NI is England, Wales and Northern Ireland.

Year	France								Ireland			Scotland	E&W&NI		Spain	Total
	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.d	7	
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**

Year	France								Ireland			Scotland	E&W&NI		Spain	Total
	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.d	7	
1995		0	52	121	9		74	385				-				**641**
1996		0	104	130	2		60	360				-				**658**
1997		0	24	200	1		33	202				-			1	**462**
1998		0	15	104	6		52	211				-			2	**390**
1999	-	-	7	97	0	2	70	177				-			0	**355**
2000	-	-	25	173	1	4	100	253				3			0	**559**
2001	-	-	40	237	0	3	180	267				41			0	**768**
2002	-	0	33	105	2	7	138	49				53				**386**
2003	-	-	15	29	1	3	159	36				1				**245**
2004	-	-	31	28	8	9	115	63				0				**253**
2005	0	5	6	11	1	17	105	23				-				**169**
2006	-	-	3	10	1	24	315	20	1	32	37	0	2			**445**
2007	-	-	2	7	0	4	168	7	0	52	17	-	-			**257**
2008	-	-	2	19	0	6	148	4	-	-	-	0	-			**179**
2009	-	-	-	29	1	2	53	4	-	-	-	-	-			**90**
2010	-	-	2	40	0	2	36	-	-	-	-	-	-			**81**
2011	-	-	0	81	0	2	129	-	-	-	-	-	-			**212**
2012	-	-	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	52	3	30	0	-	-	-				1	**92**
2017			1	0	4	1	9	0	-	-	-	0			0	**15**
2018			0	0	0	6	29	0		0					0	**35**
2019			0	0	0	6	15	0		0					10	**30**
2020			1	0	0	16	15	0		0					6	**38**
2021			0	0		3	18	0						0	7	**28**
2022			0	0	1	0	10	0		0					2	**14**

Table 9.2.4e. Landings of black scabbardfish from Divisions 27.6 and 27.7. Working Group estimates. E&W&NI is England, Wales and Northern Ireland.

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**

Year	Ireland	E&W&NI	Total
2016	-	-	**0**
2017	-	-	**0**
2018		0	**0**
2019			**0**
2020	0	0	**0**
2021			**0**
2022			**0**

Table 9.2.4f. Landings of black scabbardfish from Subarea 27.5.a. Working group estimates of landings.

Year	Iceland	Faroes	Total
1988	-		**0**
1989	-		**0**
1990	-		**0**
1991	-		**0**
1992	-		**0**
1993	0		**0**
1994	0		**0**
1995	0		**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**

Year	Iceland	Faroes	Total
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**
2017	294		**294**
2018	142		**142**
2019	65		**65**
2020	102		**102**
2021	31		**31**
2022	63		**63**

9.3 Black scabbardfish (*Aphanopus carbo*) in subareas 27.8 and 27.9

9.3.1 The fishery

The main fishery taking place in these subareas is derived from Portuguese longliners. This fishery was described in 2007 WGDEEP report (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 27.8. In 2014 and 2015, Spain has also reported catches of black scabbardfish in Subareas 27.8 and 27.9 but these are also relatively low.

9.3.2 Landings trends

Landings in subareas 27.8 and 27.9 are mostly from the Portuguese longline fishery that takes place in Division 27.9.a, which represents more than 96% of the total landings (Figure 9.3.1).

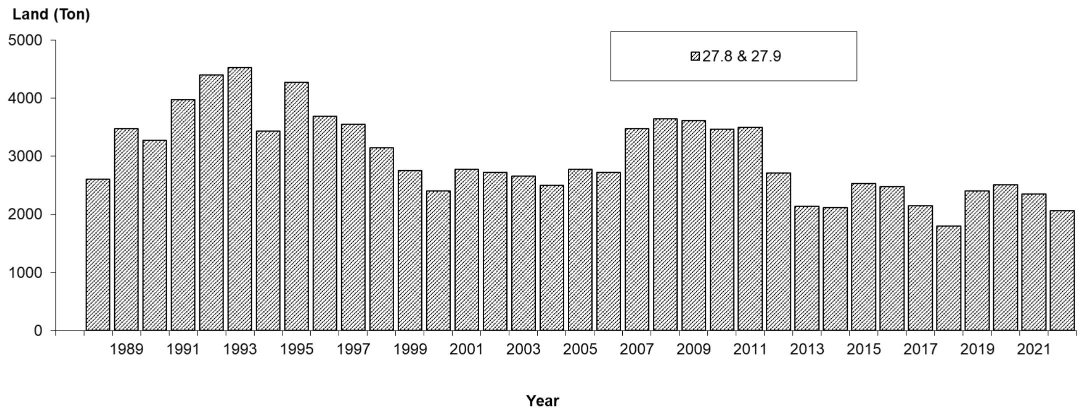


Figure 9.3.1. bsf.27.nea Southern component. Annual landings for ICES Subarea 27.8 and Division 27.9.a.

9.3.3 ICES Advice

The latest ICES advice, in 2022, was: "*ICES advises that when the precautionary approach is applied, catches should be no more than 4214 tonnes in each of the years 2023 and 2024.*"

9.3.4 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 until 2020, as well as the total landings in subareas 27.8, 27.9, and 27.10 are presented in Table 9.3.1.

Table 9.3.1. Black scabbardfish TACs and total landings of EU vessels in subareas 27.8, 27.9, and 27.10 from 2006 to 2020.

Year	EU TAC 27.8,27.9,27.10	EU Landings in 27.8 and 27.9	EU Landings in 27.10*
2006	3042	2726	65

2007	4000	3481	0
2008	4000	3647	75
2009	3600	3620	162
2010	3348	3470	102
2011	3348	3494	164
2012	3348	2711	462
2013	3700	2140	206
2014	3700	2118	30
2015	3700	2532	240
2016	3700	2476	86
2017	3330	2151	70
2018	2997	1801	14
2019	2832	2409	20
2020	2832	2507	0
2021	2266	2348	0
2022	2266	2063	0
2023	2130		

*** The proportion of *A. intermedius* in the catches is considered high but is not quantified.**

9.3.5 Data available

9.3.5.1 Landings and discards

New information on the discards of deep-water species produced by the Portuguese on-board sampling programme (EU DCR/NP) was presented (Fernandes, 2021, WD).

Discards of most species carried out by Portuguese vessels operating deep-water set longlines (targeting black scabbardfish) within the Portuguese part of ICES Division 27.9.a were not quantified at fleet level. The black scabbardfish discards are mainly due to shark and cetacean predation on hooked specimens and are relatively low when compared to catches.

The low frequency of occurrence of discarding and the low number of discarded specimens registered in the sampled hauls and sets lead to assume that discards in the Southern component are negligible.

9.3.5.2 Length compositions

Length–frequency distributions of the black scabbardfish landed at the main landing port for the species in ICES Division 27.9.a (Sesimbra port) by the Portuguese longline fleet derived from the DCF/EU landing sampling program from 2014 to 2022 are presented in Figure 9.3.2.

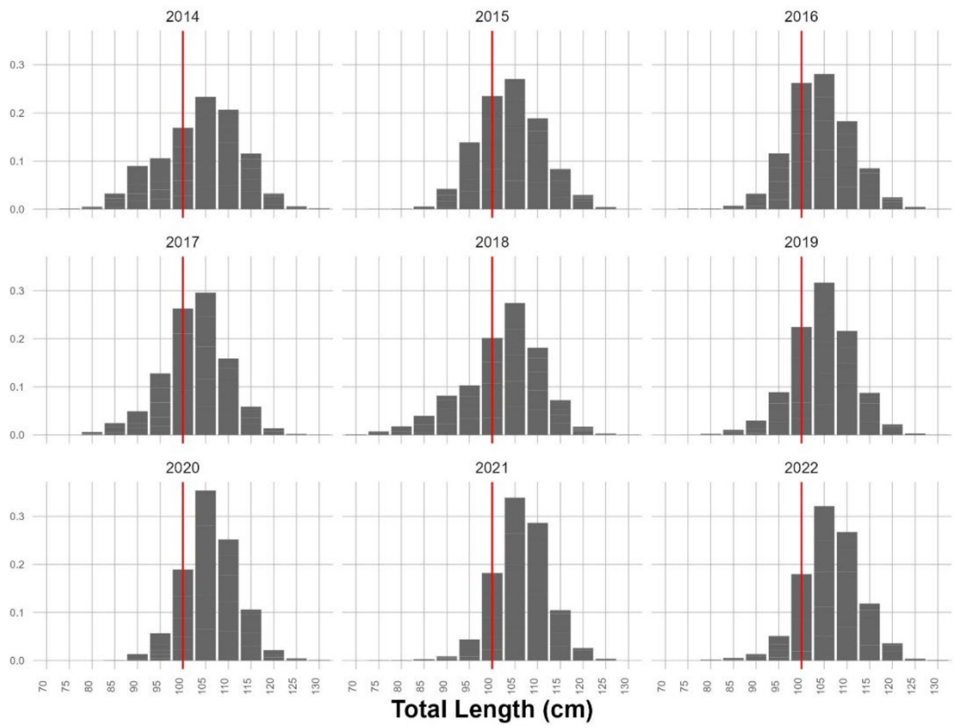


Figure 9.3.2. bsf.27.nea Southern component. Length–frequency distribution of black scabbardfish exploited by the deep-water longline fishery for ICES Division 27.9.a, from 2014 to 2022.

In the last assessment, in 2022, length–frequency distributions of the black scabbardfish from 2001 to 2021 were used, to separate the Southern component into the two length groups (TL (total length): 70 cm < C2 < 103 cm; C3: TL > 103 cm) defined by the assessment approach adopted by WKDEEP 2014 (Table 9.3.2).

Table 9.3.2. bsf.27.nea Southern component. Total catch estimates (in ton), and total catch estimates (in number) in length groups C2 and C3 by six-month time period (Sem 1 and Sem 2) for the years 2001 to 2021.

	Catch (in ton)		Catch (in number) C2		Catch (in number) C3	
Year	Sem 1	Sem 2	Sem 1	Sem 2	Sem 1	Sem 2
2001	1025	1162	166255	224512	454294	494926
2002	994	1205	242627	281845	394790	486076
2003	1001	1038	246200	326925	391912	369658
2004	939	1087	319954	289114	326133	421767
2005	1001	1068	173811	191031	441320	470265
2006	970	1229	154077	200083	447828	561937
2007	1162	1713	258842	348131	512897	808791
2008	1392	1335	252886	248574	617378	582175
2009	1390	1346	225098	183532	633817	627814
2010	1464	1287	126636	353994	720474	501186
2011	1257	1808	299508	395972	520973	768757
2012	1188	1245	273648	374823	470397	454947
2013	1011	1079	266160	307426	393448	402958
2014	1213	778	184781	170974	566298	434516
2015	1193	1409	269687	215836	498477	660411
2016	1265	1220	277735	277217	560100	522064
2017	1070	1072	260820	291457	461063	420469
2018	1117	1101	167281	185525	354059	513357
2019	1167	1283	226458	172273	634939	672000
2020	1284	1135	225138	164736	642378	678455
2021 *	1216		112985		429113	

* incomplete SEM 2 since January and February 2022 were not available

9.3.5.3 Age compositions

The black scabbardfish population is not structured by ages because the approach followed to assess the stock is a stage-based model. The age growth parameters are used to construct the prior distribution for the probability a specimen transits from C2 to C3 length group during one semester taking into account the length structure of the population inhabiting the Southern area (for further details see the Stock Annex).

9.3.5.4 Weight-at-age

No new information on age was presented.

9.3.5.5 Maturity and natural mortality

In ICES Division 27.9.a, only immature and early developing specimens have been observed (Figueiredo, 2009, WGDEEP WD; Neves *et al.*, 2009). Mature individuals have only been reported in Madeira (Figueiredo *et al.*, 2003), Canary Islands (Pajuelo *et al.*, 2008), and the Northwestern coast of Africa (Perera, 2008). In those areas, spawners of two congener species (*Aphanopus carbo* and *A. intermedius*) coexist (Stefanni and Knutsen, 2007; Biscoito *et al.*, 2011; Besugo *et al.*, 2014, WD).

Black scabbardfish has a determinate fecundity strategy; the relative fecundity estimates ranged from 73 to 373 oocytes/female weight (g). Skipped spawning was also considered to occur; the percentages of non-reproductive females between 21% and 37% (Neves *et al.*, 2009).

9.3.5.6 Catch, effort and research vessel data

Standardised Portuguese CPUE series covering the period 1998-2021 are presented by a six-month time period, as: SEM1=months 3-8 of the year; SEM2=month 9-12 of the year plus months 1 and 2 of the following year (Figure 9.3.3). Estimates of CPUE were 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.

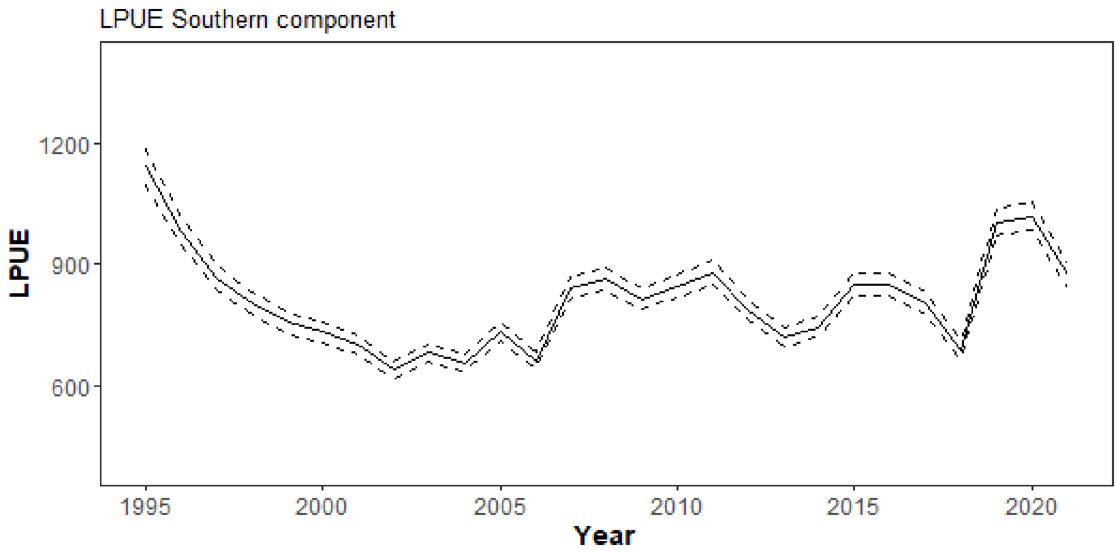


Figure 9.3.3. bsf.27.nea Southern component. Standardised Portuguese CPUE.

For the period 2006 to 2021, the monotonic trend in the standardised fishing effort time series for the Southern component was tested using the Kendall rank correlation. The time series plot with LOWESS smooth indicates a downward trend (Figure 9.3.4) and the autocorrelation in this data is not significant (Figure 9.3.5). The Mann-Kendall trend test (tau = -0.391; 2-sided p-value = 0.0054823) confirms the downward trend in fishing effort for the Southern component.

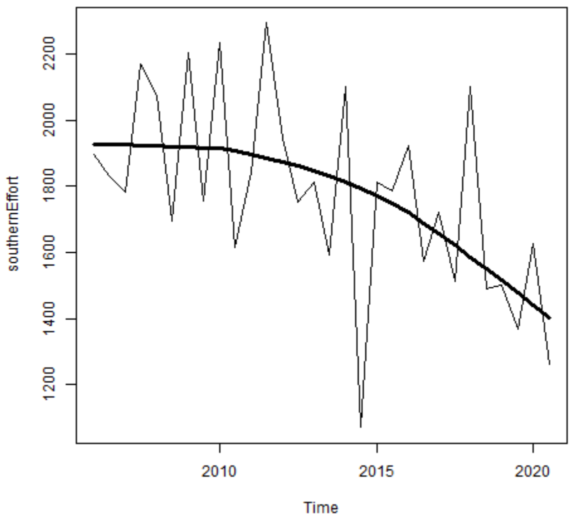


Figure 9.3.4. bsf.27.nea Southern component. Standardised effort by new semesters, i.e., SEM1= months 3-8 of the year and SEM2=month 9-12 of the year, plus months 1 and 2 of the next year.

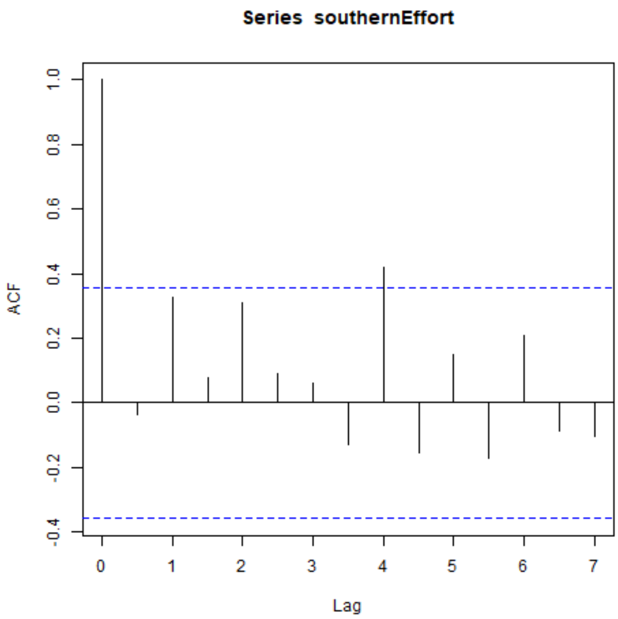


Figure 9.3.5. bsf.27.nea Southern component. Standardised fishing effort time series autocorrelation.

9.3.6 Data analyses

Data analyses are described in section 9.2.5. One single assessment is admitted for the stock, which combines data from the two fisheries areas: subareas 27.5, 27.6 and 27.7 and Division 27.12.b; and divisions 27.8 and 27.9 on the other hand.

9.3.7 Management considerations

Management considerations are described in section 9.2.6.

9.3.8 Tables

Table 9.3.3a. Black scabbardfish from Subarea 27.9. 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**

Year	Portugal	France	Spain	Total
2015	2527		0	**2527**
2016	2456		0	**2456**
2017	2117		0	**2117**
2018	1727		0	**1727**
2019	2302			**2302**
2020	2369		0	**2369**
2021	2245		0	**2245**
2022	1994		0	**1995**

Table 9.3.3b. Black scabbardfish from Subarea 27.8. Working group estimates of landings.

Year	France						Spain					Total
	8	8.a	8.b	8.c	8.d	8.e	8.a	8.b	8.c	8.d.2	8	
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**

Year	France						Spain					Total
	8	**8.a**	**8.b**	**8.c**	**8.d**	**8.e**	**8.a**	**8.b**	**8.c**	**8.d.2**	**8**	
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**
2017		2	0		0						32	**35**
2018		4	2	0	4		34	12	1	18		**74**
2019		12	5		8		45	15	0	22		**108**
2020		19	5	0	14		55	23	1	20	0	**138**
2021		13	12	0	5		36	19	2	17	0	**103**
2022		14	5	0	5		18	11	2	14		**69**

9.4 Black scabbardfish (*Aphanopus carbo*) in other areas (27.1, 27.2, 27.3.a, 27.4, 27.10, and 27.14)

9.4.1 The fishery

This assessment unit is made up of diverse areas. In some of these areas, fisheries have occurred sporadically or at extremely low levels, such as in subareas 27.1–4. Those levels may just indicate that the species has a low occurrence in those areas. On the contrary, landings from other areas, particularly in Subarea 27.10, indicate that the level of abundance of the species appears to be significant.

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 27.5.a in the Northern component (ICES, 2016). Consequently, landings information from ICES Division 27.5.a, which was formerly included in the present section, has been moved to section 9.2 of this Report.

No further information is available on the Faroese exploratory trawl fishery that was taking place in the Mid-Atlantic Ridge area, starting from 2008.

9.4.2 Landings trends

In ICES Subarea 27.10 landings have been variable but, for the period 2012-2016 landings increased, decreasing to less than 100 kg since 2016. The 111 tonnes reported in 2010 in ICES Subarea 27.14 are considered as misreporting.

9.4.3 ICES Advice

The latest ICES advice, in 2022, was: "*ICES advises that when the precautionary approach is applied, catches should be no more than 4214 tonnes in each of the years 2023 and 2024.*"

9.4.4 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 2020 by subarea are presented in Table 9.4.1.

In 2010, between 2012 and 2014, and in 2016, the TACs have been exceeded, particularly in 2010. More information is needed to track the situation.

Table 9.4.1. Black scabbardfish TACs in subareas 27.1, 27.2, 27.3, and 27.4 and total landings of EU vessels in subareas 27.2, 27.3, 27.4, and 27.14 and Division 27.5a, from 2007 to 2022.

YEAR	EU TAC 27.1, 27.2, 27.3, and 27.4	EU Landings 27.2, 27.3, 27.4, 27.5a, and 27.14
2007	15	3
2008	15	0
2009	12	20

2010	12	236
2011	12	174
2012	9	453
2013	9	416
2014	9	370
2015	9	268
2016	9	356
2017	9	294
2018	9	156
2019	-	66
2020	-	106
2021	-	33
2022	-	63

*** TACs and landings for subarea 27.10 are included in Table 9.3.1.**

9.4.5 Data available

9.4.5.1 Landings and discards

Landings are given in Tables 9.4.2a–e and in Figure 9.4.1. In subareas 27.2, 27.4, and 27.14 reported landings are considered to be misreported, although it is not known to what extent.

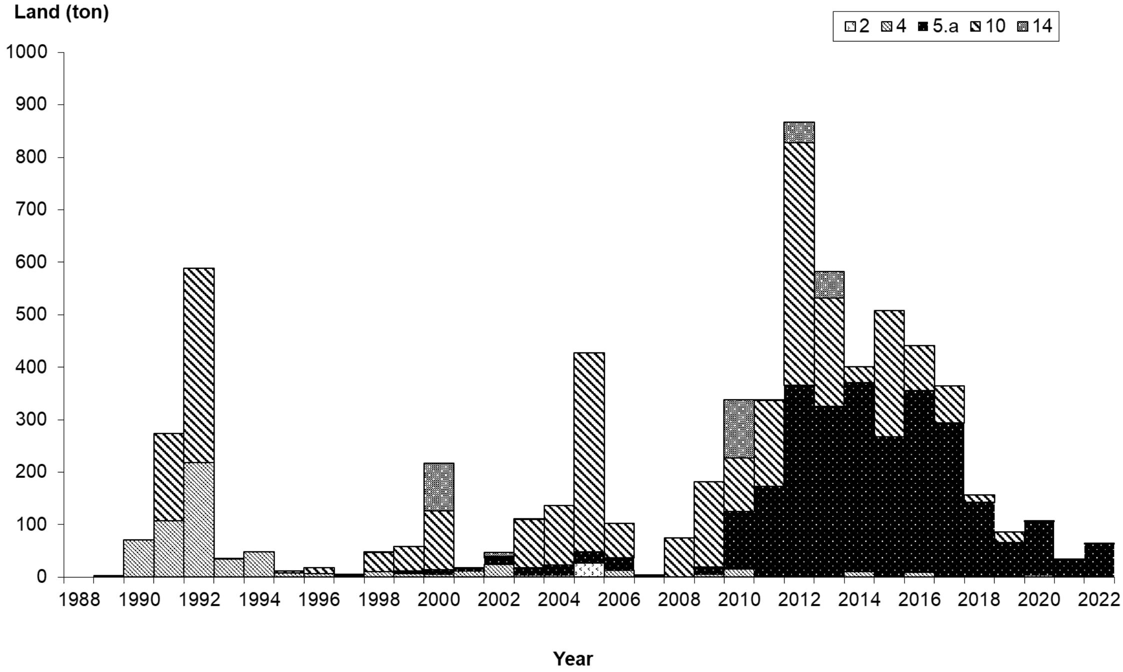


Figure 9.4.1. Annual landings for black scabbardfish in ICES subareas 27.2, 27.4, 27.5a, 27.10, and 27.14, between 1988 and 2022.

Greenland catches of black scabbardfish have been null in years between 1998 and 2022 except 2010 and 2011 (Nogueira, 2023, *pers. comm.*). For these two later years, 100 and 300 kg were reported from trawl bycatch, both in September (Figure 9.4.2).

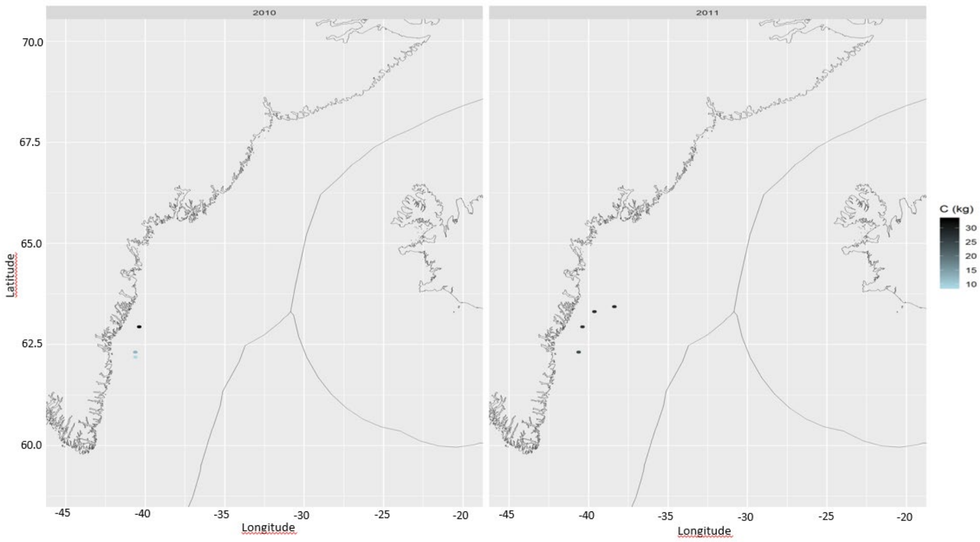


Figure 9.4.2. bsf.27.nea Black scabbardfish in 14. Distribution of commercial catches of black scabbard fish (in Kg) in East Greenland from 2010 and 2011. (Source: Nielsen et al., 2019b WD)

9.4.5.2 Length compositions

No new information has been reported, except for ICES Division 27.5.a, which was included in the Northern component Section 9.2.4.3.

9.4.5.3 Age compositions

No data were available.

9.4.5.4 Weight-at-age

No data were available.

9.4.5.5 Maturity and natural mortality

No new data were available.

9.4.5.6 Catch, effort and research vessel data

In ICES Division 27.14.b, catches of black scabbard fish have been zero all years except 2010 and 2011 when 100 and 300 kg were reported from trawl bycatch from the fishery for Greenland halibut (*Reinhardtius hippoglossoides*) (Nielsen, 2021 WD).

From 1998 to 2016, the Greenland Institute of Natural Resources conducted stratified bottom trawl surveys in East Greenland (ICES Subarea 27.14.b). The survey is held onboard R/V Pâmiut. The depth of surveyed area ranged from 400 to 1500 m (Nielsen *et al.*, 2019a WD). Until 2008, the survey took place in June but for almost all years it was affected by the ice covering the east coast of Greenland during early summer. From 2008 onwards, surveys have been held in August/September and the ice problems were eliminated. The 2008 survey was combined with a new shrimp/fish survey that uses a different trawl gear and operates at more shallow waters than the Greenland halibut survey. The combination of the two surveys led to a change in trawling hours so that most of the stations since 2008 were taken during night-time. Details on the survey namely information on survey design, vessel and trawling gear and handling of the catch see NWWG working document for Greenland halibut (Christensen & Hedeholm, 2016). The vessel (R/V Paamiut) used for the surveys from 1998-2016 was retired in 2018 before paired trawling experiments with a replacement vessel could be conducted. In 2022, the new vessel owned by GINR, R/V Tarajoq with a Bacalao 476 trawl began a new survey series (Nogueira and Christiansen, 2023, WD).

Black scabbardfish are rarely caught in this survey series (Nogueira and Christiansen, 2023, WD). There were no catches in the years 1998, 1999, 2000, 2002, 2003, 2006 and 2016, and neither in 2022 (Figure 9.4.3). In 2013 and 2015, the species was caught only in 1 station, whereas it was found in 4-6 stations in 2011, 2012 and 2014. For these years, catches ranged from 0.7 kg to 21.7 kg. In 2015, it was only registered in Q5 at depths between 801-1200 m, where the majority of the biomass also has been observed in previous years.

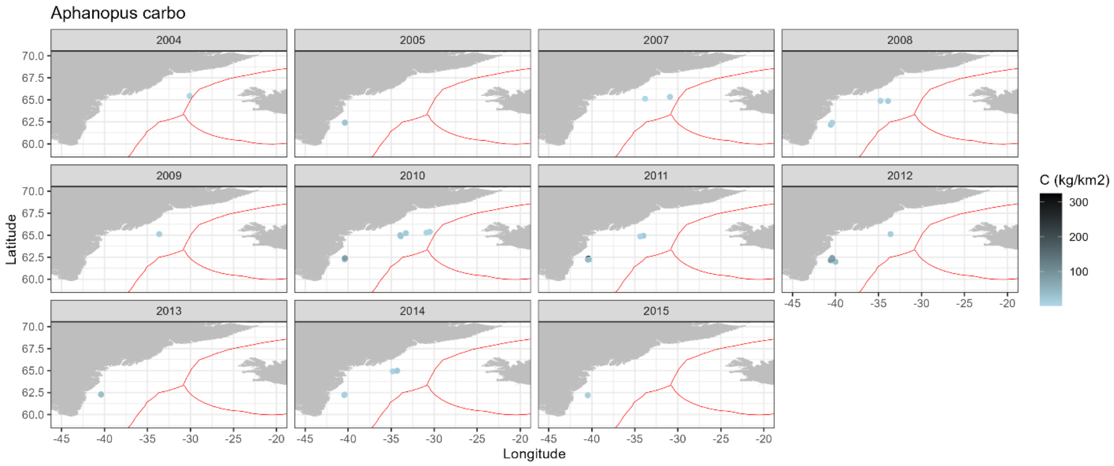


Figure 9.4.3. bsf.27.nea Black scabbardfish in Subarea 27.14. Distribution of survey catches of black scabbard fish at East Greenland (ICES Division 27.14.b) from 1998-2016 and 2022. Figure (Source: Nogueira and Christiansen, 2023 WD)

In 2008 and 2010-2012, the estimated biomass varied between 32.8 t and 56.4 t, whereas in all the other years the biomass was less than 7.9 t. This is most likely because black scabbardfish is benthopelagic and deep living, hence it is not fully fished by the applied bottom trawl. Hence the biomass estimates are considered not to reflect the actual biomasses in the surveyed area. The length frequency distributions based on 2011 and 2012 surveys show a wide mode between 70 cm and 110 cm (Figure 9.4.4).

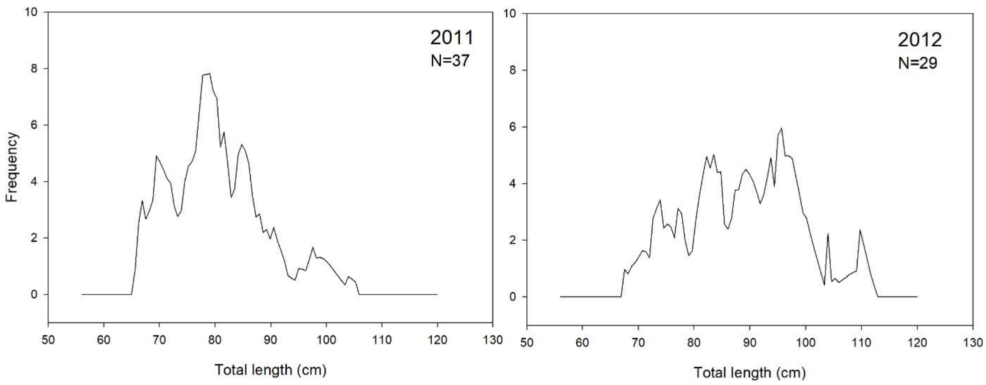
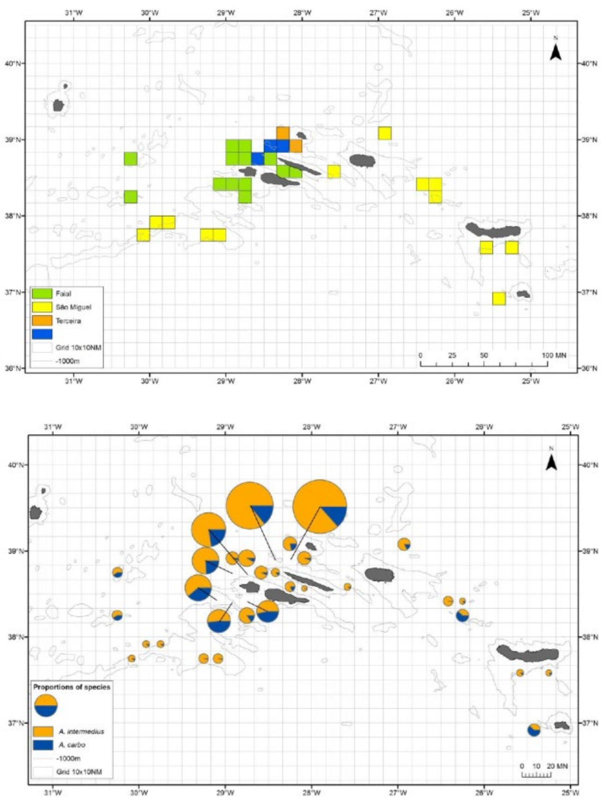


Figure 9.4.4 bsf.27.nea Black scabbardfish in Subarea 27.14. Length distribution of black scabbardfish at East Greenland (ICES Division 27.14.b) for 2011 and 2012. Survey years with n<20 are not shown. (Source: Nielsen *et al.*, 2019a WD)

9.4.6 Data analyses

In Subarea 27.10, the commercial interest for the exploitation of black scabbardfish has varied over time, but apart from the data presented from the Faroese exploratory survey in 2008, the data available are only landings.

Results from the Azores (MARPROF project, unpublished data), based on counting of the vertebrae indicate that two species of *Aphanopus* coexist in ICES Division 27.10.a, *A.carbo* and *A. intermedius* (Besugo *et al.*, 2014 WD). The spatial distribution of the proportion of co-occurrence of the two species, presented in Figure 9.4.5, shows that the overall proportion of *A. intermedius* in relation to the overall catches of *Aphanopus* species is about 0.75. It is important to note that the proportion can vary according to the sampling location.



(a)

(b)

Figure 9.4.5. 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) in Division 27.10.a. (Source: Besugo *et al.*2014 WD)

9.4.7 Comments on the assessment

Despite the variability on the overall landings along the years, data available suggest that ICES Subarea 27.10 is an 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 Subarea 27.10 (Besugo *et al.*, 2014 WD) needs to be, in the future, taken into consideration to provide advice for this stock.

9.4.8 Management considerations

The information available does not unequivocally support the assumption of a single stock for the whole NE Atlantic area, although the evidence is in line with it.

The co-occurrence of two different species, *A. carbo* and *A. intermedius*, in ICES Subarea 27.10 needs to be considered when providing advice for this stock.

9.4.9 Tables

Table 9.4.2a. Black scabbardfish other areas: subareas 27.2 and 27.3. Working Group estimates of landings.

Year	France	Faroes 27.2.a	Iceland* 27.2.a.2	France 27.3.a	Total
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**

Year	France	Faroes 27.2.a	Iceland* 27.2.a.2	France 27.3.a	Total
2014	-	-			**0**
2015	-	-			**0**
2016	-	-		0	**0**
2017	-	-		-	**0**
2018	-	.	13	-	**13**
2019					**0**
2020	0				**0**
2021					0
2022					0

*** Preliminary catch statis**

t

Table 9.4.2b. Black scabbardfish other areas: Subarea 27.4. Working Group estimates of landings. E is England, W is Wales, NI is Northern Ireland.

Year	France				Scotland				Germany *	E&W&NI		Netherlands**	Total
	27.4	27.4.a	27.4.b	27.4.c	27.4	27.4.a	27.4.b	27.4.c	27.4.a	27.4.a	27.4.c	27.4.c	
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**

Year	France				Scotland				Germany *	E&W&NI		Netherlands**	Total
	27.4	27.4.a	27.4.b	27.4.c	27.4	27.4.a	27.4.b	27.4.c	27.4.a	27.4.a	27.4.c	27.4.c	
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		9	-	-									**9**
2017		0	-	0		0	0	0					**0**
2018	-	1	-	0	0	-	-	-		0		0	**1**
2019		1											**1**
2020		0	3			0						0	**4**
2021		2			0								**0**
2022											0		**0**

.

Table 9.4.2c. Black scabbardfish other areas: Subarea 27.10. 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			**240**

Year	Faroes	Portugal	France	Ireland	Total
2016	50	36			**86**
2017	7	63			**70**
2018	-	14			**14**
2019	3	17			**20**
2020		0	0	0	**0**
2021		0			**0**
2022		0			**0**

Table 9.4.2d. Black scabbardfish other areas: Subarea 27.14. Working Group estimates of landings.

Year	Faroes	Spain	Greenland	Unallocated	Total
	27.14		27.14.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		**0**
2000		90	0		**90**
2001		0	0		**0**
2002		8	0		**8**
2003		2	0		**2**
2004			0		**0**
2005	0		0		**0**
2006			0		**0**

Year	Faroes 27.14	Spain	Greenland 27.14.b	Unallocated	Total
2007	0		0		**0**
2008	0		0		**0**
2009	0		0		**0**
2010		111	0		**111**
2011	0		0		**0**
2012		39	0	49	**88**
2013		50	0	40	**90**
2014	0	0	0	0	**0**
2015	0	0	0	0	**0**
2016			0		**0**
2017	0	0	0	0	**0**
2018	0		0		**0**
2019					**0**
2020		0			**0**
2021					**0**
2022					**0**

9.5 Black scabbardfish (*Aphanopus carbo*) in CECAF area

WGDEEP does not assess fisheries in Madeira (Eastern Central Atlantic area, CECAF) or in other areas outside the ICES area. Nonetheless, it is admitted that the incorporation of reliable CECAF data could provide a wider perception of the stock dynamics. Updated information on the black scabbardfish fishery in Madeira (CECAF 34.1.2) has been presented to WGDEEP (Sousa *et al.*, 2023 WD).

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 have moved to new fishing grounds, some of them located outside the EEZ of Madeira (SE of the Azores and off the Canaries) (Figure 9.5.1).

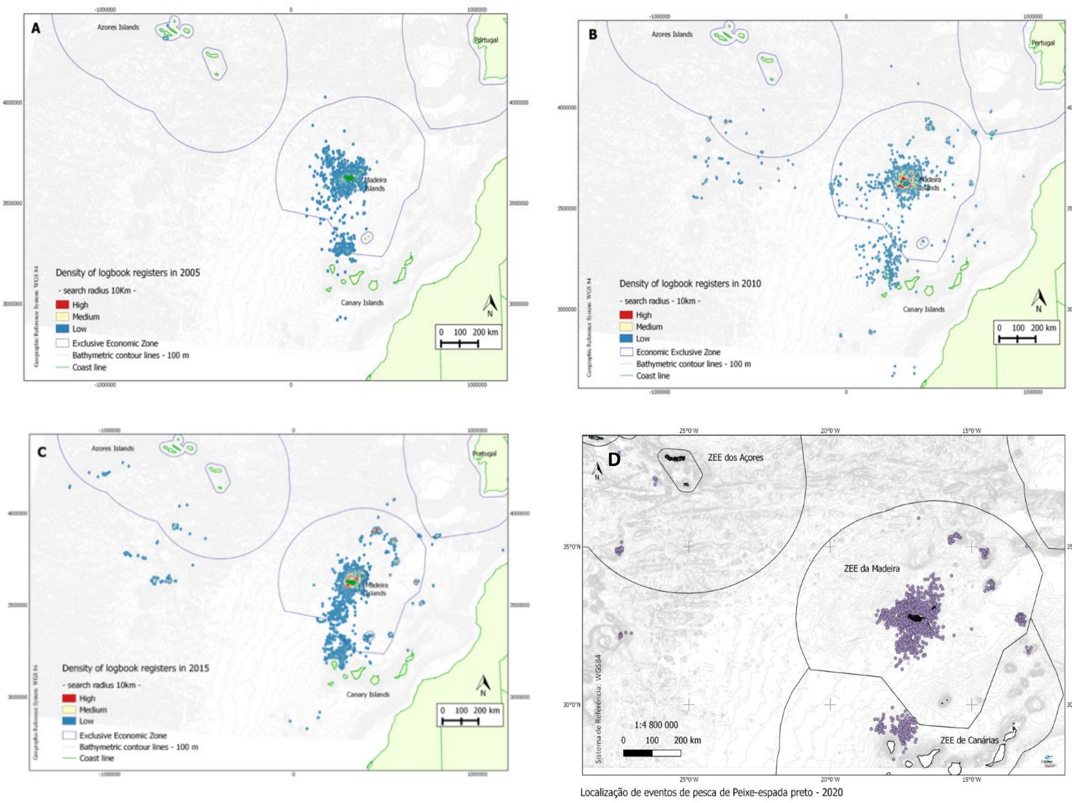


Figure 9.5.1. bsf CECAF area. Density plots illustrating the geographical distribution of the fishing sets with catches in 2005 (A), 2010 (B), 2015 (C) (Delgado *et al.*, 2018) and (D) 2020 (Sousa *et al.*, 2021 WD).

Catches in CECAF 34 area were updated with fishery data from Madeiran longliners landings from 1990 to 2022 (Figure 9.5.2). These catches are recorded by the Regional Fisheries Department of Madeira. CECAF catches have been decreasing after the 1998 peak, but a slight increase was observed from 2012 to 2019, remaining around 2000 ton until 2022 (Figure 9.5.2 and Table 9.5.1).

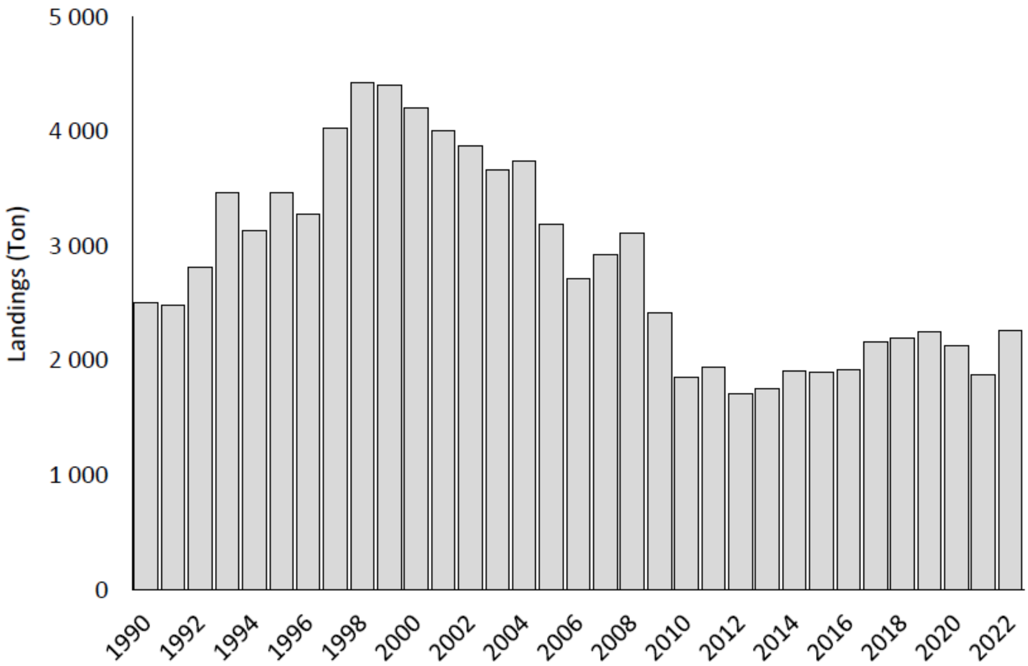


Figure 9.5.2. bsf CECAF 34. Time-series of annual Portuguese landings at CECAF area.

The EU TAC and total catches for CECAF 34 area from 2005 to 2022 are presented in Table 9.5.1.

Table 9.5.1. bsf. Black scabbardfish TACs and total landings in CECAF 34 area between 2005 and 2022.

Year	EU TAC CECAF 34.1.2 area	Landings CECAF 34.1.2. Area
2005	4 285	3 195
2006	4 285	2 717
2007	4 285	2 922
2008	4 285	3 109
2009	4 285	2 413
2010	4 285	1 860
2011	4 071	1 941
2012	3 867	1 716
2013	3 674	1 758
2014	3 490	1 913
2015	3 141	1 902
2016	2 827	1 917
2017	2 488	2 163
2018	2 189	2 199
2019	2 189	2 246

2020	2 189	2 136
2021	2189	1873
2022	2189	2259

For the period 2009–2022, the total length frequency distributions of the exploited population caught by the Madeiran longline fleet varied between 114 and 118 cm (Figure 9.5.3). From 2010 to 2018 the mean length varied between 117 and 118 cm TL, occurring a decrease to 115-116 cm TL between 2019 and 2022.

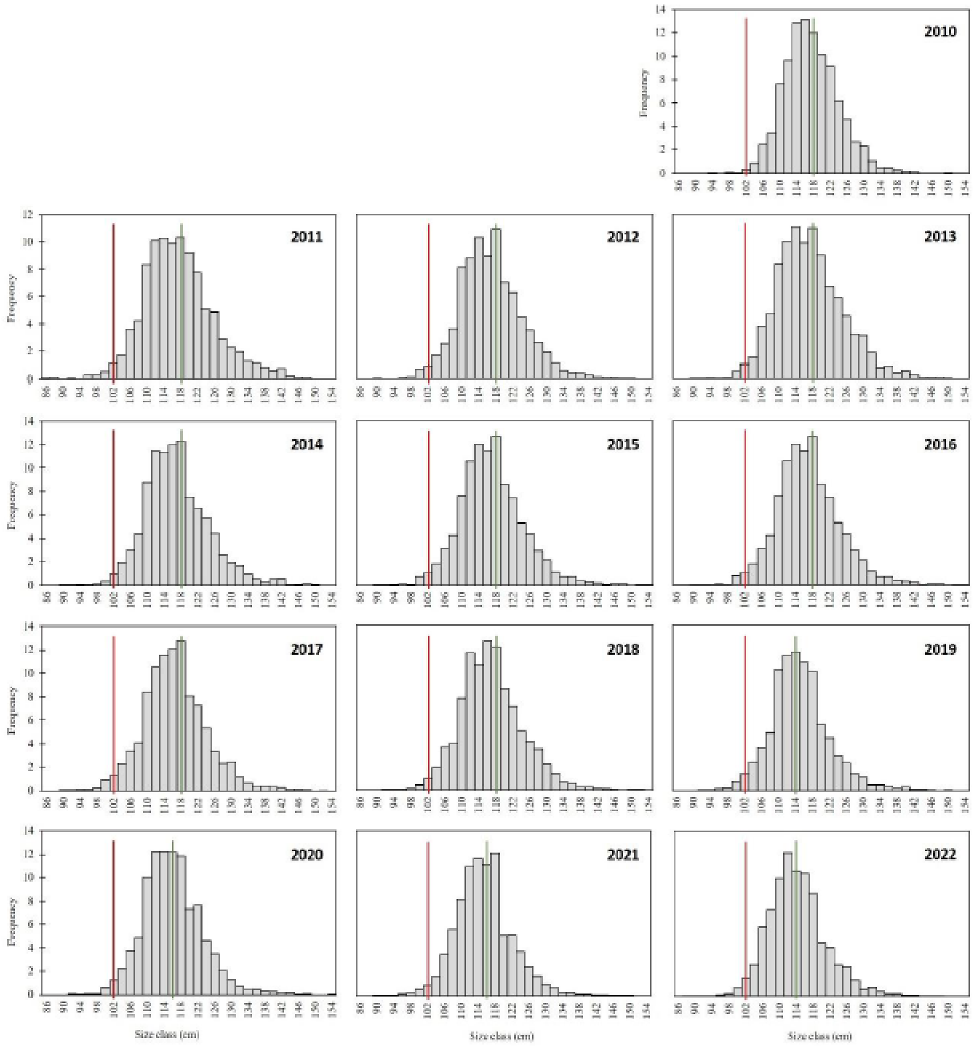


Figure 9.5.3. bsf CECAF. Annual length–frequency distribution of specimens landed by the Portuguese longliners operating along CECAF area. The red line is the length at first maturity (103 cm) and the green line is the annual mean length.

In CECAF 34 area, the fishing effort that corresponds to the total number of hooks per year shows a continuous decrease from 2000 to 2021 and a slight increase in 2022 (Figure 9.5.4). Such decreasing trend is in line with a reduction in the number of active vessels.

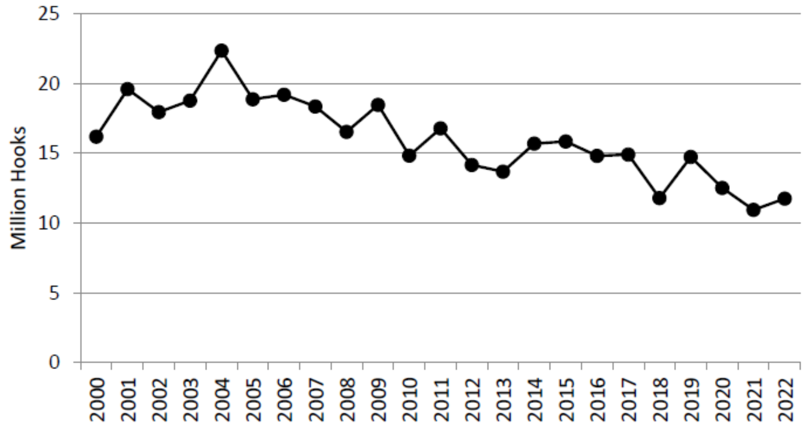


Figure 9.5.4. bsf CECAF 34 area. Time-series of the total annual effort estimated for the CECAF area (million hooks).

The nominal CPUE shows an initial decreasing trend followed by a stable period (2010–2016), a peak in 2017, and an increasing trend between 2018 and 2022 (Figure 9.5.5).

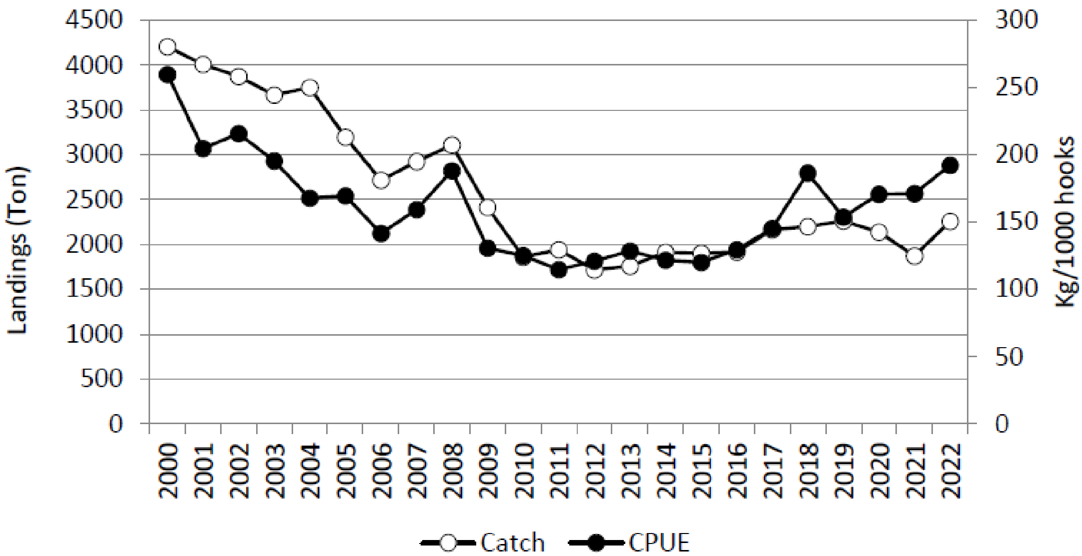


Figure 9.5.5. bsf CECAF 34 area. Time-series of landings per unit effort, nominal CPUE (kg/thousand hooks), in CECAF area.

For the period between 2008 and 2022, a standardised CPUE was obtained by adjusting a GLM model based on daily landings of the commercial drifting longline fishery in CECAF 34 (Figure 9.5.6). The response variable (CPUE) was black scabbardfish catches in weight per fishing haul. The standardized CPUE has been increasing since 2019.

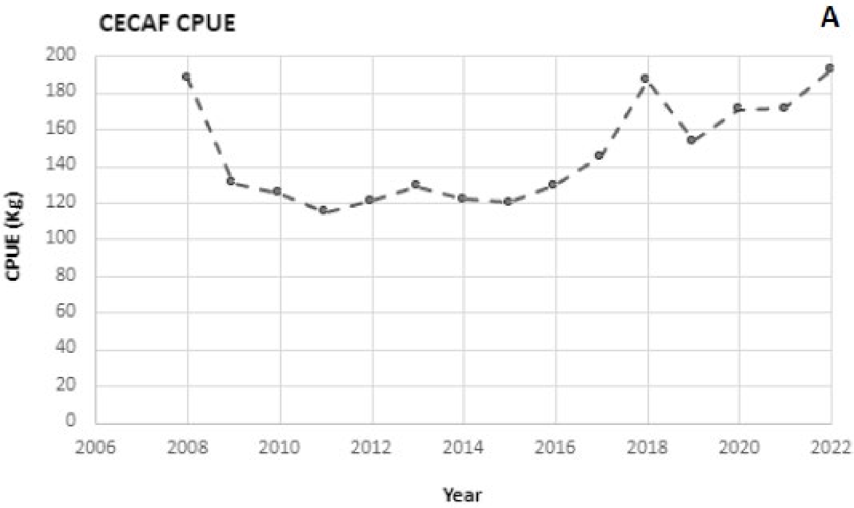


Figure 9.5.6. bsf.27.nea CECAF 34 area. Standardised CPUE (catch weight per fishing haul) from 2008 to 2022.

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10 Greater forkbeard (*Phycis blennoides*) in all ecoregions

10.1 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.

Spanish, French, Norwegian and UK trawl and longline are the main fleets involved in this fishery. In the last ten years 67% of landings have come from Subareas 6 and 7. Although it is not a large economic species in the all Northeast Atlantic, however, is locally important for certain fleets (LLS and OTB) fishing in subareas 6 and 7 with base port mainly in the North West of Spain and in France. 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. Many countries are involved in the fishery in subareas 1, 2, 3, and 4 that accounted the 17% of total landings since 2013, but most of the landings are traditionally reported by the Norwegian fleets. Russian, Swedish, Faroese and the Icelandic fisheries in the Northeast Atlantic (Division 5b) land small and occasional quantities of greater forkbeard as bycatch of the trawler fleet targeting roundnose grenadier, tusk and ling on Hatton and Rockall Banks.

A further 16% 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* in subarea 9 decreasing every year since 2000 and 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 in Subarea 10 with zero catches since 2019 and in Division 5.a. There is no directed fishery for greater forkbeard in Faroese waters (Division 5b) and only small amount is landed as bycatch (Ofstad, 2022). In subarea 12 there are not reported landings since 2012 (only 0.5 t by Norway in 2021). In Subarea 10, 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 0.5% of total deep-water landings in the period 2016-2020, can be considered as bycatch.

10.2 Landings trends

Tables 10.0a–i and Figure 10.1 show landings of greater forkbeard by country and subarea.

In Subareas 1, 2, 3 and 4 only Norwegian landings are significant reaching in total 213 t in 2021, and increasing to 244 t in 2022. The Norwegian longliners which fish in these areas catch *P. blennoides* as a bycatch in the ling fishery and 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. Denmark currently is the second country in landings and reported their first landings in subareas 3 and 4 in 2016 reaching 70 t in 2020 and 49 t in 2022.

Although historically seven countries contributed to the landings in 5b the main landings in come from Norway. Total landingsreached the highest values in 2001 and 2002 with 102 and 149 t respectively. Data from Norway landings in 2011 (301 t) and 2012 (145 t) have been corrected this year according to the new estimates provided in the Working Document Ofstad (2023), that reduced these landings to 0.31 t and 0.083 t respectively. Since 2003 combined landings in this subdivision dropped to lower levels and landings reported in 2022 by all countries were 26 t.

Traditionally, the most important landings in 6 and 7 come from Spain, France, Norway, UK (EW) and UK (Scot) and Ireland. Historical landings decreased since the peak of 4967 t in 2000 and they were particularly low in 2009 and 2010 due to the low landings reported by Spain in those years. After these two years reported international landings increased marginally to 1802 t in 2012 but decreased in last years to 889 t in 2022 with the majority of landings reportedfrom France (390 t) and Spain (339 t)..

The main landings from subareas 8 and 9 come from Spanish fleets reaching on average are 240 t in the last ten years. In 2010 landings were the lowest of the series mainly due to the reduction of landings reported by Spain. Reported landings increased from 321 t in 2021 to 337 t in 2022.

Historically in Subarea 10 landings come only from Portugal (although France reported 0.2 t in 2014). After the peaks to 136 t in 1994 and 91 t in 2000, the average in this Subarea in the last ten years is 9 t, but since 2017 only 14 t in 2018 were reported in this Subarea

Although since 1991 several countries were involved in the fishery in Subarea 12 only Spain reported significant landings in the period 2002–2009, and since 2013 only Norway reported 0.5 t in 2021.

10.3 ICES Advice

ICES advice applicable to 2019 and 2020

ICES advised that when the precautionary approach is applied, landings should be no more than 1346 tonnes in each of the years 2019 and 2020. ICES cannot quantify the corresponding catches.

ICES advice applicable to 2021 and 2022

ICES advised that when the precautionary approach is applied, landings should be no more than 861 tonnes in each of the years 2021 and 2022. ICES cannot quantify the corresponding catches.

10.4 Management

According to the Council Regulation (EU) 2018/2025, the TACs for greater forkbeard in all ICES subareas was no longer be set for 2020 and 2021. The ICES advice establishes that the absence of TACs would result in no or a low risk of unsustainable exploitation. Landings in subareas 1, 2, 3 and 4 include Norwegian landings.

PHYCIS BLENNOIDES	EU TAC	TOTAL INTERNATIONAL LANDINGS	
Subarea	**2021-2022**	**2021**	**2022**
1, 2, 3, 4	no TAC	**213**	**244**
5, 6, 7	no TAC	**893**	**914**
8, 9	no TAC	**321**	**337**
10, 12	no TAC	**1**	**0**
Total	no TAC	**1427**	**1495**

10.5 Stock identity

ICES currently considers greater forkbeard as a single stock for the entire ICES area. It is considered probable that the stock structure is more complex; however further studies would be required to justify change to the current perception of stock boundaries.

10.6 Data available

10.6.1 Landings and discard

Landings are presented in Table 10.0a–i and in Figure 10.1.

Landings by fishing gear in 2022 are shown in Table 10.1a for countries reporting landings to InterCatch.

The estimates of the discard/catches available from 2013–2022 were in the range between 13% and 49% (Table 10.2a). In 2022 the main reported discards come from subareas 7 (76%), 6 (12%), 8 (4%), 4 (5%) and 9 (2%) (Table 10.2b). Discards estimates in the first years of the series should be considered with caution because (i) not all countries report discards (ii) the method for estimating discards may not have been the same in all years. Nevertheless, in recent years (2015 onwards) discards of the most important countries in involved in the fishery (except Norway) are reported in InterCatch.

Series of Effort data (kWd) since 2014 of the Denmark, Ireland, Portugal, Spain, UK (England), UK(Scotland), France, Germany, Netherlands, Norway, UK(Northern Ireland), Sweden, have been provided by subarea (Figure 10.2b). The effort for a given year is calculated as the sum of kWd of those fleets/countries reported information in InterCatch. As greater forkbeard is a by-catch for many of the fleets, reporting catches the presented effort could not be representative specifically for this species.

A standardized CPUE was developed for reference fleet within the polyvalent Portuguese fleet, based on fishery dependent data collected from commercial landings for the period 2009-2020, particularly the landed weight (in Kg) by fishing trip. A fishing trip is defined from the moment the vessel leaves the dock to when it returns to the dock (Table 10.3). The standardized CPUE series, based on commercial data, suggest that the status of the greater forkbeard population inhabiting the Portuguese continental waters in recent years has been stable (Farias et al., 2022). For the period between 1997 and 2016, an increasing trend was also observed for the juvenile component of the population, indicating that the fishing pressure over the Portuguese population had not seriously impaired the recruitment (Lagarto et al., 2017).

10.6.2 Length compositions

Figure 10.2a shows the available length frequencies of commercial fleets and indicates that discards in 2015 affected specially individuals smaller than 17 cm of which 100% were discarded. In 2016 and 2017 the length range of discarded greater forkbeard increased affecting in high proportion also individuals smaller than 36 cm and 45 cm respectively, but in 2018 the size of the individual discarded took place in the range from 8 to 33 cm, in 2019 and 2020 the situation is similar to 2016 and mostly of the discarded individuals are smaller than 33 cm. The situation in 2021 and 2022 was similar, and the majority of discarded individuals was between 17 and 40 cm.

The Figures 10.3 to 10.6b present the length–frequency distributions of the following surveys:

Spanish Groundfish Survey in the Porcupine bank in Divisions 7.c and 7.k. from 2001 to 2022 (Figure 10.3).

- Northern Spanish Shelf bottom-trawl in Divisions 9.a and 8.c from 1983 to 2022 (Figure 10.4).
- French EVHOE IBTS until 2020 EVHOE in Divisions 7.f, g, h, j; and 8.a,b,d from 1997 to 2022 (Figure 10.5).
- Portuguese Crustacean Surveys/*Nephrops* TV Surveys (PT-CTS (UWTV (FU 28–29) in Division 9a from 1997 to 2018 (Figure 10.3).
- Faroes deep-water survey in Division 5b from 2014 to 2022 (Figure 10.6b).

10.6.3 Age compositions

Data of age proportion of the commercial Spanish fleets were provided in WGDEEP for subareas 7, 8 and Division 9.a since 2011. The series show that most of greater forkbeard belongs to the age 1 in all subareas, although in 2019 individuals of age 2 reached 50% of the total and in 2016 61% in Subarea 8 and Division 9.a In 2021 and 2022 the high proportion of individuals of age 1 decreased significantly and appears for first time fish with age 0. In Subareas 7 and 6 in 2021 all the ages showed more similar proportion and in 2022 older ages (age 3) reached 40% of the total. In Subareas 8 and 9 in 2021 the higher proportion belongs to age 2 and in 2022 ages 0, 1 and 3 reached values between 33% and 42% (Figure 10.6c).

10.6.4 Weight-at-age

This year the accumulated mean weight-at-length of the international commercial landings and discards reported to InterCatch from 2016 to 2022 was presented (Figure 10.7). The weight of discarded greater forkbeard in 2016, 2018 and 2019 were quite lower than landings weight since overall, the fleets discard the smallest individuals (see Figure 10.2a). In 2021 and 2022 the landings and discard weight patter are very similar with most of the accumulated weight belonged to individuals larger than 30 cm with a peak in the range of 48-50 cm.

10.6.5 Maturity and natural mortality

No new information was provided to the WG in 2023. Updated Life History parameters were provided in the 2021 Data Call by the Spanish fleet:

	Value	Reference	Comments
L_{mat} males	27.5	CV= 2%	n=388; year= 2018+2019+2020; Males

L_{mat} females	47.2	CV= 3.3%	n=1025; year= 2018+2019+2020; Females
Li_{nf}	111.1	CV=11%	n=1076; year= 2018+2019+2020; Both sex
K	0.13	CV=15%	n=1075; year= 2018+2019+2020; Both sex

10.6.6 Catch, effort and research vessel data

In 2023 the Faroe Plateau survey was included for first time in the analysis of biomass and abundance indices, completing nine surveys in total of which SWC-IBTS and PT-CTS (UWTV (FU 28–29) two do not take place since 2014 and 2019 respectively. These surveys cover a significant proportion of the all ecoregions in Divisions 3, 4, 5, 6, 7, 8, 9 (Figure 10.8):

- Spanish Groundfish Survey in the Porcupine bank (SP-PorcGFS-(G5768) in Divisions 7.c and 7.k from 170 to 800 m. Biomass and abundance of greater forkbeard from 2001 to 2022 are presented in Figure 10.9.
- French EVHOE IBTS (FR-EVHOE-(G9527) in Divisions 7.f, g, h, j; and 8.a,b,d from 0 to 600 m. Abundance and biomass raised to the total subarea have been provided for a series from 1997 to 2022. This survey did not take place in 2017. (Figure 10.10).
- Irish Groundfish survey (IE-IGFS-(G7212) in Divisions 6.a South and 7.b from 10 to 150 m. Abundance and biomass Indices (nº per hour and kg per hour) from the period 2005 to 2022. This survey provides abundance indices for the total catches and for individuals <32 cm by shelf and slope strata (Figure 10.11).
- Northern Spanish Shelf bottom-trawl survey (SP-NGFS-(G2784) in Divisions 9.a and 8.c from 35 to 700 m. Biomass and abundance (kg/30 min tow and No/30 min tow) of greater forkbeard in the Cantabrian Sea from 1983 to 2022 are presented in Figure 10.12.
- North Sea IBTS survey (NS-IBTS-(G1022-G2829) in Divisions 4.abc, 3.a and 3.c. from 0 to 2000 mAbundance in number per hour from 1976 to 2022 is presented in Figure 10.13.
- Scottish Western Coast Groundfish IBTS survey (SWC-IBTS-(G1179-G4299) in Divisions 5.b, 6.ab, 7.ab from 20 to 500 m. No new information is available since 2014 onwards. Abundance in number per hour from 1986 to 2014 is presented in Figure 10.14.
- Scottish Deep-water trawler survey in Divisions 6.a (SCOWCGFS-G4748-G4815) from 300 to 1200 m. Biomass and abundance of greater forkbeard from 1998 to 2021 are presented in Figure 10.15. As it is a biennial since 2014 this survey did not take place in 2016, 2018,2020 and 2022.
- Portuguese crustacean surveys/*Nephrops* TV Survey (PT-CTS (UWTV (FU 28–29)- G2913) in Division 9.a South from 200 to 750 m, Biomass in kg per hour from 1997 to 2018 is presented in Figure 10.16. This survey did not take place in 2019 and 2020.
- Faroe Plateau in spring and summer survey in Division 5b (FO-GFS-Q1-Q3-G1264-G3284) from 70 to 510 m, Biomass in kg per hour from 1994 to 2022 is presented in Figure 10.17.

10.7 Data analyses

In the Spanish Groundfish Survey in the Porcupine bank the biomass and abundance of *P. blennoides* decreased slightly and remained among the lowest values of the time series (Figure 10.9). Biomass patches were widely found in the south, west and east area, but scarcely in the north, as in previous years (Figure 10.18). Most specimens were from 28 cm to 35 cm in this last survey and fewer recruits were found in contrast to the previous year (Figure 10.3) (Ruiz-Pico *et al.* 2023).

The EVHOE IBTS survey in Divisions 7.f,g,h,j and 8.a,b,d 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 until 2016. In 2018 and 2019 an important recovery but the abundance decreases again in 2020 and 2021 and increases in 2022.

The historical series indicates an increase in biomass since 1996, with peaks in 2004, 2007 and 2012 and a decrease from 2013 to 2015 and increases again until 2019. In the period 2020-2022 the biomass decreased compared to the values in the 2019 peak. However, landings have decreased from 2012 onwards since the most important peak was in 2011. (Figure 10.10). The mean length has increased since the beginning of the series reaching the highest value in 2005, 2016 and 2020 (Figure 10.5).

Irish GFS indicates an increase in the abundance (No/hour) and biomass (Kg/hour) from 2009 to 2012 and 2013 respectively. From these years onwards a decrease in both parameters is shown to 2017 that is the lowest value of the series. In 2018 a slight recovery in biomass is recorded compared with values in 2017 but since this year the trend decreased. (Figure 10.11).

In Northern Spanish Shelf bottom-trawl survey in 2022, 21% of the hauls where *P. blennoides* was found were additional hauls deeper than 500 m and contained 77% of the biomass. The length distribution in standard hauls was similar to the previous year, with a great recruitment again and a mode in 18 cm. The largest individuals, which ranged from around 24 cm to 66 cm, were found mostly in the additional deeper hauls, with a mode in 38 cm (Figure 10.4). This last year the biomass in standard hauls increased steadily, reaching the highest value of the previous eight years. The biomass in additional deep hauls increased even more compared to the previous year, reaching the highest value of the time series (Figure 10.12). The geographical distribution of *P. blennoides* remained similar to previous years, being widespread in the sampling area (Figure 10. 19). (Fernández-Zapico *et al.*, 2023).

The NS-IBTS shows an increase on abundance since 1976 although the average abundance recorded until 2010 (3.1 individuals/hour) was lower than 2011 onwards (22.0 individuals/hour). The abundance recorded in 2012 (40.2 individuals/hour) is the most important of the series although the trend shows a decrease since this year to 2016 (Figure 10.13). In 2017 the survey recovered one of the highest abundance values but dropped to 0.2 individuals/hour in 2022 the lowest value of the series.

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 10.14.

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 from 1998 to 2015 with a peak in 2017 of 37.2 kg/hour but dropped again in 2019 to 16.5 kg/hour and 15.5 kg/hour in 2021. The abundance shows the same profile of the biomass with an important increase from 2011 to 2013 and also a peak in 2017 (53.6 individuals/hour). In 2019 the abundance decreased slightly to similar values found in the period from 2011 to 2013, reaching in 2021 the lowest value since 2015 (Figure 10.15).

In the Portuguese survey in 9.a south the series of biomass show a decrease trend since 1997 to 2004 but with significant peaks in 1999 and 2002. In recent years *P. blennoides* standardized biomass index estimates are above the overall mean, showing an increasing trend, particularly from 2013 to 2018 (a slight decrease was observed in 2017 in relation to 2016 (Moura *et al* 2019). Values of biomass are in the range of 0 kg/hour to 2.33 kg/hour (Figure 10.16). 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 years 2007 and 2008 (Figure 10.6). The size range observed in the Portuguese continental coast, provides evidence that the species is able to complete the life cycle in this area. In 2019 and 2020, the survey was not performed. In 2021, the R/V Mário Ruivo started to operate, but the survey's spatial coverage was smaller and fishing stations in the area where the species is traditionally more abundant were missing (Moura et al., 2022). Therefore, the standardized biomass index has not been updated since 2021 (Farias et al., 2023).

The Faroe Plateau survey in 5b show low catches near to zero from 1994 to 2006, but a continuous increase was registered from 2007 to 2015 in which the highest value in the combined series was recorded (2.13 kg/h), The biomass dropped strongly in 2016 and recovered again in 2017. Since 2017 and important decrease is observed to 0.45 kg/h in 2022 (Figure 10.17). The spatial distribution of greater forkbeard from the bottom trawl groundfish surveys were mainly on the Faroe Plateau deeper than 200 m (Figure 10.20). In the deepwater survey greater forkbeard was caught around the Banks and on the Wyville-Thomson ridge. In the Faroese 0-group surveys on the Faroe Plateau in June/July there are 26 registrations of greater forkbeard caught pelagic. The length was between 8-54 mm, mainly around 30-40 mm. 11 of there were caught in the period 1991-1999, 14 in the period 2001-2005 and one in 2022 (Ofstad 2023).

Although the data provided by the surveys have increased the area covered in the ecoregion, neither the available surveys nor discard data cover the Subareas 1 and 2.

10.7.1 Exploratory assessment

Following the guidance on application of the rfb rule, possible estimates of the input values were tested in WGDEEP 2022. Given the uncertainties in the input parameters (e.g. life-history), WGDEEP considers that further discussion with ICES WKLIFE would be required before the implementation of the method to provide landings advise for this stock.

10.7.2 Comments on the assessment

An analytical assessment was presented in WGDEEP 2022 for Greater forkbeard. Six surveys are used to produce the stock size indicator. In some years one or more of these surveys is missing (for example SDS; G6642, in 2016 and EVHOE-WIBTS-Q4F; G9527 in 2017); however, the stock size indicator is still considered to be valid in these years. The surveys cover most of the distribution of the stock, except the northern subareas 1 and 2.

Several shelf fisheries have a bycatch of juveniles which is currently poorly estimated. Discard reporting does not cover the entire distributional area of the stock; data are missing, especially in subareas 1–3. In 2022, reported discards were 18%. Given that discards from other fleets are not quantified, ICES cannot fully quantify catches.

10.7.3 Management considerations

As Greater Forkbeard 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.

In the subareas 3 and 4 the NS IBTS survey shows an increasing trend since 1976, more noticeable from 2010 onwards, however the trend after 2012 records a continuous and strong decrease . In the areas Subareas 6, and 7 covered by the Porcupine and Irish IGFS surveys and the indices indicate a decrease in the abundance since 2013, and in biomass since 2014 with biomass stabilized at very low values since 2018. However, in the northern area of the Subarea 6 covered by the Scottish deep-water survey it is observed an important increase of the biomass in 2017 perhaps due to the high abundance recorded in 2011 to 2013 but decreasing since then. The trend in Subarea 8 indicated by the Northern Spanish Shelf bottom-trawl (Division 8c) shows a decrease in biomass and abundance since 2011. Data from 2021 and 2022 showed an increase in biomass, with maximum values since 2017. On the contrary, the French EVHOE (in Divisions 7.f, g, h, j; and 8.a, b, d) shows a decrease from the peak in 2013 to 2016 and a slight increase in biomass an abundance since 2018. In Division 9.a south annual standardized biomass index of the Portuguese survey suggests an increase of biomass and abundance since 2013. The standardized indicator of the combined six survey index indicates an increase in the biomass in last two years (2020-2021 over the period 2017-2019).

On the other hand, landings in all ecoregions have been reduced since 2013 below the biennial TAC established for this period. In this sense, although the TAC increased in 2015 and 2016 to 2856 t landings reported have always been below, especially in 2017 in which landings were only 59% of TAC. It was supposed that the removing of the TAC from 2019 onwards could increase the landings (and discards) but it does not have affected the decreasing trend.

Although greater forkbeard is a bycatch of the traditional demersal trawl and longline mixed fisheries, and it is only locally important for certain fleets fishing in subareas 6 and 7 with base port mainly in the Northwest of Spain, discards of this species are considered high. Many of the countries involved in the fishery report data to InterCatch, and according to the information available, reported discards to catches ratio are high but have decreased from 2013 to 2022 (36%, 34%, 49%, 25%, 13%, % 17%, 15%, 13and 18%). Similarly, the commercial length frequency data is only available from some countries and areas and the historical series is not considered robust to be conclusive on observed trends.

10.8 Application of MSY proxy reference points

A Stochastic Production Model in Continuous Time (SPiCT) was applied in 2017 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, SpPGFS-WIBTS-Q4, SpGFS-WIBTS-Q4, SDS, PT-CTS (UWTV (FU 28–29) from the period 2005–2016. The model did not converge, so a new model was adjusted, and the series of landings were shortened 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 10.21 and 10.22.

10.9 Tables and Figures

Table 10.0a. Greater forkbeard (*Phycis blennoides*) in the Northeast Atlantic. Working group estimates of landings.

YEAR	1+2	3+4	5	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**

YEAR	1+2	3+4	5	6+7	8+9	10	12	TOTAL
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**
2017	80	155	9	1073	186	0	0	**1503**
2018	60	192	12	1264	258	14	0	**1801**
2019	192	184	18	1242	214	0	0	**1850**
2020	118	187	31	869	281	0	0	**1486**
2021	82	131	13	880	321	0	< 1	**1427**
2022	56	188	26	889	337	0	0	**1495**

Table 10.0b. Greater forkbeard *(Phycis blennoides)* in Subareas 1 and 2. Working group estimates of landings.

YEAR	NORWAY	FRANCE	RUSSIA	UK (SCOT)	UK (EWNI)	GERMANY	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**

YEAR	NORWAY	FRANCE	RUSSIA	UK (SCOT)	UK (EWNI)	GERMANY	FAROE ISLANDS	TOTAL
2016	187	0.3		0				**187**
2017	79	0.7		1				**80**
2018	60	0.1						**60**
2019	192	0.04						**192**
2020	118	0.1				0.0		**118**
2021	81	< 0.5	0	< 0.5	0	0	0	**82**
2022	56	<0.5		<0.5				**56**

Table 10.0c. Greater forkbeard *(Phycis blennoides)* in Subareas 3 and 4. Working group estimates of landings.

YEAR	FRANCE	NORWAY	UK (EWNI)	UK (SCOT)[(1)]	GERMANY	DENMARK	SWEDEN	NETHER-LANDS	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**

YEAR	FRANCE	NORWAY	UK (EWNI)	UK (SCOT)(1)	GERMANY	DENMARK	SWEDEN	NETHER-LANDS	TOTAL
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**
2017	1	140		9		5	0		**155**
2018	1	150		2		37	2		**192**
2019	3	113		3		65	0		**184**
2020	3	111		2	0.1	70		0.4	**187**
2021	3	78	0	3	**	46	0	0	**131**
2022	4	132	0	3	0	49	0		**188**

(1) Includes Moridae, in 2005 only data from January to June. *Preliminary landings data. **Negligible landings.

Table 10.0d. 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

YEAR	FRANCE	NORWAY	UK (SCOT)[1]	UK (EWNI)	FAROE ISLANDS	RUSSIA	ICELAND	TOTAL
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					2	34
2016	7	3	0				3	13
2016	7	3	0				3	13
2017	9		0					9
2018	5	7						12
2019	7	10						18
2020	7	24	0					31
2021*	6	7	0	0	0	0	0	13
2022	4	21	0					26

[1] Includes Moridae in 2005 only data from January to June. *Preliminary landings data.

Table 10.0e. Greater forkbeard *(Phycis blennoides*) in Subareas 6 and 7. Working group estimates of landings.

YEAR	FRANCE	IRE-LAND	NOR-WAY	SPAIN[1]	UK (EWNI)	UK (SCOT) [2]	GER-MANY	RUS-SIA	FAROE IS-LANDS	NETH-ER-LANDS	TO-TAL
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

YEAR	FRANCE	IRE-LAND	NOR-WAY	SPAIN(1)	UK (EWNI)	UK (SCOT) (2)	GER-MANY	RUS-SIA	FAROE IS-LANDS	NETH-ER-LANDS	TO-TAL
2015	451	37	135	716	26	105					1471
2016	412	13	97	641	13	90					1265
2017	431	6	134	399	14	88					1073
2018	458	10	203	453	20	121					1264
2019	430	18	187	498	13	95					1242
2020	360	18	72	339	18	62				0.5	869
2021	462	12	0	296	13	96	0	0	0.1	0.3	880
2022	390	3	76	339	8	70	0				889

(1) Landings of *Phycis* spp Included from 1988 to 2012.

(2)Includes Moridae in 2005 only data from January to June.

***Preliminary landings data.**

Table 10.0f. 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

YEAR	FRANCE	PORTUGAL	SPAIN(1)	UK(EWNI)	UK (SCOT)	TOTAL
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
2017	18	9	159		0	186
2018	31	9	218		0	258
2019	29	7	178	0	-	214
2020	38	5	238	0	0	281
2021	46	3	272	0	0	321
2022	50	3	283		0	337

(1) Landings of *Phycis spp* Included from 1988 to 2012. *Preliminary landings data.

Table 10.0g. 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

YEAR	PORTUGAL	FRANCE	TOTAL
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**
2017			**0**
2018	14		**14**
2019			**0**
2020			**0**
2021*	0	0	**0**
2022			**0**

***Preliminary landings data.**

Table 10.0h. 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							**0**
2014	0						**0**

YEAR	FRANCE	UK (SCOT)(1)	NORWAY	UK (EWNI)	SPAIN(2)	RUSSIA	TOTAL
2015							**0**
2016							**0**
2017							**0**
2018							**0**
2019							**0**
2020							**0**
2021	**	0	0.5	0	0	0	**0.5**
2022					0		**0**

(1)Includes Moridae in 2005 only data from January to June.
(2) Landings of *Phycis spp* Included from 1988 to 2012.
***Preliminary landings data. ** Negligible landings data.**

Table 10.0i. Greater forkbeard *(Phycis blennoides*). Working group estimates of landings. Catches inside and outside the NEAFC Regulatory Area (RA) as estimated by ICES for the stock in WGDEEP.

WGDEEP Stock gfb.27.nea	Catch Inside NEAFC RA (t)	Catch Out-side NEAFC RA (t)	Total Catches	Proportion of catch inside the NEAFC RA (%)	NEAFC RA areas where caught
2020	0	1486	1486	0%	
2019	0	1850	1850	0%	
2018	0	1801	1801	0%	
2017	0	1503	1503	0%	
2018	0	1801	1801	0%	
2019	0	1850	1850	0%	
2020	0	585	585	0%	
2021	0	1427	1427	0%	
2022	0	1495	1495	0%	

***Preliminary landings data.**

Table 10.1a. Greater forkbeard *(Phycis blennoides*). European landings (t) by métier in 2022.

Landings (t)	2022
Denmark	**49**
GNS_DEF	0.0
OTB_CRU	1.4
OTB_DEF	44.8
SSC_DEF	3.0

OTB_DWS	0.0
Ireland	**3**
MIS_MIS_0_0_0_HC	0.1
OTB_DEF_>=120_0_0_all	2.4
OTB_DEF_70-99_0_0_all	0.6
Portugal	**3**
MIS_MIS_0_0_0	3.3
OTB	0.2
Spain	**623**
MIS_MIS_0_0_0_HC	1.0
OTB_DWS_100-129_0_0	0.0
OTB_DEF_70-99_0_0	3.1
OTB_DEF_100-119_0_0	118.5
OTB_DEF_>=70_0_0	17.0
OTB_MCD_>=55_0_0	10.1
GNS_DEF_80-99_0_0	6.3
PTB_MPD_>=55_0_0	4.7
LLS_DEF_0_0_0	324.2
OTB_MPD_>=55_0_0	10.7
GNS_DEF_>=100_0_0	12.2
OTB_DEF_>=55_0_0	105.6
GNS_DEF_120-219_0_0	6.7
GNS_DEF_60-79_0_0	0.6
LHM_DEF_0_0_0	0.1
GTR_DEF_60-79_0_0	1.3
PS_SPF_0_0_0	0.0
OTB_MPD_>=70_0_0	0.7
LHM_SPF_0_0_0	0.0
UK (England)	**7**
GNS_DEF	2.3
LLS_DEF	0.4
MIS_MIS_0_0_0_HC	0.2
OTB_DEF	4.0
UK(Scotland)	**73**
LLS_DEF_0_0_0_all	8.5
MIS_MIS_0_0_0_HC	1.9
OTB_DEF_>=120_0_0_all	61.9
OTB_CRU_70-99_0_0_all	0.8
France	**449**
LLS_DEF	46.6
MIS_MIS_0_0_0	8.9
OTB_DEF_70-99_0_0	3.6
OTB_DEF_100-119_0_0	48.9
OTT-DWS	1.4
GNS_DEF_100-119_0_0_all	38.1
OTT_DEF_100-119_0_0	49.7

OTT_DEF_>=70_0_0	10.1
OTB_DEF_>=70_0_0	2.8
OTB_DEF_>=120_0_0	130.2
OTB_DWS_>=120_0_0_all	71.5
OTT_CRU_100-119_0_0	0.4
OTT_DEF_70-99_0_0	0.0
GNS_DEF_120-219_0_0_all	0.0
OTB_CRU_100-119_0_0_all	3.1
OTM_DEF_100-119_0_0_all	0.0
OTT_DEF_>=120_0_0_all	33.1
OTB_DEF_32-69_0_0	0.0
OTB_CRU_70-99_0_0_all	0.0
OTT_CRU_70-99_0_0_all	0.0
Germany	**0**
OTB_DEF	0.0
Netherlands	**3**
OTM_SPF_32-69_0_0_all	2.5
Norway	**286**
GNS_DEF	27.3
LLS_DEF	222.5
OTB_DEF	35.9
SDN_DEF	0.1
FPO_DEF	0.4
UK(Northern Ireland)	**0**
GNS_DEF_100-119_0_0_all	0.4
Sweden	**0**
MIS_MIS_0_0_0_HC	0.0
OTB_DEF_>=120_0_0_all	0.0
OTB_CRU_32-69_2_22_all	0.0
GNS_DEF_all_0_0_all	0.0
OTB_CRU_90-119_0_0_all	0.0
MIS_MIS_0_0_0_IBC	0.0
LLS_FIF_0_0_0_all	0.0
OTB_CRU_70-89_2_35_all	0.0
OTB_CRU_32-69_0_0_all	0.0
GTR_DEF_all_0_0_all	0.0
FPO_CRU_0_0_0_all	0.0
SDN_DEF_>=120_0_0_all	0.0
Total	**1496.2**

Table 10.2a. Greater forkbeard ***(Phycis blennoides*)**. Reported of total discards (ton) of *P. blennoides* from 2014 to 2022 and proportion in the catches.**

ton	2014	2015	2016	2017	2018	2019	2020	2021	2022
DISCARDS	1166	2068	677	513	263	366	256	215	332
LANDINGS	2269	2175	2012	1503	1801	1850	1486	1427	1495
CATCHES	3435	4243	2689	2016	2064	2216	1742	1642	1827

DISCARDS/CATCHES	34%	49%	25%	25%	13%	17%	15%	13%	18%

Table 10.2b. Greater forkbeard (*Phycis blennoides*). Reported discards (ton) of P. blennoides from 2013 to 2022 by subarea.

subarea	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2								0	0	0
3	0.9	2	0	6	3	10	10	0	1	3
4	334	7	83	99	279	57	42	27	8	18
5			1	7	0	0		0	0	0
6	769	647	1359	225	51	47	45	32	65	38
7			256	301	131	74	245	167	106	254
8	82	510	302	25	39	67	18	30	25	12
9			67	15	10	7	6		10	6
TOTAL	1185	1166	2068	677	513	263	366	256	215	332

Table 10.3. Greater forkbeard (*Phycis blennoides*). Annual mean CPUE (Kg/trip) and GLM estimates, of the Portuguese Reference fleet as well as, upper and lower limits of the 95% CPUE confidence intervals for the period 2013-2020.

year	Observation (kg/trip)	CPUE Upper limit	CPUE Estimate (Kg/trip)	CPUE Lower limit
2013	10.39	13.43	10.39	8.04
2014	11.88	16.07	12.25	9.34
2015	10.83	16.09	12.32	9.43
2016	10.28	13.96	10.74	8.27
2017	9.81	12.72	9.68	7.37
2018	10.59	13.43	10.17	7.7
2019	8.83	12.56	9.57	7.29
2020	8.35	11.66	8.88	6.77

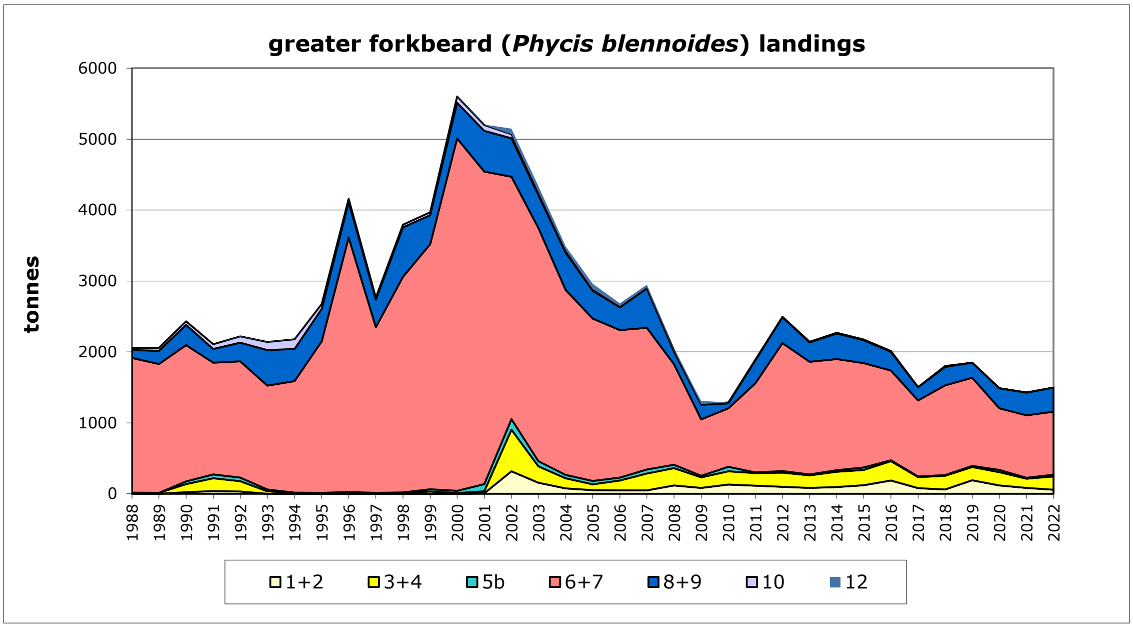

Figure 10.1. Greater forkbeard landing trends in all ICES subareas since 1988.

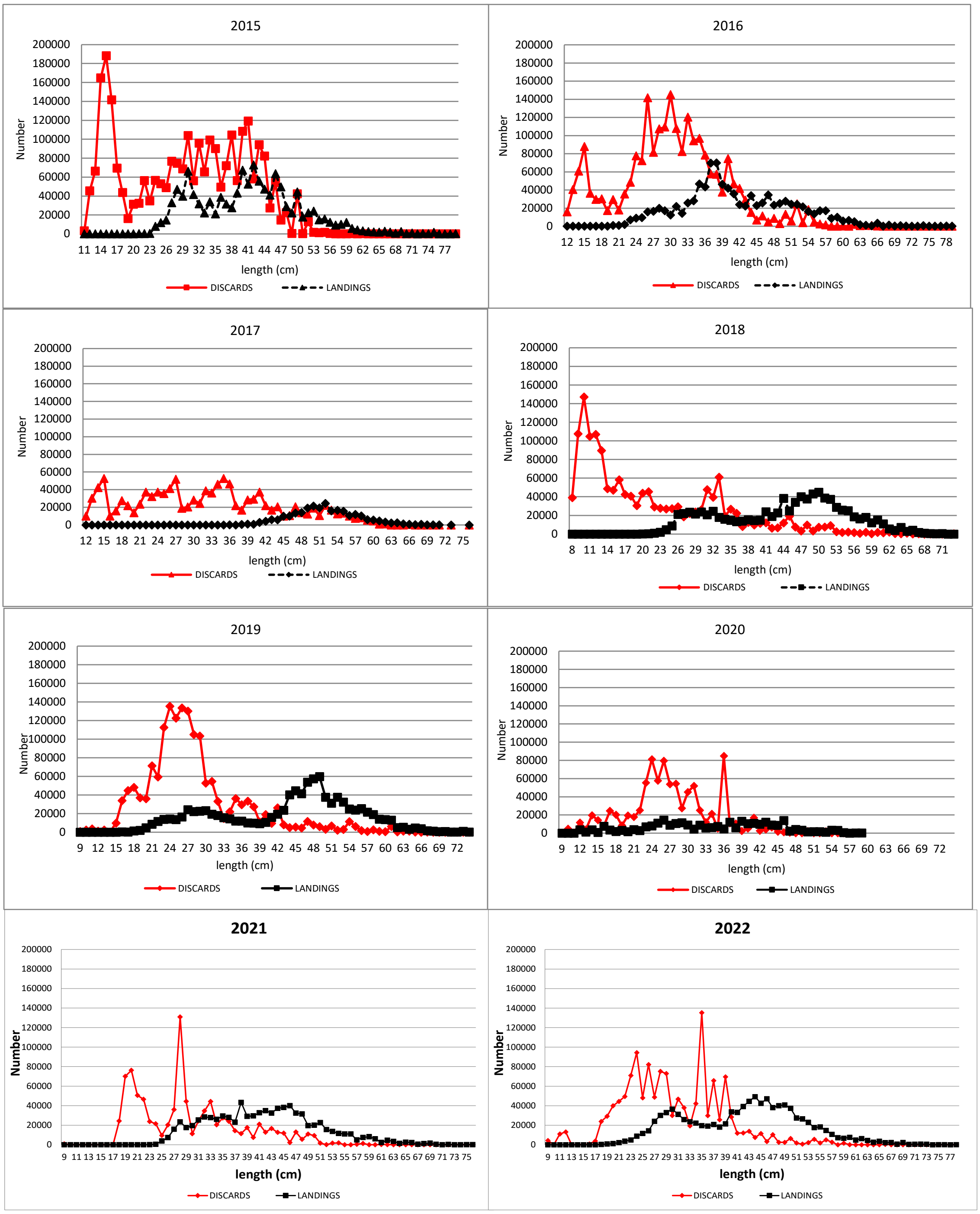

Figure 10.2a. Commercial length frequencies of the greater forkbeard landings and discards from 2015 to 2022 from France, Spain, Ireland, Portugal, Denmark, Sweden, UK (England), and UK (Scotland).

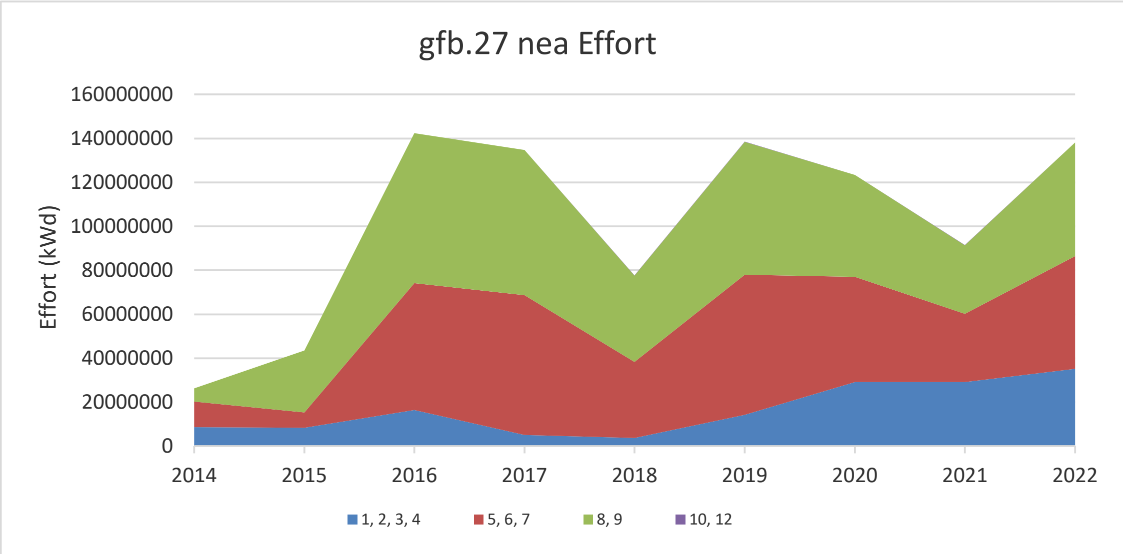

Figure 10.2b. Effort data (kWd) by stock units since 2014 of the Spanish, French, Swedish, UK (Scotland) and Irish fleets.

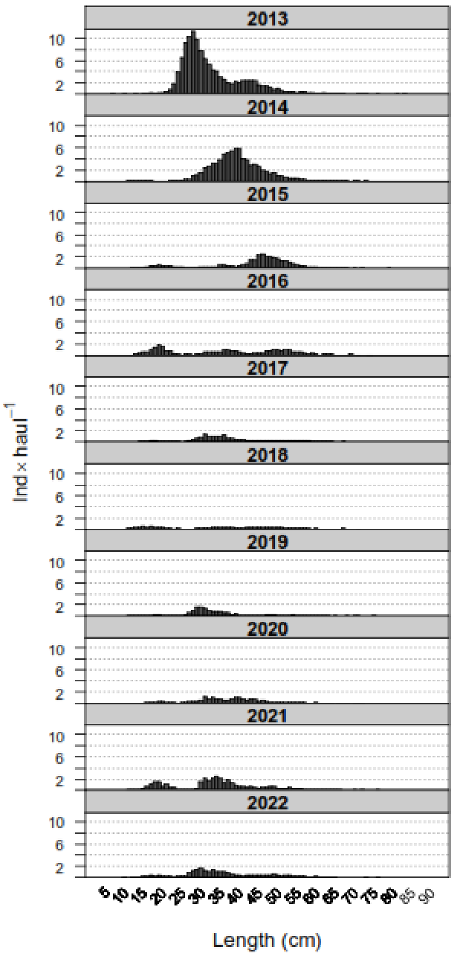

Figure 10.3. Mean stratified length distributions of greater forkbeard (*P. blennoides*) in Porcupine survey (Divisions 7.c and 7.k) time-series (2012–2022).

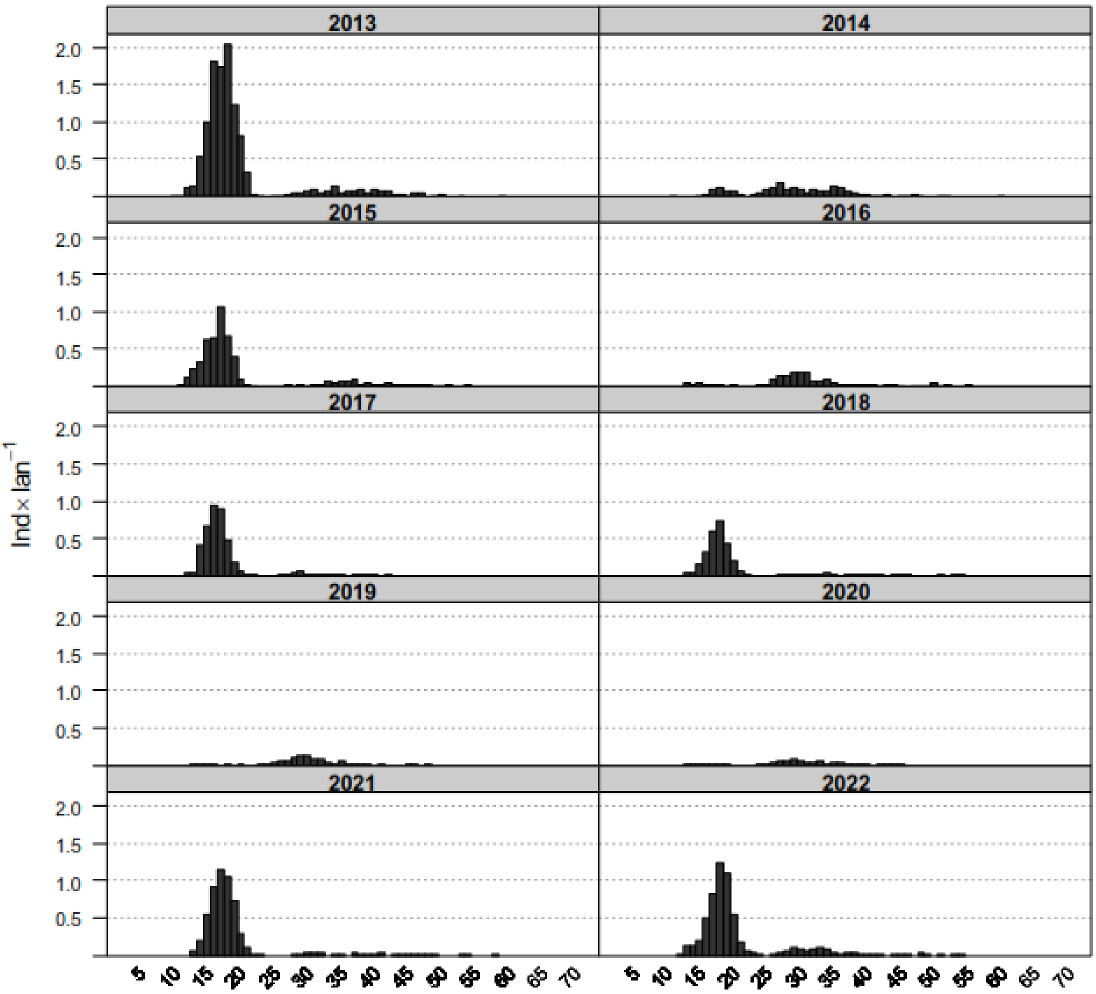

Figure 10. 4. Mean stratified length distributions of greater forkbeard (*P. blennoides*) in Northern Spanish Shelf survey (8.c and 9.a) in the period 2009–2022.

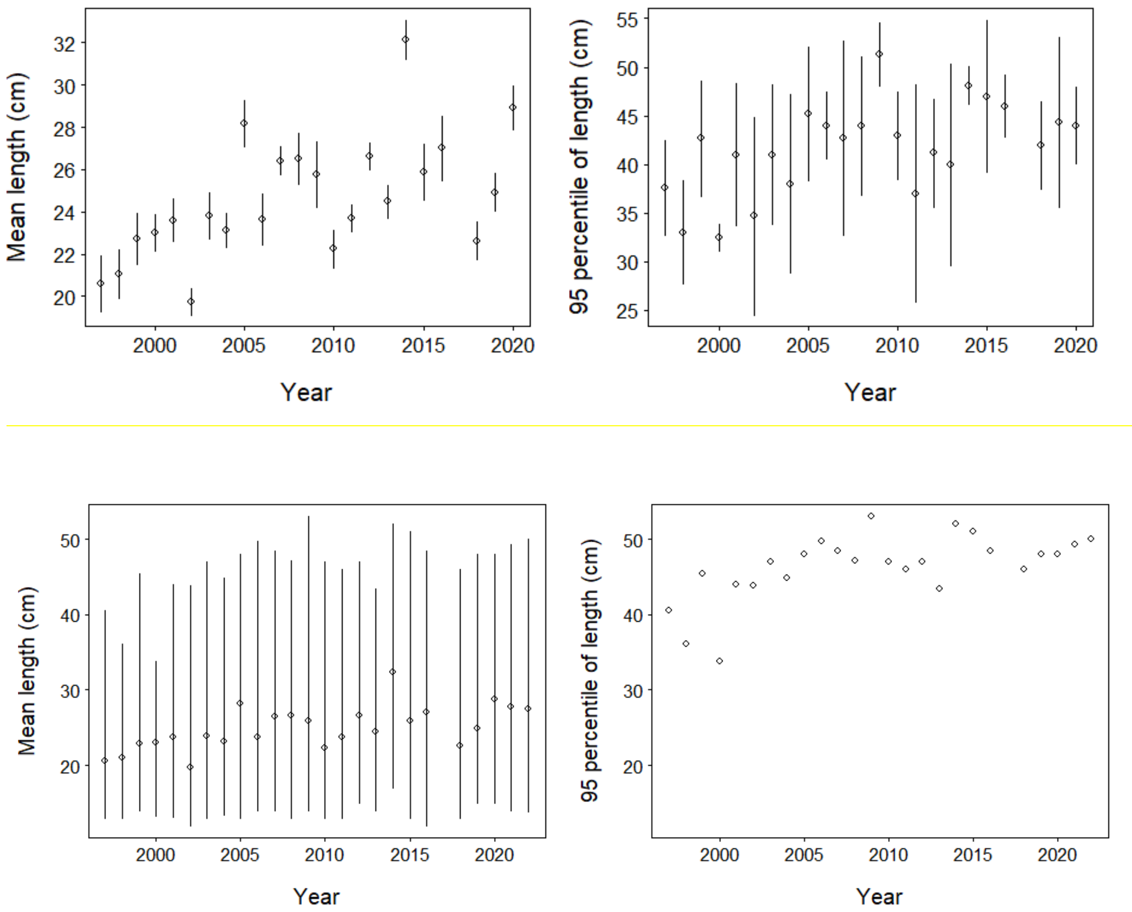

Figure 10.5. Greater forkbeard series of mean length from the French IBTS survey Divisions 7.fghj and 8.abd until 2022.

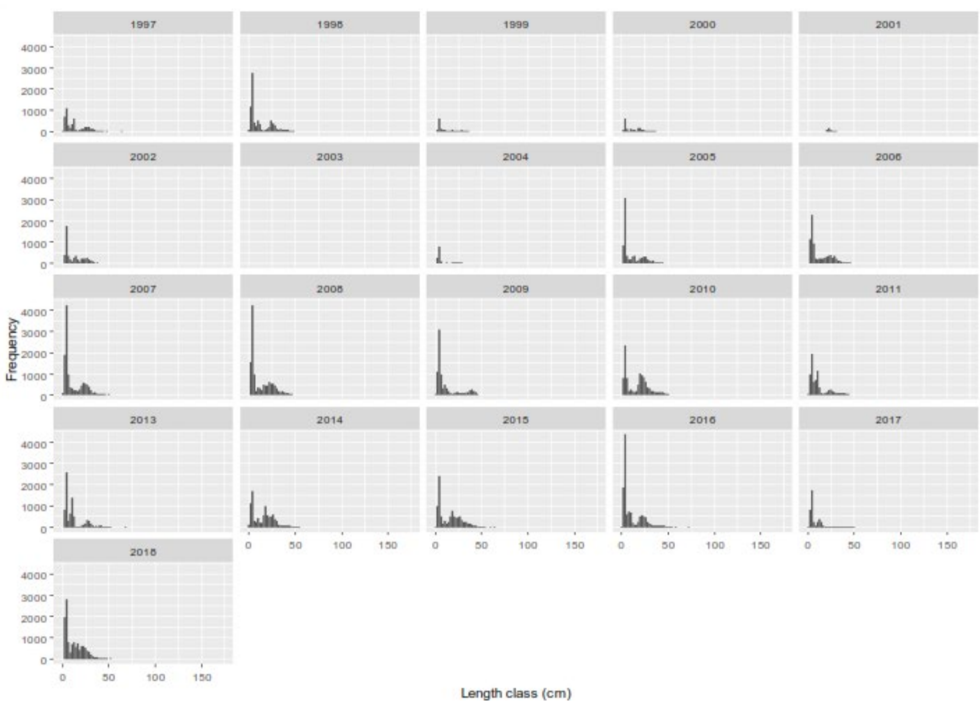

Figure 10.6a. Length frequency distribution of the greater forkbeard in the PT-CTS (UWTV (FU 28-29) until 2018.

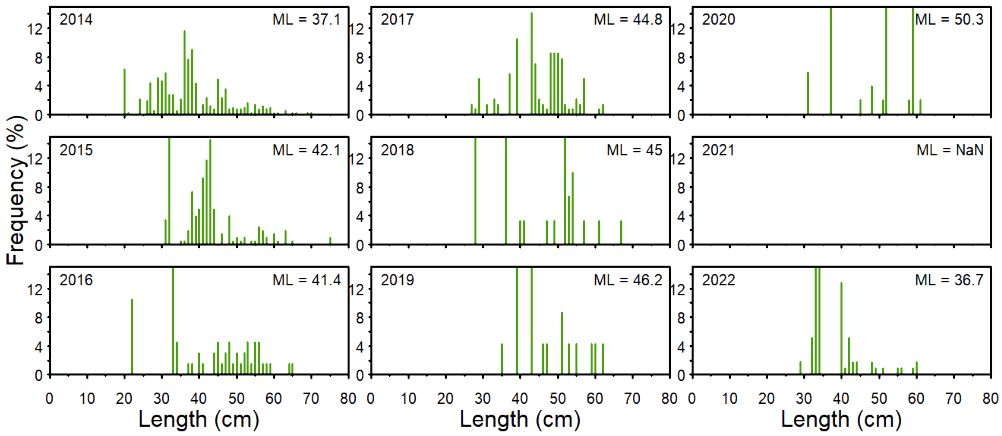

Figure 10.6b. Length-frequency distribution from the deepwater survey in 2014-2022 (no survey in 2021).

Figure 10.6c. Age proportion of the Spanish commercial fleets from 2011 to 2022 in subareas 7, 8 and Division 9a.

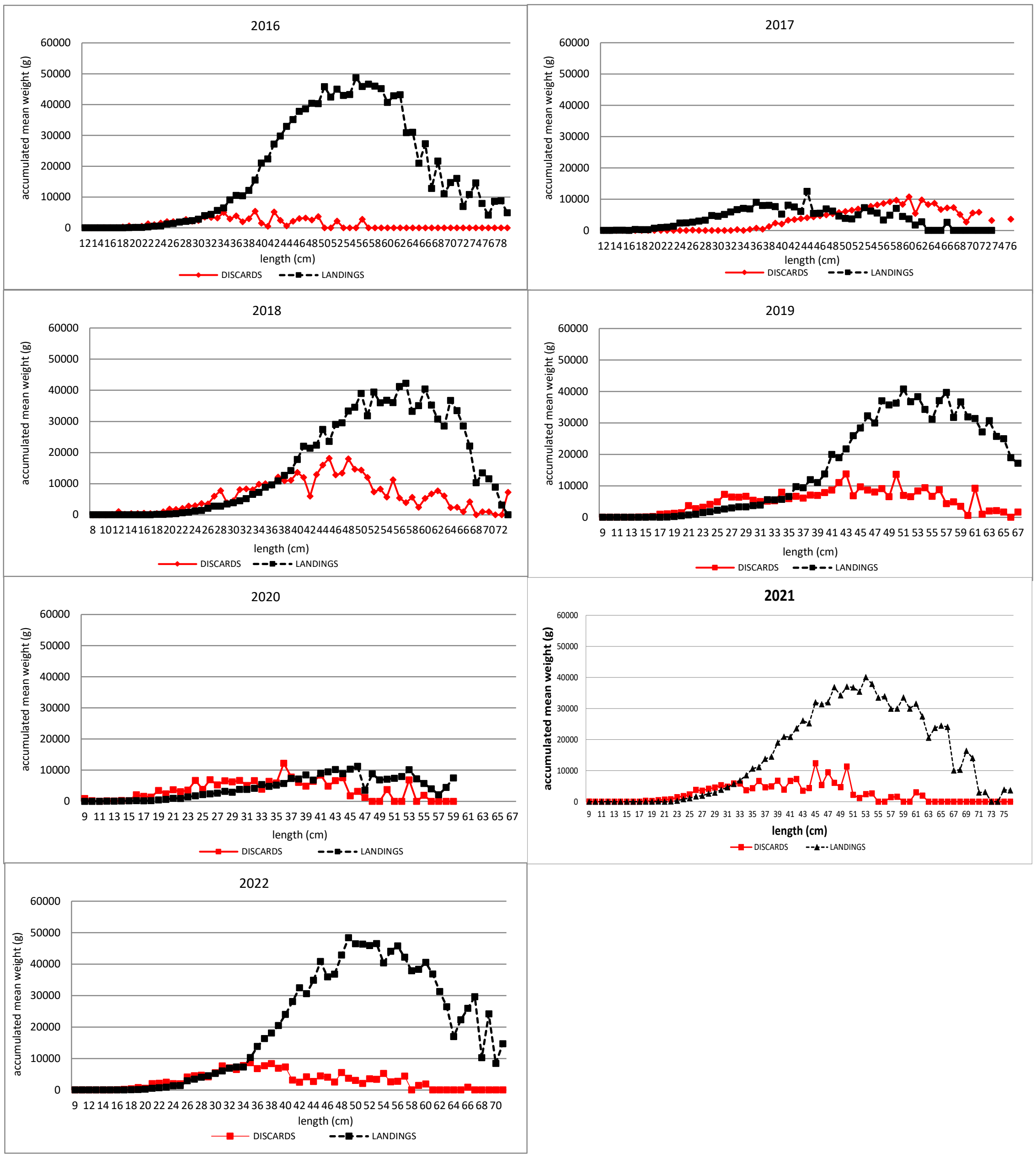

Figure 10.7 Accumulated mean weight at length of the international commercial landings and discards reported to InterCatch from 2016 to 2022.

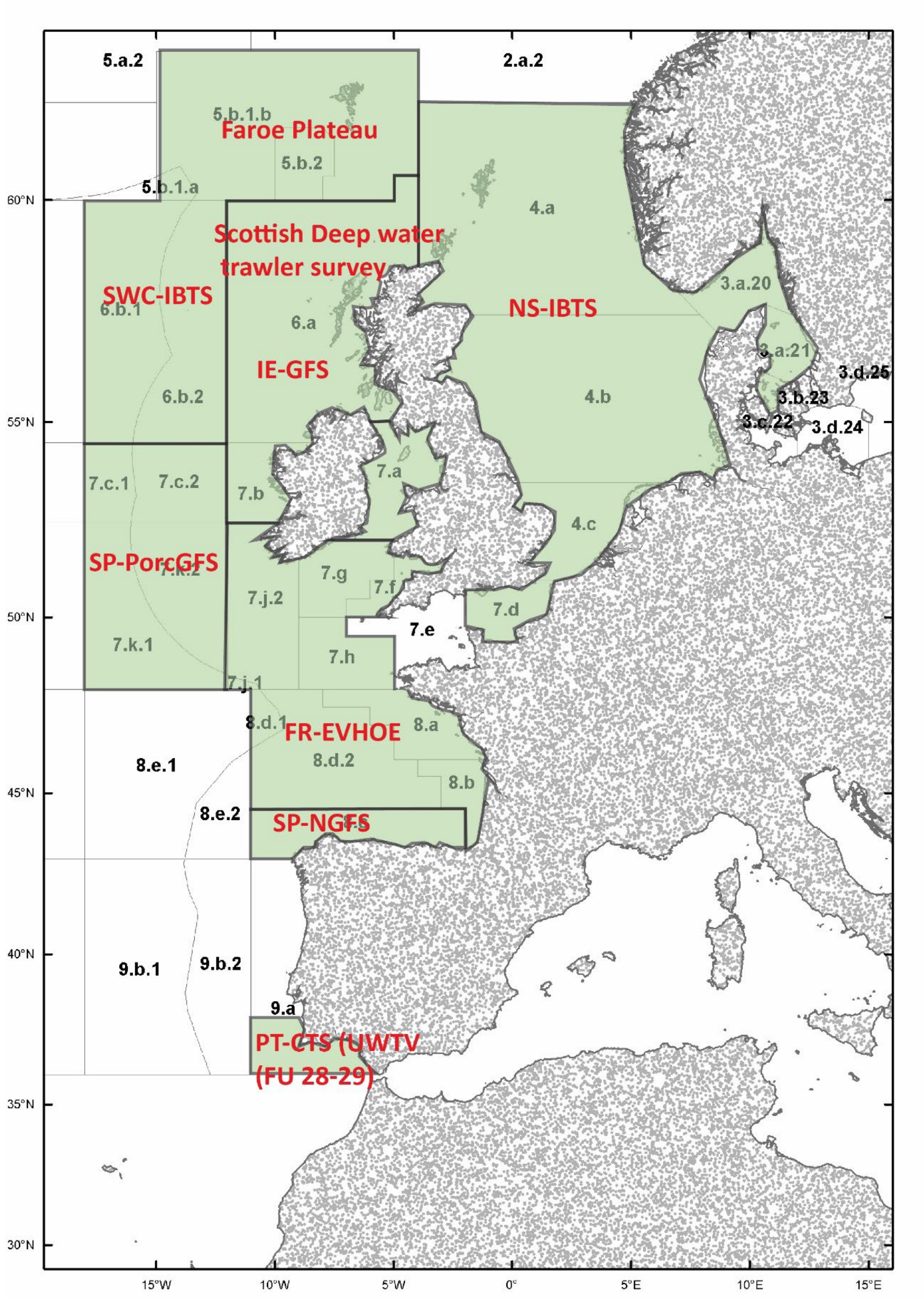

Figure 10.8. Map of the Divisions covered by the nine surveys used in the trend analysis of abundance and biomass of GFB.

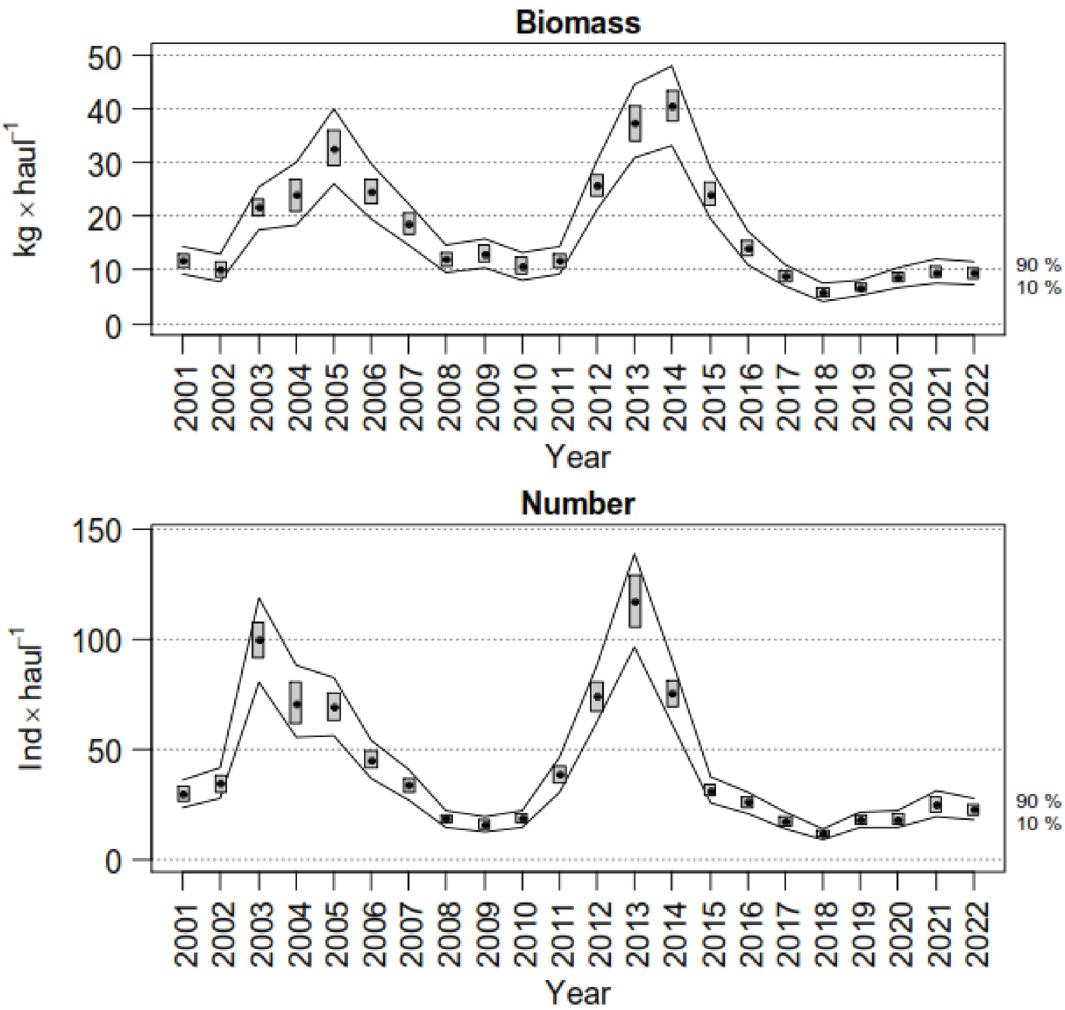

Figure 10.9. Evolution of *Phycis blennoides* biomass and abundance indices during Porcupine Survey time-series (2001–2022) in Divisions 7.c and 7.k. Boxes mark parametric standard error of the stratified abundance index. Lines mark boot-strap confidence intervals (α= 0.80, bootstrap iterations = 1000).

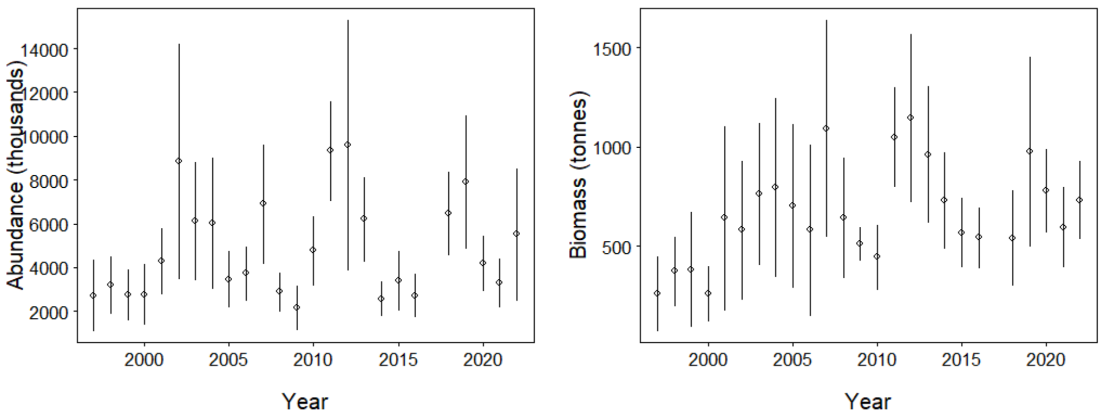

Figure 10.10. Greater forkbeard series of abundance and biomass of the French EVHOE IBTS survey in the Divisions 7.fghj and 8.abd combined until 2022.

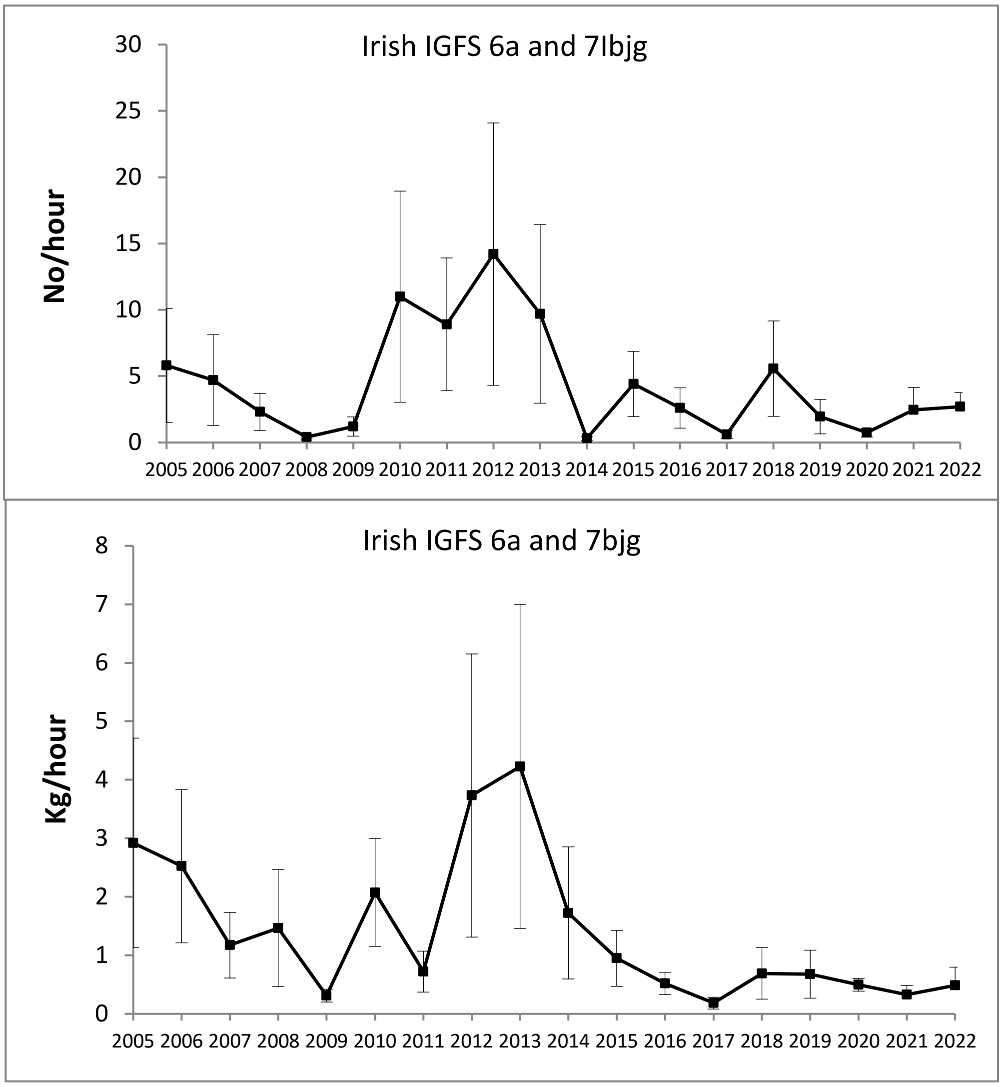

Figure 10.11. Abundance and biomass Indices (no. per hour and kg per hour) of Greater forkbeard total catches of the Irish IGFS Survey in the slope and shelf strata, 2005–2022.

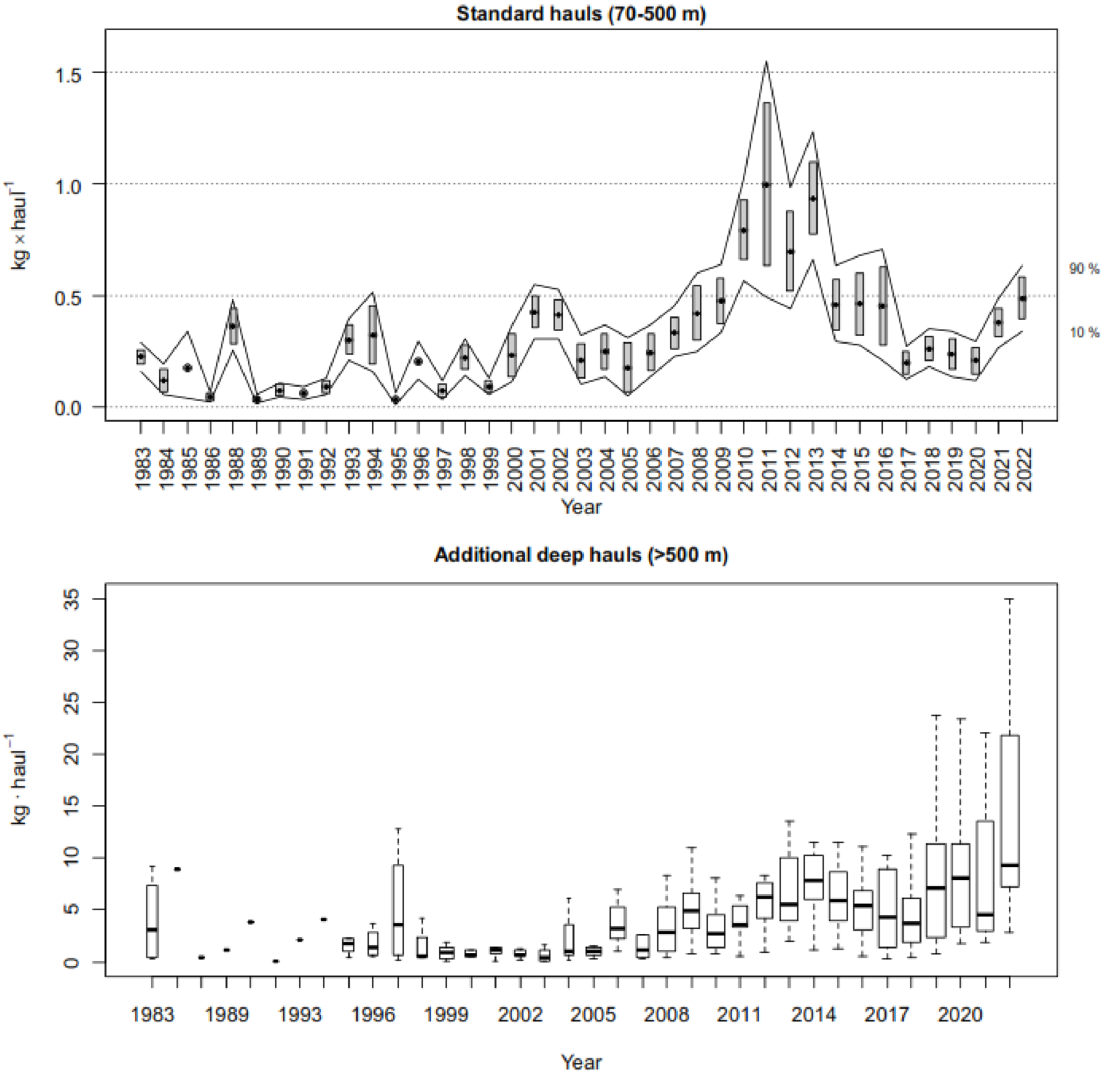

Figure 10.12. Evolution of *Phycis blennoides* stratified biomass index in standard hauls and additional deep hauls during the North Spanish shelf bottom trawl survey time series (1983-2022). For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartile of the biomass catches in the deep hauls performed.

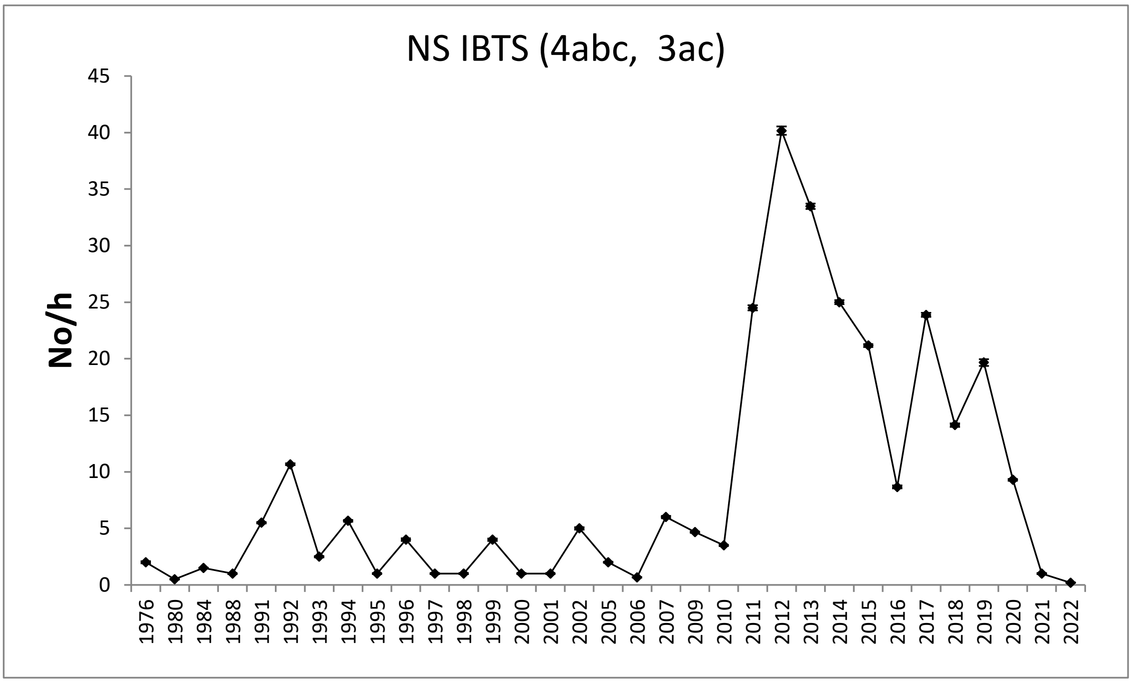

Figure 10.13. Greater forkbeard series of abundance (No/hour) of the North Sea IBTS survey (NS-IBTS) until 2022 in Divisions 4.abc and 3.ac.

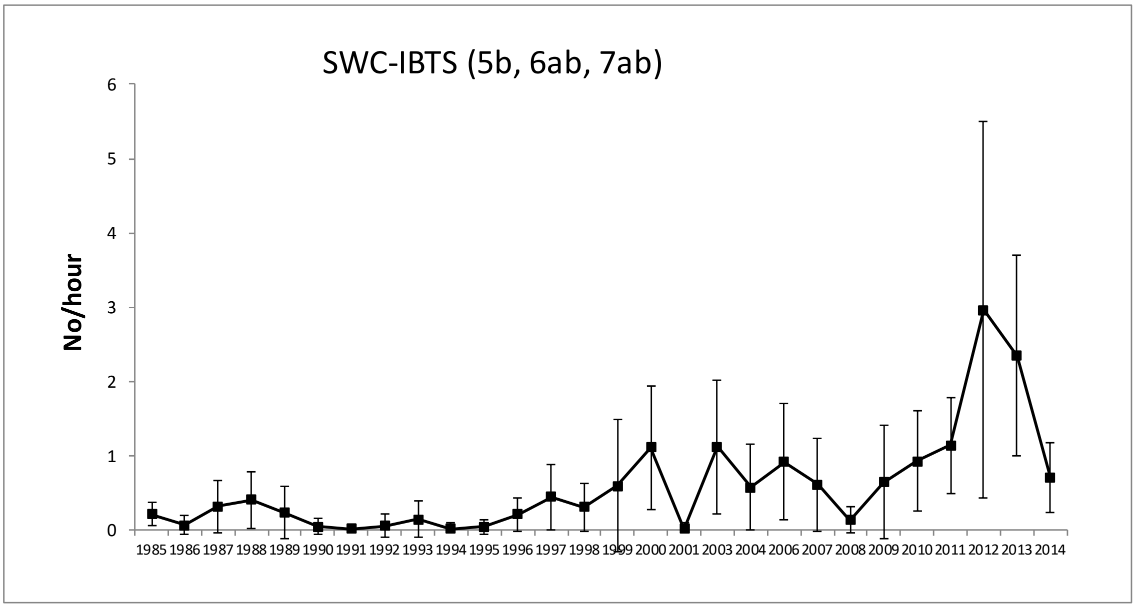

Figure 10.14. Greater forkbeard series of abundance (No/hour) of the Scottish Western Coast Groundfish IBTS survey (SWC-IBTS) until 2014 in Divisions 5.b, 6.ab and 7.ab.

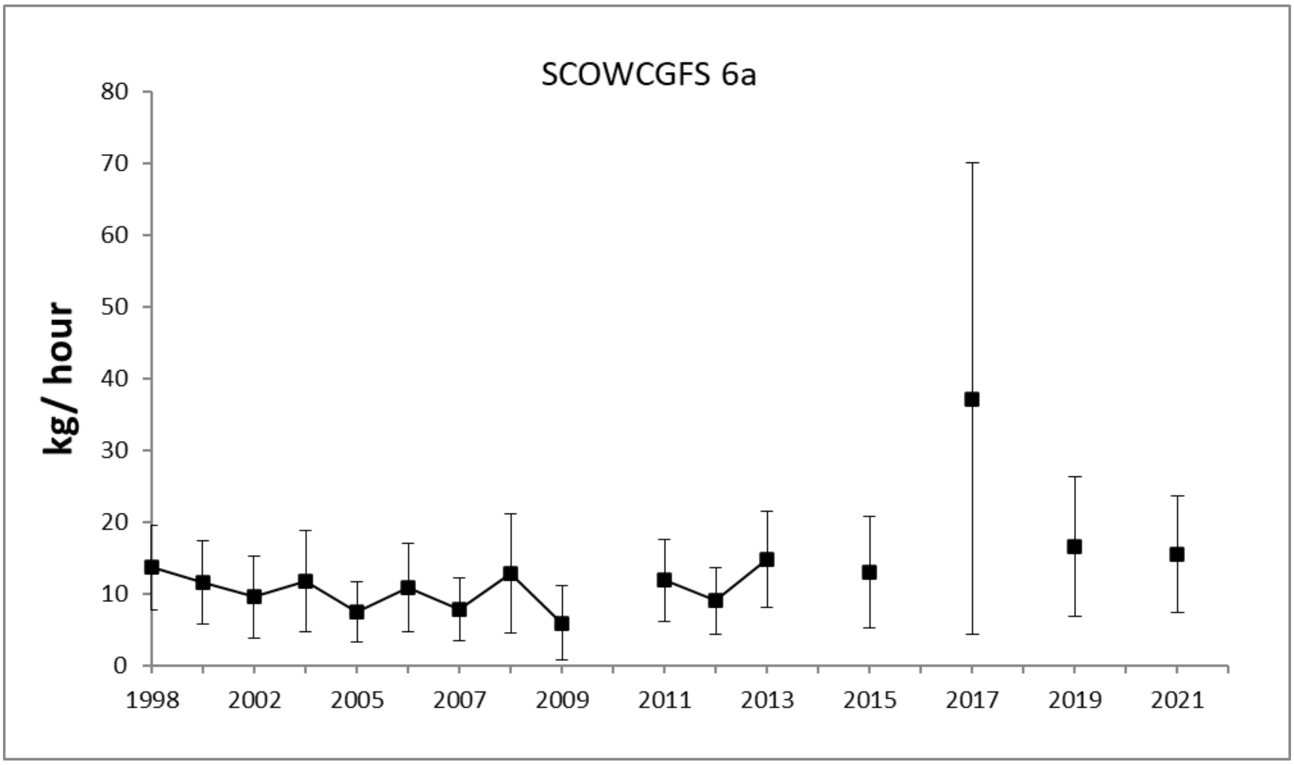

Figure 10.15. Greater forkbeard series of biomass (kg/hour) and abundance (No/hour) of the Scottish Deep-water trawl survey in ICES Division 6.a between 1998 and 2021.

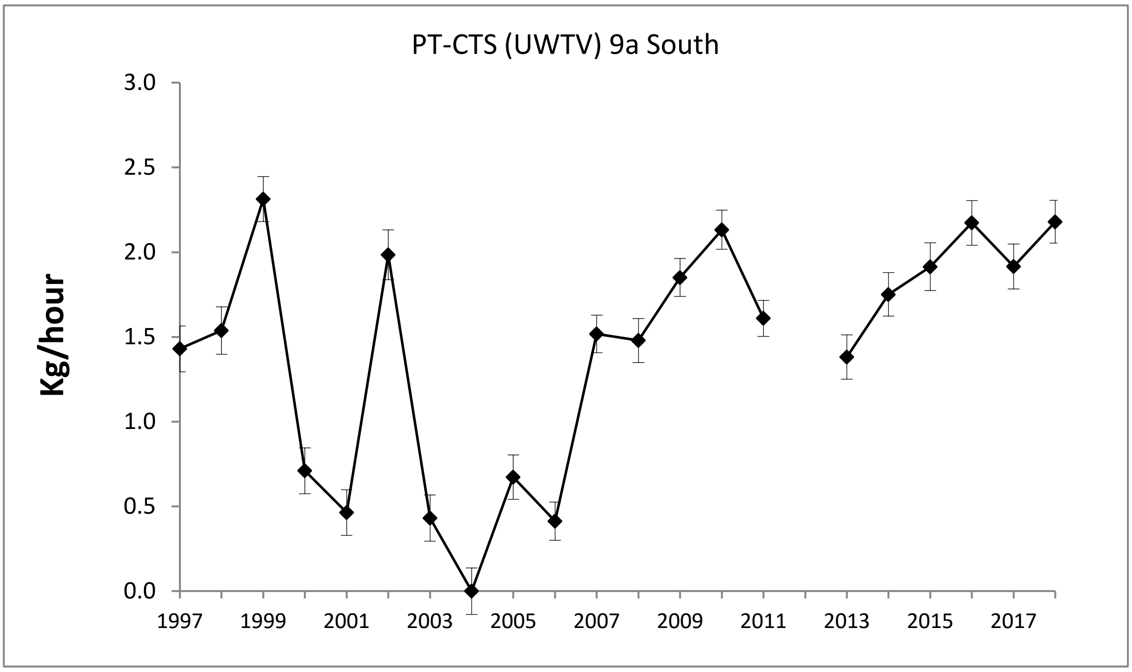

Figure 10.16. Greater forkbeard series of Standardized biomass index (kg.hour-1) of the Portuguese PT-CTS (UWTV (FU 28–29) survey until 2019 in the Division 9.a South. CPUE values estimated for the sector "Milfontes".

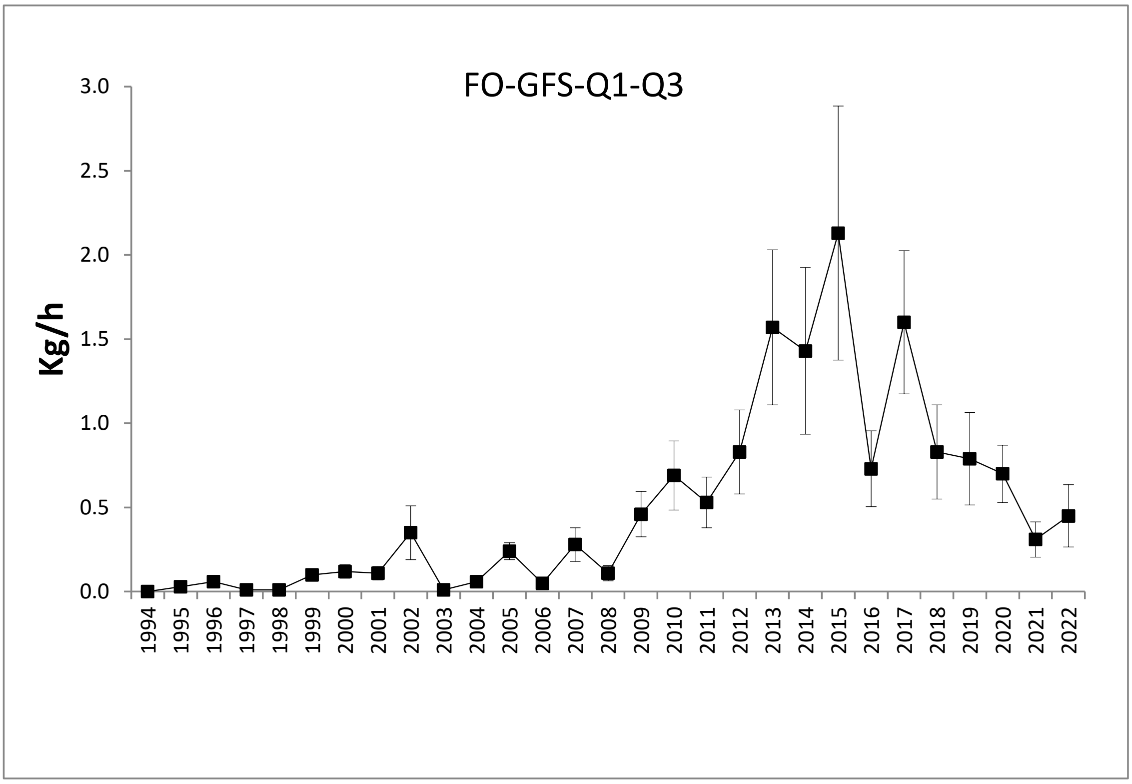

Figure 10.17. Faroe Plateau survey in Division 5b. Data of Biomass (kg/h) from 1994 to 2022 in the combined spring and summer surveys.

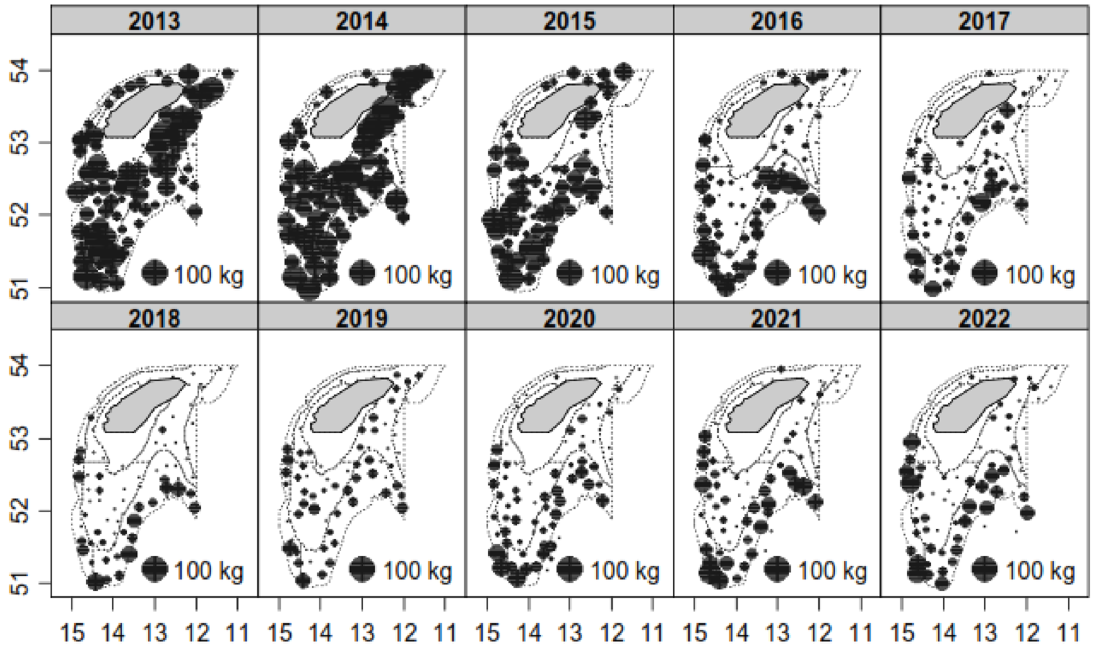

Figure 10.18. Geographic distribution of *Phycis blennoides* catches (kg×30 min haul^{-1}) and recruits (1-25 cm) in the Porcupine surveys (2014-2022).

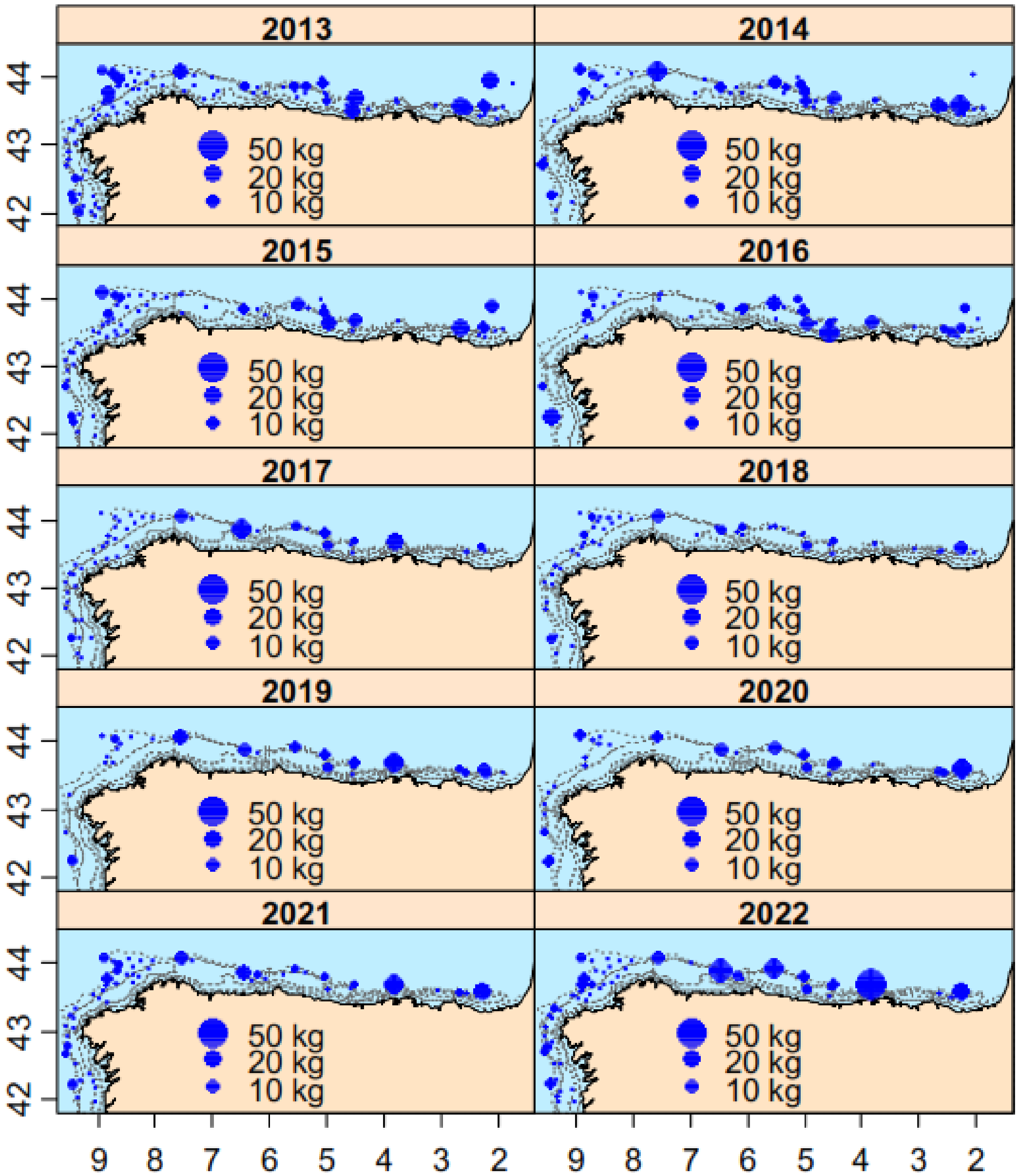

Figure 10.19. Catches in biomass of greater forkbeard on the Northern Spanish Shelf bottom-trawl surveys between 2012 and 2022.

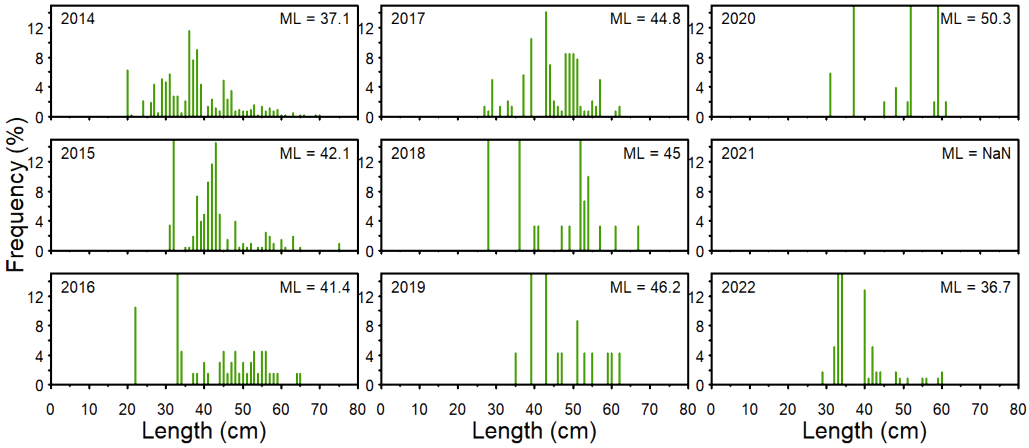

Figure 10.20. Length-frequency distribution from the Faroes deepwater survey from 2014 to 2022 (no survey in 2021).

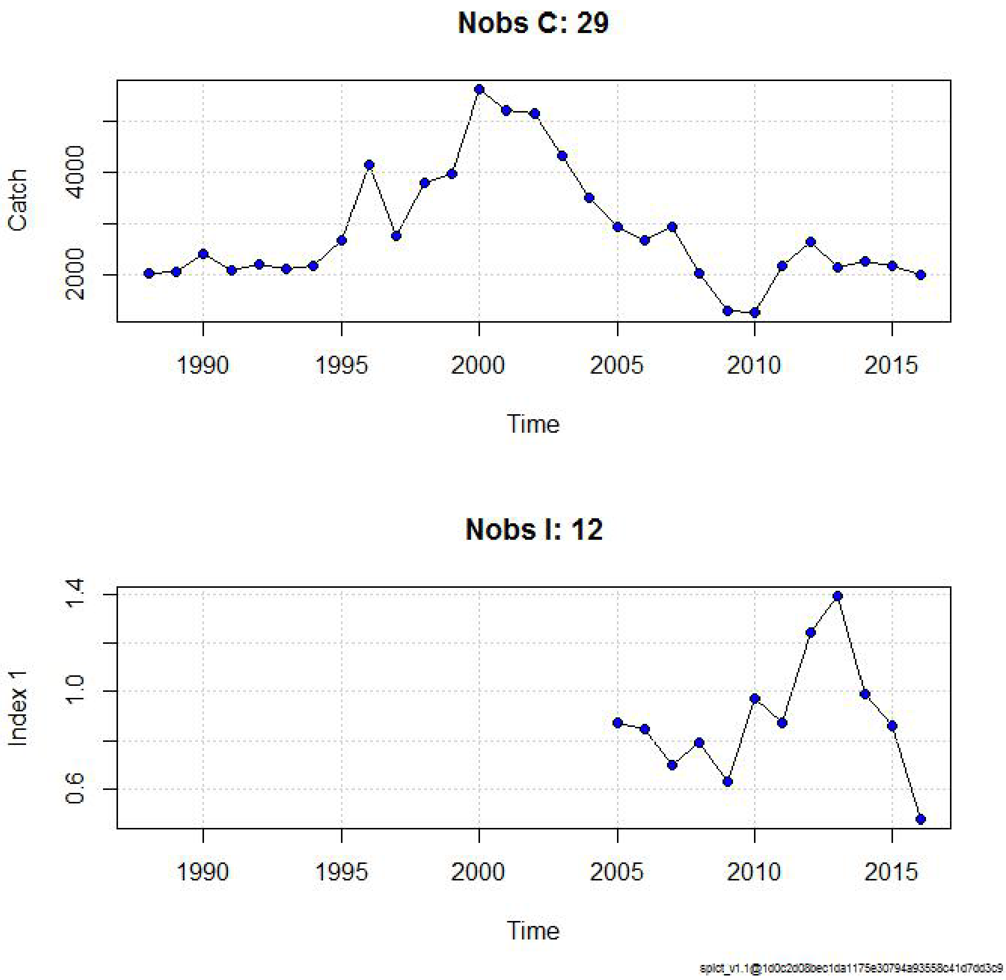

Figure 10.21. Inputs of the SPICT model used in the Greater Forkbeard stock.

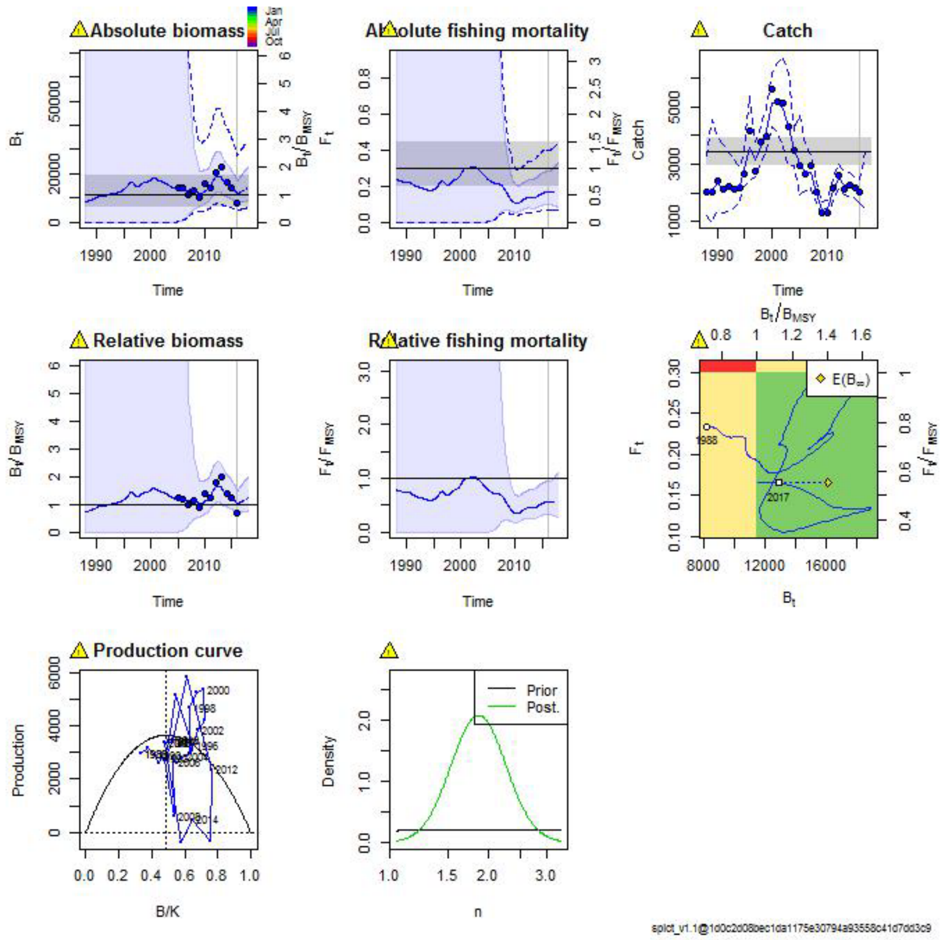

Figure 10.22. Results of the SPICT model for the Greater Forkbeard stock.

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11 Alfonsinos/Golden eye perch (*Beryx* spp.) in all ecoregions

11.1 The fishery

Alfonsinos includes two species, *Beryx splendens* and *Beryx decadactylus*. Both are generally considered as bycatch species in the demersal trawl and longline mixed fisheries targeting other deep-water species. For most of the fisheries, the catches of alfonsinos are reported under a single category, as *Beryx* spp.

The proportion of each species in the catches is not well known. Detailed landings data by species are available only for the Portuguese (Azores) hook and line fishery in Division 10a2, where the landings of *B. decadactylus* averaged 20% of the catches of both species in the last twenty years. Russian trawl fishery targeted *B. splendens* till 2000. Portuguese, Spanish and French trawlers and longliners are the main fleets involved in this fishery.

Landings from a targeted fishery by Russian vessels operating in the NEAFC area (ICES Division 10.b) were available for the period 1993–2000 and some minor landings as bycatch in fisheries targeting other species since 2000. Since 2000, there are no target fisheries occurring in the Mid-Atlantic Ridge (NEAFC) (see Section 4).

Currently, landings are reported from bycatch fisheries occurring 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 11.1 c, d and e).

11.1.1 Landings trends

The available landings data for alfonsinos (*Beryx* spp.) by ICES subarea/division as officially reported to ICES or to the WGDEEP, are presented in Tables 11.1(a–g), 11.2 and 11.3 and Figures 11.1–11.2. Total landings are stabilized since 2005, due to EU management measures introduced (TAC/quotas and effort regulation), being around 327 tonnes between 2005 and 2022, with high landings during 2012 (605 t).

11.1.2 ICES Advice

ICES advised that when the precautionary approach is applied, landings should be no more than 179 tonnes in each of the years 2023 and 2024. ICES cannot quantify the corresponding catches.

11.2 Management

Fishing with trawl gears is forbidden in the Azores region (EC. Reg. 1568/2005). A box of 100 miles limiting deep-water fishing to vessels registered in the Azores was created in 2003 under the management of fishing effort of the CFP for deep-water species (EC. Reg. 1954/2003). An EU TAC of 179 t for EC vessels is in force for the period 2023–2024 (see historical developments in the table down).

Technical measures were introduced in the Azores in 1998. In 2009 new measures were adopted, particularly to control the effort of longliners through restrictions on fishing area, minimum length, gear and effort. These measures were updated from 2015–2019. A network of MPAs was 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.

NEAFC adopted effort regulations for fisheries targeting deep-water species and in 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* spp.	2005	3, 4, 5, 6, 7, 8, 9, 10, 12	328	422
	Beryx spp.	2006	3, 4, 5, 6, 7, 8, 9, 10, 12	328	367
Reg 2015/2006	*Beryx* spp.	2007	3, 4, 5, 6, 7, 8, 9, 10, 12	328	396
	Beryx spp.	2008	3, 4, 5, 6, 7, 8, 9, 10, 12	328	405
Reg 1359/2008	*Beryx* spp.	2009	3, 4, 5, 6, 7, 8, 9, 10, 12	328	382
	Beryx spp.	2010	3, 4, 5, 6, 7, 8, 9, 10, 12	328	296
Reg 1225/2010	*Beryx* spp.	2011	3, 4, 5, 6, 7, 8, 9, 10, 12	328	331
	Beryx spp.	2012	3, 4, 5, 6, 7, 8, 9, 10, 12	328	596
Reg 1262/2012	*Beryx* spp.	2013	3, 4, 5, 6, 7, 8, 9, 10, 12	312	272
	Beryx spp.	2014	3, 4, 5, 6, 7, 8, 9, 10, 12	296	282
Reg. 1367/2014	*Beryx* spp.	2015	3, 4, 5, 6, 7, 8, 9, 10, 12	296	365
	Beryx spp.	2016	3, 4, 5, 6, 7, 8, 9, 10, 12	296	300
Reg. 2285/2016	*Beryx* spp.	2017	3, 4, 5, 6, 7, 8, 9, 10, 12	280	240
	Beryx spp.	2018	3, 4, 5, 6, 7, 8, 9, 10, 12	280	263
Reg. 2025/2018	*Beryx* spp.	2019	3, 4, 5, 6, 7, 8, 9, 10, 12	252	294
	Beryx spp.	2020	3, 4, 5, 6, 7, 8, 9, 10, 12	252	233
Reg. 1239/2021	*Beryx* spp.	2021	3, 4, 5, 6, 7, 8, 9, 10, 12	224	205
	Beryx spp.	2022	3, 4, 5, 6, 7, 8, 9, 10, 12	224	
Reg. 194/2023	*Beryx* spp.	2023	3, 4, 5, 6, 7, 8, 9, 10, 12, 14	179	
	Beryx spp.	2024	3, 4, 5, 6, 7, 8, 9, 10, 12, 14	179	

11.3 Stock identity

No new information.

11.4 Data available

11.4.1 Landings and discards

Tables 11.1a–g, describe the alfonsinos landings by subarea and country. In 2014 discards estimates for the Azorean longliners were reported (WD Pinho, 2014). Annual longline discard estimates by year for the sampled trip vessels with alfonsinos catches during the period 2004–2011 range from 0.8% to 8.6% for *B splendens* and 0.07% to 10.2% for the *B. decadactylus* (Table 11.4). In 2018, discards of combined alfonsinos from longline fisheries represented about 5.8% (8.6 t) of total landings. These discards are mostly a result of the Azorean management measures such as TAC and minimum length.

11.4.2 Length compositions

Length data from the Azorean spring bottom longline survey were not updated because the 2022 cruise was not conducted. No new information was available from the Azorean fishery.

Length information from the Northern Spanish Shelf Groundfish Survey (Divisions 8c and Northern part of 9a; SPNGFS) and Spanish Groundfish Survey on the Porcupine Bank (ICES Divisions 7c and 7k; SP-PORCQ3) was made available for 2022 in WD9 Fernández-Zapico *et al.* (2023) and WD10 Ruiz-Pico *et al.*(2023).

11.4.3 Age compositions

No new information.

11.4.4 Weight-at-age

No new information.

11.4.5 Maturity, sex-ratio, length–weight and natural mortality

No new information.

11.5 Data analyses

Total landings declined in the late 1990s and since 2003 stabilized at about 357 tonnes (for the two species combined), with a peak of 605 tonnes in 2012 due to the landings reported by Spain for subareas 6–7 (Figure 11.1). Species-specific landings trends in the Azores fishery showed similar trends for both species (Figure 11.2).

Beryx spp. were found in two hauls between 540 m and 589 m in Galician waters and in three hauls between 530 m and 609 m in the Cantabrian Sea (Figures 11.3–11.4). Five specimens were *B. decadactylus*, ranging between 25 and 32 cm, and one was *B. splendens* with 29 cm. In the Porcupine Bank, three specimens of *B. splendens* with 25, 29 and 30 cm were found in the southern part of the bank. *B. decadatylus* was only caught in the eastern area (two specimens with 28 and 30 cm, in one haul).

11.6 Comments on the assessment

No assessment was carryout this here.

11.7 Management considerations

The spatial distribution of the two *Beryx* species is closely associated with seamounts (Figures 11.5–11.7). This behaviour as well as their life history make them particularly vulnerable to exploitation being easily overexploited by trawl fishing. Given their life strategy, it is admitted that both species can only sustain low rates of exploitation.

The population dynamics *Beryx* species are uncertain (Santos *et al.*, 2019). Age estimates suggest high longevity (>50 years), while other suggest a longevity of about 15 years.

Because of their biology and aggregative behaviour, fisheries on those species should not be allowed to expand above current levels unless it can be demonstrated that such expansion is sustainable. Furthermore, to prevent wiping out entire subpopulations that have not yet been mapped and assessed the exploitation of new seamounts should not be allowed.

11.8 References

Fernández-Zapico, O.; Ruiz-Pico, S.; Blanco, M.; González-Irusta, J.M.; Punzón,A.; Velasco, F. Results on greater forkbeard (*Phycis blennoides*), Spanish ling (*Molva macrophthalma*), roughsnout grenadier (*Trachyrincus scabrus*), bluemouth (*Helicolenus dactylopterus*) and other scarce deep water species on the 2022 Northern Spanish Shelf Groundfish Survey. Working Document (WD9). ICES Working Group on Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 3-9 May 2023.

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11.9 Tables and Figures

Table 11.1a. 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**

YEAR	FRANCE	TOTAL
2015	0	**0**
2016	0	**0**
2017	0	**0**
2018	3	**3**
2019	0	**0**
2020	0	**0**
2021	0	**0**
2022*	0	**0**

***Preliminary.**

Table 11.1b. Alfonsinos (*Beryx* spp.) from Division 5.b.

YEAR	FAROES	FRANCE	TOTAL
1988			**0**
1989			**0**
1990		5	**5**
1991		0	**0**
1992		4	**4**
1993		0	**0**
1994		0	**0**
1995	1	0	**1**
1996	0	0	**0**
1997	0	0	**0**
1998	0	0	**0**
1999	0	0	**0**
2000	0	0	**0**
2001	0	0	**0**
2002	0	0	**0**
2003	0	0	**0**
2004	0	0	**0**
2005	0	0	**0**

YEAR	FAROES	FRANCE	TOTAL
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**
2017	0	0	**0**
2018	0	0	**0**
2019	0	0.1	**0.1**
2020	0	0	**0**
2021	0	0	**0**
2022*	0	0	**0**

***Preliminary.**

Table 11.1c. Alfonsinos (*Beryx* spp.) from Subareas 6 and 7.

YEAR	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**

YEAR	FRANCE	E & W	SPAIN	IRELAND	SCOTLAND	TOTAL
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**
2017	7	0	11	0	0	**18**
2018	27	0.209	19	0	0	**46**
2019	57		24	0	0	**81**
2020	7	3.1	14	0	0	**25**
2021	6	0	12	0	0	**18**
2022*	3	0	9	0	0	**12**

***Preliminary.**

Table 11.1d. 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	0	**61**

YEAR	FRANCE	PORTUGAL	SPAIN	E & W	TOTAL
2016	3	1	71	0	**76**
2017	3	2	67	0	**73**
2018	6	0	52	0	**58**
2019	5	10	55	0	**70**
2020	10	11	48	0	**69**
2021	6	0	57	0	**63**
2022*	9	17	51	0	**76**

*** Preliminary.**

Table 11.1e. 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**

	10.a	10.b				
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**
2017	149	0	0	0	0	**149**
2018	159	0	0	0	0	**159**
2019	138	5	0		0	**143**
2020	139	0	0		0	**139**
2021	124	0	0		0	**124**
2022*	127	0	0		0	**127**

*** Preliminary.**

**** Not official data from ICES Area 10.b.**

Table 11.1f. Alfonsinos (*Beryx* spp.) from Subarea 12.

YEAR	FAROES	TOTAL
1988		
1989		
1990		
1991		
1992		
1993		
1994		

YEAR	FAROES	TOTAL
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**
2017	0	**0**
2018	0	**0**
2019	0	**0**
2020	0	**0**
2021	0	**0**
2022*	0	**0**

*** Preliminary.**

Table 11.1g. Landings of Alfonsinos (*Beryx* spp.) from Madeira (Portugal) outside the ICES area.

YEAR	*B. splendens*	*B. decadactylus*	TOTAL
1988*			
1989*			
1990*			
1991*			
1992*			
1993*			
1994*			
1995	1228	255	**1483**
1996	10724	403	**11127**
1997	4029	300	**4329**
1998	2602	56	**2658**
1999	1610	97	**1707**
2000	710	121	**832**
2001	433	122	**555**
2002	231	38	**269**
2003	223	143	**366**
2004	194	67	**261**
2005	41	87	**127**
2006	361	337	**698**
2007	83	591	**674**
2008	290	342	**632**
2009	88	16	**104**
2010	355	17	**373**
2011	79	137	**216**
2012	228	51	**279**
2013	38	11	**49**
2014	140	26	**166**
2015	63	12	**75**

YEAR	*B. splendens*	*B. decadactylus*	TOTAL
2016	58	20	**77**
2017	41	78	**119**
2018	236	83	**319**
2019	90	146	**235**
2020	12	13	**25**
2021	156	185	**340**
2022	145	109	**254**

*** No information.**

Table 11.1h. 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**

YEAR	4	5.b	6+7	8+9	10.a	10.b	12	TOTAL
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**
2017	0	0	18	73	149	0	0	**240**
2018	0	0	46	58	159	0	0	**263**
2019	0	0	81	70	143	0	0	**294**
2020	0	0	25	69	139	0	0	**233**
2021	0	0	18	63	124	0	0	**205**
2022*	0	0	12	76	127	0	0	**216**

***Preliminary.**

Table 11.3. Reported landings of *Beryx splendens* and *B. decadactylus* in the Azores (ICES Division 10a2).

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**

YEAR	*B. splendens*	*B. decadactylus*	TOTAL
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**
2016	127	29	**156**
2017	119	30	**149**
2018	107	50	**157**
2019	92	46	**138**
2020	67	72	**139**
2021	70	54	**124**
2022	63	64	**127**

Table 11.4. Annual percentage of *Beryx* spp. discarded by year in the Azores (ICES Division 10a2) from the sampled trip vessels that caught and discard alfonsinos.

SPECIES	2004	2005	2006	2007	2008	2009	2010	2011
Beryx splendens	1,79	1,87	1,55	1,02	1,19	8,64	4,69	0,76
Beryx decadactylus	0,37	0,07	1,31	0,14	0,57	10,18	2,36	0,95

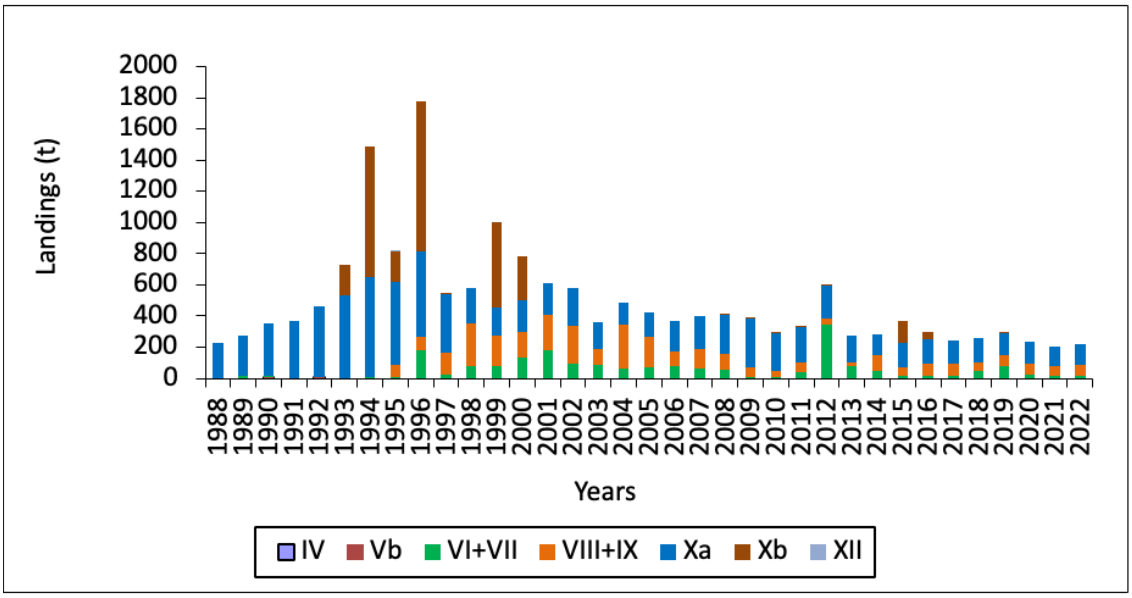

Figure 11.1. Reported landings for the alfonsinos, (*Beryx* spp), by ICES subarea/division.

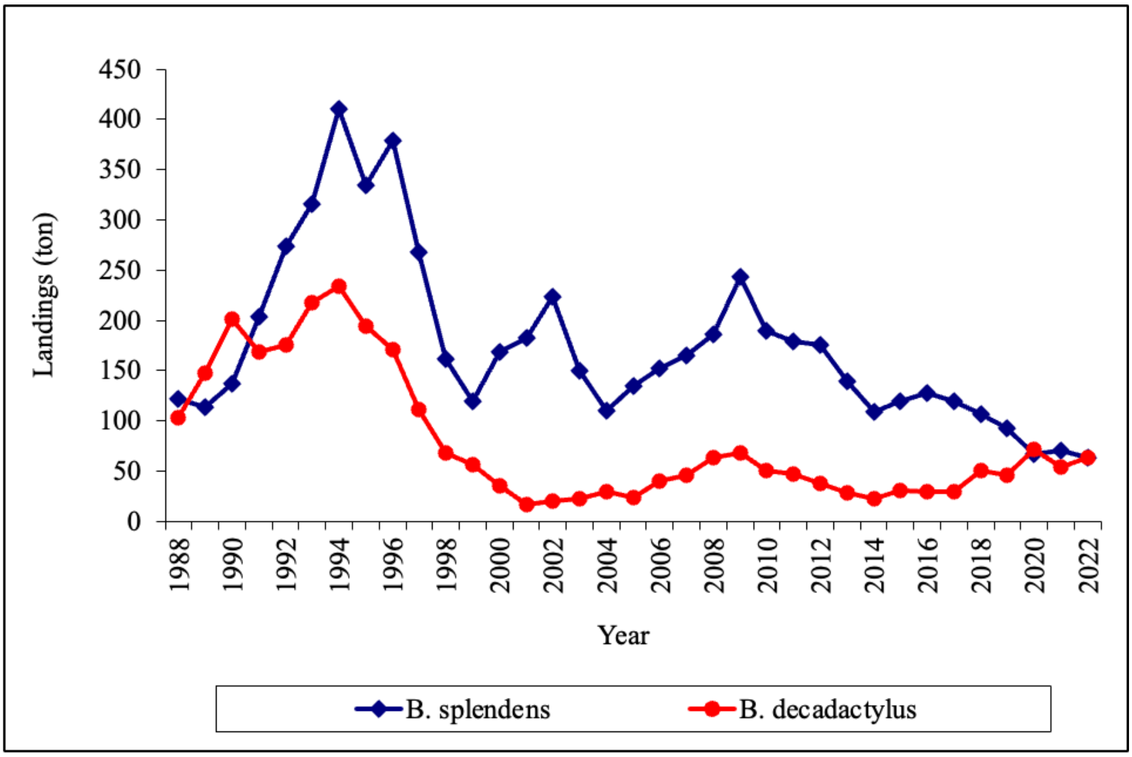

Figure 11.2. Landings of Beryx splendens and B. decadactylus in Azores (ICES 10a2).

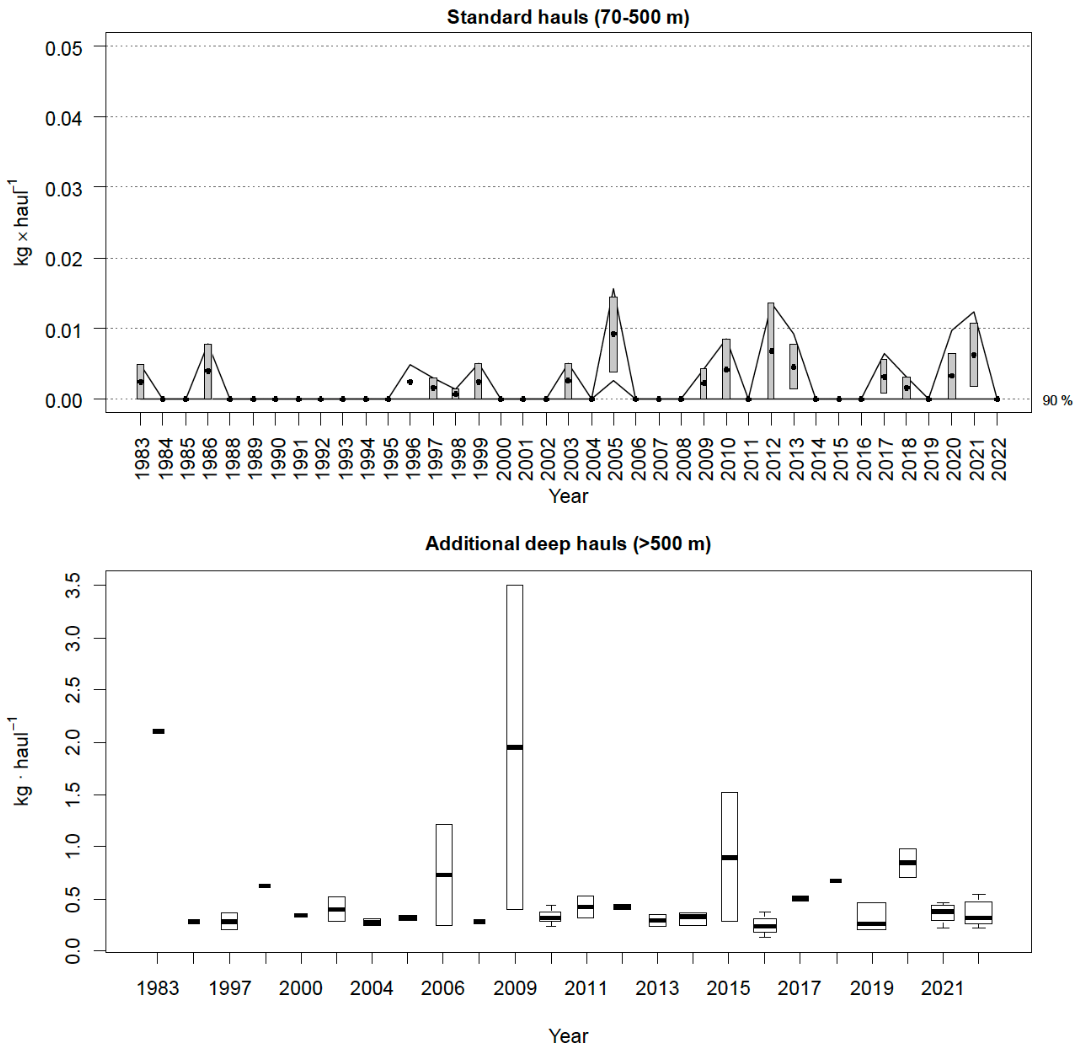

Figure 11.3. Evolution of *Beryx* spp. stratified biomass index in standard hauls and additional deep hauls during the North Spanish shelf bottom trawl survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed. Source: WD9 Fernández-Zapico *et al.* (2023).

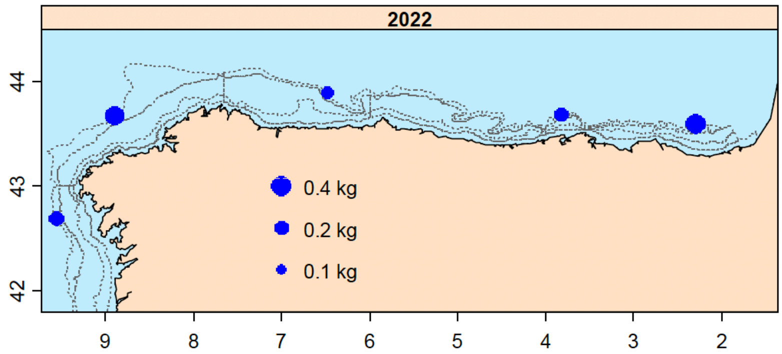

Figure 11.4. Geographic distribution of *Beryx* spp. catches (kg per haul) in the Northern Spanish Shelf bottom trawl survey 2022. Source: WD9 Fernández-Zapico *et al.* (2023).

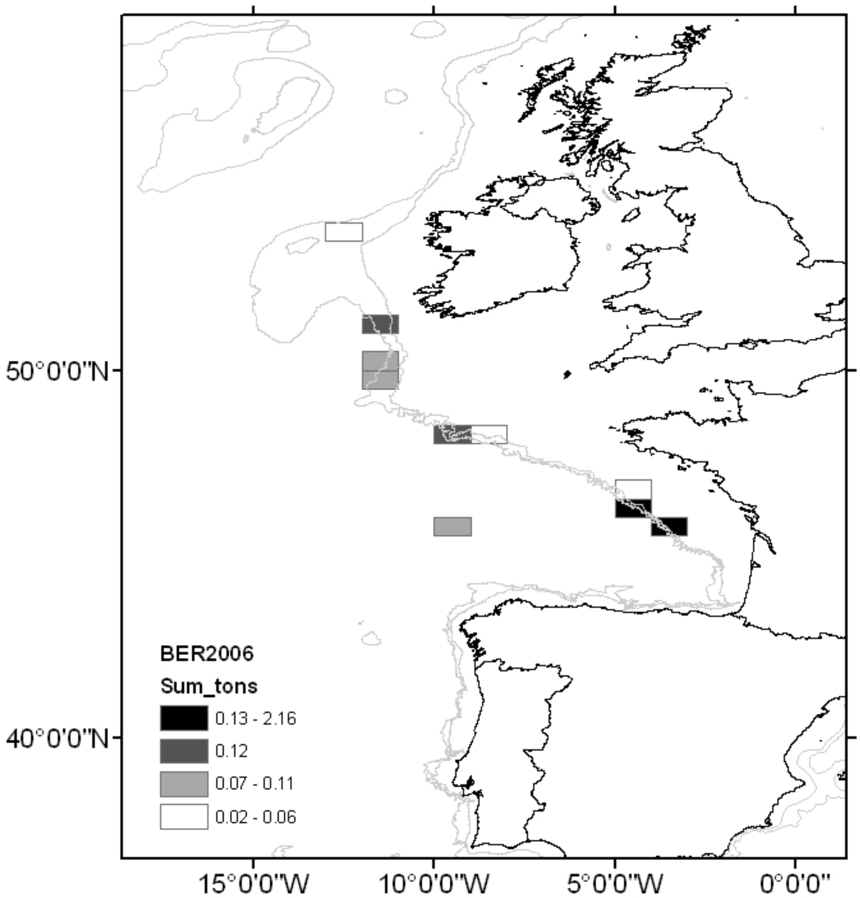

Figure 11.5. Catches of alfonsinos by French, Irish, UK (England and Wales and Scotland) and Icelandic vessels, 2006.

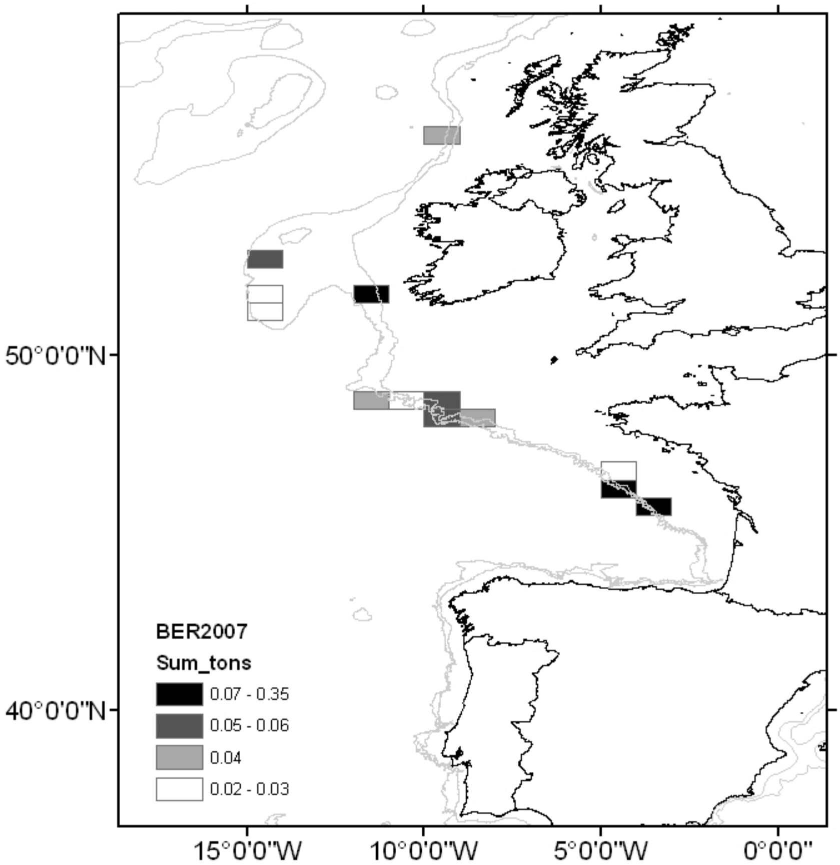

Figure 11.6. Catches of alfonsinos by French, Irish, UK (England and Wales and Scotland) and Icelandic vessels, 2007.

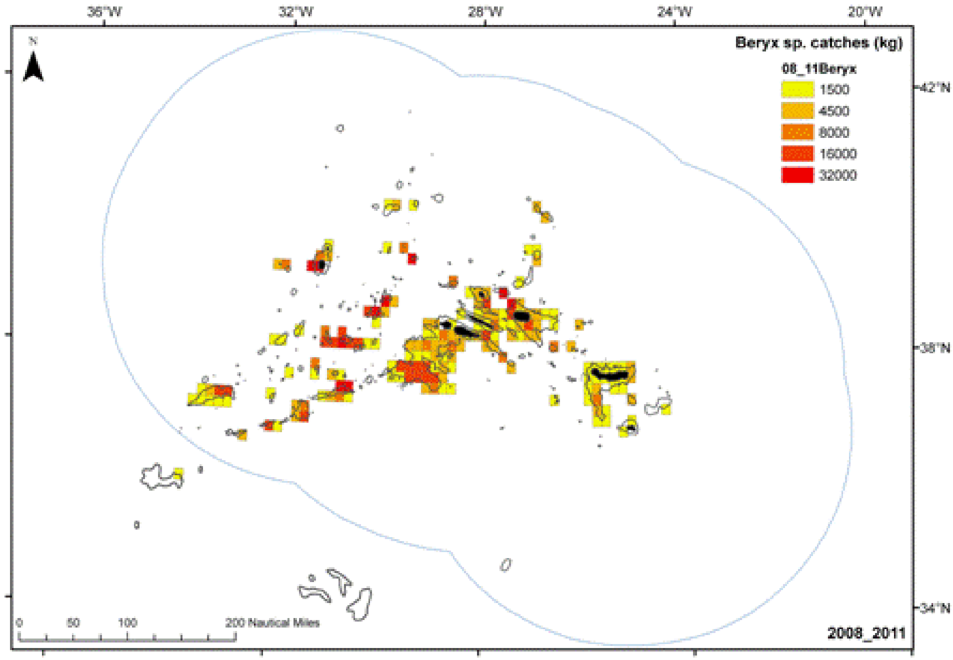

Figure 11.7. Catches of alfonsinos by Azores vessels, 2008–2011 (ICES, 10a2).

12 Blackspot seabream (*Pagellus bogaraveo*)

12.1 Stock description and management units

The stock structure of blackspot seabream in ICES area is still unknown. Thus, for stock assessment and scientific advice on management purposes ICES considers three different components: a) Subareas 6, 7, and 8; b) Subarea 9, and c) Subarea 10 (Azores region).

The interrelationships of the blackspot seabream from subareas 6, 7, and 8, and the northern part of Division 9.a, and their migratory movements within these areas have been observed by tagging studies (Gueguen, 1974). However, there is no evidence of movement to the southern part of 9.a where different longline fisheries targeting the species take place, extending outside the ICES area.

Genetics studies show that there is 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 the Azores (ICES Subdivision 10.a.2) and mainland Portugal, ICES Division 9.a (Stockley et al., 2005; Castilho et al., 2022 WD). These results, combined with the known distribution of the species by depth, suggest that Subarea 10 component of this stock can effectively be considered as a separate assessment unit. Not genetic structure has been found on the Atlantic continental shelf with small genetic differentiation between the Mediterranean Sea and the Atlantic (Stockley et al., 2005, Pinera et al., 2007). Unpublished genomic results, using a high number of SNP markers henchwith higher differentiation power than previous studied, show evidence for genetic differentiation between the Atlantic eastern continental margin and the Gulf of Cadiz (Castilho et al., 2022 WD).

12.2 Blackspot seabream (*Pagellus bogaraveo*) in Subareas 6, 7 & 8

12.2.1 The fishery

From the 1950s to the 1970s, the blackspot seabream 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 (1988–2021), most of the estimated landings from the subareas 6, 7 and 8 were taken by Spain (70%), followed by France (18%), UK (10%) and Ireland (1%).

The fishery in Subareas 6, 7 and 8 strongly declined in the mid-1970s, and the stock is seriously depleted (Figure 12.2.1a and Table 12.2.1b). Since the 1980s, the species is mainly a bycatch from otter trawl, longline and gillnet fleets and only a few small-scale hand liners have been targeting the species. Since 1988 the landings from Subarea 8 represent 68% and 32% of total accumulated landings are from subareas 6 and 7. At present the blackspot seabream reported catches in these areas are almost all bycatches of longline and otter trawl fleets from France, Ireland and Spain.

12.2.2 Landings trends

Landings data by ICES Subareas reported to the working group are shown in Table 12.2.1a–c. Figure 12.2.1a presents an overview of the historical series of landings in Subareas 6, 7 and 8 since the middle of the last century. Figure 12.2.1b shows, in greater detail, landings of the same subareas since 1988. In 2014, UK (Scotland) reported landings for the first time in 7.j, and Netherlands since 2017 and UK (Scot) since 2014 in Subarea 7 respectively. This ICES division represents part of the historical species distribution area (Olivier, 1928; Desbrosses, 1932).

For those 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 to 91 tonnes in 2022. The main driver for the decreasing landings in recent years is considered to be the effect of the TAC, which decreased from 350 tonnes in 2003 to 95 t in 2022.

12.2.3 ICES Advice

In 2020, ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2021 and 2022.

12.2.4 Management

The EU TAC for subareas 6, 7, and 8 was set for the first time in 2003 and has been reducing since then from 350 t to 95 t in 2022. Landings in 2007, 2010, 2012, 2014, 2015, 2016, 2018 and 2021 were slightly above the TAC. A minimum landing size of 35 cm applied from 2010 to 2012 and a minimum conservation reference size of 33 cm applies since 11 May 2017 (commission implementing regulation (EU) 2017/787 of 8 May 2017).

***Pagellus bogaraveo* TACs and total landings in European countries in Subarea 27.6, 7, and 8 in recent years.**

Pagellus bogaraveo			
year	**EU TAC**	**UK TAC**	**landings**
2003	350		129
2004	350		183
2005	298		158
2006	298		139
2007	298		324
2008	298		159
2009	253		203
2010	215		281
2011	215		177
2012	215		257
2013	196		295

	Pagellus bogaraveo		
2014	178		256
2015	169		177
2016	160		164
2017	144		126
2018	130		133
2019	117		98
2020	102		91
2021	95	11	98
2022	95	11	91
2023	95	11	

Under Common Fisheries Policy it is stated that "Recreational fisheries can have a significant impact on fish resources and Member States should, therefore, ensure that they are conducted in a manner that is compatible with the objectives of the CFP" (Regulation (EU) no 1380/2013 of the European Parliament and of the Council). Therefore, a short account of regulations relevant to blackspot seabream in recreational fisheries is given here.

The Irish Specimen Fish Committee recommends that all recreational catches be returned alive, and the SI No. 747 of 2004 forbids commercial catching of blackspot seabream except where it is less than 5% of the total catch. In France, specific regulation for blackspot seabream set in 2019 forbids the landings of individuals smaller than 35 cm and the fishing of this species from 1st of January to 30th of June. Moreover, the French regulation, forbids the catch, landing and sale of this species to the purse seine fleet and established several catch limits by trip or by year to the rest of the fleets (trawlers, gillnetters and liners).

Since 2019 Spain has established closure areas with the aim to protect the juveniles of this species (MAPA 2019). The regulation bans the Spanish trawling and deep-water long-liners fleets to fish in several areas of the centre and west of Division 8.c from April to September. Spain also established annually a maximum catch per day to the vessels involved in the fishery in subareas 6, 7, 8.

12.2.5 Data available

12.2.5.1 Landings and discards

The Spanish, French and UK extended landing time-series of *P. bogaraveo* in Northeast Atlantic were updated (Figure 12.2.1b). In recent years landings have been dropping in accordance to the continuous reduction of the biannual TAC since 2003.

Historically, discards are considered negligible, and estimates are available since 2014 representing between 0.0 % and 2.7% of the annual catches in all subareas (Table 12.2.2). Discards resulting from low quotas are compulsory as the fishery for the species ceases. In 2015 and 2016, discards in French fisheries may have resulted from legal closures of quota (MEDDE, 2015; MEEM, 2016). As the blackspot seabream 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. Table 12.2.3 shows that since 2017 there were not catches inside the NEAFC Regulatory Area (RA)

Misidentification in on-board observer program may occur as *P. bogaraveo* occurs at low abundance and closely related sparids species, to which it may be confused, also occur (*P. acarne*, *P. erythrinus*, *P. bellotii* and *Pagrus pagrus*).

12.2.5.2 Length compositions

Length–frequency distribution of commercial landings and discards in 2015-2022, are presented (Figure 12.2.2). Length frequency distribution of discards reported data in InterCatch in 2017 were very scarce, therefore length distribution for this year is not presented. No length–frequency distribution for discards were presented in 2020 and 2022 as in these years reported discards were 0.

12.2.5.3 Age compositions

No age data were available to the working group. No age estimations are carried out for this stock.

12.2.5.4 Weight-at-age

Mean size and weight-at-age (Table 12.2.4) derived from Guéguen (1969) and Krug (1998) were used by Lorance (2011) as input data for the yield-per-recruit model used to simulate the effect of fishing mortality on the blackspot seabream stock of Bay of Biscay.

12.2.5.5 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 to 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).

12.2.5.6 Catch, effort and research vessel data

Regarding the research vessels data of blackspot seabream, the Subareas 6, 7 and 8 are covered by four surveys (Figure 12.2.3), but at the current level of abundance, the blackspot seabream is rarely caught in the northern surveys by French EVHOE IBTS (G9527) divisions 7.f-j and 8.a,b,d, Irish IGFS (G7212) in divisions 6.a South and 7.b,g,j, is a scarce species in the Northern Spanish Shelf Groundfish Survey (G2784) SP-NGFS in Divisions 8c and 9a, and is not caught in the Spanish Groundfish Survey on the Porcupine bank -SP-PorcGFS (G5768) in divisions 7.c and 7.k,

In the Northern Spanish Shelf Groundfish Survey, in 2020 zero catches were reported for this species. The trend in recent years show a decreased since in 2019 in which a biomass of 0.11 Kg·haul^{-1} and an abundance of 0.53 ind·haul^{-1} were recorded. (see figures 12.2.4, 12.2.5 and 12.2.6 for previous series) (Fernández-Zapico *et al.*, 2023). Last information available indicated that specimens caught in 2019 ranged from 22 cm to 29 cm, with a mode in 25-26 cm (Figure 12.2.7) (Fernández-Zapico *et al.*, 2020).

In French surveys, similar to the current western IBTS, from early 1980s when the stock was already low, blackspot seabream was still presented in 40–60% of the hauls. This proportion dropped to around zero by 1985 (Lorance, 2011). This observation indicates that the current survey would allow monitoring the stock if it recovers to past levels. 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 of the stock. In particular, a large catch of more than 1000 individuals in a single hauls occurred in the 2016 survey. In subsequent years only 3 individuals were caught over years 2018-2021 (no survey in 2017), which represent on average for these years less than one catch for 100 hauls. The level of occurrence that would be expected if the stock rebuilt to past levels can be appraised from two surveys carried out in the Bay of Biscay in 1973 and 1976 with the same protocol and gear as the current EVHOE survey (Figure 12.2.8). In 1973 and 1976, blackspot seabream was caught in 25% and 55 % of the hauls respectively (Figure 12.2.9). 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. 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 increasing occurrence in on-board observations is however consistent with fishers reporting more encounters.

In the Irish IGFS blackspot seabream is also very scarce and since 2010 only few kg in were caught in four years of the series. Also, the occurrence along the whole stations in the survey is very low ranging since 2010 from 0% to 4.3% (Table 12.2.5).

12.2.6 Data analyses

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 12.2.1a). Catches recorded in the surveys are very scarce and are mainly juveniles smaller than 30 cm.

In 2003, when TACs were set for this species there were conflicts between fishing métiers in this area, 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 French on-board observations (Figure 12.2.10). 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 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 trawl 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 12.2.11).

12.2.7 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.

12.2.8 Exploratory assessment

Ongoing studies carried out as part of the H2020 Pandora and the French National DynRose projects were presented to the group in 2021. These included an analysis of the essential habitats of the species and approaches to assess the current biomass.

The study of the habitats modelling applies several Species Distribution Model (SDM) in an Ensemble modelling approach. The study is carried out at the scale of whole species distribution area, including therefore not only the stock in the Celtic Sea and Bay of Biscay but also the area of the two other stock units considered by ICES (in Iberian and Azorean waters) and the

Mediterranean western basin. Occurrence data from a number of sources including (1) French on-board observation, carried out in application of the EU data collection framework (DCF), (2) surveys, (3) CPUEs derived from the vessel monitoring system installed on Spanish artisanal vessels in the Strait of Gibraltar using GPRS/GSM (Burgos et al., 2013) and (4) data available from the WEB such as OBIS. Occurrence data were modelled using several physical chemical and biological environment variables including bathymetric, hydrological, seafloor and water data. Preliminary results suggest that only a low fraction of its potential habitat is occupied (realized habitat) by the blackspot seabream in the Bay of Biscay in recent years (Figure 12.2.12).

Approaches to assess the current biomass include acoustics and environmental DNA (eDNA) investigations. Acoustics surveys were carried out to the West of Brittany in 2019 and were presented during the 2020 meeting (ICES, 2020). In September 2020, a three-day eDNA survey was carried out in the same area as the acoustic survey of 2019 (Figure 12.2.13). The results from the two approaches were consistent is terms of spatial distribution of the species. So far none of these methods allowed to derive a direct quantitative estimate of the biomass in the area surveyed and both have advantages and inconveniences. For acoustics, one drawback is that fishing operation are needed for identification of echoes and their classification. In the rocky area surveyed, this was done by handlining, which appeared to be selective as more species were identified from eDNA. In particular, with eDNA seabass seemed to occur at a similar abundance as blackspot seabream in the surveyed area, while it was not caught on handlines and the two species may have similar echoes. eDNA has a number of advantages, it covers all species (from microbes to mammals), all habitats (e.g.; both trawlable grounds and waters above rocky outcrops came be sampled with the same method) and does not depend on behaviour (egg daily vertical migration) and does not need identification fishing. However, as no catches are implied, eDNA provides no information of population composition (size, sex).

12.2.9 Management considerations

In the 2014 advice, ICES recommend the establishment of a recovery plan for the stock and in 2016, 2018, 2020 and 2022 the general advice recommended zero catch. This stock is collapsed, however, a recovery plan was never applied, and instead a TAC that is reduced every two years was stablished. In this sense, landings in 2007, 2010, 2012, 2014, 2015, 2016, 2018 and 2021 were slightly above the TAC. Measures such as a minimum landing size of 35 cm was applied but only for the period from 2010–2012, and since 2019 Spain has established closure areas with the to protect the juveniles in Division 8c. The 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).
Based on the STECF conclusions in previous assessments in which studies represented reasonably sound scientific evidence for the survival of red seabream, the Commission Delegated Regulation (EU) 2020/2015, of 21 August 2020 specified the details of the implementation of the landing obligation to red seabream caught with the artisanal gear voracera in ICES division 9a and with hooks and lines (gear codes: LHP, LHM, LLS, LLD) until 31 December 2022 in ICES subareas 8 and 10 and in ICES division 9a. The regulation specifies that according to the survivability exemption when discarding red sea bream caught shall be released immediately.

12.2.10 Tables and Figures

Table 12.2.1a. Blackspot seabream in subareas 6 and 7; landings by country.

YEAR	FRANCE*	IRELAND	SPAIN	UK (E & W)	UK (Scot)	CH. ISLANDS*	NETHERLANDS	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

YEAR	FRANCE*	IRELAND	SPAIN	UK (E & W)	UK (Scot)	CH. ISLANDS*	NETHERLANDS	TOTAL
2015	13	0	21					34
2016	24	0	15	1	0			40
2017	15	1	19	1		0	0	37
2018	17	0	2	1			1	22
2019	19	0	15	1				35
2020	8		13	0				21
2021	6	0	9	+				15
2022		4	0	6	0		0	11

*Channel Islands

Table 12.2.1b. Blackspot seabream in Subarea 8; 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

YEAR	FRANCE*	SPAIN	UK (E & W))	TOTAL
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
2017	3	85	0	89
2018	6	105	0	111
2019	4	59	0	63
2020	4	59		63
2021	7	77		84
2022	6	74		80

Table 12.2.1c Blackspot seabream in Subareas 6, 7 and 8; 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

YEAR	6 AND 7	8	TOTAL
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
2017	37	89	126
2018	22	111	133
2019	35	63	98
2020	21	71	91
2021	15	84	98
2022	11	80	91

Table 12.2.2. Blackspot seabream in subareas 6, 7 and 8; discards reported to ICES in subareas 6, 7 and 8 since 2014.

	Discards (t)	Landings (t)	Catches (t)	Discards/Catches (%)
2014	2.40	256	258	0.9

	Discards (t)	Landings (t)	Catches (t)	Discards/Catches (%)
2015	2.33	177	179	1.3
2016	0.91	164	165	0.6
2014	2.40	256	259	0.9
2015	2.33	177	179	1.3
2016	0.91	164	165	0.6
2017	1.17	126	127	0.9
2018	2.3	133	136	1.7
2019	2.7	98	101	2.7
2020	0	91	91	0
2021	0.4	98	99	0.4
2022	0	91	91	0

Table 12.2.3. Blackspot seabream in Subareas 6, 7 and 8.Landings inside and outside the NEAFC Regulatory Area (RA) as estimated by ICES for the stock in WGDEEP.

WGDEEP Stock sbr.27.6-8	Catch Inside NEAFC RA (t)	Catch Outside NEAFC RA (t)	Total Catches	Proportion of catch inside the NEAFC RA (%)
2017	0	126	126	0%
2018	0	136	136	0%
2019	0	101	101	0%
2020	0	91	91	0%
2021	0	99	99	0%
2022	0	91	91	0%

Table 12.2.4 Mean size and weight-at-age of Blackspot seabream in Bay of Biscay. From Lorance (2011), derived from Guéguen (1969b) and Krug (1998).

Age group	Mean size (total length, cm)	Mean weight (g)	Proportion of mature females
0			0
1	11.2	18	0
2	17.6	72	0
3	22.3	149	0
4	26	239	0

Age group	Mean size (total length, cm)	Mean weight (g)	Proportion of mature females
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

Table 12.2.5. Occurrence (kg and % of occurrence in the sampled stations) of the Blackspot seabream (*P. bogaraveo*) in Irish IGFS survey time-series (2010–2020).

	kg	% of occurrence in the stations
2010	0.2	0.8%
2011	0	0
2012	0.1	0.6%
2013	0	0
2014	0	00
2015	0	0
2016	2.1	2.4%
2017	8.2	4.3%
2018	0	0
2019	0	0

2020	0	0
2021	0	0
2022	0	0

Table 12.2.6. References and sources of reconstructed landings data in the Figure 12.2.1a.

France	-Years 1977–1987: Landings of P.bogaraveo (sic?) from the Northeast Atlantic. M. Pinho, pers. com. Source: SGDeep 1995. -Years 1950–1984: Landings of Pagellus sp. ("seabreams") from the Northeast Atlantic. Source: Dardignac (1988), quoted by Castro (1990). SGDeep
Portugal	-Years 1948–1987 Subarea 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. ("seabreams") from the Northeast Atlantic. Source: Anuarios de Pesca maritima. Castro (1990). SGDeep 1996.Table 12.2.3. -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 12.2.4. -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 1988–2022 landings reported to ICES

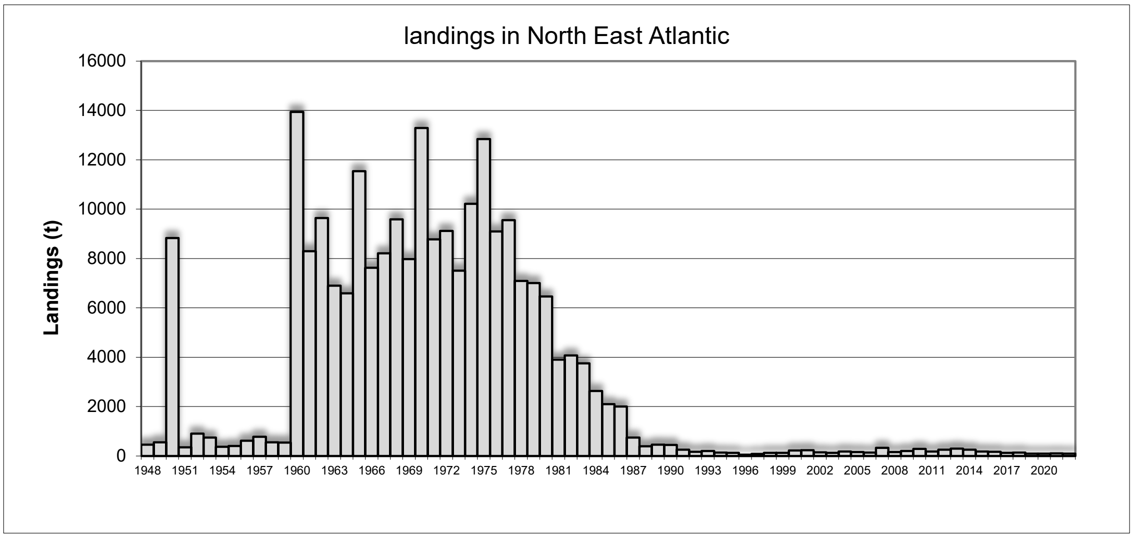

Figure 12.2.1a. Blackspot seabream in Subareas 6, 7 and 8. Source of the reconstructed landings of blackspot seabream in the Bay of Biscay from 1948 to 2022.

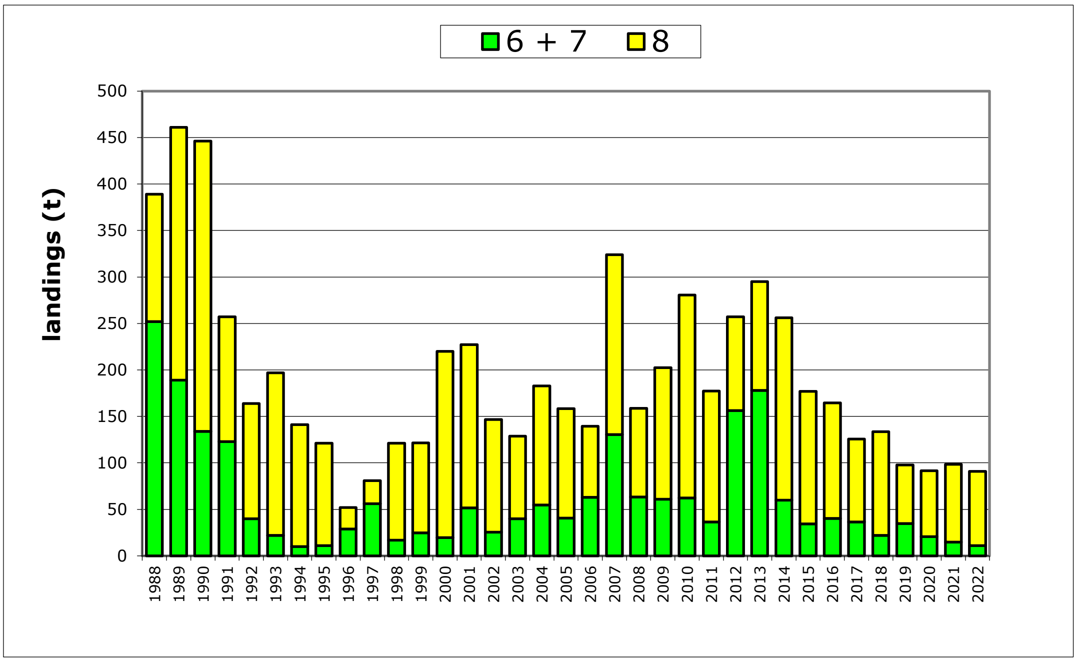

Figure 12.2.1b. Blackspot seabream landing trends in ICES subareas 6 and 7 combined and Subarea 8 since 1

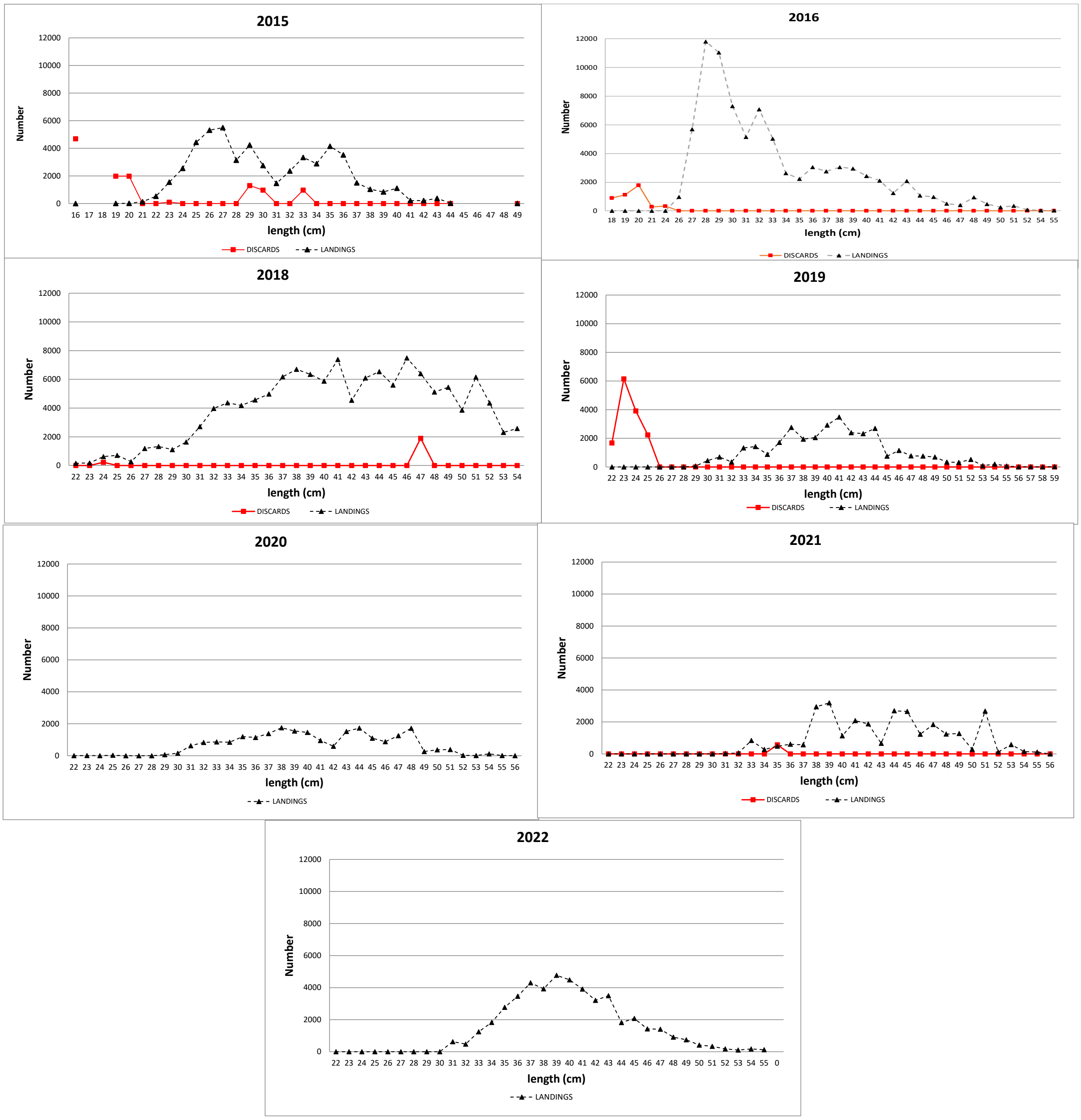

Figure 12.2.2. Length frequencies of the blackspot seabream in commercial catches, landings and discards since 2015, in Subareas 6, 7 and 8 in the period 2015-2022.

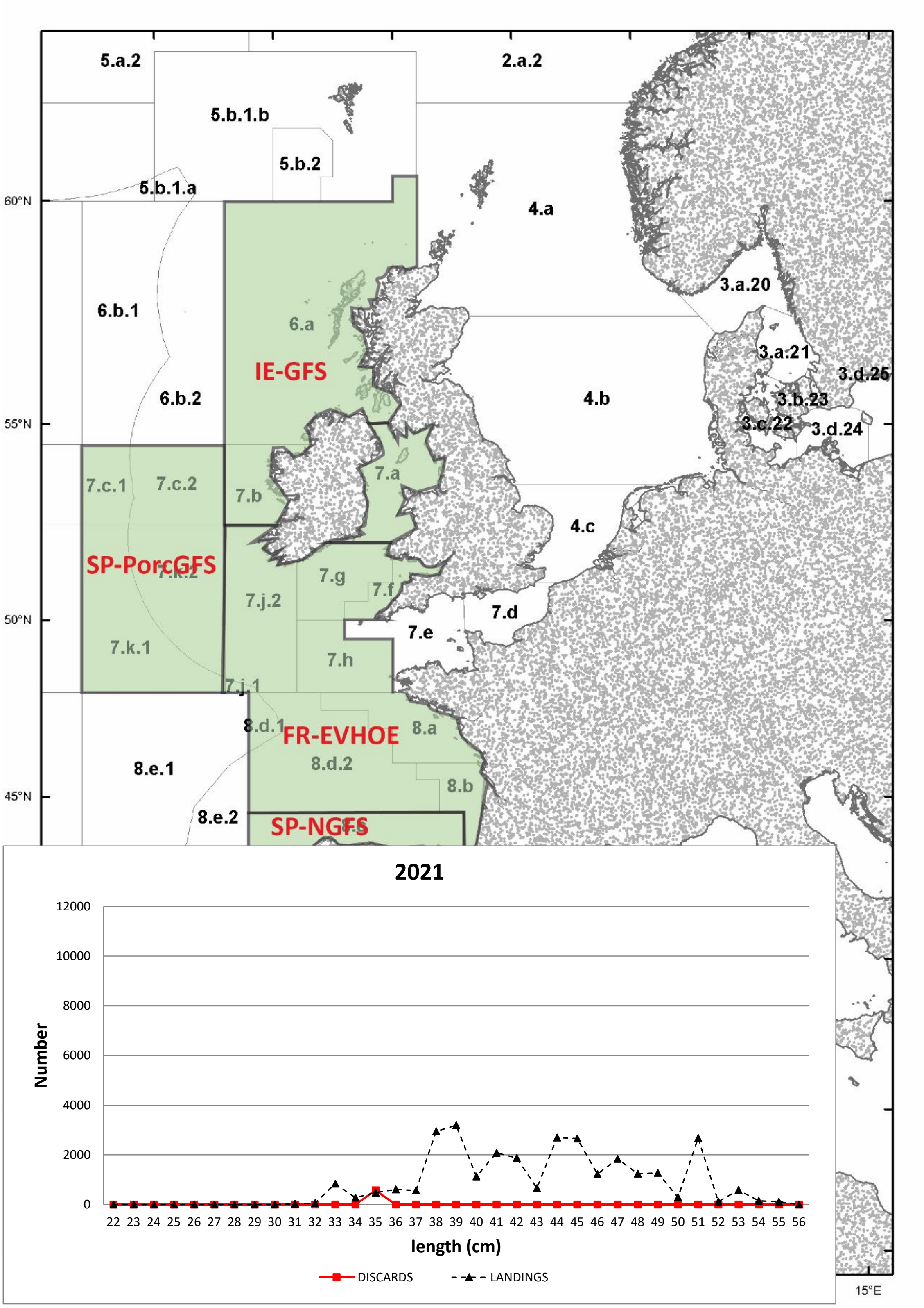

Figure 12.2.3. Map of the Divisions and the four surveys covering the stock rsb.27. 6-8.

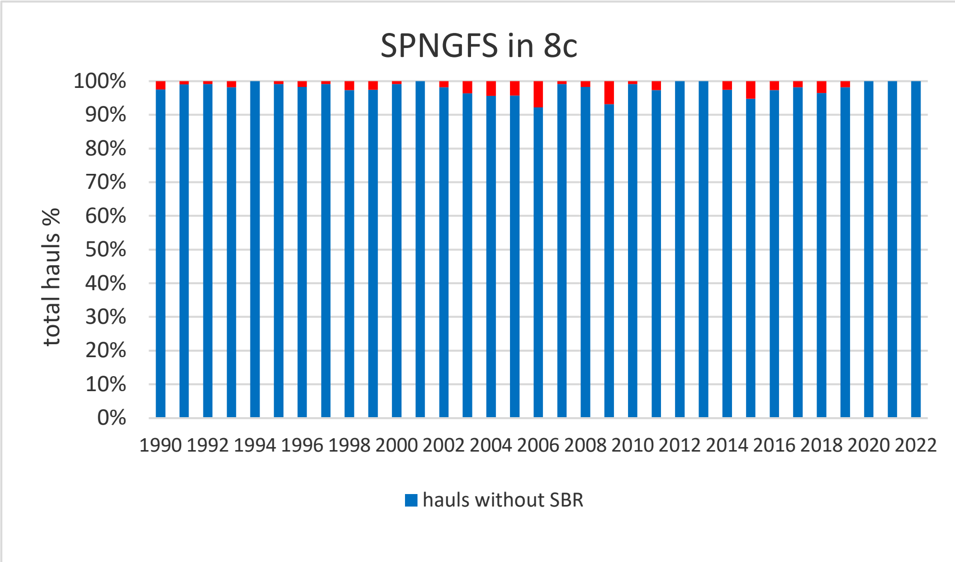

Figure 12.2.4. Occurrence (%) of the Blackspot seabream (*P. bogaraveo*) in Northern Spanish Shelf survey time-series (1990–2022).

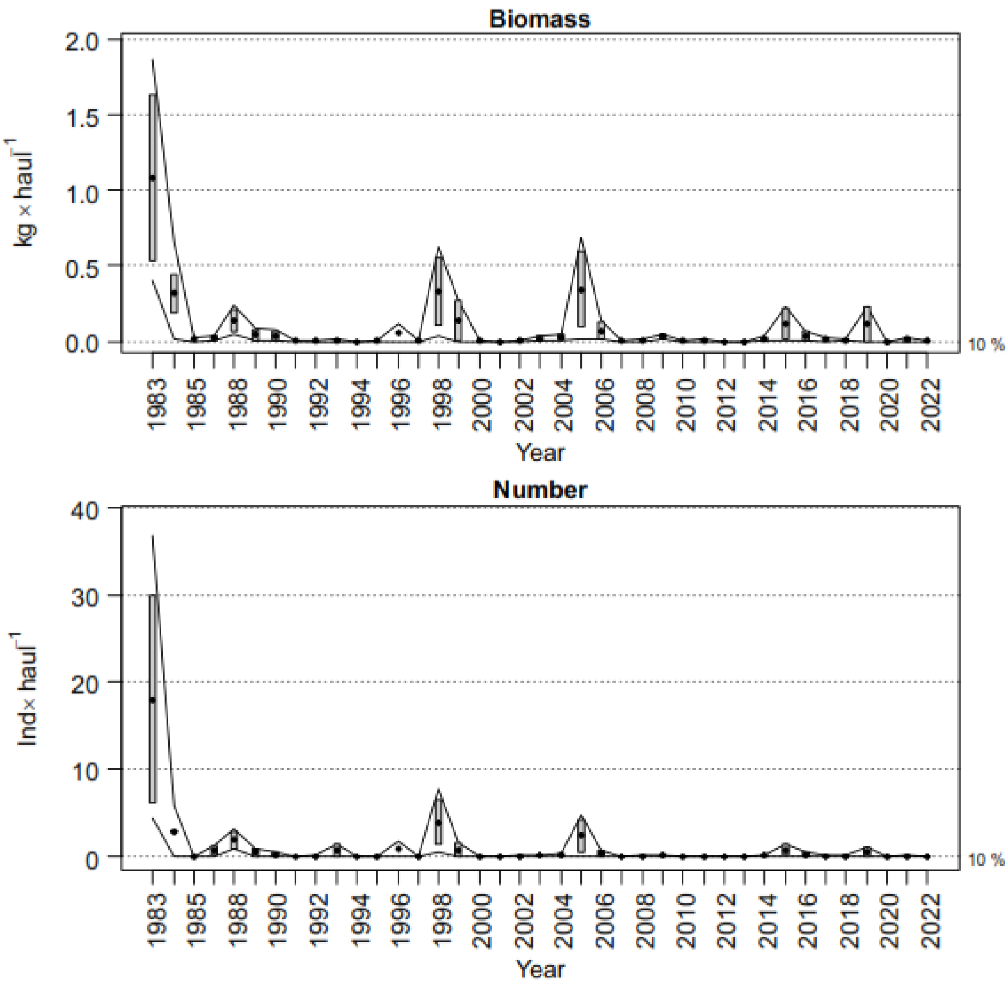

Figure 12.2.5. Evolution of Blackspot seabream (*P. bogaraveo*) mean stratified biomass (upper panel) and abundance (lower panel) in Northern Spanish Shelf survey time-series (1983–2022).

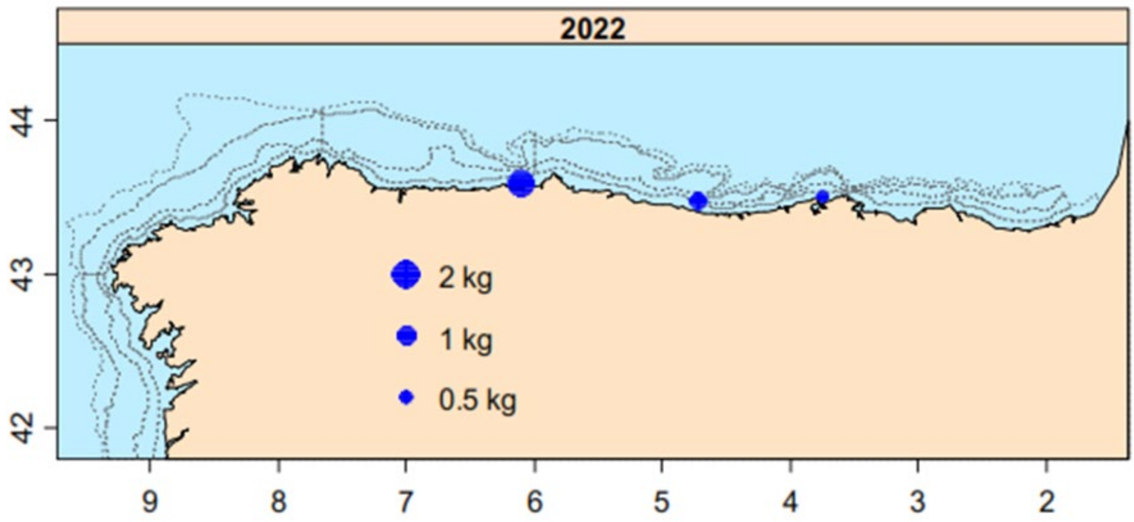

Figure 12.2.6. Catches in biomass of Blackspot seabream on the Northern Spanish Shelf bottom-trawl surveys in 2022.

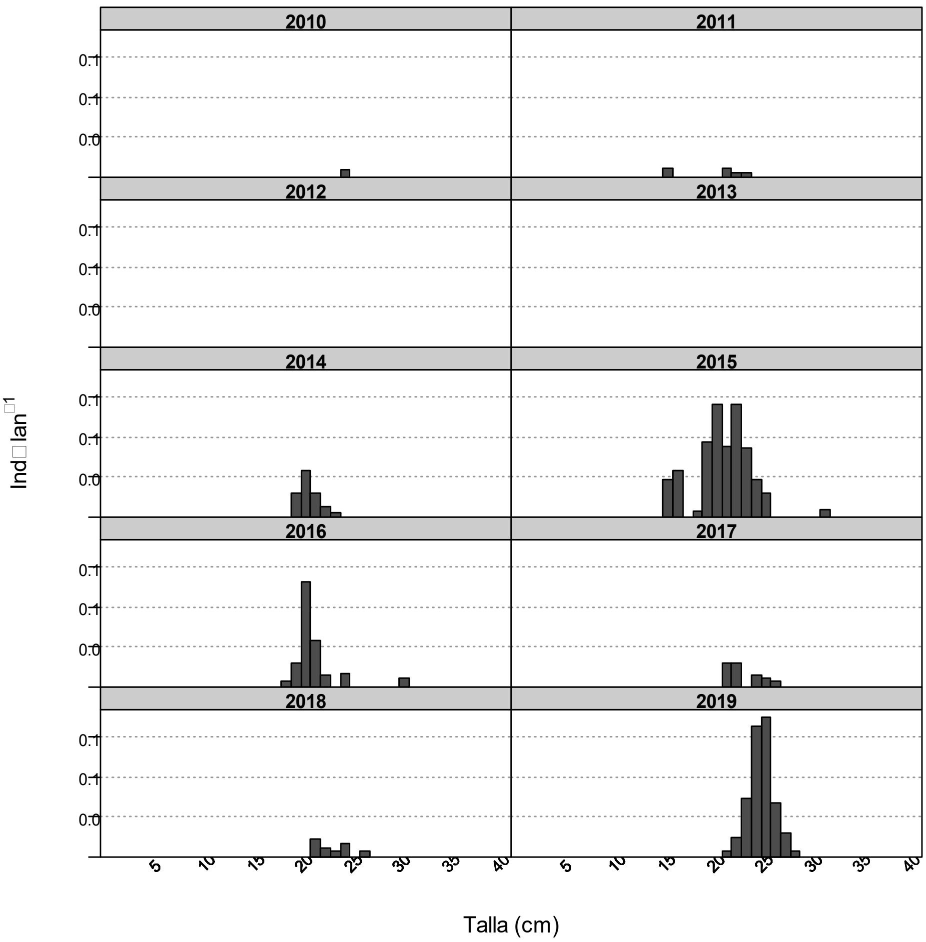

Figure 12.2.7. Mean stratified length distributions of Blackspot seabream (*P. bogaraveo*) in Northern Spanish Shelf surveys (2010–2019), no data before 2009.

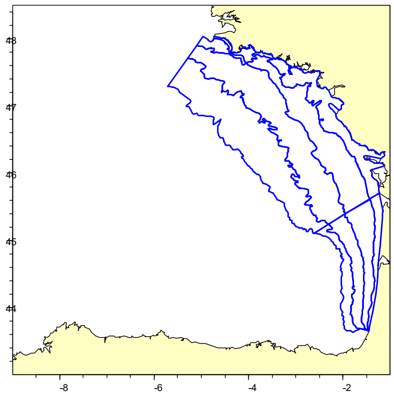

Figure 12.2.8. Strata covering the Bay of Biscay shelf, sampled in the current EVHOE survey and in two previous surveys in 1973 and 1976.

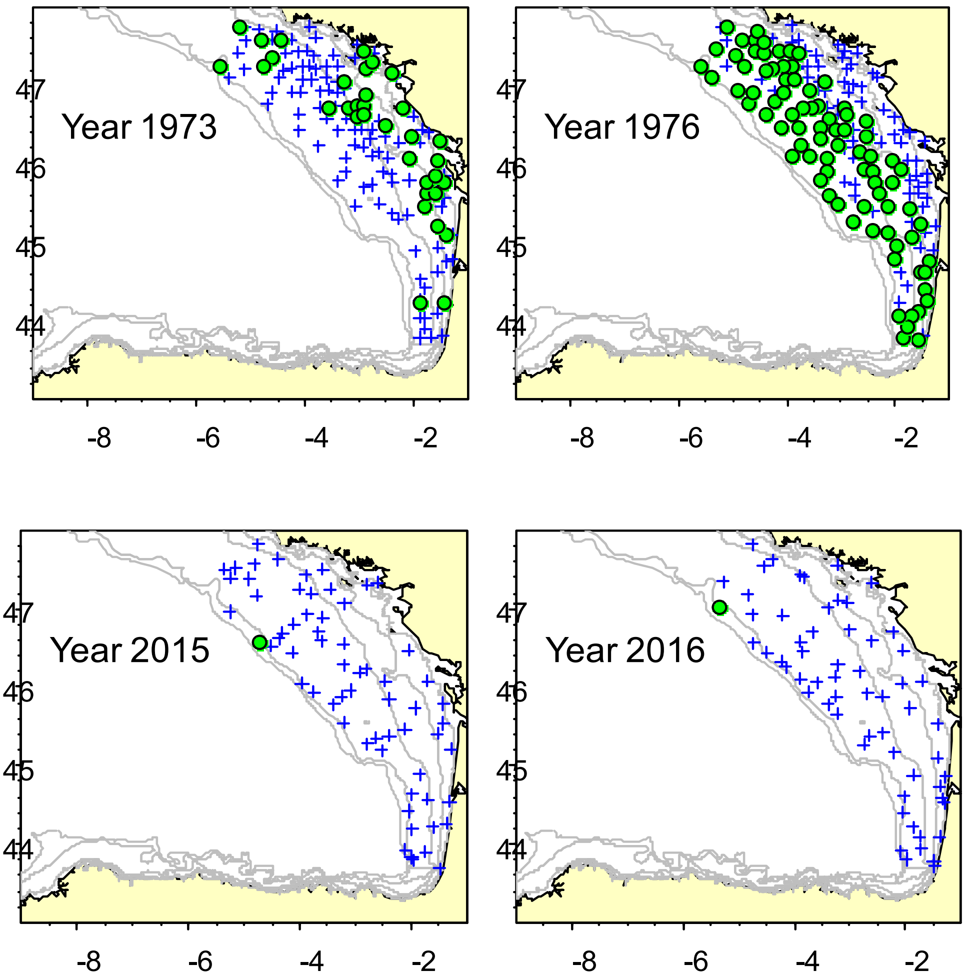

Figure 12.2.9. Occurrences of Blackspot seabream in surveys carried out in 1973 and 1976 and in the EVHOE survey in 2015 and 2016.

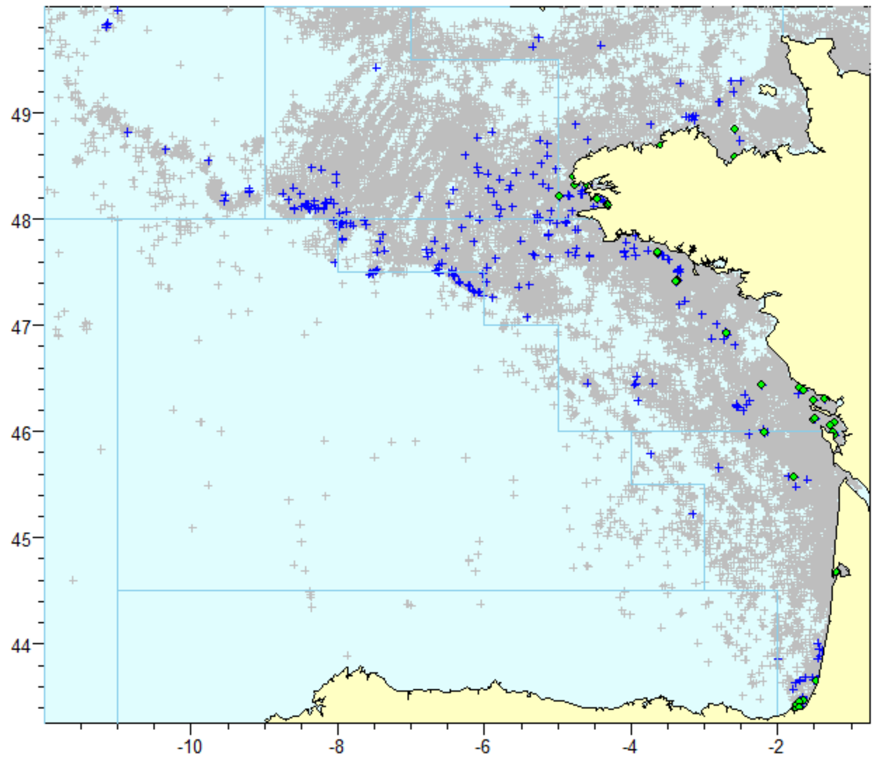

Figure 12.2.10. Geographical distribution on catch of the Blackspot seabream in French on-board observations 2010–2016 in the Bay of Biscay and southern Celtic Sea, all métiers. (Grey) all haul/sets observed, (Blue crosses) hauls with catch of blackspot seabream, (Green dots) hauls with catch of blackspot seabream <20 cm which species identification may be uncertain.

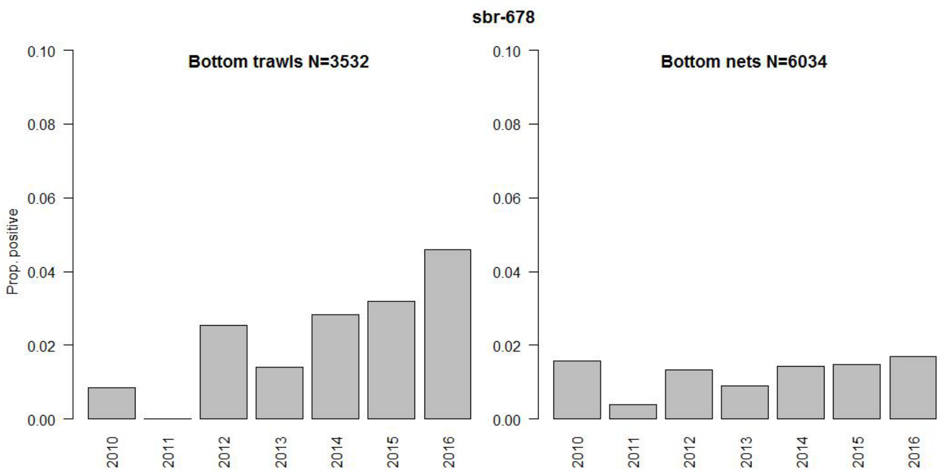

Figure 12.2.11. Proportion of fishing operations with catch of Blackspot seabream in bottom trawls (left) and bottom net (right) in French fisheries to the south of 49°N (ICES divisions 8.a–d and the southern part of 7.d and 7.h–k).

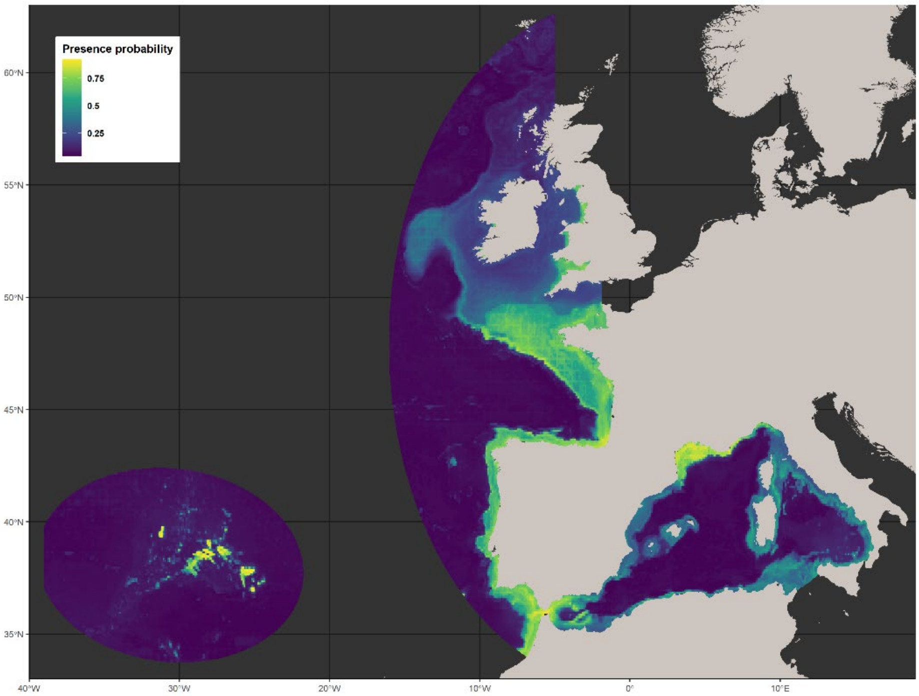

Figure 12.2.12. Potential habitat of the blackspot seabream in the Mediterranean Sea, Azorean waters and European Atlantic shelf estimated from the ensemble modelling.

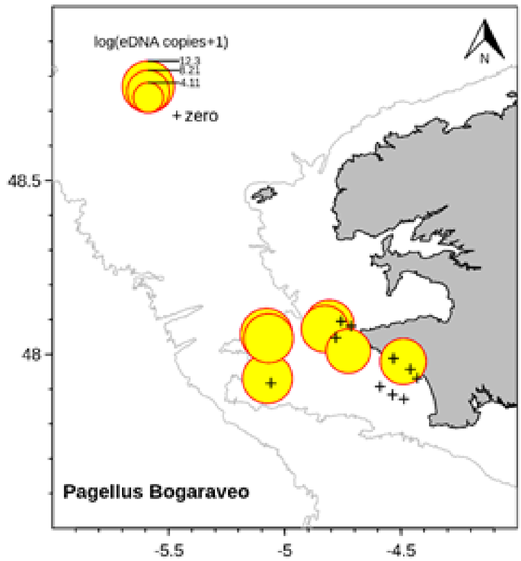

Figure 12.2.13. Number of eDNA copies (log scale) of blackspot seabream by location sampled in September 2020.

12.2.11 References

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12.3 Blackspot seabream (*Pagellus bogaraveo*) in Subarea 9 (Atlantic Iberian waters)

12.3.1 The fishery

Pagellus bogaraveo is caught by Spanish and Portuguese fleets in ICES Subarea 27.9. Spanish landings data from this area are available from 1983, Portuguese data from 1988 and Moroccan information from 2001. 2016–2022 European landings in Subarea 27.9, most of which are taken with lines, are from Portugal (~48%) and Spain (~52%). Important to note that these changes partially reflect restrictive TAC constrains in recent years.

An update of the available information on the Spanish target fishery, from the southern part of Subarea 27.9, Strait of Gibraltar region, has been provided to the WGDEEP (Gil *et al.*, WD 12 to the 2023 WGDEEP). Currently, less than 20 Spanish vessels are involved in the fishery. The fishing grounds of the Spanish fleet are located on both sides of the Strait of Gibraltar and near, i.e. mostly less than 20 nautical miles, from the main ports (Tarifa and Algeciras). It should be noted that not all the catches/landings come exclusively from ICES Subarea 9 although it was considered to belong to the same stock, the fishing grounds encompass areas of different Regional Organizations/Commissions (ICES, General Fisheries Commission for the Mediterranean (GFCM) and Fishery Committee for the Eastern Central Atlantic (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 artisanal vessels from Conil port have joined the blackspot seabream fishery. Those boats operate in other fishing grounds and use longlines. This section of the Spanish fleet is currently composed by about six vessels. Species landings are disaggregated into different commercial categories due to the wide size range of the catch and size-varying prices. Historically these categories have varied but from 1999 onwards have remained the same in all ports.

Since 2001, Moroccan longliners held a fishery in the Strait of Gibraltar area. These are about 102 vessels that are mainly based in Tangier. The average technical characteristics of these vessels are: 20 GRT and 160 HP. Moreover, 435 artisanal vessels (±15 CV, ≤2 GRT and 4–6 m length) also target this species in the Strait of Gibraltar area. The WGDEEP considers the account of Moroccan catches appropriate as the fishery operates in the same area as the Spanish fishery and obviously targets the same stock. Landings information until 2021 was also available from GFCM WGSAD sessions for the assessment of blackspot seabream in GSAs 1-3 (2022).

Detailed information from Portuguese fisheries has been updated in the Working Group by Farias and Figueiredo (WD 15 to the 2023 WGDEEP). As well as in other Spanish places in Subarea 27.9, it is admitted that there are no fisheries targeting the blackspot seabream in Portugal mainland although the species can be seasonally targeted: the species is usually caught as bycatch of fisheries targeting other species. In mainland Portugal, most of species landings are as fresh specimens and are derived from the polyvalent fleet, which uses mainly longlines. The main landing ports (≈89% of the species mainland Portugal total landings) from North to South are: Matosinhos (Portugal North), Aveiro, Nazaré and Peniche (Portugal Centre) and Sagres (Portugal Algarve).

In the Portuguese area of 27.9.a stock, Peniche is the most important landing port for blackspot seabream (landings between 1999 and 2022 represented nearly 50% of the Portuguese landings of the species. The species is mainly landed between December and March: this seasonal fishery pattern can reflect differences on the species' availability (coinciding with the spawning season) or differences on skippers' seasonal fishing grounds preferences (Farias and Figueiredo, WD 7 to the 2020 WGDEEP).

12.3.1.1 Landing trends

Since 1990, the maximum catch was reached in 1993–1994 and 1997 (about 1000 t) whereas the minimum (about 50 t) in 2022 (Figure and Table 12.3.1). It should be reinforced that not all Spanish landings from the Strait of Gibraltar come from ICES Subarea 27.9. Moroccan landings from the Strait of Gibraltar area are supposed to be outside ICES Subarea 27.9: 2022 landings were not available yet.

12.3.2 ICES Advice

The ICES advices for 2023 and 2024 was "*that when the precautionary approach is applied, catches should be no more than 114 tonnes in each of the years 2023 and 2024. All catches are assumed to be landed.*"

12.3.3 Management

Since 2003, TAC and Quotas have been applied to the blackspot seabream fishery in Subarea 27.9. The table below shows a summary of *P. bogaraveo* recent years' TACs and European countries landings in this Subarea.

Pagellus bogaraveo **TACs and total landings in European countries in Subarea 27.9 in recent years.**

P. bogaraveo	2016–2017		2018–2019		2020–2021		2022–2023	
ICES Subarea	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings
9	183 – 174	165 (77*) – 130 (17*)	165 – 149	87 (8*) – 56 (4*)	149 – 119	59 (3*) – 45 (4*)	119 – 114	40 (2*) –

***from InterCatch info: landings from adjacent waters of the Strait of Gibraltar (FAO 34.1.11 and FAO 37.1.1).**

There is a minimum conservation reference size of 33 cm for this species in the Regions 1–5 (as defined in Article 2 of Regulation (EC) No 850/98) since 11 May 2017 (Commission Implementing Regulation (EU) 2017/787 of 8 May 2017). This size coincides with the previously applied minimum size in the Mediterranean Sea. The European Commission granted the exemption for the Strait of Gibraltar target fishery, which is expressed in the discard plan for certain demersal fisheries in South-Western waters for the period 2019-2021 (Commission Delegated Regulation (EU) 2018/2033).

European landings have always been below the adopted TACs although these have been reduced over the years. However, in the year 2016 (considering other areas such as FAO 34.1.11 and FAO 37.1.1) European countries landings (242 t) are above the 2016 TAC (183 t) for ICES Subarea 27.9 (Figure 12.3.1).

12.3.4 Stock identity

Stock structure of the species in ICES Subarea 27.9 is still unknown. Genetic studies showed a restricted gene flow among the populations located in the Azores (ICES Division 27.10.a.2) and those on the Portuguese continental slope (ICES Division 27.9.a) and Madeira (CECAF FAO Division 34.1.2) (Stockley *et al*., 2005; Piñera *et al*., 2007). Recent genetic studies using mitochondrial control region indicated a similar genetic diversity among sampling sites in the NE Atlantic and the Mediterranean, and no differentiation between the Azores and the remaining locations (Robalo *et al*., 2021). Derived from a genomic study, latest genetic results on the stock structure of blackspot seabream in the NE Atlantic were shown to the WGDEEP (Castilho *et al*., 2022): these results confirm the poor connectivity between the Azorean population and the Atlantic eastern continental margin locations with additional evidences for genetic differentiation within off Iberian waters (ICES subarea 27.9.a) and the Strait of Gibraltar.

In the Strait of Gibraltar area tagging surveys (56 days at sea in 2001, 2002, 2004, 2006 and 2008) have been conducted. A total of 4500 fish were tagged, of which 423 recaptures have been reported. The main results indicate the inexistence of significant movements. Although strict movements 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.

Farias and Figueiredo (WD 14 to the WGDEEP 2019) present information on blackspot seabream spatial distribution from Portuguese research surveys, considering the relative frequency of fishing hauls with species catch rates higher than 5 specimens in the 1990-2017 surveys. It is concluded that the species is not evenly distributed along the surveyed area, being more frequently caught at specific grounds, suggesting a patchy distribution. In the northern coast of Portugal, the species is caught down to 100 m deep, whereas preferred habitats are between 200 and 400 m deep in the south-western coast (Figure 12.3.2). There is no evidence of movements between the northernmost component and the southern part of Subarea 27.9 where Spanish fishery takes place.

12.3.5 Data available

12.3.5.1 Landings and discards

Historical landing data series available to the Working Group are described in Section 12.3.1 and detailed in Table 12.3.1. It should be noted that since 2015 Spanish landings include adjacent areas outside ICES Subarea 27.9 (data are not separated in earlier years). In addition, Morocco landings from the Strait of Gibraltar area are available since 2001 (not in 2022), although fishing is supposed to have taken place outside ICES Subarea 27.9. Table 12.3.2 presents the WG estimates of landings restricted to the ICES Subarea 9, without considering those from the Strait of Gibraltar target fishery.

Portuguese and Spanish discard information was available to the Working Group from on-board sampling programme (EU DCF/NP). Given the low levels of discards, the discarded rate is admitted to be nearly zero for most assessment purposes and those that do occur are mainly related to catches of small individuals. Consequently all catches of blackspot seabream in management are 27.9a. are assumed to be landed. Survival studies taken in ICES 27.9.a are consistent with a high survival rate after capture and release to the see

12.3.5.2 Length compositions

Length frequencies of landings are available for the Spanish "*voracera*" blackspot seabream target fishery in the Strait of Gibraltar (1997–2022). Figure 12.3.3 show the updated length distribution data (from Gil *et al*., WD 12 to the 2023 WGDEEP). The table below shows the mean and median landed size since 1998:

Summary statistics of *Pagellus bogaraveo* landed sizes by year since 1998.

Year	Mean	Std. Dev.	Median	Year	Mean	Std. Dev.	Median
1998	34.33	5.07	34	2010	36.03	5.28	35
1998	35.98	5.07	35	2011	36.33	6.36	34

Year	Mean	Std. Dev.	Median	Year	Mean	Std. Dev.	Median
1999	36.23	5.30	36	2012	36.40	5.91	35
2000	36.79	4.81	36	2013	34.80	3.64	34
2001	37.11	5.45	37	2014	37.11	5.14	36
2002	38.10	5.93	38	2015	39.15	5.79	38
2003	38.35	6.27	38	2016	37.47	5.28	37
2004	36.56	5.69	35	2017	37.72	4.37	37
2005	36.79	6.02	35	2018	37.84	4.67	37
2006	35.87	5.58	35	2019	37.27	4.21	37
2007	37.26	5.95	36	2020	37.37	4.30	37
2008	37.76	6.22	36	2021	42.19	5.90	41
2009	38.29	6.23	37	2022	36.77	3.96	36

Only one mean value (in 1998) is lower than the 2013 year´s mean landing size. However, changes are small and gradual. 2021 year's increase should be interpreted with caution and must be revised because is not consistent with previous and following years (Figure 12.3.3).

Landings length distribution by fishing segment (polyvalent and trawlers) from 2014 until 2022 are presented in Figure 12.3.4 (from Farias and Figueiredo, WD 15 to the WGDEEP 2023). Differences in length distribution between the polyvalent the trawl segments indicate that polyvalent fleet catch larger fish than the trawl fleet because operate in areas farther from the coast and at higher depths, where larger fish are more common (Farias *et al*., WD to the 2018 WGDEEP).

12.3.5.3 Age compositions

No new information was presented to the group.

12.3.5.4 Weight-at-age

No new information was presented to the group.

12.3.5.5 Maturity and natural mortality

No new information was presented to the group.

12.3.5.6 Catch, effort and research vessel data

Figure 12.3.5 and Table 12.3.2 present CPUE information, restricted to the Strait of Gibraltar fishery (Gil *et al.*, WD 12 to the 2023 WGDEEP). Effort, as indicated, from sales sheets is not standardized and is potentially underestimated in some years as the effort unit chosen may be inappropriate while CPUE estimated from VMS analysis shows the same trend.

Farias and Figueiredo (WD 15 to the 2023 WGDEEP) identify two reference fleets landing at Peniche port: a total of 36 fishing vessels (with more than 9 fishing trips per year and more than 6 months with positive landings of the species) were selected for the polyvalent (longliners) while 10 fishing vessels (with more than 9 fishing trips per year and more than 5 months with positive landings of the species) were selected for the trawl fleet. The GLM estimates of the reference fleets' CPUE, considered as landed weight per fishing trip, for the selected model are also presented in the WD. Catch rates derived from longliners are slightly higher than those from trawl – this probably reflects a difference on the species length composition between the two fleets (Figure 12.3.6 and Table 12.3.4).

12.3.5.7 Data analyses

The stock identity is still unclear linkages between the Strait of Gibraltar populations and the populations in the northern and central area of Subarea 27.9 are unlikely.

The trend is clear in the target fishery of the Strait of Gibraltar. Landings declined significantly until 2013 which may be considered as an indication of a substantial reduction in exploitable biomass. Current CPUE low levels may also be consistent with an almost depleted population: the fishing grounds of this target fishery partially overlap the southern limit of ICES Subarea 27.9 (Figure 12.3.7). Moroccan fleet also targets this species in the Strait of Gibraltar since 2001.

However, the analysis from the Portuguese (Peniche port) reference fleets' CPUE is not in accordance with the clear decreasing trend observed in the Strait of Gibraltar target fishery: longlines and bottom trawl catch rates from West Portugal coast are relatively stable. Furthermore, preliminary genomic studies confirmed low connectivity between the Azorean population and the Atlantic eastern continental margin locations and suggested genetic differentiation between the Strait of Gibraltar and locations further north in Iberian waters (Castilho et *al*., WD 5 to the 2022 WGDEEP).

Length-based indicators (LBI) screening methods were applied to the length data for continental Portugal (Farias and Figueiredo, WD 15 to the 2023 WGDEEP). Lmat (35.1 cm, females) and Linf (62 cm, both sexes) estimates were adopted from Gil (2006) and CopeMed II (2019), respectively. The length-weight relationship parameters ($W = 1.17542e\text{-}05 \times L^{3.0366}$) were estimated based on biological sampling data collected in 2020 and following the procedure in fishR Vignette (Ogle, 2013). Results from the LBI screening method are shown in Figure 12.3.8.

WGDEEP experts suggest that the stock in 27.9 should be assessed based on biomass indices which cover a representative fraction of the area of ICES Subarea 27.9. It is not clear that the fishery biomass index currently used fill this criterion, as it is derived from a fishery that takes place on the southern edge of ICES 27.9. This fishery targets blackspot seabream do not appear to mix greatly with blackspot seabream in western and northerly areas of 27.9, and are furthermore targeted in a fishery that mostly extends outside of 27.9.

In 2022 as in previous WGDEEP attempts, SPiCT results were quite uncertain with wide confidence intervals. The WG considered that if SPICT will be essayed again a dedicated working group would be set (next SPiCT benchmark, late 2023 – early 2024) including both stock experts and model developers to explore the adequacy of SPiCT to this stock. Adjustments on the code and extensive sensitivity analyses, particularly concerning on the choice of priori distributions, are expected to take a decision on the appropriateness of the method for this stock.

12.3.6 Management considerations

A TAC regime (114 t) was established for 2023 and 2024 for whole Subarea 27.9. 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 27.9, nevertheless catches in the GFCM area 37.1.1 and CECAF area 34.1.11 should be reported (Council Regulation (EU) 2016/2285). Recent landings are below the corresponding TAC levels but in 2016, European landings (including other areas such as FAO 34.1.11 and FAO 37.1.1) were above the 2016 TAC.

The combination of the minimum size of 33 cm for this species and the landing obligation (EU Regulation 2013/1380) might have an effect on certain fisheries: the exemption from the landing obligation of the target fishery of the Strait of Gibraltar (“*voracera*” gear) does not apply to other blackspot seabream catches in ICES Subarea 27.9.

GFCM established a management plan for the blackspot seabream fishery of the Strait of Gibraltar in 2022 (GFCM/45/2022/3 on a multiannual management plan for the sustainable exploitation of blackspot seabream in the Alboran Sea, geographical subareas 1 to 3). The update of benchmark assessment (gadget model) for blackspot seabream in the Strait of Gibraltar was presented in the last GCFM WGSAD (December 2022): results indicated that the stock is depleted with unsustainable exploitation and low fishing mortality. The recommendation was to proceed with immediate reduction of fishing mortality, implementing also a recovery plan (GFCM, 2022). WGDEEP still expresses its concern on the fact that the population of blackspot seabream in the Strait of Gibraltar is being assessed within two different advisory bodies (ICES and GFCM), who derive scientific advice to managers: coordination between all parties would be welcomed.

As well as in other ICES Subareas (27.6, 27.7, 27.8 and 27.10), 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.

Trends in abundance at the western coast of Portugal is not consistent with the trend in the Strait of Gibraltar: the CPUE of the Peniche reference fleets does suggest a different trend than the Strait of Gibraltar “*voracera*” fleet and there is no evidence of movements between the northernmost component and the southern part of Subarea 27.9, where Spanish fishery takes place. In fact, according to Castilho *et al*. (WD 5 to the 2022 WGDEEP), recent genetic results support the existence of three well-differentiated clusters in the Atlantic: (i) the Azores; (ii) Cadiz (Strait of Gibraltar) and (iii) the continental Atlantic coast. These results provided evidence for genetic differences between the populations off ICES subarea 27.9, clearly separating the population from the Strait of Gibraltar that might be more related to Mediterranean components. Therefore, it might not be appropriate to infer the stock status in all ICES Division 9a from the Strait of Gibraltar target fishery CPUE. Besides, this biological evidence could provide the scientific basis for the revision of the ICES management components adopted for blackspot seabream the Iberian waters.

12.3.7 Tables and Figures

Table 12.3.1. Blackspot seabream (*Pagellus bogaraveo*) in Subarea 27.9: 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	17		374 (17*)
2002	111	248	32		359 (32*)
2003	142	329	20		471 (20*)
2004	183	297	30		480 (30*)
2005	129	365	37		494 (37*)
2006	104	440	70		544 (70*)
2007	185	407	85		592 (85*)
2008	158	443	72		601 (72*)

Year	Portugal	Spain	Morocco*	Unallocated	TOTAL
2009	124	594	90		718 (90*)
2010	105	379	142		484 (142*)
2011	74	259	148		333 (148*)
2012	143	60	135	92	295 (135*)
2013	90	91	106		181 (106*)
2014	59	203	131		262 (131*)
2015	66	87 (142**)	224		295 (224*)
2016	70	95 (77**)	161		242 (161*)
2017	69	61 (18**)	190		148 (190*)
2018	58	29 (8**)	76		95 (76*)
2019	36	20 (4**)	119		60 (119*)
2020	43	16 (3**)	83		62 (83*)
2021	29	16 (4**)	114		49 (114*)
2022	33	7 (2**)			42 (N/A*)

***Morocco landings are available from the GFCM Working Group on Stock Assessment of Demersal species (GFCM 2022)**

****Figures in brackets includes blackspot seabream from other areas (FAO 34.1.11. and FAO 37.1.1).**

Table 12.3.2. Blackspot seabream (*Pagellus bogaraveo*) estimated landings in strictly Subarea 27.9, without considering those from the Strait of Gibraltar.

Year	Portugal	Spain	TOTAL
1988	370	0	370
1989	260	0	260
1990	166	0	166
1991	109	0	109
1992	166	0	166
1993	235	0	235
1994	150	0	150
1995	204	0	204
1996	209	0	209
1997	203	0	203

Year	Portugal	Spain	TOTAL
1998	357	0	343
1999	265	0	262
2000	83	33	116
2001	97	41	138
2002	111	82	193
2003	142	117	259
2004	183	57	240
2005	129	35	164
2006	104	93	197
2007	185	45	230
2008	158	27	185
2009	124	15	139
2010	105	13	118
2011	74	19	93
2012	143	26	169
2013	90	24	114
2014	59	65	124
2015	66	61	127
2016	70	72	142
2017	69	35	104
2018	58	29	87
2019	36	6	42
2020	43	7	49
2021	29	11	40
2022	33	8	41

Table 12.3.3. Spanish "*voracera*" blackspot seabream fishery of the Strait of Gibraltar (ICES Subarea 27.9): Estimated CPUE using sales sheets or VMS data as effort unit (adapted from Gil *et al.*, WD 12 to the 2023 WGDEEP).

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

Year	cpue	VMS cpue
2010	46	38
2011	42	31
2012	35	21
2013	30	14
2014	39	22
2015	49	32
2016	41	27
2017	33	14
2018	18	4
2019	24	8
2020	24	13
2021	21	10
2022	7	1

Table 12.3.4. Standardized CPUE series estimates for Portuguese reference fleets, predicted values and its 95% confidence interval lower – upper values in brackets (adapted from Farias and Figueiredo., WD 15 to the 2023 WGDEEP).

Year/ Reference fleet	Polyvalent	Trawl
2015	7.31 (6.18 – 8.65)	7.51 (6.22 – 9.06)
2016	7.03 (5.88 – 8.40)	6.41 (5.32 – 7.73)
2017	8.44 (7.03 – 10.12)	6.21 (5.19 – 7.43)
2018	7.82 (6.51 – 9.39)	5.35 (4.43 – 6.45)
2019	6.33 (5.23 – 7.65)	4.38 (3.59 – 5.35)
2020	6.13 (7.28 – 8.65)	5.66 (4.63 – 6.92)
2021	6.82 (5.61 – 8.29)	4.40 (3.64 – 5.33)
2022	8.10 (6.51 – 10.08)	4.45 (3.63 – 5.47)

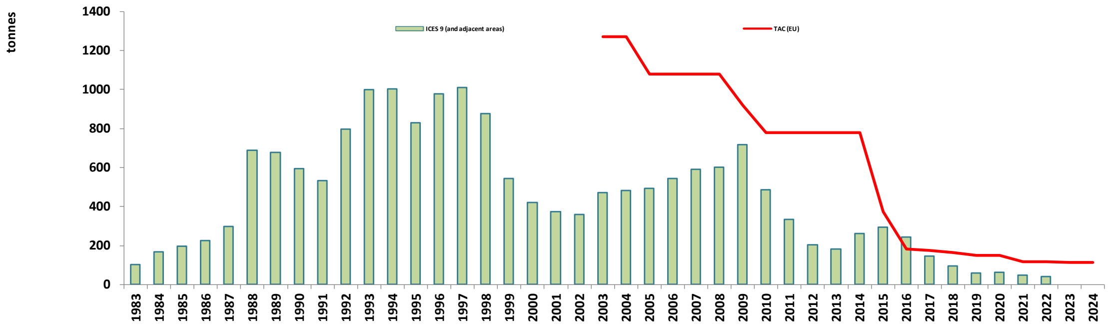

Figure 12.3.1. Blackspot seabream in ICES Subarea 27.9 (and adjacent waters): Total European landings (Morocco landings are not included) and EU TACs. Since 2015 landings from Strait of Gibraltar includes other areas (FAO 34.1.11 and FAO 37.1.1).

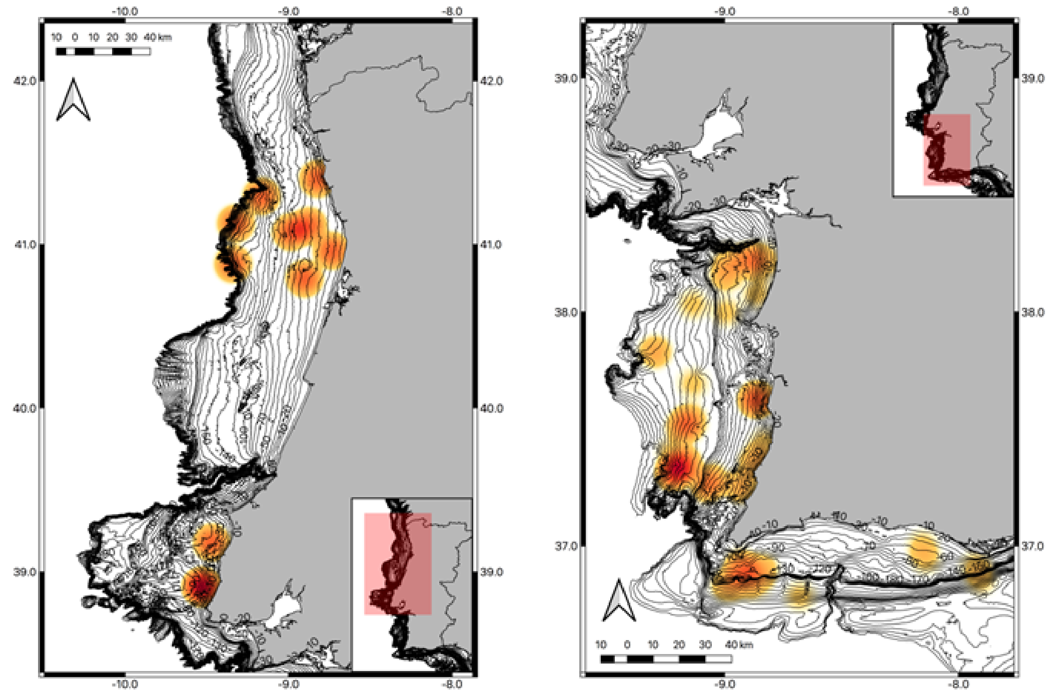

Figure 12.3.2. Blackspot seabream in ICES Subarea 9: Distribution *of Pagellus bogaraveo* along the Portuguese coast based on Portuguese surveys from the period between 1997-2011 and 2013-2017. The coloured blotches are hauls with *Pagellus bogaraveo* **catches over 5 n.h-1. The colour intensity of the blotches reflects species occurrence (from Farias and Figueiredo, WD 14 to the 2019 WGDEEP).**

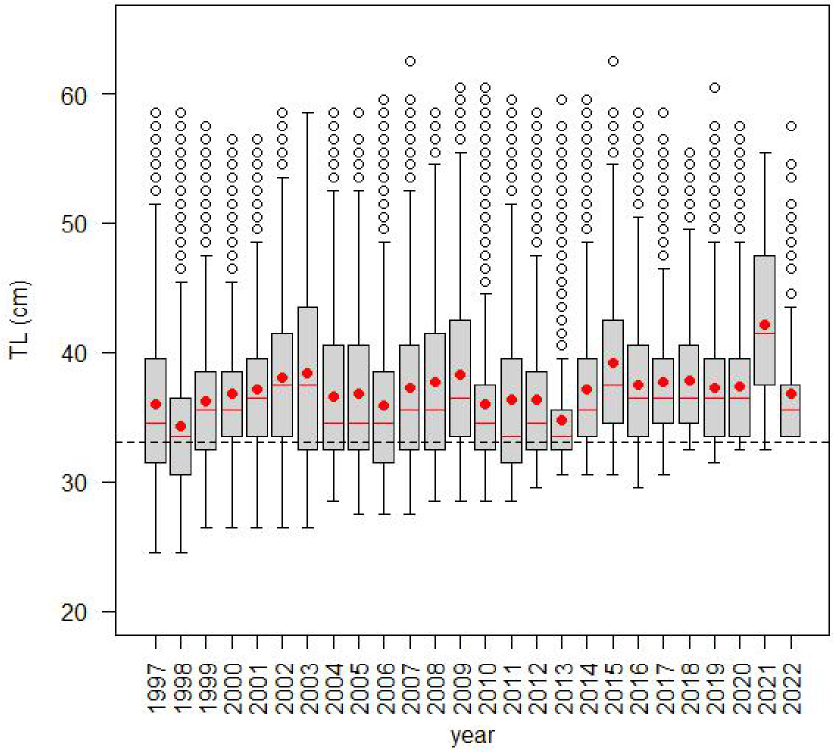

Figure 12.3.3. Spanish “*voracera*” blackspot seabream fishery of the Strait of Gibraltar: 1997–2021 (from Gil *et al.*, WD 12 to the 2023 WGDEEP). Dashed line (at 33 cm) represents the current minimum landing size for the species in Atlantic NE and Mediterranean European waters. Red dot are the mean value while red line represents the median.

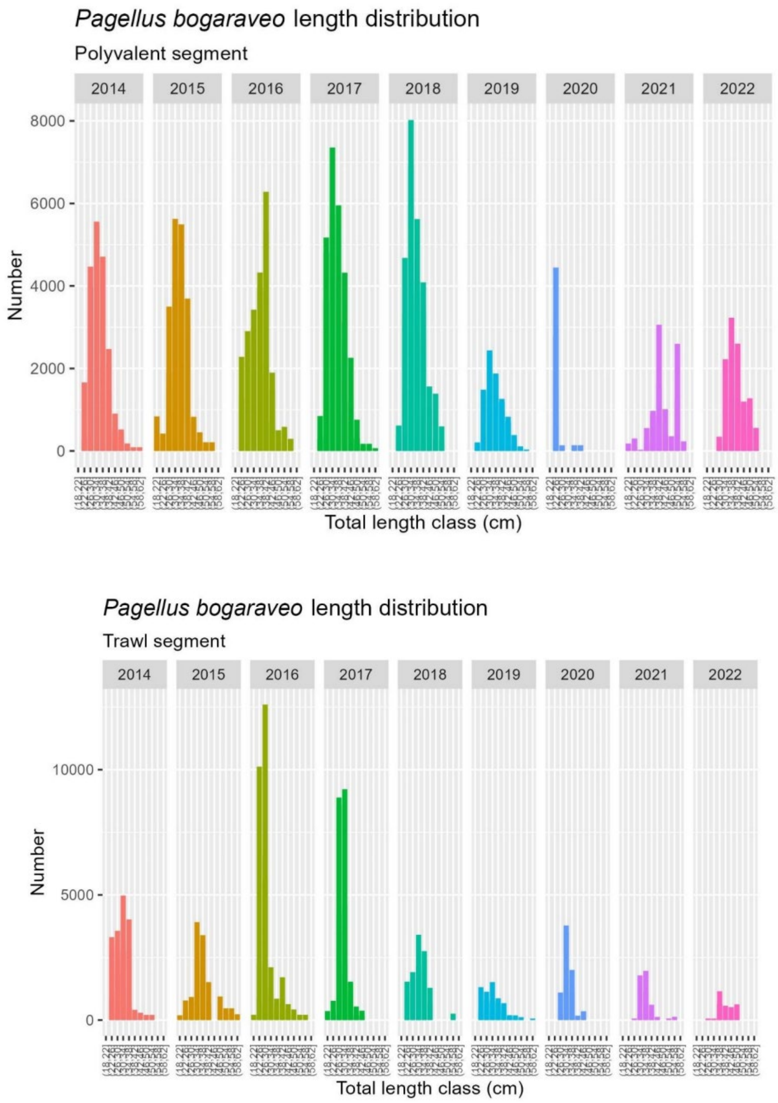

Figure 12.3.4. Peniche (Portugal) landing port: ***Pagellus bogaraveo*** **length frequency distribution by fishing gear (polyvalent and trawl fleet) for the years 2014 to 2022 (from Farias and Figueiredo, WD 15 to the 2023 WGDEEP). Length classes are aggregated by 4 cm range (from 18-22 and 20-24 in polyvalent and trawl fleets, respectively).**

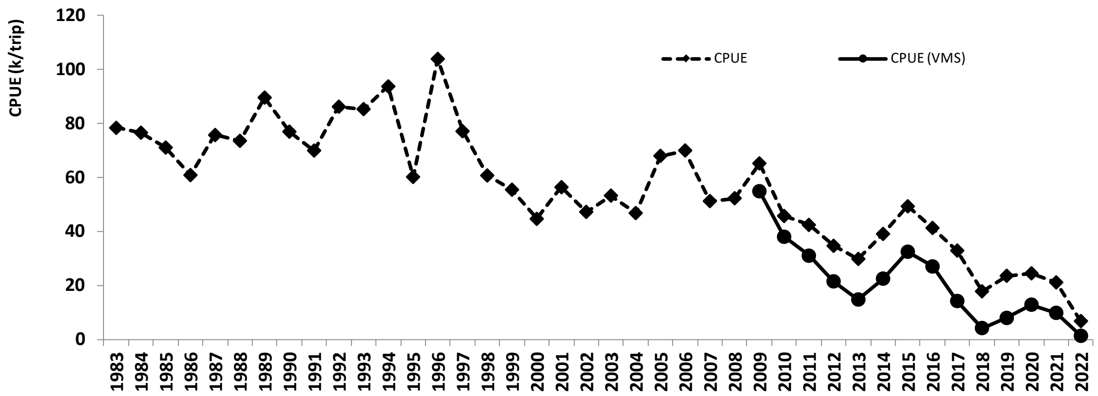

Figure 12.3.5. Blackspot seabream in ICES Subarea 27.9: Spanish "voracera" target fishery of the Strait of Gibraltar estimated CPUE, using sales sheets (dashed line: 1983-2022) and VMS data as unit of effort (solid line: 2009-2022) (from Gil et al., WD 12 to the 2023 WGDEEP).

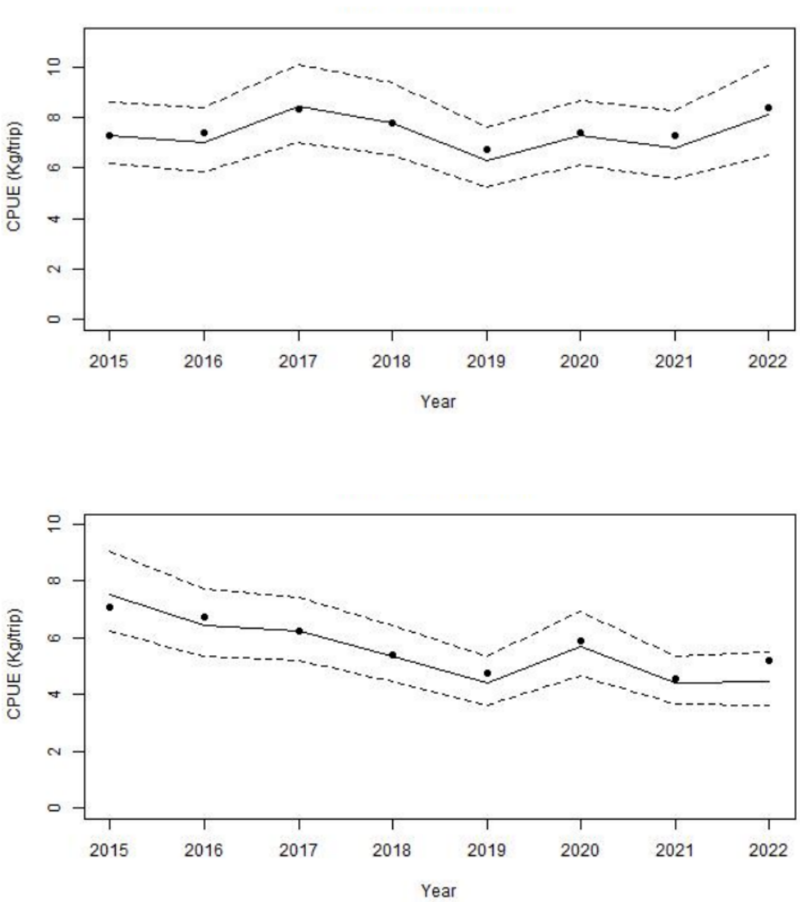

Figure 12.3.6. Blackspot seabream in ICES Subarea 27.9: Standardized annual estimates of CPUE by fleet segment (polyvalent and trawl) from the Peniche´s port reference fleets in 2015 - 2022 (from Farias and Figueiredo, WD 15 to the 2023 WGDEEP).

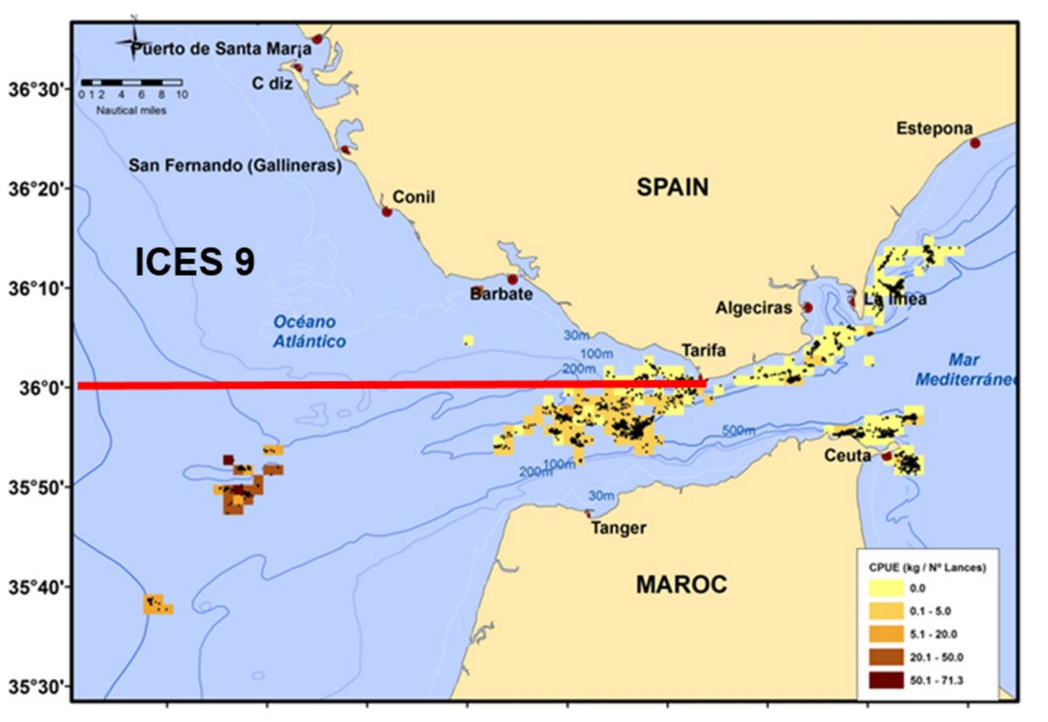

Figure 12.3.7. Blackspot seabream in ICES Subarea 27.9: Spanish "*voracera*" fleet footprint (from VMS data).

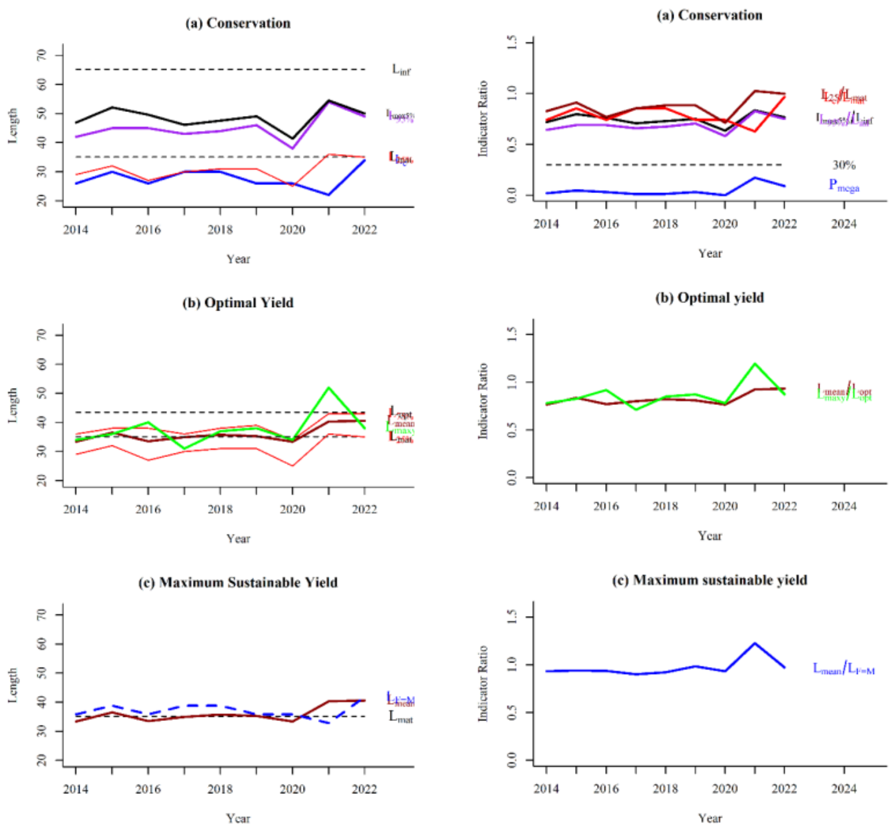

Figure 12.3.8. Blackspot seabream in ICES Subarea 27.9: Results from LBI screening (left) and LBI screening ratios (left) from length data of continental Portugal (from Farias and Figueiredo, WD 15 to the 2023 WGDEEP).

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12.4 Blackspot seabream (*Pagellus bogaraveo*) in Division 10.a.2

12.4.1 The fishery

Blackspot seabream (*Pagellus bogaraveo*) has been exploited in the Azores (ICES Division 10.a.2), at least since the XVI century as part of the Azorean demersal fishery. A directed hook exploits the species and line fishery that encompasses two fleet components: the artisanal (handlines) and the longliners (Pinho and Menezes, 2009; Pinho *et al.,* 2014). Important expansion of the fishery to offshore seamounts occurred during the 2000s (Ordinance No. 101/2002). This expansion was particularly held by the longline fleet because of the regional spatial management measures introduced (Santos et al., 2019). 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 is only authorized to operate on offshore (>6 nm) banks and seamounts (Pinho *et al.*, 2014; Santos et al., 2021). The tuna fishery caught, until the end of the nineties, juveniles (age 0) of blackspot seabream 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 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 given the plasticity of the fishery to the target effect related with variability of abundance and markets (prices of the fish in general along the year).

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 12.4.1). This increase was mainly due to the development of new markets, increased fish value, entry of new and modern boats, better professional education of the fisher and introduction of bottom longline gear, permitting the expansion of the exploitable area to deeper waters, banks, and seamounts as well as the expansion of the fishing season (ICES, 2006). Between 1990 and 2009 the annual landings have fluctuated around 1000 t, with a peak in 2005. During the period 2010–2012 the landings decreased significantly to an average of 641 t, which correspond to about 57% of the TAC adopted for that period, maintaining thereafter around this value due to the TAC introduced. Since 2005 a continuous decrease of the landings has been observed. Currently the fishery is highly constrained by management measures. Landings of the last four years (2019, 2020, 2021 and 2022) were: 474t,491t, 559t and 482t respectively.

12.4.2 ICES Advice

Latest ICES advise that when the precautionary considerations are applied, catches in 2022 should be no more than 610 tonnes for area 10. All catches are assumed to be landed.

12.4.3 Management

Under the European Union Common Fisheries policy, a TAC was introduced in 2003 (EC. Reg. 2340/2002). The recent time-series of TACs and landings from ICES Subarea 10 is given below.

Year	2008	2009	2010	2011	2012	2013	2014	2015
EU TAC	1136	1136	1136	1136	1136	1022	920	678

Landings	1089	1042	687	624	613	692	663	701
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
EU TAC	507	517	517	576	553	610	610	610
Landings	515	499	445	474	491	559	482	

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). In 2006 the Regional Azorean 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 (EC. Reg. 1811/2004) and bottom gillnets (EC. Reg. 91/2005) are forbidden in the Azores region.

In 2009, the Regional Government introduced (Ordinance No. 1/2010) 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). The seamount (Condor), located approximately 17 km to the southwest off Faial Island, was closed to fisheries (Ordinance No. 48/2010) to allow multidisciplinary research (ecological, oceanography and geological). During 2015, 2016 and 2017 additional technical measures were introduced which included limitation of the fishing area for long-liners, update of the minimum landing size to 33 cm (Ordinance No. 120/2016) and introduction of marine protected areas for coastal and oceanic areas (Santos *et al*., 2019). During 2017 license limitations were introduced for littoral hook and line fisheries. Since 2018 the Azorean quota is managed by quarter, island, and vessel. In 2019 some techniques measures have been changed by the Regional Government and European Union, as for example a closed season (Ordinance No. 74/2015) implemented in 2016, to reduce effort during the spawning aggregations (among January 15 and end of February), was revoked by Ordinance No. 63/2019 which allows fishing throughout the year. By the end of 2022 the Council Regulation (EU) proceeded the roll-over of Blackspot seabream fishery opportunities assigned to the European Union in 2023 to 610 t.

12.4.4 Data available

12.4.4.1 Landings and discards

Total annual landings data for ICES Division 10.a.2 are available since 1980. However, detailed, and precise landing data are available for the assessment since 1990 (WD08 Medeiros-Leal *et al*., 2022). Landings ICES Division 10.a.2 Area are presented in the Table 12.4.1 and Figure 12.4.2.

Information on the discards in the Azorean longline fishery has been collected by a team of observers on board the longline fleet as part of the European Commission Data Collection Framework (DCF; EU, 2008). During 2018 about 6% (12.7 t) of the total landings were discarded. However, no new information about discards for the period of 2019-2022 are available.

12.4.4.2 Length compositions

Fishery length composition from the landings collected as part of the European Commission Data Collection Framework (DCF; EU, 2008) is available for the most recent period 2019-2022 (Figure 12.4.3). Length composition from the fishery showed a stable pattern, however, a small increase of the larger individuals (>40 cm) was observed in the last years (Figure 12.4.3). This increase could be a result of the several changes in minimum landing size implemented since 2010 as a management measure in the Azores (Figure 12.4.1).

Length compositions from survey (Figure 12.4.4) showed a mode around 25-31 cm, evidencing a relative selectivity of the fishing gear for this cohort. Besides that, since 2017 the survey also has presented a decrease for larger length classes in the last years (2017, 2018, 2019 and 2021). These results indicate that there were not changes in the exploitation patterns of the commercial fishery.

12.4.4.3 Age compositions

The information is available from the survey until 2021 but are not presented here because it is not relevant to the current assessment.

12.4.4.4 Weight-at-age

No new information was presented to the WGDEEP2023 because there are no relevant changes on the biology of the species.

12.4.4.5 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 by Silva et al. (2021) exploring several empirical methods for the M estimation. A mean value of M=0.3 was estimated but with a considerable uncertainty.

12.4.4.6 Catch, effort and research vessel data

Standardized fishery CPUE was updated (WD13 Novoa-Pabon et al., 2020) only until 2017 because fishery data collected by DCF was not available between 2018-2022 (Table 12.4.2). A new standardized fishery LPUE is available, but also only until 2017 because the fishery data collected by DCF was not available for 2018-2022 (WD17, Medeiros-Leal et al. 2023).

Due to survey issues, the abundance index derived from the annual Azorean spring bottom longline survey data were updated (WD09 Medeiros-Leal et al., 2022) based on the data availability and reliability of the indexes. This information is resumed on Table 12.4.3, Figure 12.4.5 and Figure 12.4.6.

12.4.5 Data analyses

The standardised fishery CPUE has been variable (Figure 12.4.7). 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. A new standardised fishery dependent (LPUE) index is now available (Figure 12.4.7). The LPUE, presented a high variability on the estimates mainly between 1985-2005 and in recent years a declining trend (Figure 12.4.7). The variability in the beginning of the LPUE time series could be related with changes in the data collection, where first were performed by the Department of Oceanography and Fisheries of the University of the Azores and after 2000s as part of the Data Collection Framework (DCF; EU, 2008). Besides that, this trend pattern coincides with a declining trend in landings (Figure 12.4.2) and survey abundance indices (Figure 12.4.5) over the same period, except for the last five years (2016-2021) for the survey case.

The Azorean bottom longline survey targeting *Pagellus bogaraveo* is considered reliable for abundance estimates (Pinho et al., 2020), 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 12.4.3). The survey time-series is not continuous because in 1998, 2006, 2009, 2014, 2015 and 2020 there was no survey, and in 2021 just coverage 50% of the survey area. Detailed information about the statistical procedures to estimates the abundance indices from the survey areas coverage in 2021 are provided in WD09 Medeiros-Leal et al. (2022). The annual values were computed using sampling statistical areas I-II because the areas III and IV was not sampled in 2021, however the abundance trend derived from Areas I-II are like the trends from Areas I-IV (Figure 12.4.5).

Survey indices from 1995 to 2021 show no trend with a high value every three years until 2005 and for the years of 2017, 2018, 2019 and 2021 (Figure 12.4.5). The 2017 and 2019 correspond to the year with the highest index value observed in the time series. These high values may be related with some sort of catchability variability (fish are more available to the gear in some years than in others) as a function of the feeding behaviour (benthopelagic), reproduction (protandric forming spawning aggregations) of the species, due to environmental effects or result of management measures. However, the survey abundance indices from 2010–2013 are in the range of lowest values and with a decrease trend. This period corresponds to the lowest catch observed during the last 21 years being on average 60% of the precedent years (1995–2009) (Figure 12.4.2).

The stock is classified under ICES category 3 and the WGDEEP tried to implement the methods recommended by WKLIFE X: SPiCT model and “rfb” rule to replace the former 2 over 3 advice. The SPiCT results were quite robust using the three abundance indexes available (CPUE, LPUE and Survey), but not applicable because the time series of the indexes did not present the most recent year (2022). Detailed information about the SPiCT results and others exploratory stock assessment methods as JABBA and LBI, is presented in the exploratory analysis section and WD XX Medeiros-Leal et al. (2023). For this reason, the assessment was performed based on the "rfb" rule with the survey abundance index trends and fishery length composition.

Due to the interruption of COVID-19 and a strike of the crew members of the research vessel, the annual Azorean spring bottom longline survey was not carried out in 2020 and 2022. Given these considerations, it was decided present two alternative bases for advice this year, following the “rfb” rule for advice opportunities:

- Scenario A: Previous catch advice Ay (2023). The index A were calculated using only 2021 and B based on an interpolation of the 2020 (2018, 2019, 2020). These indices were calculated to estimate the r - stock biomass trend (index ratio A/B); The fishing pressure proxy (f) were calculated using the length-composition from the fishery for the period 2019-2022.
- Scenario B: Previous catch last three years Cy (average 2020-2022). The index A were calculated using only 2021 and B based on an interpolation of the 2020 (2018, 2019, 2020). These indices were calculated to estimate the r - stock biomass trend (index ratio A/B). The fishing pressure proxy (f) were calculated using the length-composition from the fishery for the period 2019-2022.

Following the guidance on the parameter determination for the “rfb” rule, possible estimates of the input values and some comments are presented in the table below.

Variable	Estimate	Input data	Comment
r: Stock biomass trend	0.87	The Azorean bottom longline survey was used as the index of stock development.	An important increase in the last five years (2016-2021).
f: Fishing proxy	0.95	Fishery length composition from the landings, collected by DCF (2019-2022).	No changes in the exploitation patterns of the commercial fishery, in terms of length composition.
b: Biomass safeguard $= \min\left(1, I_{y-1}/I_{\text{trigger}}\right)$ $I_{\text{trigger}} = I_{\text{loss}}\ \omega$, considering $\omega = 1.4$	1	Due to the survey indices series continuous increasing trend a question: how realistic is this increase?	The CPUE and LPUE indexes presents the opposite of the survey index.

m linked to von Bertalanffy k	0.95	k estimated from the Von Bertalanffy model, valid for both exercises

Survey data show an important increase in the relative abundance index for the last five years (2016-2021) relative to the previous period. The observed increase is consistent through all statistical survey areas (Figure 12.4.6). The lack of updated fishery abundance data to compare the observed trend makes it difficult to interpret the mean of this large increase; however, it may be a consequence of the severe management measures introduced, as e.g., minimum landing size, fishing area restrictions by vessel size and gears, limitations of the fisheries licence numbers, quotas by island and introduce of marine protected areas (Figure 12.4.1).

Catches in recent years are highly constrained by several management measures.

Exploratory analysis

Length-based Indicators (LBI)

Length-base indicators reported from WKLIFEV were explored and for this exercise were used Azorean commercial fishery length compositions for pooled sexes from 2019–2022 (discards are assumed to be negligible). Main life-history parameters used are resumed in Table 13.4.4. Computations were performed using R software and the codes were available in the GitHub library of ICES.

Results from the analysis are shown in Figure 12.4.8 and Table 13.4.5. Results show that for immature conservation a substantial harvesting occurs after maturity (L_c and $L25\%>L_{mat}$). This was expected since the current relative exploitation pattern corresponds to a $L50\%\geqq L_{mat}$. This L_{mat} value is already considered low (L_{mat} moved from 32 cm to 29 cm along time) being probably a response of the population to the fishing pressure.

For mature fraction of the population the results suggest that the large individuals are present but decreasing ($L_{max}\leq L_{inf}$). The L_{mat} (29 cm) is considerably lower than L_{opt} (36 cm) and the results of P_{mega} indicator clearly suggest that the mega spawners in the Azorean commercial fishery are lower than 30% throughout the analysed period. The MSY proxy results show that exploitation is close to the MSY level (Lmean>Lopt and Lmean<LF=M; Table 13.4.5 and Figure 12.4.8).

Surplus production models

The JABBA and SPiCT production models were explored using all available information from CPUE (1990-2017), LPUE divided in two-time blocs (1985-2006 and 2006-2017) due to the variability in the index estimates, and exploited biomass (individuals > 33 cm) of bottom longline survey (1996-2019; Figure 12.4.7). As all catches are assumed to be landed and the discards considered negligible, the landings for the period 1985–2019 were used (Figure 12.4.7). Several runs were explored using the four indexes and were analysed different periods of years by excluding uncertainty years. The final set of years used in the base-case model are presented in Table 12.4.6. To reduce the uncertainty of the results and to obtain robust estimates of the reference points, priors (Table 12.4.6) were defined unifying the parametrization between age-structured and production models as recommended by WKBMSYSPiCT guidelines (ICES, 2021) and detailed information is available on WD17,-Medeiros-Leal et al. (2023).

JABBA

Results of JABBA model suggests a carrying capacity (K) of 14853 t, a B_{MSY} of 5644 t, F_{MSY} = 0.14 year^{-1} and MSY=811 t for blackspot seabream in Azores. The stock biomass at the end of 2019 was 20% of the B_{MSY} and the fishing mortality was 29% of the F_{MSY}. Biomass presented a continuous decreased period from 1995 to 2010, with a stable period between 2011 to 2015, and a very slight increase since thereafter (Figure 12.4.10), while the fishing mortality was above F_{MSY} between 1998 to 2015. The relative biomass (B_{2019}/B_{MSY}) and exploitation level (F_{2019}/F_{MSY}) in 2019 were 0.81 and 0.72 respectively, indicating that the blackspot seabream fishery in the Azores was in a recovering status. The default JABBA plots are shown in Figures 12.4.10. JABBA model presented a good fit of the residual's diagnostics and retrospectivity analysis, and the convergence was achieved (Figures 12.4.11).

SPiCT

Results of SPiCT model suggests a carrying capacity (K) of 13061 t, a B_{MSY} of 4378 t, F_{MSY} = 0.17 year^{-1} and MSY=753 t for blackspot seabream in Azores. The stock biomass at the end of 2019 was 22 % of the B_{MSY} and the fishing mortality was 12% of the F_{MSY}. Biomass presented a continuous decreased period from 1999 to 2010, with a stable period between 2011 to 2015, and a very slight increase since thereafter (Figure 12.4.12), while the fishing mortality was above F_{MSY} until 2015. The relative biomass (B_{2019}/B_{MSY}) and exploitation level (F_{2019}/F_{MSY}) in 2019 were 0.78 and 0.85 respectively, indicating that the blackspot seabream fishery in the Azores was in a recovering status. The default SPiCT plots are shown in Figures 12.4.12. SPiCT model presented a good fit of the residual's diagnostics and retrospectivity analysis, and the convergence was achieved (Figures 12.4.13 and 12.4.14).

Comments on the explanatory analysis

Results from the methods used in the exploratory analysis seem to be all in agreement suggesting that the stock has been explored at or above the MSY level and still recovering the biomass after an overfishing period. There are some data analyses that should be explored in future works, which can considerably improve the assessment:

- Analyse the effects of factors such as competition, gear saturation and soak time on the survey data to better understand the reliability of the abundance indices for assessment.
- Analyse the reproductive biology of the Blackspot seabream clarifying aspects related to the maturity stages and sex transition phase.
- A benchmark workshop to tailor the simulation process to the knowledge available for the species and to validate the surplus production models assessments.

12.4.6 Tables and Figures

Table 12.4.1. Historical landings of blackspot seabream *Pagellus bogaraveo* **from the Azores (ICES Area 10.a.2).**

Year	Azores (10.a.2)	Total
1980	415	415
1981	407	407

Year	Azores (10.a.2)	Total
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

Year	Azores (10.a.2)	Total
2011	624	624
2012	613	613
2013	692	692
2014	663	663
2015	701	701
2016	515	515
2017	499	499
2018	445	445
2019	474	474
2020	491	491
2021	559	559
2022	482	482

Table 12.4.2. Nominal and standardized bottom longline fishery abundance index (scaled cpue to the mean) of the blackspot seabream *Pagellus bogaraveo* in Subarea 10.

YEAR	NOMINAL cpue	STANDARDIZED cpue	Lower CI	Upper CI
1990	0.92	0.97	0.87	1.08
1991	0.92	0.94	0.81	1.07
1992	0.96	0.98	0.78	1.17
1993	0.79	1.01	0.87	1.15
1994	0.97	1.01	0.84	1.18
1995	1.09	1.08	0.92	1.23
1996	1.24	1.5	1.25	1.75
1997	1.63	1.32	1.1	1.53
1998	1.03	1.21	1.06	1.35
1999	1.1	1.3	1.16	1.44
2000	0.82	0.82	0.75	0.9
2001	1.12	0.96	0.84	1.07
2002	1.24	1.02	0.9	1.15
2003	0.98	1	0.91	1.1

YEAR	NOMINAL cpue	STANDARDIZED cpue	Lower CI	Upper CI
2004	1.42	1.08	0.96	1.19
2005	1.71	1.16	1.06	1.27
2006	1.26	0.95	0.86	1.04
2007	1.34	1.22	1.09	1.36
2008	1.21	1.13	1.02	1.24
2009	1.18	0.96	0.88	1.05
2010	0.62	0.72	0.66	0.78
2011	0.59	0.76	0.69	0.82
2012	0.62	0.81	0.74	0.88
2013	0.64	0.91	0.83	0.99
2014	0.67	0.83	0.76	0.90
2015	0.56	0.74	0.68	0.80
2016	0.39	0.61	0.56	0.67
2017	0.48	0.59	0.60	0.57
2018	na	na	na	na
2019	na	na	na	na
2020	na	na	na	na
2021	na	na	na	na
2022	na	na	na	na

Na – not available

Table 12.4.3. Survey relative abundance index in number of blackspot seabream *Pagellus bogaraveo* from the Azores (ICES Area 10.a.2).

Year	Lower	Index	Upper
1995	6	84	6
1996	7	34	6
1997	11	38	9
1998	0		
1999	32	103	32
2000	13	39	15
2001	10	57	10

2002	9	114	8
2003	19	78	17
2004	25	90	26
2005	25	143	23
2006			
2007	25	79	26
2008	17	101	18
2009			
2010	13	67	16
2011	17	60	18
2012	9	48	11
2013	8	38	8
2014			
2015			
2016	22	112	21
2017	21	117	22
2018	21	80	20
2019	30	142	28
2020			
2021	11	99	12
2022	na	na	na

na – not available

Table 12.4.4. Input constant parameters used in Length Based Indicators analysis for blackspot seabream *Pagellus bogaraveo* of the Azores (ICES area 10).

Parameters	Value	Definition	Obs.
L_{oo} (cm)	55.12	Asymptotic average maximum length	Medeiros-Leal et al. (2023)
K (year-1)	0.12	Growth coefficient of the von Bertalanffy growth model	Medeiros-Leal et al. (2023)
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_{mat} (L_F, cm)	29	Length at size first maturity	Santos et al. (2020)
M	0,3	Natural mortality	Silva et al. (2021)
M/k	1,67	Ratio natural mortality over growth coefficient	Medeiros-Leal et al. (2023)

Table 12.4.5. Traffic light indicators for blackspot seabream *Pagellus bogaraveo* from the Azorean commercial fishery (ICES Area 10.a.2).

Year	Conservation				Optimizing Yield	MSY
	L_c / L_{mat}	$L_{25\%}$ / L_{mat}	$L_{max\,5}$ / L_{inf}	P_{mega}	L_{mean} / L_{opt}	L_{mean} / $L_{F=M}$
	> 1	> 1	> 0.8	> 0.3	~ 1 (> 0.9)	≥ 1
2019	1.02	1.05	0.87	0.13	0.95	0.95
2020	1.02	1.05	0.86	0.16	0.97	0.97
2021	1.02	1.05	0.83	0.12	0.95	0.95
2022	1.02	1.05	0.84	0.13	0.96	0.96

Table 12.4.6. Input constant priors used, and years excluded in surplus production model analysis for blackspot seabream *Pagellus bogaraveo* of the Azores (ICES area 10).

Priors	Value	Model	Indexes	Years
r	0.15	JABBA	CPUE	1990, 1991 and 2000
m	1.1	JABBA	LPUE 1	1998
BMSY/B0	0.38	JABBA	LPUE 2	2012
Logpsi	0.6	JABBA	Survey	1996, 1997 and 2017
r	0.15	SPiCT	CPUE	1990, 1991 and 2000
m	1.1	SPiCT	LPUE 1	1998
BMSY/B0	0.38	SPiCT	LPUE 2	2012
Logpsi	0.6	SPiCT	Survey	1996, 1997 and 2017

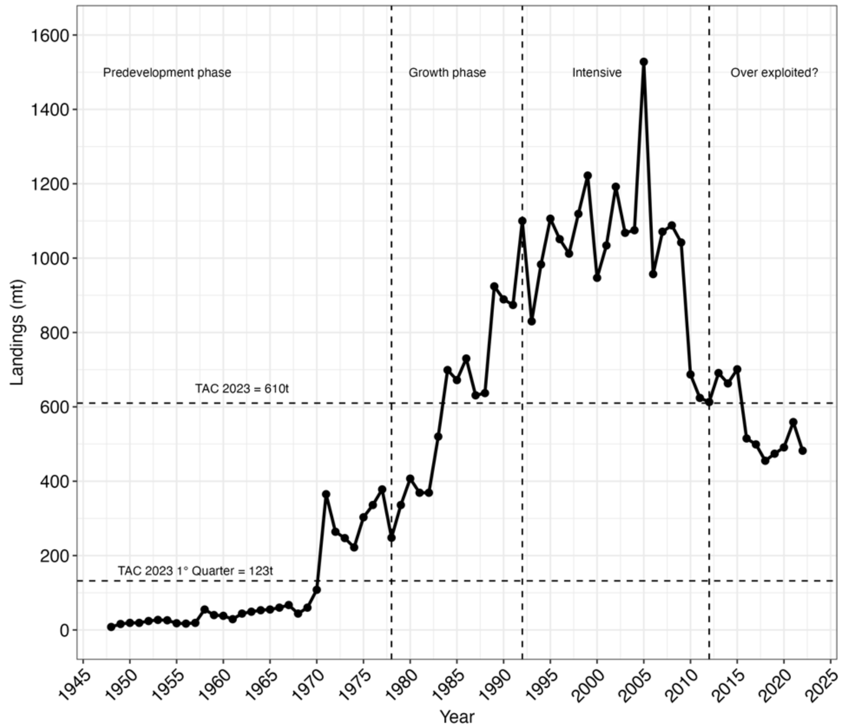

Figure 12.4.2. Historical landings of blackspot seabream *Pagellus bogaraveo* from the Azores (ICES Area 10.a.2).

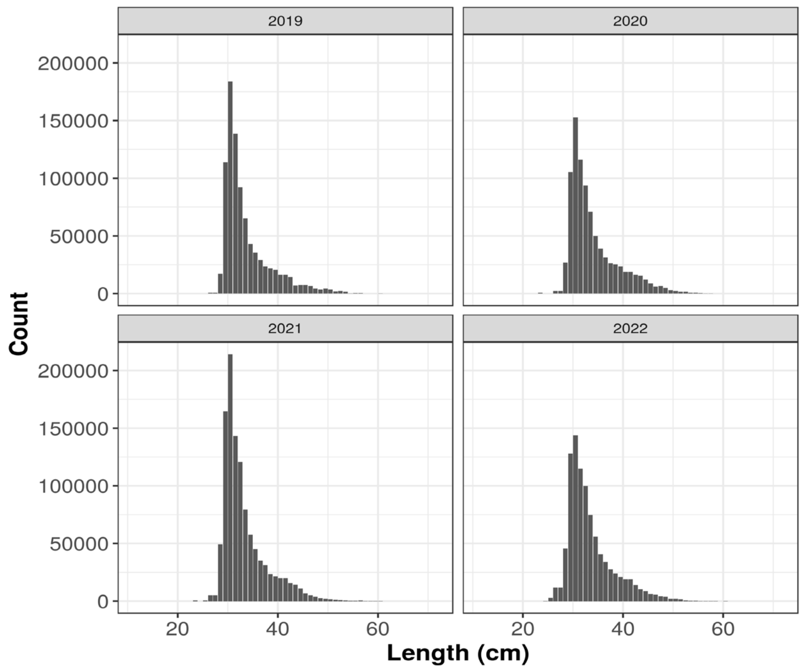

Figure 12.4.3. Annual fishery length composition of blackspot seabream *Pagellus bogaraveo* for the period 2019–2022 (ICES division 10.a.2).

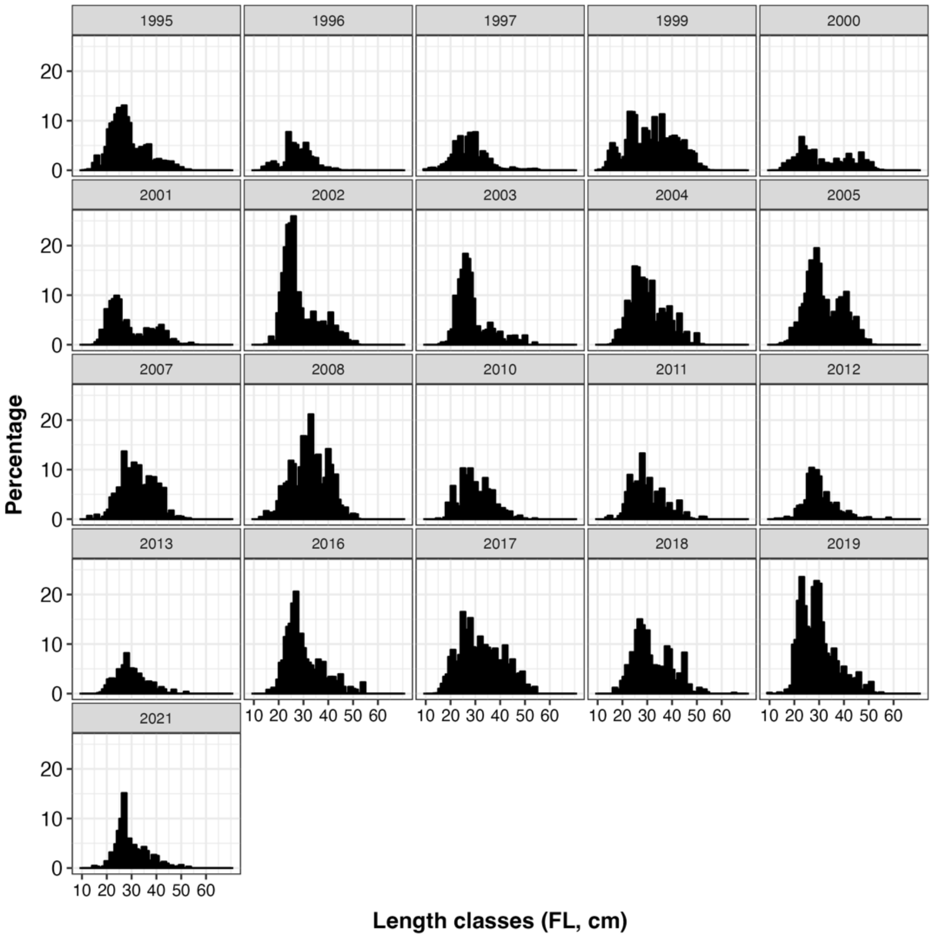

Figure 12.4.4. Annual length composition of blackspot seabream *Pagellus bogaraveo* from the Azorean spring bottom longline survey for the period 1995–2021 for areas I and II (ICES division 10.a.2).

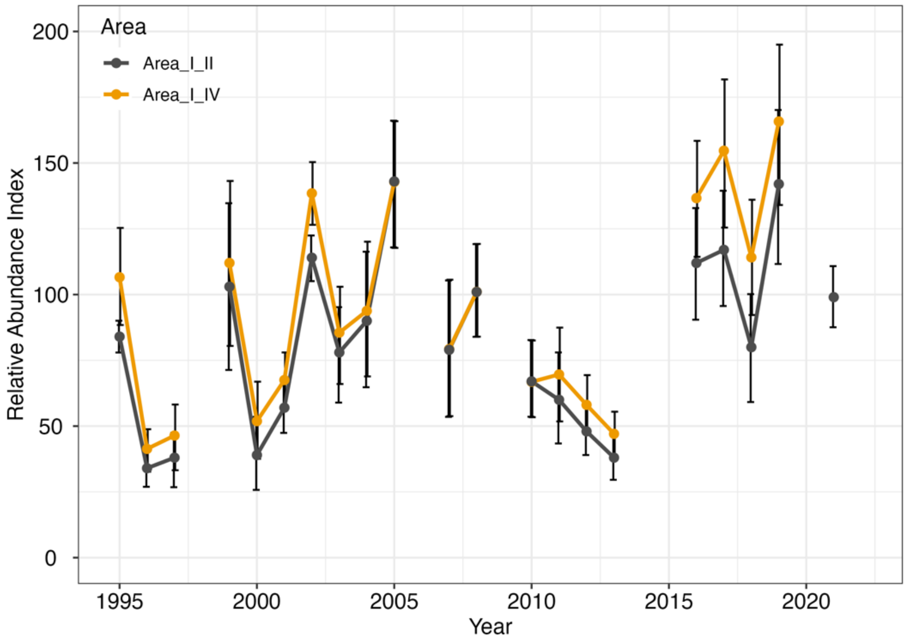

Figure 12.4.5. Annual abundance in number (Relative Population Number) of blackspot seabream *Pagellus bogaraveo* from surveys for the period 1995–2021 (ICES Area 10.a.2).

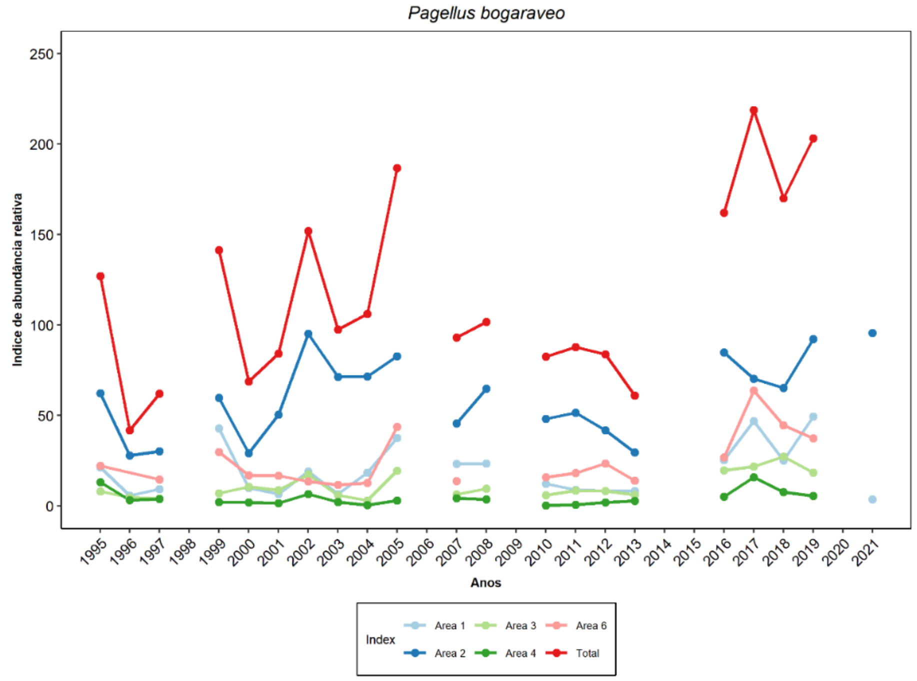

Figure 12.4.6. Annual abundance in number (Relative Population Number) by statistical areas of blackspot seabream *Pagellus bogaraveo* from surveys for the period 1995–2021, by sampling statistical areas (ICES Area 10.a.2).

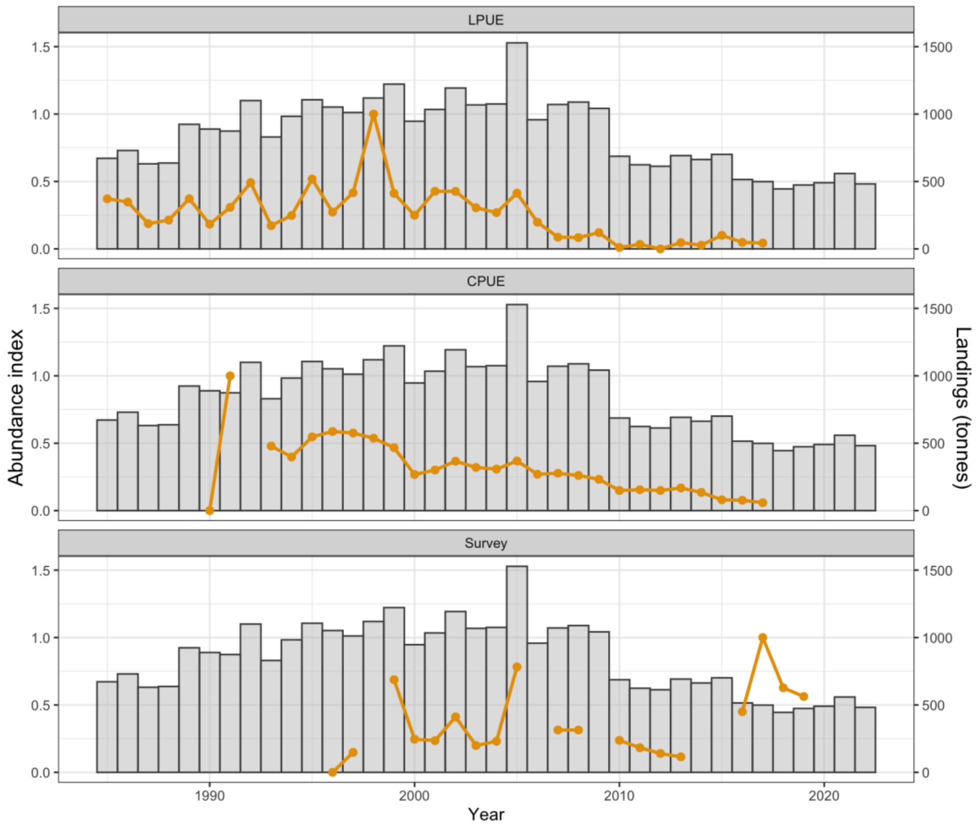

Figure 12.4.7. Standardized and scaled to mean LPUE (Kg landings−1 vessel−1), CPUE Nominal (Kg days at sea−1 vessel−1) from the Azorean bottom longline fishery (1985-2017), and exploited biomass (>33 cm) of Annual abundance in number (Relative Population Number) from the bottom longline survey (1996-2019) for blackspot seabream *Pagellus bogaraveo* from the Azorean bottom longline fishery.

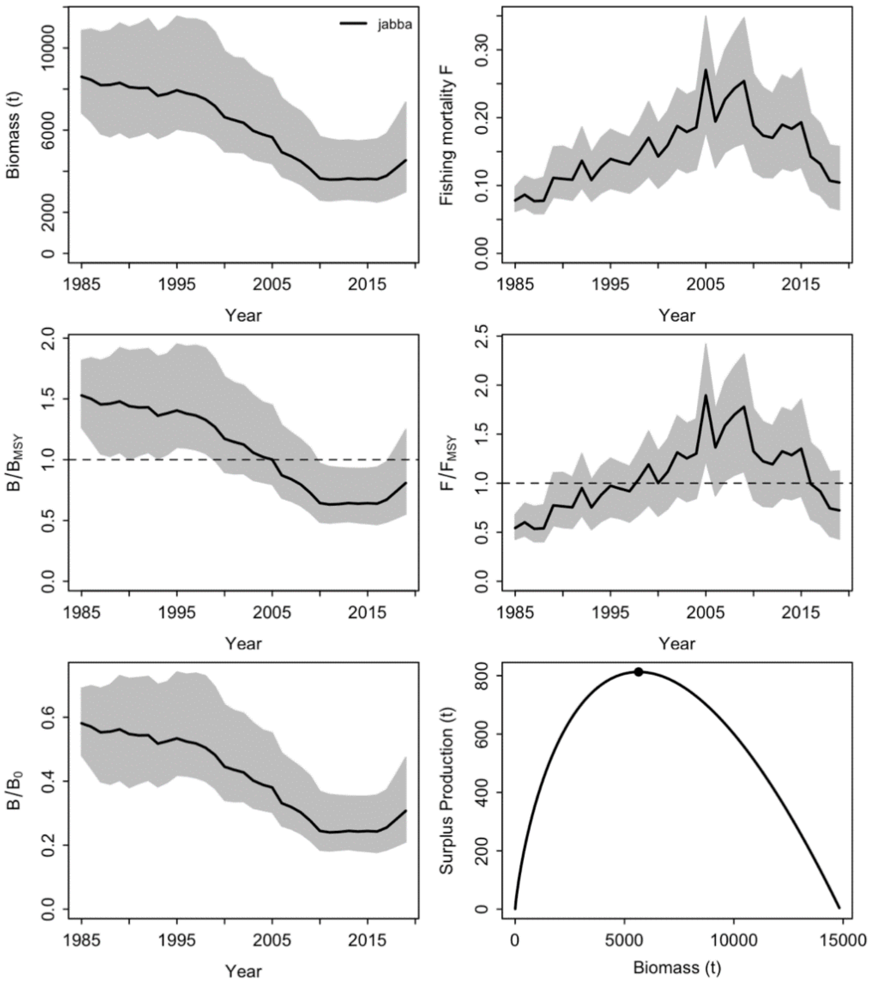

Figure 12.4.9. Basic results of JABBA model for the blackspot seabream *Pagellus bogaraveo* from the Azores using standardized CPUE, LPUE and Survey data (ICES, 10.a.2).

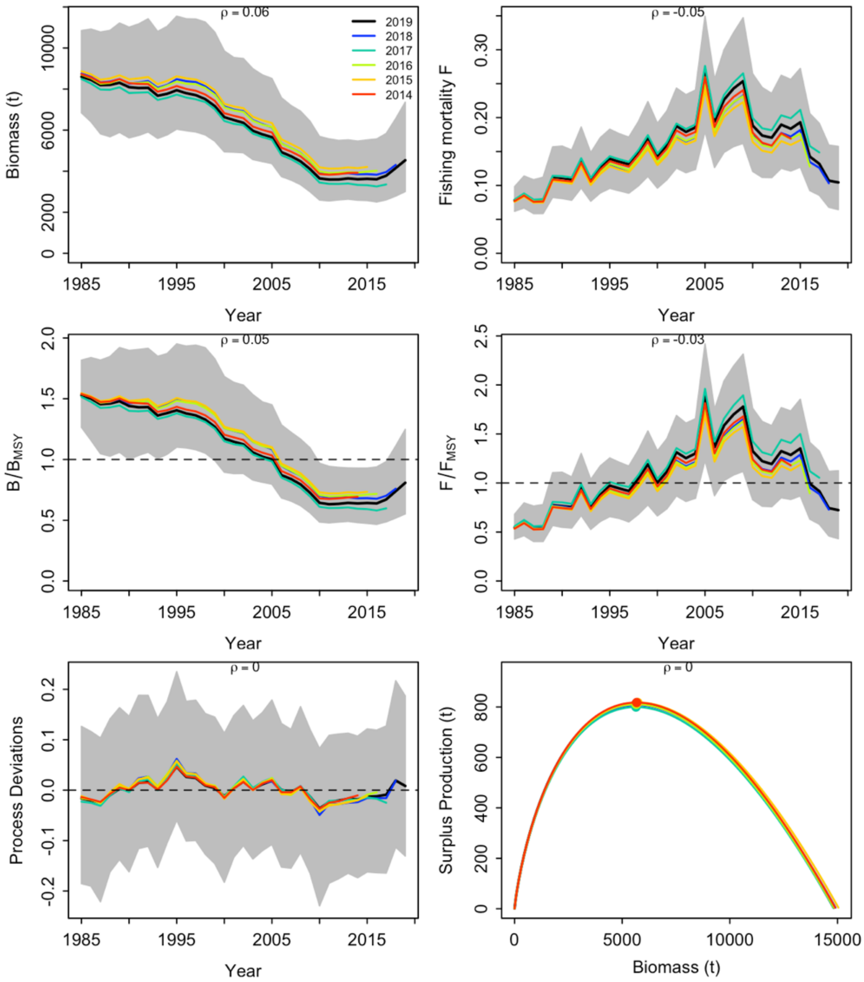

Figure 12.4.10. Retrospectivity analysis from JABBA model applied to the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

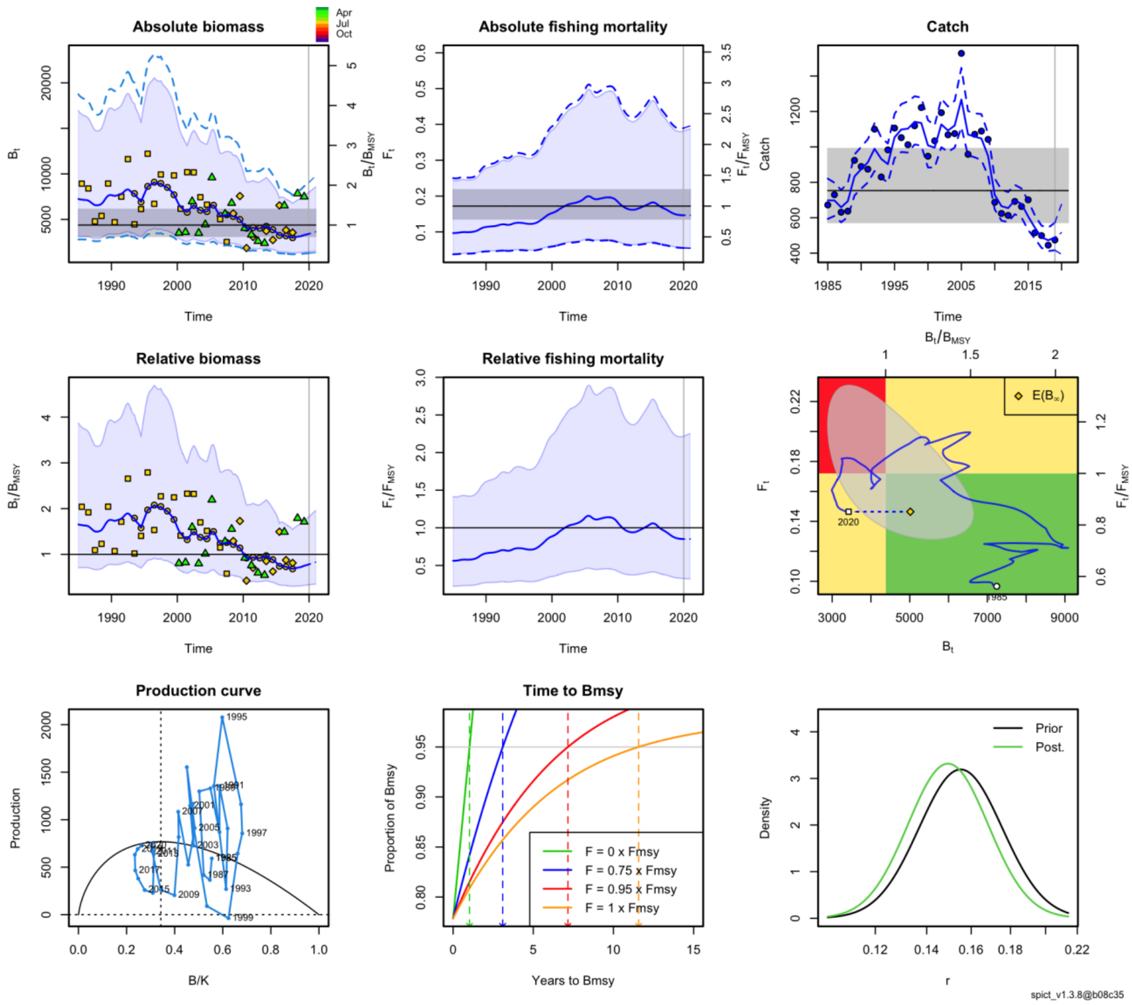

Figure 12.4.11. Basic results of SPICT model for the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

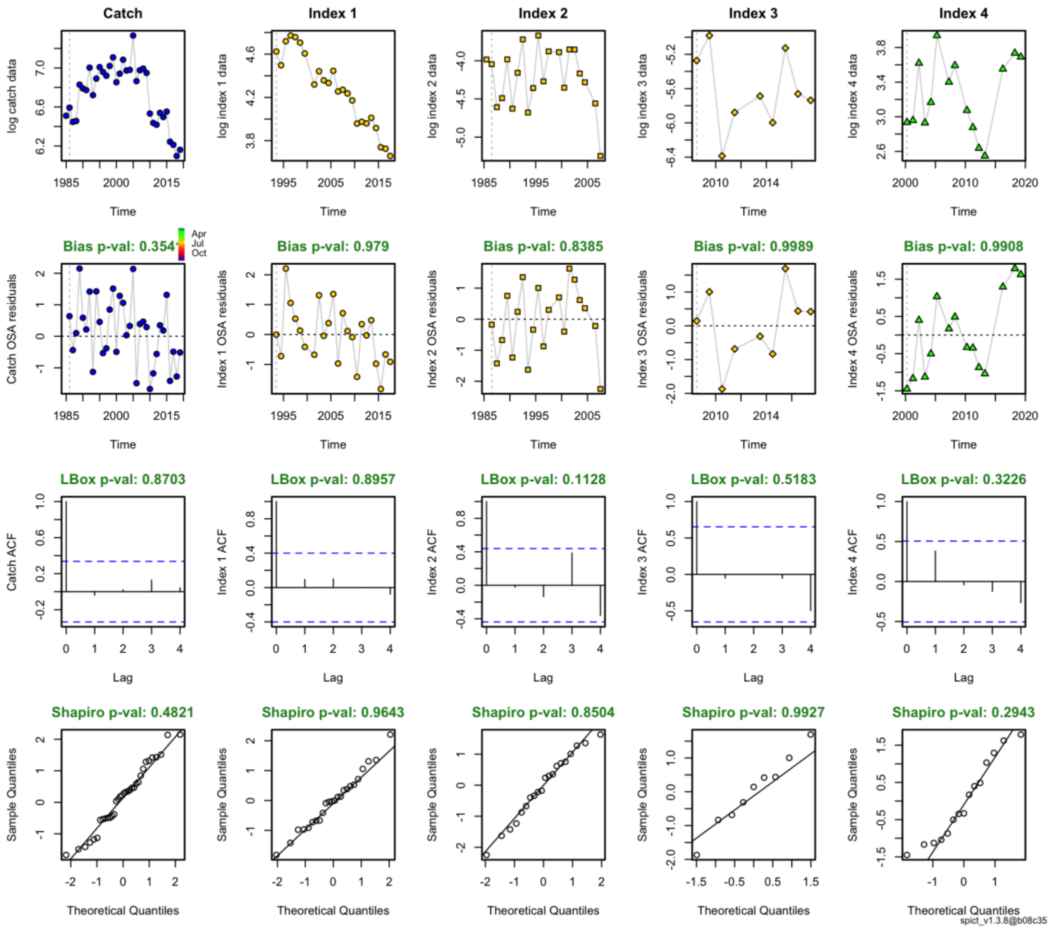

Figure 12.4.12. Residual results from SPICT model applied to the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

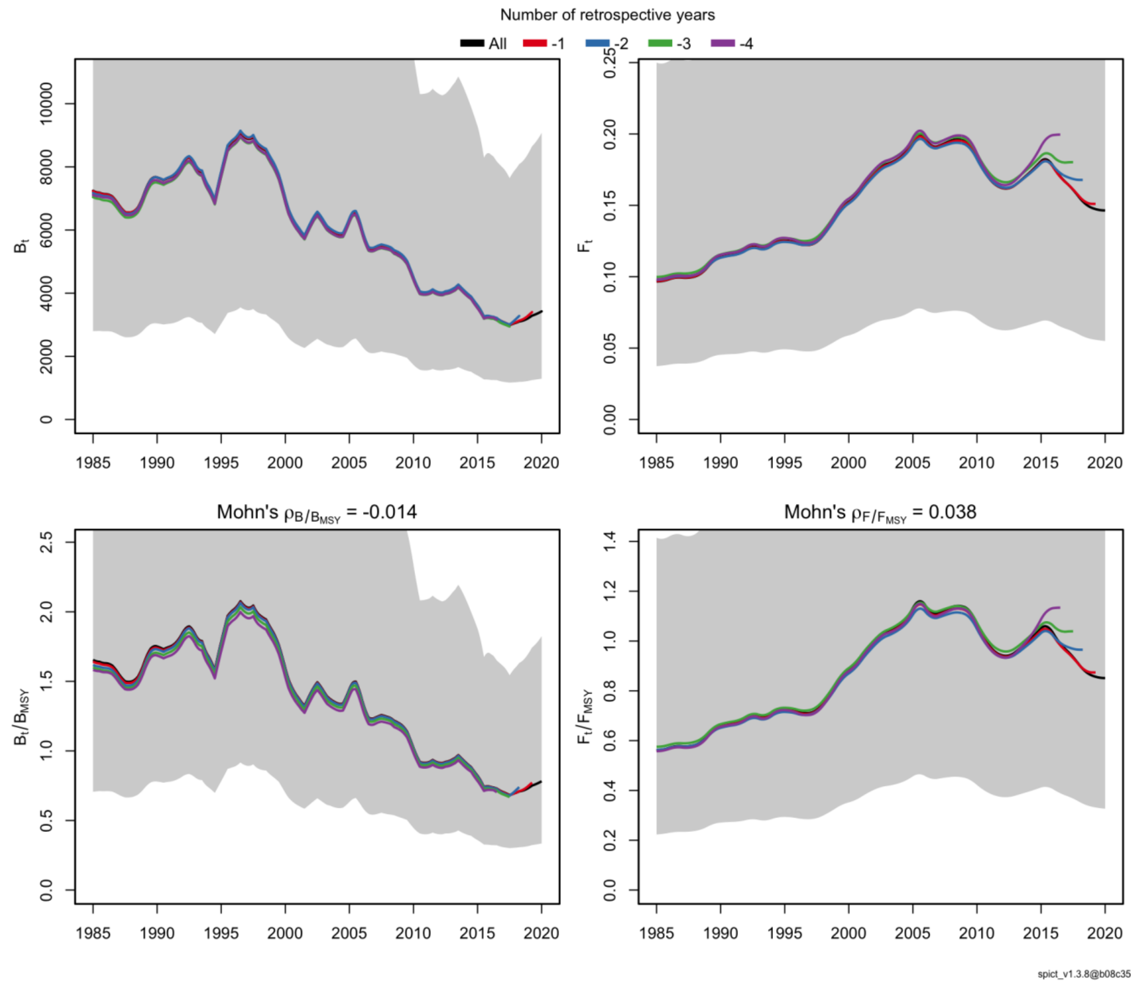

Figure 12.4.13. Retrospectivity analysis results from SPICT model applied to the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

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13 Roughhead grenadier (*Macrourus berglax*) in the Northeast Atlantic

13.1 Stock description and management units

The population structure of roughhead grenadier in the Northeast Atlantic is poorly known. 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, although the population structure remains uncertain.

This stock is classified as Category 2 in the NEAFC categorization of deep-sea species/stocks in subareas 4, 12 and 14, which implies that directed fisheries are not authorised and that bycatches should be minimised in the NEAFC RA (NEAFC, 2016). In all other areas, this stock is classified as Category 4 in the NEAFC categorization of deep-sea species/stocks, which implies that fisheries are primarily restricted to Coastal State exclusive economic zones (EEZs) and therefore management measures are not taken by NEAFC unless complementary to coastal state conservation and management measures (NEAFC, 2016).

13.2 The fishery

There is no directed fishery for roughhead grenadier and catches are taken as bycatch from other fisheries. Unusually large catches (> 500 t) were reported in Subarea 6 in 2005–2007, in Subarea 12 in 2002, 2006 and 2009 as well as in Subarea 14 in 2010–2014. Afterwards in 2015–2017, the level of reported landings returned to past levels. However, these large catches have been considered doubtful and suspected to correspond to species misreporting. In 2021, landings returned to similar amounts of 2018, with most landings reported from ICES subareas 2 and 14, and Division 5.a. Preliminary estimates are suggestive that landings in 2022 reached the highest value since 2012.

Roughhead grenadier was mostly caught with bottom trawl but, in Subarea 14 and Division 12.a, catches with pelagic trawl, a GLORIA type in the first year (2010) and a modified alfonsinos pelagic trawl in the following years, were reported. As significant catches of the species in pelagic trawls are unexpected, these catches could represent species misreporting of roundnose grenadier catches or errors of the reported fishing gear. No catches have been reported in Subarea 12 since 2017.

Most landings of roughhead grenadier from ICES Subarea 14 are from Norway and Greenland commercial trawl and longline fishery. Before 2014, the catch was dominated by trawlers, but from 2014 most catches are from the longline fishery. The Spanish fleet fishing grenadiers on the Mid-Atlantic ridge (MAR) historically targeted redfish and grenadier fisheries in Subdivision 14.b.1. This fishery has decreased since 2016, and there are no reported landings from the Spanish fleet since 2017. Preliminary estimates for 2022 indicate that landings from the Norwegian fleet in Subarea 14 reached the highest value since 1993 (187 t).

13.3 Landings trends

In subareas 1 and 2 there are landing records since 1990. The highest landings (400-800) occurred in the three first years and declined significantly thereafter. Since 2005 they are in the range of 30 to 50 t, except a higher level to 100 tonnes in 2016, 153 tonnes in 2020, 124 tonnes in 2021 and

186 tonnes in 2022. Most landings are from Norway with a smaller contribution from Russia. Landings from France are occasional and negligible, below 0.5 t in most years (Table 13.1).

Reported landings from subareas 3 and 4 also started in 1990 and have been very low, peaking in 2005 at 39 t. Historically, most landings have been reported by Norway, France, UK (Scotland) and Ireland. Since 2006, reported annual landings are negligible. (Table 13.2).

In Division 5.a, roughhead grenadier is occasionally caught. Before 2010, reported annual landings have been mostly below 10 tonnes and have increased to about 20 tonnes per year afterwards. Between 2015-2019 landings ranged between 20 and 40 tonnes. However, reported annual landings by Iceland increased to 44 tonnes in 2020. A total of 56 tonnes were reported in 2021 by Iceland and Norway, and 77 tonnes by Iceland and France in 2022 (Table 13.3).

Landings have been reported in Division 5.b since 1997. The highest catch was 99 t in 1999, but in other years landings were < 12 t. Since 2013, reported landings have been reported exclusively by French and Norwegian vessels, although at quantities lower than 1 tonne per year, except 4 tonnes reported in 2018 by Norway. Less than 1 tonne have been reported annually since 2018 (Table 13.4).

Landings from subareas 6 and 7 were mostly caught by the Spanish demersal multispecies fishery in Hatton Bank operated by freezer trawlers. Official records series started in 1992, with official landings peaking during the period 2011–2013, when they reached 632 tonnes in 2012 due to an exceptional report of 436 tonnes 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 13.5). Landings from subareas 6 and 7 have declined since 2004, particularly in the last few years with the implementation of the regulation prohibiting bottom trawling below depths of 800 m. Given the known geographical distribution of the species, any recent landings in subareas 6 and 7 are considered to be misidentification.

Occasional landings of less than 0.5 tonnes have been reported from Subarea 8. These were considered as coding errors or area misreporting as the species is not known to occur in Subarea 8 and was never caught in fisheries-independent surveys in this subarea.

Official records in Subarea 12 include landings from both the demersal multispecies fishery in Hatton Bank (Division 12.b) and the pelagic redfish and grenadier fishery on the MAR (Division 12.a). The historical time-series dates to 2000, reaching 2200 tonnes in 2005 and 2832 tonnes in 2009. Since 2017, no landings have been reported in these areas (Table 13.6).

Annual landings have been reported from Subarea 14 since 1993 mostly by Norway, Greenland and Russia. Between 2010–2014, Spanish vessels reported between 500 and 2700 tonnes/year in Subarea 14, sharply decreasing since then (Table 13.7). More recently, landings decreased to less than 85 tonnes in each of the years 2019-2020, increasing to 146 tonnes in 2021. In 2022, a total of 202 tonnes, mostly from Norway, were reported from Subarea 14, the highest value since 2014.

13.4 ICES Advice

The previous advice for roughhead grenadier was issued for 2016 to 2020 and stated that "*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.*"

The current advice was given in 2020 and states that "*when the precautionary approach is applied, there should be no directed fisheries for roughhead grenadier, and bycatch should be minimized for each of the years 2021 to 2025.*"

13.5 Management

WGDEEP is not aware of any management plan for roughhead grenadier within ICES area. Since 2015, bycatch of roughhead grenadier by EU vessels in Union and International waters should be reported under the roundnose grenadier TAC for the same area. Currently, no directed fisheries for roughhead grenadier are permitted in EU and UK waters, including EU and UK vessels in international waters. Catches shall be counted against the roundnose grenadier quota and may not exceed 1% of the quota. This stock is also covered by a TAC for grenadiers for EU and Norway in Greenland waters of 5 and 14 (GRV/514GRN)[1]. In eastern Greenland, main fishing operations are in Subdivision 14.b.2 and here, the annual TAC of roundnose and roughhead grenadier combined has been 1000 t since 2010. This TAC has been set by the Greenland Government and is not based on a biological assessment.

Management measures adopted by NEAFC establish a total allowable catch limitation of 574 tonnes of roundnose grenadier in 2021 and no direct fisheries for roughhead grenadier and roughsnout grenadier should be authorised in NEAFC Regulatory Area. Any bycatches of these grenadiers as well as other grenadiers (Macrouridae) should be counted against the total allowable catch of roundnose grenadier. Since then, NEAFC did not renew specific measures for grenadiers. ICES WGDEEP understands that measures are now just covered by the Recommendation 7: 2018 on Deep-Sea Fisheries within the NEAFC Regulatory Area.

There are other management measures that afford protection to deep-water fishery resources in the North-east Atlantic including depth limits on bottom trawling and netting (Regulation (EU) 2016/2336[2]), spatial management (e.g., MPAs) and specific requirements for the protection of Vulnerable Marine Ecosystems (Regulation (EU) 2016/2336 and Regulation (EU) 2022/1614[3]). In terms of current depth limits in EU and UK waters, and for EU and UK vessels in international waters, bottom set gillnets may be deployed to depths less than 600 m, whilst bottom trawling is prohibited at depths greater than 800 m (Regulation (EU) 2019/1241)[4].

There may be other management measures that WGDEEP experts may not be aware of.

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[1] Regulation (EU) 2023/194 fixing for 2023 the fishing opportunities for certain fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, as well as fixing for 2023 and 2024 such fishing opportunities for certain deep-sea fish stocks.

[2] Regulation (EU) 2016/2336 of the European Parliament and of the Council of 14 December 2016 establishing specific conditions for fishing for deep-sea stocks in the north-east Atlantic and provisions for fishing in international waters of the north-east Atlantic and repealing Council Regulation (EC) No 2347/2002. http://data.europa.eu/eli/reg/2016/2336/oj/eng

[3] EU. 2022. Commission implementing regulation (EU) 2022/1614 of 15 September 2022 determining the existing deep-sea fishing areas and establishing a list of areas where vulnerable marine ecosystems are known to occur or are likely to occur. http://data.europa.eu/eli/reg_impl/2022/1614/oj

[4] Regulation (EU) 2019/1241 of the European Parliament and of the Council of 20 June 2019 on the conservation of fisheries resources and the protection of marine ecosystems through technical measures, amending Council Regulations (EC) No 1967/2006, (EC) No 1224/2009 and Regulations (EU) No 1380/2013, (EU) 2016/1139, (EU) 2018/973, (EU) 2019/472 and (EU) 2019/1022 of the European Parliament and of the Council, and repealing Council Regulations (EC) No 894/97, (EC) No 850/98, (EC) No 2549/2000, (EC) No 254/2002, (EC) No 812/2004 and (EC) No 2187/2005

13.6 Data available

13.6.1 Landings and discards

Earlier years data are WG estimates based on national submissions to ICES, which are not fully included in InterCatch.

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 13.8).

National catch statistics of Greenland were used to update catches in Subarea 14.b.2 from 1999 to 2022. Data from recent years may include both landings from Greenland and other countries vessels, wherefore it was unclear whether this implies double count with landings reported by other countries. A potential misreporting is suspected for roughhead grenadier, as the scientific survey of this species, has revealed that roughhead grenadier is more abundant in ICES 14.b.2. (Nogueira and Christiansen, 2023; WD06). Similarly, it is possible that a part of landings in subareas 6 and 7 are probably misidentification, since catches from fishery-independent surveys are negligible.

Since 2019, there was virtually no Russian directed fishery in the deep waters of the Northeast Atlantic and bycatches of roughhead grenadier were obtained in longline fisheries in the Norwegian seas, and in the trawl fisheries targeting Greenland halibut (*Reinhardtius hippoglossoides*) in the eastern part of the Fishing Zone of Greenland (Nogueira and Christiansen, 2023; WD07)). Between 2014 and 2018 reported higher catches of roughhead grenadier by Greenland are considered to be linked to the longline fishery targeting tusk (WGDEEP 2022, WD12).

Reported landings of roughhead grenadier inside and outside the NEAFC Regulatory Area are provided in Table 13.9.

There remains some uncertainty given that historical landings and discards data are not always accurately recorded, or not provided by all countries. Therefore, it is noted that available data needs to be reviewed to provide robust estimations.

13.7 Length composition of the landings and discards

Fishery length composition of landings from the Russian fishery are shown in Figure 13.3 for 2019. Information provided is based on daily fishing vessel reports, materials collected during research surveys and data collected by observers on board fishing vessels (WGDEEP 2020, WD23).

No new data was provided for 2022.

13.8 Age composition

No new data available to WGDEEP in 2022. Recent studies provided information on age composition and growth parameters for *Macrourus berglax* in the Norwegian Sea shelf edge in ICES subareas 1 and 2, based on pooled length at age data from slope surveys 2009-2018 (Bergstad *et al.*, 2021).

Age was derived from otolith readings. Where data was suitable, age distributions showed that sampled individuals consisted mainly of 5 to 25 years old, but older individuals (up to 30 years old) were also common. The oldest specimens recorded were around 50 years old. Estimated parameters of the von Bertalanffy growth functions were L_{inf}: 27.36 cm PAFL; K: 0.11 year^{-1}; t_0: -0.02 year for females; and L_{inf}: 22.85 cm PAFL; K: 0.13 year^{-1}; t_0: -0.74 year for males.

13.9 Weight-at-age

No new data available.

13.10 Maturity and natural mortality

Maturity data was last available for 2019, provided by the Russian investigations in the Norwegian Sea (ICES divisions 2.a and 2b) (WGDEEP 2020, WD23).

Deep-water fish catches were taken by bottom and pelagic trawls of 16-135 mm mesh size. The biological samples were collected according to the methods employed at PINRO (Anon., 2004). Mass measurement was based on the total length (hereinafter referred to as 'length'). Maturity stages were assigned using the following maturity scale: II – immature, III – maturing, IV – prespawning, V – spawning, VI – post-spawning, VI-VII – postspawning recovery.

8-76 cm long roughhead grenadier was observed in by-catches of bottom fishing and research trawls, the mean length of the studied individuals was 39.5 cm, while 27-49 cm long roughhead grenadier prevailed (Fig. 13.3). In November-December, mainly immature individuals were recorded in catches. Among the sampled individuals, there were also males with maturing sex products, as well as individuals of both sexes at the stage of post-spawning recovery (Fig. 13.4). Research vessel survey and cpue

13.10.1 Research vessel survey

The Icelandic autumn groundfish survey is the main source of fishery-independent data for *Macrourus berglax* in Icelandic waters. Further, data can be compiled from several other older surveys of exploratory nature.

This survey covers Icelandic shelf and slope at depths from 20–1500 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).

Norway conducts a long-term monitoring survey of deep-water species on the shelf-break and upper slope off Norway and Spitsbergen (between 68 and 80° N in ICES subareas 1 and 2), since the mid-1990s. An analysis of the fisheries-independent time series (1997–2020) suggests that roughhead grenadier is widely distributed between 500-800 m deep. Trends in abundance is more variable, showing a decline in the northern areas, but such trend was not detected towards the southern parts of the Norwegian shelf-edge, suggesting that distribution extends southwards beyond the sampling area (Bergstad *et al.*, 2021). Biomass indices varied without trends in the survey period. A considerable temporal variation in recruitment is reported by Bergstad *et al.* (2021), which can be linked to the seasonal variability in food supply (Priede, 2017).

Greenland's annual bottom trawl survey is the main source for fishery-independent data for roundnose grenadier in Subarea 14 (Greenland waters).

Greenland carried out a bottom buffered bottom trawl fishery-independent survey from 1998 to 2017 (no survey in 2001) on board R/V Paamiut using an Alfredo III bottom trawl. The survey was resumed in 2022, starting a new index survey series, after interruption since 2017, covering areas within the Greenland waters of subarea 14.b.2 (Greenland waters). The survey in 2022 has a new fix station allocation design. The survey is depth stratified and covers the slope and shelf (400-1500 m) between the 3 nm line (baseline) and the 200 nm (Exclusive Economic Zone) or middle line to Iceland. A new research vessel, RV Tarajoq and a new trawl gear, Bacalao 476, with a mesh size of 136 mm and a 30-mm mesh-liner in the cod-end were used. Towing speed is between 2.5-3.0 knots and is estimated from the start and end positions of the haul, with a 30-min bottom time (tows of at least 15 min are accepted). Detailed information is provided in the Working Document available to WGDEEP (Nogueira and Christiansen, 2023; WD06).

13.10.2 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 in 1996–2015.

13.11 Data analyses

Length distributions from ICES Subarea 14.b.2 show that from 1998 to 2016 a single mode around 19 cm (total length) dominated the survey and from 2010 to 2016 a second and smaller mode around 29 cm (total length) is also evident (Fig. 13.1). From this survey, it is shown that the highest biomass and abundance in Subarea 14.b.2 is equally distributed between three depth strata of 601-800 m, 801-1000 m and 1001-1500 m (Table 13.10). Survey biomass index appears stable from 2008 until 2016. The value estimated for 2022 is the highest since the beginning of the time-series, but changes in survey design and effects of gear selectivity in observed changes in length distributions cannot be excluded (Fig. 13.2; Nogueira and Christiansen, 2023; WD06).

13.12 Benchmark assessments

There has been no benchmark for this stock.

13.13 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 certainty of these catches. 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.

Available biological data (length or age composition, weight-at-age, maturity, mortality) does not allow to assess changes in stock status.

The population structure of roughhead grenadier in the Northeast Atlantic is poorly known. The species occurs at small abundance in some areas, mostly to the North of 60°N. Available literature suggests a significant gene flow of the roughhead grenadier *Macrourus berglax* across the

North Atlantic (Coscia *et al*., 2018), in contrast to the depth-dependent genetic structure found in *Coryphaenoides rupestris* (Gaither *et al*., 2018).

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; González-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).

Whilst roughhead grenadier continue to occur as a bycatch, the proportions reported remain relatively low. There is very limited data available for this species, and some of the reported landings data are considered to be species misreporting. Thus, no expansion of current fisheries should be permitted until adequate data are collected from the exploited population to identify stock structure and conduct an appropriate assessment.

Given the bathymetric distribution of roughhead grenadier in the Northeast Atlantic, the fishery for this species may be affected by the recent EU regulation for the protection of Vulnerable Marine Ecosystems (Regulation (EU) 2022/1614). In terms of depth limits in EU and UK waters, and for EU and UK vessels in international waters, bottom set gillnets may be deployed to depths less than 600 m, whilst bottom trawling is prohibited at depths greater than 800 m (Regulation (EU) 2016/2336 and Regulation (EU) 2019/1241).

WGDEEP is aware of Norwegian regulations for fisheries in Norwegian EEZ, and in Jan Mayer and Svalbard (ICES Subarea 2), that define seabed deeper than 1000 m as vulnerable and ban the deployment of bottom-contact gears.

13.14 Tables and Figures

Table 13.1. 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

Year	Germany	Norway	Russia	France	Spain	TOTAL
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	62			100
2017	0	41	9	+	0	50
2018[1]	0	89	0	+	0	89
2019[1]	0	141	1	< 0.5	0	142
2020[1]	0	148	5	< 0.5	0	153
2021[1]	0	121	***	0.1	0	121
2022[1]	0	186	0	0	0	186

[1]–preliminary statistics.

Table 13.2. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in Subareas 3 and 4.

Year	France	Ireland	Norway	UK (Scot.)	TOTAL
1991					
1992			7		7

Year	France	Ireland	Norway	UK (Scot.)	TOTAL
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				< 0.5
2007					0
2008					0
2009					0
2010				< 0.5	< 0.5
2011	2				2
2012	1			< 0.5	1
2013	1				1
2014					0
2015	+	0	+	0	+
2016	< 0.5		< 0.5		< 1
2017	< 0.5		< 0.5		< 1
2018[1]	< 0.5	0	< 0.5	0	< 0.5
2019[1]	< 0.5	0	0	0	< 0.5
2020[1]	< 0.5	0	0	0	< 0.5
2021[1]	0.1	0	0	0	0.1

Year	France	Ireland	Norway	UK (Scot.)	TOTAL
2022[1]	< 0.1	0	< 0.1	0	< 0.1

[1]–preliminary statistics.

Table 13.3. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in 5.a.

Year	Iceland	Norway	France	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
2017	40[1]			40[1]
2018[2]	20	< 0.5		20
2019[2]	28			28

Year	Iceland	Norway	France	TOTAL
2020[2]	44			44
2021[2]	31	25		56
2022[2]	74	0	3	77

[1]–revised catch data. [2]–preliminary statistics

Table 13.4. 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					0
2010		1			1
2011					0
2012	2		1		3
2013	2				2
2014	< 0.5				0
2015	1	+	0	0	1
2016					0
2017	< 0.5	< 0.5			0.5
2018[1]	1	4	0	0	5
2019[1]	< 0.5	< 0.5	0	0	< 1

Year	France	Norway	UK (Scot.)	Russia	TOTAL
2020[1]	< 0.5	0	0	0	< 0.5
2021[1]	0.4	0.5	0	0	0.9
2022[1]	< 0.5	< 0.1	0	0	< 0.5

[1]–preliminary statistics.

Table 13.5. Official landings (t) roughhead grenadier (*Macrourus berglax*) in Subareas 6 and 7.

Year	UK (E+W)	France	Norway	UK (Scot.)	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

Year	UK (E+W)	France	Norway	UK (Scot.)	Spain	Ireland	Russia	Lithuania	TOTAL
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		35			32				67
2017		3	1		1	< 0.5			5
2018[1]	0	7	0	7	0	0	0	0	14
2019[1]	0	4	2	< 0.5	0	0	0	0	6
2020[1]	0	3	0	< 0.5	0	0	0	0	3
2021[1]		4		2					6
2022[1]	0	2	0	1	0	0	0	0	3

[1]–preliminary statistics.

Table 13.6. 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

Country	Norway	France	Spain	Russia	Lithuania	TOTAL
2012			526		4	530
2013			210			210
2014			164			164
2015			53			53
2016	< 0.5		31			31
2017						0
2018[1]	0	0	0	0	0	0
2019[1]			0			0
2020[1]			0			0
2021[1]	0	0	0	0	0	0
2022[1]	0	0	0	0	0	0

[1]—preliminary statistics.

Table 13.7. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in Subarea 14.

Country	Greenland	Norway	Russia	Spain	UK (E+W)	Germany	TOTAL
1993	18	34					52
1994	5						5
1995	2						2
1996							0
1997							0
1998		6					6
1999		14					14
2000							0
2001		26					26
2002		49	4				53
2003		33					33
2004		46	9				55
2005	20	30	10				60
2006	4	1	3				8
2007	4	6	9				19

Country	Greenland	Norway	Russia	Spain	UK (E+W)	Germany	TOTAL
2008	12		3				15
2009	4	3			1		8
2010	12	1	13	1500	1		1527
2011	2		27	1516			1545
2012	14	16	18	2687			2735
2013			32	803			835
2014	62		11	450			523
2015	38	68	0	12			121
2016	74	73	8	4			159
2017	93	88[1]	17				198[1]
2018[2]	89	97	16	0	0		202
2019[2]	1	76	5	0			82
2020[2]	18	19	0	0	0	9	46
2021[1]	45	101	0	0	0	0	146
2022[2]	0	187	0	0	0	15	202

[1]–revised catch data. [2]–preliminary statistics.

Table 13.8. 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	

Year	6.b	12.a	12.b	14.b
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

Table 13.9. Roughhead grenadier in the Northeast Atlantic. Landings inside and outside the NEAFC Regulatory Area (RA) as estimated by ICES. Landings in tonnes.

Year	Inside the NEAFC RA	Outside the NEAFC RA	Total landings	Proportion inside the NEAFC RA (%)
2016	4	373	377	1
2017	0	294	294	0
2018	0	330	330	0
2019	0	259	259	0
2020[1]	0	247	247	0
2021[1]	0	330	330	0
2022	0	468	468	0

[1]—preliminary statistics.

Table 13.10. Biomass (t) and abundance (in numbers) with SE of roughhead grenadier expressed as mean catch per km² and total biomass by Q-subarea and depth stratum in ICES subarea 14.b.2 in 2016. Q-subareas encompass Q1-Q5 (see Nielsen *et al*. 2019) for which area and number of survey hauls in 2016 are listed.

				Biomass			Abundance		
Subarea	Depth strata	Area	Hauls	Mean/km²	Biomass	SE	Mean/km²	Abundance	SE
Q1	401-600	6975	12	0.0305	212.9	91.5	28.1	195794	91854
Q2	401-600	1246	5	0.6579	819.7	466.7	615.6	766985	379861
	601-800	1475	7	1.3791	2034.7	746.6	844.3	1245641	356006
	801-1000	1988	10	0.9196	1828.5	503.4	676.8	1345717	458547
	1001-1500	6689	7	0.2539	1698.3	612.7	298.0	1993532	768271
Q3	401-600	9830	11	0.0106	104.2	61.5	12.6	124283	84253
	601-800	3788	14	0.0121	45.7	18.6	7.9	30040	11284
	801-1000	755	6	0.0171	12.9	8.6	12.7	9610	6398
Q5	401-600	1819	3	0.0032	5.9	5.9	4.4	7970	7970
	601-800	257	6	0.0486	12.5	4.1	53.3	13700	2996
	801-1200	256	5	0.1387	35.5	7.9	285.6	72993	15673
	1201-1400	986	9	0.1037	102.2	29.0	147.4	145251	36288
	1401-1500	615	5	0.0672	41.3	14.1	87.7	53912	24270
All		36679	100	0.1896	6954.2	1191	163.7	6005430	1044

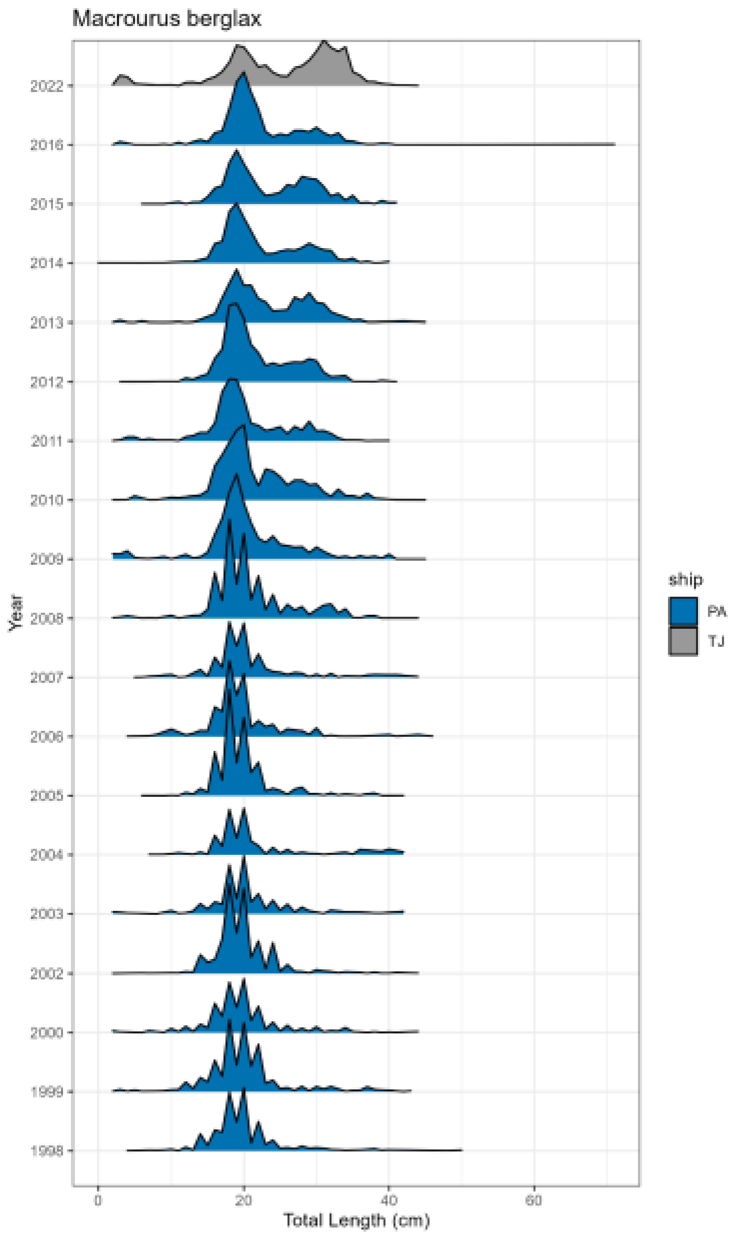

Figure. 13.1. Length frequency distribution of roughhead grenadier sampled in ICES subarea14.b.2, onboard the R/V Paamiut (PA) between 1998-2016, and onboard R/V Tarajoq (TJ) in 2022. No survey was carried out in 2001, and between 2017-2021 (Nogueira and Christiansen, 2023; WD06).

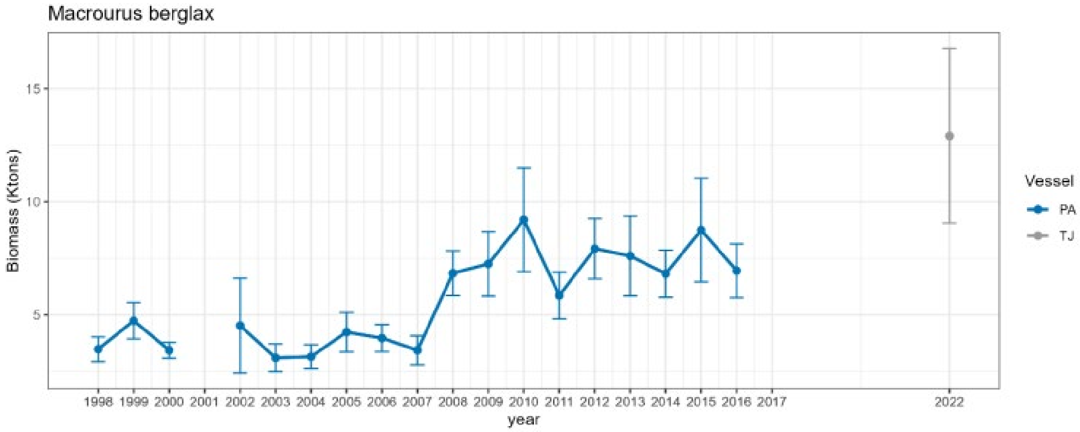

Figure 13.2. Roughhead grenadier (RNG) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut (PA) and on board R/V Tarajoq (TJ) in 2022 (Nogueira and Christiansen, 2023; WD06).

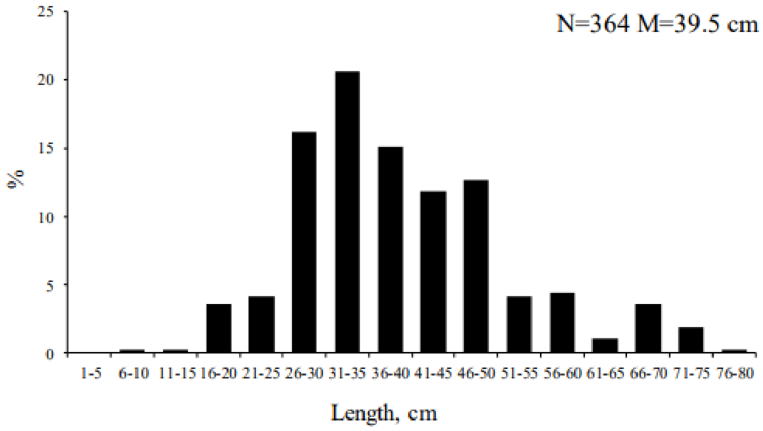

Figure 13.3. Length composition of roughhead grenadier in the Norwegian Sea (subareas 2a and 2b) in 2019 (Aleksandrovand Khlivnoi, 2020; WD23 WGDEEP 2020).

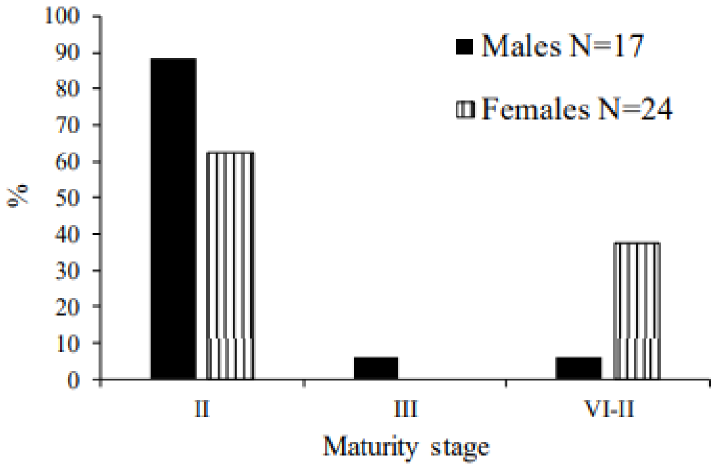

Figure. 13.4. Maturity of roughhead grenadier in the Norwegian Sea (subareas 2a and 2b) in November-December 2019 (Aleksandrovand Khlivnoi, 2020; WD23 WGDEEP 2020).

13.15 References

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14 Roughsnout grenadier (*Trachyrincus scabrus*) in the Northeast Atlantic

14.1 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 roughnose grenadier (*Trachyrincus murrayi*) is a closely related species that is abundant throughout the north of Northeast Atlantic (Jonsson, 1992). The scientific names and common name of these species changed over time. The similarity of the English names (roughsnout grenadier and roughnose grenadier) can increase 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* was caught by the Marine Scotland deep-water research surveys in sufficient numbers to allow the estimation of population indicators (Neat and Burns, 2010).

In the published literature, there is no report of 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. Similarly, to the East of Greenland (Division 14.a and 14.b.2) only *Trachyrincus murrayi* is caught in scientific surveys.

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 sizes 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 it. *T. murrayi* does not reach sufficient sizes to be of commercial interest. It is only a bycatch of deep-water fisheries in Subareas 5, 6, 7, 12 and 14.

As *T. scabrus* and *T. murrayi* can be misidentified in fisheries catches 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 the most a minor bycatch. The occurrence of the species is 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. WGDEEP considered that the reporting of 0 landings in response to the data call for landings and discards in 2016 to 2019, confirms that landings reported before 2016 were misreporting, misidentification or coding errors.

14.2 Landings trends

Landings of 57 and 649 tonnes were reported in 2012 and 2014 respectively. In 2014, these came mainly from divisions 12.b and 14.b. (Table 14.1a)

In 2006–2008, Lithuania reported significant landings for subareas 6 and 12 (Table 14.1b, source ICES catch statistics 2006–2015). Landings reported by Spain in 2012-14 are not included in ICES catch statistics 2006–2017 (downloaded from the ICES website on 24.04.2020). No landings have been reported neither in preliminary catch statistics nor InterCatch from 2014 to 2022.

14.3 ICES Advice

The ICES advice for the years 2021–2025 is that "*when the precautionary approach is applied, there should be no directed fisheries for roughsnout grenadier and bycatch should be minimized for each of the years 2021 to 2025*."

The previous advice, for the years 2016–2020 further added " *and bycatch should be counted against the TAC for roundnose grenadier to minimize the potential for species misreporting*."

14.4 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 and 2019-2020 made no mention of the roughsnout grenadier since. There is no regulation for this species in other countries (Norway, Iceland, Faroe Islands, UK) where these species should be landed when caught.

The EU regulation 2016/2336 establishing specific conditions for fishing for deep-sea stocks, does not mention *Trachyrincus* species.

14.5 Data availability

14.5.1 Landings and discards

No new information see 2022 report (ICES, 2022).

14.6 Length compositions

No new information see 2022 report.

14.6.1 Age compositions and longevity

No new information see 2022 report.

14.6.2 Weight-at-age

No weight-at-age data are available.

14.6.3 Maturity and natural mortality

No data were available.

14.6.4 Catch, effort and research vessel data

No new information see 2022 report.

14.7 Data analyses

No new information see 2022 report.

14.7.1 Biological reference points

Not applicable.

14.8 Comments on assessment

Not applicable.

14.9 Management considerations

No new information see 2022 report.

14.10 References

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14.11 Tables

Table 14.1a. Official landings of roughsnout grenadier by ICES Subarea reported by Spain in 2012-2014.

Year	6.b	12.a	12.b	14.b	Total
2012		54		3	57
2013					0
2014	42	4	155	448	649

Table 14.1b. Official landings of roughsnout grenadier by ICES Subarea reported by Lithuania.

Year	6	12	Total
2006	506	67	573
2007	442	101	543
2008	49	50	99

15 Atlantic wolffish (*Anarcichas lupus*) in Division 5.a (Icelandic grounds)

15.1 Atlantic wolffish in 5a

15.1.1 Fishery

The main fishing grounds for Atlantic wolffish are in the west and northwest part of the Icelandic shelf. From 2010, the proportion of the catch has been increasing in northwest of Iceland compared to west of Iceland. Catches at the main spawning ground (Látragrunn) west of Iceland have been decreasing since 2008 (Figures 15.1.1 and Figure 15.1.2). About 80% of the catch of Atlantic wolffish is caught at depths less than 120 m. Proportion of the catch taken at depth range 0-60 m decreased from 2003 to 2007, but since then it has been increasing. At the depth range 61-120 m the proportion of the catch has been rather stable since 2000. At depths from 121 to 180 m, which includes the main spawning ground (Látragrunn), the proportion of the catch increased in 2003-2008 but since then it has been decreasing (Figure 15.1.3).

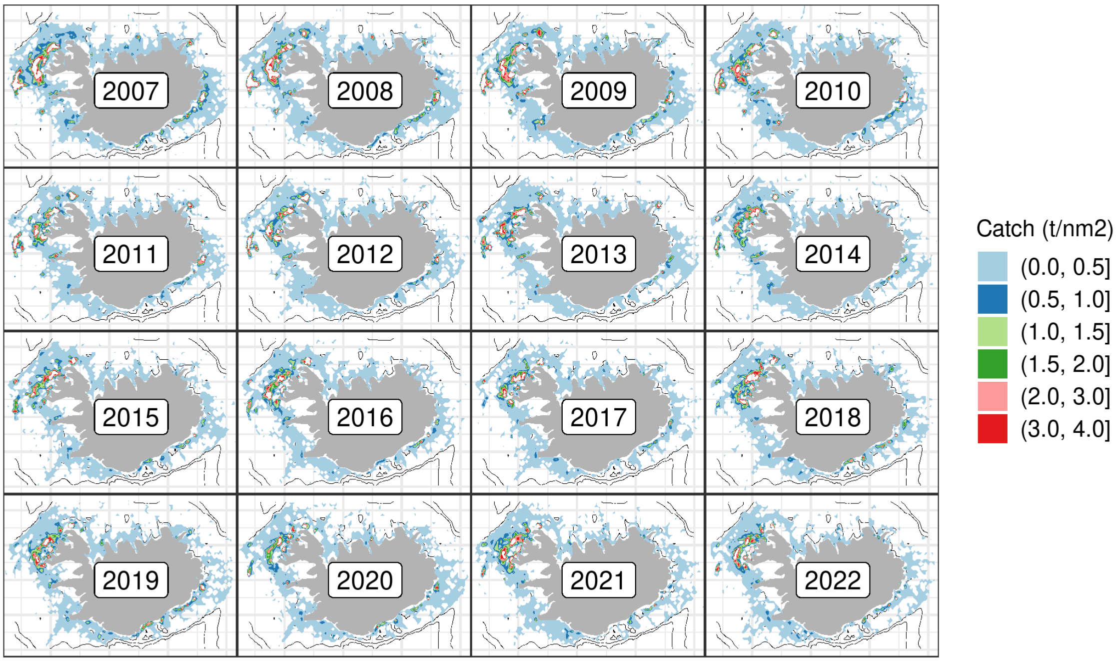

Figure 15.1.1 Atlantic wolffish in 5.a. Geographical distribution of the Icelandic fishery since 2007 as reported in logbooks. All gear types combined.

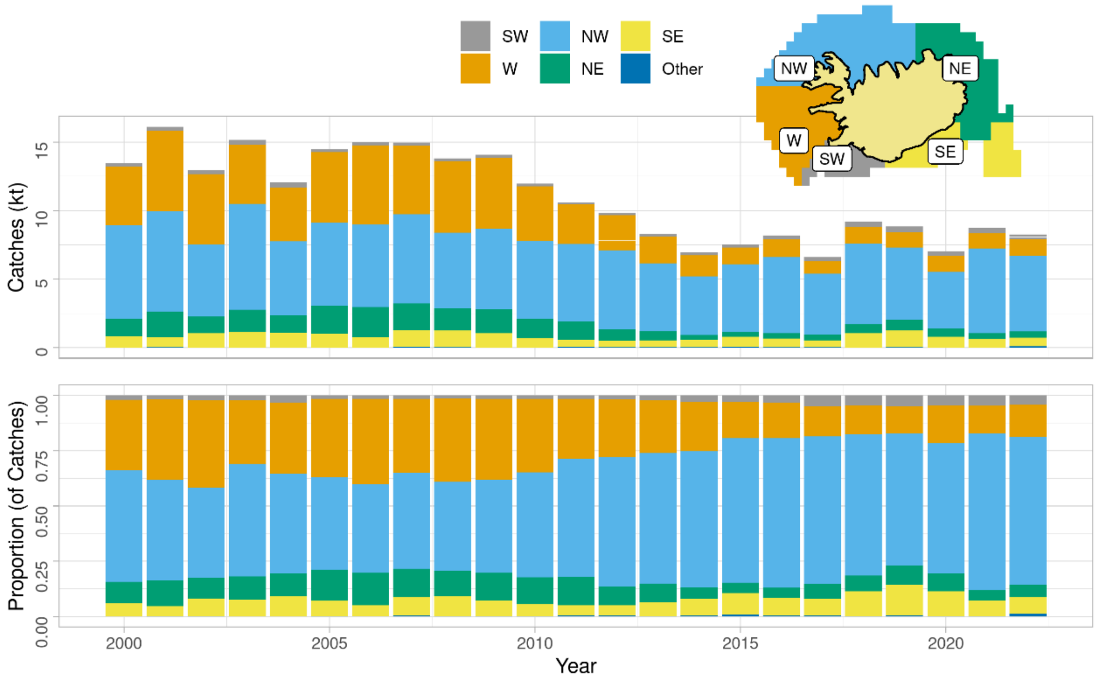

Figure 15.1.2: Atlantic wolffish in 5a. Spatial distribution of the Icelandic fishery by fishing area since 2000 according to logbooks. All gears combined.

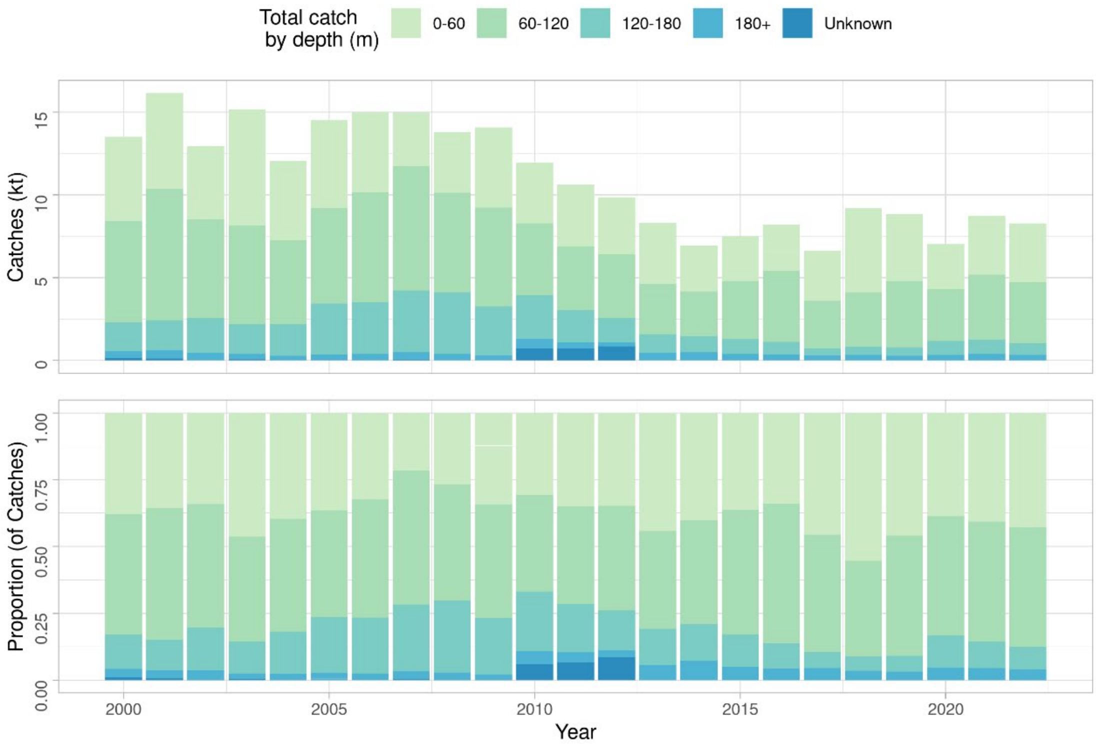

Figure 15.1.3. Atlantic wolffish in 5.a. Depth distribution of demersal trawl, longline and demersal seine catches according to logbooks.

15.1.2 Landings trend

More than 97% of the Atlantic wolffish catch is taken by longliners (50-65%), demersal trawlers (20-30%) and demersal seiners (about 10%) (Figure 15.1.4). These proportions have been relatively stable through the years. However, in 2004-2008 longline and demersal trawl catches were similar (40-50%) and in the last three years catches by demersal seiners have been increasing and are now greater than in demersal trawlers (Figure 15.1.4). Since 2001, the number of longliners and trawlers reporting Atlantic wolffish catches of 10 tonnes/year or more has decreased. In the longline fleet, the number of vessels has dropped from 198 in 2001, down to 42 in 2022. The number of trawlers has also decreased significantly from 76 in 2000 to 49 in the last year (Table 15.1.1).

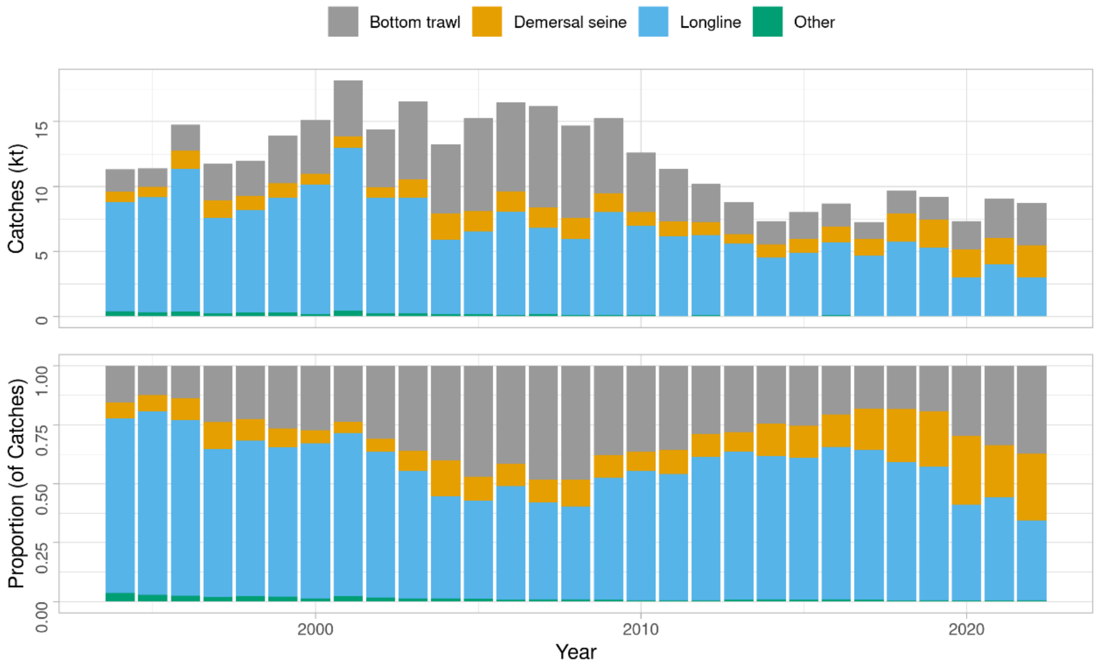

Figure 15.1.4. Atlantic wolffish in 5.a. Total catch (landings) by fishing gear since 1994, according to statistics from the Directorate of Fisheries.

In 1994 and 1995, more than 500 vessels accounted for 95% of the annual catch of Atlantic wolffish in Icelandic waters, but this number had dropped to 200 vessels in 2008 despite higher catches. Since 2010 the number of vessels accounting for 95% of the annual catch has remained relatively constant (about 150-200 vessels), despite catch reductions (Figure 15.1.5).

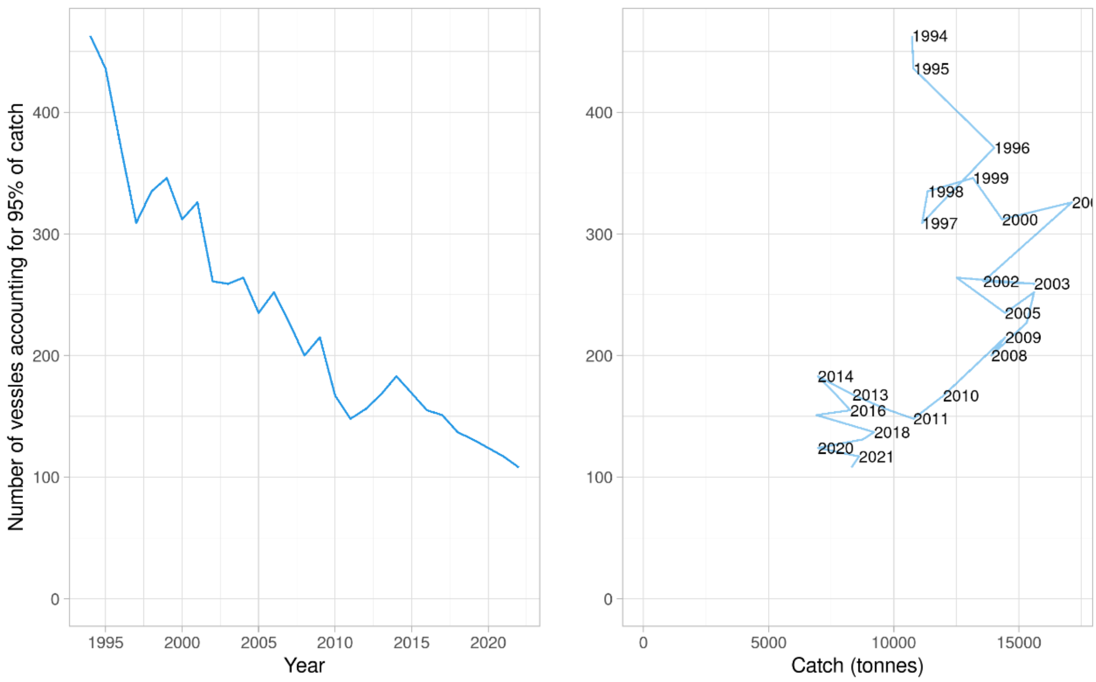

Figure 15.1.5. Atlantic wolffish in 5.a. Number of vessels (all gear types) accounting for 95% of the total catch annually since 1994. Left: Plotted against year. Right: Plotted against total catch. Data from the Directorate of Fisheries.

15.1.3 Data available

The commercial catch samples taken are normally representative of the landings with the greatest number of samples taken in areas of high catch intensity (Figure 15.1.7).

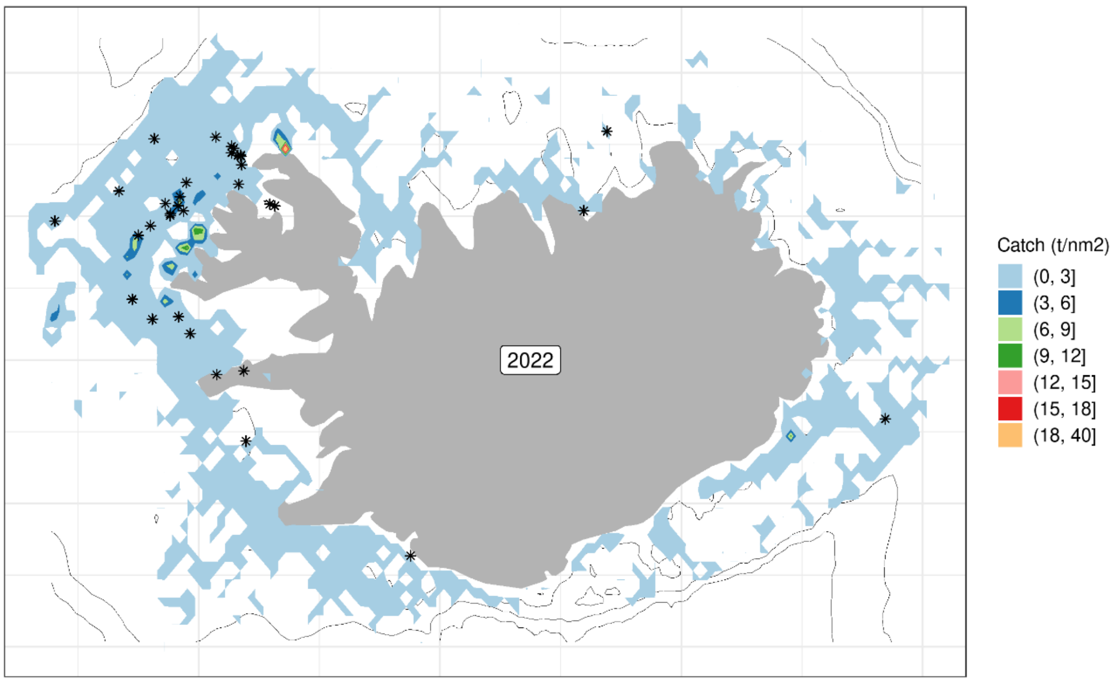

Figure 15.1.7. Atlantic wolffish in 5.a. Fishing grounds in 2022 as reported in logbooks and positions of samples taken from landings (asterisks).

15.1.3.1 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, as well as in Norway. Measures in the Icelandic management system such as converting quota share from one species to another are used by the Icelandic fleet to a large extent, and this is thought to discourage discards in mixed fisheries.

15.1.3.2 Length composition

The length distribution of landed Atlantic wolffish has been relatively stable since 2004 (Figure 15.7.8). The average length in the commercial catch increased from about 63 cm in 1998 to about 70 cm in 2011 where from it has been similar.

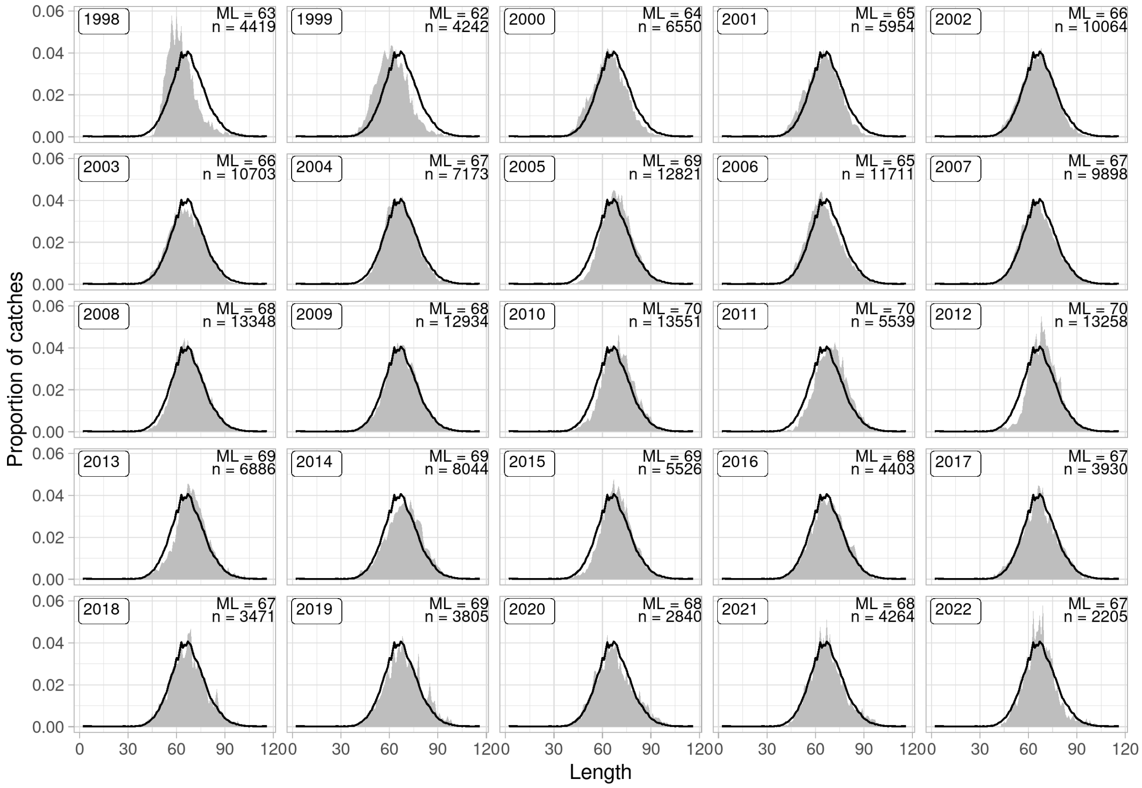

Figure 15.7.8. Atlantic wolffish in 5.a. Length distribution of fish sampled from landed catch. The black line represents the mean length distribution for the period.

Since 2004, the length frequency distribution in the spring survey has been bimodal because of a relatively greater decrease in number of fish at 40–60 cm (Figure 15.7.9). The mean length of Atlantic wolffish has been about 39 cm on average. It was, however, lowest in 1994-2004, about 37 cm, but in these years the recruitment index was high. Due to decreasing recruitment beginning 2004 (Figure 15.7.9), the mean length increased and was on average about 42 cm in 2007-2023 (Figure 15.7.9). Mean length in the autumn survey oscillated from 34-40 cm in 1996-2022, with no clear trend (Figure 15.7.10).

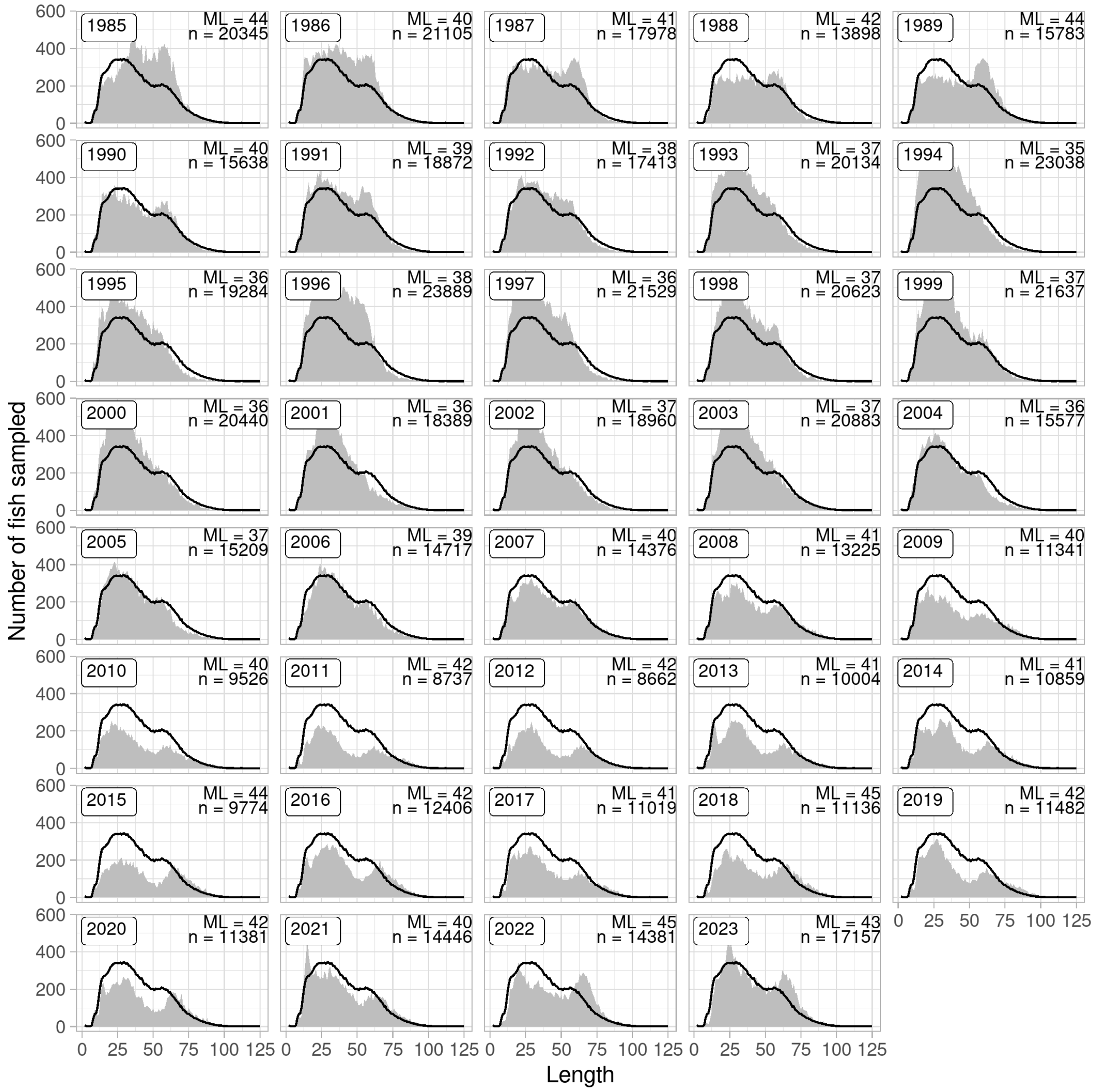

Figure 15.7.9. Atlantic wolffish in 5.a. Length distribution from the spring survey. The black line shows the mean for all years.

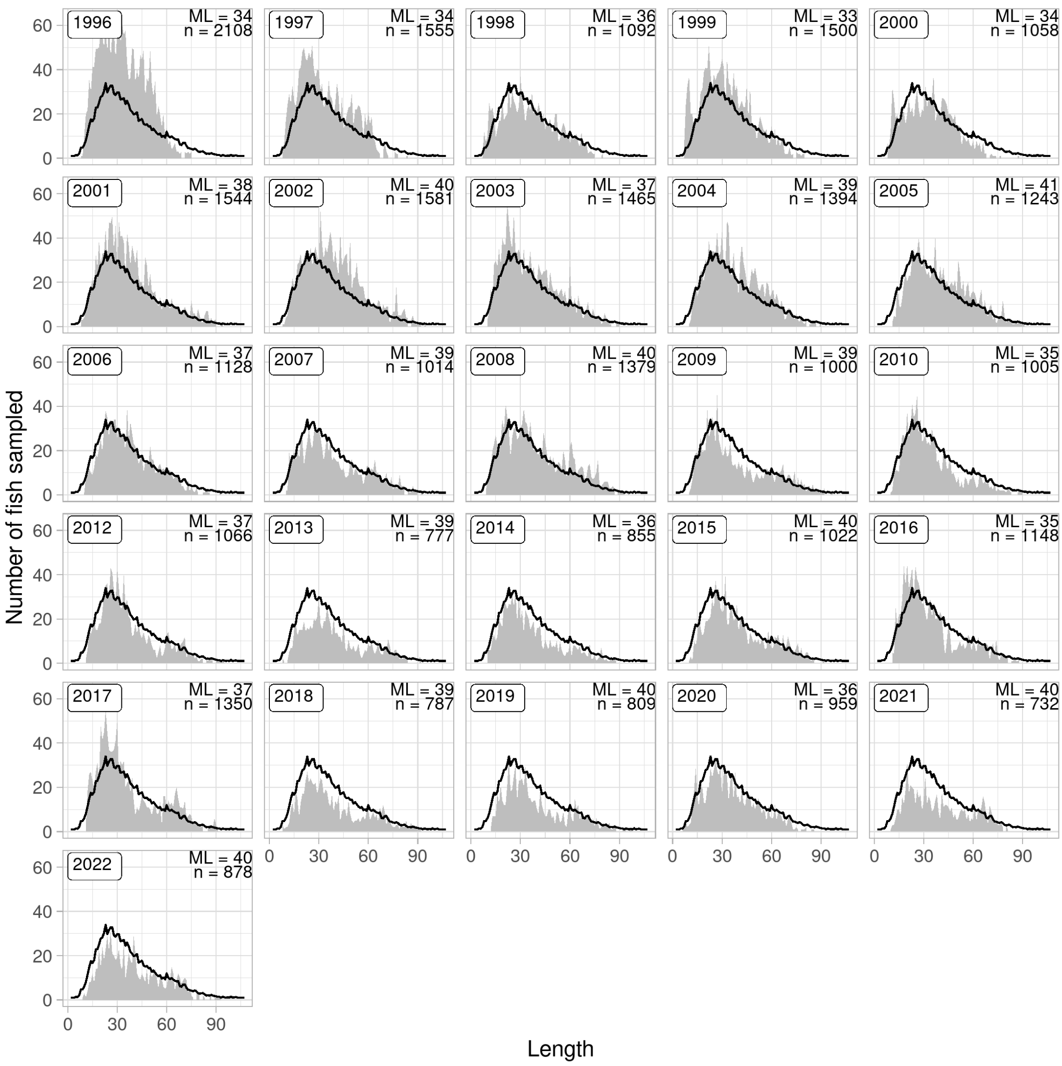

Figure 15.7.10. Atlantic wolffish in 5.a. Length distribution from the autumn survey. The black line shows the mean for all years.

15.1.3.3 Age composition

Age composition data are available from surveys. Commercial age data are available from earlier periods (1978). In samples from commercial landings, the mean age of Atlantic wolffish was around 10.7 years in 1999. Since then, mean age in samples from commercial catches has generally been increasing to around 12 years in recent years.

15.1.3.4 Weight-at-age

Weight-at-age data in Icelandic waters are available from 1996.

15.1.3.5 Maturity and natural mortality

Females have the most reliable maturity designations; a maturation scale for males is unavailable. Therefore, maturity analysis is based on females caught during the autumn survey and in commercial catches from June – December. From these data, maturation occurs close to 60 cm and around age 10 but is highly variable and difficult to measure. No information is available on natural mortality. For assessment and advisory purposes, the natural mortality is set to 0.15 for all age groups.

15.1.3.6 Catch, effort and survey data

CPUE estimates of Atlantic wolffish in Icelandic waters are not considered representative of stock abundance, as changes in fleet composition, technical improvements, and differences in gear setup among other things have not been accounted for when estimating CPUE. Effort of demersal trawl was defined as the number hours towed, and for longline number of hooks. Non-standardized estimates of CPUE in longline (kg/1000 hooks), and demersal trawl (kg/hour), are calculated as the total weight in a set or tow per effort measure. For both effort and CPUE measures, only sets or tows in which Atlantic wolffish was more than 10% of the catch, according to logbooks, were included. CPUE in longline vessels has been similar among years prior to 2018, around 100-150 kg/1000 hooks. CPUE of demersal trawl increased from about 230 to 400 kg/h in 2000-2005, but since 2006 it has fluctuated at around 250-300 kg/h (Figure 15.7.11). Fishing effort in longline increased from 66 million hooks in 2000 to 97 million hooks in 2001. Since then, it has been generally decreasing and was around 22 million hooks in 2018. In demersal trawl, fishing effort increased from about 14 thousand tow-hours in 2004 to 23 thousand tow-hours in 2008, followed by a sharp decrease to 4.8 thousand tow-hours in 2014. Since then, it has increased. Note that tow-hours are missing in 2022 (Figure 15.7.11).

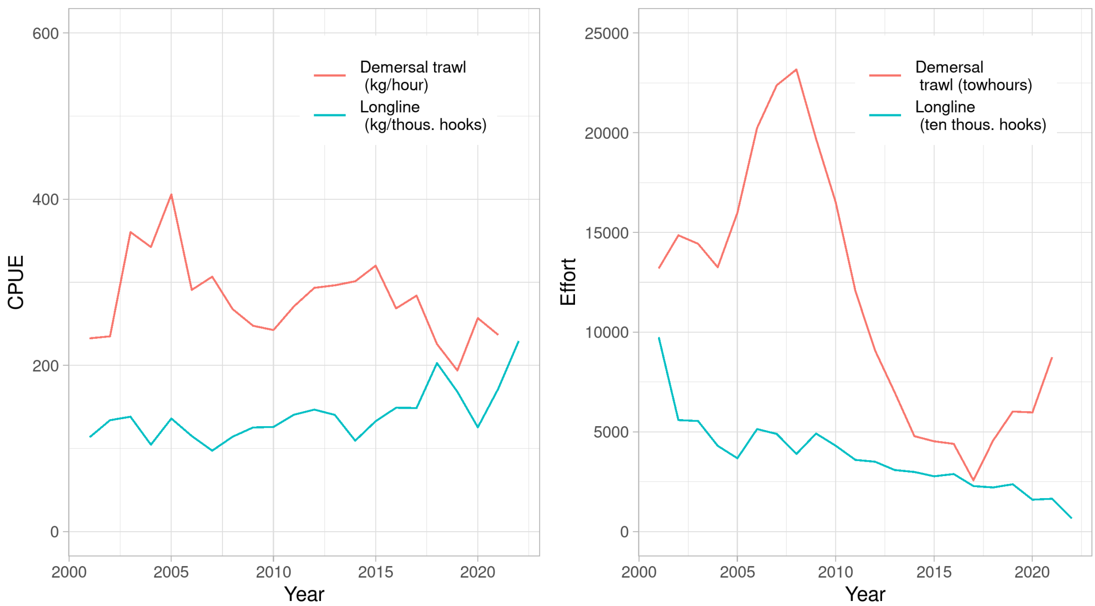

Figure 15.7.11. Atlantic wolffish in 5.a. Non-standardized estimates of CPUE (left) from demersal trawl (kg/h) and long-line (kg/1000 hooks). Fishing effort (right) for longline (10000 hooks) for demersal trawl (tow-hours).

Total biomass and harvestable biomass indices decreased from 1985-1995. In 1996, the biomass index increased to 1998, then decreased to a historical low level in 2010-2012, but has increased since (Figure 15.7.12). The harvestable biomass has generally been increasing from 1995 with considerable oscillations. The recruitment index was high in the years 1992-2003, since 1999 it has been decreasing, which coincides with increasing effort and catch of trawlers at the main spawning ground west of Iceland (Látragrunn) during the spawning and incubation time. The recruitment index reached a historical low level in 2011, but since then it has been rather stable but slightly increasing. This coincides with the enlarging of the area closure of the spawning/incubation area on Látragrunn from 500 km² (in 2002) to 1000 km² in October 2010.

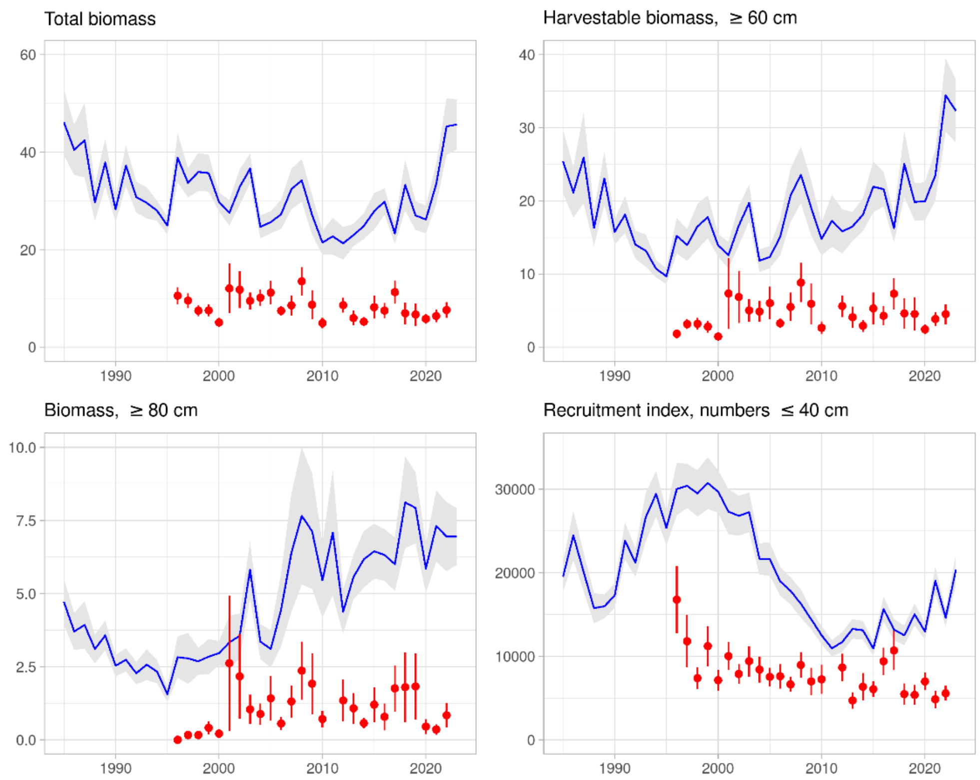

Figure 15.7.12. Atlantic wolffish. Total biomass indices (upper left) and harvestable biomass indices (≥60 cm, upper right), large fish biomass indices (≥80 cm, lower left) and juvenile abundance indices (≤40 cm, lower right), from the spring survey (blue) and the autumn survey (red), along with the standard deviation.

When the spring survey is conducted, Atlantic wolffish are on their feeding grounds which are commonly in relatively shallow waters. In the spring survey, the highest abundance has always been measured in the NW area (Figure 15.7.13).

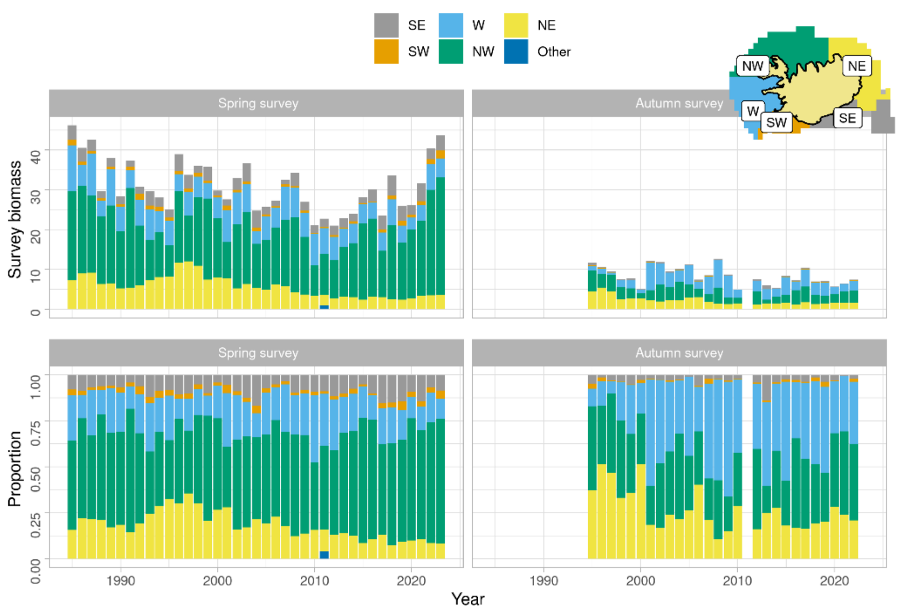

Figure 15.7.13. Atlantic wolffish in 5.a. Spatial distribution of biomass index from the spring and autumn survey.

15.1.4 Data analysis

15.1.4.1 Assessment on Atlantic wolffish in Icelandic waters using SAM

Atlantic wolffish in 5.a is new to ICES where it became a part of the ICES assessment process after an MoU between Iceland and ICES was signed on December 1st, 2019.

During the benchmark in April 2022, a SAM model (State-space stock assessment model) was agreed upon for use in the assessment.

15.1.4.2 Data used by the assessment and model settings

The new assessment model is a statistical catch at age model based on:

- commercial catch-at-age and landings data from 1979 onwards
- the Icelandic spring groundfish survey from 1985
- the autumn groundfish survey in Iceland from 2000. Recruitment at age 1 every year

The maximum age of the model is 16, which is considered a plus group. The assessment showed that SSB has been rather stable over the time period, while fishing mortality has gradually decreased, and recruitment has slightly decreased after 2001 but remained stable.

Natural mortality of 0.15 was chosen for all age groups. During the workshop, a wide range of estimates for natural mortality were tested and none showed a significant improvement in terms of model fit. It was therefore decided to use a M of 0.15.

15.1.4.3 Diagnostics

Fits to the catch-at-age data and survey numbers-at-age indices can be found in Figure 15.1.14). The fit to total catch and landings data can be found in figures 15.5.15) and 15.1.16). Catch and spring survey data are followed the closest by the model, whereas fits to the autumn survey series are slightly noisier but follow a similar pattern. Fits to landings data are quite variable, but more recent catch at age data show a better fit.

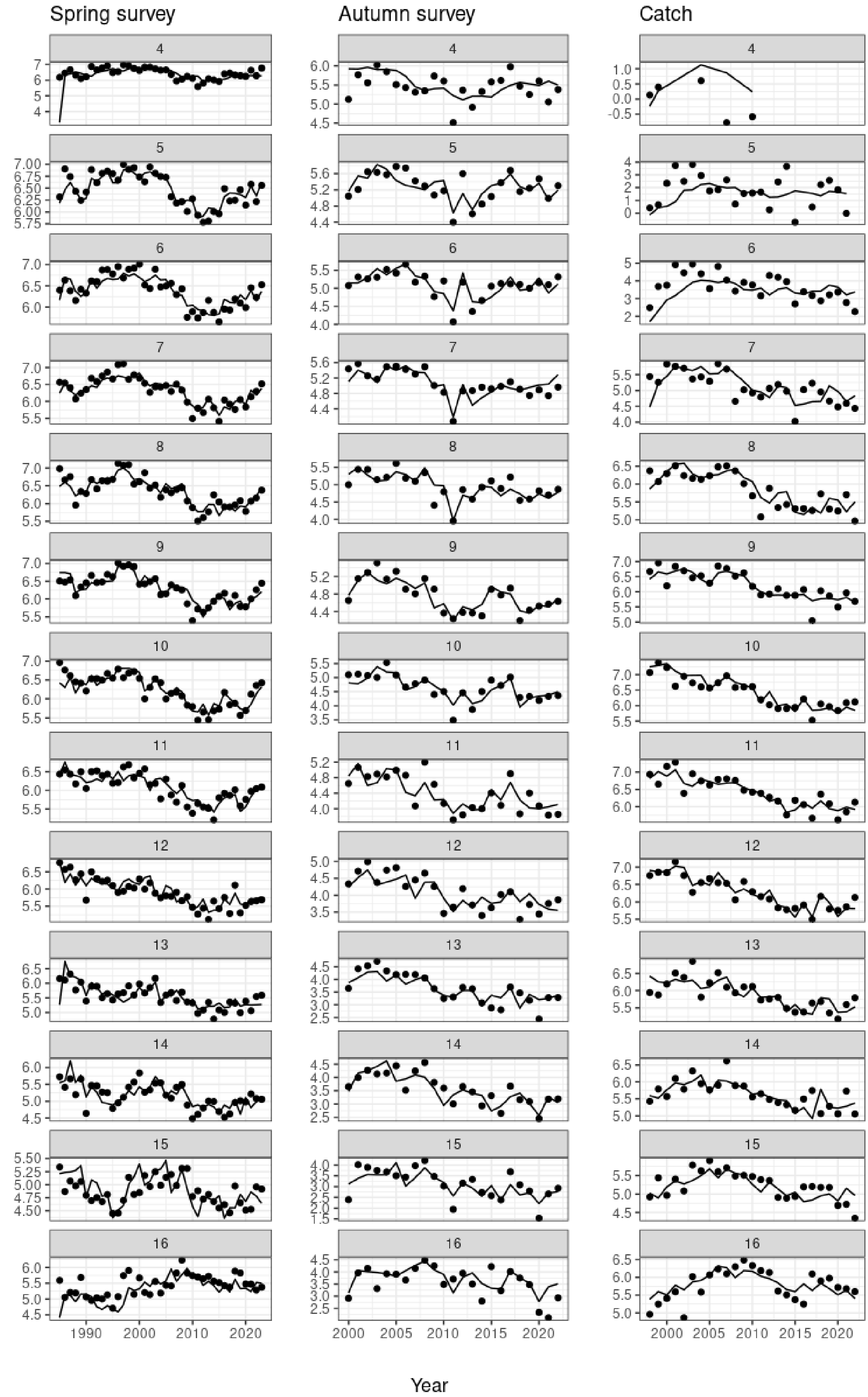

Figure 15.1.14 Atlantic wolffish in 5.a. Fit to the numbers at age input data to the proposed SAM model (columns left to right: spring survey, autumn survey, and catch.

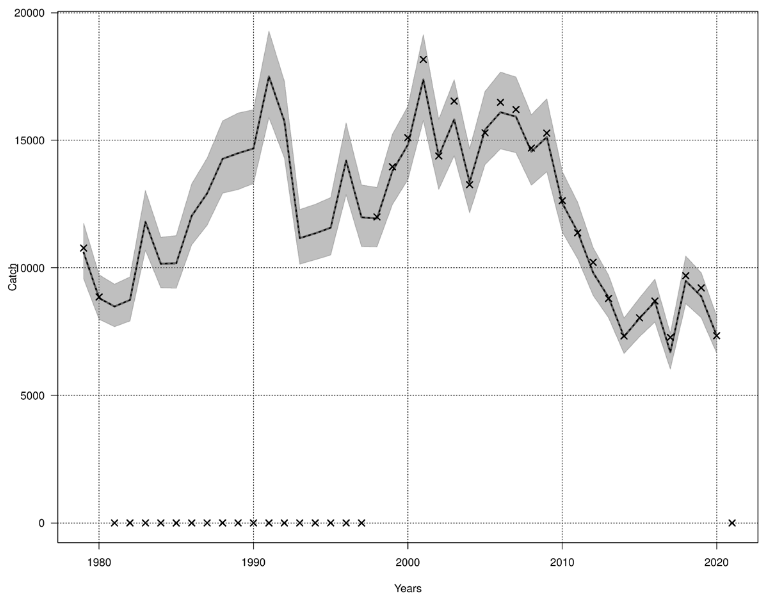

Figure 15.1.15. Atlantic wolffish in 5.a. Atlantic wolffish in 5.a. Fit to the total catch in the proposed SAM model.

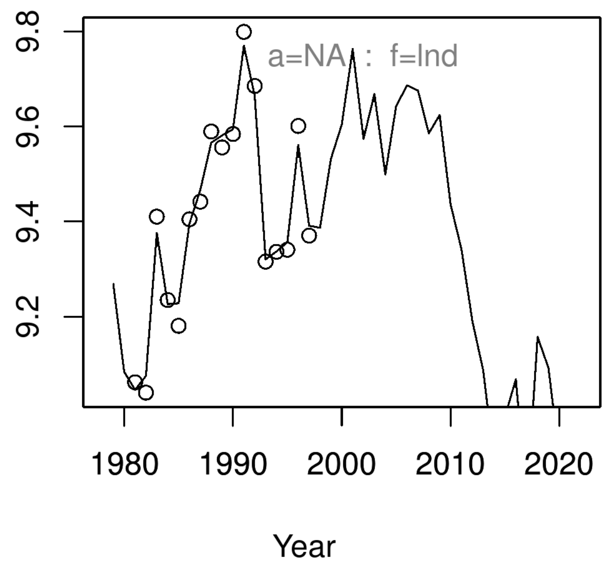

Figure 15.1.16. Atlantic wolffish in 5.a. Fit to the landings input data to the proposed SAM model.

15.1.5 Model results

Model results show that Atlantic wolffish total biomass levels decreased from high levels in 2000 – 2012 but have increased since then and are now at its highest level. Recruitment levels have also increased after being at the lowest level in 2011. Spawning stock biomass has also shown a steady increase since 1992 (Figure 15.1.18).

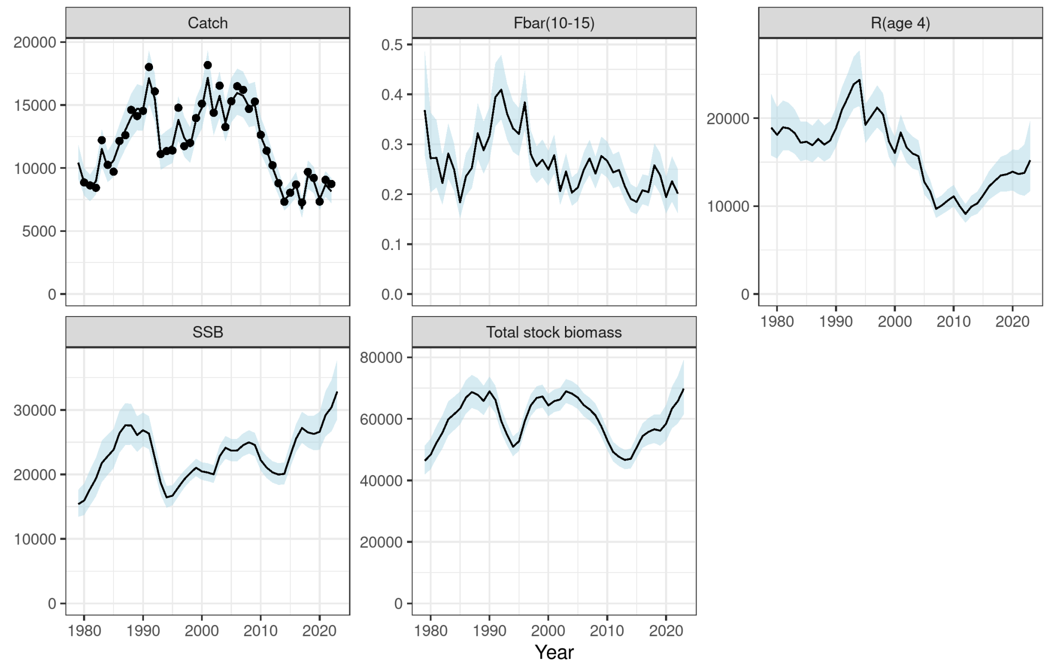

Figure 15.1.18. Atlantic wolffish in 5.a. Estimated biomass, spawning stock biomass (SSB), fishing mortality for fully selected fish and harvest rate, recruitment, total stock biomass and total catches.

3.4.10.1 Retrospective analysis

The results of an analytical retrospective analysis are presented. The analysis indicates relatively stable estimation, except in the earliest peel. Mohn's rho was estimated to be -0.0278 for SSB, 0.0385 for F, and 0.0368 for recruitment.

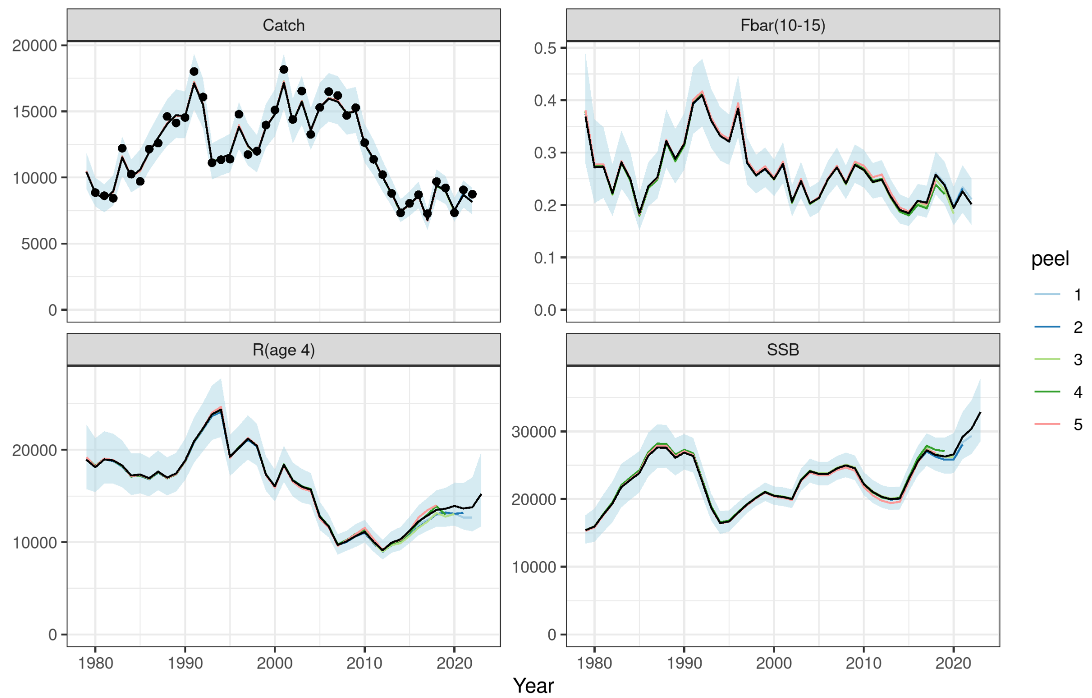

Figure 15.1.19. Atlantic wolffish in 5.a. Retrospective plots illustrating stability in model estimates over a 5-year 'peel' in data. Results of spawning stock biomass, fishing mortality F, and recruitment (age 4) are shown.

Neither observation nor process residuals show obvious trends (Figs. 3.4.15 and 3.4.16).

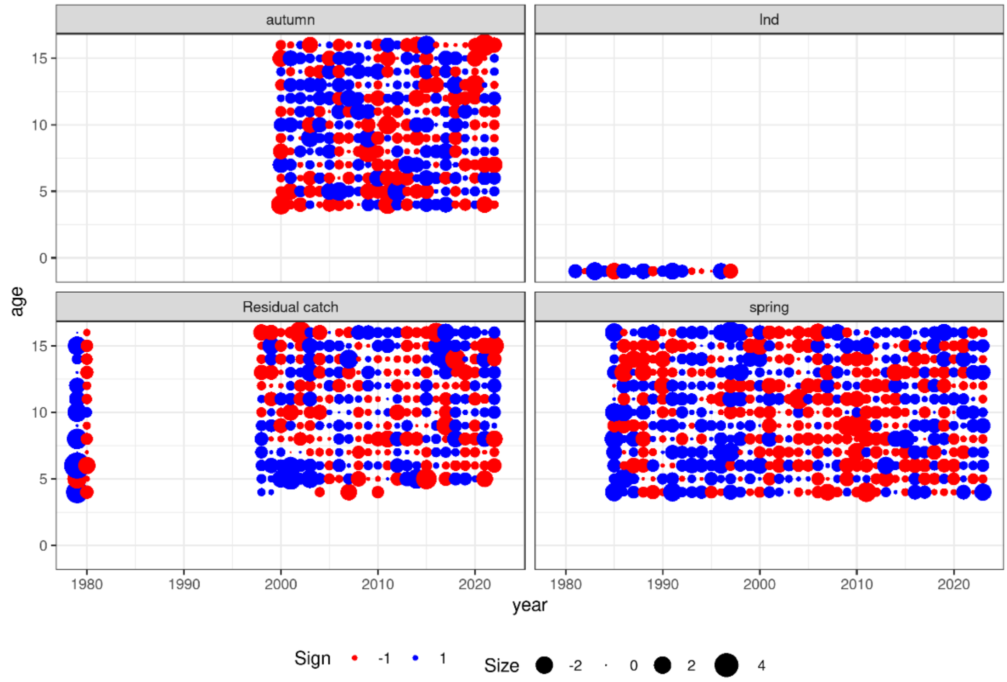

Figure 15.1.20. Atlantic wolffish in 5.a. Observation error residuals of the SAM model.

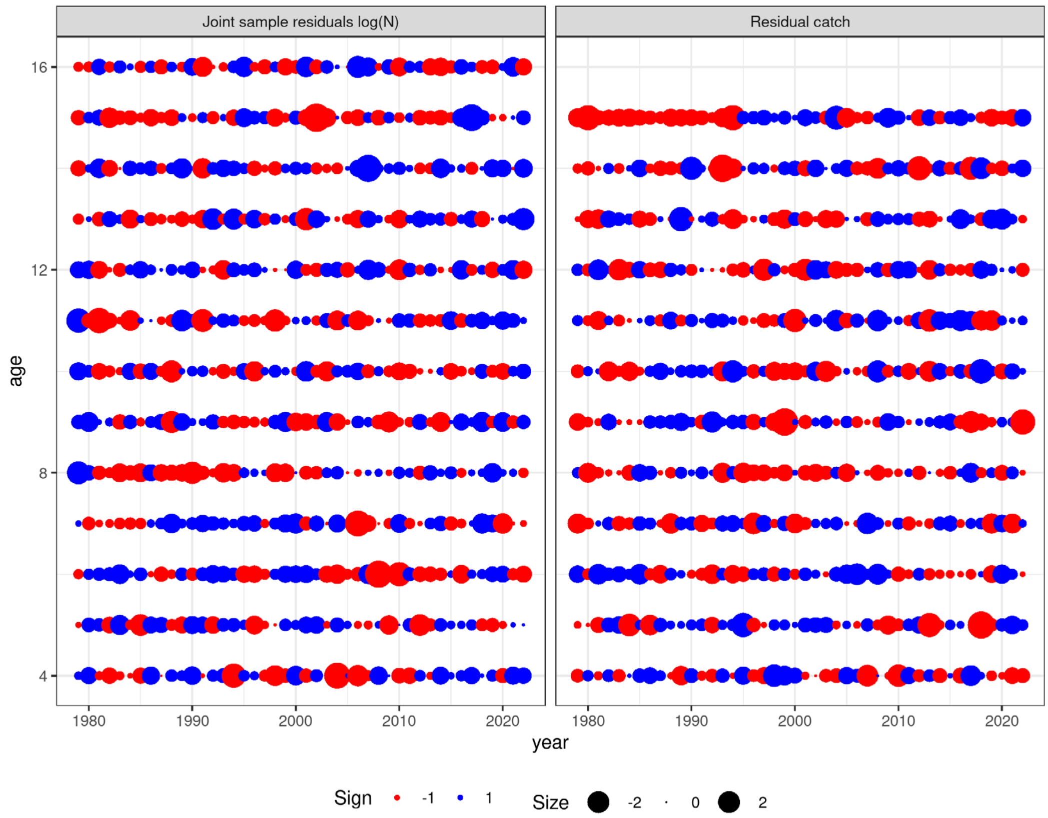

Figure 15.1.21. Atlantic wolffish in 5.a. Process error residuals of the SAM model.

15.1.6 Management

The Ministry of Industries and Innovation is responsible for management of the Icelandic fisheries and implementation of legislation. Atlantic wolffish was included in the ITQ system in the 1996/1997 quota year and as such subjected to TAC limitations. From that time to the fishing year 2004/2005, the catch was on average 5% more than recommended by the MRI, although in some years it was lower than advised TAC. In the fishing years 2005/2006 to 2011/2012, the catch was on average around 34% above the advised TAC. The main reasons were that national TAC was set higher than the advised TAC, and quota of other species were being transferred to Atlantic wolffish quota (Table 15.1.2, Figure 15.1.6). Net transfer of Atlantic wolffish quota for each fishing year is usually less than 10%.

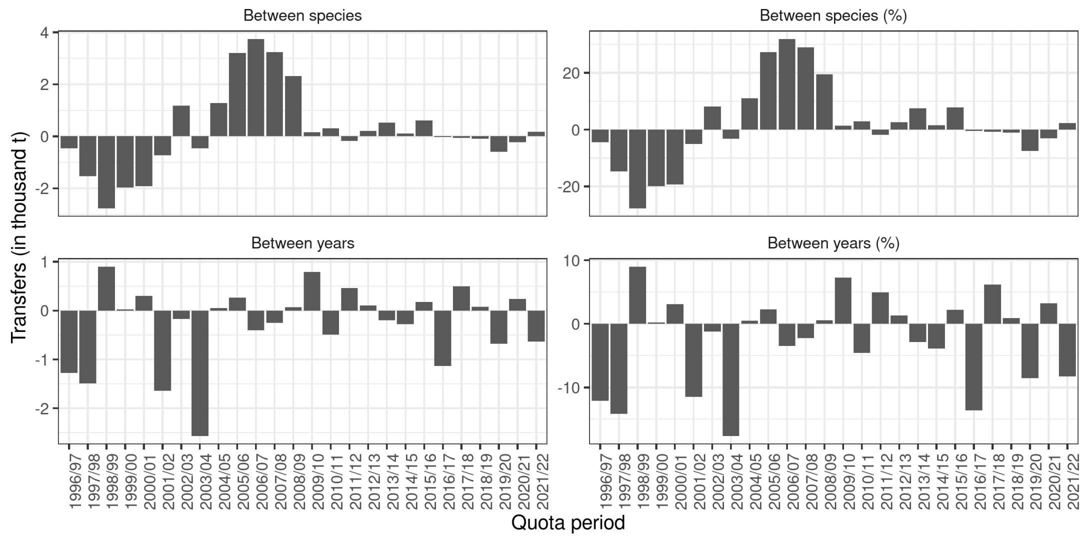

Figure 15.1.22: Atlantic Wolffish in 5.a. Net transfer of quota, from Atlantic Wolffish to other species, in the Icelandic ITQ system by fishing year.

15.1.7 Current Advisory Framework

Reference points were calculated for the stock. This resulted in B_{pa} of 21 000 t, based on the lowest estimate of SSB observed after the 2001 shift in recruitment had been observed (2002), and B_{lim} of 18 500 t. The fishing pressure estimates, defined in terms of fishing mortality applied to ages from 10 to 15, were estimated in accordance with the ICES guidelines. This resulted in an estimate of F_{lim} of 0.33, F_{p05} of 0.20 and F_{MSY} of 0.20. The MSY $B_{trigger}$ was set as B_{pa}.

The proposed HCR for the Icelandic Atlantic wolffish fishery, which sets a TAC for the fishing year y/y+1 (September 1 of year y to August 31 of year y+1) based on a fishing mortality F_{mgt} of 0.20 applied to ages 10 to 15 modified by the ratio SSB_y/MGT $B_{trigger}$ when SSB_y < MGT $B_{trigger}$, maintains a high yield while being precautionary as it results in lower than 5% probability of SSB < B_{lim} in the medium and long term.

15.1.8 Management considerations

A reduction in fishing mortality has led to harvestable biomass and SSB that seem to be stable. Atlantic wolffish is a slow-growing late-maturing species, therefore closures of known spawning areas should be maintained and expanded if needed. Similarly, closed areas fishing where there is high juvenile abundance should also be maintained and expanded if needed.

15.1.9 Ecosystem considerations

Most fishing for Atlantic wolffish occurs in the northwest and west of Iceland, where the fastest growing Atlantic wolffish are found. A likely cause for differences in growth is environmental differences between the relatively warm southwestern waters versus colder northeaster waters. However, Atlantic wolffish are also highly sedentary, especially while guarding nests during spawning and rearing season, and therefore additional metapopulation structure cannot be excluded. Therefore, it is possible that local depletion may occur in more heavily fished areas despite a stable overall biomass level.

Table 15.1.1. Atlantic wolffish in 5.a. Number of Icelandic vessels reporting catch of 10 tonnes/year or more of Atlantic wolffish, and all landed catch divided by gear type.

Number of vessels					Catch (tonnes)				
Year	Long liners	Trawls	Seiners	Other	Longline	Trawl	D. seine	Other	Sum
2000	172	76	20	1	9979	4173	834	241	15227
2001	198	76	19	4	12595	4319	862	394	18170
2002	151	65	14	3	8897	4423	800	304	14424
2003	142	63	25	1	8943	5960	1402	263	16568
2004	109	60	40	2	5746	5349	2010	216	13321
2005	96	64	34	0	6370	7247	1552	177	15346
2006	136	66	32	1	7962	6885	1569	144	16560
2007	124	65	27	1	6655	7857	1551	171	16234
2008	100	60	25	2	5810	7026	1642	152	14630
2009	124	58	34	1	7896	5709	1462	143	15210
2010	82	46	23	2	6923	4531	1033	175	12662
2011	68	36	18	0	6094	4062	1138	97	11391
2012	80	28	21	0	6209	2910	992	103	10214
2013	77	29	19	2	5537	2424	721	110	8792
2014	77	22	17	1	4463	1722	1006	138	7329
2015	68	34	18	2	4828	1926	1097	137	7988
2016	65	37	19	3	5563	1713	1201	148	8625
2017	65	26	19	1	4586	1243	1286	128	7243
2018	67	40	26	4	5657	1689	2185	125	9656
2019	66	36	22	1	5223	1748	2154	90	9215

2020	50	38	25	1	2984	2147	2147	54	7340
2021	51	48	22	1	3941	3047	2012	45	9046
2022	42	49	23	0	2951	3262	2460	55	8728

Table 15.1.2: Atlantic wolffish in 5.a. Advised TAC, national TAC and total landings since the quota year 2013/2014.

Fishing Year	MFRI Advice	National TAC	Landings
2013/14	7500	7500	7531
2014/15	7500	7500	7862
2015/16	8200	8200	8982
2016/17	8811	8811	7545
2017/18	8540	8540	9515
2018/19	9020	9020	9355
2019/20	8344	8344	7166
2020/21	8761	8761	8974
2021/22	8933	8933	8561
2022/23	8107	8107	

Table 15.1.3. Atlantic wolffish. Number of samples and aged otoliths from landed catch of Atlantic wolffish.

Year	Longline		Demersal trawl		Demersal seine	
	Samples	Otoliths	Samples	Otoliths	Samples	Otoliths
2010	29	1669	18	1090	5	285
2011	14	750	15	778	9	550
2012	26	1300	14	700	7	350
2013	25	1249	14	691	5	200
2014	30	800	26	675	28	700
2015	25	625	19	479	19	474
2016	25	625	13	325	9	225
2017	23	575	9	220	6	150
2018	22	550	9	225	17	425
2019	22	550	10	276	20	500
2020	9	225	12	350	16	400
2021	14	350	25	625	15	375
2022	14	110	17	330	14	273

Table 15.1.4. Atlantic wolffish in 5.a. Estimates of spawning–stock biomass (SSB) in thousands of tonnes, recruitment at age 4 (thousands), fishing mortality over ages 10 - 15 (Fbar) and catch from SAM.

Year	SSB	Recruitment	Fbar	Catch
1979	15388	18931	0.368	10429
1980	15957	18103	0.272	8837
1981	17724	18958	0.273	8357
1982	19349	18842	0.222	8960
1983	21773	18298	0.281	11520
1984	22827	17214	0.249	10043
1985	23829	17324	0.184	10610
1986	26396	16923	0.236	11909
1987	27618	17637	0.253	13015
1988	27588	16996	0.322	14035
1989	26103	17448	0.288	14712
1990	26854	18828	0.317	14626
1991	26346	20919	0.394	17115
1992	22560	22320	0.409	15485
1993	18709	23846	0.361	11136
1994	16439	24354	0.332	11467
1995	16700	19254	0.321	11757
1996	17992	20232	0.384	13817
1997	19222	21202	0.280	12389
1998	20196	20425	0.256	11719
1999	21031	17326	0.269	13808
2000	20467	16043	0.249	14778
2001	20296	18367	0.278	17150
2002	20007	16676	0.206	14185
2003	22787	15995	0.245	15729
2004	24124	15675	0.203	13582

Year	SSB	Recruitment	Fbar	Catch
2005	23690	12758	0.213	15289
2006	23720	11684	0.249	15955
2007	24525	9685	0.272	15734
2008	24978	10093	0.241	14860
2009	24554	10649	0.276	15001
2010	22215	11114	0.267	12512
2011	21053	10024	0.244	11405
2012	20320	9116	0.248	10043
2013	19979	9945	0.216	8792
2014	20096	10308	0.191	7441
2015	22907	11227	0.184	7970
2016	25545	12251	0.208	8634
2017	27198	12881	0.204	6787
2018	26521	13490	0.258	9418
2019	26274	13617	0.238	8993
2020	26604	13918	0.194	7518
2021	29188	13644	0.226	8688
2022	30383	13783	0.201	8143
2023	32864	15214		

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*, *Rhinochimaera atlantica* and *Hydrolagus* spp), Alepocephalidae including Baird's smoothhead (*Alepocephalus bairdii*) and Risso's smoothhead (*A. rostratus*), wreckfish (*Polyprion americanus*), blackbelly rosefish (*Helicolenus dactylopterus*), silver scabbardfish (*Lepidopus caudatus*), deep-water cardinal fish (*Epigonus telescopus*) Mediterranean slimehead, also known as silver roughy (*Hoplostethus mediterraneus*), Black gemfish (*Nesiarchus nasutus*) Atlantic thornyhead (*Trachyscorpia cristulata*), greater eelpout (*Lycodes esmarkii*), Norway redfish (*Sebastes viviparus*) and deep-water red crab (*Chaceon affinis*). Deepsea sharks are not considered as these species are in the remit of WGEF. The species considered include all teleost species from annex 1 of Council Regulation (EC) 2016/2336.

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.

In Subarea 14b, Baird's smoothhead, rabbit fish and species of Moridae are caught as bycatch in demersal trawl fisheries for Greenland halibut (*Reinhardtius hippoglossoides*) but are most likely under reported in official reports from the area.

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. This fishery reduced strongly from 826 tonnes in 2007 to 125 t in 2008 and have remained at a similar level since.

Although in annex 1 of Council Regulation (EC) 2016/2336 black gemfish and eelpouts (not only greater eelpout but all eelpouts were searched in catch statistics) were never landed from fisheries operating in the ICES area from 2006 to 2017.

16.1.1 Landings trends

Landings reported to ICES are presented in Tables 16.1–16.12, based on ICES catch statistics using historical nominal and the official nominal catches from 2006-2020, downloaded from the ICES website in May 2023. Catch data in 2021 and 2022 were not available as they were not included in preliminary catch statistics and were not reported to InterCatch either.

Mora moro and Moridae have been landed in variable quantity over time from subareas 6 to 10. Landings of chimaerids peaked to around 1000 t in the early 2000s and have shown large year-to-year variations since. Landings of smoothheads peaked to level over 10 000 tonnes in the early 2000s and have been around 400 tonnes in recent years. Landings of wreckfish peaked to more than 1000 tonnes in 2007. The main area is Subarea 10, where landings seem to be on a declining trend. Blackbelly rosefish is landed from subareas 6 to 10, in variable yearly quantity averaging to about 1000t per year. Silver scabbardfish is mostly landed from subareas 8, 9 and 10, landing have decline since the late 1990s. More than 1000 t/year of deepwater cardinal fish was landed in the early 2000. Landings almost ceased in recent years.

Mediterranean slimehead was landed in variable amount with greater quantities from Subarea 9 in years 2012-2015. Atlantic thornyhead was landed in small amount, typically less than one tonne per year from subareas 6, 7 and 8. Norway redfish was mostly landed from Subarea 5, in declining quantity over 2010–2017.

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 these species are presented in Tables 16.1–16.12. 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 to be revised.

In 2016, some data provided to the working group were not suitable. One country reported species which are not deep-water species, such as coastal Rajidae, another reported American plaice (*Hippoglossoides platessoides*) and Spotted wolffish (*Anarhichas minor*).

In Subareas 6 and 12 landings of silver scabbardfish are suspected to be misreported (probably of black scabbardfish, *Aphanopus carbo*) 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 blackbelly rosefish was high in 2016 and 2017 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 blackbelly rosefish 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. Trends in mean length of blackbelly rosefish in the French EVHOE survey (Bay of Biscay) is shown in Figure 16. 3. The cumulated length distribution of blackbelly rosefish, silver scabbardfish, common mora and wreckfish in Azorean surveys are presented in Figures 16.4, 16.5, 16.6 and 16.7, respectively.

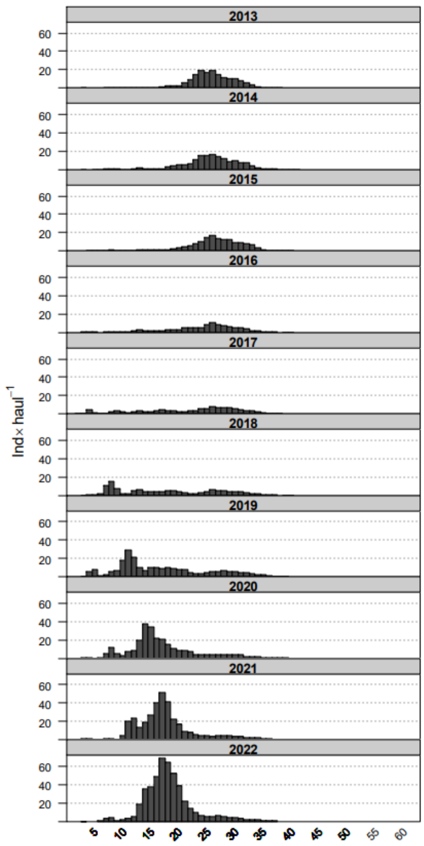

Figure 16.1. Mean stratified length distributions of *Helicolenus dactylopterus* in Porcupine surveys (2013-2022) (from Ruiz-Pico et al., WD 10 to the 2023 WGDEEP).

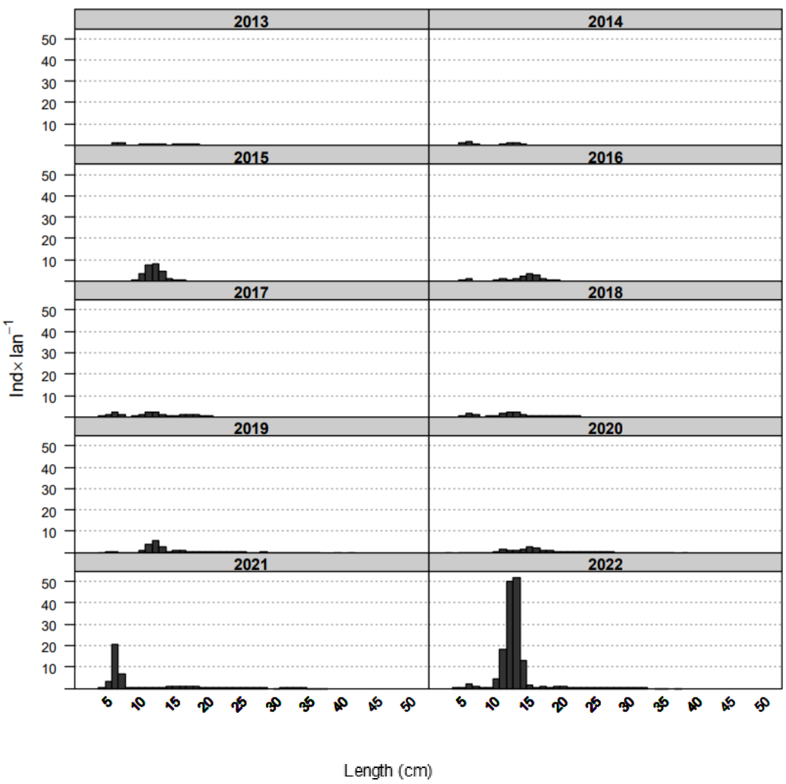

Figure 16.2. Mean stratified length distributions of bluemouth (*H. dactylopterus*) in Northern Spanish Shelf surveys (2013–2022) (from Fernández-Zapico et al., WD 9 to the 2023 WGDEEP).

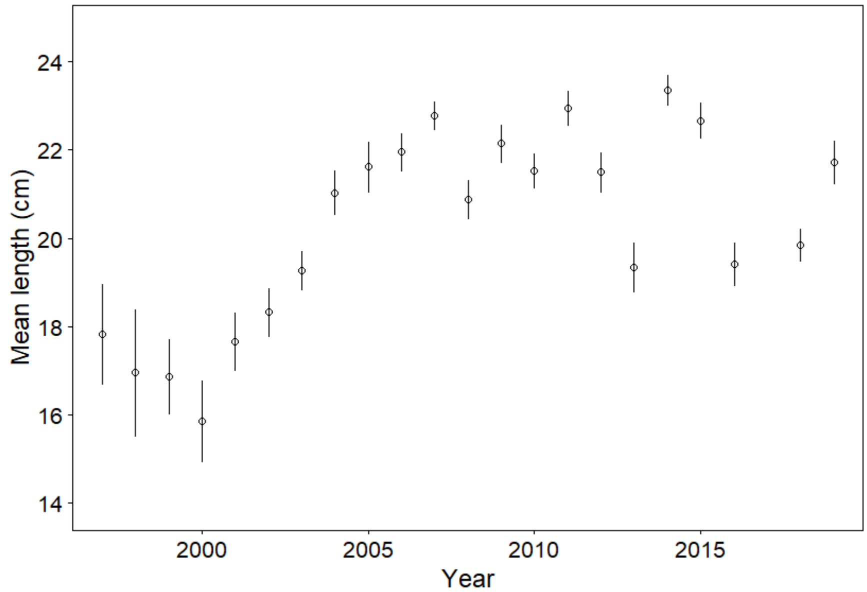

Figure 16.3 Mean length of *Helicolenus dactylopterus* in the French survey in Bay of Biscay and Celtic Sea (EVHOE) from 1997 to 2019 (no survey in 2017).

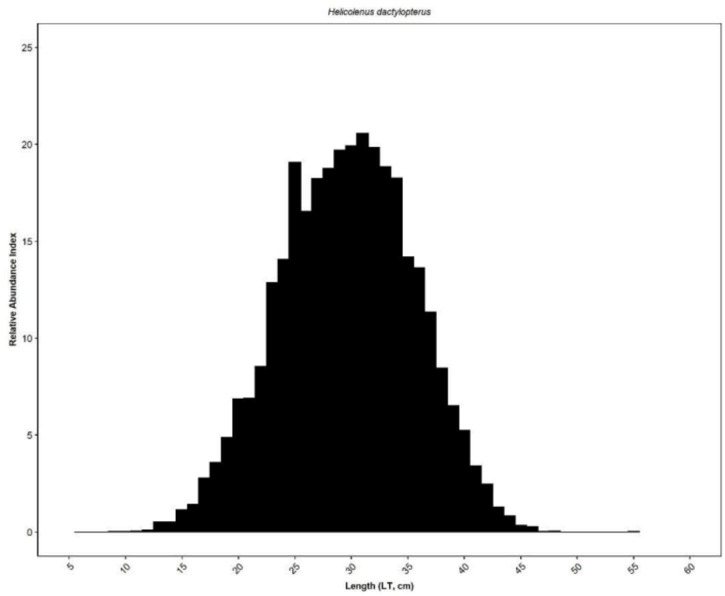

Figure 16.4. Mean length of Helicolenus dactylopterus in Azores bottom longline survey 1995–2021 (from Medeiros et al., WD 10 to the 2022 WGDEEP).

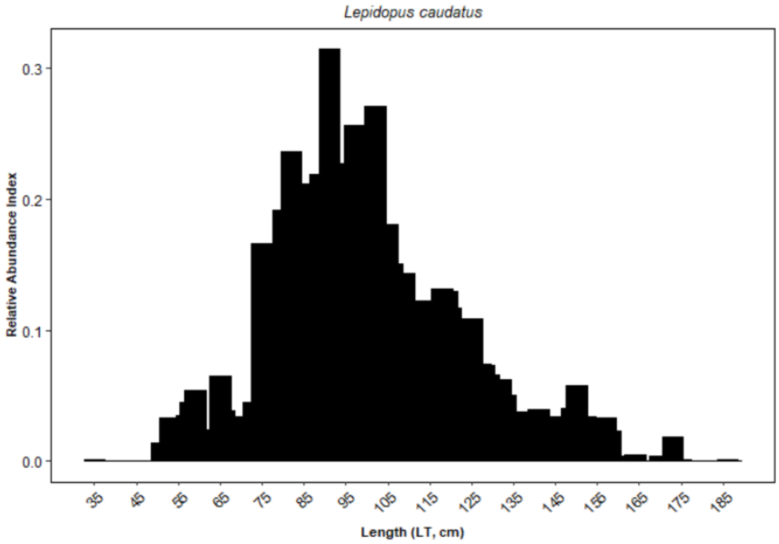

Figure 16.5. Mean length of *Lepidopus caudatus* in Azores bottom longline survey 1995–2021 (from Medeiros et al., WD 10 to the 2022 WGDEEP).

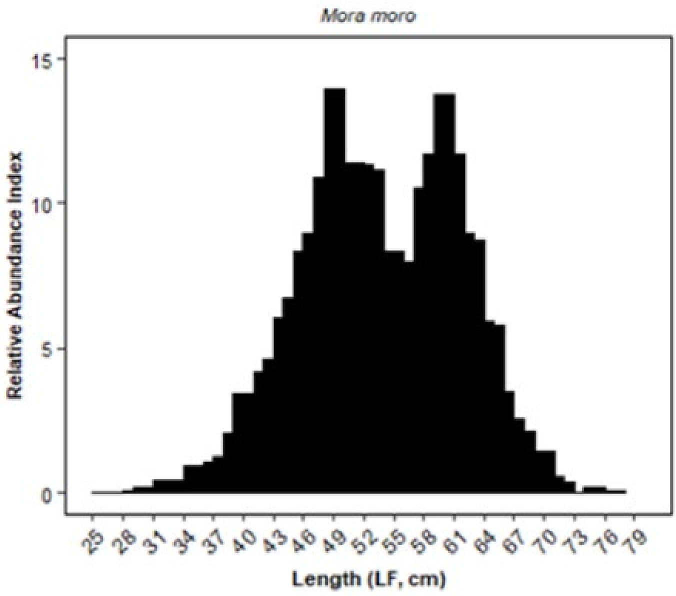

Figure 16.6. Mean length of *Mora moro* in Azores bottom longline survey 1995–2021 (from Medeiros et al., WD 10 to the 2022 WGDEEP).

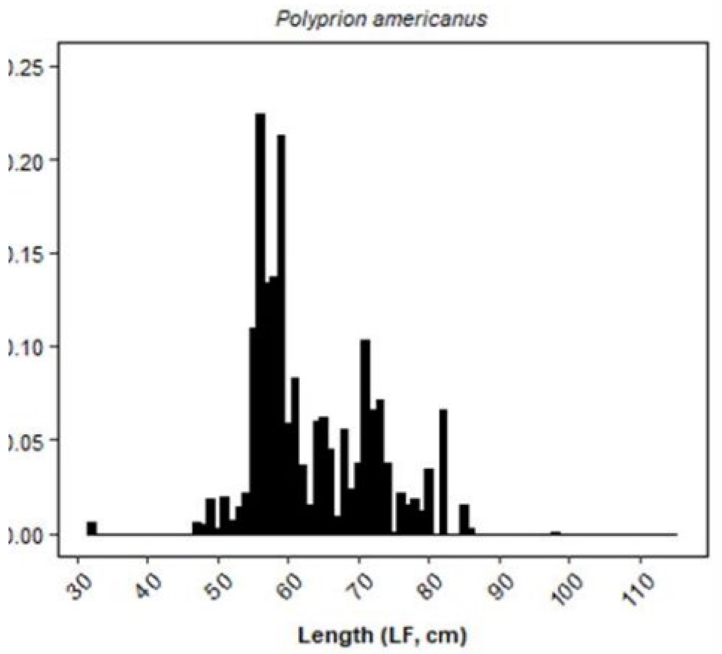

Figure 16.7. Mean length of *Polyprion americanus* in Azores bottom longline survey 1995–2021 (from Medeiros et al., WD 10 to the 2022 WGDEEP).

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 blackbelly rosefish standardized indices from the Spanish Porcupine Bank Survey (abundance and biomass), the French EVHOE survey in the Celtic Sea and Bay of Biscay (biomass), the Spanish bottom-trawl survey (SP-NGFS) in Divisions 9.a and 8.c and the Portuguese longline survey in the Azores Islands (abundance) and are given in Figures 16.7–16.11.

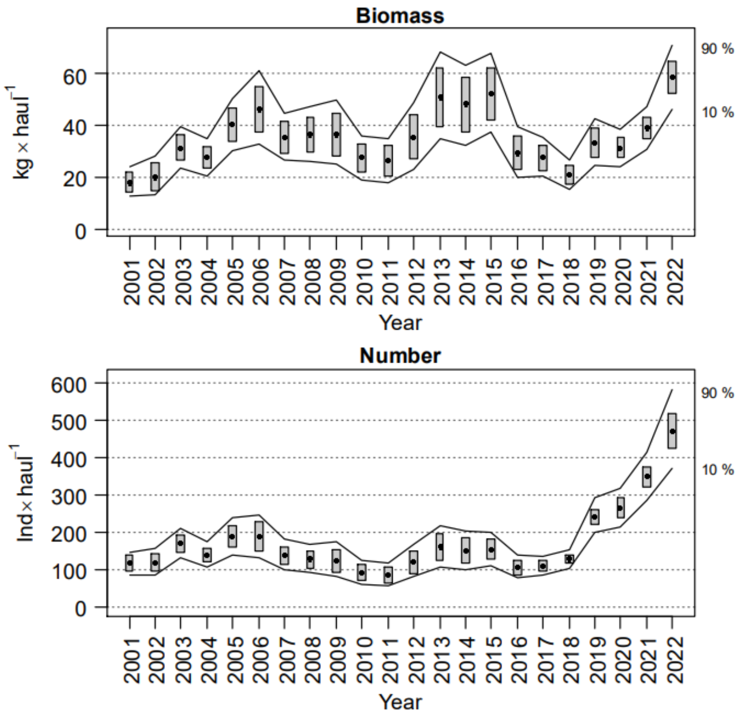

Figure 16.7. Trends of *Helicolenus dactylopterus* biomass and abundance indices during Porcupine Survey time-series (2001–2022). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000) (from Ruiz-Pico et al., WD 10 to the 2023 WGDEEP).

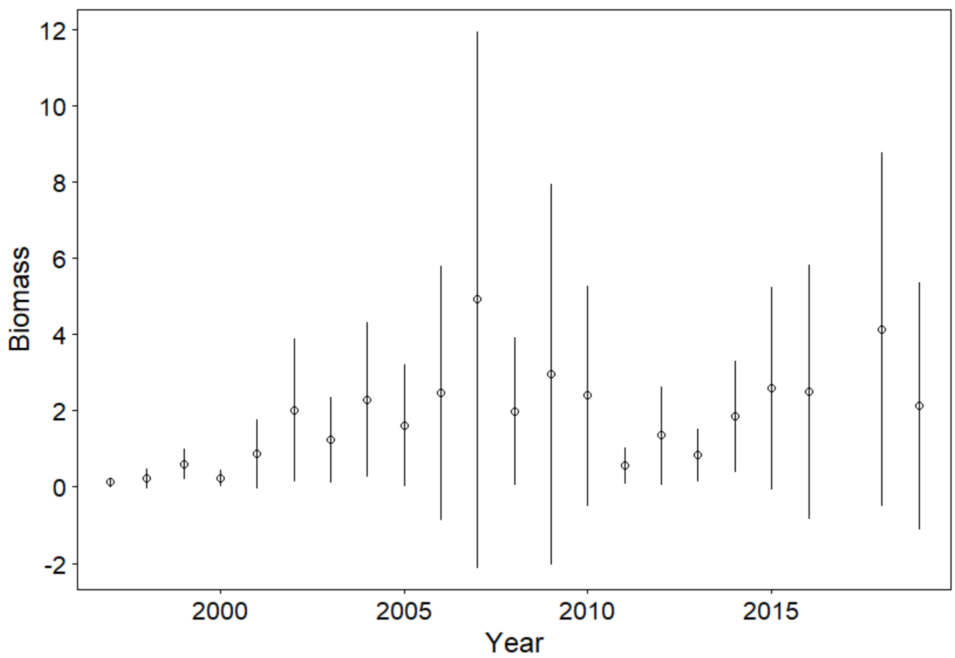

Figure 15.8. Survey biomass index from the French survey (EVHOE) for *Helicolenus dactylopterus*.

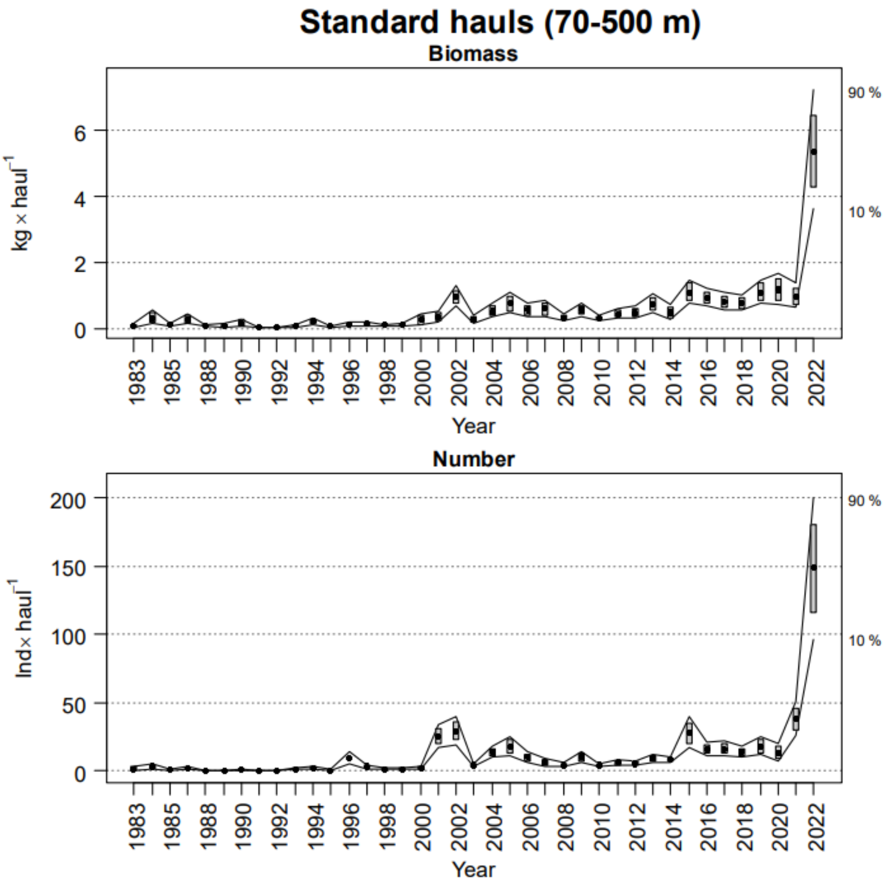

Figure 16.9. Evolution of *Helicolenus dactylopterus* mean stratified biomass and abundance in Northern Spanish Shelf surveys time-series (1983–2022). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000) (from Fernández-Zapico et al., WD 9 to the 2023 WGDEEP).

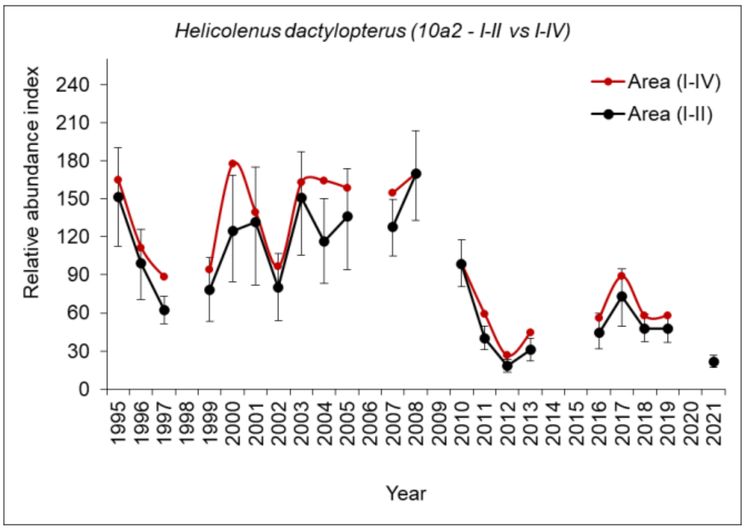

Figure 16.10. Annual bottom longline survey abundance index for *Helicolenus dactylopterus* in Azorean bottom longline surveys (from Medeiros et al., WD 10 to the 2022 WGDEEP).

Abundance indices for silver scabbardfish, common mora and wreckfish from the Portuguese longline survey in the Azores Islands are given in Figures 16.11 to 16.13.

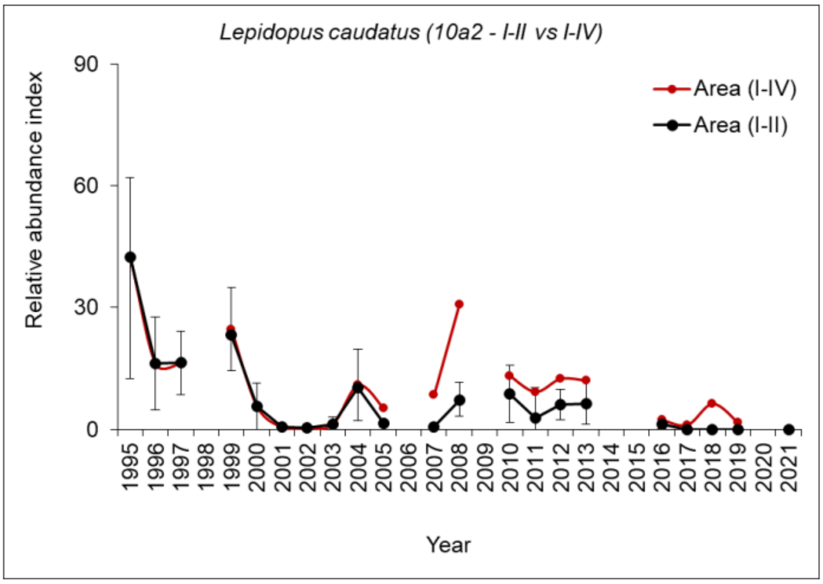

Figure 16.11 Annual bottom longline survey abundance index for Lepidopus caudatus in Azorean bottom longline surveys.

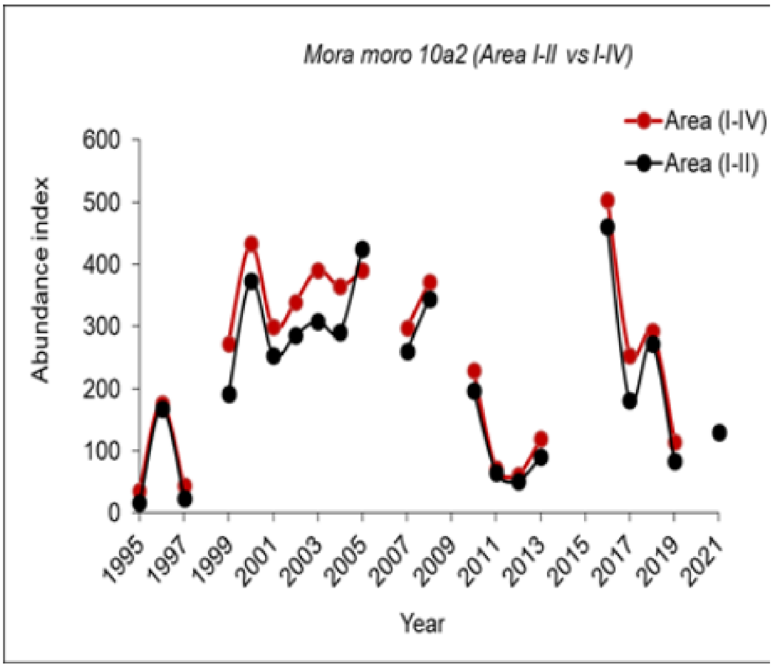

Figure 16.12. Annual bottom longline survey nominal cpue for *Mora moro* in Azorean bottom longline surveys (from Medeiros et al., WD 10 to the 2022 WGDEEP).

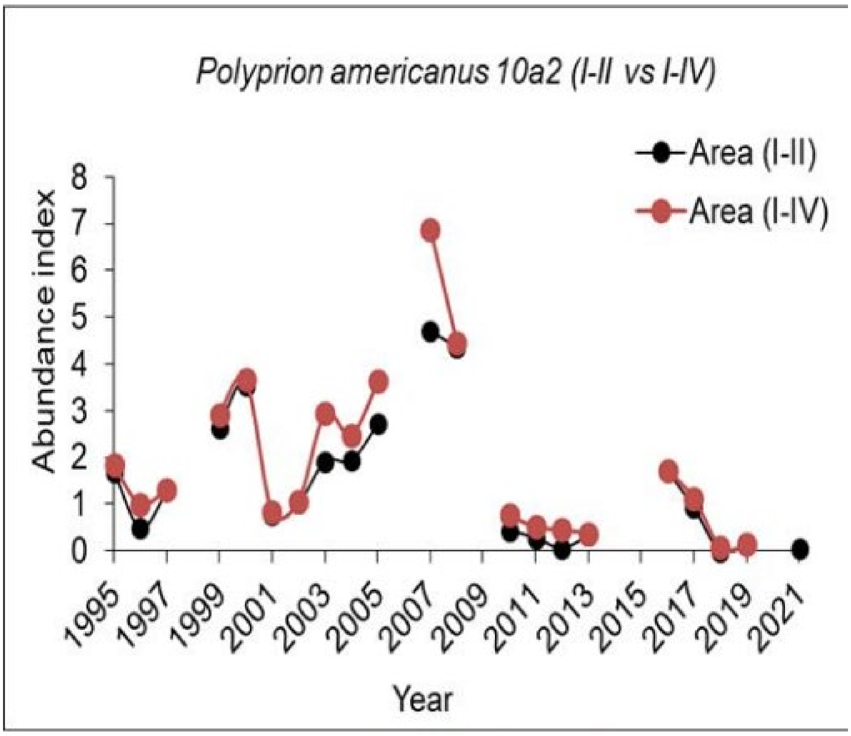

Figure 16.13. Annual bottom longline survey nominal cpue for *Polyprion americanus* in Azorean bottom longline surveys (from Medeiros et al., WD 10 to the 2022 WGDEEP).

16.3.7 Data analysis

No new analyses were carried out in 2023. Updated surveys series from several species are included in different working documents presented to the 2022 WGDEEP (WD 10) and to the 2023 WGDEEP (WD 9 and WD 10).

16.3.8 Comments on the assessment

16.3.9 Management considerations

Currently no advice is required for these stocks.

Table 16.1. Official landings of *Mora moro* and *Moridae* (t).

Year	2	5b	6 and 7	8 and 9	10	12	14b
1988							
1989							
1990					2		
1991		5	1		4		
1992			25				
1993			10				
1994			10				

Year	2	5b	6 and 7	8 and 9	10	12	14b
1995				83			
1996				52			
1997				88			
1998			41				
1999		1	20				
2000	8	3	159	25		1	
2001	1	100	194	25		87	
2002	1	19	159	10	100	13	
2003		8	327	12	125	15	7
2004		1	71	15	87	4	
2005		1	63	50	69		
2006	0	4	135	45	92*	0	
2007	0	5	100	15	86*	0	0
2008	0	10	72	14	53*	0	0
2009	0	10	80	9	68*	0	0
2010	0.04	14	84	4	55*	0	0
2011	0.02	6	87	3	57*	0	0
2012	0.04	5	71	2	31*	0	0
2013	0.06	1	103	7	52*	0	0
2014	0	1	65	20	62*	0	0
2015	0.43	2	77	54	92*	0	0
2016	0	1	54	56	191*	0	0
2017	0	3	30	62	169*	0	0
2018	0	5	59	28	165*	0	0
2019	0.13	15	59	19	124*	0	0.35
2020	0	5	78	15	60*	0	0

*** Only data from Azore**

Table 16.2 Official landings of rabbitfish (*Chimaera monstrosa* and *Hydrolagus* spp) (t).

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
2017	69	32	0	103	144	<1	0	0	1	350
2018	131	21	0	60	146	<1	0	0	0	360

Year	1 and 2	3 and 4	5a	5b	6 and 7	8	9	12	14	TOTAL
2019	220	24	0	70	145	<1	0	0	<1	461
2020	133	37	0	25	42	<1	0	0	0	238
2021	0	0	0	0	0	0	0	0	0	0
2022	114	75	0	46	200	2	0	0	0	437

Table 16.3. Official 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

Year	5a	5b	6 and 7	12	14	TOTAL
2014			235 0+	228		463
2015			127 3+	91		218
2016			131	258		389
2017	14	0	156	326	<1	496
2018	5	0	77*	323*	1	406*
2019	5	0	72	246	0	322
2020	6	0	46	193	0	245
2021	0	0	0	0	0	0
2022	0	0	0	0	0	0
* Only data from Spain						

Table 16.4. Official landings of wreckfish (*Polyprion americanus*) (t).

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
2017	9	114	131	254
2018	6	70	89*	166*
2019	4	66	78*	149*
2020	5	101	79	185
2021	0	0	0	0
2022	0	0	0	0

* Only data from Azores

Table 16.5. Official landings of blackbelly rosefish (*Helicolenus dactylopterus*) (t)

Year	3 and 4	5b	6	7	8 and 9	10
1980						18

Year	3 and 4	5b	6	7	8 and 9	10
1981						22
1982						42
1983						93
1984						101
1985						169
1986						212
1987						331
1988						439
1989			79	48	2	481
1990	4		69	31	5	480
1991	5		99	29	12	483
1992	3		112	47	11	575
1993	1		87	65	8	650
1994	2		62	55	4	708
1995	2		62	9		589
1996	2		77	10		483
1997	1		78	10	1	410
1998			53	92	3	381
1999	8	64	194	160	29	340
2000		16	213	119	33	441
2001			177	102	34	301
2002			81	115	18	280
2003			184	213	124	338
2004	2	3	142	291	135	282
2005			103	204	206	190
2006	0	1	195	839	328	209
2007	0	1	387	1968	519	277
2008	0	1	138	1175	527	287
2009	2	1	150	1321	651	317

Year	3 and 4	5b	6	7	8 and 9	10
2010	1	0	201	1681	1861	216
2011	1	3	178	2303	1821	239
2012	0	1	161	954	1402	192
2013	7	3	130	517	1326	236
2014	1	6	152	480	809	224
2015	0	1	112	496	665	258
2016	0	1	116	487	592	327
2017	0	3	135	647	595	344
2018	4	2	170	583	489	295
2019	9	2	219	543	434	192
2020	7	2	200	500	478	130

Table 16.6. Official landings of silver scabbardfish (*Lepidopus caudatus*) (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

	6 and 7	8 and 9	10	12	TOTAL
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
2017	62	146	112	29	349
2018	1	42	81*	13	137
2019		48	66*		114
2020		94	91*		185
*Only data from Azores					

Table 16.7. Official landings of deep-water cardinal fish (*Epigonus telescopus*) (t)

Year	5b	6	7	8 and 9	10	12
1990					3	

Year	5b	6	7	8 and 9	10	12
1991					11	
1992						
1993		15	15			
1994	4	35	182			
1995	3	20	71			
1996	8	13	32			
1997	8	27	22			
1998		86	29			
1999	8	54	224	3		
2000	2	121	181	5	3	
2001	7	109	284	4		
2002		97	888	8	14	
2003	2	47	1031	5	16	1
2004	1	30	843	10	21	2
2005		50	637	8	4	
2006	0	27	66	26	10	0.1
2007	0	10	17	31	7	0
2008	0	5	12	11	7	0
2009	0	10	13	34	7	0
2010	0	7	11	30	5	0
2011	0	4	45	3	5	0
2012	0	16	4	4	4	0
2013	0.1	10	2	2	4	0
2014	0	5	1	1	4	0
2015	0	5	1	1	4	0
2016	0	13	11	1	11	0
2017	0.3	12	0.4	3	8	0
2018	0.3	32	0.3	1	5	0
2019	1	0	0	3	143	0

Year	5b	6	7	8 and 9	10	12
2020	2	19	1	3	5	0

Table 16.8. Official estimates of landings of deep-water red crab (*Chaceon affinis*) (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	110	75	10	115	309
2010	2	247	79	46	71	445
2011		246	148	37	43	475
2012	10	67	45	10	21	153
2013	3	91	34	18	32	178
2014	1	112	29	3	48	194
2015		151	40	26	74	291
2016		103	55	41	23	222
2017	9	102	48	21		180
2018						
2019						
2020						

Table 16.10. Official landings (t) of Mediterranean slimehead, also known as silver roughy (*Hoplostethus mediterraneus*) (t)

Year	27.7	27.8	27.9
2006	0	0	0.7
2007	0	0	0
2008	0	0	0.01
2009	0	0	0.01
2010	0	0	14
2011	0	0	3.38
2012	0	0	27.26
2013	0	0.82	34.93
2014	0	3.85	36.11
2015	0	6.9	14.98
2016	0	2.68	1.62
2017	0.25	2.33	1.06
2018	0.585	3.845	0.25
2019	0.701	1.277	0.29
2020	1.067	1.783	22.73

Table 16.11. Official landings of Atlantic thornyhead (*Trachyscorpia cristulata*) (t)

Year	27.4	27.6	27.7	27.8
2006	0	0	0.01	26
2007	0.01	4.6	13.73	1.41
2008	0	2.8	4.2	0.62
2009	0	1.6	4.61	0.6
2010	0	0	0	0
2011	0	0.38	2.59	0.4
2012	0	0.06	4.43	0.36
2013	0.01	0.07	2.05	0.48
2014	0	0	0.92	0.72
2015	0	0	0.75	0.58

2016	0	0.45	0.14	0.29
2017	0	0.02	0.26	0.04
2018	0	0.025	0.585	0.035
2019	0	0.485	0.542	0.397
2020	0	0.019	1.607	1.453

Table 16.12. Official landings of Norway redfish (*Sebastes viviparus*) (t)

Year	27.2	27.5	27.6	27.12	27.14
2006	13	0	0	0	0
2007	7.3	0	0	0	0
2008	0	0	0	0	0
2009	0	0	0	0	0
2010	0	2600.7	0	0	0
2011	0	1415	0	0	10
2012	0	532	0	1	1
2013	0	532	0	0	0
2014	1	546	0	0	4
2015	0	468	0	0	0
2016	0	0	0.3	0	0
2017	0	170	0	0	0
2018	0.5	117	0	0	0
2019	0.6	142	0	0	0
2020	0	118	0	0	0

Annex 1: List of participants

Participant	Institute	e-mail	Country (of Institute)
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Annex 2: Resolutions

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

Approved in Resolutions meeting on 9 November 2022

2022/2/FRSG10 Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP), chaired by Elvar Hallfredsson, Norway and Juan Gil Herrera*, Spain, will meet in Lisbon, Portugal, 3–9 May 2023 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. In particular, describe and prepare a first advice draft of any new 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 status of stocks for the provision of advice in 2023.

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 on the dates specified in the 2023 ICES data call.

WGDEEP will report by 26 May 2023 for the attention of ACOM.

Only experts appointed by national Delegates or appointed in consultation with the national Delegates of the expert's country can attend this Expert Group

Generic ToRs for Regional and Species Working Groups

Approved in Resolutions meeting on 9 November 2022

The following ToRs apply to: AFWG, HAWG, NWWG, NIPAG, WGWIDE, WGBAST, WGBFAS, WGNSSK, WGCSE, WGDEEP, WGBIE, WGEEL, WGEF, WGHANSA and WGNAS.

The working group should focus on:

a) Consider and comment on Ecosystem and Fisheries Overviews with a focus on:

i) identifying and correcting mistakes and errors (both in the text, tables and figures), and

ii) proposing concrete evidence-based input that is considered essential for the advice but is currently under-developed or missing (with references and Data Profiling Tool entries, as appropriate).

The input will feed into the annual updates of the overviews. Delivery of contributions other than those outlined above is also welcomed but will be utilised during the revision process (around every 5 years).

b) Conduct an assessment on the stock(s) to be addressed in 2023 using the method (assessment, forecast or trends indicators) as described in the stock annex; - complete and document an audit of the calculations and results; and produce a **brief** report of the work carried out regarding the stock, providing summaries of the following where relevant:

i) Input data and examination of data quality; in the event of missing or inconsistent survey or catch information refer to the ACOM document for dealing with missing data and the linked template that formulates how deviations from the stock annex are to be reported.

ii) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;

iii) For relevant stocks (i.e., all stocks with catches in the NEAFC Regulatory Area), estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in 2022.

iv) For category 3 and 4 stocks requiring new advice in 2023, implement the methods recommended by WKLIFE X (e.g. SPiCT, rfb, chr, rb rules) to replace the former 2 over 3 advice rule (2 over 5 for elasmobranchs). MSY reference points or proxies for the category 3 and 4 stocks (guidelines)

v) Evaluate spawning stock biomass, total stock biomass, fishing mortality, catches (projected landings and discards) using the method described in the stock annex;

1) for category 1 and 2 stocks, in addition to the other relevant model diagnostics, the recommendations and decision tree formulated by WKFORBIAS (see Annex 2 of https://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/Fisheries%20Resources%20Steering%20Group/2020/WKFORBIAS_2019.pdf) should be considered as guidance to determine whether an assessment remains sufficiently robust for providing advice.

2) If the assessment is deemed no longer suitable as basis for advice, provide advice using an appropriate Category 2- 5 approach as described in ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3 or ICES.

3) If the assessment has been moved to a Category 2-5 approach in the past year consider what is necessary to move back to a Category 1 and develop proposal for the appropriate benchmark process.

vi) Catch scenarios for the year(s) beyond the terminal year of the data for the stocks for which ICES has been requested to provide advice on fishing opportunities;

vii) Historical and analytical performance of the assessment and catch options with a succinct description of associated quality issues. For the analytical performance of category 1 and 2 age-structured assessments, report the mean Mohn's rho (assessment retrospective bias analysis) values for time series of recruitment, spawning stock biomass, and fishing mortality rate. The WG report should include a plot of this retrospective analysis. The values should be calculated in accordance with the "Guidance for completing ToR viii) of the Generic ToRs for Regional and Species Working Groups - Retrospective bias in assessment" and reported using the ICES application for this purpose.

c) Produce a first draft of the advice on the stocks under considerations according to ACOM guidelines.

d) Review progress on benchmark issues and processes of relevance to the Expert Group.
i) update the benchmark issues lists for the individual stocks in SID;
ii) review progress on benchmark issues and identify potential benchmarks to be initiated in 2024 for conclusion in 2025;
iii) determine the prioritization score for benchmarks proposed for 2024–2025;
iv) as necessary, document generic issues to be addressed by the Benchmark Oversight Group (BOG)

e) Prepare the data calls for the next year's update assessment and for planned data evaluation workshops;

f) Identify research needs of relevance to the work of the Expert Group.

g) Review and update information regarding operational issues and research priorities on the Fisheries Resources Steering Group SharePoint site.

h) If not completed previously, complete the audit spread sheet 'Monitor and alert for changes in ecosystem/fisheries productivity' for the new assessments and data used for the stocks. Also note in the benchmark report how productivity, species interactions, habitat and distributional changes, including those related to climate-change, could be considered in the advice.

i) Deliver conservation status advice in accordance with the "Technical Guidelines on the conservation status advice". The advice is only to be given when conservation aspects were identified and where clear, demonstrable management action can be recommended for any non-catch anthropogenic pressure. It can also be used to highlight clear demonstrable sensitivity to climate change. The qualification required to show clear, demonstratable management action is high. Avoid generic statements that are of no specific application to management.

j) Update SAG and SID with final assessment input and output

Information of the stocks to be considered by each Expert Group is available here.

Annex 3: Working documents

The following eighteen working documents were presented at WGDEEP 2023.

WD01 ICES WGDEEP 2023

Greater forkbeard in Faroese waters (27.5.b).

Lise H. Ofstad, Faroe Marine Research Institute
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Introduction

There is very little catch of greater forkbeard in Faroese waters and a few fish is caught in different surveys. The objective for this document is to provide information on greater forkbeard in Faroese waters (27.5.b).

Methods

The background data is mainly from the annual surveys on the Faroe Plateau in spring (1994-2023) and summer (1996-2022). Some data are also from the deepwater survey (September 2014-2022, no survey in 2021). There are only small amounts of commercial catch, so there is no data individual fish data of this species from landings.

The fishery

There is no directed fishery for greater forkbeard in Faroese waters (5b) and only small amount is landed as bycatch.

Landings

There have always been very little landings of greater forkbeard by the Faroese fishery (Table 10.0d copied from WGDEEP report 2022). The main catch of greater forkbeard in Faroese waters is from Norway and France. The preliminary landing in 5b of greater forkbeard from Faroese in 2021 was 0.1 tons and in 2022 0 (zero) tons of greater forkbeard. NB! In the WGDEEP report 2022 (page 552 and in Table 10.0d page 561) - the landings in 5b of 301 tons in 2011 and 145 tons in 2012 seems to be wrong! In statlant 2011 the Faroese fleet fished 0.310 tons in 5a and in statlant 2012 the Faroese fleet fished 0.062 tons in 5a and 0.083 tons in 5b2 (Table 10.0d copied from WGDEEP report 2022 with only update of year 2011, 2012 and preliminary 2022 data for 5b).

Table 10.0d. 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				0		1	8
2012	6	5			0.083	7	7	25
2013	7	3	0				0	11
2014	7	14	0		0		2	24
2015	5	27					2	34
2016	7	3	0				3	13
2016	7	3	0				3	13
2017	9		0					9
2018	5	7						12
2019	7	10						18
2020	7	24	0					31
2021	6	7	0	0	0	0	0	13
2022*	5.436	21.018	0.2528		0			26.7

Spatial distribution

The spatial distribution of greater forkbeard from the bottom trawl groundfish surveys were mainly on the Faroe Plateau deeper than 200 m (Figure 1 and Appendix 1, 2). In the deepwater survey greater forkbeard was caught around the Banks and on the Wyville-Thomson ridge (Figure 2 left and Appendix 3).

In the Faroese 0-group surveys on the Faroe Plateau in June/July there are 26 registrations of greater forkbeard caught pelagic (Figure 2 right). The length was between 8-54 mm, mainly around 30-40 mm. 11 of there were caught in the period 1991-1999, 14 in the period 2001-2005 and one in 2022.

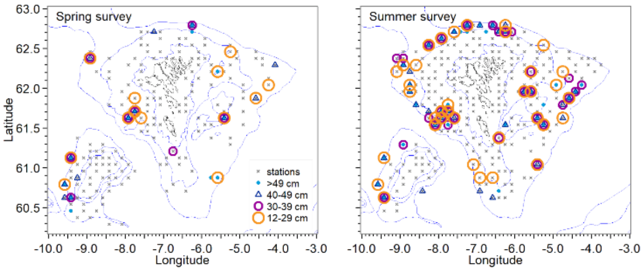


Figure 1. Greater forkbeard 5.b. Spatial distribution of greater forkbeard for all years together divided by size in the annual spring- and summer survey.

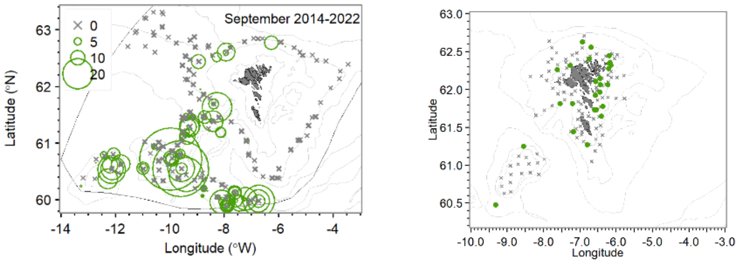


Figure 2. Greater forkbeard 5.b. Spatial distribution of (left) CPUE (kg/h) from the deepwater surveys in September 2014- 2022 (no survey in 2021) and (right) positions of 8-54 mm long greater forkbeard caught pelagic in the 0-group survey in June/July (1983-2022).

Data available

Data available from different surveys in Faroese waters is presented in Table 1. A standardized CPUE is available from the annual spring- and summer surveys on the Faroe Plateau. There are also some data from the deepwater survey and Greenland halibut survey.

Table 1. Greater forkbeard 5.b. Sampling overview from different surveys around the Faroes.

year	length	round weight	gutted weight	gender	maturity	otoliths	aged	gonad	stomach
1994	3	2							
1995	27	5							
1996	26	2							
1997	7	2							
1998	17	2							
1999	27	25							
2000	46	46							
2001	101	86							
2002	55	53							
2003	21	21							
2004	47	47							
2005	24	24							
2006	17	17							
2007	15	15							
2008	13	13							
2009	81	81							
2010	110	109							

2011	92	92							
2012	99	99							
2013	133	117							
2014	257	255	23	37	37	36		2	1
2015	131	130	16	27	27	27			1
2016	89	89	15	18	18	18			
2017	108	108	6	11	11	11			1
2018	96	96		1	1	1			
2019	50	50		7	7	7			
2020	31	31							
2021	36	32		3	3	3			3
2022	39	39		9	9	9		2	2
2023	23	23							
Total	1821	1711	60	113	113	112	0	4	8

Length composition

Annual length-frequency distribution of greater forkbeard from the Faroese groundfish surveys (very few individuals see appendix 4 and 5) and Faroese deep-water surveys for the period 2014-2022 are presented in Figure 3.

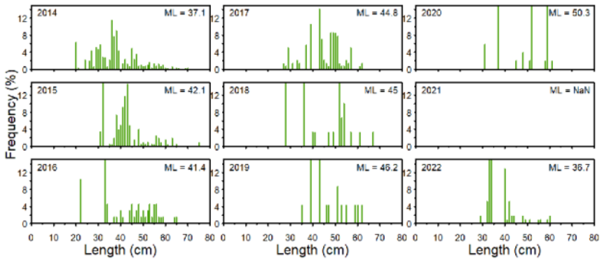


Figure 3. Greater forkbeard 5.b. Length-frequency distribution from the deepwater survey in 2014-2022 (no survey in 2021).

Length-weights

Round weight at length from all surveys showed that 40 cm greater forkbeard was around 0.5 kg and 50 cm around 1.0 kg (Figure 4).

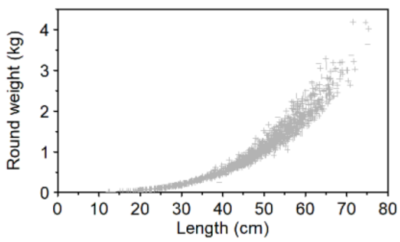


Figure 4. Greater forkbeard 5.b. Length- round weight relation from different surveys.

Catch, effort and research vessel data

Abundance index of greater forkbeard from the annual Faroese groundfish surveys covering the Faroe Plateau is presented in Table 2 and Figure 5.

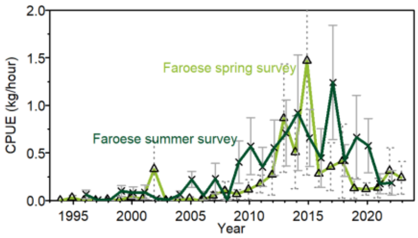
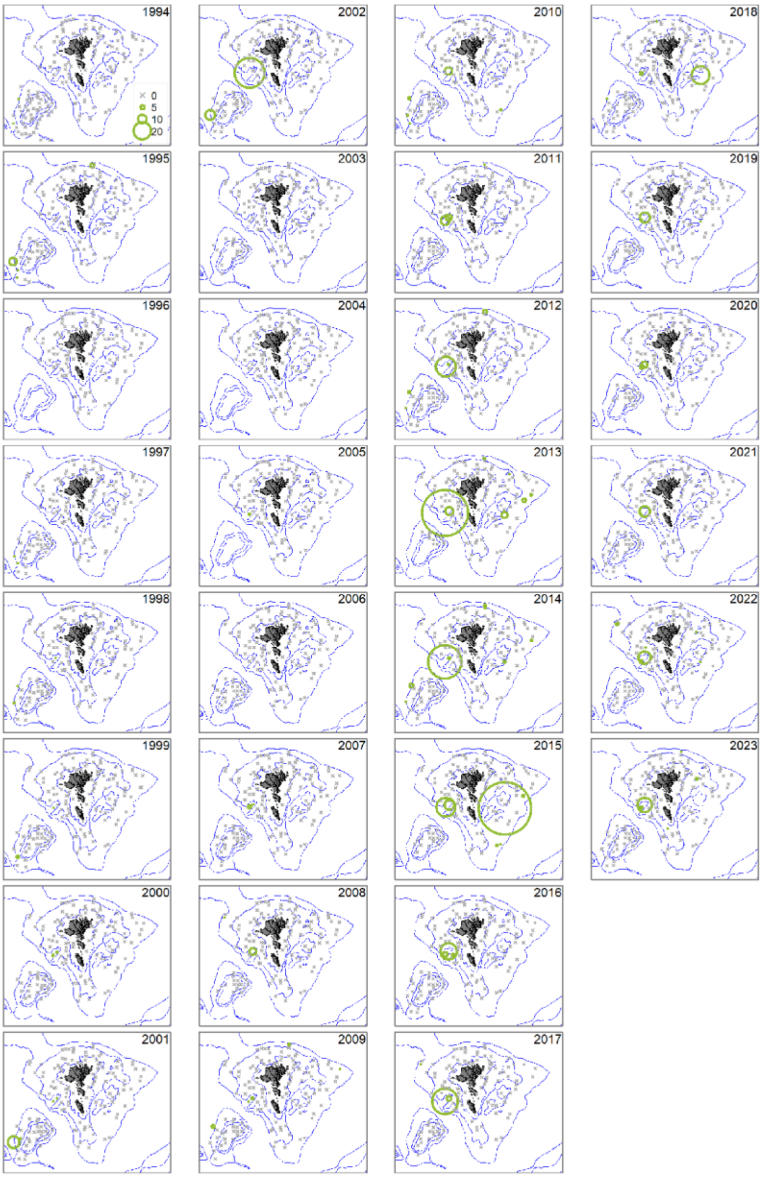


Figure 5. Greater forkbeard 5.b. Standardized cpue (kg/hour) from the Faroese spring- and summer groundfish survey.

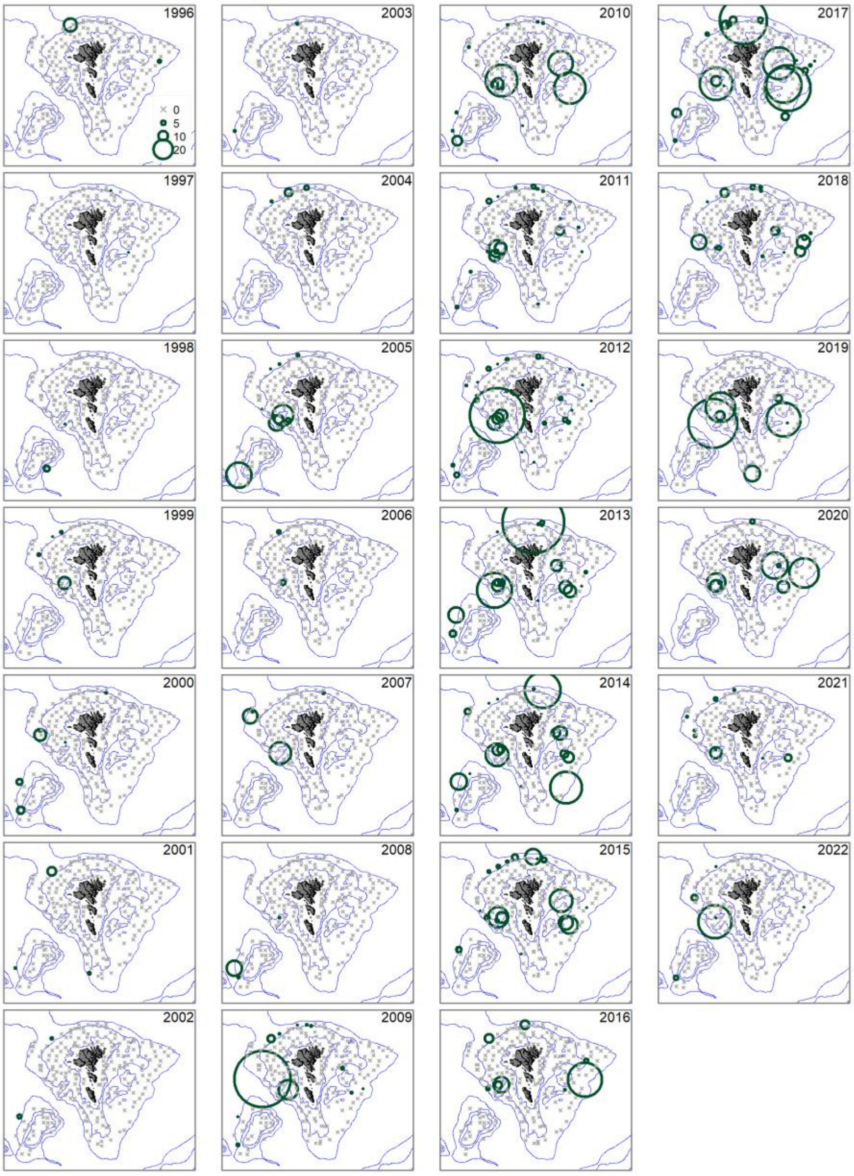
Table 2. Greater forkbeard 5.b. Standardized cpue from Faroe Plateau spring- and summer surveys. N- number of hauls, SE- standard error.

	Spring survey		Summer survey	
year	cpue	se	cpue	se
1994	0.00	0.00		
1995	0.03	0.02		
1996	0.00	0.00	0.06	0.04
1997	0.00	0.00	0.01	0.01
1998	0.01	0.01	0.00	0.00
1999	0.00	0.00	0.10	0.06
2000	0.04	0.02	0.08	0.06
2001	0.02	0.01	0.09	0.07
2002	0.33	0.30	0.02	0.02
2003	0.00	0.00	0.01	0.01
2004	0.00	0.00	0.06	0.04
2005	0.02	0.02	0.22	0.08
2006	0.00	0.00	0.05	0.04
2007	0.05	0.04	0.23	0.16
2008	0.10	0.09	0.01	0.00
2009	0.06	0.05	0.40	0.22
2010	0.12	0.11	0.57	0.30
2011	0.18	0.09	0.35	0.21
2012	0.27	0.21	0.56	0.29
2013	0.86	0.57	0.71	0.35
2014	0.51	0.38	0.92	0.61
2015	1.47	1.21	0.66	0.30
2016	0.28	0.14	0.45	0.31
2017	0.36	0.25	1.24	0.60
2018	0.41	0.39	0.42	0.17
2019	0.13	0.11	0.66	0.44
2020	0.12	0.06	0.58	0.28
2021	0.13	0.10	0.18	0.11
2022	0.26	0.24	0.19	0.13
2023	0.27	0.17		

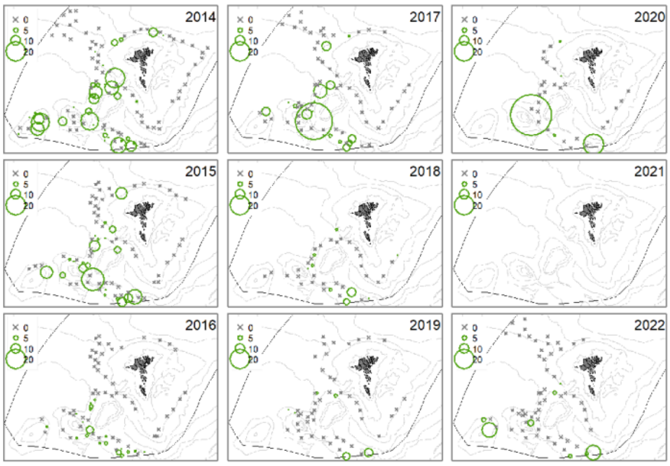
Appendix



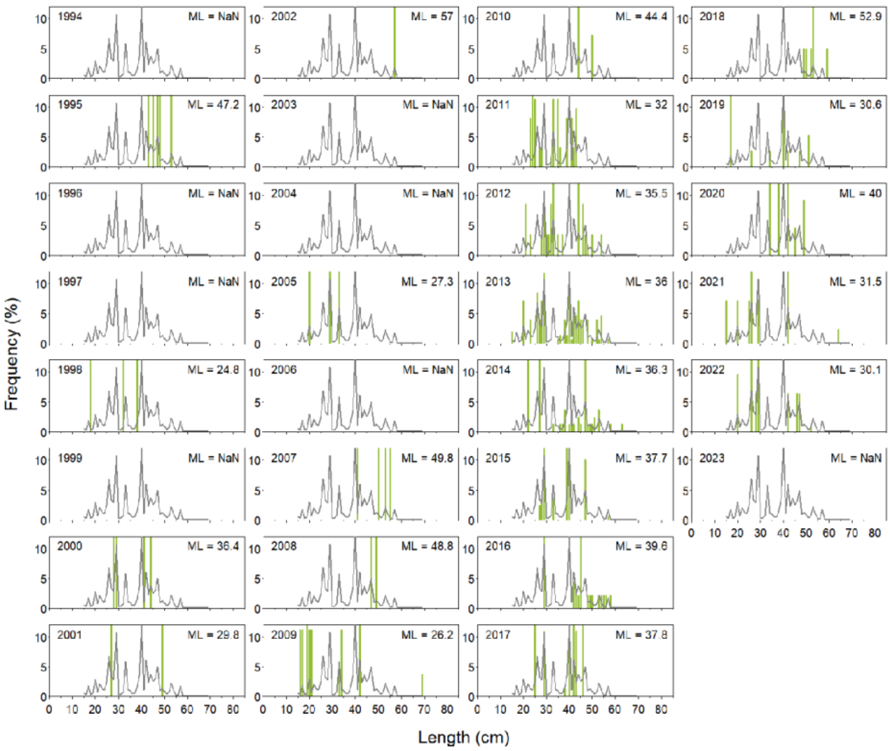
Appendix 1. Greater forkbeard 5.b. Spatial distribution (kg/hour) in the spring survey in February/March.



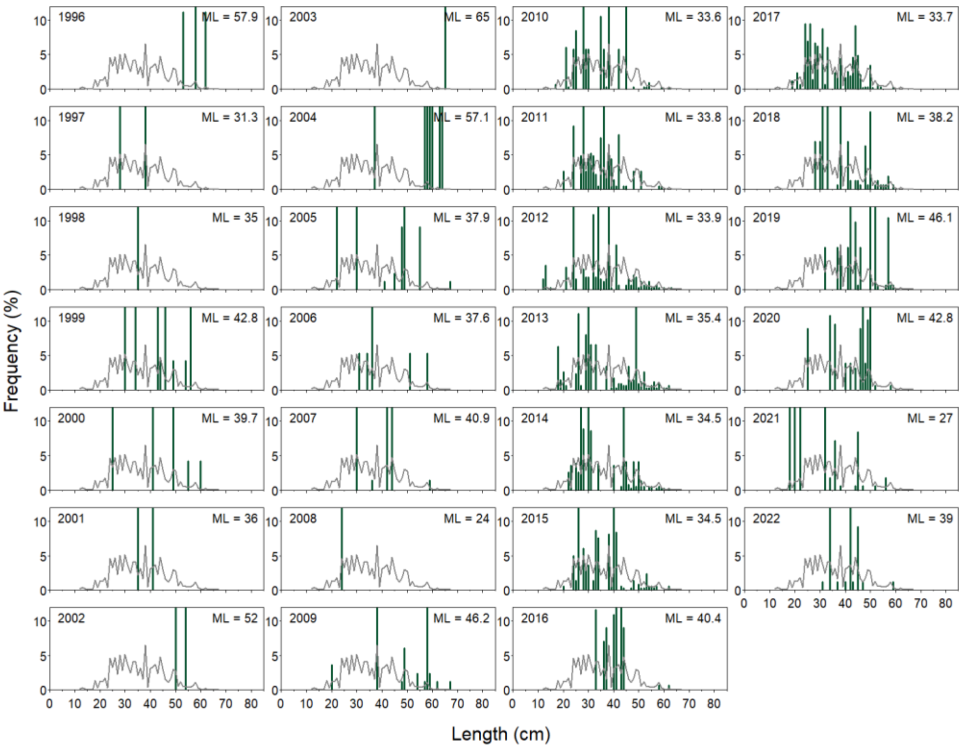
Appendix 2. Greater forkbeard 5.b. Spatial distribution (kg/hour) in the summer survey in August.



Appendix 3. Greater forkbeard 5.b. Spatial distribution (kg/hour) in the deepwater survey in September. No survey in 2021.



Appendix 4. Greater forkbeard 5.b. Length distribution in the spring survey in February/March.



Appendix 5. Greater forkbeard 5.b. Length distribution in the summer survey in August.

WD02 ICES WGDEEP 2023

Black scabbard fish in Faroese waters (27.5.b).

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Introduction

The objective for this document is to provide information on black scabbard fish in Faroese waters (27.5.b).

The fishery

The black scabbard fish fishery in Faroese waters are managed by licences. Since 2013, only one trawler has had licence to fish black scabbard fish as a targeted species. This particular trawler was sold in 2022. In the black scabbard fishery, the commercial trawler used a star trawl with 486 meshes, 160 mm. Mesh size in the net was 80 mm. The usual fishing depth varied between 600-1000 m and the trawling hours varied between six to eight hours, but may last less if the species was very abundant.

The main fishing areas of black scabbard fish in Faroese waters are located on the slope around the Faroe Bank and on the Wyville-Thomsen ridge close to the southernmost Faroese EEZ boarder (Figure 1, Appendix 1).

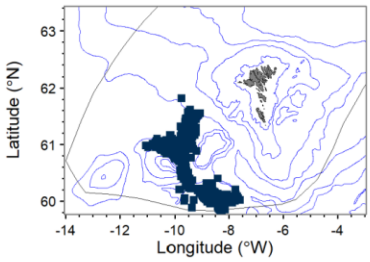

Figure 1. Black scabbard fish 5.b. Spatial distribution of the Faroese commercial trawl fishery of black scabbard fish 2000-2022.

Landings

The mean landings of black scabbard fish in Faroese waters from 1989 to 2018 were 569 t (Figure 2). The highest landings of around 1600-1800 t were in 2002, 2003 and 2008. The preliminary catch data for 2022 showed that the Faroese landings were 13.2 t in 5b2 and 2.9 t in 5b1. French catch was 6.26 t in 5.b.

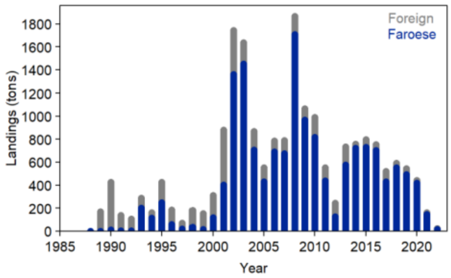

Figure 2. Black scabbard fish 5.b. Nominal landings in Faroese waters.

Spatial distribution

The spatial distribution of black scabbard fish from the deepwater surveys was mainly on the slope north of the Faroe Bank/Bill Bailey bank (Figure 3), which are the main fishing areas. A closer look at different surveys showed that black scabbard fish was only caught in the area north-west of the Faroes and never caught on the Faroe Plateau (Figure 4).

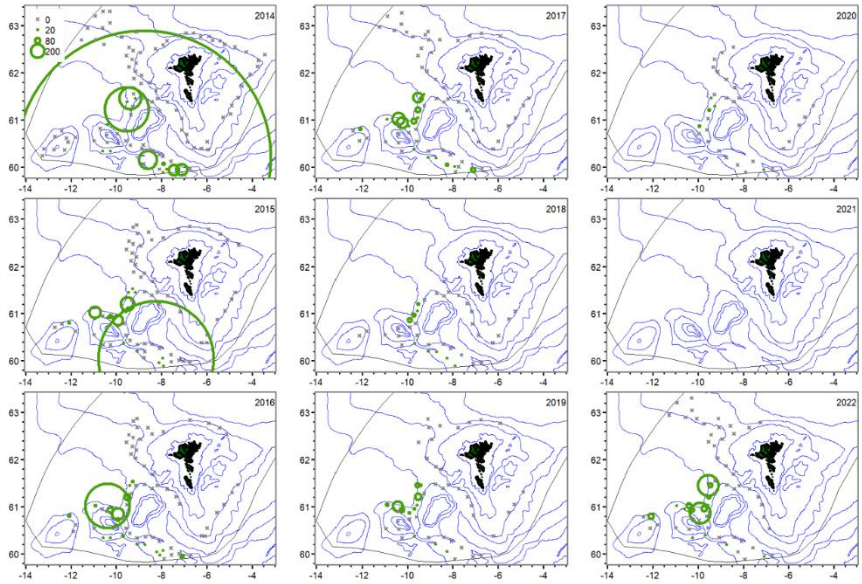

Figure 3. Black scabbard fish 5.b. Spatial distribution of CPUE (kg/h) from the deepwater surveys in 2014-2022 (no survey in 2021).

Length distribution

Annual length-frequency distribution of the Faroese landings data and Faroese deep-water surveys for the period 2014-2022 are presented in Figure 4. The mean length of black scabbard fish in the catches was around 90-92 cm, which is about the same mean length as in the deep-water survey (Figure 4). Numbers of black scabbard fish sampled from the landings and in the deep-water surveys are presented in Table 1. All the sampled fish in the deepwater survey was immature.

Table 1. Black scabbard fish 5.b. Number of fish sampled from the commercial trawler and from the deepwater surveys. * Blue ling survey in April 2018.

	Landings		Deep-water surveys					
Year	Lengths	Weights	Lengths	Round weights	Gender	Maturity	Otoliths	Stomachs
2014	575		4477	785	150	150	150	8
2015	1475		2117	389	78	78	78	9
2016	7603	5077	1271	459	94	94	94	11
2017	4984	4983	874	574	118	118	118	31
2018	4193	4143	598	217	64	64	64	8
2018*			94	94	13	13	13	4
2019	4515	4515	557	483	132	132	132	10
2020	4476	4476	91	67	19	20	20	1
2021	2012	2012	-					
2022	-		1278	474	107	107	107	9

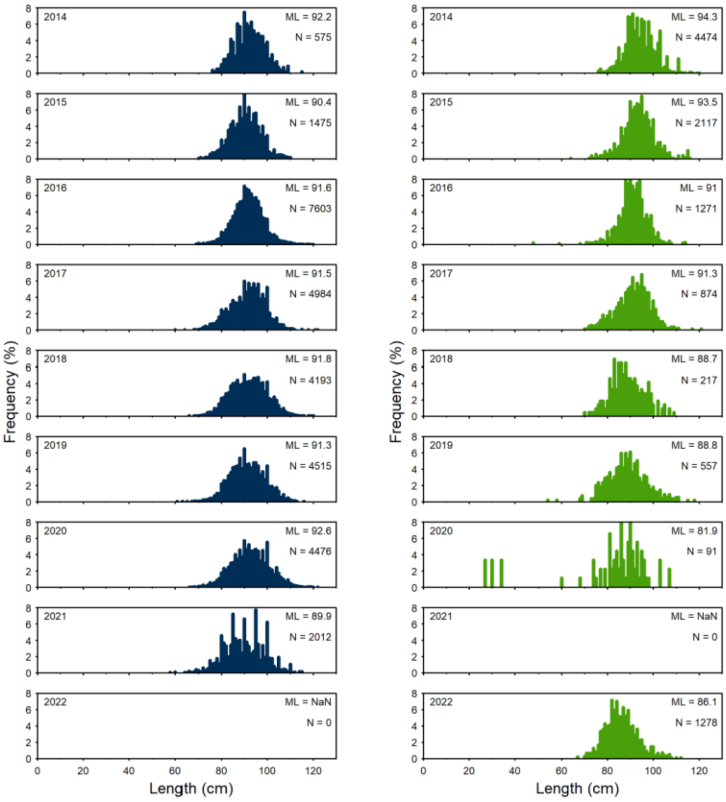

Figure 4. Black scabbard fish 5.b. Length-frequency distribution for the period 2014-2022 from the landings (no samples in 2022) (left) and the deep-water survey (no survey in 2021) (right).

Length-weights

Comparing mean weight at length from the commercial trawler with the deep-water survey showed that the data are similar (Figure 5). Black scabbard fish of 70 cm length had a round weight around 0.4 kg, 100 cm was 1.5 kg; and the largest fish was 114 cm and 2.4 kg.

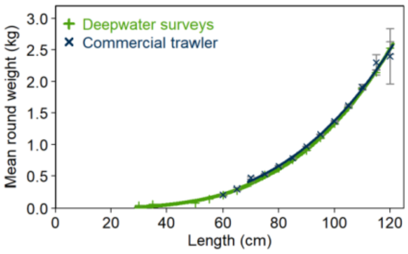

Figure 5. Black scabbard fish 5.b. Length-weight relation comparison between the landings (blue) and the deep-water survey (green).

Commercial cpue

In 2022, the commercial trawler that had a fishery licence for black scabbardfish was sold. This trawler had only 8 black scabbardfish hauls in 2022, so the CPUE-data are not presented. A map of the fishery area is presented in Figure 6.

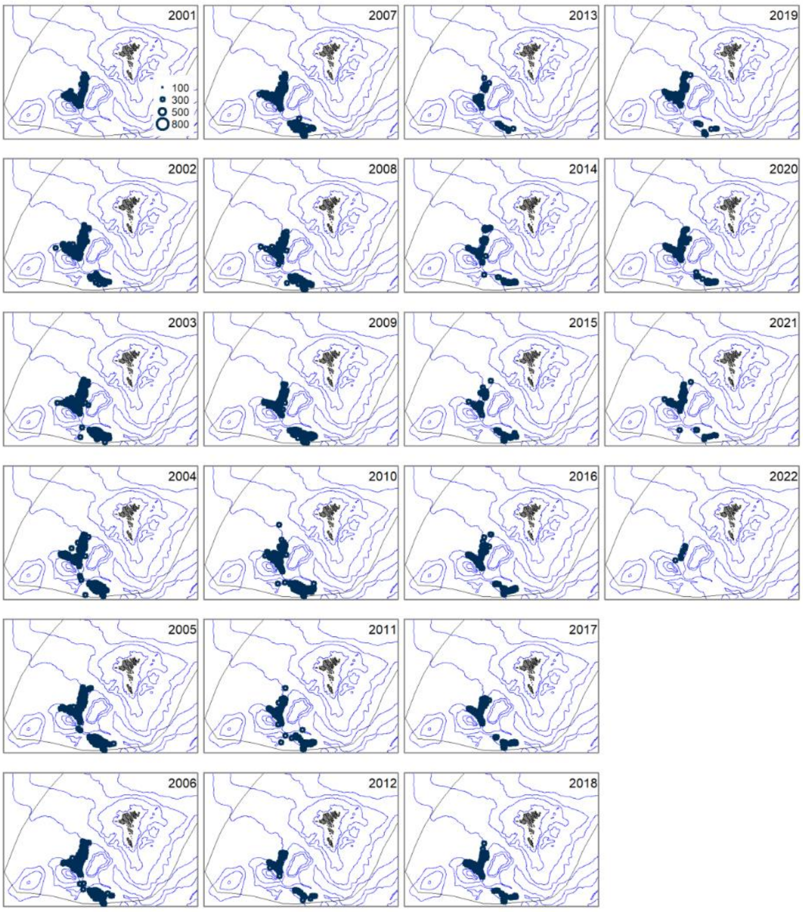

Figure 6. Black scabbard fish 5.b. Spatial distribution (kg/hour) in the commercial trawl fishery per year. Only hauls with more than 30% black scabbard fish of the total catch.

WD03 ICES WGDEEP 2023

Roundnose grenadier in Faroese waters (27.5.b).

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Introduction

The objective for this document is to provide information on roundnose grenadier in Division 27.5.b.

Landings

The landings in Faroese waters (ICES Division 27.5.b) are showed in Table 1.

Table 1. Roundnose grenadier 5.b. Nominal landings in Faroese waters.

Year	Faroes	France	Norway	Germany	Russia	UK (E+W)	UK (Scot.)	Total
1988				1				1
1989	20	181		5	52			258
1990	75	1470		4				1549
1991	22	2281	7	1				2311
1992	551	3259	1	6				3817
1993	339	1328		14				1681
1994	286	381		1				668
1995	405	818						1223
1996	93	983		2				1078
1997	53	1059						1112
1998	50	1617						1667
1999	104	1861	2			29		1996
2000	48	1699		1		43		1791
2001	84	1932						2016
2002	176	774				81		1031
2003	490	1032				10		1532
2004	508	985			6		76	1575
2005	903	884	1		1		48	1837
2006	900	875						1775
2007	838	862						1700
2008	665	447						1112
2009	322	122					2	446
2010	229	381					1	611
2011	63	11						74
2012	16	28						44
2013	24	36						60
2014	33	44						77
2015	24	28						52
2016	30	7						38
2017	9	21						30
2018	0	6						6
2019	19	11						30
2020	20	13						33
2021	12	10						22
2022*	0.732	5.967	0.509				0.345	7.553

Information from deepwater surveys

Overview of the roundnose grenadier sampling from the deepwater surveys in September are showed in Table 2. The mean lengths in the surveys were between 14.8- 17.5 cm (Figure 1). The length- round weight relation is presented in Figure 2. The spatial distribution was mainly on the Wyville-Thomsen ridge (Figure 3).

An investigation of the roundnose grenadier catch according to depth and temperature data showed that roundnose grenadier were distributed in depths deeper than around 600 m and temperatures warmer than 6°C. This is in accordance with the oceanic temperature and depth distribution in Faroese waters.

Table 2. Roundnose grenadier 5.b. Sampling overview from the deepwater survey (no survey in 2021).

Year	Lengths	Round weights	Gender	Maturity	Otoliths	Liver weights	Gonad weights	Stomachs
2014	209	186	72	72	69		18	10
2015	166	103	40	40	40			11
2016	153	139	30	30	30			7
2017	234	174	52	52	52			23
2018	101	92	21	21	21			5
2019	80	80	28	28	25			8
2020	41	31	5	5	5			3
2021	-	-	-	-	-	-	-	-
2022	143	140	46	46	46	11	14	12
Total	1127	945	294	294	288	11	32	79

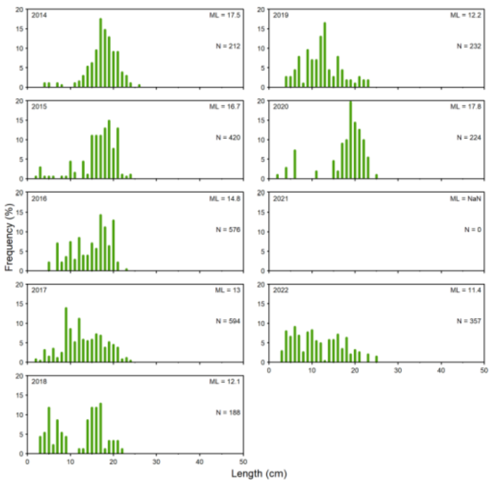

Figure 1. Roundnose grenadier 5.b. Length distribution in the deepwater surveys.

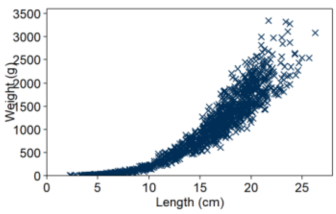

Figure 2. Roundnose grenadier 5.b. Length - round weight relation in the deepwater surveys.

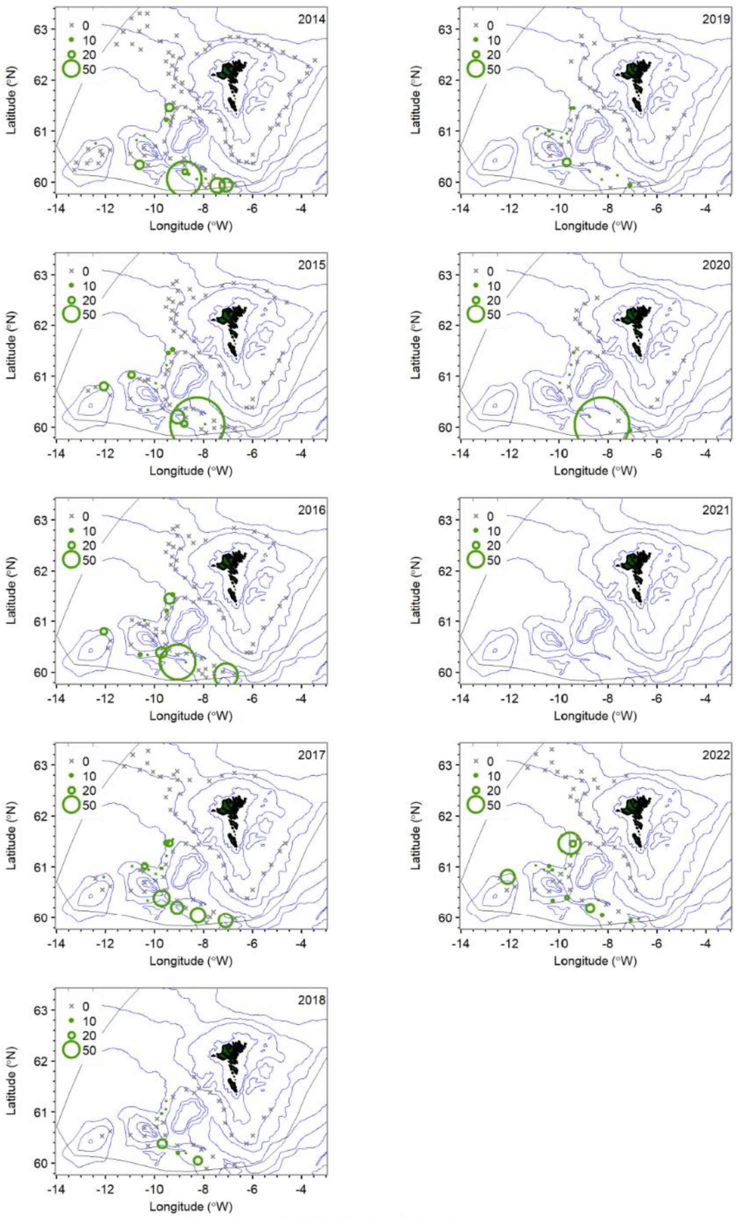

Figure 3. Roundnose grenadier 5.b. Spatial distribution in the deepwater surveys 2014-2022 (no survey in 2021).

WGDEEP 2022, WD xx

CPUE Standardization of Silver smelt in 5b and 6a @ WGDEEP 2022

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24/04/2023

Abstract

At the WKGSS 2020 benchmark of Greater silver smelt in 5b and 6a, a combined and standardized CPUE series for the Faroe and EU fleets has been introduced (Quirijns and Pastoors 2020). On checking the data in preparation for WGDEEP 2023, a few errors were detected in the way CPUE was calculated, which was proposed as a correction for the assessment in WGDEEP 2023. These relate to 1. the rounding of CPUE values as the model fitted is a negative binomial (small impact) 2. the introduction of smoothers for the week and depth effect rather than fitting them as independent covariates througout 3. the introduction of a fleet effect to account for a mis-balance in data availability througout the time-series with almost an absence of PFA data in the early part of the time-series where Faroese data was availabe. Furthermore, the method applied in WGDEEP 2023 has been extended to cover the whole time series up to 2022.

It is noted that the signals in the two separate CPUE series are somewhat different in the most recent year, with a decline observed in the Faroese CPUE and an increase observed in the PFA CPUE.

1 Introduction

At the WKGSS 2020 benchmark of Greater silver smelt in 5b and 6a, a combined and standardized CPUE series for the Faroe and EU fleets has been introduced (Quirijns and Pastoors 2020).

2 Results

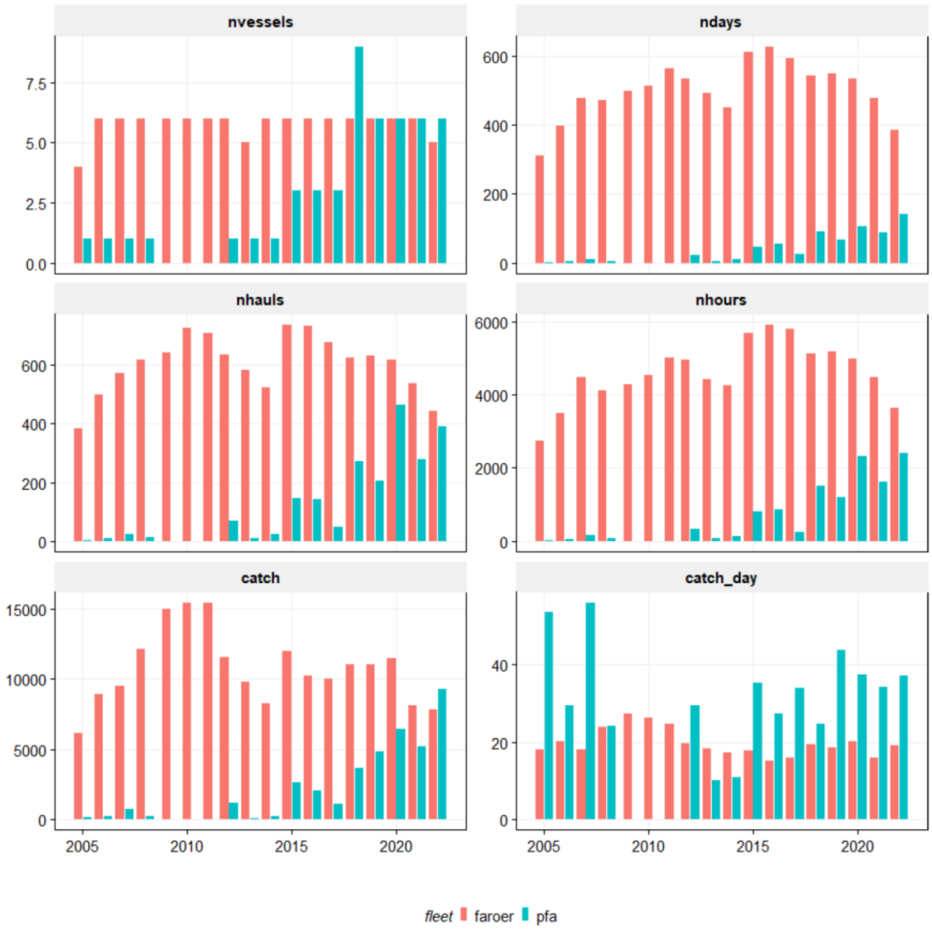


Figure 1: ARU.27.5b6a metrics describing the fisheries

The 'raw' (unstandardized) CPUE is based on the catch per day.

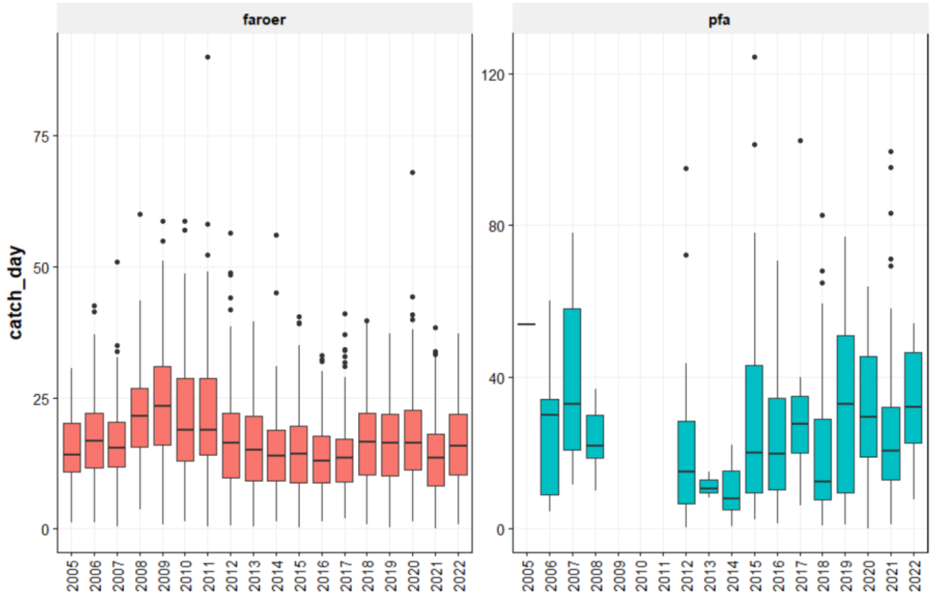


Figure 2: ARU.27.5b6a Catch per unit effort.

For the years 2005-2022, below are the spatial distributions of the used number of hauls by fleet.

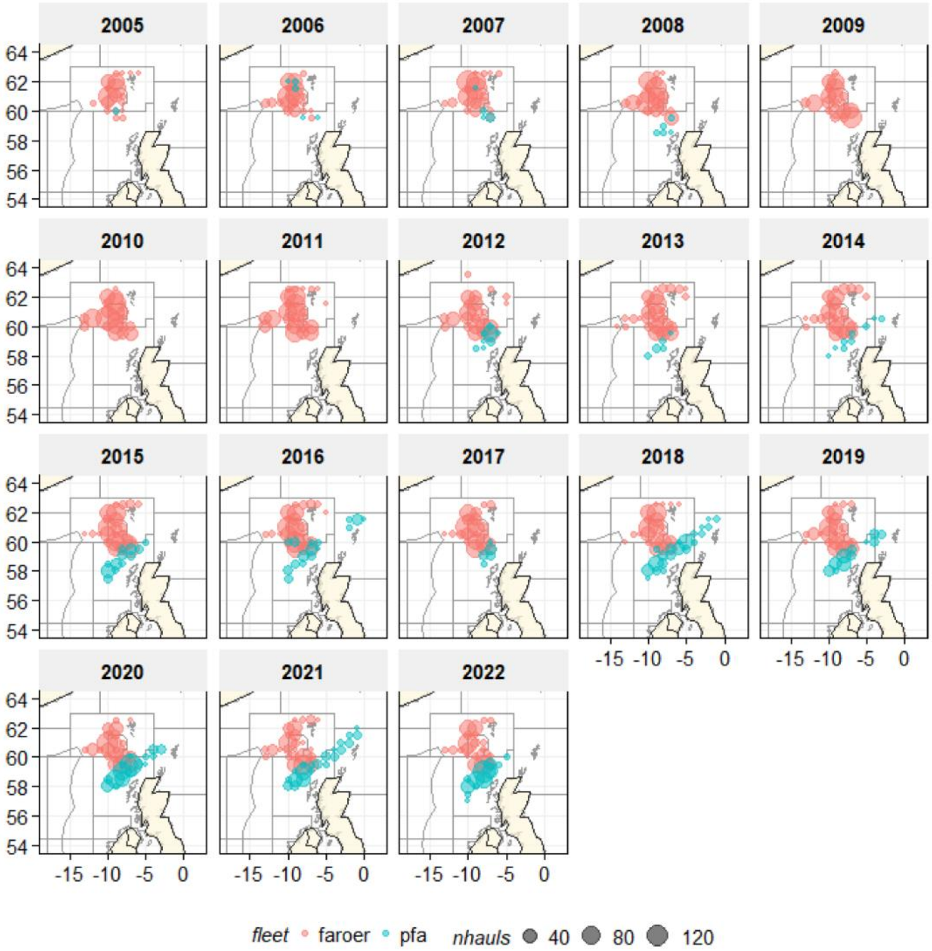


Figure 3: ARU.27.5b6a plot of the number of hauls by rectangle and day

Standardized CPUE index

We applied un updated model for standardization of of CPUE: CPUE ~ year + s(week) + s(depth) + fleet, where CPUE is expressed as catch per day and per rectangle. Catches have first been summed by vessel, year, week and rectangle and the number of hauls and fishing days have been calculated. Then the catches and effort (fishing days) have been summed over all vessels by year, week, fleet and the average depth has been calculated. CPUE was then calculated as the average catch per rectangle and per day by fleet.

The differences in modelling approach are shown below where we compare the model setup used in WGDEEP 2022 with the glm and gam approach.

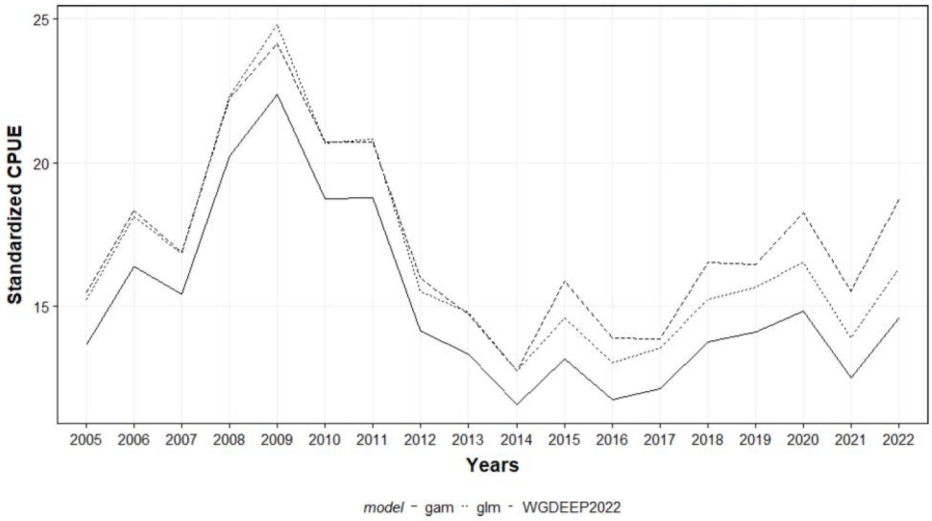


Figure 5: ARU.27.5b6a comparison of standardized CPUE between WGDEEP 2022 and updated model settings

Not only a scaling is visible, but also a change in trend from around 2015 onwards.

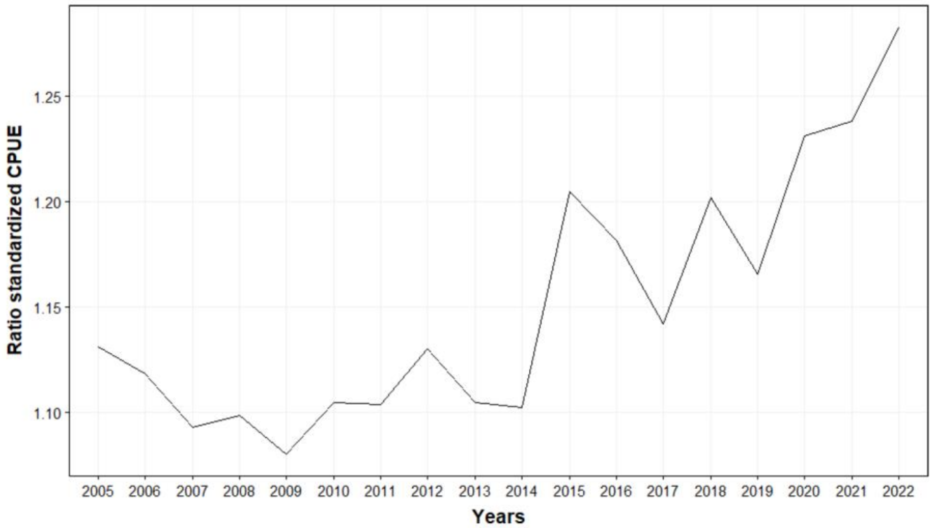


Figure 6: ARU.27.5b6a ratio between WGDEEP 2022 and updated standardized CPUE model settings

Finally, the comparison of the WGDEEP 2022 and WGDEEP 2023 time-series is presented.

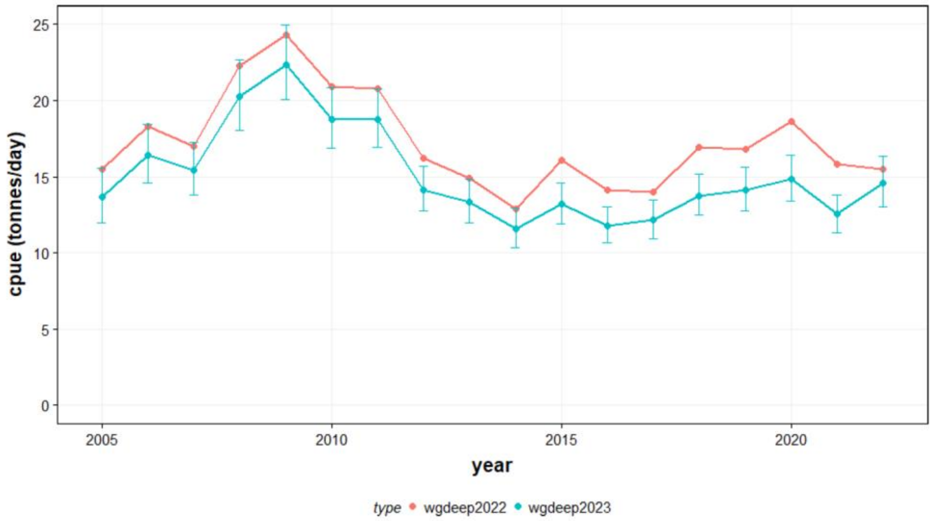
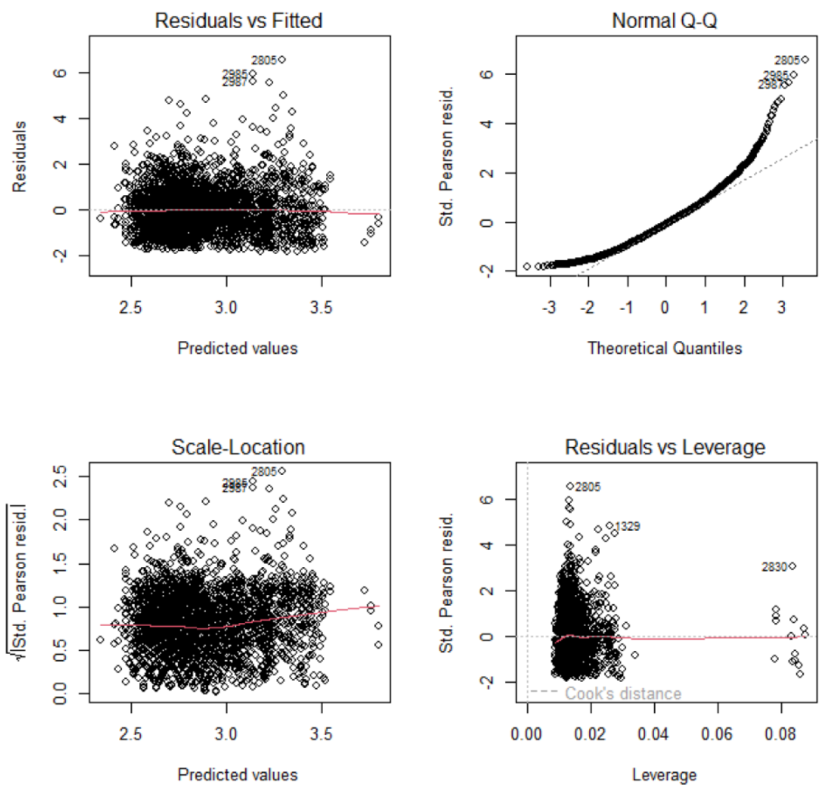


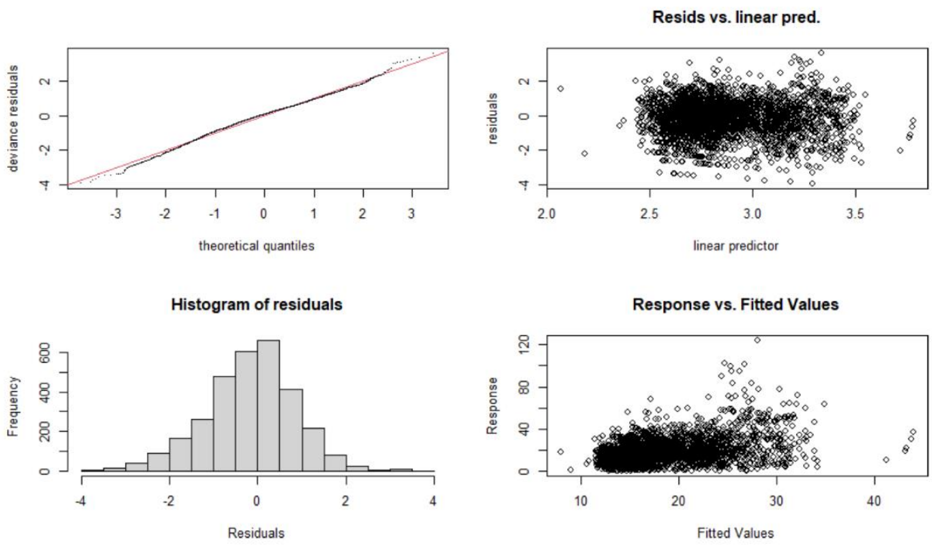
Figure 4: ARU.27.5b6a standardized CPUE (catch per rectangle and day), in comparison with WKGSS series

Model diagnostics




```
Analysis of Deviance Table

Model: Negative Binomial(3.7212), link: log

Response: get(cpuevar)

Terms added sequentially (first to last)

          Df Deviance Resid. Df Resid. Dev Pr(>Chi)
NULL                       3064     3823.0
fyear     17  201.071      3047     3621.9  < 2e-16 ***
fweek     19  160.783      3028     3461.1  < 2e-16 ***
depth_cat  6   11.277      3022     3449.8  0.08017 .
fleet      1  191.585      3021     3258.3  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 7a: ARU.27.5b6a standardized CPUE GLM model diagnostics




```
Method: UBRE   Optimizer: outer newton
full convergence after 5 iterations.
Gradient range [3.912368e-11,1.592991e-10]
(score 0.0805767 & scale 1).
Hessian positive definite, eigenvalue range [0.0002822595,0.0006414133].
Model rank =  37 / 37

Basis dimension (k) checking results. Low p-value (k-index<1) may
indicate that k is too low, especially if edf is close to k'.

           k'  edf k-index p-value
s(week)  9.00 6.16    0.82  <2e-16 ***
s(depth) 9.00 3.85    0.89  <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 7b: ARU.27.5b6a standardized CPUE GAM model diagnostics

Evaluation of explanatory variables

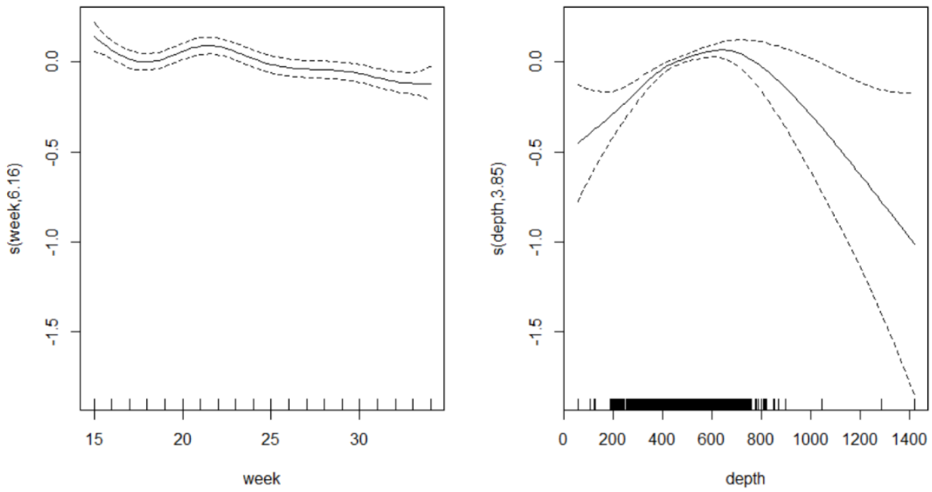


Figure 8: ARU.27.5b6a standardized CPUE explanatory variables

year	cpue	lwr	upr
2005	15.21	13.02	17.78
2006	18.13	15.67	20.97
2007	16.84	14.63	19.38
2008	22.31	19.37	25.69
2009	24.78	21.56	28.48
2010	20.69	18.06	23.72
2011	20.81	18.22	23.77
2012	15.53	13.61	17.73
2013	14.78	12.92	16.92
2014	12.76	11.1	14.66
2015	14.59	12.81	16.62
2016	13.04	11.46	14.84
2017	13.56	11.87	15.49
2018	15.23	13.38	17.34
2019	15.66	13.75	17.84
2020	16.52	14.48	18.85
2021	13.91	12.21	15.84
2022	16.33	14.19	18.79

Table 1: ARU.27.5b6a standardized (GLM) commercial CPUE (tonnes/day) for greater silversmelt, with lower and upper values based on the standard error.

year	cpue	lwr	upr
2005	13.66	11.97	15.59
2006	16.39	14.57	18.43
2007	15.43	13.79	17.25
2008	20.23	18.07	22.65
2009	22.36	20.05	24.94
2010	18.75	16.85	20.87
2011	18.76	16.92	20.79
2012	14.14	12.75	15.68
2013	13.33	11.97	14.84
2014	11.57	10.34	12.94
2015	13.18	11.91	14.58
2016	11.77	10.66	12.99
2017	12.14	10.95	13.46
2018	13.75	12.48	15.15
2019	14.12	12.77	15.61
2020	14.84	13.4	16.43
2021	12.53	11.35	13.83
2022	14.58	13.01	16.33

Table 2: ARU.27.5b6a standardized (GAM) commercial CPUE (tonnes/day) for greater silversmelt, with lower and upper values based on the standard error.

Single fleet analysis

A single fleet analysis was carried out by using the combined raw CPUE datasets and extracting the separate parts for the Faroese and PFA fleets. These data were then processed in a similar fashion as in the combined analysis. It is clear that the Faroese data is substantially more precise that the data from PFA as evident from the confidence intervals. This is likely due to the number of observations, where the dataset from Faroe Islands over all years is based on 10 times the number of hauls compared to the PFA data. In addition, the Faroese fishery is a targeted fishery for silver smelt, while the PFA fishery is a mixed fishery with blue whiting in the daytime and silver smelt in the nighttime.

It is noted that the signals in the two separate CPUE series are somewhat different in the most recent year, with a decline observed in the Faroese CPUE and an increase observed in the PFA CPUE.

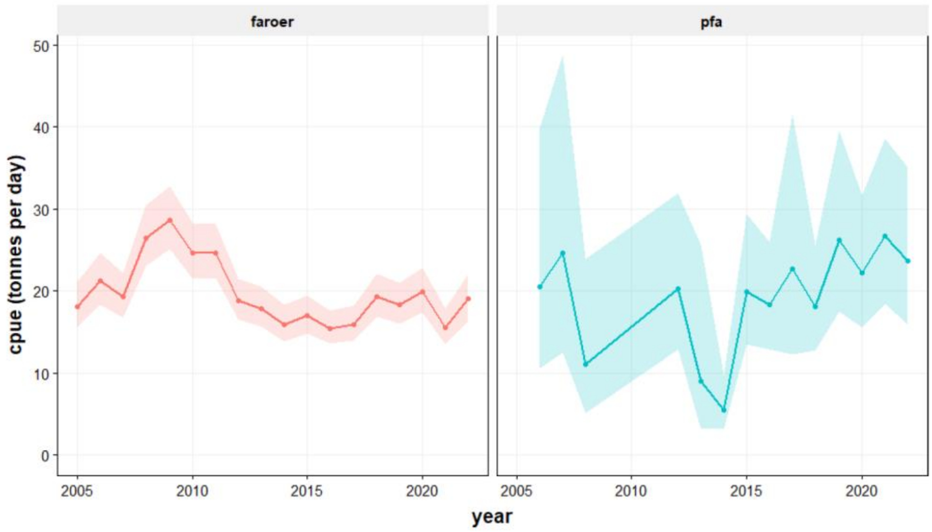


Figure 9: ARU.27.5b6a standardized single fleet CPUE (catch per rectangle and day)

3 Discussion

CPUE standardization using GAM procedures is a common way of dealing with CPUE information. Here we used aggregated data (catch per day) as the main response variable and year, week, depth and fleet as explanatory variables. Both area and period cannot use attributes that are related to the hauls. The standardized CPUE for WGDEEP 2023 shows a marked departure from WGDEEP 2022 time-series owing to the changes in the methodology described above.

Both data sources (Faroese data and PFA data) indicate an increase in CPUE in the last year again after a dip in 2021, although it does not reach the level seen in the late 2000s. The data from the Faroese fisheries are generated from a targetted fishery on silver smelt, while the data from the PFA is from a mixed fishery with blue whiting (blue whiting in the daytime, silver smelt in the nighttime). This probably leads to the higher uncertainties in the CPUE estimates for the PFA compared to the Faroese fleet. It is also noted that the number of observations in the PFA fisheries prior to 2015 is much lower than after 2015, because the self-sampling program only started in 2015.

It is noted that the signals in the two separate CPUE series are somewhat different in the most recent year, with an increase observed in the Faroese CPUE and a decrease observed in the PFA CPUE.

4 References

ICES (2020). Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP). ICES Scientific Reports. Volume 2, Issue 38: 928 pp.

Pastoors, M. A. and F. J. Quirijns (2020). Correcting an error in the CPUE Standardizing of Greater silversmelt for WGDEEP 2020, WD05.

Quirijns, F. J. and M. A. Pastoors (2020). CPUE standardization for greater silversmelt in 5b6a. WKGSS 2020, WD03.

PFA self-sampling report for WGDEEP 2023 (v1)

Niels Hintzen, 30/03/2023 22:24:52

Summary

This report summarizes the self-sampling data collected by the Pelagic Freezer-trawler Association (PFA) with a focus on Argentines or Silversmelts. The self-sampling data consists of two main sources: (1) the historical catch per haul data derived from a limited number private logbooks of skippers, and (2) the self-sampling program that has been initiated from 2015 onwards on an increasing number of freezer-trawlers.

The PFA fishery for argentines takes place in the months April and May, and sometimes into June. The predominant fishing area is ICES division 27.6.a with also some catches being taken in 2.a, 4.a and 5.b. The fishery is combined with the fishery for blue whiting, whereby the catches of blue whiting take place during the day and catch of argentines mostly in the night.

Overall, the self-sampling activities for the argentines fisheries during the years 2016 – 2023 covered 42 fishing trips with 1254 hauls, a total catch of 78562 tonnes and 67255 individual length measurements.

The length compositions of argentines are relatively stable over the years, varying between medians of 34 to 36 cm.

1 Introduction

The Pelagic Freezer-trawler Association (PFA) is an association that has nine member companies that together operate 19 freezer trawlers (in 2023) in six European countries (www.pelagicfish.eu). In 2015, the PFA has initiated a self-sampling program that expands the ongoing monitoring programs on board of pelagic freezer-trawlers by the specialized crew of the vessels. The primary objective of that monitoring program is to assess the quality of fish. The expansion in the self-sampling program consists of recording of haul information, recording the species compositions per haul and regularly taking random length-samples from the catch. The self-sampling is carried out by the vessel quality managers on board of the vessels, who have a long experience in assessing the quality of fish, and by the skippers/officers with respect to the haul information. The scientific coordination of the self-sampling program is carried out by Niels Hintzen (PFA chief science officer) with support of Lina de Nijs (PFA) and Floor Quirijns (contractor).

2 Overview of self-sampling methodology

The PFA self-sampling program has been incrementally implemented on freezer-trawler vessels from the Netherlands, UK, Germany, France, Poland and Lithuania during the years 2015-2017. From 2018 onwards, all vessels in the association are covered by the self-sampling program. The program is designed in such a way that it follows as closely as possible the working practices on board of the different vessels and that it delivers the biological and fisheries information needed for the relevant scientific bodies (e.g. ICES, SPRFMO, CECAF), certification bodies (e.g. MSC) and as a mechanism of feedback for the participating companies.

The following main elements can be distinguished in the self-sampling protocol:

- haul information (date, time, position, weather conditions, environmental conditions, gear attributed, estimated catch, optionally: species composition)
- batch information (total catch per batch=production unit, including variables like species, average size, average weight, fat content, gonads y/n and stomach fill)
- linking batch and haul information (essentially a key of how much of a batch is caught in which of the hauls)
- length information (length frequency measurements, either by batch or by haul)
- biological information (measuring individual fish)

The self-sampling information was initially collected using standardized Excel worksheets. From 2018 onwards a transition is being made from Excel spreadsheet to dedicated data-recording software (M-Catch) with live synchronization to a shore-based system. The information collected during a trip will be sent for data processing by the end of the trip. The self-sampling data is being checked and added to the database by Floor Quirijns and/or Martin Pastoors, who also generate standardized trip reports (using RMarkdown) which are being sent back to the vessel and company. The compiled data for all vessels is being used for specific purposes, e.g. reporting to expert groups, addressing specific fishery or biological questions and supporting detailed biological studies. The PFA publishes an annual report on the self-sampling program.

For this report, the PFA self-sampling data has been filtered for vessel-trip-week combinations using the following criteria:

- hauls in divisions 27.6.a; 27.5.b; 27.4.a
- catch of arg by trip and week at least 10% of the total catch of that trip and week.
- catch of arg by trip and week at least 10 tonnes.

The selection resulted in 99 vessel-trip-week combinations over the years 2016-2022.

A particular challenge in the PFA self-sampling program is dealing with the different length metrics in use. Routinely, on freezer-trawlers, fish will be measured in standard length (SL, until the onset of the tail of the fish). However, for scientific purposes, length is required mostly in total length (TL), or, in the case of the South Pacific RFMO, in fork length (FL). The PFA self-sampling program aims to utilize the appropriate scientific length metric: TL in Europe and Africa, FL in the South Pacific. However, in some instances, the quality managers on board of the vessels have used the wrong length metric for the area they were fishing in. Until 2021, these situations were 'corrected' by applying a direct length-to-length conversion based on data from individual measurements of SL, FL and TL. It was recognized that this approach could lead to holes in the length distributions.

In 2022 a new method of converting length-to-length was implemented, based on the paper by Hansen et al (2018). The method consists of generating simulated length-length-keys similar to the often used age-length-keys. The implementation of the new method means to some differences may exist in length data compared to previous reports.

3 Results

3.1 General

An overview of all the self-sampled trips for arg in 27.6.a, 27.5.b, 27.4.a. The percentage non-target species is defined as the catch of non-pelagic species relative to the catch of pelagic species.

year	nvessels	ntrips	ndays	nhauls	catch	catch/day	nontarget	nlength	nbio
2016	2	2	30	65	3,980	133	3.28%	5,478	0
2017	3	3	33	90	7,464	226	1.23%	6,150	0
2018	7	7	67	172	8,426	126	1.79%	10,931	509
2019	6	7	48	118	10,792	225	0.06%	7,450	7
2020	7	9	104	288	15,342	148	0.53%	14,258	131
2021	5	6	59	139	10,704	181	0.74%	6,607	102
2022	6	8	148	382	21,855	148	1.58%	16,381	16
(all)		42	489	1,254	78,563			67,256	765

Table 3.1.1: PFA deepwater fisheries for argentines. Self-sampling Summary of number of vessels, trips, days, hauls, catch (tonnes), catch per day(tonnes/day), percentage non-target species, number of fish measured and number of biological samples

Catch and number of self-sampled hauls by year and division

division	2016	2017	2018	2019	2020	2021	2022	all	perc
27.6.a	3,980	7,464	8,426	10,792	15,342	10,704	21,855	78,563	100.0%
(all)	3,980	7,464	8,426	10,792	15,342	10,704	21,855	78,563	100.0%

division	2016	2017	2018	2019	2020	2021	2022	all	perc
27.6.a	65	90	172	118	288	139	382	1,254	100.0%
(all)	65	90	172	118	288	139	382	1,254	100.0%

*Table 3.1.2: PFA deepwater fisheries for argentines. Self-sampling Summary of catch (top) and number of hauls (bottom) per year and division. * denotes incomplete year*

Catch and number of self-sampled hauls by year and month

month	2016	2017	2018	2019	2020	2021	2022	all	perc
Apr	0	596	2,316	3,557	9,600	3,669	14,048	33,786	43.0%
May	3,033	6,868	6,110	7,234	4,522	7,035	7,807	42,610	54.2%
Jun	946	0	0	0	1,146	0	0	2,092	2.7%
Oct	0	0	0	0	75	0	0	75	0.1%
(all)	3,980	7,464	8,426	10,792	15,342	10,704	21,855	78,563	100.0%

month	2016	2017	2018	2019	2020	2021	2022	all	perc
Apr	0	4	50	33	143	39	247	516	41.1%
May	54	86	122	85	119	100	135	701	55.9%
Jun	11	0	0	0	19	0	0	30	2.4%
Oct	0	0	0	0	7	0	0	7	0.6%
(all)	65	90	172	118	288	139	382	1,254	100.0%

Table 3.1.3: PFA deepwater fisheries for argentines. Self-sampling summary of catch (top) and number of hauls (bottom) per year and month.

Catch and number of self-sampled hauls by year and country (flag)

flag	2016	2017	2018	2019	2020	2021	2022	all	perc
DEU	1,832	0	2,054	3,617	2,711	1,095	1,350	12,659	16.1%
LIT	0	0	0	0	75	0	0	75	0.1%
NL	2,148	7,464	6,372	7,175	12,556	9,610	20,504	65,830	83.8%
(all)	3,980	7,464	8,426	10,792	15,342	10,704	21,855	78,563	100.0%

flag	2016	2017	2018	2019	2020	2021	2022	all	perc
DEU	27	0	59	46	74	27	44	277	22.1%
LIT	0	0	0	0	7	0	0	7	0.6%
NL	38	90	113	72	207	112	338	970	77.4%
(all)	65	90	172	118	288	139	382	1,254	100.0%

Table 3.1.4: PFA deepwater fisheries for argentines. Self-sampling summary of catch (top) and number of hauls (bottom) per year and month.

Catch by species and year

species	english_name	scientific_name	2016	2017	2018	2019	2020	2021	2022	all	perc
whb	blue whiting	Micromesistius poutassou	2,234	5,030	5,082	6,792	9,116	6,093	11,963	46,310	58.9%
arg	argentines	Argentina spp	1,580	2,248	3,013	3,899	5,946	4,398	9,416	30,501	38.8%
mac	mackerel	Scomber scombrus	15	94	179	95	199	132	131	846	1.1%
hke	hake	Merluccius merluccius	113	89	125	3	39	50	277	696	0.9%
sqr	squid	Loligo vulgaris	0	0	4	0	15	5	47	72	0.1%
mcd	NA	Ceratoscopelus maderensis	0	0	0	0	11	18	2	31	0.0%
hom	horse mackerel	Trachurus trachurus	19	0	1	0	0	1	0	21	0.0%
sqm	Broadtail shortfin squid	Illex coindetii	0	0	0	0	0	4	15	19	0.0%
mzz	other fish	Osteichthyes	0	0	19	0	0	0	0	19	0.0%
boc	boarfish	Capros aper	18	0	0	0	0	0	0	18	0.0%
squ	various squids nei	Loliginidae, Ommastrephidae	0	0	0	3	14	0	0	17	0.0%
pok	saithe	Pollachius virens	0	3	2	0	0	3	0	7	0.0%
gfb	NA	Phycis blennoides	0	0	0	0	1	0	3	4	0.0%
brf	NA	Helicolenus dactylopterus	0	0	0	0	0	0	0	1	0.0%
usk	Tusk	Brosme brosme	0	0	0	0	0	0	0	0	0.0%
oth	NA	NA	0	0	0	0	0	0	0	0	0.0%
(all)	(all)	(all)	3,980	7,464	8,426	10,792	15,342	10,704	21,855	78,563	100.0%

Table 3.1.5: PFA deepwater fisheries for argentines. Self-sampling Summary of total catch (tonnes) by species. OTH refers to all other species that are not the main target species

Haul positions

An overview of all self-sampled hauls in the PFA deepwater fisheries for argentines..

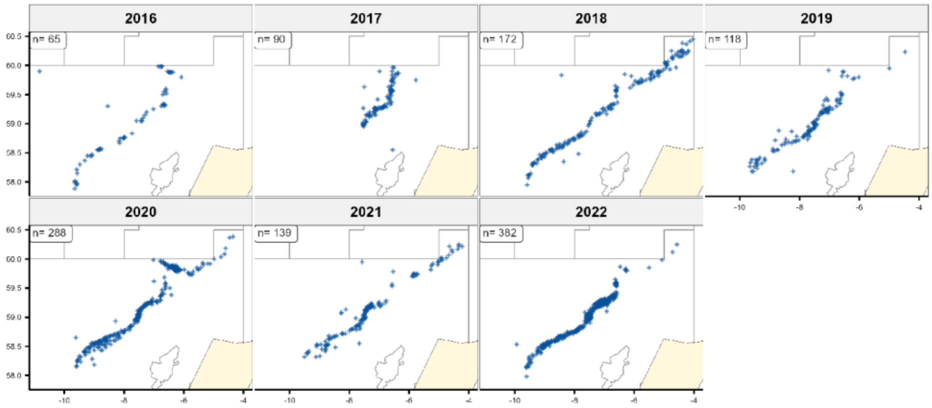


Figure 3.1.1: PFA deepwater fisheries for argentines. Self-sampling haul positions. N indicates the number of hauls.

Catches for the main target species

Summed catches (tonnes) of the main target species aggregated in rectangles.

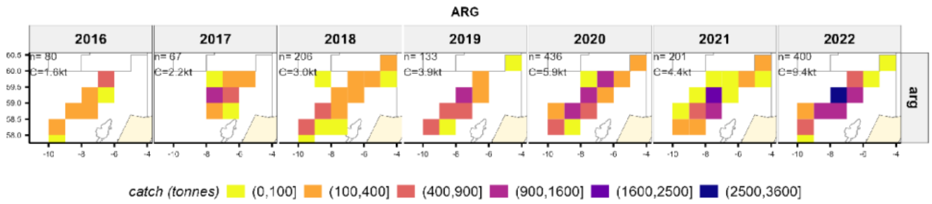


Figure 3.1.2: PFA deepwater fisheries for argentines. Self-sampling catch per species and per rectangle. N indicates the number of hauls. Catch refers to the total catch per year.

Catch rates (catch/day) for the main target species

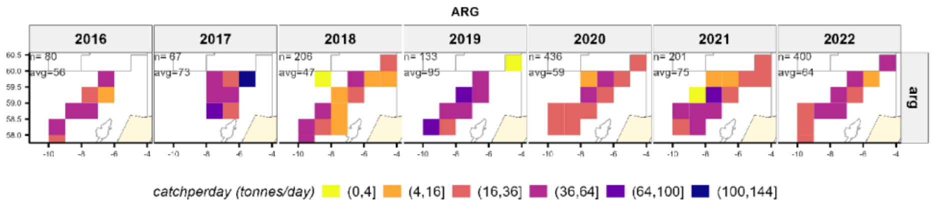


Figure 3.1.3: Average catch per day, per species and per rectangle. N indicates the number of hauls; avg refers to the average catch per day.

Average surface temperature by quarter and by rectangle.

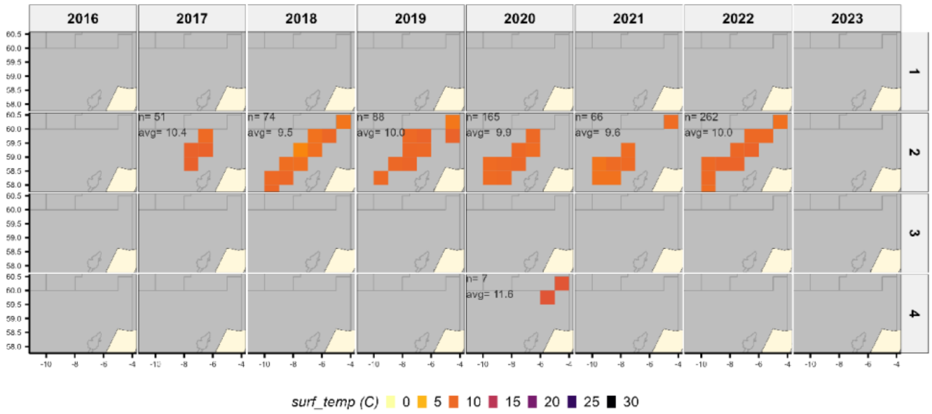


Figure 3.1.4: PFA deepwater fisheries for argentines. Average surface temperature (C) by year and quarter. N indicates the number of hauls. Avg refers to the average temperature.

Average fishing depth.

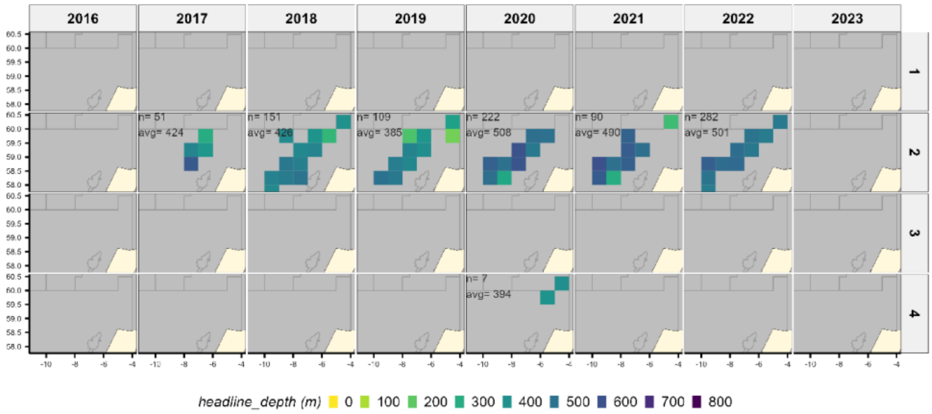


Figure 3.1.5: PFA deepwater fisheries for argentines. Average fishing depth (m) by year and quarter. N indicates the number of hauls. Avg refers to the average fishing depth.

Average wind force.

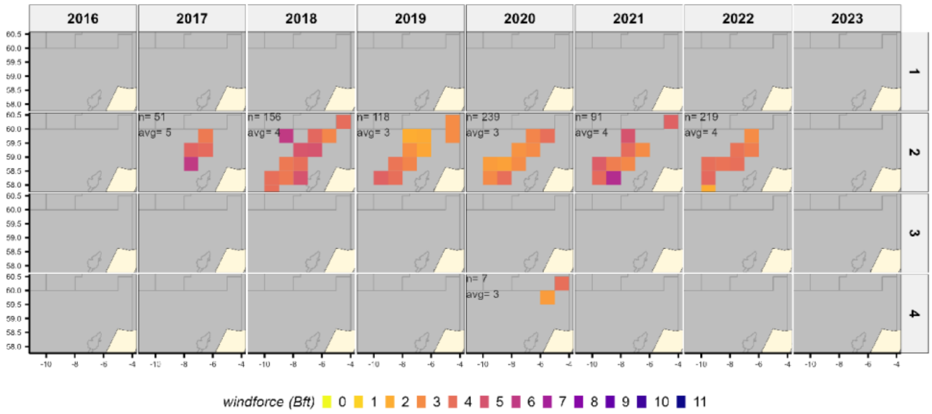


Figure 3.1.6: PFA deepwater fisheries for argentines. Average windforce (Bft) by year and quarter. N indicates the number of hauls. Avg refers to the average windforce.

3.2 Argentines (ARG, Argentinus sp.)

Argentines self-sampling summary.

species	year	nvessels	ntrips	ndays	nhauls	catch	catch/day	nlength	nbio
arg	2016	2	2	28	57	1,580	56	1,063	0
arg	2017	3	3	31	67	2,248	73	668	0
arg	2018	7	7	64	161	3,013	47	968	459
arg	2019	6	7	41	94	3,899	95	3,039	0
arg	2020	7	9	101	273	5,946	59	3,980	32
arg	2021	5	6	59	136	4,398	75	3,099	0
arg	2022	6	8	146	366	9,416	64	6,231	0
(all)	(all)		42	470	1,154	30,501		19,048	491

Table 3.2.1: Argentines. Self-sampling summary with the number of days, hauls, trips, vessels, catch (tonnes), catch rate (ton/day), number of fish measured, number of biological observations.

Argentines. Catch by division

species	division	2016	2017	2018	2019	2020	2021	2022	all	perc
arg	27.6.a	1,580	2,248	3,013	3,899	5,946	4,398	9,416	30,501	100.0%
(all)	(all)	1,580	2,248	3,013	3,899	5,946	4,398	9,416	30,501	100.0%

Table 3.2.2: Argentines. Self-sampling summary with the catch (tonnes) by year and division

Argentines. Catch by month

species	month	2016	2017	2018	2019	2020	2021	2022	all	perc
arg	Apr	0	38	811	720	3,201	1,289	5,739	11,799	38.7%
arg	May	1,333	2,210	2,202	3,179	2,276	3,110	3,677	17,986	59.0%
arg	Jun	248	0	0	0	452	0	0	700	2.3%
arg	Oct	0	0	0	0	16	0	0	16	0.1%
(all)	(all)	1,580	2,248	3,013	3,899	5,946	4,398	9,416	30,501	100.0%

Table 3.2.3: Argentines. Self-sampling summary with the catch (tonnes) by year and month

Argentines. Catch by rectangle

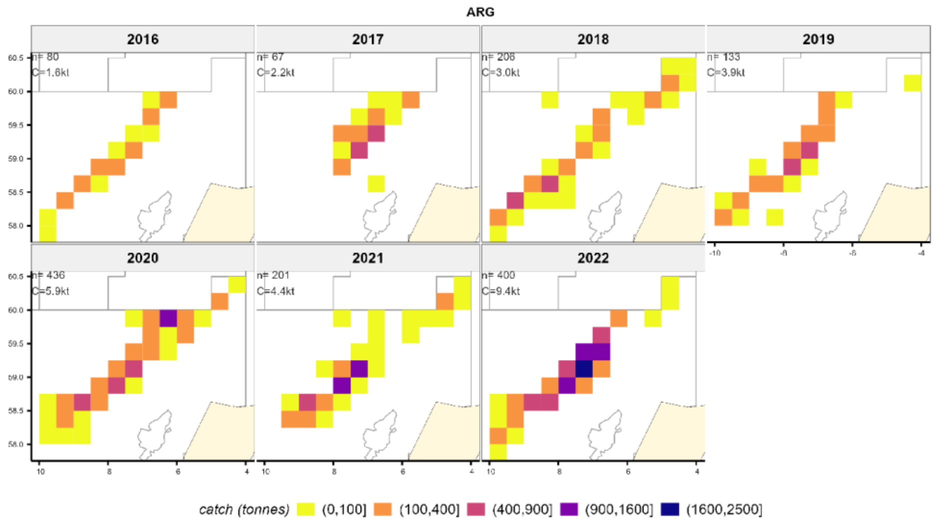


Figure 3.2.1: Argentines. Catch per rectangle. N indicates the number of hauls; Catch refers to the total catch per year.

Argentines. Catchrate (ton/day) by rectangle

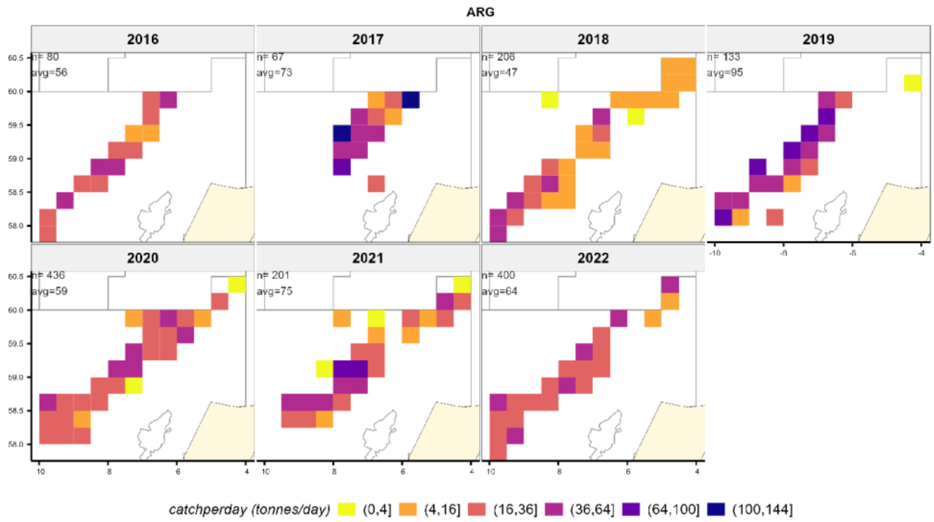


Figure 3.2.2: Argentines. Catchrate (ton/day) per rectangle. N indicates the number of hauls; Avg refers to the average catchrate per rect.

Argentines. Spatio-temporal evolution of catch by month and rectangle

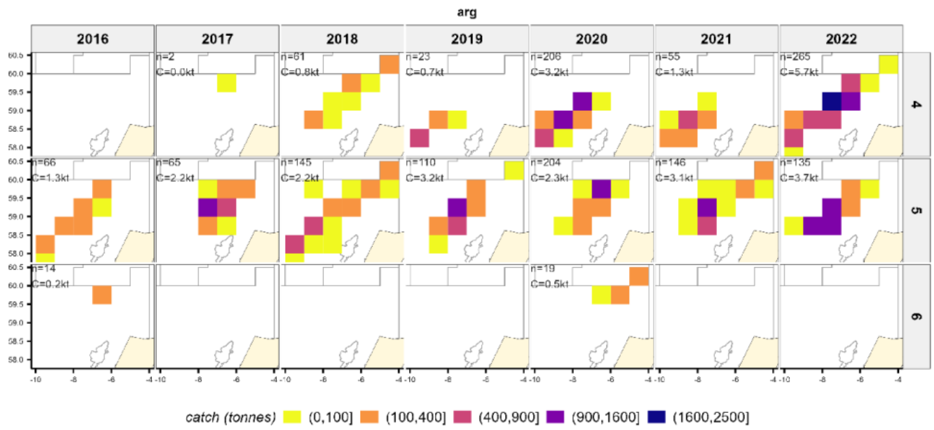


Figure 3.2.3: Argentines. Spatio-temporal evolution of the catches per rectangle and month. N indicates the number of hauls; C refers to the total catch by year and month.

Argentines. Catch proportion at depth

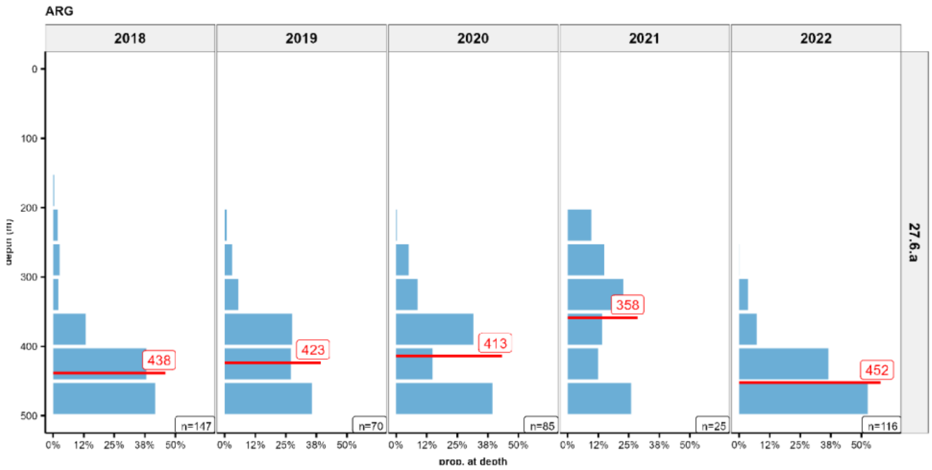


Figure 3.2.4: Argentines. Catch proportion at depth. N indicates the number of hauls.

Argentines. Length distributions of the catch

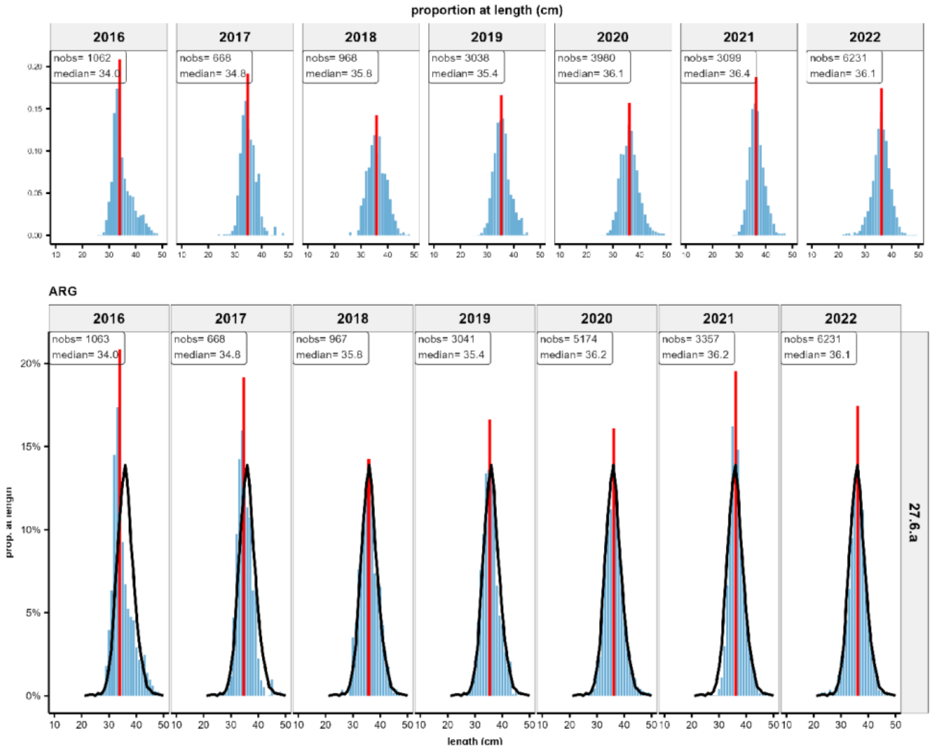


Figure 3.2.5: Argentines. Length distributions by year (top) and by year and division (bottom). Nobs refers to the number of observations; median denotes the median length.

Argentines. Length distributions as proportions by (large) rectangle

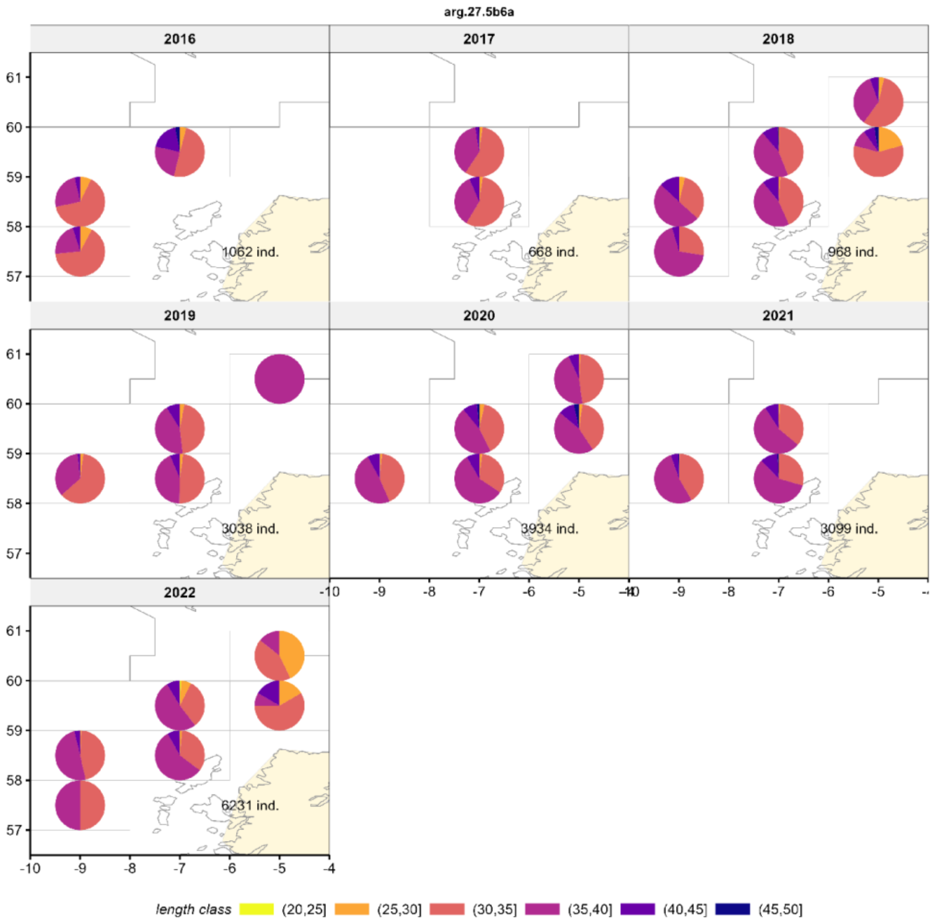


Figure 3.2.6: Argentines. Length distributions as proportions by large rectangle. Ind. refers to the number of length measurements

Argentines. Average length, weight and fat content by year and month

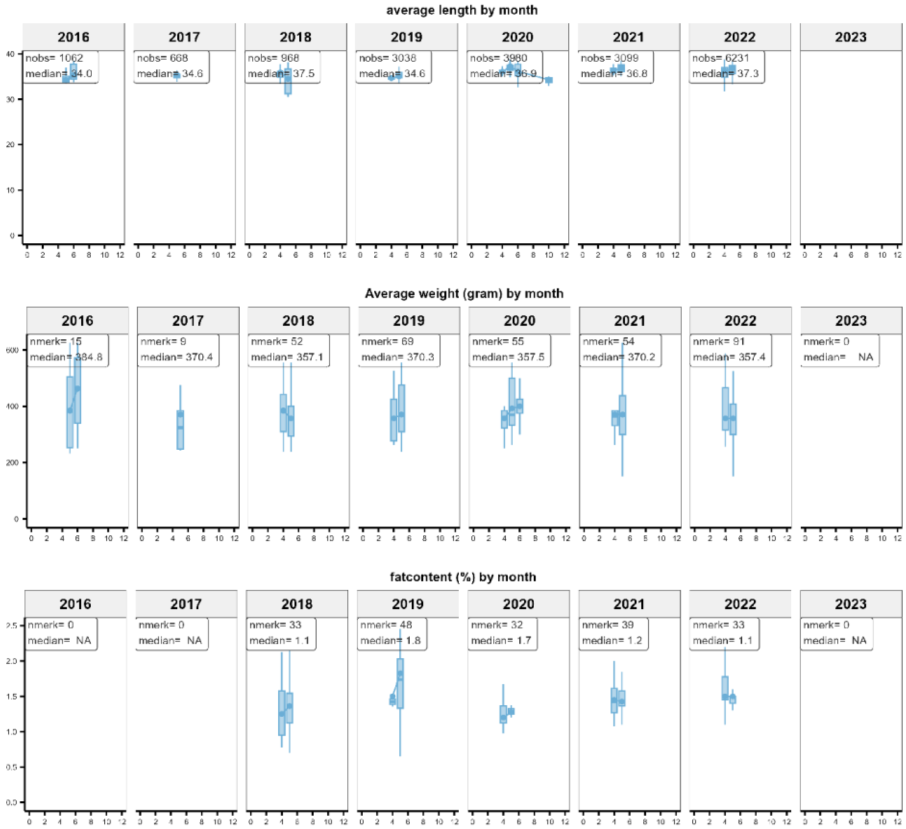


Figure 3.2.7: Argentines. Average length, average weight, and average fat content. Nobs indicates the number of measurements, median indicates the median values

4 Discussion and conclusions

From 2018 onwards, all PFA vessels were participating in the PFA self-sampling program.

The definition of what constitutes 'a fishery' for a certain species is not straightforward to resolve. In this report we selected all vessel-trip-week combinations with:

- hauls in divisions 27.6.a; 27.5.b; 27.4.a
- catch of arg by trip and week at least 10% of the total catch of that trip and week.
- catch of arg by trip and week at least 10 tonnes.

Since 2020, the measurements of average weight and fat content are included in the self-sampling report. Weights and fat content are routinely being collected for some of the target species (e.g. herring, mackerel) on the basis of production units (batches). The measurements are being carried out both when the species is the main target of the fishery and when it is a bycatch in other fisheries.

5 Acknowledgements

The skippers, officers and the quality managers of many of the PFA vessels are putting in a lot of effort to make the PFA the self-sampling work. Without their efforts, there would be no self-sampling.

6 References and publications

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7 More information

Please contact Niels Hintzen (nhintzen@pelagicfish.eu) if you would have any questions on the PFA self-sampling program or the specific results presented here.

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Survey results of roughhead grenadier, roundnose grenadier, greater argentine, tusk, blue ling, black scabbard fish, ling, and orange roughy in ICES division 14b in the period 1998-2016 and 2022.

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Abstract
A stratified bottom trawl survey in East Greenland (ICES 14.b) has been conducted by the Greenland Institute of Natural Resources (GINR) from 1998 to 2016 (no survey was conducted in 2001), at depths between 400 to 1500 m with R/V Paamiut, using an Alfredo II bottom trawl gear. In 2017, R/V Paamiut was retired and in 2022 the survey was conducted with a new vessel owned by the GINR, R/V Tarajoq using also a new trawl gear, Bacalao 476. There was unfortunately not any comparative trawling between the old vessel R/V Paamiut and R/V Tarajoq. Survey results include biomass and abundance estimates and length frequency distributions, which are presented for roughhead grenadier (*Macrourus berglax*), roundnose grenadier (*Coryphaenoides rupestris*), greater argentine (*Argentina silus*), tusk (*Brosme brosme*), blue ling (*Molva dypterygia*), black scabbardfish (*Aphanopus carbo*), ling (*Molva molva*), and orange roughy (*Hoplostethus atlanticus*). Only roughhead grenadier and roundnose grenadier from ICES division 14.b have previously been reported to NWWG (Nogueira et al. 2023). This document contains the available information on the species mentioned above, in ICES division 14.b from scientific surveys from 1998 to 2016, and from 2022.

1. Introduction

During the period 1987-1989 the Japan Marine Fishery Resources Research Centre (JAMARC) and the Greenland Institute of Natural Resources (GINR) jointly conducted 3 bottom trawl surveys at East Greenland as part of a joint venture agreement on fisheries development and fisheries research in Greenland waters (Jørgensen and Akimoto 1990; Yatsu and Jørgensen 1988abc; Yatsu and Jørgensen 1989). The surveys were primarily aimed at Greenland halibut (*Reinhardtius hippoglossoides*) and redfish (*Sebastes* spp.) and covered various areas between Cape Farewell and 72°N at depths down to 1500 m. During the period 1989-1996 the GINR conducted annual shrimp trawl surveys with R/V Paamiut off East Greenland (Anon. 1997), but the surveys only covered depths down to 600 m with a poor coverage of depths > 400 m. In 1998, GINR initiated a bottom trawl surveys series with R/V Paamiut, which has been rigged for deep sea trawling. The survey has been carried out between 1998 and 2016 (except in 2001), and in 2017 R/V Paamiut was retired. A new survey was conducted in 2022, with the new R/V Tarajoq, owned by the GINR, using a new gear. There has unfortunately not been any comparative trawling between the Japanese R/V Shinkai Maru and R/V Paamiut, and between R/V Paamiut and R/V Tarajoq making comparisons between the surveys difficult, and there is very little overlap in the depth range between the shrimp trawl survey and the present survey. There was no survey off East Greenland in 2001. The vessel (R/V Paamiut) used for the surveys from 1998-2016 was retired in 2018 before paired trawling experiments with a replacement vessel could be conducted. In 2022, the new vessel owned by GINR, R/V Tarajoq with a Bacalao 476 trawl began a new survey series.

2. Materials and methods

The Greenland halibut surveys in East Greenland (ICES 14.b) were initiated in 1998. Until 2008, the survey was conducted in June, and had in almost all years suffered under the ice coverage found at the east coast of Greenland during early summer. Therefore, from 2008 and onwards surveys have taken place in August/September without ice induced problems. Also, in 2008 the survey was combined with a new shrimp/fish survey using a different trawl gear at more shallow waters than the Greenland halibut survey. The combination of the two surveys led to a change in trawling hours so that most of the stations since 2008 were taken during night-time. In 2022 the Greenland halibut survey was conducted between September 23 and October 7.

Stratification

The survey was planned to cover ICES Division 14.b from between the 3-nm line and the 200-nm line or the midline to Iceland at depths from 400 to 1500 m. The survey area was stratified in 5 Subareas Q1-Q5 (Table 1). Area Q1 consists of one depth stratum 401-600 m on Dohrn Bank in the northern part of the survey area. Area Q2 is the shelf area in the northern part of the survey area and is sub-divided in the depth strata 401-600, 601-800, 801-1000 and 1001-1500 m. Area Q3 is a large area with depths generally below 800 m. The stratification in the area has not been changed: 401-600, 601-800 and 801-1000 m. The slope, >1000 m, has not been covered due to steep and rough bottom. Area Q4 is not covered due to steep and rough bottom. Area Q5 is sub-divided in the depth strata 401-600, 601-800, 801-1200, 1201-1400 and 1401-1500 m. One area, Q6, off Southeast Greenland has been included in previous survey plans, but it has never been possible to make any hauls in the area due to ice and rough bottom. Therefore, Q6 has been excluded from the survey area since 2004. Survey areas of all Q-areas are presented in Table 1. In 2022, the Stratified Random Bottom Trawl Survey has been changed to a fix station allocation design due to many stations being moved and problems finding suitable fishing grounds because of rough sea bed.

Sampling design

From 1998 to 2016, the survey was planned as a Stratified Random Bottom Trawl Survey with a total of 70 hauls, which gives an overall coverage on 527 km^2 per haul. Each stratum was allocated at least two hauls. The remaining hauls were allocated in order to minimize the variance in the estimation of the biomass of Greenland halibut; *i.e.* strata with great variation in the catches of Greenland halibut in the previous year's surveys were assigned relatively more hauls than strata with little variation in the catches.

In 2004 a new method of choosing stations was introduced. The method combines the use of a minimum between-stations-distance rule (buffer zone) with a random allocation scheme (Kingsley et al. 2004). In Q5 depth stratum 801-1200 m had only 7 positions suitable for trawling. The positions of the 3 hauls allocated to this stratum were chosen at random between the 7 trawlable positions.

In 2022, the Stratified Random Bottom Trawl Survey has been changed to a fix station allocation design due to many stations being moved and problems finding suitable fishing grounds because of rough sea bed.

Vessel and gear and handling of the catch

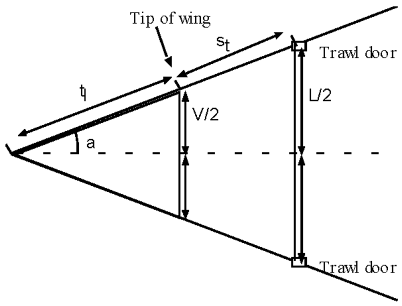
From 1998 to 2017, the survey was conducted by the 1084 GT trawler Paamiut, using an Alfredo III trawl with a mesh size on 140 mm and a 30-mm mesh-liner in the cod-end. The ground gear was of the rock hopper type. The trawl doors were changed to "Injector" type doors weighing 2700 kg in 2004, but this has not affected the performance of the trawl. Figures of rigging and bobbins chain together with further information about the gear is given in Jørgensen (1998). A Furuno net sonde mounted on the head rope measured net height. Scanmar sensors measured the distance between the trawl doors. In 2022, R/V Tarajoq (2896 GT) began a new survey series using a Bacalao 476 trawl with a mesh size of 136 mm and a 30-mm mesh-liner in the cod-end (Table 2). The same doors as on R/V Paamiut are used on R/V Tarajoq.

Swept area calculation

Nominal swept area for each tow was calculated as the straight-line distance between its GPS start and end positions multiplied by the wingspread. The distance between the trawl doors is recorded 3 or 5 times during each tow; provided it was recorded at least 3 times. Wingspread with the Alfredo trawl, taken as the distance between the outer bobbins, was calculated as:

Distance between outer bobbins = 10.122 + distance between trawl doors * 0.142

This relationship was estimated based on flume tank measurements of the trawl and rigging (Jørgensen 1998).
In 2022, the gear was changed to Bacalao 476 gear. The wingspread for a tow was calculated from the mean door spread and the geometry of the trawl as if the shape would be a triangle. V has been calculated as follows; Where the trawl and the trawl plus bridles are assumed to form two similar triangles, bridles and wings making a straight line:



and the lengths of the bridles (s) and the trawl wings (t) are known. The wingspread V is then calculated as:
$V = (t_l \cdot L) / (t_l + s_t)$
where L is the distance between the doors (doorspread). The trawl wing is 26.83 meters and the length of the bridles is 129 m. Because the shape of the Bacalao gear is not a triangle, a constant based on the sensors measurements during the Canadian survey at the same depths was applied. Scanmar sensors measured wingspread during the deep

Canadian survey in Subarea 0A. The difference between our estimation and the sensors measurement in each depth strata has been added as a constant in our wingspread calculations.

Trawling procedure

Towing time is usually 30 min, but towing times down to 15 min are accepted. Towing speed is between 2.5-3.0 kn and is estimated from the start and end positions of the haul. Since 2008, trawling takes place day and night. Previously, trawling was conducted only during day time.

3. Results and discussion

The available data from scientific surveys reveal that the evaluated species are present in ICES division 14.b in very different quantities. Below data are presented for each species with focus on the most recent year the species has been registered. Overall length distributions are shown only for years when more than 20 specimens of a given species were available. In total 73 hauls were made in 2022 (Table 4), with good coverage of all areas.

Roughhead grenadier (*Macrourus berglax*, RHG)

Roughhead grenadier was caught in 59 of the 73 hauls in 2022. Catches ranged from 0.246 kg to 736.33 kg, taken at 677 m in Q2 (Appendix, 1). The species was found in all strata. The vast majority of the biomass was found in Q2, similar to other years (Table 6). The biomass has been at a similar level from 1998 to 2007, where it ranged between 3151 tonnes to 5702 tonnes (Table 5, Fig. 1). The biomass then increased from 2008 until 2016 where it ranged between 5871 tonnes to 9208 tonnes (Table 5, Fig. 1). This increase could be linked to the change in survey design, where most stations from 2008 and onwards were taken during night time. The biomass since 2008 appears stabil although fluctuating (Fig. 1). In 2022, the biomass was 12915 t (S.E. = 3861, Table 5).In 2022, the abundance was estimated $7338*10^3$ (S.E. = $1703*10^3$) and follows a similar distribution pattern as the biomass (Table 6). The overall length distribution in 2022 was dominated by a clear mode at 20 cm similar to previous years (Fig. 4). From 2010 to 2016, a smaller second mode around 30 cm was present in the time series, and it became very high in numbers in 2022. The higher numbers found in the second mode in 2022 could be due to changes in the gear selectivity.

Roundnose grenadier (*Coryphaenoides rupestris* ; RNG)

Roundnose grenadier was caught in 18 of the 73 hauls and catches were generally very low, and were only found in Q2 at 1001-1500 and Q5 between depth of 601 to 1500 m (Table 7 and 8). The total biomass estimate for roundnose grenadier in 2022 is 84 t (S.E. = 17) (Table 7, which is very low. The abundance estimate follows the same pattern with a total estimate of $1364*10^3$ (S.E. = $436*10^3$), (Table 7, Fig. 6). The majority of the fish are found in the deeper parts (800 – 1000 m) of Q2 (Table 8). In 2022, there was a mode in the length distribution around 3 cm (Fig. 8), which may indicate there are currently only smaller individuals and less larger ones (which were previously regularly visible in the length distribution).

Greater argentine (*Argentinus silus*; ARU)

In 2022, greater argentine was caught in 24 of the 74 hauls. Catches ranged from 0.35 kg to 94.04 kg. The vast majority of the biomass was found in Q2 and Q5 at depth less that 1100 m (Table 10, Fig. 11). Biomass for greater argentine has been increasing from 1998 t (6.4 tonnes) to 2016 (808.1 tonnes), peaking in 2014 (2166.7 tonnes)

(Table 9, Fig. 9). In 2022, the biomass was 1061.44 t (SE = 713.84).tonnes In 2022, the abundance was estimated to 2260.9*10^3 (S.E. = 1653.7*10^3) and generally follows the same patterns as biomass (Table 10).
The overall length distribution shows that from 2003-2011 and 2014-2016 catches were dominated by a mode around 30-40 cm, whereas a second mode around 20 cm was evident in years 2012-2013 (Fig. 12). In 2022, only one mode around 38 cm was found.

Tusk (*Brosme brosme*, USK)

In 2016, tusk was caught in 17 of the 74 hauls. Catches ranged from 0.9 kg to 13 kg. The species was caught in all subareas but the majority of the biomass was in Q2 similar to previous years (Table 12, Fig. 15) Biomass for tusk has been low until 2010 (mean biomass = 18.2 t), with no catches in 1998, 1999 and 2005. From 2010 untill 2016, the biomass has been distinctly higher (mean biomass = 275 tonnes) ranging from 78.8 tonnes (2014) to 504.0 tonnes (2013) (Table 11, Fig. 13). In 2016, the biomass was 296.83 (SE = 77.86).tonnes
In 2022, the abundance was estimated 153.34*10^3 (S.E. = 53*10^3) (Table 12). The overall length distribution for all years are based on relatively low sample sizes (N<100), individual size ranged from 43 cm to 82, and we can not distinguish any mode (Fig. 16). Larger individuals were caught with the new gear in 2022.

Blue ling (*Molva dypterygia*, BLI)

In 2022, blue ling was caught in 12 out of 73 hauls. Catches ranged from 2.25 kg to 28.74 kg. The species was caught in all subareas, but with the vast majority in Q2 in depths between 600 and 800 m (Table 14, Fig. 19). Biomass for blue ling has been low from 1998 to 2005 (mean biomass =138.4 tonnes). From 2006 until 2016, the biomass has been distinctly higher (mean biomass = 786.5 tonnes) ranging from 158 tonnes (2007) to 1365 tonnes (2012) (Table 13, Fig. 17). In 2022, the biomass was 447 t (SE = 164).In 2022, the abundance was estimated to 178*10^3 (S.E. = 69*10^3) and generally follows biomass estimates. No mode can be observed in the length distribution. The size of the individuals ranged from 21 to 124 cm. (Fig. 20).

Black scabbardfish (*Aphanopus carbo*, BSF)

Black scabbardfish are rarely caught in this survey.There were no catches in the years 1998, 1999, 2000, 2002, 2003, 2006 and 2016, and neither in 2022. In 2013 and 2015, the species was caught only in 1 station, whereas it was found in 4-6 stations in 2011, 2012 and 2014. For these years, catches ranged from 0.7 kg to 21.7 kg. In 2015, it was only registered in Q5 at depths between 801-1200 m (Table 15, Fig. 23), where the majority of the biomass also has been observed in previous years (Fig. 23). In 2008 and 2010-2012, the biomass was estimated between 32.8 t and 56.4 t, whereas all other years the biomass was less than 7.9 t (Table 15). This is most likely because this pelagic and deep living pelagic fish is not targeted by the applied type of bottom trawl and hence the estimated biomasses (Fig. 21) are not truly representative of actual biomass in the investigated area. Overall length distributions from 2011 and 2012 show a wide mode between 70 cm and 110 cm.

Ling (*Molva molva*; BSF)

Ling are not commonly caught in this survey. There were no catches from 1998 to 2004, 2008, 2013-2014 and 2016. In 2022, only 1 individual was caught in 1 haul out of 74 hauls in Q2 at depths between 601-800 m (Table 16). Except from 2011, where the estimated biomass was 267.8 t (S.E. = 14.8 tonnes) (Table 16), yearly estimates are 10-fold less or zero evidencing that ling do not commonly occur in the investigated area (Table 16, Fig. 24, Fig. 26). In 2022, the estimated biomass was 6 t, estimated abundance was 2*10^3 (Table 17). The overall length distribution shows that specimens were shorter in 2011 (mode 40-50 cm) than in 2010 (mode=90-100) and further that less fish were caught in 2011 (Fig. 24) where, in contrast, the estimated biomass was more than 10 times higher. This is explained by the fact that in 2011 all ling were caught in Q3 at 601-800 m – a depth stratum which comprises 26.3 % of the total area of all strata combined (Table 1). The size of the individual caught in 2022 was 82 cm.

Orange roughy (*Hoplostethus atlanticus*; ORY)

Orange roughy is not commonly caught in this survey. The species was only caught in 2008, 2013, 2014 and 2015 (Fig. 27). In 2014 and 2015, estimated biomass was 1.7 t and 1.1 t, respectively, and in all other years it was zero or very close to zero (Table 18, Fig. 27). In 2015, all fish were caught in Q3 at depths between 801-1200 m . No length distributions are shown as too few specimens (N<20) were caught.

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Table 1. Areas (km^2) and their percentage distribution for subareas and depth strata (m). Q4 areas are not included.

Subarea	Depth strata	Area	% distribution
Q1	401-600	6975	18.7
Q2	401-600	1246	3.3
Q2	601-800	1475.4	3.9
Q2	801-1000	1988.3	5.3
Q2	1001-1500	6689.4	17.9
Q3	401-600	9830.2	26.3
Q3	601-800	3788.1	10.1
Q3	801-1000	755.4	2.0
Q3	1001-1200	191.1	0.5
Q3	1201-1400	213.3	0.6
Q3	1401-1500	312.9	0.8
Q4	401-600	2053.6	
Q4	601-800	665.7	
Q4	801-1000	336.2	
Q4	1001-1200	549.9	
Q4	1201-1400	1147	
Q4	1401-1500	940.5	
Q5	401-600	1819.4	4.9
Q5	601-800	257.1	0.7
Q5	801-1200	255.6	0.7
Q5	1201-1400	985.5	2.6
Q5	1401-1500	614.5	1.6
Sum (without Q4)		37397.2	100

Table 2.- General survey information and gear specifications for the surveys 1998-2016 on board R/V Paamiut and for the survey in 2022 with R/V Tarajoq.

Procedure	Specifications	
Vessel	R/V Paamiut	R/V Tarajoq
TRB	1084 GT	2896 GT
Dimensions	LOA 58.61m, Beam 11.21 m	LOA 61.4 m, Beam 16.3 m
Main engine	2000BHP, Diesel 257, 1471KW	3943/4896 BHP, Diesel 475, 2900/3600 KW
Survey Area	14b (401- 1500 m)	14b (401- 1500 m)
Years	1998-2016 (no survey 2001)	2022
Time of year	August/September	September/October
Number of days	15	15
Towing speed (knots)	3	3
Tow duration	30 min	30 min
Gear	Alfredo 3	Bacalao 476
Vertical trawl opening (m)	5.6	4.5*
Distance between doors	120 -145 m	151.8*
Winds spread	10.122 + distance between the doors * 0.142.	$V = (t_l * L) / (t_l + s_t)$ + constant
Mesh size (mm)	140 mm	136
Door	until 2003:Greenland Perfect (370*250 cm) from 2004: Shark injector (353*273)	Shark injector (353*273)
Door type (kg)	2400 kg with extra 20 kg	2850
Mesh size (mm)	44	44
Mesh-line in the cod-end	30 mm	30
Sampling design	Buffered Random Stratified	Fix stations
Number of Stations	100	74 fix + 70 extra (min 80)
Number of strata	10	10
Trawling schedule	24 hours	
Criteria for rejecting a haul	Snag of the trawling gear in the bottom Damage in the cod-end or severe damages in large sections of the wings or belly Less than 15 minutes of effective trawling time Gear malfuntion	
Criteria for change haul position	Wrong depth interval Poor bottom conditions	
Samling species	All fish species and invertebrates	
Target species	Greenland halibut	

Table 3.- Number of valid hauls for the period 1998 - 2003. No survey was conducted in 2001.

Subarea	Depth stratum (m)	Area (km2)	1998	1999	2000	2002	2003
Q1	401-600	7444.1	6	4	3	1	4
Q1	601-800	622	3	3	3	3	3
Q1	801-1000	652.3	3	3	3	2	2
Q1	1001-1200	881.8	2	2	2	2	1
Q1	1201-1400	741.4	2	2	2	2	1
Q1	1401-1500	462.3	2	2	2	2	2
Q2	401-600	777	2	2	2	2	3
Q2	601-800	853.4	4	3	3	3	3
Q2	801-1000	1336	5	4	3	4	3
Q2	1001-1200	1699.3	2	2	2	2	2
Q2	1201-1400	1742	2	2	2	0	2
Q2	1401-1500	1162.6	1	2	2	2	1
Q3	401-600	9830.2	6	7	9	3	1
Q3	601-800	3788.1	3	4	4	1	5
Q3	801-1000	755.4	2	0	2	0	2
Q5	401-600	1819.4	2	2	1	0	0
Q5	601-800	257.1	0	2	2	2	1
Q5	801-1000	106.7	0	2	2	2	2
Q5	1001-1200	148.9	2	2	2	2	1
Q5	1201-1400	985.5	2	2	2	3	1
Q5	1401-1500	614.5	3	2	2	2	0
TOTAL			54	54	55	40	40

Table 4.- Number of valid hauls for the period 2004-2016 with R/V Paamiut (no survey in 2001) and in 2022 with R/V Tarajoq, after a new stratification scheme was introduced.

Subarea	Depth stratum (m)	Area (km2)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2022	Total
Q1	401-600	6975	2	0	0	2	4	4	2	8	7	10	7	11	12	0	5	74
Q2	401-600	1246	4	4	5	3	5	4	4	2	4	5	5	5	5	0	7	62
Q2	601-800	1475.4	5	5	6	5	7	5	5	6	9	5	7	7	7	0	5	84
Q2	601-1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Q2	801-1000	1988.3	8	9	12	9	3	9	8	8	9	8	7	8	10	0	8	116
Q2	1001-1500	6689.4	3	3	4	3	4	5	5	4	7	4	7	7	7	0	5	68
Q3	401-600	9830.2	9	1	2	2	2	5	5	6	4	9	7	8	11	0	4	75
Q3	601-800	3788.1	4	8	2	6	6	10	6	7	7	11	12	10	14	0	11	114
Q3	801-1000	755.4	0	2	0	0	2	3	3	5	4	4	5	5	6	0	5	44
Q4	801-1200	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Q5	401-600	1819.4	3	0	1	2	3	2	0	1	2	1	2	3	3	0	4	27
Q5	601-800	257.1	3	1	3	2	3	4	1	3	3	6	6	6	6	0	6	53
Q5	801-1000	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
Q5	801-1200	255.6	3	4	3	4	0	4	3	3	4	5	6	2	5	0	2	48
Q5	1201-1400	985.5	5	6	3	5	3	6	5	8	5	9	3	7	9	6	9	89
Q5	1401-1500	614.5	3	4	2	3	1	3	3	5	2	3	3	5	5	4	2	48
		TOTAL	52	47	43	46	47	64	50	66	67	80	78	84	100	10	73	

Table 5.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of roughhead grenadier (*Macrourus berglax*, RHG) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Roughhead grenadier			
Year	**Vessel**	**Biomass**	**SE**	**Abundance**	**SE**
1998	PA	3480.9	546.2	4027.81	639.14
1999	PA	4741.67	803.82	5268.51	979.85
2000	PA	3434.36	351.12	3894.76	380.16
2001	PA	-	-	-	-
2002	PA	4523.51	2095.86	5409.19	3429.93
2003	PA	3100.01	609.13	3421.35	741.1
2004	PA	3150.55	532.5	2813.58	266.75
2005	PA	4237.93	872.42	5230.35	1225.6
2006	PA	3972.49	597.02	4600.06	620.9
2007	PA	3435.29	637.47	3590.22	445.99
2008	PA	6841.49	983.99	6590.11	818.97
2009	PA	7256.96	1425.21	6836.17	1173.32
2010	PA	9201.84	2292.12	7532.03	1162.02
2011	PA	5855.39	1032.07	5678.71	1055.34
2012	PA	7926.09	1330.41	7060.19	1030.43
2013	PA	7604.93	1765.46	5756.69	1212.99
2014	PA	6816.97	1043.22	5426.8	713.5
2015	PA	8751.71	2292.95	5647.58	1239.19
2016	PA	6953.35	1190.37	6004.64	1043.39
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	12913.87	3860.92	7337.53	1703.26

Table 6. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE with SE of roughhead grenadier (RHG) by subarea and depth stratum in 2022.

Subarea	**Stratum (m)**	**Area (sq.km)**	**Tow number**	**Mean Catch**	**Biomass**	**SE**	**Mean Number**	**Abundance**	**SE**
Q1	0401-0600	6975	12	10.625	74	67	9	64	46
Q2	0401-0600	1246	5	145.899	182	90	167	208	96
Q2	0601-0800	1475	7	3761.844	5550	2687	1739	2565	1123
Q2	0801-1000	1988	10	1018.74	2026	1358	551	1096	639
Q2	1001-1500	6689	7	695.394	4652	2412	432	2893	1101
Q3	0401-0600	9830	11	10.56	104	50	12	114	50
Q3	0601-0800	3788	14	19.726	75	27	31	118	20
Q3	0801-1000	755	6	25.514	19	7	39	30	10
Q5	0401-0600	1819	3	41.222	75	75	33	60	60
Q5	0601-0800	257	6	27.582	7	7	29	8	7
Q5	0801-1200	256	5	48.005	12	8	76	19	12
Q5	1201-1400	986	9	73.759	73	29	93	92	27
Q5	1401-1500	614	5	106.683	66	17	116	71	11
TOTAL		36678	100	105.26	12915	3861	46.44	7338	1703

Table 7.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of roundnose grenadier (*Coryphaenoides rupestris*, RNG) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Roundnose grenadier			
Year	Vessel	Biomass	SE	Abundance	SE
1998	PA	2877.29	1299.84	6166.28	2654.39
1999	PA	4303.63	463.11	9661.55	1012.45
2000	PA	2294.69	1237.14	5630.96	2486.13
2001	PA	-	-	-	-
2002	PA	1771.06	1224.19	7065.28	4542.48
2003	PA	4459.12	2097	13593.18	4742.32
2004	PA	1151.83	792	4369.14	1841.27
2005	PA	1174	337.77	5883.41	1813.27
2006	PA	689.04	300.31	3781.2	967.65
2007	PA	878.79	250.81	8312.51	2493.72
2008	PA	772.93	242.56	4296.04	1277.88
2009	PA	215.67	52.05	1452.29	368.99
2010	PA	416.21	93.74	2525.65	478.99
2011	PA	3202.25	2821.1	9207.74	6687.45
2012	PA	5379.46	4774.44	15325.86	13521.71
2013	PA	294.99	151.77	1469.95	694.61
2014	PA	106.1	36.39	826.32	322.61
2015	PA	999.46	815.95	3065.97	2106.33
2016	PA	170.25	46.08	530.16	127.62
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	83.68	16.92	1363.29	436.43

Table 8. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE with SE of roundnose grenadier (*Coryphaenoides rupestris*, RNG)by subarea and depth stratum

Subarea	Stratum (m)	Area (sq.km)	Tow number	Mean Catch	Biomass	SE	Mean Number	Abundance	SE
Q1	0401-0600	6975	12	0	0	0	0	0	0
Q2	0401-0600	1246	5	0	0	0	0	0	0
Q2	0601-0800	1475	7	0	0	0	0	0	0
Q2	0801-1000	1988	10	0	0	0	0	0	0
Q2	1001-1500	6689	7	2.463	16	11	4	27	17
Q3	0401-0600	9830	11	0	0	0	0	0	0
Q3	0601-0800	3788	14	0	0	0	0	0	0
Q3	0801-1000	755	6	0	0	0	0	0	0
Q5	0401-0600	1819	3	0	0	0	0	0	0
Q5	0601-0800	257	6	14.16	4	3	27	7	6
Q5	0801-1200	256	5	35.336	9	4	4435	1134	432
Q5	1201-1400	986	9	52.526	52	12	183	180	55
Q5	1401-1500	614	5	4.507	3	2	27	16	9
TOTAL		36678	100	0.46	84	17	11.9	1364	436

Table 9.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of greater silver smelt (*Argentinus silus*, ARU) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Argentina silus			
Year	**Vessel**	**Biomass**	**SE**	**Abundance**	**SE**
1998	PA	5.39	3.14	11.69	7.73
1999	PA	2.13	2.13	5.32	5.32
2000	PA	6.5	3.54	18.2	9.49
2001	PA	-	-	-	-
2002	PA	53.79	36.23	197.17	141.11
2003	PA	162.26	93.46	493.99	293.54
2004	PA	96.91	36.05	302.86	116.52
2005	PA	55.11	19.63	186.41	67.75
2006	PA	167.25	58.48	471.75	176.95
2007	PA	126.62	45.78	384.07	143.34
2008	PA	240.62	105.47	608.6	279.75
2009	PA	347.48	155.47	747.82	343.53
2010	PA	370.78	100.95	753.41	206.27
2011	PA	432.1	145.02	1145.74	405.38
2012	PA	481.74	166.49	954.86	294.72
2013	PA	643.7	173.47	1239.71	309.73
2014	PA	2046.61	842.8	4127.26	1594.59
2015	PA	257.55	71.72	506.79	119.83
2016	PA	808.11	360.38	1609.62	889.75
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	1061.44	713.84	2260.91	1653.76

Table 10. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE of of greater silver smelt (*Argentinus silus*, ARU) by subarea and depth stratum in 2022.

Subarea	**Stratum (m)**	**Area (sq.km)**	**Tow number**	**Mean Catch**	**Biomass**	**SE**	**Mean Number**	**Abundance**	**SE**
Q1	0401-0600	6975	12	0	0	0	0	0	0
Q2	0401-0600	1246	5	63.82	80	46	107	133	81
Q2	0601-0800	1475	7	44.425	66	38	74	109	60
Q2	0801-1000	1988	10	5.185	10	2	11	23	5
Q2	1001-1500	6689	7	0.961	6	6	1	10	10
Q3	0401-0600	9830	11	0	0	0	0	0	0
Q3	0601-0800	3788	14	0	0	0	0	0	0
Q3	0801-1000	755	6	0	0	0	0	0	0
Q5	0401-0600	1819	3	430.82	784	709	982	1787	1648
Q5	0601-0800	257	6	447.65	115	53	772	198	87
Q5	0801-1200	256	5	2.796	1	0	7	2	1
Q5	1201-1400	986	9	0	0	0	0	0	0
Q5	1401-1500	614	5	0	0	0	0	0	0
TOTAL		36678	100	19.46	1062	714	45.09	2262	1654

Table 11. Total biomass (tonnes) with SE, and abundance (10^3) with SE, of tusk (*Brosme brosme*, USK) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Brosme brosme			
Year	Vessel	Biomass	SE	Abundance	SE
1998	PA	0	0	0	0
1999	PA	0	0	0	0
2000	PA	3.75	3.75	0.99	0.99
2001	PA	-	-	-	-
2002	PA	61.06	34.27	194.13	108.82
2003	PA	2.21	1.6	8.82	4.41
2004	PA	4.36	4.36	9.69	9.69
2005	PA	0	0	0	0
2006	PA	16.47	7.74	19.3	7.93
2007	PA	18.42	14.94	11.95	7.28
2008	PA	69.25	29.48	166.13	93.72
2009	PA	47.4	22.34	112.41	54.81
2010	PA	225.8	113.64	369.05	206.85
2011	PA	113.62	48.34	92.71	39.91
2012	PA	349.74	261.82	138.21	67.2
2013	PA	504.06	159.77	286.14	68.41
2014	PA	188.3	111.11	126.96	50
2015	PA	277.94	87.08	186.26	47.79
2016	PA	371.81	92.08	325.44	81.58
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	296.83	77.86	153.34	53.66

Table 12. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE of of tusk (*Brosme brosme*, USK) by subarea and depth stratum in 2022.

Subarea	Stratum (m)	Area (sq.km)	Tow number	Mean Catch	Biomass	SE	Mean Number	Abundance	SE
Q1	0401-0600	6975	12	7.863	55	55	7	47	47
Q2	0401-0600	1246	5	92.869	116	37	25	32	9
Q2	0601-0800	1475	7	29.252	43	23	17	25	15
Q2	0801-1000	1988	10	4.602	9	6	3	5	3
Q2	1001-1500	6689	7	0	0	0	0	0	0
Q3	0401-0600	9830	11	5.592	55	29	4	35	18
Q3	0601-0800	3788	14	0	0	0	0	0	0
Q3	0801-1000	755	6	0	0	0	0	0	0
Q5	0401-0600	1819	3	8.593	16	16	4	8	8
Q5	0601-0800	257	6	13.081	3	1	9	2	1
Q5	0801-1200	256	5	0	0	0	0	0	0
Q5	1201-1400	986	9	0	0	0	0	0	0
Q5	1401-1500	614	5	0	0	0	0	0	0
TOTAL		36678	100	2.12	297	78	1.46	154	54

Table 13.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of blue ling (*Molva dypterygia*, BLI) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Molva dypteria			
Year	Vessel	Biomass	SE	Abundance	SE
1998	PA	87.47	42.49	34.41	11.78
1999	PA	163.48	69.45	65.93	27.83
2000	PA	211.09	114.02	161.13	75.62
2001	PA	-	-	-	-
2002	PA	76.26	17.34	86.61	15.93
2003	PA	101.38	31.39	96.62	35.86
2004	PA	81.59	32.72	89.16	42.79
2005	PA	111.08	30.99	83.28	15.38
2006	PA	570.07	264.94	355.56	131.03
2007	PA	158.35	57.06	136.59	57.59
2008	PA	870.02	404.82	1013.83	574.84
2009	PA	1239.68	617.42	860.55	353.19
2010	PA	892.11	157.68	689.48	193.73
2011	PA	588.19	232.69	665.09	318.57
2012	PA	1339.72	194.16	976.82	369.4
2013	PA	1248.22	412.14	571.84	159.41
2014	PA	865.88	288.05	471.72	127.73
2015	PA	417.65	162.08	204.49	74.07
2016	PA	432.5	155.17	182.92	66.68
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	446.04	164.23	176.81	69.22

Table 14. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE of of blue ling (*Molva dypterygia*, BLI) by subarea and depth stratum in 2022.

Subarea	Stratum (m)	Area (sq.km)	Tow number	Mean Catch	Biomass	SE	Mean Number	Abundance	SE
Q1	0401-0600	6975	12	7.013	49	49	2	16	16
Q2	0401-0600	1246	5	31.105	39	17	8	10	4
Q2	0601-0800	1475	7	149.958	221	143	49	73	50
Q2	0801-1000	1988	10	0	0	0	0	0	0
Q2	1001-1500	6689	7	0	0	0	0	0	0
Q3	0401-0600	9830	11	7.105	70	47	2	24	16
Q3	0601-0800	3788	14	0	0	0	0	0	0
Q3	0801-1000	755	6	0	0	0	0	0	0
Q5	0401-0600	1819	3	35.538	65	40	30	54	42
Q5	0601-0800	257	6	0	0	0	0	0	0
Q5	0801-1200	256	5	10.252	3	3	4	1	1
Q5	1201-1400	986	9	0	0	0	0	0	0
Q5	1401-1500	614	5	0	0	0	0	0	0
TOTAL		36678	100	4.48	447	164	1.89	178	69

Table 15.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of black scabbardfish (*Aphanopus carbo*, BSF) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Aphanophus carbo			
Year	Vessel	Biomass	SE	Abundance	SE
1998	PA	0	0	0	0
1999	PA	0	0	0	0
2000	PA	0	0	0	0
2001	PA	-	-	-	-
2002	PA	0	0	0	0
2003	PA	0	0	0	0
2004	PA	0.82	0.82	4.08	4.08
2005	PA	1.71	1.71	1.37	1.37
2006	PA	0	0	0	0
2007	PA	2.33	1.98	7.49	5.35
2008	PA	37.53	33.34	33.79	27.28
2009	PA	2.66	2.66	3.1	3.1
2010	PA	56.38	25.08	82.79	35.31
2011	PA	39.86	26.67	56.44	35.99
2012	PA	33.12	9.57	34.13	12.07
2013	PA	1.81	1.81	2.05	2.05
2014	PA	7.91	4.87	6.85	3.52
2015	PA	1.52	1.52	2.15	2.15
2016	PA	0	0	0	0
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	0	0	0	0

Table 16.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of blue ling (*Molva molva*, LIN) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

Year	Vessel	Biomass	SE	Abundance	SE
1998	PA	0	0	0	0
1999	PA	0	0	0	0
2000	PA	0	0	0	0
2001	PA	-	-	-	-
2002	PA	0	0	0	0
2003	PA	0	0	0	0
2004	PA	0	0	0	0
2005	PA	15.69	15.69	9.26	9.26
2006	PA	29.89	29.89	6.29	6.29
2007	PA	14.61	10.34	25.32	19.91
2008	PA	0	0	0	0
2009	PA	3.09	3.09	3.67	3.67
2010	PA	19.23	0	8.21	0
2011	PA	267.64	251.03	491.56	484.77
2012	PA	19.92	19.92	6.04	6.04
2013	PA	0	0	0	0
2014	PA	0	0	0	0
2015	PA	23.43	14.85	9.18	6.1
2016	PA	0	0	0	0
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	6.43	6.43	2.12	2.12

Table 17. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE of of blue ling (*Molva molva*, LIN) by subarea and depth stratum in 2022.

Subarea	Stratum (m)	Area (sq.km)	Tow number	Mean Catch	Biomass	SE	Mean Number	Abundance	SE
Q1	0401-0600	6975	12	0	0	0	0	0	0
Q2	0401-0600	1246	5	0	0	0	0	0	0
Q2	0601-0800	1475	7	4.357	6	6	1	2	2
Q2	0801-1000	1988	10	0	0	0	0	0	0
Q2	1001-1500	6689	7	0	0	0	0	0	0
Q3	0401-0600	9830	11	0	0	0	0	0	0
Q3	0601-0800	3788	14	0	0	0	0	0	0
Q3	0801-1000	755	6	0	0	0	0	0	0
Q5	0401-0600	1819	3	0	0	0	0	0	0
Q5	0601-0800	257	6	0	0	0	0	0	0
Q5	0801-1200	256	5	0	0	0	0	0	0
Q5	1201-1400	986	9	0	0	0	0	0	0
Q5	1401-1500	614	5	0	0	0	0	0	0
TOTAL		36678	100	0.18	6	6	0.06	2	2

Table 18. Total biomass (tonnes) with SE, and abundance (10^3) with SE, of Orange roughy (*Hoplostethus atlanticus*, ORY) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Hoplostethus atlanticus			
Year	Vessel	Biomass	SE	Abundance	SE
1998	PA	0	0	0	0
1999	PA	0	0	0	0
2000	PA	0	0	0	0
2001	PA	-	-	-	-
2002	PA	0	0	0	0
2003	PA	0	0	0	0
2004	PA	0	0	0	0
2005	PA	0	0	0	0
2006	PA	0	0	0	0
2007	PA	0	0	0	0
2008	PA	0.16	0.16	0.92	0.92
2009	PA	0	0	0	0
2010	PA	0	0	0	0
2011	PA	0	0	0	0
2012	PA	0	0	0	0
2013	PA	0.02	0.02	0.69	0.69
2014	PA	1.74	1.74	2.33	2.33
2015	PA	1.09	1.09	2.15	2.15
2016	PA	0	0	0	0
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	0	0	0	0

Figure 1. Roughhead grenadier (RHG) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

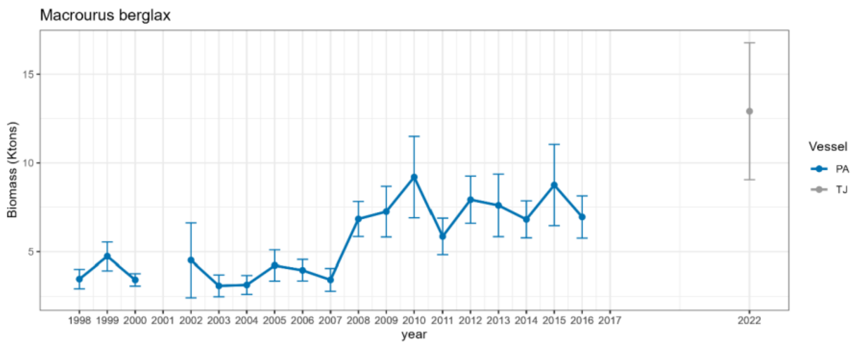


Figure 2. Roughhead grenadier (RHG) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

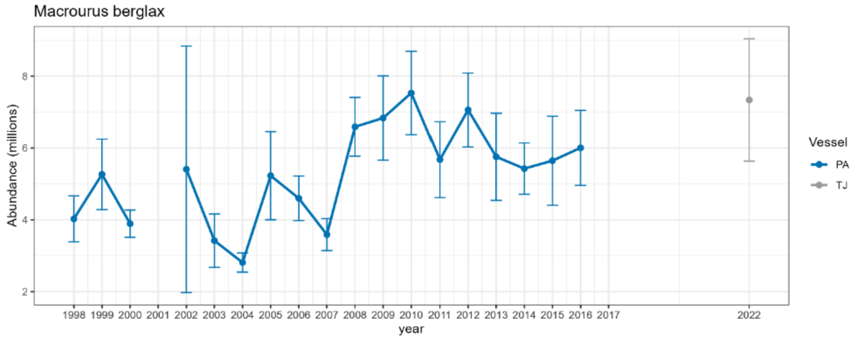


Figure 3. Distribution of survey catches of roughhead grenadier (RHG) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

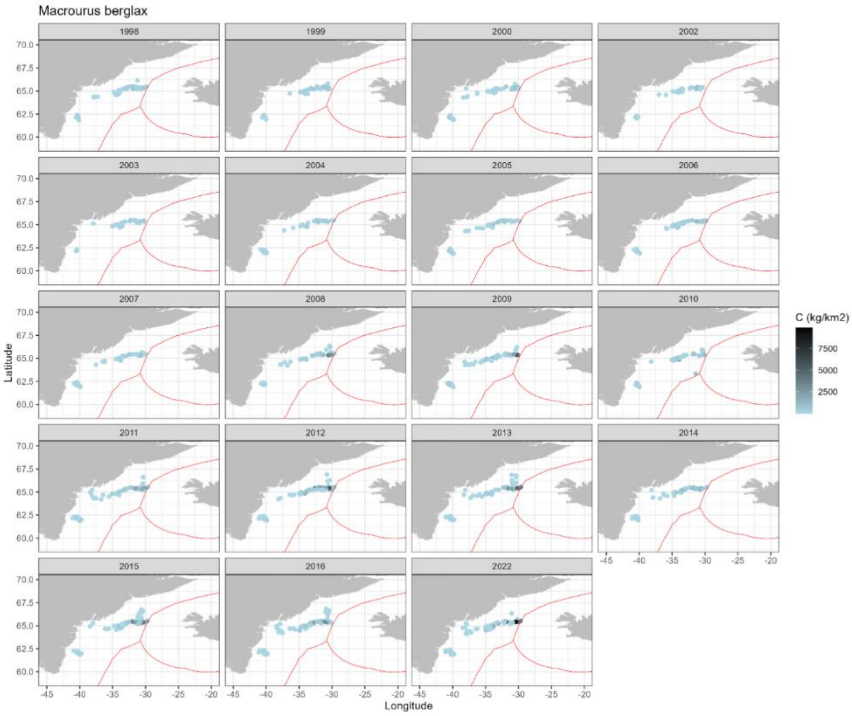


Fig. 4. Length frequency distribution per swept area of roughhead grenadier (RHG) for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

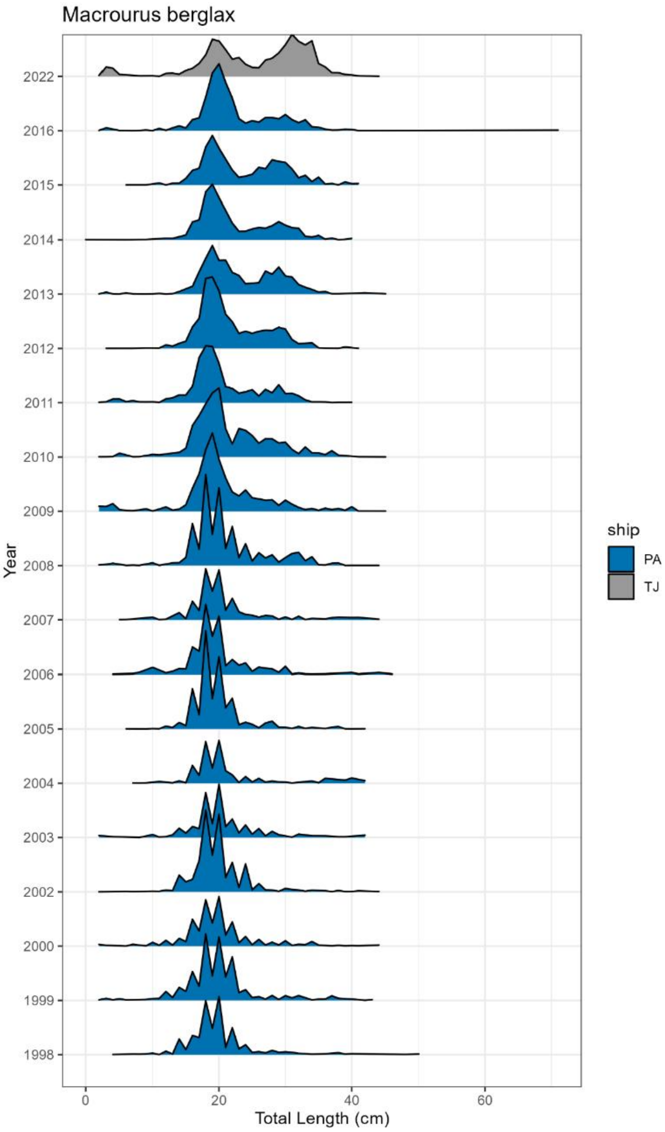


Figure 5.- Roundnose grenadier (RNG) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

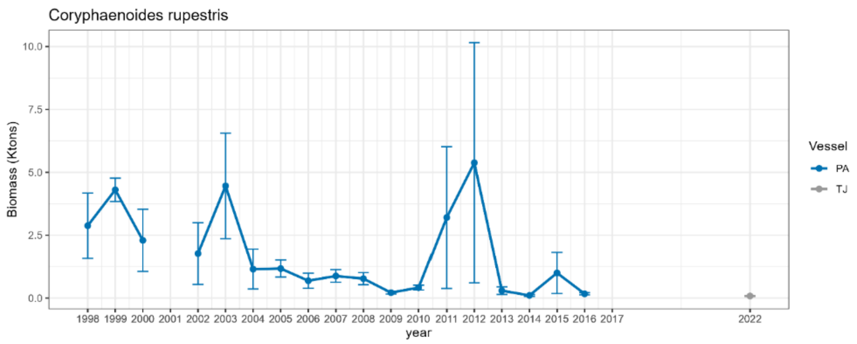


Figure 6.- Roundnose grenadier (RNG) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

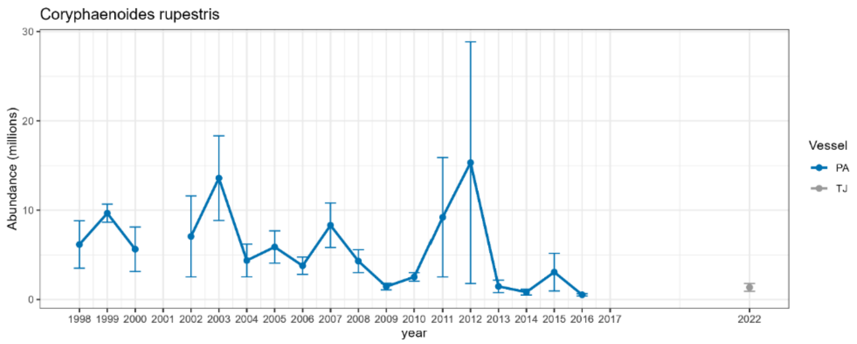


Figure 7. Distribution of survey catches of roundnose grenadier (RNG) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

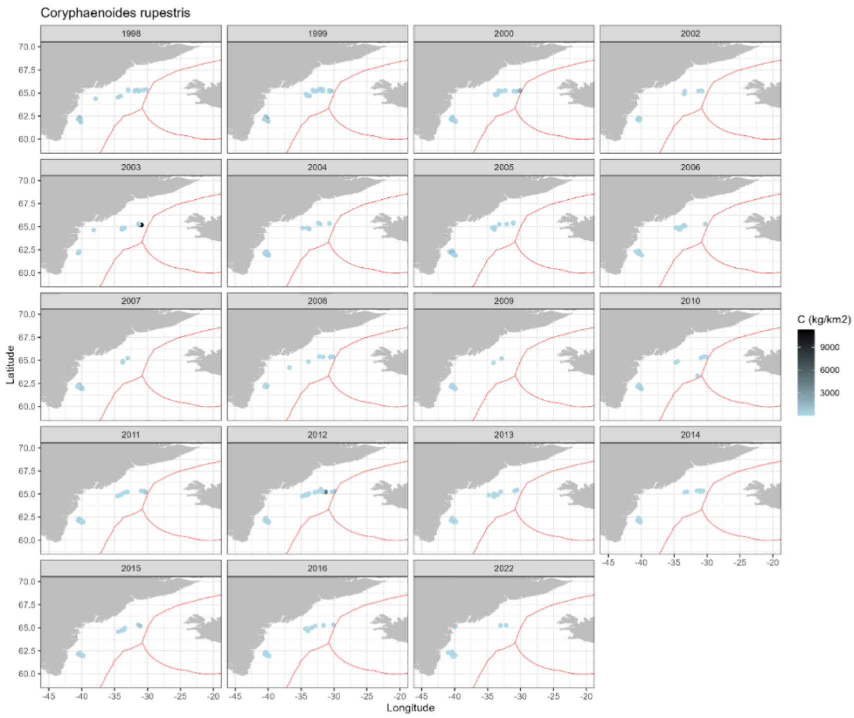


Fig. 8. Length frequency distribution per swept area of roundnose grenadier (RNG) for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

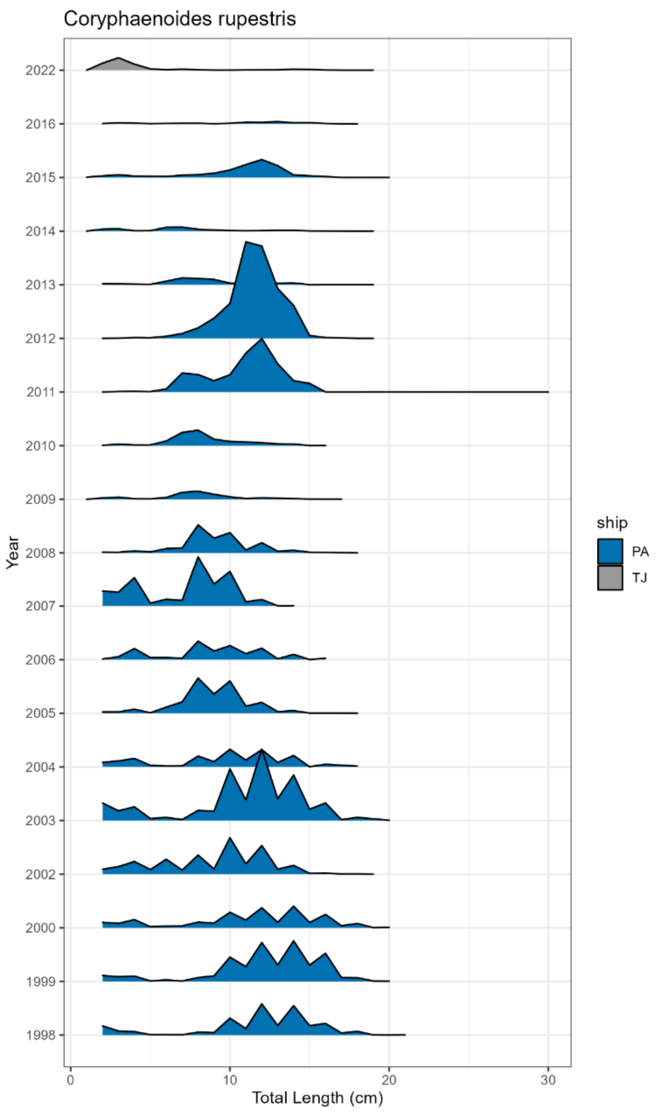


Figure 9. Greater argentine (ARU) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

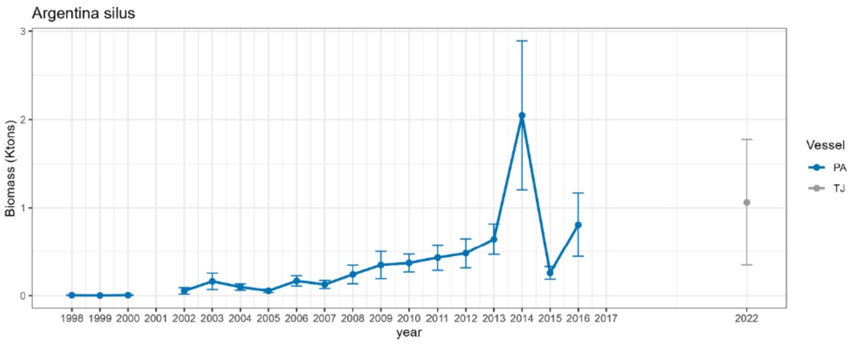


Figure 10. Greater argentine (ARU) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

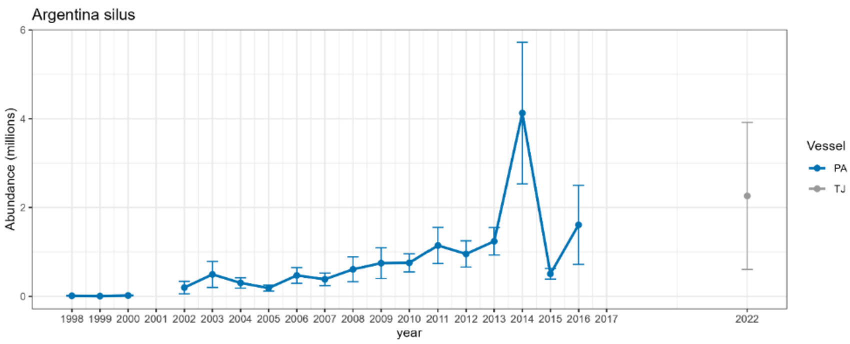


Figure 11. Distribution of survey catches of greater argentine (ARU) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

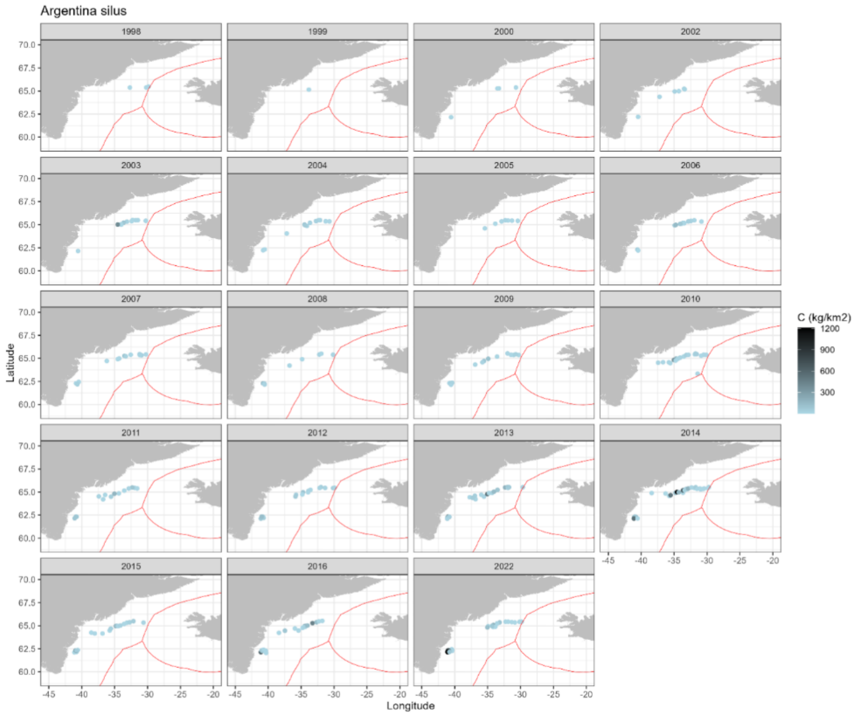


Fig. 12. Length frequency distribution per swept area of greater argentine (ARU) for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

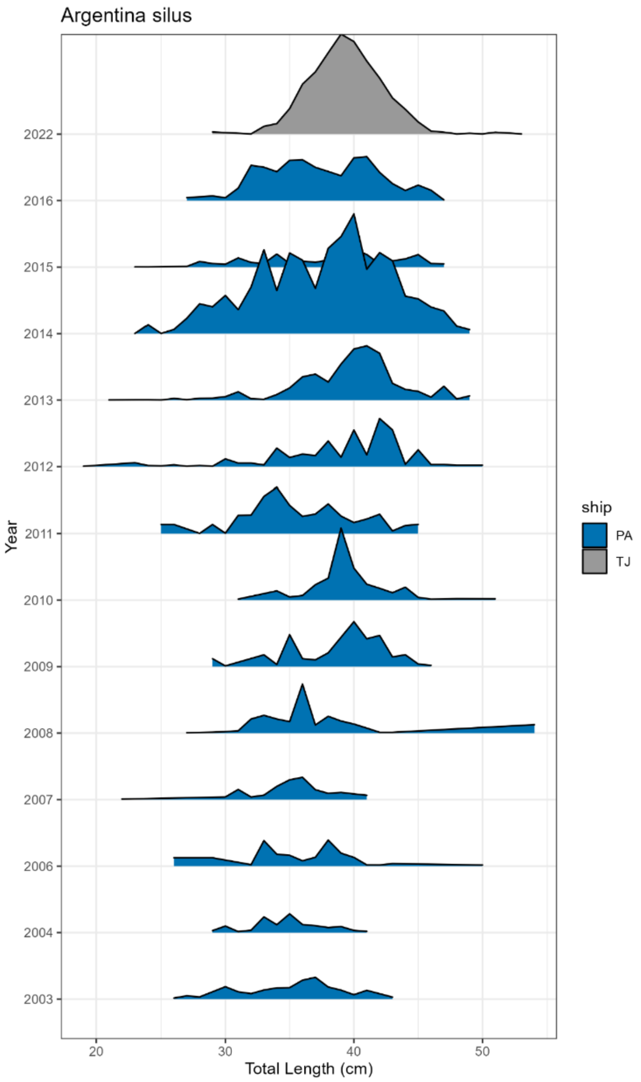


Figure 13. Tusk (USK) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

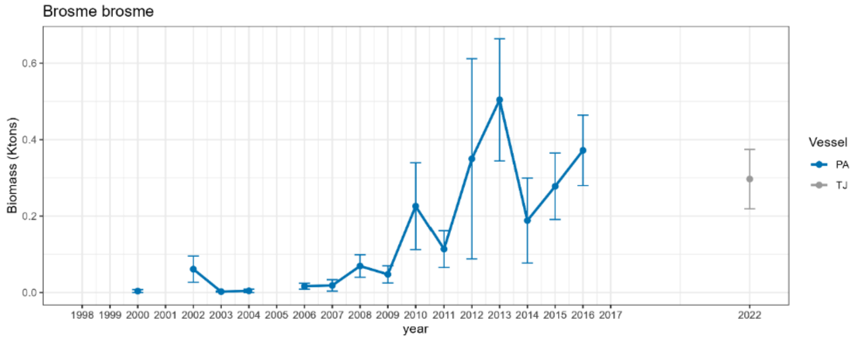


Figure 14. Tusk (USK) abundance (‘000s) calculated by swept area method and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

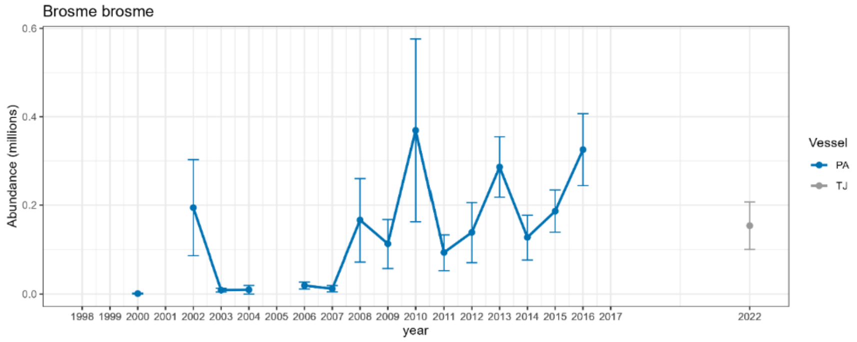


Figure 15. Distribution of survey catches of tusk (USK) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

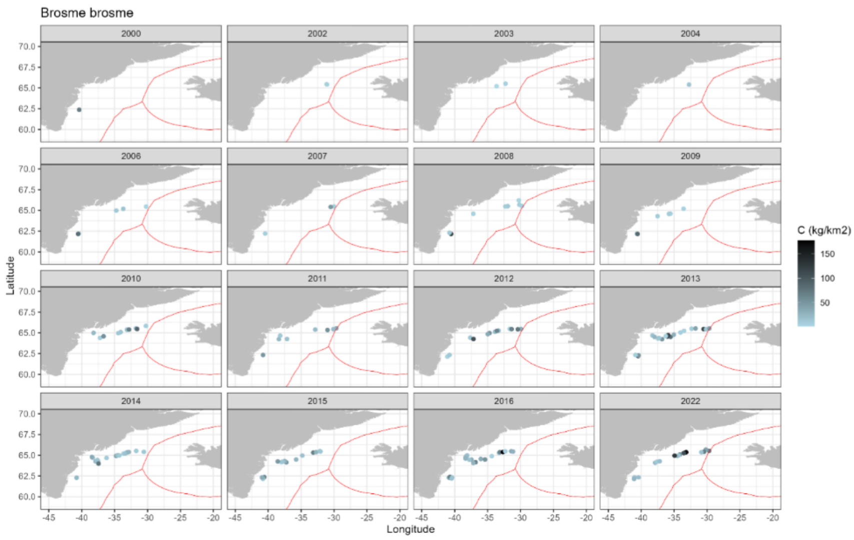


Fig. 16. Length frequency distribution per swept area of tusk (USK) for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq

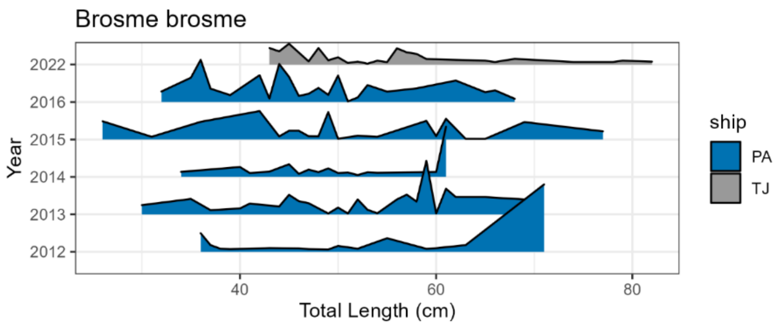


Figure 17. Blue ling (BLI) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

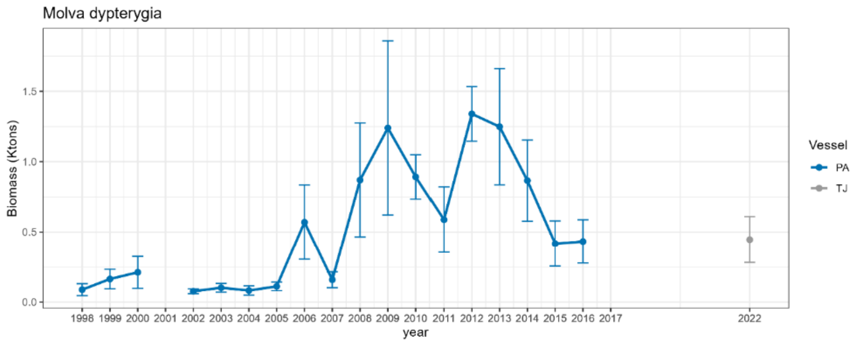


Figure 18. Blue ling (BLI) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

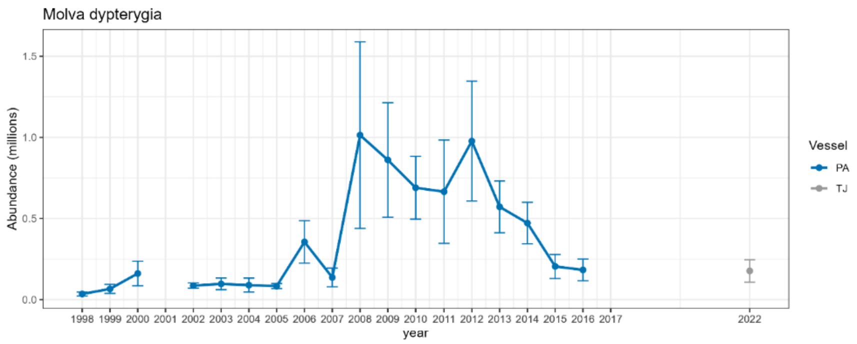


Figure 19. Distribution of survey catches of blue ling (BLI) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

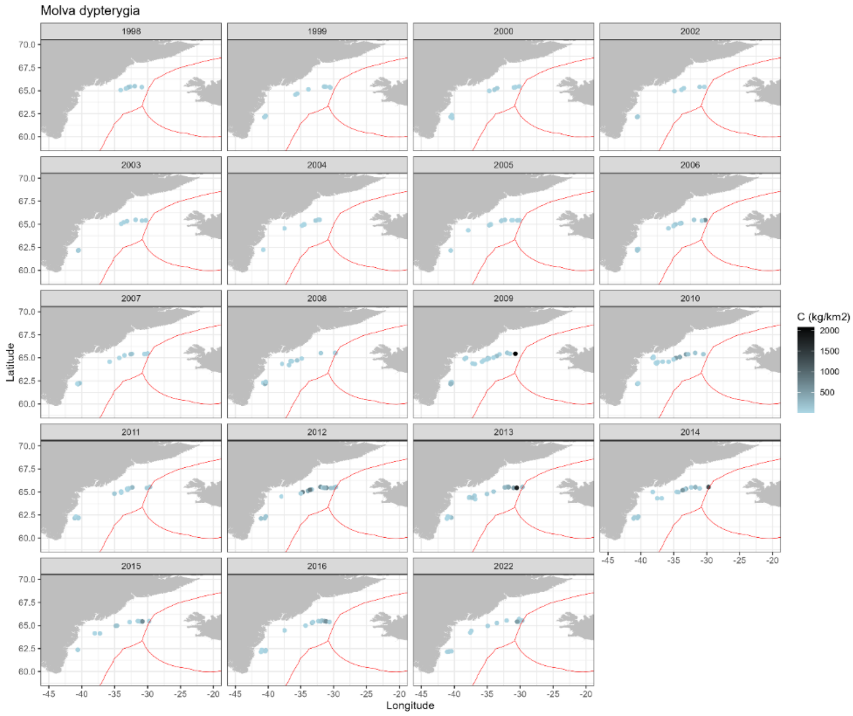


Fig. 20. Length frequency distribution per swept area of blue ling (BLI) for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq

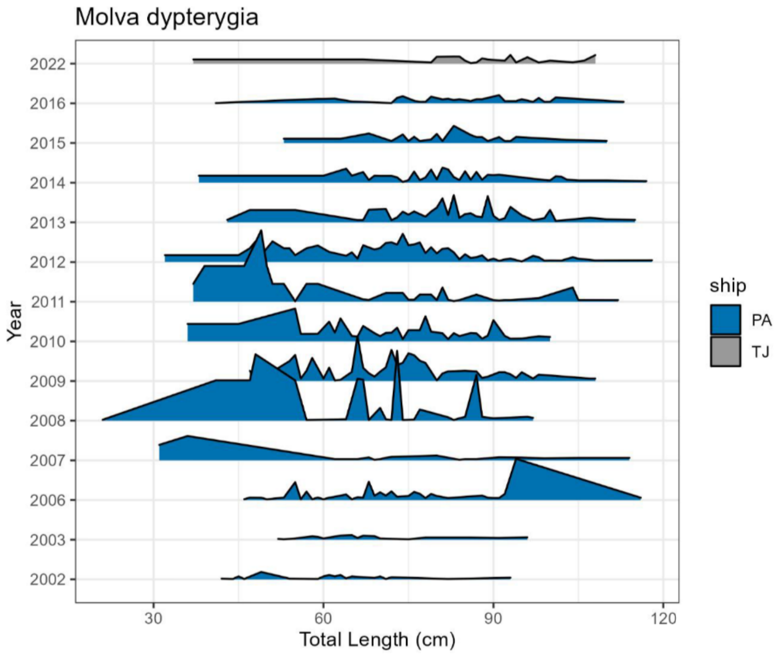


Figure 21.- Black scabbardfish (BSF) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

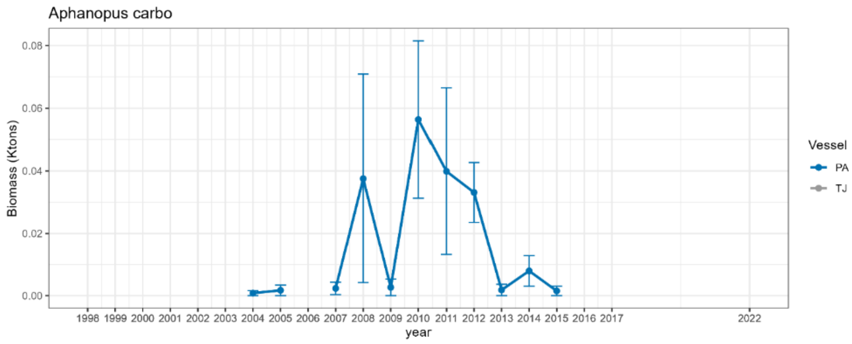


Figure 22.- Black scabbardfish(BSF) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

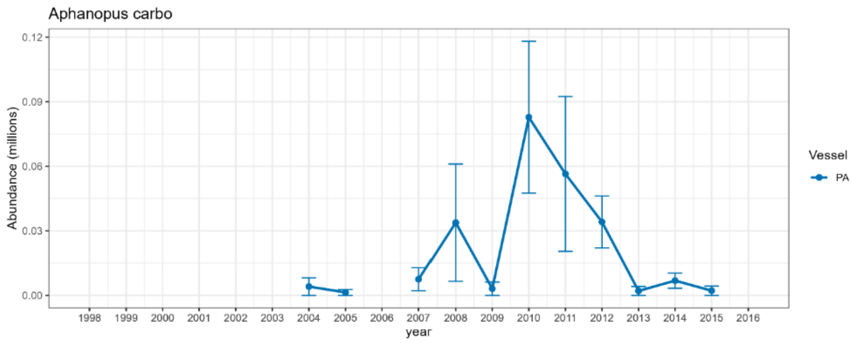


Figure 23. Distribution of survey catches of black scabbardfish (BSF) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

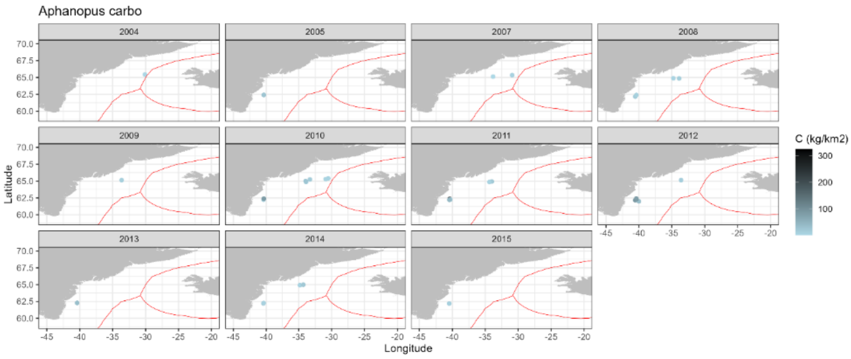


Figure 24.- Ling (LIN) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

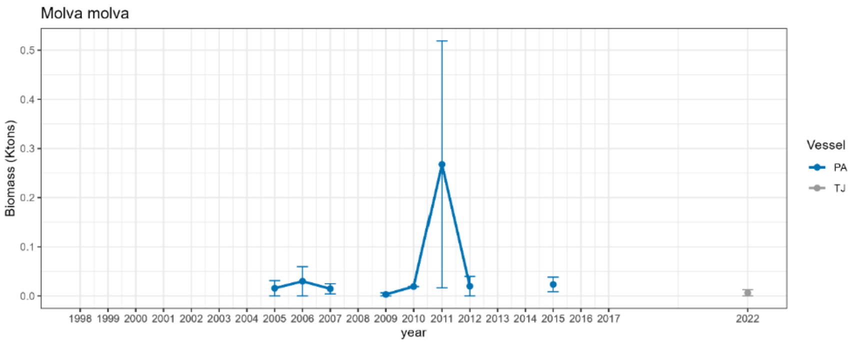


Figure 25.- Ling (LIN) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

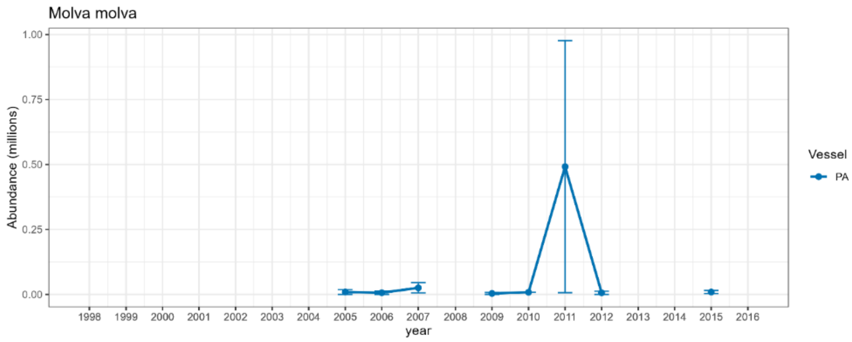


Figure 26. Distribution of survey catches of ling (LIN) off East Greenland (ICES 14.b) from 1998-2016 and 2022**.**

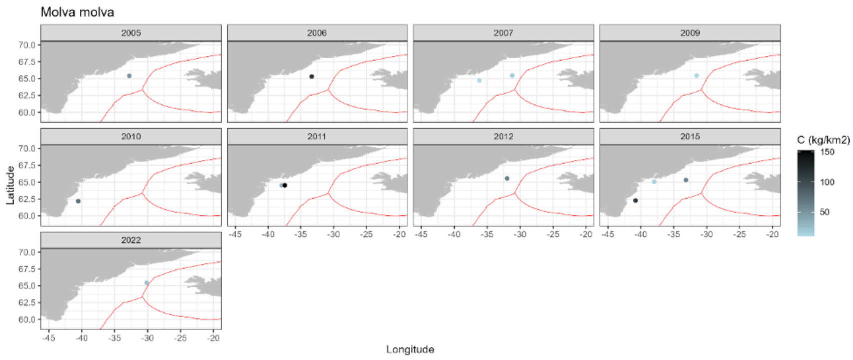


Figure 27.- Orange roughy (ORY) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

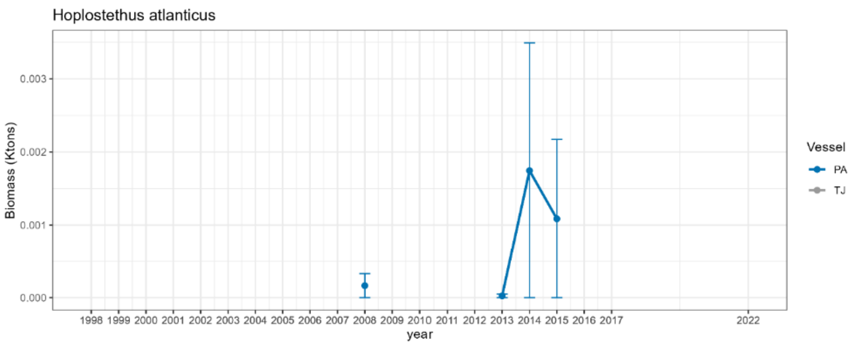


Figure 28.- Orange roughy (ORY) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

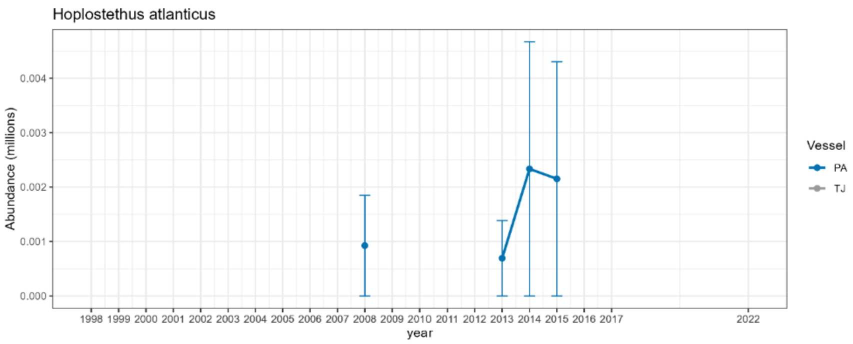
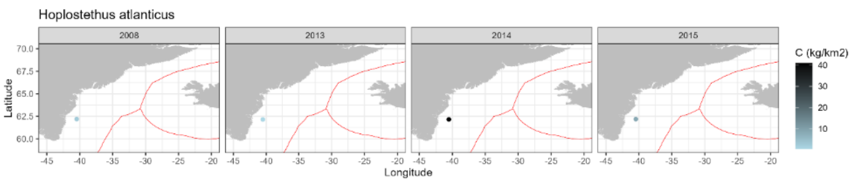


Figure 29. Distribution of survey catches of orange roughy (ORY) off East Greenland (ICES 14.b) in 1998-2016 and 2022.



Appendix 1. Catch weight and numbers (not standardized to kg/km2) of roughhead grenadier, roundnose grenadier, greater silver smelt and tusk by haul, in 2019. Depth in meters, swept area in km2 and bottom temperature in ºC.

						RHG		RNG		ARS		USK	
St. No	Swept Area	Subarea	Stratum	Depth	Bottom Temp.	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
1	0.0773	Q2	0801-1000	826.5	5.3	20.3	12	0	0	0.3	1	0	0
2	0.0731	Q2	0601-0800	634.5	2.21	244.5	146	0	0	0	0	4.8	4
3	0.0894	Q1	0401-0600	412.5	0.93	4.4	3	0	0	0	0	3.5	3
4	0.092	Q1	0401-0600	458	0.81	0	0	0	0	0	0	0	0
5	0.0923	Q1	0401-0600	507	0.71	0	0	0	0	0	0	0	0
6	0.0832	Q1	0401-0600	498	0.88	0.4	1	0	0	0	0	0	0
7	0.0764	Q1	0401-0600	448.5	0.72	0	0	0	0	0	0	0	0
11	0.1389	Q2	0601-0800	677.5	3.48	736.3	344	0	0	1.5	4	0	0
12	0.0548	Q2	0601-0800	618	3.83	541.8	223	0	0	0	0	3.8	1
13	0.1065	Q2	0801-1000	833.5	3.26	57.2	30	0	0	0.4	1	1.7	1
14	0.0742	Q2	1001-1500	1378	2.41	1.8	14	0	0	0	0	0	0
15	0.1033	Q2	0801-1000	838	2.97	23.8	17	0	0	0.8	2	0	0
16	0.096	Q2	0801-1000	883.5	1.46	553.7	265.2	0	0	0.6	1	0	0
17	0.1121	Q2	0401-0600	523	3.61	12.8	16	0	0	0	0	0	0
20	0.0976	Q2	0801-1000	964	3.04	58	54	0	0	1.1	2	0	0
21	0.0865	Q2	1001-1500	1422	1.93	10.1	8	0.7	1	0	0	0	0
22	0.0615	Q2	1001-1500	1073.5	2.67	131.4	68	0.6	1	0	0	0	0
23	0.0681	Q2	0401-0600	449.5	4.01	27	28	0	0	6.1	10	11.7	3
24	0.0888	Q2	0401-0600	466.5	3.69	17.8	23	0	0	2.2	3	9.7	3
25	0.1079	Q2	0801-1000	861.5	4.65	1.3	2	0	0	0.4	1	0	0
26	0.1019	Q2	0401-0600	441.5	5.45	0.4	1	0	0	20	35	5.6	2
27	0.1003	Q2	1001-1500	1075	2.02	201.8	90	0	0	0.7	1	0	0
28	0.0968	Q2	1001-1500	1208	3.2	8.3	12	0	0	0	0	0	0
29	0.1035	Q2	0801-1000	958.5	2.23	66.9	40	0	0	0.5	1	0	0
30	0.0986	Q2	0601-0800	689	4.8	21.3	12	0	0	8.2	14	1.1	1
31	0.0891	Q2	0801-1000	881.5	3.85	9.2	8	0	0	0	0	1.9	1
32	0.1003	Q2	0401-0600	470	4.49	1.4	1	0	0	0.9	1	13	3
33	0.1013	Q2	0601-0800	739	4.82	6.2	3	0	0	12.9	20	0	0
34	0.1081	Q2	1001-1500	1417.5	2.74	3.4	2	0	0	0	0	0	0
36	0.1015	Q2	1001-1500	1262.5	3.05	47	61	0	0	0	0	0	0
42	0.085	Q3	0601-0800	644.5	3.46	0.8	3	0	0	0	0	0	0
43	0.0974	Q3	0601-0800	680.5	3.45	5.2	4	0	0	0	0	0	0
44	0.0934	Q3	0601-0800	692	3.73	1.8	2	0	0	0	0	0	0
46	0.0884	Q3	0801-1000	842.5	3.72	0.7	1	0	0	0	0	0	0
49	0.0873	Q3	0601-0800	634.5	3.66	1.8	3	0	0	0	0	0	0
50	0.0905	Q3	0601-0800	780.5	3.72	0.8	4	0	0	0	0	0	0
56	0.0961	Q3	0801-1000	866	3.65	2.3	4	0	0	0	0	0	0
57	0.0967	Q3	0401-0600	426.5	3.75	0	0	0	0	0	0	0	0
59	0.0944	Q3	0401-0600	573.5	3.66	4.1	4	0	0	0	0	0	0
61	0.0989	Q3	0801-1000	849	3.61	1.4	2	0	0	0	0	0	0
62	0.0885	Q3	0801-1000	891	3.65	2.1	3	0	0	0	0	0	0
63	0.0898	Q3	0801-1000	817	3.65	5.2	8	0	0	0	0	0	0
64	0.1001	Q3	0401-0600	492.5	3.75	1.5	2	0	0	0	0	0	0
65	0.097	Q3	0401-0600	444	3.81	1.1	2	0	0	0	0	2	1
66	0.0879	Q3	0401-0600	578	3.71	0	0	0	0	0	0	0.9	1
67	0.0989	Q3	0601-0800	663.5	3.67	0.6	1	0	0	0	0	0	0
68	0.0948	Q3	0401-0600	520	3.65	2.4	2	0	0	0	0	1.9	1
69	0.0805	Q3	0401-0600	414.5	3.71	0	0	0	0	0	0	0	0
70	0.11	Q3	0401-0600	432	3.74	0	0	0	0	0	0	0	0
71	0.1007	Q3	0401-0600	424.5	3.77	0	0	0	0	0	0	0	0
80	0.0797	Q5	0401-0600	420.5	4.53	0	0	0	0	0.8	1	0	0
81	0.0752	Q5	0801-1200	912	4.55	0.7	2	1	52	0.4	1	0	0
82	0.0732	Q5	0601-0800	700.5	4.85	0	0	3.7	7	3.1	7	1.4	1
83	0.0717	Q5	0801-1200	897.5	4.65	3.5	5	3.3	502.8	0.4	1	0	0
86	0.0936	Q5	0601-0800	633	5.01	0	0	0	0	14.6	26	0	0
88	0.085	Q5	0601-0800	668.5	5.15	0.2	1	0.5	1	61.6	118.4	1.4	1
89	0.0854	Q5	0601-0800	647.5	5.03	9.2	9	0	0	74.2	113	1.4	1
91	0.0802	Q5	0401-0600	426.5	4.99	9.9	8	0	0	97	224	2.1	1
93	0.0709	Q5	0401-0600	436.5	5.03	0	0	0	0	5.2	10	0	0
94	0.0799	Q5	0801-1200	876	4.84	0	0	1	197.2	0	0	0	0
95	0.0629	Q5	0801-1200	988.5	4.63	8.4	13	4.4	476.3	0	0	0	0
96	0.0928	Q5	1201-1400	1316.5	3.23	6.8	9	3.7	24	0	0	0	0
97	0.0949	Q5	1201-1400	1290	3.38	4.1	8	9.6	44	0	0	0	0
98	0.0847	Q5	1201-1400	1344.5	3.28	9.3	11	3.6	9	0	0	0	0
99	0.0701	Q5	1201-1400	1332.5	3.31	16.3	16	6	10	0	0	0	0
100	0.0973	Q5	1201-1400	1296.5	3.39	2.3	4	6.2	21	0	0	0	0
101	0.0922	Q5	1201-1400	1268.5	3.71	0	0	2	4	0	0	0	0
104	0.0968	Q5	1401-1500	1445	3.25	3.8	6	0.2	7	0	0	0	0
105	0.0761	Q5	1401-1500	1418	2.93	13.6	9	0.3	1	0	0	0	0
106	0.076	Q5	1401-1500	1434	3.03	3.9	7	0	0	0	0	0	0
107	0.0768	Q5	1401-1500	1426	2.98	9.2	12	0	0	0	0	0	0
108	0.0849	Q5	1401-1500	1442	3.26	12.4	13	1.3	4	0	0	0	0
109	0.0827	Q5	1201-1400	1229	3.35	2.9	6	1.1	4	0	0	0	0

Appendix 2. Catch weight and numbers (not standardized to kg/km2) of blue ling, black scabbardfish, ling, and orange roughy by haul, in 2019. Depth in meters, swept area in km2 and bottom temperature in ºC.

St. No	Swept Area	Subarea	Stratum	Depth	ɔttom Tem	BLI Weight (kg)	BLI Number	BSF Weight (kg)	BSF Number	LIN Weight (kg)	LIN Number	HAT Weight (kg)	HAT Number
1	0.0773	Q2	0801-1000	826.5	5.3	0	0	0	0	0	0	0	0
2	0.0731	Q2	0601-0800	634.5	2.21	8.5	2	0	0	0	0	0	0
3	0.0894	Q1	0401-0600	412.5	0.93	3.1	1	0	0	0	0	0	0
4	0.092	Q1	0401-0600	458	0.81	0	0	0	0	0	0	0	0
5	0.0923	Q1	0401-0600	507	0.71	0	0	0	0	0	0	0	0
6	0.0832	Q1	0401-0600	498	0.88	0	0	0	0	0	0	0	0
7	0.0764	Q1	0401-0600	448.5	0.72	0	0	0	0	0	0	0	0
11	0.1389	Q2	0601-0800	677.5	3.48	15.1	5	0	0	3	1	0	0
12	0.0548	Q2	0601-0800	618	3.83	28.7	10	0	0	0	0	0	0
13	0.1065	Q2	0801-1000	833.5	3.26	0	0	0	0	0	0	0	0
14	0.0742	Q2	1001-1500	1378	2.41	0	0	0	0	0	0	0	0
15	0.1033	Q2	0801-1000	838	2.97	0	0	0	0	0	0	0	0
16	0.096	Q2	0801-1000	883.5	1.46	0	0	0	0	0	0	0	0
17	0.1121	Q2	0401-0600	523	3.61	4	2	0	0	0	0	0	0
20	0.0976	Q2	0801-1000	964	3.04	0	0	0	0	0	0	0	0
21	0.0865	Q2	1001-1500	1422	1.93	0	0	0	0	0	0	0	0
22	0.0615	Q2	1001-1500	1073.5	2.67	0	0	0	0	0	0	0	0
23	0.0681	Q2	0401-0600	449.5	4.01	0	0	0	0	0	0	0	0
24	0.0888	Q2	0401-0600	466.5	3.69	5.4	1	0	0	0	0	0	0
25	0.1079	Q2	0801-1000	861.5	4.65	0	0	0	0	0	0	0	0
26	0.1019	Q2	0401-0600	441.5	5.45	0	0	0	0	0	0	0	0
27	0.1003	Q2	1001-1500	1075	2.02	0	0	0	0	0	0	0	0
28	0.0968	Q2	1001-1500	1208	3.2	0	0	0	0	0	0	0	0
29	0.1035	Q2	0801-1000	958.5	2.23	0	0	0	0	0	0	0	0
30	0.0986	Q2	0601-0800	689	4.8	0	0	0	0	0	0	0	0
31	0.0891	Q2	0801-1000	881.5	3.85	0	0	0	0	0	0	0	0
32	0.1003	Q2	0401-0600	470	4.49	5.9	1	0	0	0	0	0	0
33	0.1013	Q2	0601-0800	739	4.82	0	0	0	0	0	0	0	0
34	0.1081	Q2	1001-1500	1417.5	2.74	0	0	0	0	0	0	0	0
36	0.1015	Q2	1001-1500	1262.5	3.05	0	0	0	0	0	0	0	0
42	0.085	Q3	0601-0800	644.5	3.46	0	0	0	0	0	0	0	0
43	0.0974	Q3	0601-0800	680.5	3.45	0	0	0	0	0	0	0	0
44	0.0934	Q3	0601-0800	692	3.73	0	0	0	0	0	0	0	0
46	0.0884	Q3	0801-1000	842.5	3.72	0	0	0	0	0	0	0	0
49	0.0873	Q3	0601-0800	634.5	3.66	0	0	0	0	0	0	0	0
50	0.0905	Q3	0601-0800	780.5	3.72	0	0	0	0	0	0	0	0
56	0.0961	Q3	0801-1000	866	3.65	0	0	0	0	0	0	0	0
57	0.0967	Q3	0401-0600	426.5	3.75	0	0	0	0	0	0	0	0
59	0.0944	Q3	0401-0600	573.5	3.66	3.6	1	0	0	0	0	0	0
61	0.0989	Q3	0801-1000	849	3.61	0	0	0	0	0	0	0	0
62	0.0885	Q3	0801-1000	891	3.65	0	0	0	0	0	0	0	0
63	0.0898	Q3	0801-1000	817	3.65	0	0	0	0	0	0	0	0
64	0.1001	Q3	0401-0600	492.5	3.75	0	0	0	0	0	0	0	0
65	0.097	Q3	0401-0600	444	3.81	0	0	0	0	0	0	0	0
66	0.0879	Q3	0401-0600	578	3.71	2.3	1	0	0	0	0	0	0
67	0.0989	Q3	0601-0800	663.5	3.67	0	0	0	0	0	0	0	0
68	0.0948	Q3	0401-0600	520	3.65	0	0	0	0	0	0	0	0
69	0.0805	Q3	0401-0600	414.5	3.71	0	0	0	0	0	0	0	0
70	0.11	Q3	0401-0600	432	3.74	0	0	0	0	0	0	0	0
71	0.1007	Q3	0401-0600	424.5	3.77	0	0	0	0	0	0	0	0
80	0.0797	Q5	0401-0600	420.5	4.53	0	0	0	0	0	0	0	0
81	0.0752	Q5	0801-1200	912	4.55	0	0	0	0	0	0	0	0
82	0.0732	Q5	0601-0800	700.5	4.85	0	0	0	0	0	0	0	0
83	0.0717	Q5	0801-1200	897.5	4.65	0	0	0	0	0	0	0	0
86	0.0936	Q5	0601-0800	633	5.01	0	0	0	0	0	0	0	0
88	0.085	Q5	0601-0800	668.5	5.15	0	0	0	0	0	0	0	0
89	0.0854	Q5	0601-0800	647.5	5.03	0	0	0	0	0	0	0	0
91	0.0802	Q5	0401-0600	426.5	4.99	2.5	6	0	0	0	0	0	0
93	0.0709	Q5	0401-0600	436.5	5.03	5.3	1	0	0	0	0	0	0
94	0.0799	Q5	0801-1200	876	4.84	0	0	0	0	0	0	0	0
95	0.0629	Q5	0801-1200	988.5	4.63	2.6	1	0	0	0	0	0	0
96	0.0928	Q5	1201-1400	1316.5	3.23	0	0	0	0	0	0	0	0
97	0.0949	Q5	1201-1400	1290	3.38	0	0	0	0	0	0	0	0
98	0.0847	Q5	1201-1400	1344.5	3.28	0	0	0	0	0	0	0	0
99	0.0701	Q5	1201-1400	1332.5	3.31	0	0	0	0	0	0	0	0
100	0.0973	Q5	1201-1400	1296.5	3.39	0	0	0	0	0	0	0	0
101	0.0922	Q5	1201-1400	1268.5	3.71	0	0	0	0	0	0	0	0
104	0.0968	Q5	1401-1500	1445	3.25	0	0	0	0	0	0	0	0
105	0.0761	Q5	1401-1500	1418	2.93	0	0	0	0	0	0	0	0
106	0.076	Q5	1401-1500	1434	3.03	0	0	0	0	0	0	0	0
107	0.0768	Q5	1401-1500	1426	2.98	0	0	0	0	0	0	0	0
108	0.0849	Q5	1401-1500	1442	3.26	0	0	0	0	0	0	0	0
109	0.0827	Q5	1201-1400	1229	3.35	0	0	0	0	0	0	0	0

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Commercial catches of roughhead grenadier, roundnose grenadier, greater argentine, tusk, blue ling, black scabbardfish, ling, and orange roughy in ICES 14 in the period 1999-2022.

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Abstract

Yearly and monthly logbook information, and CPUE distribution from 1999 to 2022 for roughhead grenadier (*Macrourus berglax*; RHG), roundnose grenadier (*Coryphaenoides rupestris*; RNG), greater argentine (*Argentina silus*; ARU), tusk (*Brosme brosme*; USK), blue ling (*Molva dypterygia*; BLI), black scabbardfish (*Aphanopus carbo*; BSF), ling (*Molva molva*; LIN), and orange roughy (*Hoplostethus atlanticus*; ORY), in East Greenland, ICES 14, are presented in this document. Also catches by gear and by division (14a and 14b). Data presented are a mix of targeted catches and bycatch of the Greenland halibut fishery in East Greenland in 14b.

1. Introduction

Commercial trawl and longline fisheries operate in ICES Division 14.b off East Greenland. This document presents information recorded in logbooks of these fisheries in the time period from 1999 to 2022. The species presented here are roughhead grenadier (*Macrourus berglax*; RHG), roundnose grenadier (*Coryphaenoides rupestris*; RNG), greater argentine (*Argentina silus*; ARU), tusk (*Brosme brosme*; USK), blue ling (*Molva dypterygia*; BLI), black scabbardfish (*Aphanopus carbo*; BSF), ling (*Molva molva*; LIN), and orange roughy (*Hoplostethus atlanticus*; ORY). The numbers presented in previous working documents have been updated.

Catch quotas have been set for the following of these species: grenadiers (RNG and RHG combined), tusk, blue ling, and greater argentine. The total allowable catch (TAC) for grenadiers was 3 000 tonnes (t) in 2007, 2 000 t in 2008-2009, and 1 000 tons in 2010-2022. For tusk the TAC was 500 t in 2014 and 1 500 t from 2015-2022. For blue ling the TAC was 500 t in 2014 and no quota has been set since. For greater Argentine the TAC was 10 000 t in 2013-2015 and no quota has been set since. The TAC is set by the Government of Greenland.

2. Materials and Methods

Logbooks have been mandatory for vessels greater than 30 ft (9.4 m) since 2008. Data about all logbooks records are reported to the Greenland Fishery License Authority (GFLK). Trawlers and longliners gather information about their fishery, including effort and location for individual fishing events, and send the data to GFLK on a weekly basis. Data presented here is a mix of targeted catches (greater Argentine fishery from 2015 and 2018 abd tusk fishery from 2014) and bycatch during the fishery for Greenland halibut in ICES Division 14.b (from 1999). From 2005 (except 2006) small catches for grenadiers come from 14a due to the expansion of the Greenland halibut fishery to a norther fishing ground between 67°N and 68°30'N.

3. Results and discussion

Roughhead grenadier (*Macrourus berglax*; RHG)

Only 0.01 t, in 2000, of grenadier were caught between 1999 and 2004. From 2005 to 2013 catches remained very low (mean catches 2005-2013 = 7.8 t), whereas it increased to an average of 71.2 tons between 2014 and 2018. In 2019, catches dropped to only 1 t. Catches have been increasing from 2020 (23.17 t) to 2022 reaching the highest catches since 1999 (85.23t) (Table 1 , 2 and 4, Fig. 1 and 2). From 2014 reported catches of roughhead grenadier on long lines are much higher, which might be linked to the onset of targeted long line fishery after tusk in 2014 (Table 3). There are no explanations for the drastic drop to only 1.0 tons in 2019, which has been reported by only a single vessel. Possibly, this is due to misidentification. Most of the catches are from 14b, a few catches were found years 2013, 2016-2017 and 2021 in 14a, due to the expansion of the Greenland halibut fishery to a northern fishing ground (Table 2, Fig.2 and 3).
From the surveys documents (Nielsen et al., 2019, Nogueira and Christiansen, 2023), it was established that roughhead grenadier is much more common than roundnose grenadier in ICES 14b. Therefore, it is likely that there is misidentification of grenadier species confounding the logbook data of roundnose grenadier and roughhead grenadier. Regardless of this, the TAC of 1.000 tons for grenadiers in East Greenland (roughhead and roundnose combined) is not reached any years.

Roundnose grenadier (*Coryphaenoides rupestris*; RNG)

Catches of roundnose grenadier have been relatively stable (annual mean catch=91.4 tons) throughout the evaluated time period (1999 to 2022) ranging from 30.6 tons (2008) to 167.4 tons (2021) (Table 1 and 5, Fig.1). Most of the catches are also from 14b, a few catches are found from 2005 in 14a, due to the expansion of the Greenland halibut fishery, this year, to a northern fishing ground (Table 2, Fig.4 and 5).The majority of this is caught as bycatch by trawlers, whereas longlines conduct a smaller fraction most of the years, only years 2019 and 2021 catches with lonliners are higher than with trawlers (Table3).
As mentioned for roughhead grenadier, the catch of roudnose grenadier is possibly overestimated due to incorrect species identification.

Greater argentine (*Argentina silus*; ARU)

From 1990 to 2013, there are only reported catches in 2002 (0.4 t). From 2014 to 2022 catches have been very low except years 2017 and 2018 (666.6 t and 425.1 t), which is due to the onset of targeted pelagic trawl fishery for the species since 2015. This targeted fishery ceased in 2019 thus low catches, since then are reported (Table 1, 3 and 6, Fig. 1 and 6).

Tusk (*Brosme brosme*; USK)

Catches of tusk have been low between 1999 to 2013 were much lower (mean annual catch=30.1 tons) compared to catches from 2015 to 2022 (mean annual catch =527.34 tons) (Table 1, 3 and 7, Fig. 1 and 7). The catch is dominated by long lines throughout the time series (Table 3). The increase in catches corresponds with the initiation of targeted fishery in 2014 where TAC was 500 tons, which was increased by the Greenland government to 1500 tons, from 2015 to 2022.

Blue ling (*Molva dypterygia*; BLI)

Catches of blue ling have been low from 1999 to 2009 (annual mean catch =3.2 tons), increasing since then, and picking in 2015 (65.4 t). Catches increased from 2010 (annual mean catch =22.6 tons, Table 1,3 and 8 Fig. 1 and 8). Blue ling was mostly caught in trawl fisheries and the composition between longline and trawl catches remains relatively constant except in 2015, where the largest trawl catch of 65.5 tons was reported (Table 3).

Black scabbardfish (*Aphanopus carbo*; BSF)

Black scabbardfish was only caught in 2010 (30kg) and 2011 (180 kg) in the month of September (Table 1 and 7, Figure 1 and 9).

Ling (*Molva molva*; LIN)

Catches of ling were fluctuating between years with no apparent trend over time (Fig. 7). In 2005, 2006, 2015 and 2016 catches were above 15 tons, whereas catches were below 5 tons in 2000-2003, 2007, 2009-2013 and 2017-2022 (Table 1 , 3 and 10 Fig. 1 and 10). The majority of catches are from trawler, expect in 2015 (Table 3).

Orange roughy (*Hoplostethus antlanticus*; ORY)

Orange roughy was caught only in 2007 and 2010 (0.4 and 0.8 t respectively, Table 1 and 11, Figure 1 and 11).

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Table 1. Total annual commercial catches (tons) of roughhead grenadier (*Macrourus berglax*; RHG), roundnose grenadier (*Coryphaenoides rupestris*; RNG), greater Argentine (*Argentina silus*; ARU), tusk (*Brosme brosme),* blue ling (*Molva dypterygia*; BLI),; USK), black scabbardfish (*Aphanopus carbo*; BSF), ling (*Molva molva*; LIN), and orange roughy (*Hoplostethus atlanticus*; ORY), in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	RHG	RNG	ARU	USK	BLI	BSF	LIN	ORY
1999	0	129.4	0	5.2	0.1	0	8	0
2000	0.01	95.1	0	0	1.4	0	0	0
2001	0	84.5	0	23.3	0.6	0	0.7	0
2002	0	54.7	0.45	0	0.2	0	0.3	0
2003	0	54.2	0	2.2	2.6	0	0.2	0
2004	0	101.4	0	17	7	0	7.1	0
2005	20	61.4	0	39.3	5.6	0	17.7	0
2006	4.4	64.4	0	102.2	5.9	0	18.6	0
2007	3.8	43	0	18.7	1.3	0	1.5	0.4
2008	11.4	30.6	0	20.7	4.8	0	11	0
2009	3.5	44.2	0	15.9	5.4	0	4.6	0
2010	11.4	59.8	0	15.1	7.4	0.03	3.1	0.8
2011	2.2	136.4	0	91.1	8	0.2	4.8	0
2012	13.4	123.3	0	74.6	13	0	5.1	0
2013	0.3	128	0	27.6	15.7	0	2.4	0
2014	61.6	99.7	4.16	167.3	13.9	0	8	0
2015	38.2	139.7	12.21	878.8	65.4	0	20.4	0
2016	75.1	63.5	16.62	562.4	8.6	0	15.2	0
2017	92.8	93.1	666.75	763.2	11.9	0	4.5	0
2018	89.1	128.6	425.19	684.5	33.6	0	4.6	0
2019	0.9	157.1	3.37	386.6	45.4	0	1.9	0
2020	23.2	46.9	28.1	216	26.8	0	1.5	0
2021	55.5	167.4	15.39	720.1	17	0	1.4	0
2022	86.2	134	0.82	367.2	27.3	0	0.7	0

Table 2. Total annual commercial catches (tons) of roughhead grenadier (*Macrourus berglax*; RHG), roundnose grenadier (*Coryphaenoides rupestris*; RNG), greater Argentine (*Argentina silus*; ARU), tusk (*Brosme brosme),* blue ling (*Molva dypterygia*; BLI),; USK), black scabbardfish (*Aphanopus carbo*; BSF), ling (*Molva molva*; LIN), and orange roughy (*Hoplostethus atlanticus*; ORY), in the Greenlandic EEZ zone of ICES in Division 14a and 14b from 1999 to 2022.

	RHG		RNG		ARU	USK		BLI		BSF		LIN	ORY	
Year	14a	14b	14a	14b	14b	14a	14b	14a	14b	14a	14b	14b	14a	14b
1999	0	0	0	129.41	0	0	5.19	0	0.15	0	0	8.05	0	0
2000	0	0.01	0	95.14	0	0	0	0	1.4	0	0	0	0	0
2001	0	0	0	84.52	0	0	23.34	0	0.56	0	0	0.73	0	0
2002	0	0	0	54.73	0.45	0	0	0	0.24	0	0	0.34	0	0
2003	0	0	0	54.24	0	0	2.19	0	2.62	0	0	0.2	0	0
2004	0	0	0	101.45	0	0	16.95	0	7.05	0	0	7.1	0	0
2005	0	19.99	0.18	61.22	0	0	39.32	0	5.64	0	0	17.69	0	0
2006	0	4.37	0	64.42	0	0	102.19	0	5.92	0	0	18.62	0	0
2007	0	3.85	0.01	43.01	0	0	18.66	0	1.27	0	0	1.53	0	0.4
2008	0	11.41	0	30.59	0	0	20.71	0	4.83	0	0	11.05	0	0
2009	0	3.48	0.09	44.07	0	0	15.93	0	5.38	0	0	4.64	0	0
2010	0	11.38	0.04	59.76	0	0	15.1	0	7.45	0	0.03	3.14	0	0.82
2011	0	2.21	0.18	136.25	0	0	91.11	0	7.95	0	0.18	4.79	0	0
2012	0	13.41	0.51	122.82	0	0	74.6	0	13.02	0	0	5.1	0	0
2013	0.01	0.26	0.09	127.94	0	0	27.63	0	15.7	0	0	2.36	0	0
2014	0	61.61	0.9	98.81	4.16	0	167.33	0	13.86	0	0	7.97	0	0
2015	0	38.19	0	139.69	12.21	0	878.76	0	65.42	0	0	20.45	0	0
2016	0.58	74.53	0	63.5	16.62	0	562.4	0	8.63	0	0	15.19	0	0
2017	0.04	92.77	0.44	92.65	666.75	0	763.16	0	11.94	0	0	4.48	0	0
2018	0	89.11	1.7	126.92	425.19	0	684.53	0.03	33.55	0	0	4.58	0	0
2019	0	0.94	0.16	156.93	3.37	0	386.65	0	45.41	0	0	1.89	0	0
2020	0	23.17	0.49	46.45	28.1	0	215.99	0	26.76	0	0	1.53	0	0
2021	1.96	53.54	1.39	166.04	15.39	0	720.1	0	17.04	0	0	1.42	0	0
2022	1	85.25	22.7	111.28	0.82	0	367.24	0	27.29	0	0	0.71	0	0

Table 3. Total annual commercial catches (tons) by gear of roughhead grenadier (*Macrourus berglax*; RHG), roundnose grenadier (*Coryphaenoides rupestris*; RNG), greater Argentine (*Argentina silus*; ARU), tusk (*Brosme brosme),* blue ling (*Molva dypterygia*; BLI),; USK), black scabbardfish (*Aphanopus carbo*; BSF), ling (*Molva molva*; LIN), and orange roughy (*Hoplostethus atlanticus*; ORY), in the Greenlandic EEZ zone of ICES (Divisions 14a and 14b) from 1999 to 2022.

	RHG			RNG			ARY	USK				BLI				BSF	LIN			ORY
Year	BTM	LL	GN	BTM	LL	Other	BTM	BTM	GN	LL	Other	BTM	GN	LL	Other	BTM	BTM	LL	Other	BTM
1999	0	0	0	129.37	0.04	0	0	1.02	0	4.17	0	0	0	0.15	0	0	8.05	0	0	0
2000	0.01	0	0	78.04	17.1	0	0	0	0	0	0	1.4	0	0	0	0	0	0	0	0
2001	0	0	0	71.96	12.56	0	0	23.34	0	0	0	0.56	0	0	0	0	0.73	0	0	0
2002	0	0	0	52.01	0	2.72	0.45	0	0	0	0	0.24	0	0	0	0	0.34	0	0	0
2003	0	0	0	54.24	0	0	0	2.19	0	0	0	2.62	0	0	0	0	0.2	0	0	0
2004	0	0	0	101.45	0	0	0	16.95	0	0	0	7.05	0	0	0	0	7.1	0	0	0
2005	19.99	0	0	61.4	0	0	0	39.12	0	0	0.2	5.64	0	0	0	0	17.69	0	0	0
2006	4.37	0	0	64.42	0	0	0	100.3	0	1.89	0	5.92	0	0	0	0	18.62	0	0	0
2007	3.85	0	0	42.37	0.65	0	0	11.39	0	7.27	0	0.27	0	1.01	0	0	1.53	0	0	0.4
2008	11.41	0	0	28.91	1.69	0	0	12.74	0	7.97	0	3.64	0	1.19	0	0	10.91	0.14	0	0
2009	3.48	0	0	37.03	0	7.13	0	0	0	0.04	15.89	3.91	0	0	1.48	0	3.41	0	1.22	0
2010	11.38	0	0	53.5	6.31	0	0	0	0	13.94	1.17	2.29	0	5.16	0	0.03	3.14	0	0	0.82
2011	2.21	0	0	130.91	5.52	0	0	0.03	0	91.07	0	5.73	0	2.22	0	0.18	2.98	1.81	0	0
2012	13.34	0.06	0	115.68	7.65	0	0	0	0	59.51	15.09	4.92	0	7.83	0.27	0	4.46	0.64	0	0
2013	0.26	0.01	0	125.89	2.13	0	0	0.46	0	14.37	12.81	15.7	0	0	0	0	0.02	1.86	0.47	0
2014	16.03	21.18	24.4	94.04	5.67	0	4.16	0.04	4.13	163.17	0	8.76	0.74	4.36	0	0	5.39	2.58	0	0
2015	3.48	34.71	0	104.9	34.79	0	12.21	0.57	0	876.76	1.43	64.84	0	0.58	0	0	2.57	17.87	0	0
2016	4.72	70.39	0	55.12	8.38	0	16.62	2.45	0	559.94	0	7.13	0	1.51	0	0	2.09	13.1	0	0
2017	0.41	92.4	0	87.82	5.27	0	666.75	1	0	762.17	0	6.98	0	4.95	0	0	1.02	3.46	0	0
2018	0.6	88.51	0	123.06	5.56	0	425.19	101.44	0	583.09	0	31.9	0	1.68	0	0	4.05	0.52	0	0
2019	0.94	0	0	61.92	95.17	0	3.37	2.25	0	384.4	0	26.79	0	18.62	0	0	1.71	0.17	0	0
2020	8.59	14.57	0	43.42	3.51	0	28.1	2.84	0	213.15	0	24.89	0	1.87	0	0	1.3	0.23	0	0
2021	10.88	44.62	0	54.97	112.46	0	15.39	4.03	0	716.08	0	10.71	0	6.33	0	0	0.88	0.54	0	0
2022	16.96	69.29	0	81.98	51.99	0	0.82	1.47	0	365.77	0	21.73	0	5.56	0	0	0.71	0	0	0

Table 4. Total monthly commercial catches (tons) of roughhead grenadier (RHG) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0.01	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	3.97	10.14	0.22	5.66	0	0	0
2006	0	0	0	0	1.3	1.76	0.21	1.1	0	0	0	0
2007	0	0	0	0	1.69	1.53	0.58	0	0.05	0	0	0
2008	0	0	0	0.39	1.9	1.53	2.71	2.68	1.42	0.77	0	0
2009	0	0	0.13	0.69	1.42	0.37	0	0.05	0.69	0	0.14	0
2010	0	0	0	0	2.16	1	4.05	1.2	0.13	2.82	0	0
2011	0	0	0	0	0	0	0.86	1.35	0	0	0	0
2012	0	0	0	9.05	4.19	0.17	0	0	0	0	0	0
2013	0	0	0	0	0	0.01	0.26	0	0	0	0	0
2014	0	0	0	21.36	28.94	0.34	7.18	0.19	0	0	0	3.61
2015	0	0	17.07	17.65	0	0	0	0	3.48	0	0	0
2016	0.8	25.33	30.85	13.41	0	2.45	1.86	0.4	0	0	0	0
2017	0	0	51.1	41.3	0	0	0	0	0	0.41	0	0
2018	0	0	50.48	37.1	1.53	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0.33	0.62	0	0
2020	0	0.87	0.83	0.54	0.91	2.65	13.59	2.54	0.54	0.62	0.08	0
2021	0	0	0	0.04	3.9	12.55	27.24	8	0.88	1.03	1.32	0.54
2022	0	0.2	15.07	14.1	1.17	0.21	0.58	5.86	8.79	39.62	0.66	0
Total	0.8	26.4	165.53	155.63	49.11	28.54	69.27	23.59	21.97	45.89	2.2	4.15

Table 5. Total monthly commercial catches (tons) of roundnose grenadier (RNG) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	12.78	23.72	20.2	23.52	0.15	5	4.42	4.75	7.04	14.47	11.53	1.83
2000	0.2	21.28	13.37	9.63	5.66	11.76	8.06	10.77	8.27	1.06	3.78	1.29
2001	0	0.01	1.8	0.68	2.71	17.96	26.91	23.9	3.4	2.43	2.37	2.35
2002	0.04	0	2.26	5	3.59	16.32	18.52	4.7	0.94	0.34	2.29	0.73
2003	0	0	1.06	3.25	11.09	10.74	9.78	7.21	4.45	4.68	1.72	0.25
2004	0	0	0.05	7.45	6.31	19.24	31.03	20.36	7.6	3.84	3.31	2.25
2005	0	0	0.04	1.48	2.63	16.29	27.05	10.1	3.06	0.92	0	0.06
2006	0	0.02	0.06	3.51	14.62	8.5	6.52	25.41	2.85	0.38	2.15	0.4
2007	0	0.06	0.26	3.77	12.82	9.06	8.16	4.63	1.59	1.23	0.98	0.45
2008	1.51	0.05	0.2	5.55	6.61	6.32	3.33	3.68	1.43	1.6	0.31	0
2009	0	0	0.86	3.48	9.3	8.48	9.61	4.73	3.55	1.97	1.83	0.35
2010	0	0	0.46	7.43	12.05	8.88	10.28	9.35	6.99	1.35	2.99	0.03
2011	0	0	2.55	7.34	18.88	42	36.48	15.84	5.48	3.8	3.02	1.03
2012	0	0	2.19	9.19	35.59	29.27	19.62	19.94	4.02	3.22	0.26	0
2013	0	0	3.02	15.42	27.68	38.25	21.04	12.41	1.25	5.8	2.89	0.26

2014	0	0.54	4.22	11.99	16.57	19.43	16.31	5.47	8.45	12.14	1.46	3.13
2015	3	0.58	22.35	42.83	16.88	4.6	12.83	12.27	13.27	3.24	1.73	6.09
2016	0	0.81	4.6	10.54	14.43	10.7	15.79	4.53	1.73	0.37	0	0
2017	0	0.67	11.38	17.9	17.13	8.15	20.11	7.83	3.51	5.44	0.41	0.56
2018	0	1.68	17.43	23.29	9.42	11.06	46.75	16.52	1.18	1.26	0.04	0
2019	0	0.73	10.4	10.88	2.45	77.73	38.78	6.88	3.17	6.02	0.06	0
2020	0	0.25	3.96	2.16	4.91	6.12	6.54	8.29	11.34	0.11	1.3	1.96
2021	0	0	0	5.79	15.16	63.52	32.23	27.81	7.88	5.05	9.44	0.54
2022	0.03	0.49	2.68	3.46	6.47	30.82	49.23	12.97	24.58	1	0.61	1.64
Total	17.56	50.89	125.4	235.54	273.11	480.2	479.38	280.35	137.03	81.72	54.48	25.2

Table 6. Total monthly commercial catches (tons) of greater argentine (ARU) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	12.78	23.72	20.2	23.52	0.15	5	4.42	4.75	7.04	14.47	11.53	1.83
2000	0.2	21.28	13.37	9.63	5.66	11.76	8.06	10.77	8.27	1.06	3.78	1.29
2001	0	0.01	1.8	0.68	2.71	17.96	26.91	23.9	3.4	2.43	2.37	2.35
2002	0.04	0	2.26	5	3.59	16.32	18.52	4.7	0.94	0.34	2.29	0.73
2003	0	0	1.06	3.25	11.09	10.74	9.78	7.21	4.45	4.68	1.72	0.25
2004	0	0	0.05	7.45	6.31	19.24	31.03	20.36	7.6	3.84	3.31	2.25
2005	0	0	0.04	1.48	2.63	16.29	27.05	10.1	3.06	0.92	0	0.06
2006	0	0.02	0.06	3.51	14.62	8.5	6.52	25.41	2.85	0.38	2.15	0.4
2007	0	0.06	0.26	3.77	12.82	9.06	8.16	4.63	1.59	1.23	0.98	0.45
2008	1.51	0.05	0.2	5.55	6.61	6.32	3.33	3.68	1.43	1.6	0.31	0
2009	0	0	0.86	3.48	9.3	8.48	9.61	4.73	3.55	1.97	1.83	0.35
2010	0	0	0.46	7.43	12.05	8.88	10.28	9.35	6.99	1.35	2.99	0.03
2011	0	0	2.55	7.34	18.88	42	36.48	15.84	5.48	3.8	3.02	1.03
2012	0	0	2.19	9.19	35.59	29.27	19.62	19.94	4.02	3.22	0.26	0
2013	0	0	3.02	15.42	27.68	38.25	21.04	12.41	1.25	5.8	2.89	0.26
2014	0	0.54	4.22	11.99	16.57	19.43	16.31	5.47	8.45	12.14	1.46	3.13
2015	3	0.58	22.35	42.83	16.88	4.6	12.83	12.27	13.27	3.24	1.73	6.09
2016	0	0.81	4.6	10.54	14.43	10.7	15.79	4.53	1.73	0.37	0	0
2017	0	0.67	11.38	17.9	17.13	8.15	20.11	7.83	3.51	5.44	0.41	0.56
2018	0	1.68	17.43	23.29	9.42	11.06	46.75	16.52	1.18	1.26	0.04	0
2019	0	0.73	10.4	10.88	2.45	77.73	38.78	6.88	3.17	6.02	0.06	0
2020	0	0.25	3.96	2.16	4.91	6.12	6.54	8.29	11.34	0.11	1.3	1.96
2021	0	0	0	5.79	15.16	63.52	32.23	27.81	7.88	5.05	9.44	0.54
2022	0.03	0.49	2.68	3.46	6.47	30.82	49.23	12.97	24.58	1	0.61	1.64
Total	17.56	50.89	125.4	235.54	273.11	480.2	479.38	280.35	137.03	81.72	54.48	25.2

Table 7. Total monthly commercial catches (tons) of tusk (USK) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0	4.72	0.48	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	4.72	5.52	10.93	1.58	0.6	0
2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	2.19	0	0	0
2004	0	0	0	0	0.04	0.04	2.28	1.21	4.5	2.35	5.4	1.14
2005	0	0	1.77	0.07	1.64	3.25	3.3	0.32	6.18	9.86	12.73	0.2
2006	0	0	2.45	2.55	4.08	0.8	0.47	6.78	1.05	1.55	3.11	79.4
2007	0	0	0	0	0.03	3.95	7.45	0.23	4.28	2.73	0	0
2008	12.74	0	0	0	1.47	0.6	0	3.69	0	2.2	0	0
2009	0.04	0	0	0.97	1.15	0.14	5.48	8.16	0	0	0	0
2010	0	0	0	0	0.1	0.7	4.67	5.57	4.06	0	0	0
2011	0	0	0.03	0	2.87	5.53	12.92	5.97	15.28	48.51	0	0
2012	0	0	0	0	1.8	13.49	9.99	33.88	11.55	3.88	0	0
2013	0	0	1.34	15.99	1.3	0.75	0.9	0	0.35	6.2	0.8	0
2014	0	0.04	0	4.06	1.52	53.2	29.16	49.65	29.27	0.39	0.04	0
2015	43.24	0	0	0	9.42	46.12	59.75	468.18	251.98	0	0.07	0
2016	0	0	1.38	24.23	48.96	95.1	180.42	34.05	147.58	13.72	3.62	13.3
2017	11.38	44.1	151	1.24	0.14	240	75.79	95.68	103.94	0.98	15.74	22.7
2018	0.79	0	108	52.71	7.96	296.1	44.34	23.54	113.42	9.33	5.26	23.5
2019	8.89	39.2	11.9	59.88	15.14	113.2	92.04	39.91	4.36	0.4	0.12	1.58
2020	7.6	9.22	5.85	86.3	34.46	4.82	45.9	10.57	2.7	3.26	0.46	4.86
2021	0	3.66	25.7	54.43	200.32	198.4	157.48	58.34	10.11	7.02	4.66	0
2022	0.15	0.07	18.2	48.89	28.76	16.87	8.19	4.2	68.78	156.3	3.31	13.5
Total	84.83	96.3	328	351.32	361.16	1093	749.97	855.93	792.51	270.3	55.92	160

Table 8. Total monthly commercial catches (tons) of blue ling (BLI) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0	0.15	0	0	0	0	0
2000	0	0	0	0	0	0	0	0.16	1.07	0	0.16	0
2001	0	0	0	0	0	0	0.56	0	0	0	0	0

2002	0	0	0.1	0.03	0	0.06	0	0	0.05	0	0	0
2003	0	0	0	0	0.26	0.14	0.95	1.27	0	0	0	0
2004	0	0	0	0.43	0.55	0.15	2.16	1.01	0.83	0.82	0.22	0.88
2005	0	0	0	1	0.13	1.27	2.07	0.38	0.8	0	0	0
2006	0	0	0	0	0	0	0	0.35	0	0.54	1.35	3.67
2007	0	0	0	0	0	0.19	0	0.27	0.74	0.08	0	0
2008	2.83	0	0	0	0.2	0.12	0	0.81	0.09	0.73	0.05	0
2009	0	0	0	0.47	2.7	2.03	0	0	0.18	0	0	0
2010	0	0	0	0	0.44	0.19	0	1.55	4.73	0.26	0.22	0.06
2011	0	0	0.07	0	0.33	2.44	0.22	0.95	0.9	1.96	0.96	0.12
2012	0	0	0.67	2.1	1.82	1.26	0.06	1.93	3.32	1.88	0	0
2013	0	0	1.11	1.09	1.22	0.3	0.15	2.1	0.1	6.98	2.65	0
2014	0	0.59	1.44	0.57	2.13	1.88	0.47	2.88	1.34	2.37	0	0.19
2015	0	1.52	1.92	0.46	0.63	0.4	0.71	0.08	26.05	32.91	0	0.74
2016	0	1	0.92	0.44	1.41	0.13	0.33	0	4.4	0	0	0
2017	0	0.37	3.72	1.81	0.08	0.79	2.1	0.6	1.24	1.23	0	0
2018	1.65	0.61	3.34	8.82	1.77	0.22	0.51	0.1	0.65	15.01	0.91	0
2019	0	0.14	1.12	0.1	0.2	0.58	16.79	6.81	7.24	11.5	0.34	0.6
2020	0	0.27	0.99	0.14	0.2	0.95	4.54	3.46	5.23	5.62	5.38	0
2021	0.27	0	0	0.03	0.03	5.09	5.61	0.23	0.83	1.33	2.51	1.11
2022	0.62	0.11	0.75	0	0.06	0.57	0	0.07	3.98	16.81	2.87	1.43
Total	5.37	4.61	16.15	17.49	14.16	18.76	37.38	25.01	63.77	100.03	17.62	8.8

Table 9. Total monthly commercial catches (tons) of black scabbardfish (BSF) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0.03	0	0	0
2011	0	0	0	0	0	0	0	0	0.18	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0

2021	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0.21	0	0	0

Table 10. Total monthly commercial catches (tons) of ling (LIN) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0.16	0.76	0.57	0.58	2.04	3.83	0.1
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0.52	0.22	0	0	0
2002	0	0	0	0	0	0.25	0.08	0	0	0	0	0
2003	0	0	0	0	0.12	0	0	0	0	0.06	0.03	0
2004	0	0	0	0	0.06	0.13	0.41	0.39	0.52	5.6	0	0
2005	0	0	0.06	0	2.69	0.07	0	4.05	0.7	8.39	1.73	0
2006	0	0	0	0	0.1	0.05	0	0.25	0	0	0	18.22
2007	0	0	0	0.4	0.21	0.16	0.43	0.34	0	0	0	0
2008	10.09	0	0	0	0.14	0	0	0.82	0	0	0	0
2009	0	0	0	0	1.68	0.85	1.26	0.52	0.11	0.22	0	0
2010	0	0	0.11	0.52	0.73	0.11	0.11	0	0	0	1.55	0
2011	0	0	0.62	0.78	0	0	1.64	1.76	0	0	0	0
2012	0	0	0.24	0.2	1.08	0.27	0.09	2.22	0.67	0.1	0.24	0
2013	0	0	0.02	1.36	0	0	0	0	0	0.97	0	0
2014	0	0	0	0.02	0	2.29	3.02	2.44	0.21	0	0	0
2015	9.45	0.11	0	0	0.72	1.9	1.76	3.42	3.09	0	0	0
2016	0	0	0	0.36	0.09	3.54	8.5	0.13	0.95	0.35	0	1.28
2017	0.57	0.34	0	0.36	0.23	0.86	0.74	1.18	0.21	0	0	0
2018	0	0.54	0.07	0	0	0.66	0	3.21	0.11	0	0	0
2019	0	0	0	0	0	0.03	0.04	0.26	0	0	1.56	0
2020	0	0.17	0	0.1	0.13	0.03	0	0	0	0	0	1.1
2021	0	0.13	0.06	0.23	0.45	0.08	0.01	0.03	0	0	0.43	0
2022	0.04	0	0.08	0	0	0.03	0.36	0.2	0	0	0	0
Total	20.15	1.29	1.26	4.33	8.43	11.47	19.21	22.31	7.37	17.73	9.37	20.7

Table 11. Total monthly commercial catches (tons) of orange roughy (ORY) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0.32	0.08	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0.82	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0

2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0.32	0.9	0	0	0	0	0	0

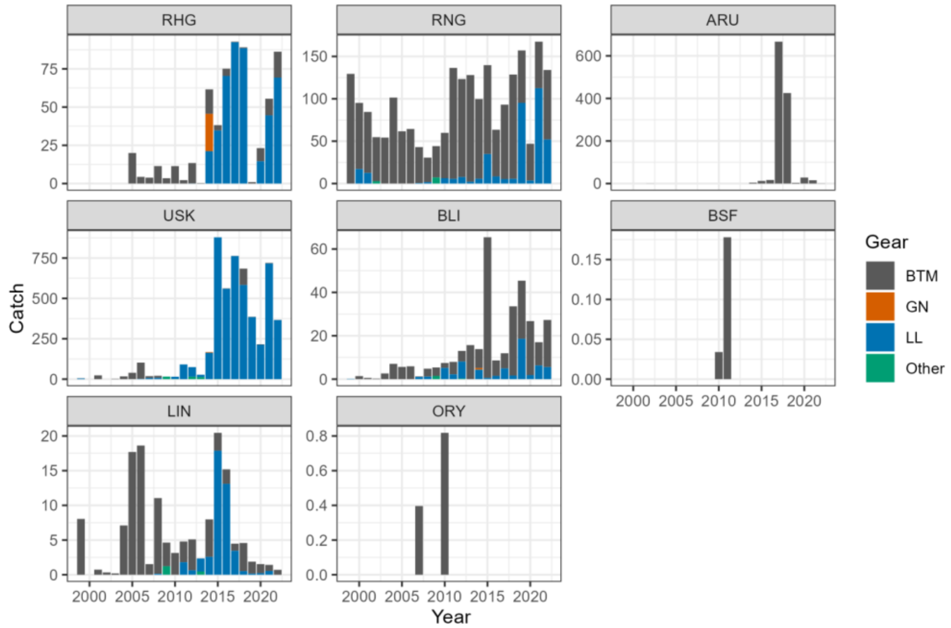

Figure 1. Total annual commercial catches by gear, in tonnes (t) of roughhead grenadier (RHG), roundnose grenadier (RNG), greater argentine (ARU), tusk (USK), blue ling (BLI), black scabbardfish (BSF), ling (LIN), and orange roughy (ORY)in the Greelandic EEZ zone of ICES 14 from 1999 to 2022. Note the different scales of the y axes. Catches for black scabbardfish and orange roughy were very low and can be seen in Table 1.

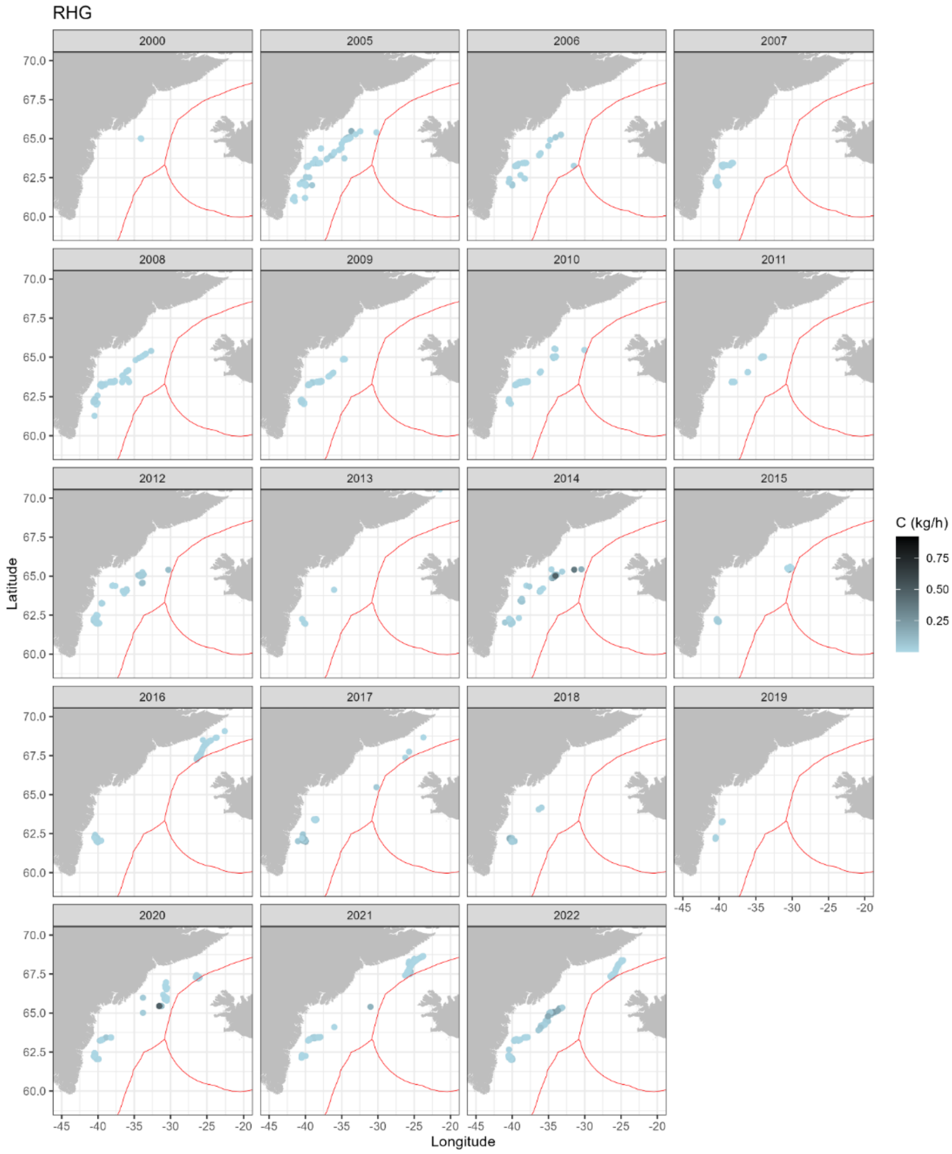

Figure 2: Roughhead grenadier (*Macrourus berglax*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

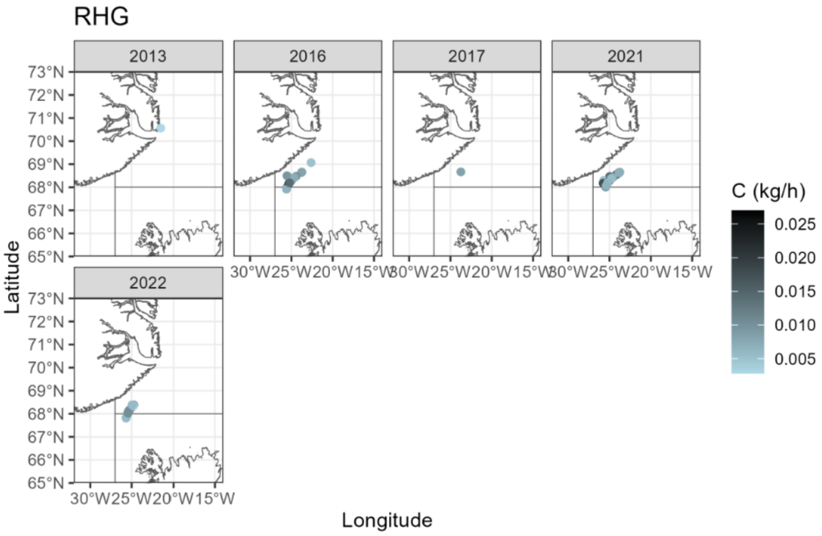

Figure 3: Roughhead grenadier (*Macrourus berglax*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.a.

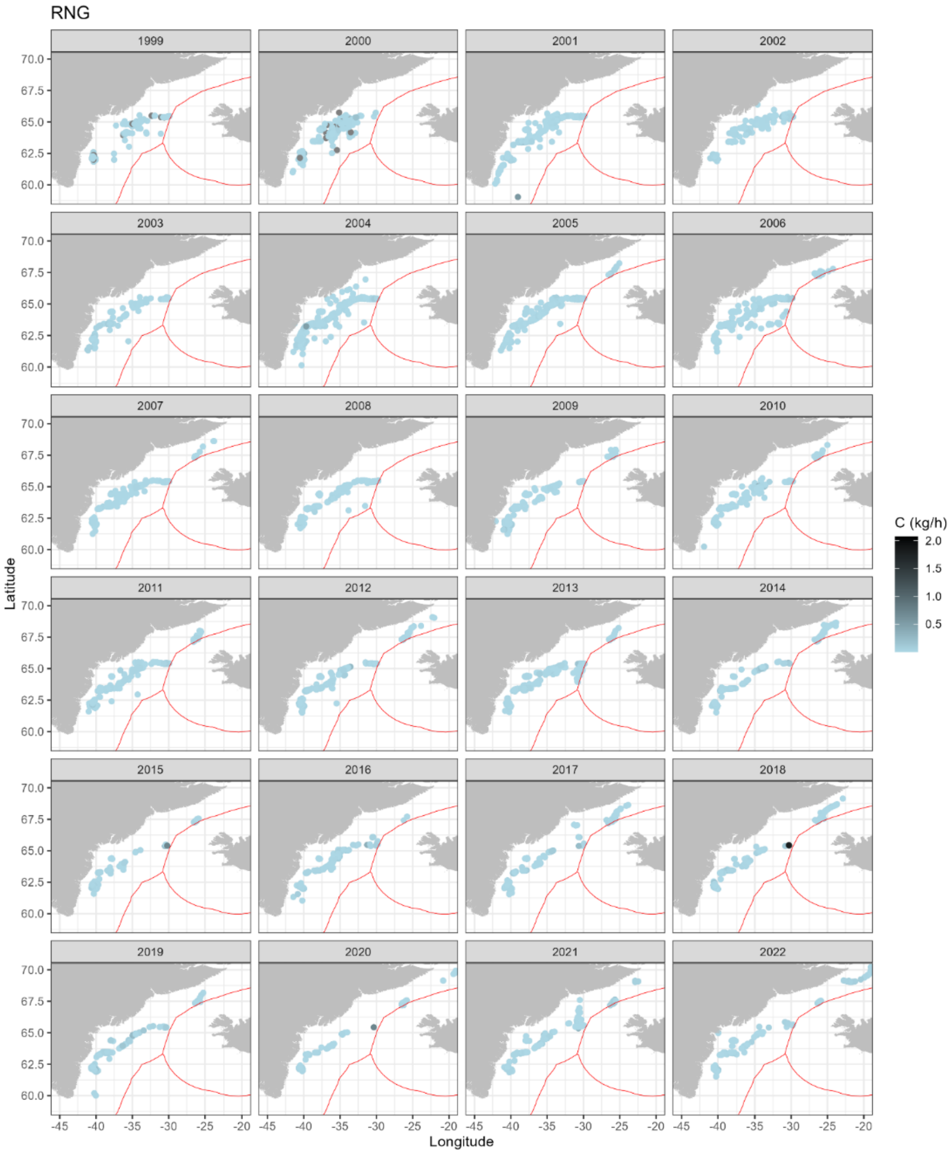

Figure 4: Roundnose grenadier (*Coryphaenoides rupestris*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

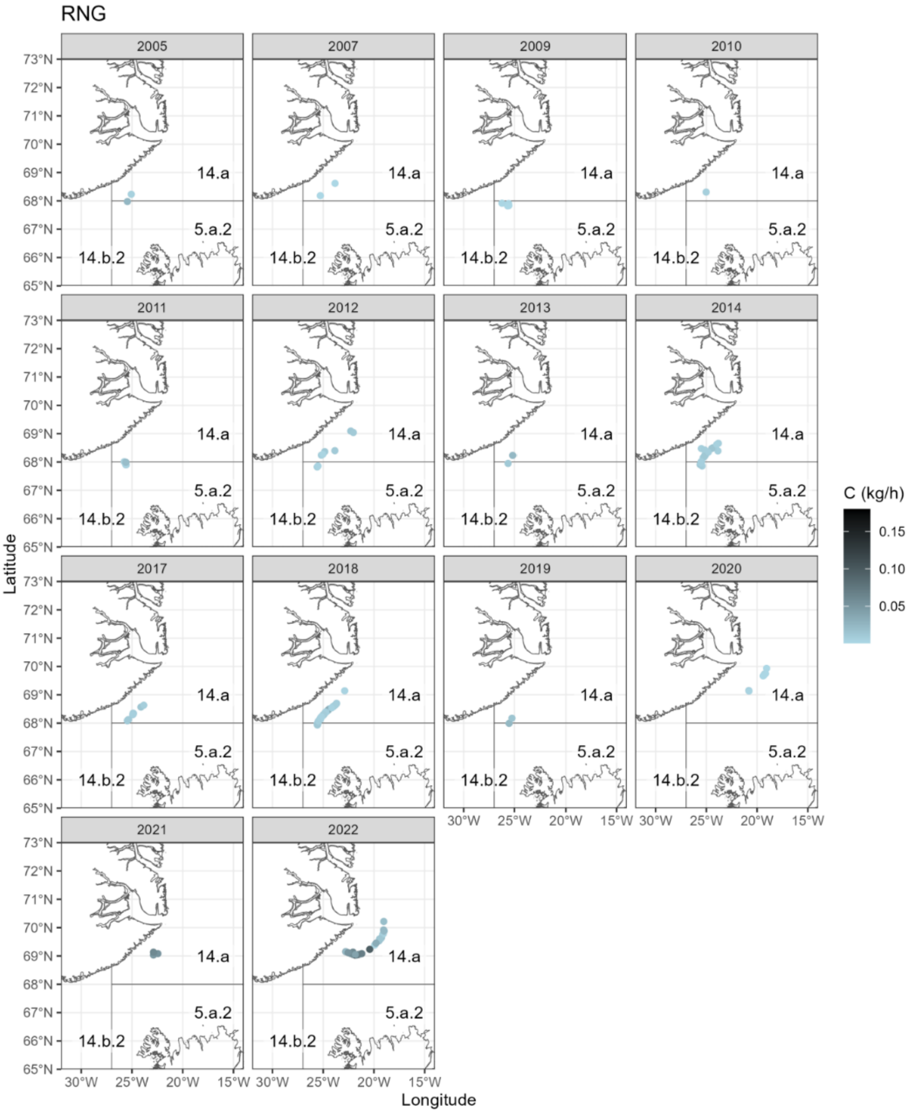

Figure 5: Roundnose grenadier (*Coryphaenoides rupestris*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.a.

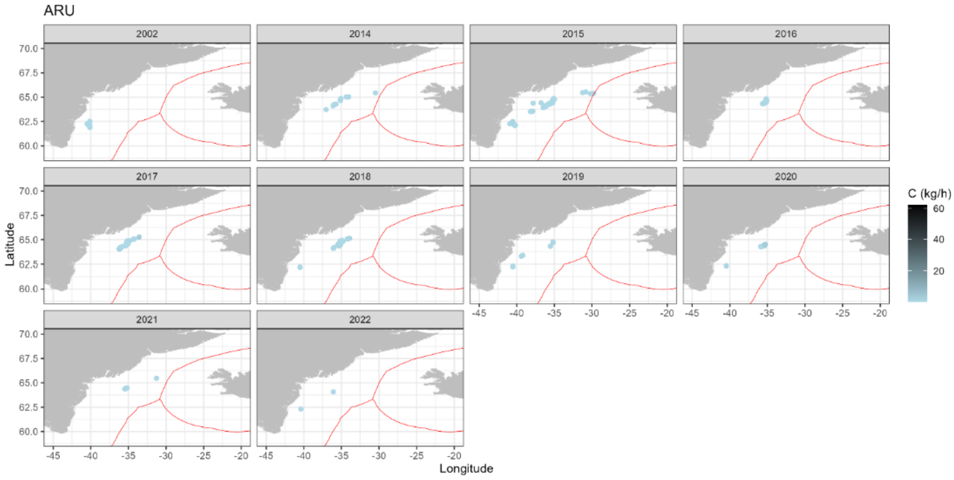

Figure 6: Greater argentine (*Argentina silus*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

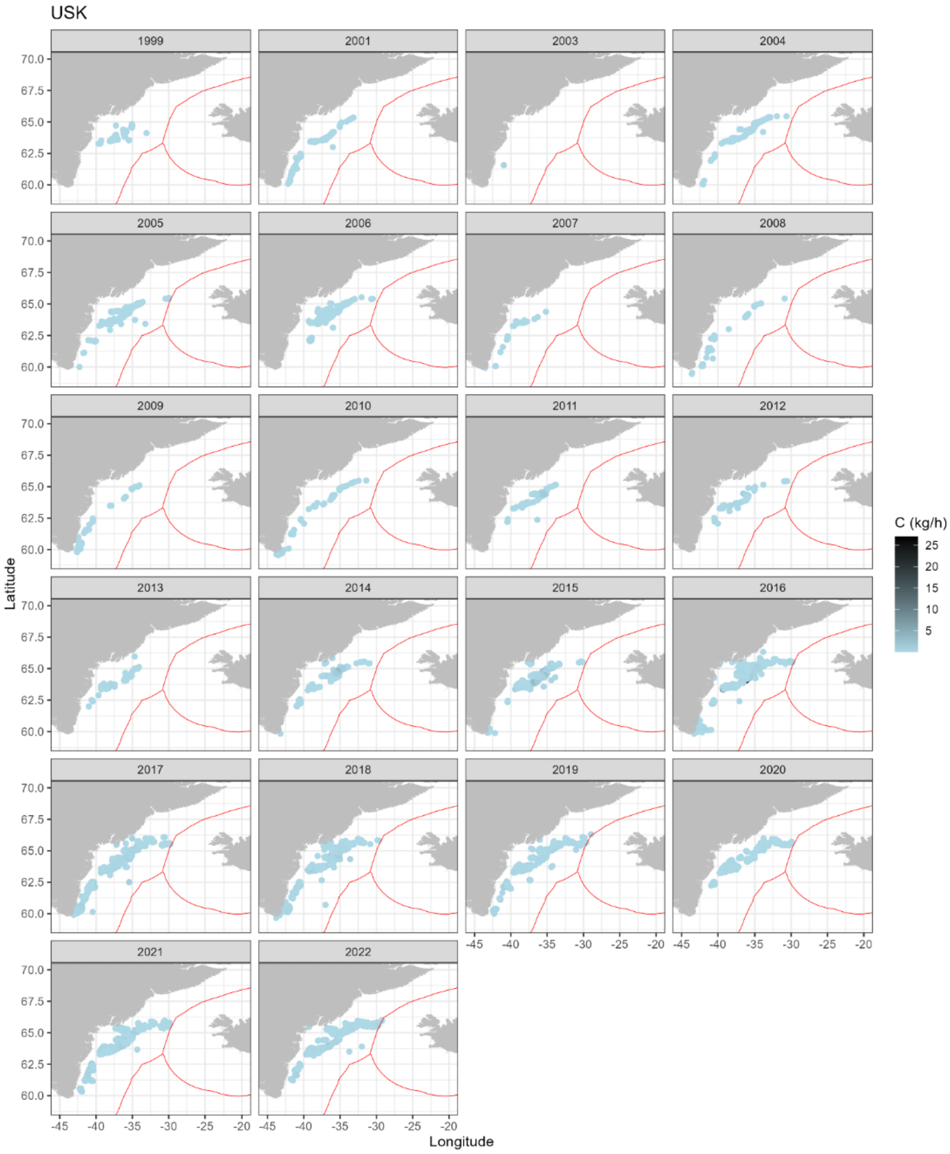

Figure 7: Tusk (*Brosme brosme*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

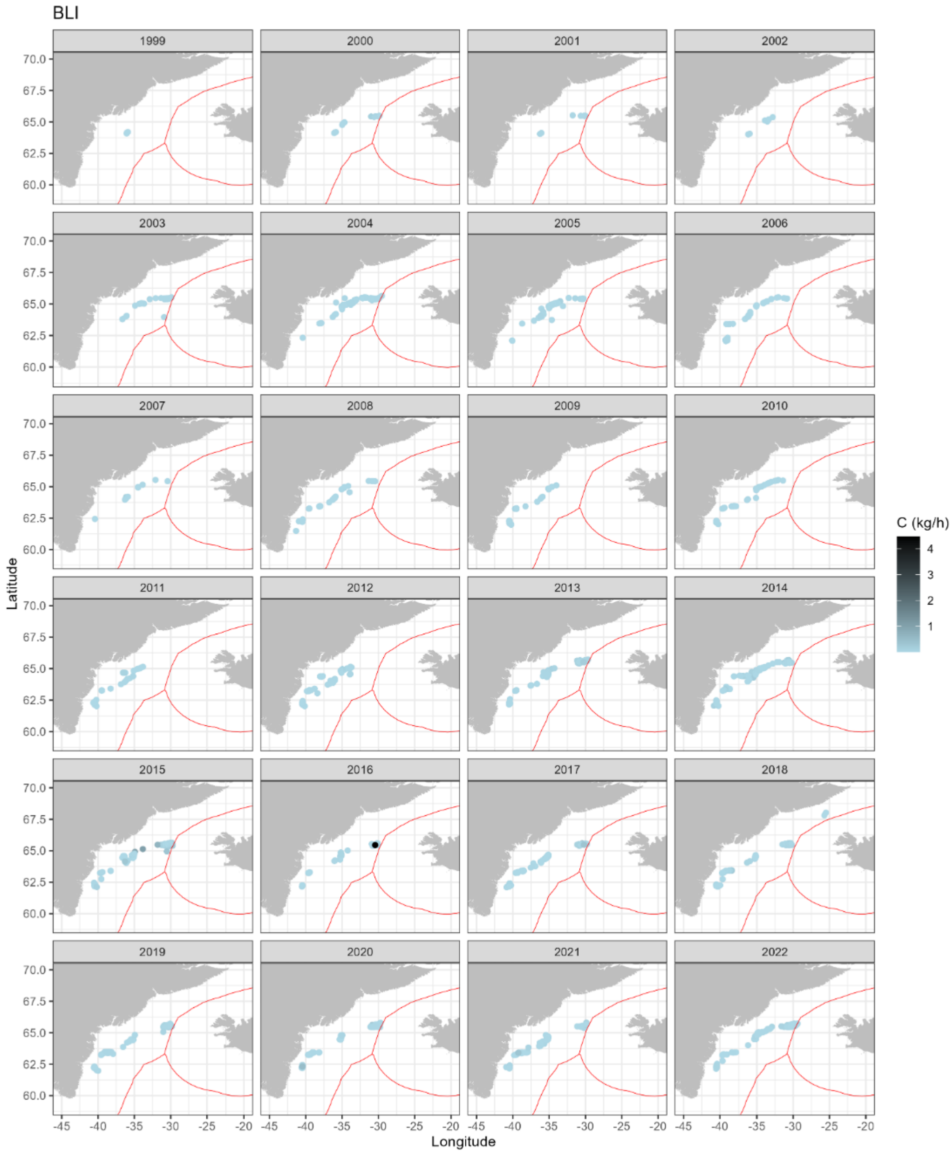

Figure 8: Blue ling (*Molva dypterygia*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

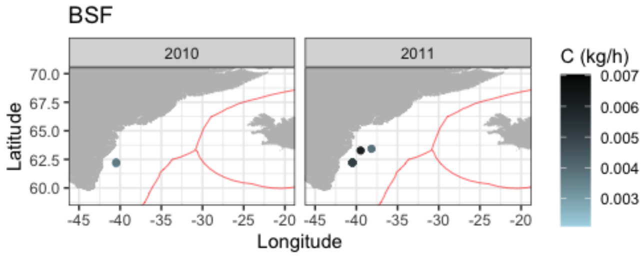

Figure 9: Black scabbardfish (*Aphanopus carbo*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

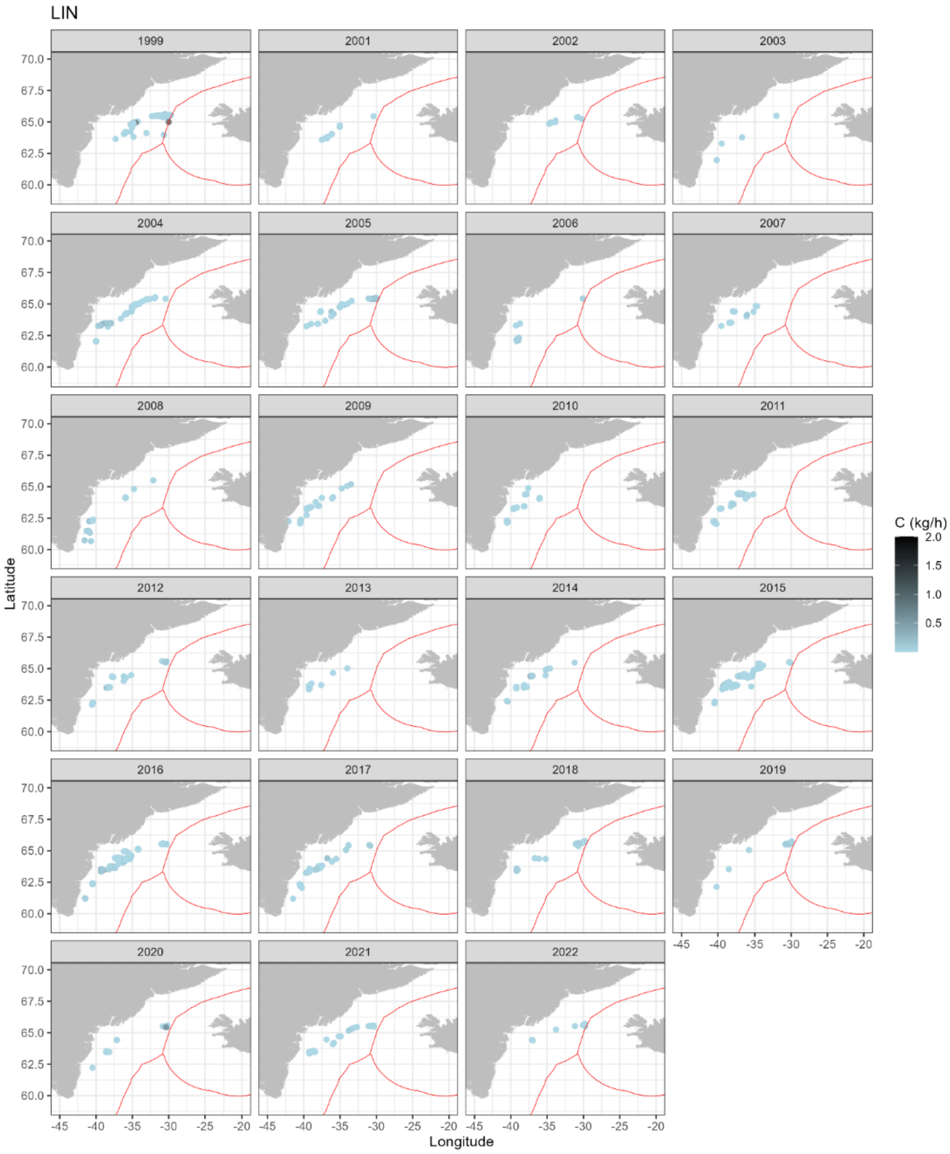

Figure 10: Ling (*Molva molva*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

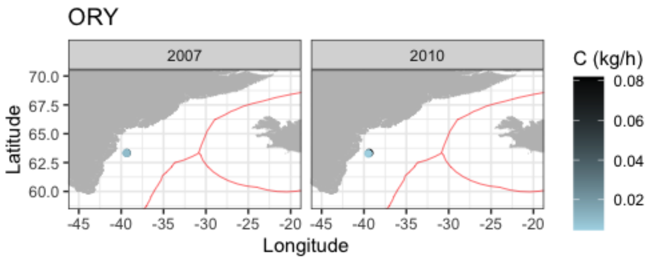

Figure 11: Orange roughy (*Hoplostethus antlanticus)* CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

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Refining stock distribution of the current bli.27.nea ICES assessment unit, based on new evidence of genetic and demographic population structure

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Working document

1. Background

Blue ling *(Molva dypterygia)* is caught over a wide area in northeast Atlantic. At present there are three stock areas for blue ling within WGDEEP (bli.27.nea, bli.27.5b67 and bli.27.5a14).

The stock area bli.27.nea consists of subareas 1, 2, 8, 9, 12 and divisions 3a and 4.a. Historically (within WGDEEP) it was defined as the combination of areas where some blue ling landings were reported from bycatch fisheries without major directed fisheries. Geographically, this stock area is split in three regions (Figure 1). Subareas 8 and 9 is the southernmost. New information suggests that landings from subareas 8 and 9 are Spanish ling (*Molva macrophthalma*) and historical records of blue ling are questionable, see section with Figure 2. Therefore, landings of blue ling from these subareas have been attributed to this Spanish ling since 2010 and, accordingly, the landing tables of the assessment unit bli.27.nea for subareas 8 and 9 have not been updated. There is a need for information and suitable identification sheets to be provided to fisheries for landings from these subareas to be reported as the right species (*M. macrophthalma*, Spanish, FAO code SLI).

Subarea 12 includes parts of the Mid-Atlantic Ridge (in ICES divisions 12.a.1, 12.a.4 and 12.c) and the western slope of the Hatton Bank (in ICES Division 12.b). Since 2014, landings from Subarea 12 have decreased from 80 to 0 tons in 2022. However, based upon the continuity of bathymetric features and lesser abundance, blue ling from the western Hatton Bank (Division 12.b) is likely to be related to those from the northern Hatton Bank (ICES Division 6.b) and blue ling from other divisions of Subarea 12 is more likely to be related to those from Icelandic and east Greenland waters. Following this, it would be more appropriate that blue ling in Division 12.b is combined with stock unit bli.27.5b67, forming a new unit bli.27.5b6712b). Other divisions of 12 should be added to the stock unit bli.5a14, becoming bli.27.5a12ac14.

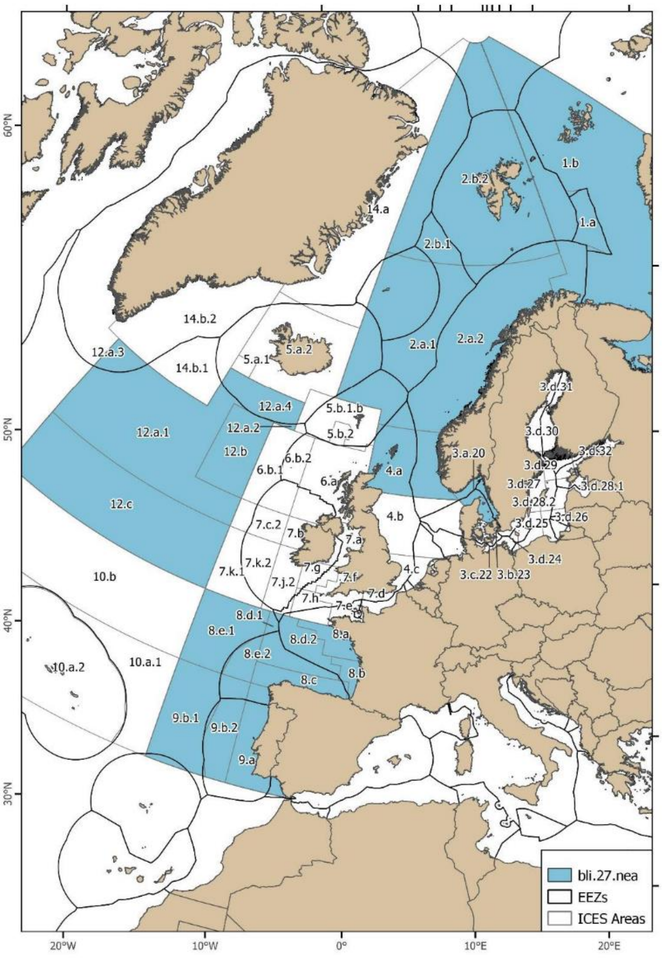

Figure 1. Map showing ICES areas covering the stock unit of Blue ling in subareas 1, 2, 8, 9, 12 and divisions 3a and 4.a (bli.27.nea).

In subareas 1, 2 and divisions 3a and 4a, blue ling inhabit the components of Barents Sea, the western slope of northern Norway, North Sea and the Skagerrak, where the bulk of the catch is from Norwegian fisheries in subareas 2a and 4a. Catches in the North Sea (Subarea 4) come from the Norwegian deep, in the eastern side of the North Sea. There are also some small catches reported from Division 4.b (Denmark and Germany).

In recent years, landings from this stock area are exclusively from subareas 1,2,4 and Division 3a. Norway contributes by far to the landings in Divisions 2.a (77%) and 4.a (77%).

There were landings reported to Intercatch from subareas 8 and 9 in 2022. These landings represent 11% of the total landings from the stock area (75 tonnes). These catches are from France (15%) and Spain (85%). Such landings are ascribed to *M. macrophthalma* and have not been included in the bli.27.nea assessment since 2010. The allocation of catch from Subarea 8 of the Spanish ling comes from the French EVHOE survey, where all individuals of the genus *Molva* caught are checked for correct taxonomic identification. There is a clear distinguishing criterion between blue ling (*Molva dypterygia*) and the Spanish ling *(Molva macrophthalma*) with the latter having the pelvic fin extending beyond the pectoral (Figure 2). All individuals caught in subarea 8 were *M. macrophthalma*.

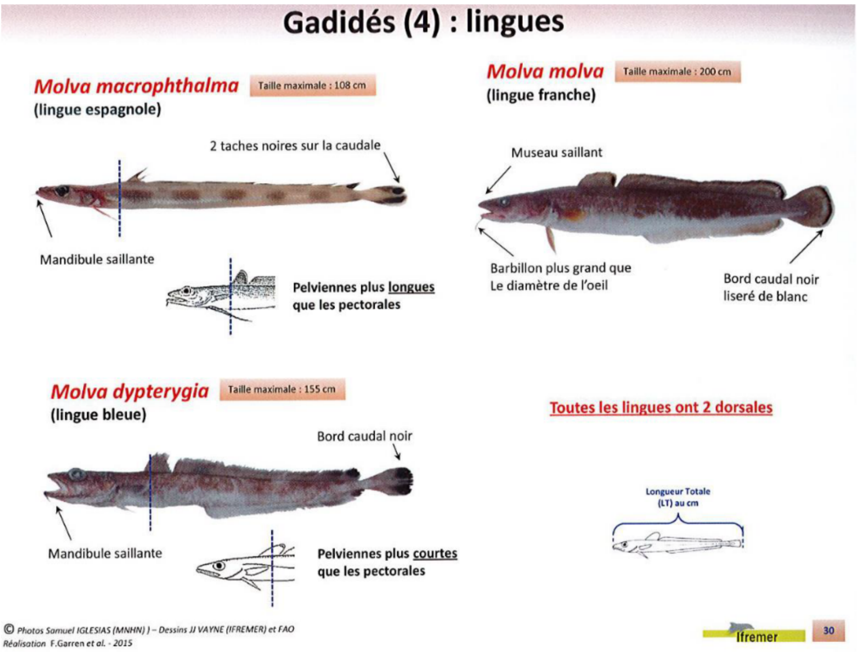

Figure 2. Identification sheet for ling (genus *Molva*) used in French surveys (from Garren, 2020)

2. Fisheries

In Subarea 12 catches have been from multispecies fishery fleets fishing for several deepwater species, primarily roundnose grenadier, black scabbardfish and blue ling, with a component of deepwater sharks and orange roughy in the 1990s. Before the 1990s, the bulk of the landings from Subarea 12 was from target fisheries of seasonal spawning aggregations, like in divisions 5.a and 6.ab. Known spawning areas are now closed seasonally to protect the spawning stock.

There was a directed fishery for blue ling in Division 2.a on spawning areas; mainly Norwegian vessels fishing with nets. The directed fishery was banned in 2009 and has since been regulated by a 10% allowed bycatch from other fisheries. The fishery in divisions 2.a and 4.a is now a bycatch fishery from longlines and nets.

3. Blue ling population structure

3.1. Recent population genetic study

Genetics information is scarce for this species. However, there is new information on population structure of blue ling (McGill *et al*, 2023). Samples from the Atlantic basin covering (Greenland, Rockall, Rosemary Bank, Anton Dohrn and Atlantic slope, i.e. to the West of Scotland) and along the Norwegian Coast, in Division 2.a by 69°N, in Division 4.a by 59-61 °N and South Norway in Division 3.a) were analyzed with Principal Component Analysis (PCA) and the Structure software (Pritchard *et al.*, 2000) and the results showed two distinct genetic units (Figure 3). Although there was found some genetic flow between the two areas, there was clearly two separate units. This information supports changing the current stock area to units reflecting better the actual population structure. Further, the current bli.27.nea include subareas 1 and 2 to the East and Subarea 12 to the West, whilst these subareas are separated by the two other assessments units considered by ICES.

Overall, the population genetic study indicated that blue ling from the Atlantic Basin and Norwegian water are distinct, which implies that Subarea 12, which is included in bli.27.nea should be separated from subareas 1 to 4.

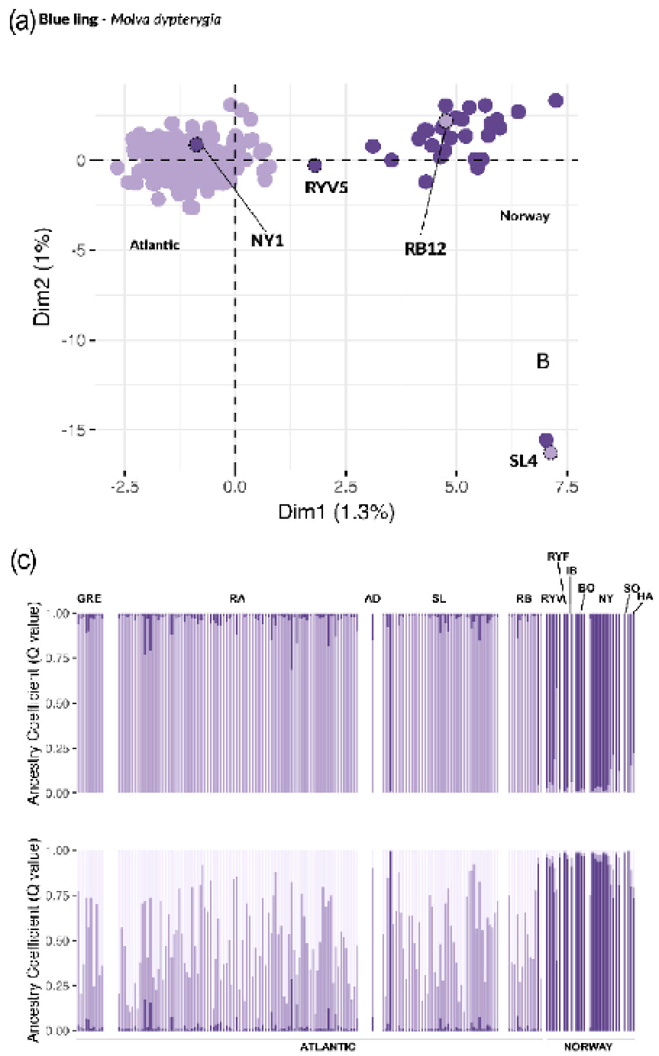

Figure 3. Genetic population structure of blue ling, based on sampling in the Atlantic basin, Norwegian Sea and North Sea. PCA plot (a) and Structure plot (c) (redrawn McGill *et al.*, 2023).

3.2. Population structure in the Atlantic basin.

The population genetic study from Gill *et al.* (2023) did not reveal structure within the Atlantic basin. This would probably need genotyping more individuals from more locations from the Atlantic. The population structure in this basin was considered for long. 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 was supported by differences in length and age structures between areas as well as in growth and maturity. Egg and larvae data from early studies also suggested the existence of many spawning grounds in each of areas of the northern and southern stocks and this was considered as indications of stock separation. These now historical approaches are the basis for distinguishing the two major current stock units: bli.27.5a14 and bli.27.5b67. To the the west of the British Isles in Subarea 6, small blue ling below 60 cm are not caught by fisheries nor surveys. Fish appear in survey and commercial catch at 60–80 cm possibly suggesting migration of juveniles from other areas. Spawning grounds are known to occur in Subarea 6, along the Scottish slope, on Rockall, Hatton, Lousy and Rosemary Banks (Figure 4, left panel) in Division 5.a, Icelandic grounds, (Figure 4, right panel). Spawning areas have also been identified in Faroese waters (Figure 5).

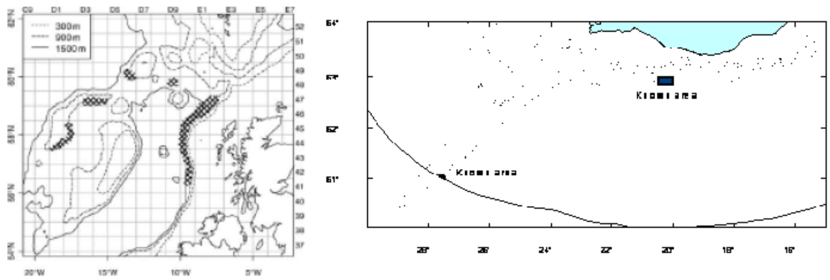

Figure 4. Spatial distribution of blue ling spawning grounds along the Scottish slope, on the Hatton, Lousy and Rosemary Banks (left) and to the South of Iceland (right).

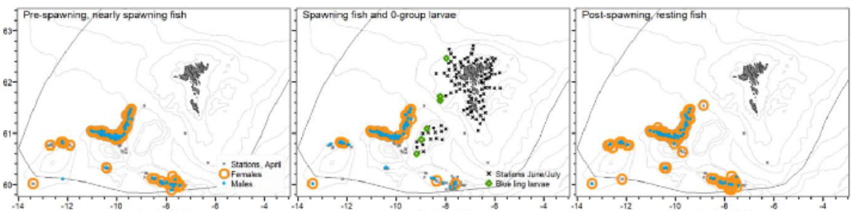

Figure 5. Spatial distribution of blue ling spawning areas in Faroese waters. Data from the blue ling surveys in April, 1995-2003. Observations of nearly spawning fish (left), spawning fish and observations of larvae (middle) and resting fish (right). Larvae data from 0-group survey June/July 1995-2017.

Small blue ling are observed in survey in Icelandic and Greenland waters. In recent decades Icelandic surveys have shown a sudden drop in small blue ling abundance, denoted recruitment (Figure 6.D) in 2008-2010 and remained at low level since. This low recruitment was followed by a decrease in biomass of fish larger than 40 cm from 2012 (Figure 6.B) which was also visible in fish larger than 70 cm TL (Figure 6.C). This suggest that small blue ling observed in Icelandic, actually represent the recruitment to this stock. Small blue ling from 21 cm has also been of observed in survey in Greenland waters since 2002 (Nogueira and Christiansen, 2023). Lastly blue ling smaller than 40 cm TL have also been observed in Faroese surveys, but in a few locations and very small numbers. Pelagic larvae (2-3 cm in length) have also been caught in the annual 0-group trawl survey in June/July (Figure 5, central panel) but in very small numbers only (Ofstad, 2018).

Overall the number of blue ling smaller than 60 cm observed in surveys in the area of the bli.27.5b67 seems very small in comparison to the adult stock, which current biomass is estimated to near 100 000 tonnes. How larvae drift and juveniles migrate to adult grounds, where they recruit to fisheries, is unknown.

If blue ling from Division 5b and subareas 6 and 7 (bli.27.5b67) was demographically connected to bli.27.5a14, the decline in biomass of fish larger than 70 cm observed for bli.27.5a14 from 2012-13 should also have occurred quite at the same time in bli.27.5b67, where blue ling recruit to the fishery at 60-70 cm. No such decline was observed, in contrast the biomass increased rather continuously since the early 2000s (Figure 7), which may have been driven by decreasing catches in the 2000, but after 2010 catches stabilized and eventually started increasing in recent years. Further, the current exploitation level is estimated to be well below MSY for bli.27.5b67 (ICES, 2022a), whilst it is above for bli.27.5a14 (ICES, 2022b). This suggest that the two stock units bli.27.5a14 and bli.27.5b67 are demographically disconnected and support the ICES practice to recognize these two major units in the Atlantic basin.

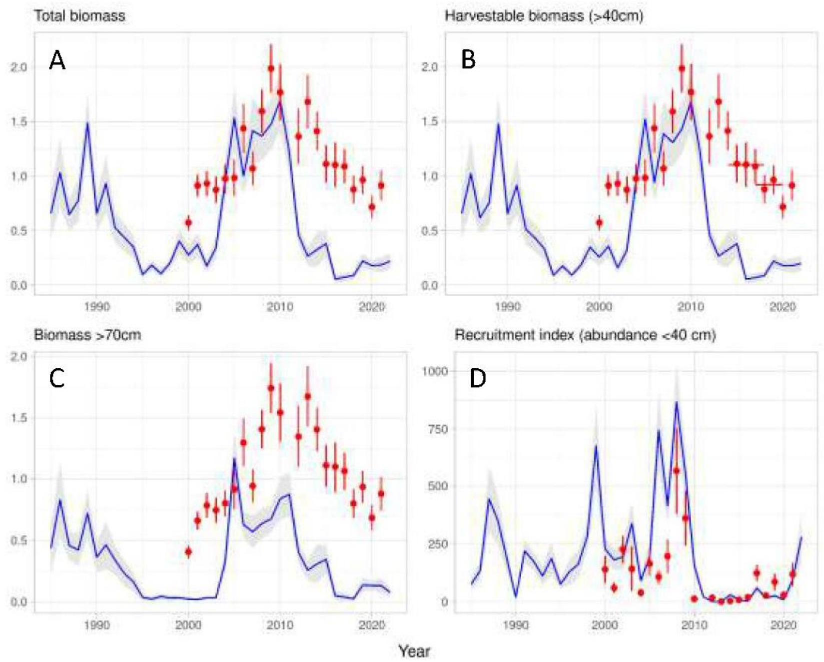

Figure 6. Biomass (thousand tonnes) and abundance (numbers) indices of blue ling in the Icelandic autumn survey since 2000 (red points) and the spring survey since 1985 (blue lines). Total biomass index (top-left), biomass of 40 cm and larger (top-right), biomass of 70 cm and larger (bottom-left) and abundance of small blue ling smaller than 40 cm, considered recruitment. Vertical red lines and shaded area represent standard error of the estimate. Redrawn from ICES (2022c).

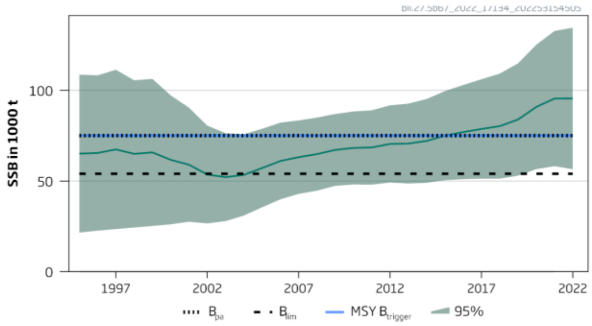

Figure 7. Estimated biomass of the bli.27.5b67 stock (ICES, 2022a).

The remaining issue is how to treat Subarea 12 from which the genetic population study had not samples (Gill *et al.,* 2023). Further, considering that this study did not found difference between samples from south Greenland and those from Rockall and Hatton, blue ling from Subarea 12 may be expected to belong to the same genetic pool.

Blue ling occurs at unknown level in different parts of Subarea 12. Current catches are minor but historical catches suggest that Subarea 12 may accommodate a significant biomass of the species (although the current level of this biomass with respect to the possible carrying capacity of the area in unknown), with 400 to 1300 tonnes landed annually from 1995 to 2005 (ICES, 2002). We suggest treated this subarea based on the continuity of bathymetric features (Figure 8 and 9). Considering that the species has a clearly demersal behavior, migration are expected to follow suitable bottom habitats. Blue ling in Division 12.b occurs on the western Hatton bank, out of this Bank (to the West) the seafloor is too deep for the species. The western Hatton Bank is in continuity with the Rockall and Hatton Banks in Division 6.b. so that blue ling from 12.b is most likely to be related to blue ling from 6.b. Division 12.a.2, is a small area where the seafloor is deeper than 1500 m, so too deep for the species.

3.3 Bathymetric and hydrological features

Oceanographic barriers may play a role in the ability for fish to move across major basins across the Northeast Atlantic. The overflow of Norwegian Sea currents across the Wyville-Thomson Ridge and its confluence with slower currents from subtropical Atlantic Ocean to the south, reaching as far as the Shetlands, associated to the regional topography, offers favourable conditions for the incidence of stratified waters (Hänninen, 2020; Kurekin *et al*., 2020). These hydrographic conditions create barriers to genetic flow and subsequently isolated fish populations (Knutsen *et al*. 2009; Longmore *et al*., 2011).

Some evidence exists, postulating that the Wyville Thomson Ridge separates fish communities distributed along the Norwegian basin and in the Skagerrak, from those to the West of the British Isles (Campbell *et al.* 2011). The general oceanic circulation patterns in the North Atlantic are suggestive that fish populations present in the Rockall and Faeroe Banks are separated from those in the Icelandic Basin, and the latter is itself separated from the Norwegian Basin by the Iceland-Faeroe Ridge (Gordon, 1986).

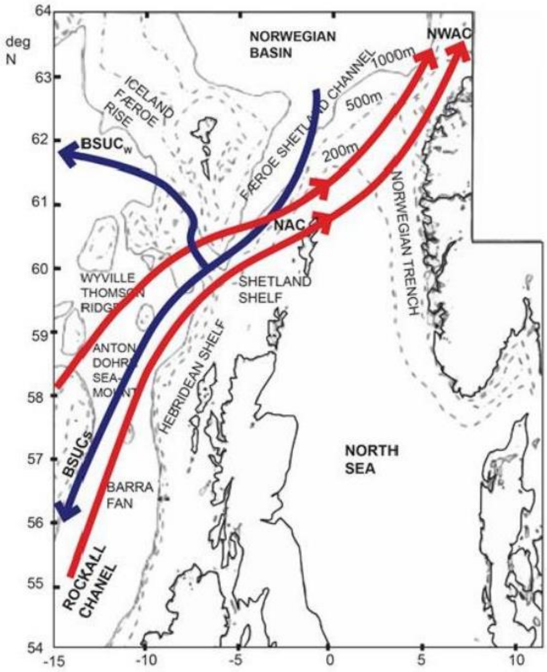

Figure 8. Hydrological circulation in the Norwegian Sea, Rockall-Hatton and Faroe area.

Suitable bottom depths for blue ling in other divisions of Subarea 12 are areas of the Mid-Atlantic Ridge to the West of Division 12.a.4 and in Division 12.a.1 (Figure 9). Blue ling occurring on these grounds is likely to be related to blue ling in Division 5.a. Blue ling is unlikely to occur in divisions 12.a.3 and 12.c, which are too deep.

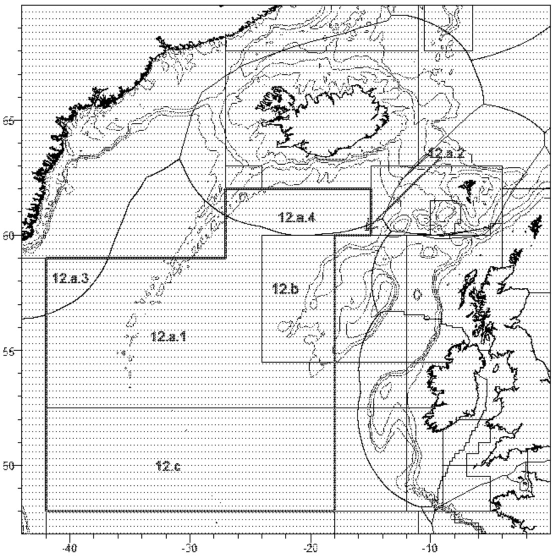

Figure 9. Subarea 12 (brown thick line) and its divisions, over the bathymetry of the Northeast Atlantic (contour lines 200, 500, 1000 and 1500 m). Depths drawn from GEBCO 2022.

Nevertheless, to the very south of the Rockall Hatton area, a small area may include suitable bottom depth for blue ling (see to the South of Division 12.b on Figure 8). Therefore, landings reported in Division 12.a.1, which is included in the NEAFC RA, may come either from this area of from the Mid-Atlantic Ridge and may belong to one stock or the other. Therefore, to be able to ascribe catches of blue ling from Division 12.a.1 to the right stock additional information is needed.

4. Conclusion

A stock area covering wide and disconnected areas is not appropriate. Available evidences suggest that stocks units more aligned to the actual population structure can easily be achieved.

Overall available data suggest that:

- Divisions 12.a.1 and 12.a.4 should be pasted to the area of the assessment unit bli.27.5a14. For simplicity, division 12.a.3 and 12.c may be included in the same stock unit, although blue ling is unlikely to occur in these divisions. The assessment unit bli.27.5a14, would become bli.27.5a12ac14, labelled "Blue ling (*Molva dypterygia*) in subareas 12 and 14 and Division 5.a (Mid-Atlantic Ridge, East Greenland and Iceland grounds)".
- Division 12.b should be pasted to the stock area of the assessment unit bli.27.5b67, which would become bli.27.5b6712b, labelled "Blue ling (*Molva dypterygia*) in subareas 6–7 and division 5.b and 12.b (Celtic Seas, Hatton Bank and Faroes grounds)". For simplicity, the small

Division 12.a.2, may be included in the same unit as this would avoid creating a potential loophole with a small area not covered by a TAC for blue ling.

- Blue ling does not occur to any significant level in subareas 8 and 9, which should therefore not be part of any blue ling stock assessment unit.
- The remaining areas of the current bli.27.nea "Blue ling (*Molva dypterygia*) in subareas 1, 2, 8, 9, and 12, and in divisions 3.a and 4.a (Northeast Atlantic)" form a suitable stock assessment unit bli.27.1-4 which can be labelled "Blue ling (*Molva dypterygia*) in subareas 1 and 2 and divisions 3.a and 4.a (Norwegian Sea, North Sea and Skagerrak)"

It is worth noting that this revision of the stock assessment units for blue ling results in the same number of ICES stocks as previously, the distribution of the new assessment units is clearly better aligned on the meta-population structure of the species than the previous one. The remaining issue of the attribution of catches from Division 12.a.1 to the right stock can be solved be one of the following options:

- **Availablity of catches at the resolution of ICES rectangle for catches coming from the NEAFC RA**. If this data can be made available and included in the WGDEEP data call then the attribution of catch to the right stock is straightforward
- **Addition of one ICES Division**. An additional ICES Division, covering the south of 12.b down to 48°N. This could be labelled, Division 12.d or Division 12.a.5 and have the following limits: Southwest corner at 24°West and 48° North; Northeast corner at 18° West 60°North.
- **Extend Division 12.b towards the South down to 48°N.** This would have the same effect as the previous option, without increasing the number of ICES divisions.

Whichever, approach is the easier to implement should be used as the three options all allow to ascribe catch to the right stock assessment unit.

4.1 Consequence for stock assessment

There was no catch from Subarea 12 in 2022. Catches were smaller than 30 tonnes per year since 2015, which is minor compared to more than 1500 and 3000 tonnes per year caught for bli.27.5b67 and bli.27.5a14 respectively. Fisheries in Subarea 12 seem to have ceased and therefore integrating parts of this Subarea to the two other stock units 5b6-7 and 5a14 would not impact current assessments substantially. Since 2010, landings of Spanish ling from subareas 8 and 9, reported as blue ling have not been included in the advice so that the exclusion of these subareas from the stock unit will not have any impact on subsequent advices either.

Excluding subareas 8 and 9 is recommended because according to survey blue ling does not occur in these subareas where the closely related Spanish ling occurs. The latter has probably a different ecology, in particular it is not known to form spawning aggregation susceptible to be targeted by fisheries. Further, in the EVHOE survey in Subarea 8, small (< 40 cm TL) and adult Spanish ling are caught in the same hauls.

Important note

This working document was presented and discussed during the 2023 meeting of WGDEEP. In additions to authors, all members of the group considered the issue thoroughly and contributed to define the most suitable solution to the stock delineation of blue ling in the ICES area, which lead to add several considerations to the text during the meeting. This final version was approved by the group.

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Working Document to be presented to the Working Group on the
Biology and Assessment of Deep Sea Fisheries Resources

ICES WGDEEP, 3rd - 9th May 2023, Lisbon, Portugal

Results on greater forkbeard (*Phycis blennoides*), Spanish ling (*Molva macrophthalma*), roughsnout grenadier (*Trachyrincus scabrus*), bluemouth (*Helicolenus dactylopterus*) and other scarce deep water species on the 2022 Northern Spanish Shelf Groundfish Survey

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Abstract

This working document presents the results on the most significant deep fish species on the Spanish Groundfish Survey on the northern Spanish shelf in 2022. Biomass, abundance, length ranges and geographic distributions were analyzed for greater forkbeard (*Phycis blennoides*), Spanish ling (*Molva macrophthalma*), roughsnout grenadier (*Trachyrincus scabrus*), bluemouth (*Helicolenus dactylopterus*) and other scarce deep sea species. The biomass of *T. scabrus* increased slightly whereas it increased sharply for *P. blennoides, M. macrophthalma* and especially for *H. dactylopterus. Aphanopus carbo, Beryx spp.* and *Pagellus bogaraveo* were scarce as usual and *Coryphaenoides rupestris* has not been found since 2019. Recruitment was significant for *P. blennoides, M. macrophthalma* and *H. dactylopterus*.

Introduction

The bottom trawl survey on the Northern Spanish Shelf has been carried out every autumn since 1983, except in 1987, to provide data and information for the assessment of the commercial fish species and the ecosystems on the Galician and Cantabrian shelves (ICES Divisions 8c and 9a North).

The aim of this working document is to update the results (abundance indices, length frequencies and geographic distribution) of the most common deep water fish species on the bottom trawl surveys on the Northern Spanish Shelf after the results presented previously (Blanco *et al.* 2022, 2019, Fernández-Zapico *et al.* 2020, 2018, Ruiz-Pico *et al.* 2021). The species analyzed are *Phycis blennoides* (greater forkbeard), *Molva macrophthalma* (spanish ling), *Trachyrincus scabrus* (roughsnout grenadier), *Helicolenus dactylopterus* (bluemouth), and some other scarce species as *Aphanopus carbo* (black scabbardfish), *Coryphaenoides rupestris* (roundnose grenadier), *Beryx spp.* (alfonsinos) and *Pagellus bogaraveo* (blackspot seabream). Although results on *Helicolenus dactylopterus* were not included in the ICES data call, they are also updated considering its remarkable abundance and geographical distribution in the surveyed area, and the fact that these indices were used in the WGDEEP report when reviewing the abundance and status of the stock on the north-eastern Atlantic.

Material and methods

The area covered in the Northern Spanish Shelf Groundfish Survey on the Cantabrian Sea and Off Galicia (Divisions 8c and Northern part of 9a; SPNGFS) extends from longitude 1° W to 10° W and from latitude 42° N to 44.5° N, following the standard IBTS methodology for the western and southern areas (ICES, 2017). The sampling design is random stratified with five geographical sectors (MF: Miño-Finisterre, FE: Finisterre-Estaca de Bares, EP: Estaca de Bares - Peñas, PA: Peñas - Ajo, AB: Ajo - Bidasoa) and three depth strata (70-120 m, 121-200 m and 201-500) (Figure 1, ICES, 2017). The shallower depth stratum was changed in 1997 from 30-100 m to 70-120 m, due to the small area and scarcity of trawlable shallower grounds.

Nevertheless, some extra hauls are carried out every year, if possible, to cover shallower (<70 m) and deeper (>500 m) grounds. These additional hauls are plotted in the distribution maps, although they are not included in the calculation of the stratified abundance indices since the coverage of these grounds (shallower and deeper) are not considered representative of the area. However, the information from these depths is considered relevant due to the changes in the depth distribution of fishing activities in the area (Punzón et al. 2011) and these hauls are also used to define the depth range of the species.

The standardized indices of the deep water fishes analyzed in this report probably underestimate its real biomass due to the fact that most of its catches might happen out of the standard stratification area, in additional hauls deeper than 500 m. For this reason, the catches in standard and deeper additional hauls were plotted in this report.

Results

In this last survey 129 valid hauls were carried out, 114 of these were standard hauls and 15 additional hauls (3 of them shallower than 70 m and 12 of them between 500 m and 800 m) (Figure 1).

The total stratified fish catch in biomass per haul increased strongly in 2022, staying within the high values of the time series (Figure 2).

In 2022, as usual, most of the biomass of *P. blennoides, T. scabrus, A. carbo* and *Beryx spp.* was found in the additional deep water hauls (>500 m) in contrast to *H. dactylopterus* which was mainly found in standard hauls. *P. bogaraveo* was scarcely found, mostly out of the stratification in the shallow area (<70 m). However, the species *M. macrophthalma*, traditionally found mainly in additional deep water hauls, increased its presence in standard hauls in the last two years.

The biomass of the species *T. scabrus* increased slightly whereas it increased sharply for *P. blennoides, M. macrophthalma* and especially for *H. dactylopterus*, reaching the highest value of the time series for the last two species. Bluemouth also rose in abundance terms, reaching likewise the highest value in the overall time series. Recruitment was significant for *P. blennoides, M. macrophthalma* and *H. dactylopterus*, being also noticeable the sharply rise on juveniles abundance for the latter species. Only a few specimens of *A. carbo, Beryx spp.* and *P. bogaraveo* were found but *C. rupestris* was not since 2019.

***Phycis blennoides* (greater forkbeard)**

In 2022, 21% of the hauls where *P. blennoides* was found were additional hauls deeper than 500 m and contained 77% of the biomass. This last year the biomass in standard hauls increased steadily, reaching the highest value of the previous eight years. The biomass in additional deep hauls increased even more compared to the previous year, reaching the highest value of the time series (Figure 3).

The geographical distribution of *P. blennoides* remained similar to previous years, being widespread in the sampling area (Figure 4).

The length distribution in standard hauls was similar to the previous year, with a great recruitment again and a mode in 18 cm (Figure 5).

The largest individuals,which ranged from around 24 cm to 66 cm, were found mostly in the additional deeper hauls, with a mode in 38 cm (Figure 6).

***Molva macrophthalma* (Spanish ling)**

In 2022, the biomass of *M. macrophtalma* increased sharply again in standard hauls, reaching the highest value of the time series, as it had already happened the previous year, whereas it decreased slightly in additional hauls deeper than 500 m (Figure 7). Unlike other years in the time series, although following the line of last year, most of the biomass (65 %) was found in standard hauls (70 - 500 m) which were 85 % of the total hauls with *M. macrophtalma.*

The species kept on being widespread in the study area but presented more spots this last survey (Figure 8).

The strong increase of recruitment in standard hauls shown the previous year is repeated in this last survey, showing a mode in 24 cm, and it is noticeable in the increment on the range of sizes, showing a second class of size, with a mode in 39 cm (Figure 9).

In contrast, in additional deeper hauls larger specimens, up to 123 cm, were found (Figure 10).

***Trachyrincus scabrus* (roughsnout grenadier)**

T. scabrus has been found mostly in additional hauls (>500 m) in the last decade. In 2022, this species was caught in five hauls, being all of them deep hauls, out of the standard stratification, and catches increased slightly compared to the previous year (Figure 11).

The geographical distribution showed more or less the same pattern during the time series, being captured in the deep hauls throughout the study area. However, the point of biomass usually caught in recent years on southern MF sector, was not caught this last survey (Figure 12).

Specimens ranged from 40 mm to 245 mm, although more abundance of large specimens (145 to 200 mm) was found, with a mode in 180 mm (Figure 13).

***Helicolenus dactylopterus* (bluemouth)**

Although bluemouth is not requested for ICES DCF Data Call, the biomass and abundance are significant in the area and useful for the assessment of the stock (ICES, 2017).

H. dactylopterus has mainly been found in standard hauls, therefore the catches of the additional deeper hauls are not plotted.

In 2022, both the biomass and abundance rose sharply, increasing five times the biomass value of the previous year and almost four times that of abundance. Both values, which were already high the previous year comparing to the time series, have reached the highest values in the overall time series (Figure 14).

The geographical distribution of *H. dactylopterus* remained similar to the previous year, with greater biomass in the Galician area, but striking in this last survey, and the usual spot in the easternmost Ajo-Bidasoa sector (Figure 15).
Length distribution showed a moderate sign of recruitment, with a small mode in 6 cm, and also a strong increment in the abundance of a second size class individuals ranged among 11 cm and 37 cm, with a marked mode in 12-13 cm (Figure 16).

Other scarce deep water species

Other species scarcely caught in the survey were *Aphanopus carbo*, *Beryx spp.* and *Pagellus bogaraveo*. They have been mainly found out of the standard stratification, the first three species in deeper additional hauls (>500 m) whereas *P. bogaraveo* in shallower additional hauls (< 70 m).
The species *C. rupestris* has continued to be absent since 2019.
A. carbo was caught in three hauls among 559 m and 608 m in easternmost Cantabrian sea (Figure 17 and Figure 18), with a total of six specimens which ranged from 87 to 104 cm.
Beryx spp. were found in two hauls between 540 m and 589 m in Galician waters and in three hauls among 530 m and 609 m in the Cantabrian sea (Figure 19 and Figure 20). Five specimens were *B. decadactylus*, ranged among 25 and 32 cm, and one was *B. splendens* with 29 cm.
Forty nine specimens of *P. bogaraveo* between 8 and 28 cm were found among 40 and 92 m depth in three hauls in the Cantabrian Sea (Figure 21 and Figure 22).

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Figures

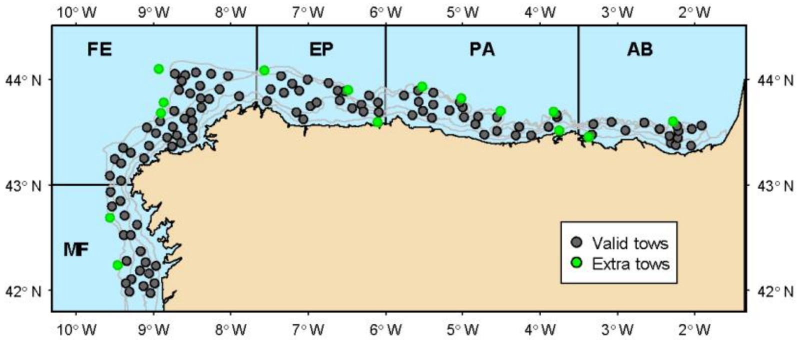

Figure 1 Stratification design and hauls on the Northern Spanish shelf groundfish survey in 2022; Depth strata are: A) 70-120 m, B) 121 – 200 m and C) 201 – 500 m. Geographic sectors are MF: Miño-Finisterre, FE: Finisterre-Estaca, EP: Estaca-cabo Peñas, PA: Peñas-cabo Ajo, and AB: Ajo-Bidasoa

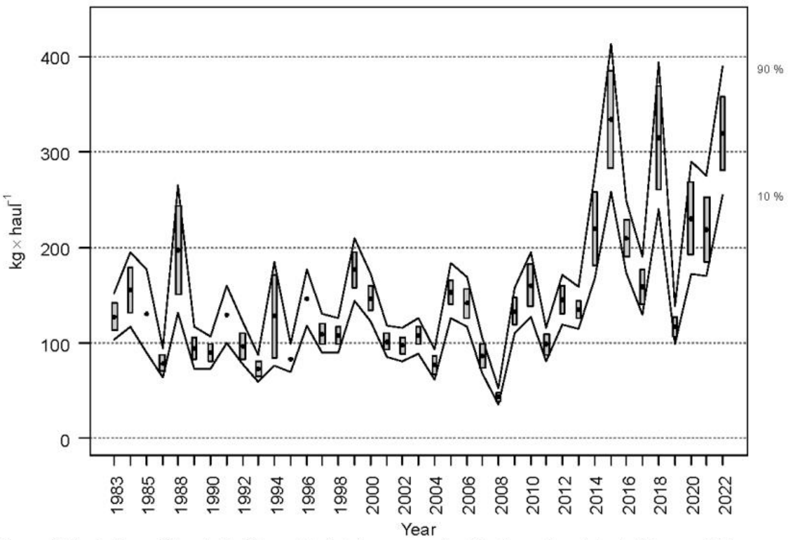

Figure 2 Evolution of the total fish catch in biomass on the Northern Spanish shelf groundfish survey, only standard hauls (>70 m & <500 m considered within the standard sampling stratified to the area.

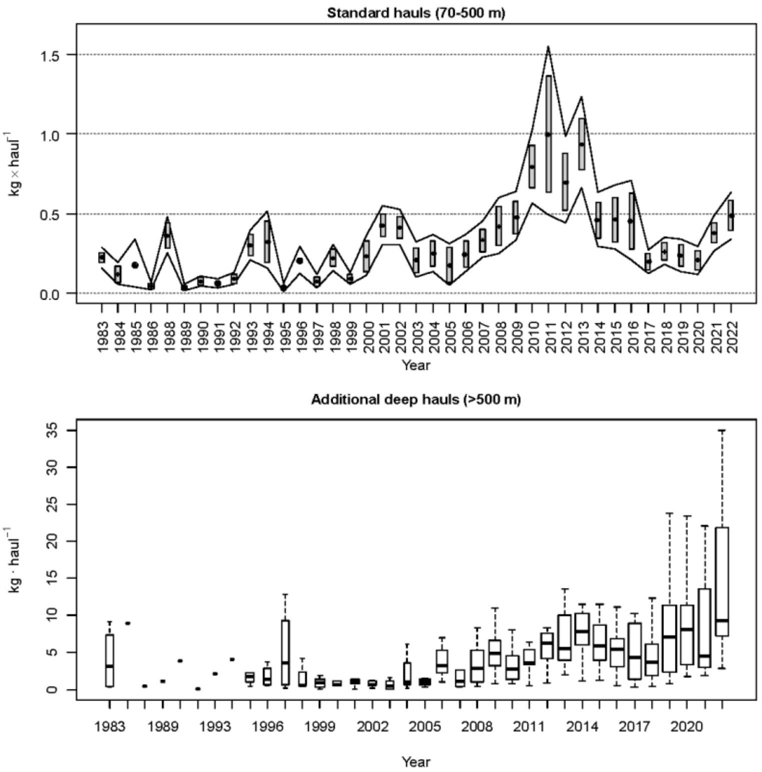

Figure 3 Evolution of *Phycis blennoides* stratified biomass index in standard hauls and additional deep hauls during the North Spanish shelf bottom trawl survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed.

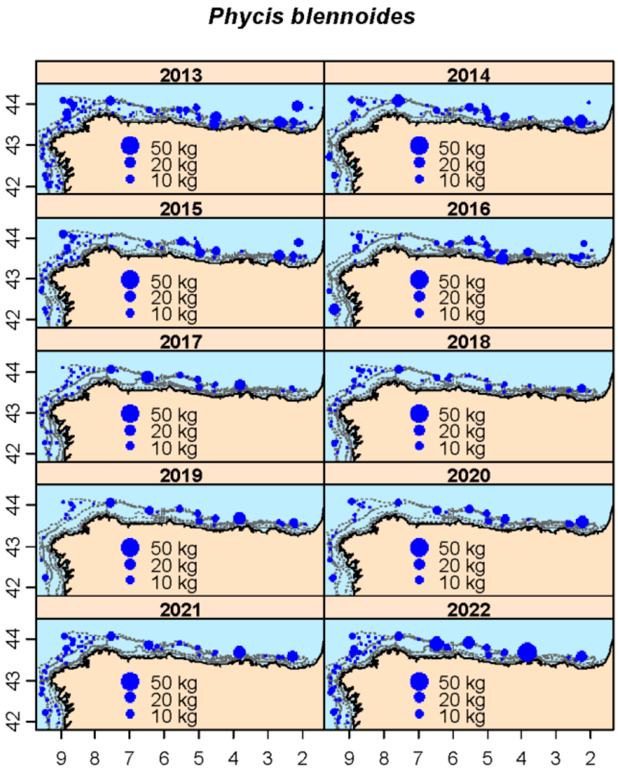

Figure 4 Geographic distribution of *Phycis blennoides* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl surveys in the last decade

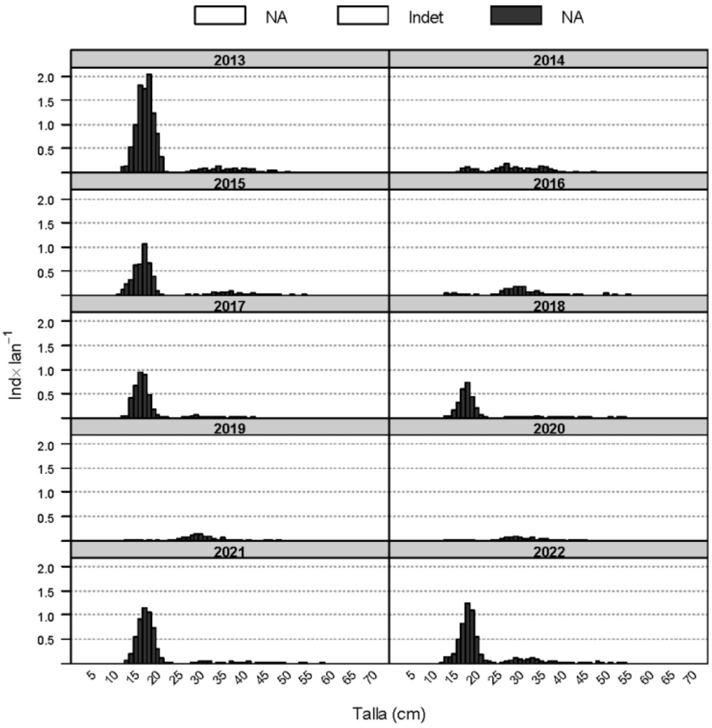

Figure 5 Mean stratified length distributions of *Phycis blennoides* in Northern Spanish Shelf surveys in the last decade

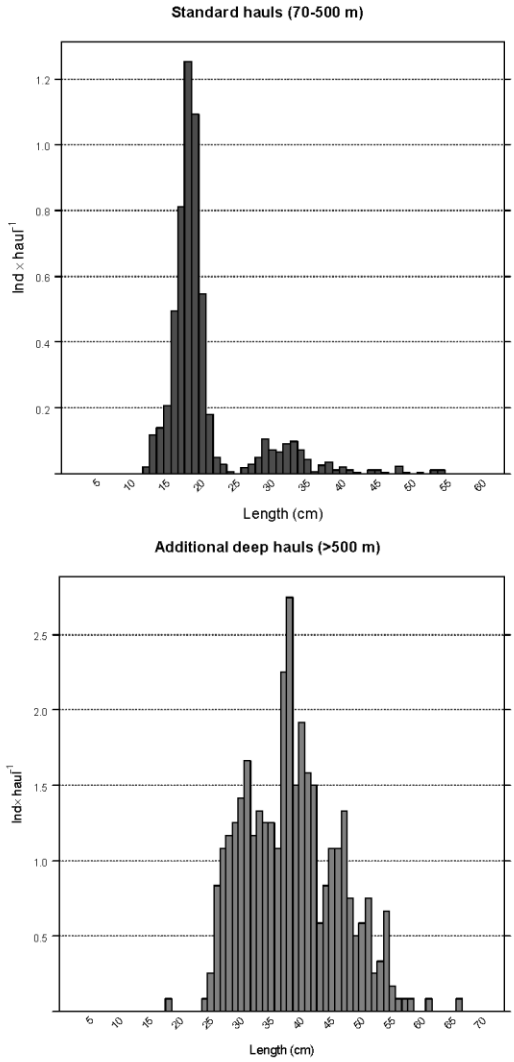

Figure 6 Mean length distributions of *Phycis blennoides* in additional hauls (>500 m) and in the standard hauls (70-500 m) in the North Spanish Shelf survey 2022

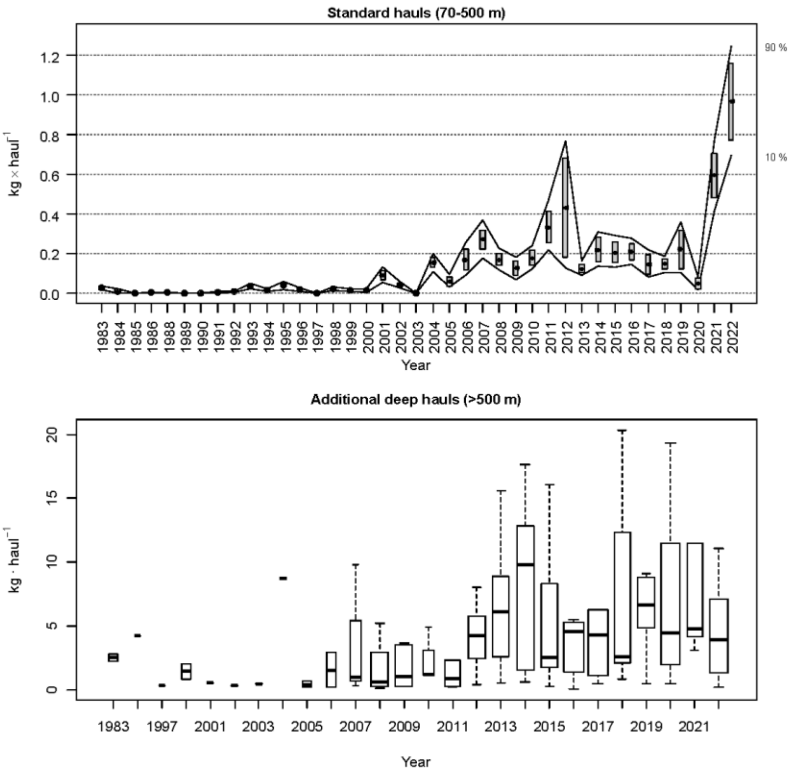

Figure 7 Evolution of *Molva macrophtalma* stratified biomass index in standard hauls and additional deep hauls during the North Spanish shelf bottom trawl survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed.

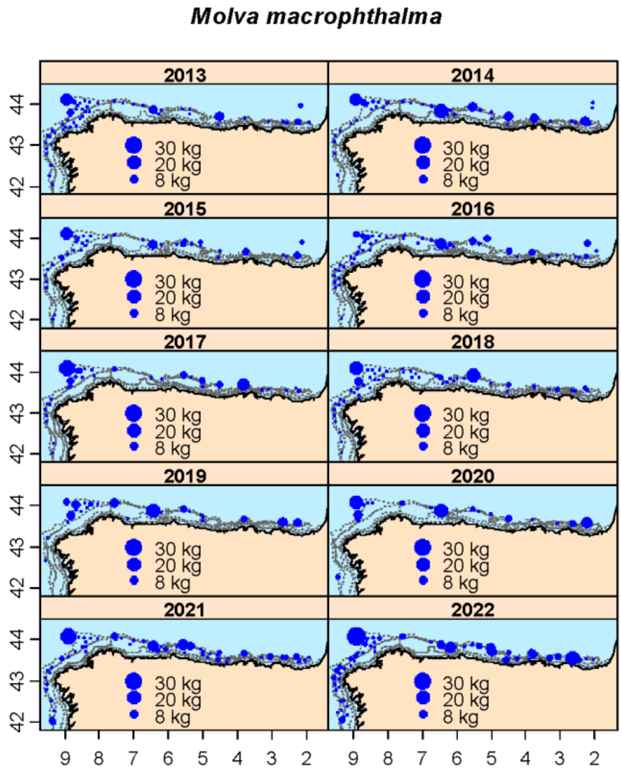

Figure 8 Geographic distribution of *Molva macrophtalma* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl surveys in the last decade

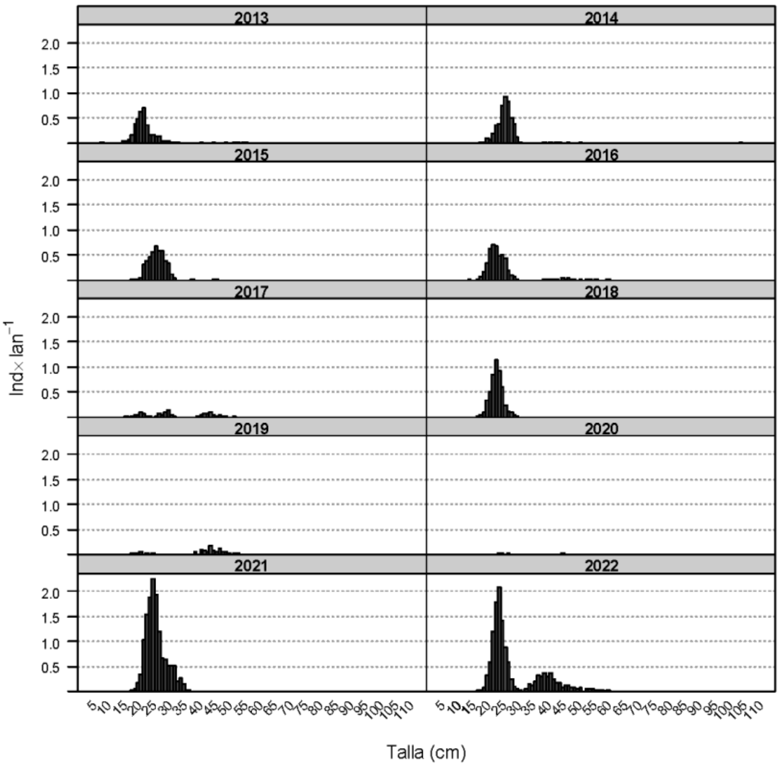

Figure 9 Mean stratified length distributions of *Molva macrophtalma* in Northern Spanish Shelf surveys in the last decade

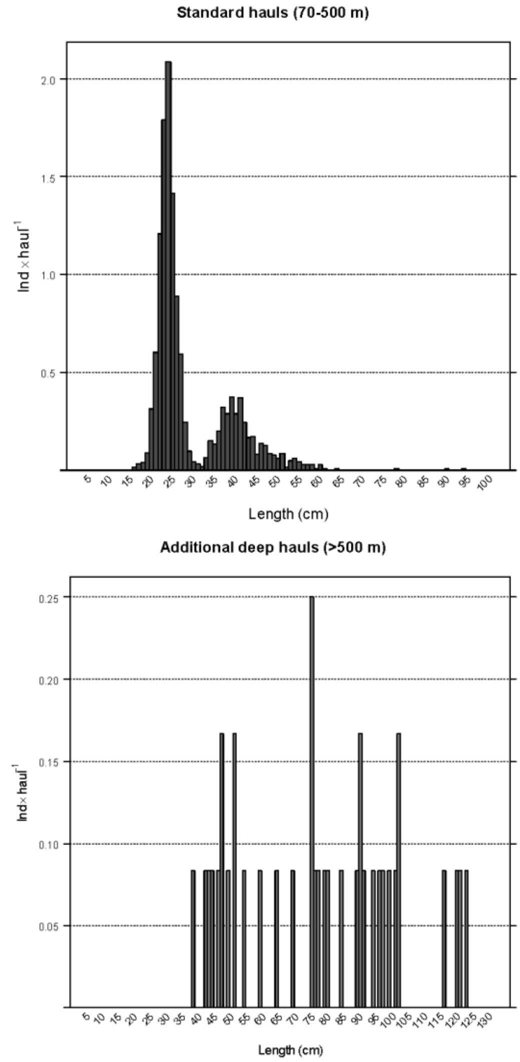

Figure 10 Mean length distributions of *Molva macrophtalma* in additional hauls (>500 m) and in the standard hauls (70-500 m) in the North Spanish Shelf survey 2022

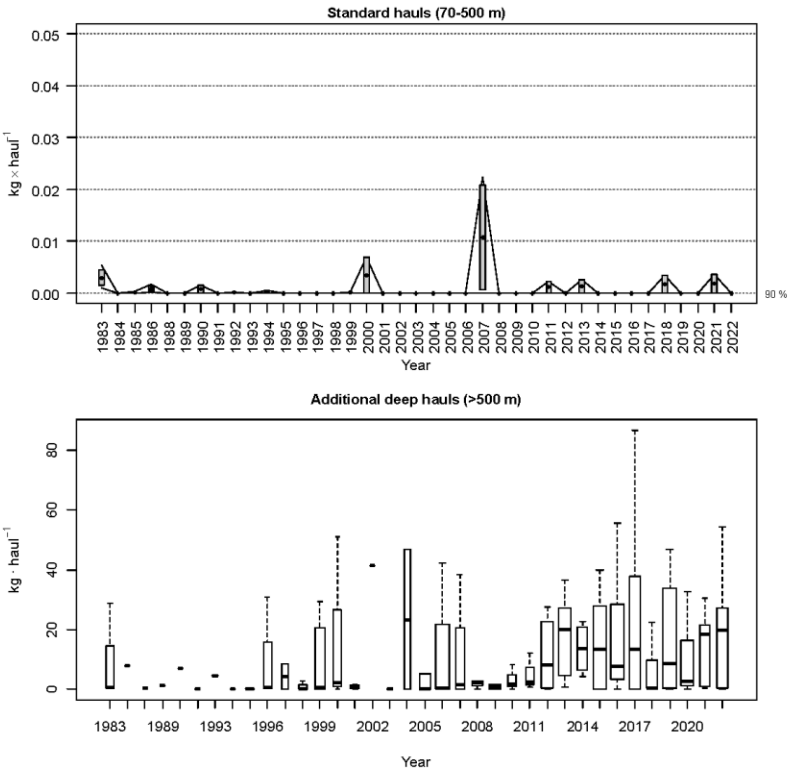

Figure 11 Evolution of *Trachyrincus scabrus* stratified biomass index in standard hauls and additional deep hauls during the North Spanish shelf bottom trawl survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed.

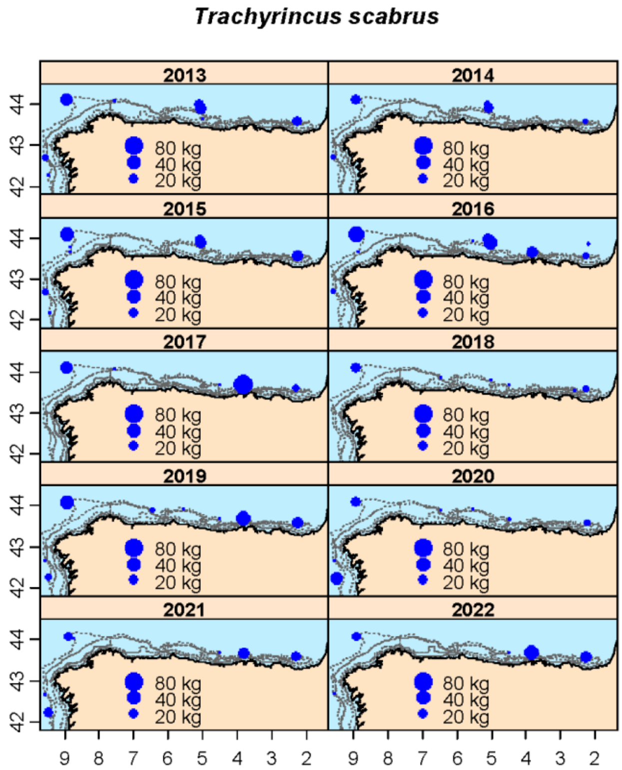

Figure 12 Geographic distribution of *Trachyrincus scabrus* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl surveys in the last decade

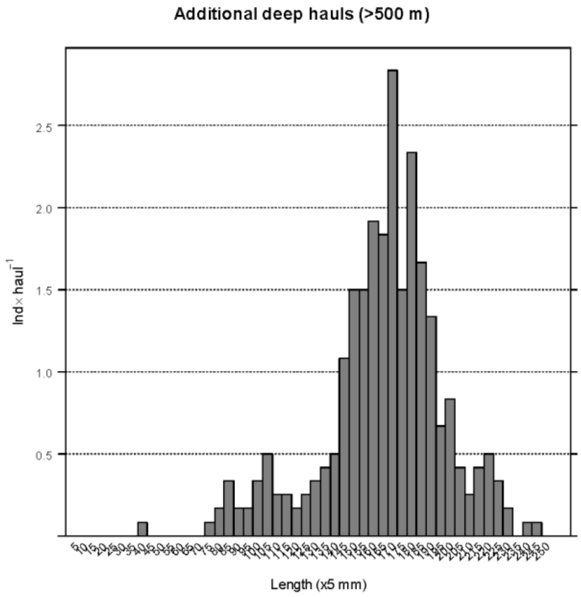

Figure 13 Mean length distributions of *Trachyrincus scabrus* in additional hauls (>500 m) in the North Spanish Shelf survey 2022

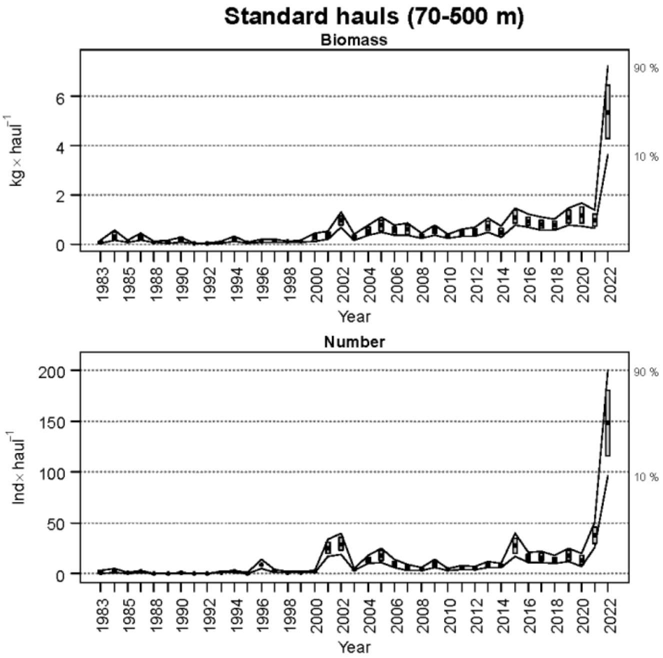

Figure 14 Evolution of *Helicolenus dactylopterus* mean stratified biomass and abundance in Northern Spanish Shelf surveys time series. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

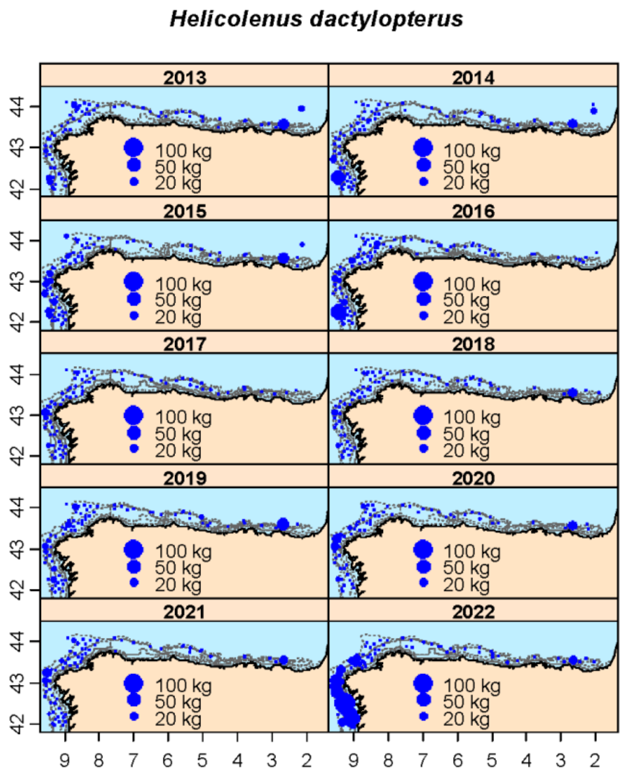

Figure 15 Geographic distribution of *Helicolenus dactylopterus* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl surveys in the last decade

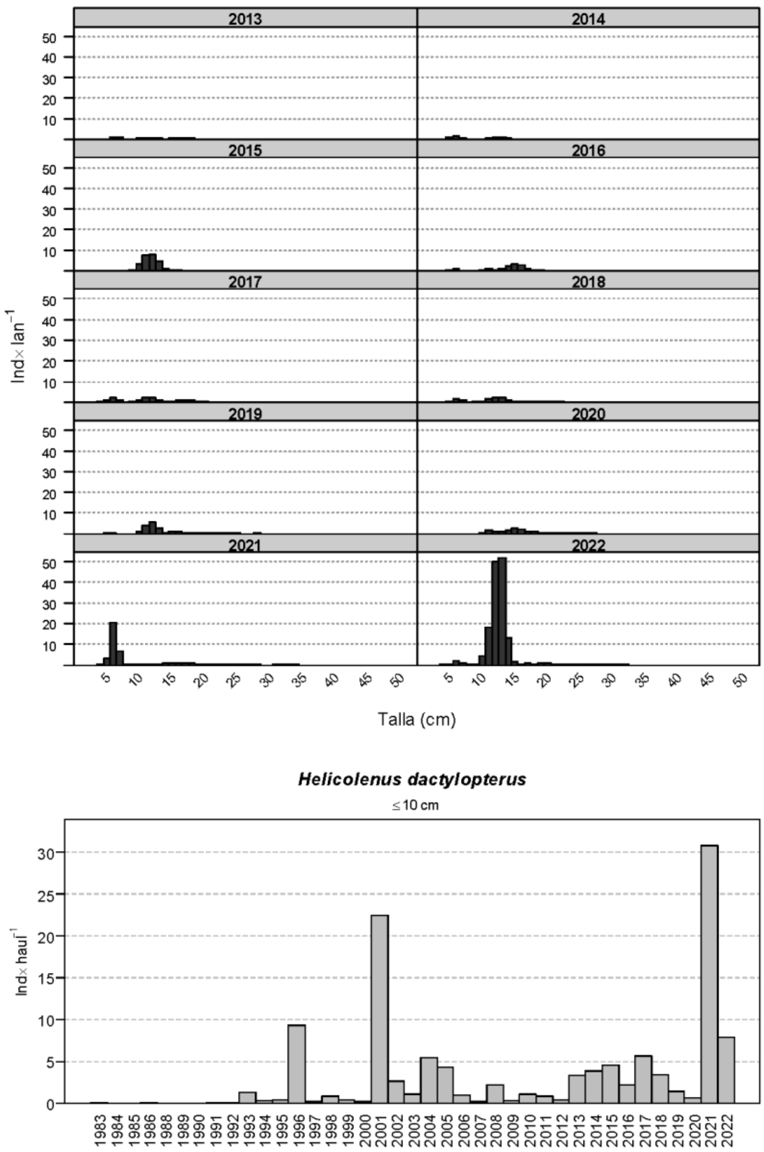

Figure 16 upper plot) Mean stratified length distribution of *Helicolenus dactylopterus* in Northern Spanish Shelf surveys during the last decade
lower plot) *H. dactylopterus* recruitment (< 10 cm) along the north Spanish shelf ground fish survey time series

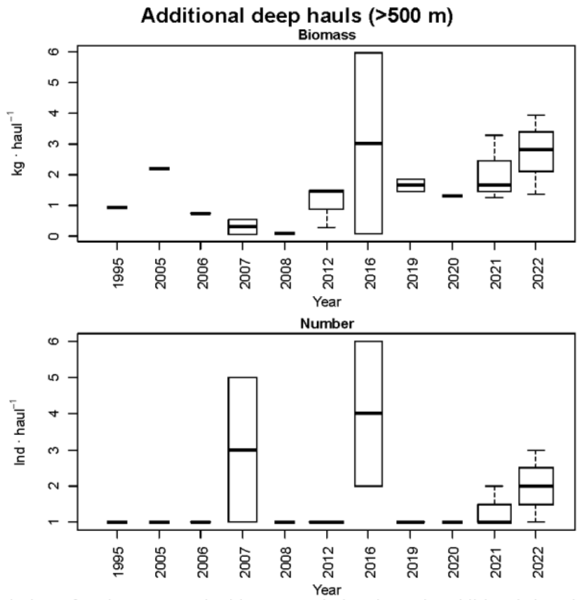

Figure 17 Evolution of *Aphanopus carbo* biomass and abundance in additional deep hauls during the North Spanish shelf bottom trawl survey time series. Boxplots represent the median and interquartiles of the biomass and abundance catches in the deep hauls performed.

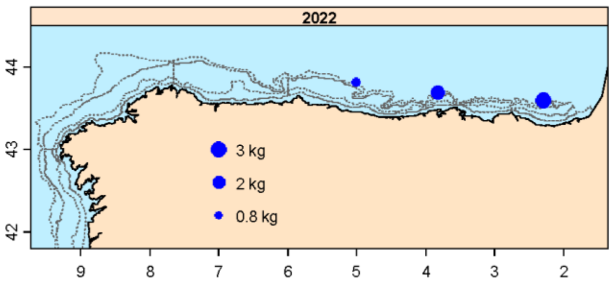

Figure 18 Geographic distribution of *Aphanopus carbo* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl survey 2022

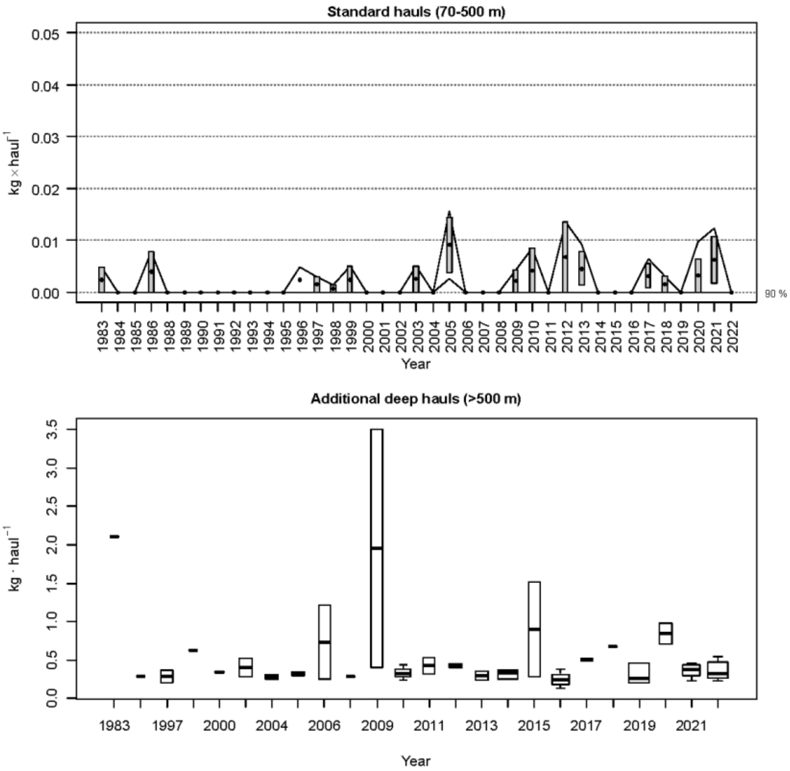

Figure 19 Evolution of *Beryx spp.* stratified biomass index in standard hauls and additional deep hauls during the North Spanish shelf bottom trawl survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed.

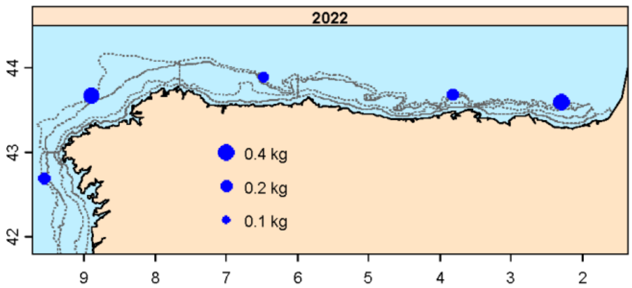

Figure 20 Geographic distribution of *Beryx* spp. catches (kg•haul-1) in the Northern Spanish Shelf bottom trawl survey 2022

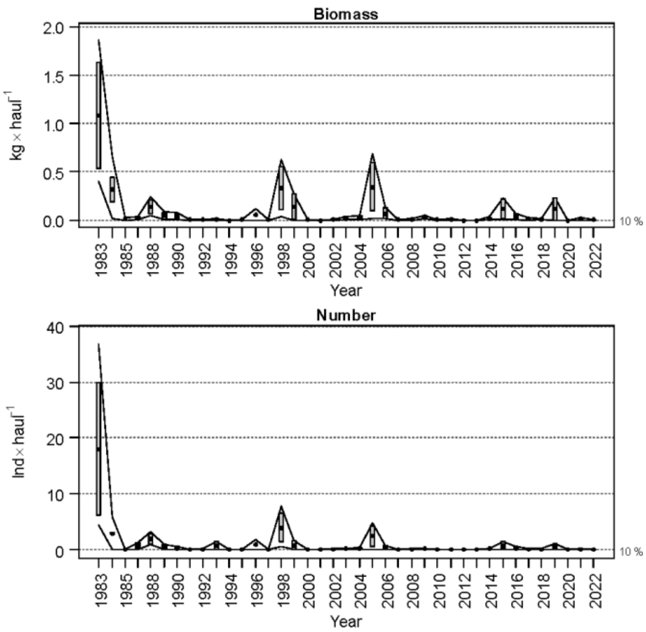

Figure 21 Evolution of *Pagellus bogaraveo* mean stratified biomass and abundance in Northern Spanish Shelf surveys time series. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

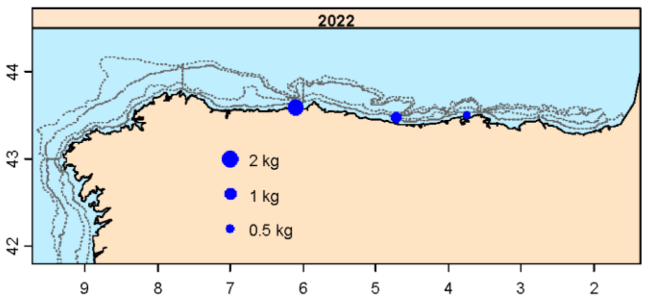

Figure 22 Geographic distribution of *Pagellus bogaraveo* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl survey 2022

Working Document to be presented to the Working Group on the
Biology and Assessment of Deep Sea Fisheries Resources

ICES WGDEEP 3rd - 9th May 2023, Lisbon, Portugal

Results on silver smelt (*Argentina silus* and *A. sphyraena*), bluemouth (*Helicolenus dactylopterus*), greater forkbeard (*Phycis blennoides*), roughsnout grenadier (*Trachyrincus scabrus*), Spanish ling and ling (*Molva macrophthalma* and *Molva molva*) from the 2022 Spanish Groundfish Survey on the Porcupine Bank (NE Atlantic)

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Abstract

This working document presents the results of the most significant deep-sea fish species caught in 2022 on the Porcupine Spanish Groundfish Survey (SP-PORC-Q3). Biomass, abundance, geographical distribution and length ranges were analysed for silver smelt (*Argentina silus* and *A. sphyraena*), bluemouth (*Helicolenus dactylopterus*), greater fork-beard (*Phycis blennoides*), roughsnout grenadier (*Trachyrincus scabrus*), Spanish ling and ling (*Molva macrophthalma* and *Molva molva*) and other scarce deep sea species. Overall, the biomass of these target species increased in this last survey, except for *P. blennoides* and *M. macrophthalma*. Despite that raise, the recruitment was poor.

Introduction

The Spanish bottom trawl survey on the Porcupine Bank (ICES Divisions 7c and 7k) has been carried out annually on the third-quarter (September) since 2001 to study the distribution, relative abundance and biological parameters of commercial fish in the area (ICES 2017).

The aim of this working document is to update the results (abundance indices, length frequency and geographic distributions) of the most common deep-sea fish species on the Porcupine bottom trawl surveys after the results presented previously (Baldó *et al.* 2008, Velasco *et al.* 2009, 2011, 2012, 2013, Fernández-Zapico *et al.* 2015, 2017, 2021, 2022, Ruiz-Pico *et al.* 2016, 2018, 2019, 2020). The species analysed were: *Argentina silus* (greater silver smelt), *Argentina sphyraena* (lesser silver smelt), *Helicolenus dactylopterus* (bluemouth), *Phycis blennoides* (greater forkbeard), *Trachyrincus scabrus* (roughsnout grenadier), *Molva molva* (ling) and *Molva macrophthalma* (Spanish ling) and some other scarce deep sea species as *Aphanopus carbo* (black scabbardfish), *Brosme brosme* (tusk) *Coryphaenoides rupestris* (roundnose grenadier), *Hoplostethus atlanticus* and *Beryx* spp.

Material and methods

The Spanish Ground Fish Survey on the Porcupine Bank (SP-PORC-Q3) has been annually carried out since 2001 onboard the R/V "*Vizconde de Eza*", a stern trawler of 53 m and 1800 Kw. The area covered extends from longitude 12° W to 15° W and from latitude 51° N to 54° N, following the standard IBTS methodology for the western and southern areas (ICES 2017). The sampling design was random stratified to the area (Velasco and Serrano, 2003) with two geographical sectors (Northern and Southern) and three depth strata (< 300 m, 300 – 450 m and 450 - 800 m) (Figure 1). Hauls allocation is proportional to the strata area following a buffered random sampling procedure (as proposed by Kingsley et al., 2004) to avoid the selection of adjacent 5×5 nm rectangles. Extra hauls were performed within the standard stratification to improve coverage in gaps left by random sampling and outside the standard stratification to explore the continuity of the fish community in Porcupine Seabight.

More details on the survey design and methodology are presented in ICES (2017).

The tow duration is 20 min since 2016, but the results were extrapolated to 30 min of trawling time to keep up the time series.

Results and discussion

In 2022, 80 valid standard hauls and 11 extra hauls were carried out, 6 of them below 1000 m in the Porcupine Seabight (Figure 1).

The total stratified catch per haul increased in 2022 reaching the highest value of the time series (Figure 2). Fish represented 95% of the total catch, and the selected deep water fish represented 13% of that total fish catch, with the following percentages per species: *Argentina silus* (38%), *Helicolenus dactylopterus* (31%), *Argentina sphyraena* (14%), *Trachyrincus scabrus* (11%), *Phycis blennoides* (5%), *Molva macrophthalma* (0.5%) and *Molva molva* (0.2%).

In 2022, the biomass of two *Argentina* species, *H. dactylopterus* and *T. scabrus* increased and even reached the highest values of the time series in the two last species. However, the biomass of *P. blennoides* and the two *Molva* species remained among the low values of the time series. Overall, recruitment decreased or remained at low values similar to those of the previous year. The species *Aphanopus carbo, Brosme brosme, Coryphaenoides rupestris, Hoplostethus atlanticus* and *Beryx spp.* were scarce and were found mainly outside the standard stratification, except *Beryx spp.*

***Argentina silus* (greater silver smelt) and *Argentina sphyraena* (lesser silver smelt)**

In 2022, the biomass and abundance of both species of *Argentina* increased, to high values of the time series for *A. sphyraena* whereas only to low-medium values for *A. silus*, the species that historically contributes most to the genus in the survey (Figure 3; Figure 4; Figure 5).

Both species were more abundant in the north of the bank, in particular in the northeast area in this last survey. *A. silus* was also found in the south of the study area, as usual, but mainly in the deeper southeastern strata in this last survey (Figure 6 and Figure 7).

The sizes of both species kept a similar distribution to previous years, *A. sphyraena* with a single mode around 23 cm and *A. silus* with two smaller modes, one rough of 22 cm and a smooth one around 30 cm (Figure 8).

***Helicolenus dactylopterus* (bluemouth)**

Although bluemouth is not requested in the ICES DCF Data Call, biomass and abundance are significant in the area and useful for the assessment of the species (ICES, 2015).

Biomass and abundance of *H. dactylopterus* followed the upward trend of the last three years reaching an all-time record high this last survey (Figure 9). However, recruitment has been falling for the last two years and was even lower in this last survey (Figure 10).

H. dactylopterus was found throughout the study area, even in the northwest of the bank where the largest biomass patches were found. However, recruits were hardly found in their usual areas, the Irish shelf and the southeastern area of the bank (Figure 11).

In the size distribution of H. dactylopterus in this latest survey only one mode was found, but a record size of about 17 cm (Figure 12). The few recruits were mainly of 7 and 8 cm, unlike the previous year when 11-12 cm specimens were more abundant.

***Trachyrincus scabrus* (roughsnout grenadier)**

T. scabrus increased sharply breaking the downward trend of the three previous years and reaching the highest value in the time series (Figure 13).

The species was found in the deepest southeastern and western area, as usual, but more abundantly in this lastest survey (Figure 14).

The length distribution in 2022 showed a marked mode around 18 cm in contras to the smooth outline of the previous year. Specimens of 11 to 13 cm were scarce in this last survey, but a few more recruits of 6 and 11 cm were found (Figure 15).

***Phycis blennoides* (greater fork-beard)**

Biomass and abundance of *P. blennoides* decreased slightly and remained among the lowest values of the time series (Figure 16).

Biomass patches were widely found in the south, west and east, but scarcely in the north, as in previous years (Figure 17).

Most specimens were from 28 cm to 35 cm in this last survey and fewer recruits were found in contrast to the previous year (Figure 18).

***Molva molva* (ling) and *Molva macrophthalma* (Spanish ling)**

These two species were analysed comparatively in this working document, as in previous reports.

M. molva was scarcer than *M. macrophthalma* in the area. Both species have been on a downward trend since 2014 and has not yet been reverted. In this last survey, the biomass and abundance of *M. macrophthalma* decreased further, reaching the lowest value of the time series (1.02 kg $haul^{-1}$ and 1.27 ind. $haul^{-1}$), whereas *M. molva* increased slightly (Figure 19).

The few biomass patches of *M. molva* were found in the west and southeast of the bank whereas *M. macrophthalma* was found in the west but further south and in the south of the study area, though scarcer than in previous years (Figure 20).

Only 9 specimens of *M. molva* were found, ranging from 31 to 99 cm. Specimens of *M. macrophthalma*, a few more, sized from 14 to 97 cm (Figure 21).

Other deep-sea fish species

The deep water species *Aphanopus carbo, Brosme brosme, Coryphaenoides rupestris, Hoplostethus atlanticus* and *Beryx spp.* were scarcely or not found in the standard stratification of the study area, but were found outside of it, except for *Beryx* spp.

In 2022, the species *C. rupestris* and *H. atlanticus* were only found in deep hauls carried out in the Porcupine Seabight, outside the stratification, the first species in five hauls from 1039 and 1477 m and the second one in three hauls between 1302 and 1477 m.

The species *A. carbo* was found from 626 and 1492 m, mainly in deep hauls in the Porcupine Seabight, but also in four hauls in the standard stratification.

The species *Brosme brosme* was not found in the three previous years, but in this last survey was found again, one specimen in one haul in the standard stratification at 489 m and also two specimens in one haul in the Porcupine Seabight at 1032 m.

Species of the genus *Beryx* were found in the standard stratification, *Beryx splendes* in the southern part of the bank (three specimens of 25, 29 and 30 cm) and *Beryx decadatylus* in the east area, but only two specimens of 28 and 30 cm, in one haul.

Acknowledgements

We would like to thank the *R/V Vizconde de Eza* crew and the IEO scientific teams that made the Porcupine Spanish Groundfish Survey possible. Included in the ERDEM project, the survey has been co-funded by the EU through the European Maritime and Fisheries Fund (EMFF) within the National Program of collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy.

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Figures

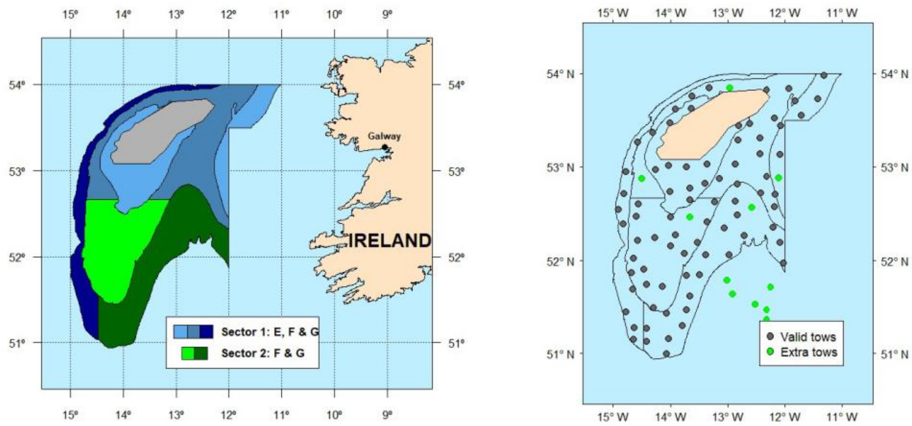

Figure 1. Left: Stratification design used in Porcupine surveys from 2003, previous data were re-stratified. Depth strata are: E) shallower than 300 m, F) 301 – 450 m and G) 451 – 800 m. The grey area in the middle of Porcupine bank corresponds to a large non-trawlable area, not considered for area measurements and stratification. Right: Distribution of hauls performed in the last survey.

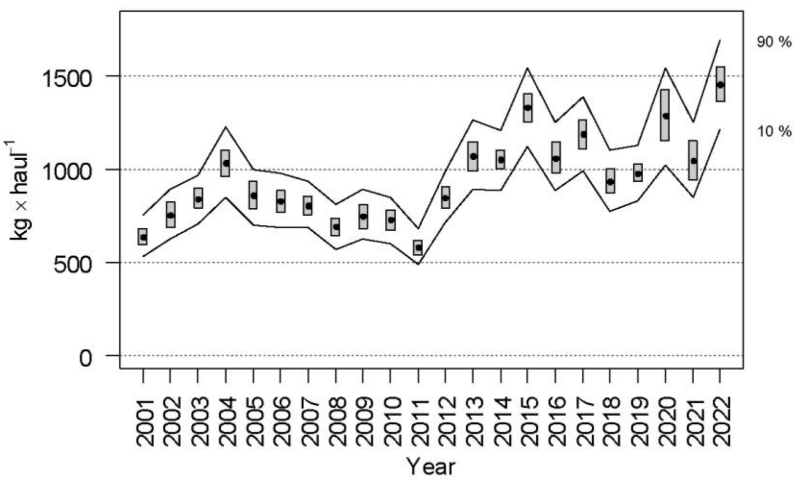

Figure 2. Evolution of the total fish catch in biomass in the Porcupine surveys.

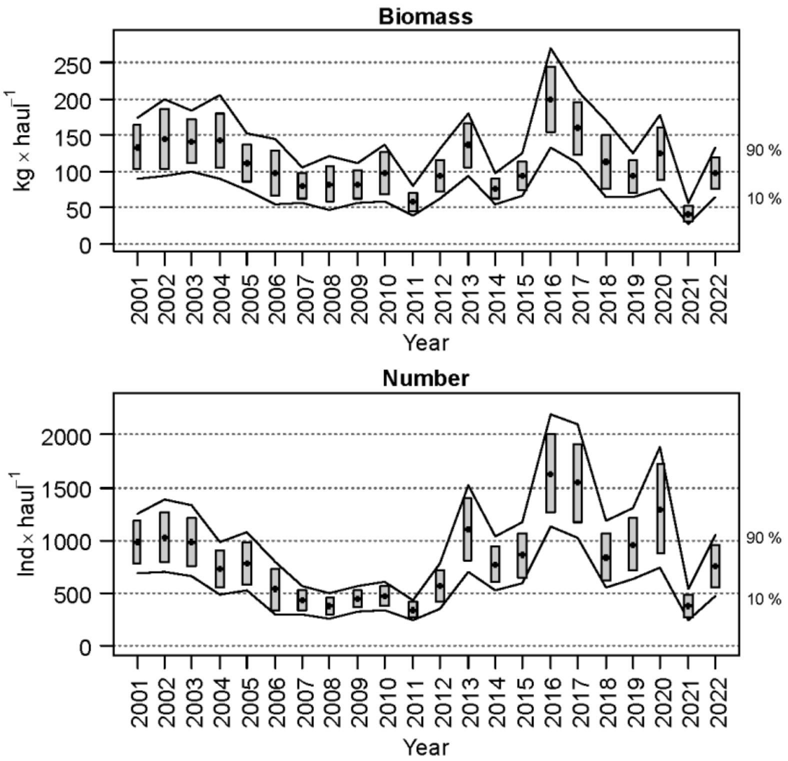

Figure 3. Evolution of biomass and abundance indices *Argentina* spp. (mainly *Argentina silus*) in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000).

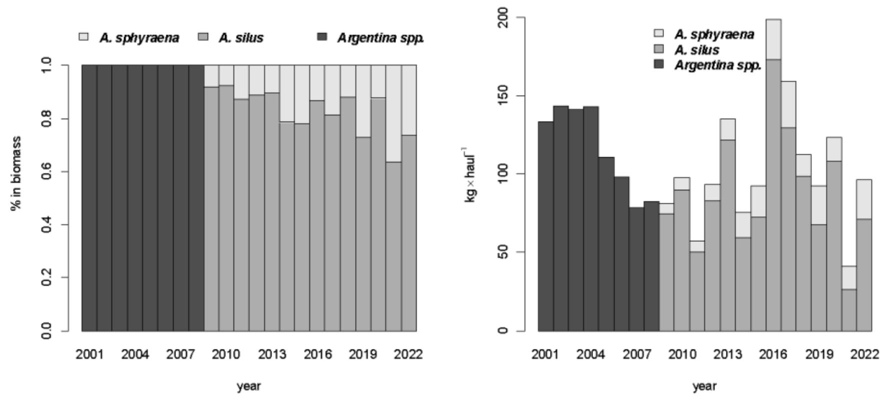

Figure 4. Share and abundance of Argentine species in the Porcupine surveys.

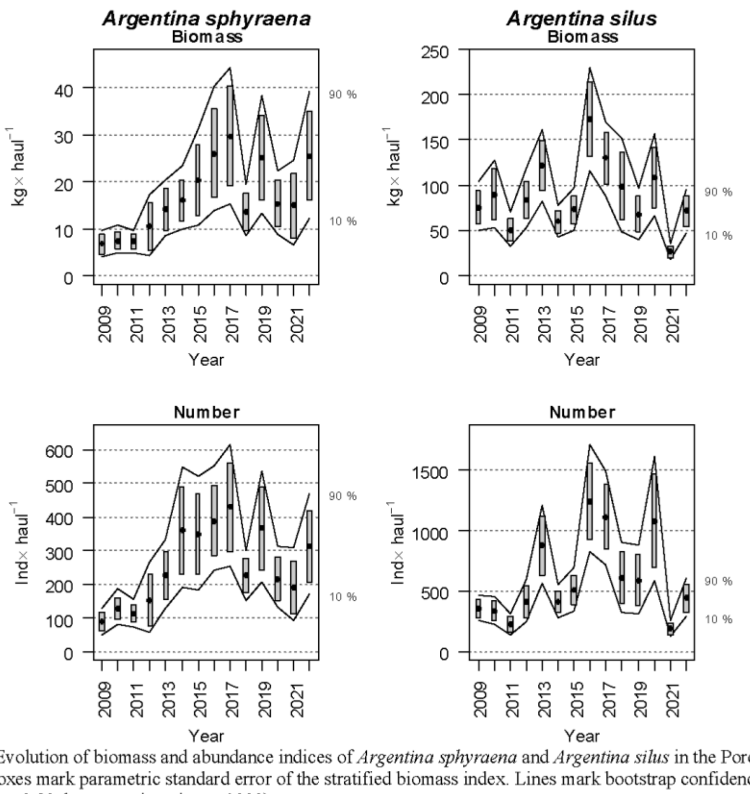

Figure 5. Evolution of biomass and abundance indices of *Argentina sphyraena* and *Argentina silus* in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

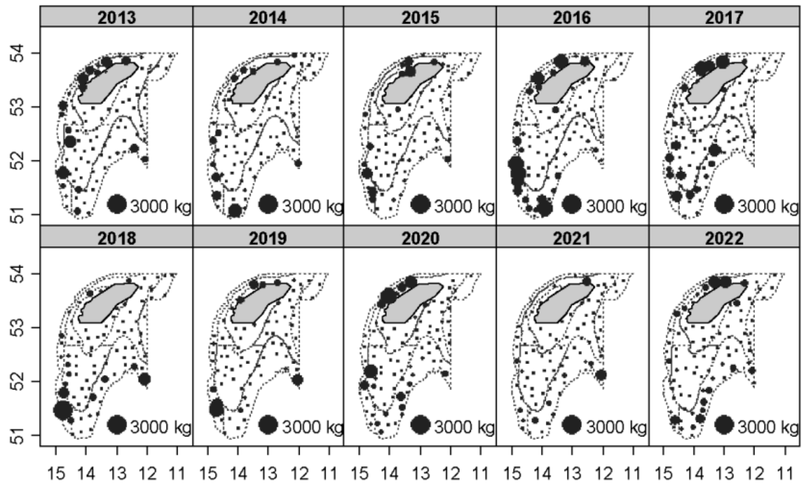

Figure 6. Geographic distribution of *Argentina* spp. catches (kg/30 min haul) in Porcupine surveys over the last decade.

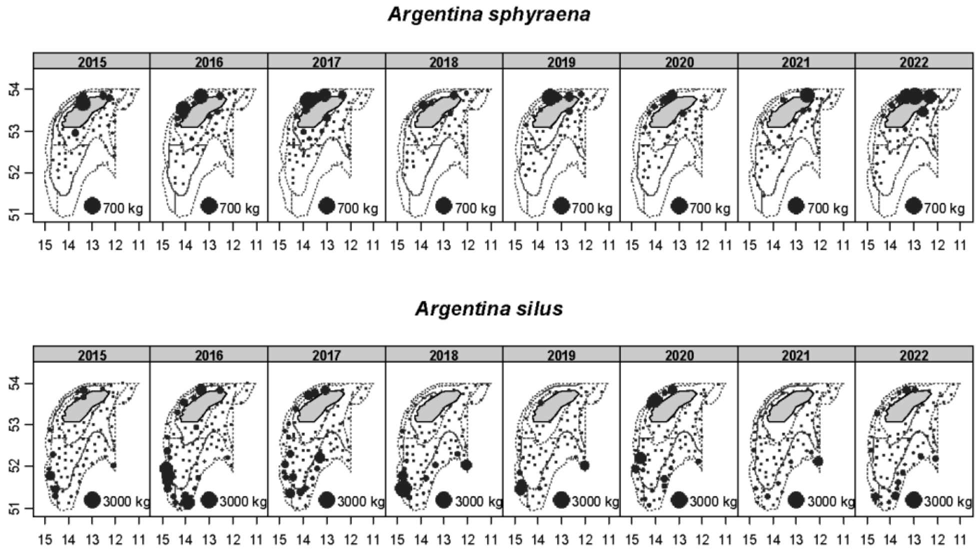

Figure 7. Geographic distribution of *Argentina sphyraena* and *Argentina silus* catches (kg/30 min haul) in Porcupine surveys (2015 - 2022).

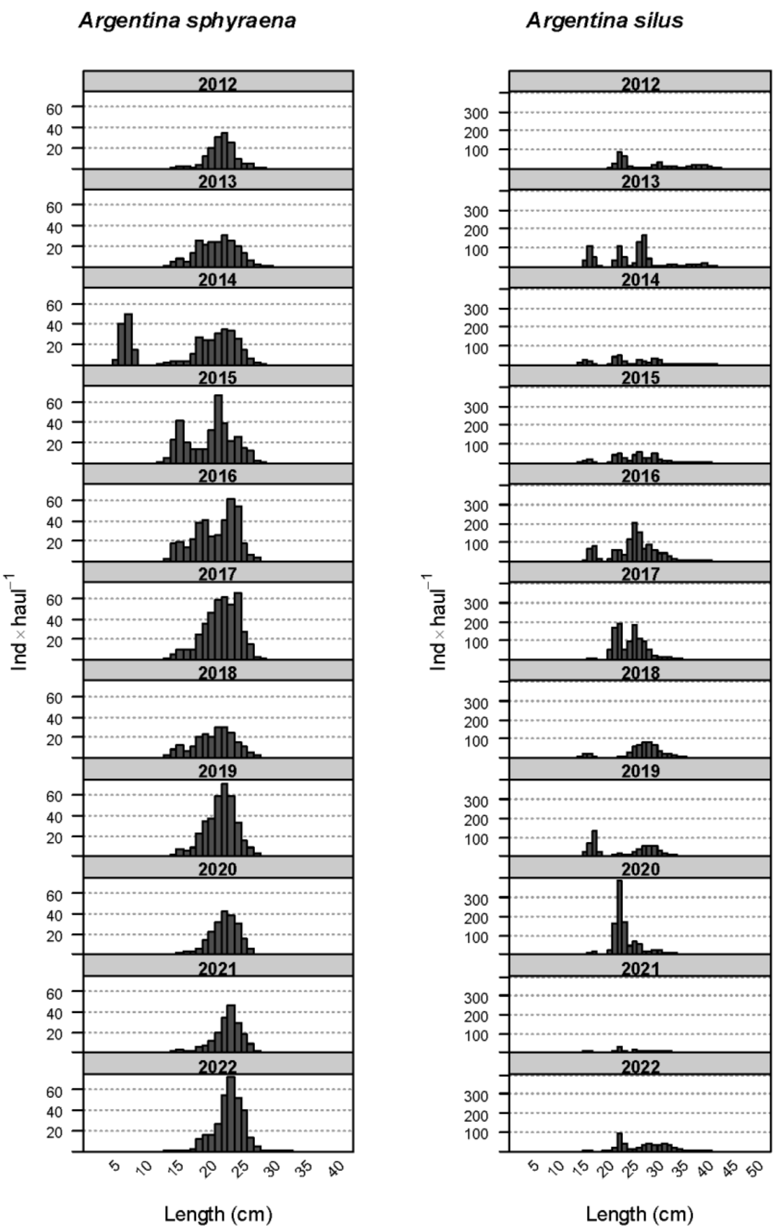

Figure 8. Mean stratified length distributions of *Argentina sphyraena* and *Argentina silus* in the Porcupine surveys (2012-2022).

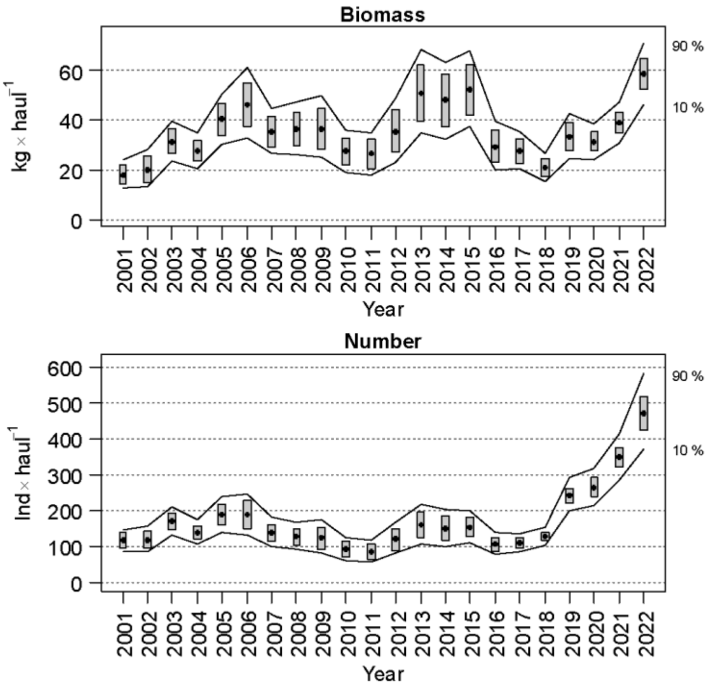

Figure 9. Evolution of biomass and abundance indices of *Helicolenus dactylopterus* in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000).

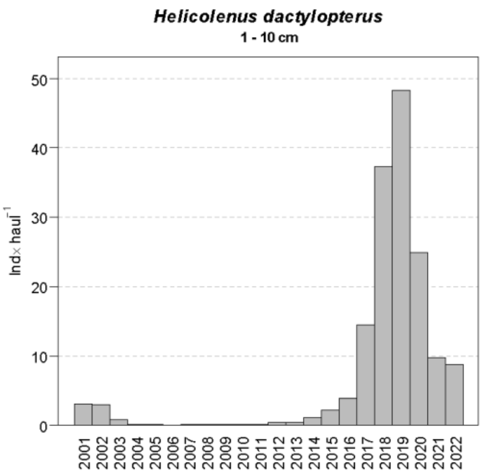

Figure 10. Mean stratified abundance of *Helicolenus dactylopterus* recruits (1-10 cm) in the Porcupine surveys.

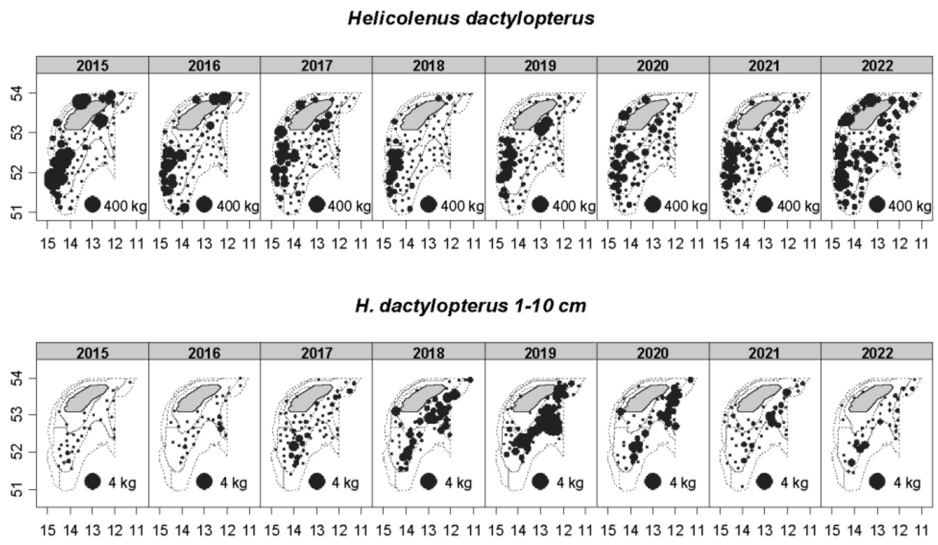

Figure 11. Geographic distribution of *Helicolenus dactylopterus* catches (kg×30 min haul-1) and recruits (1-10 cm) in the Porcupine surveys (2015-2022).

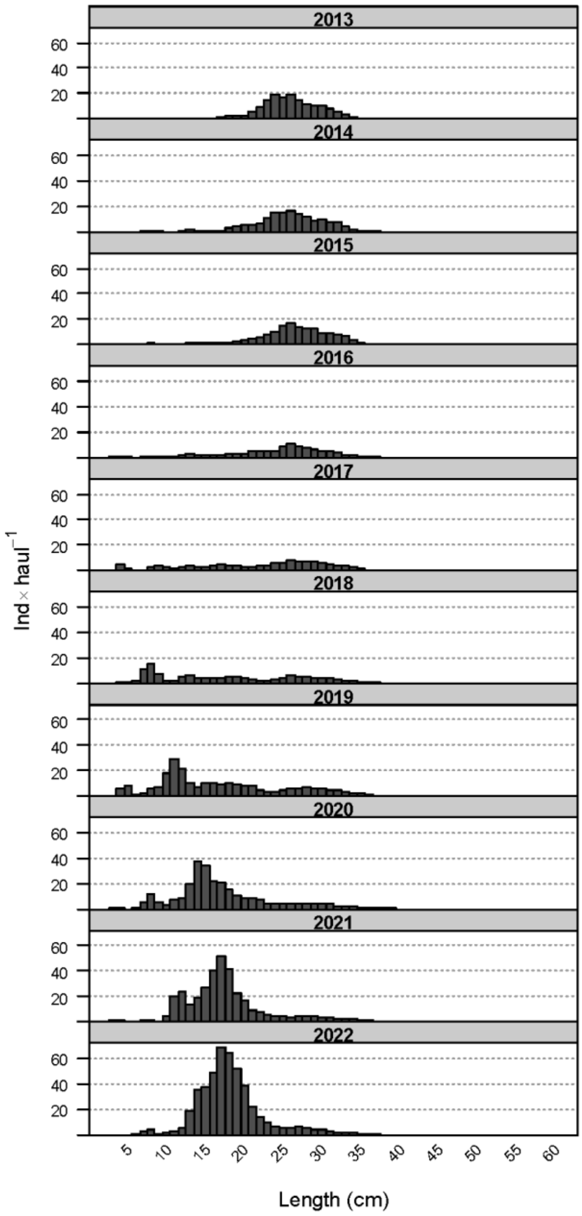

Figure 12. Mean stratified length distributions of *Helicolenus dactylopterus* in the Porcupine surveys (2013-2022).

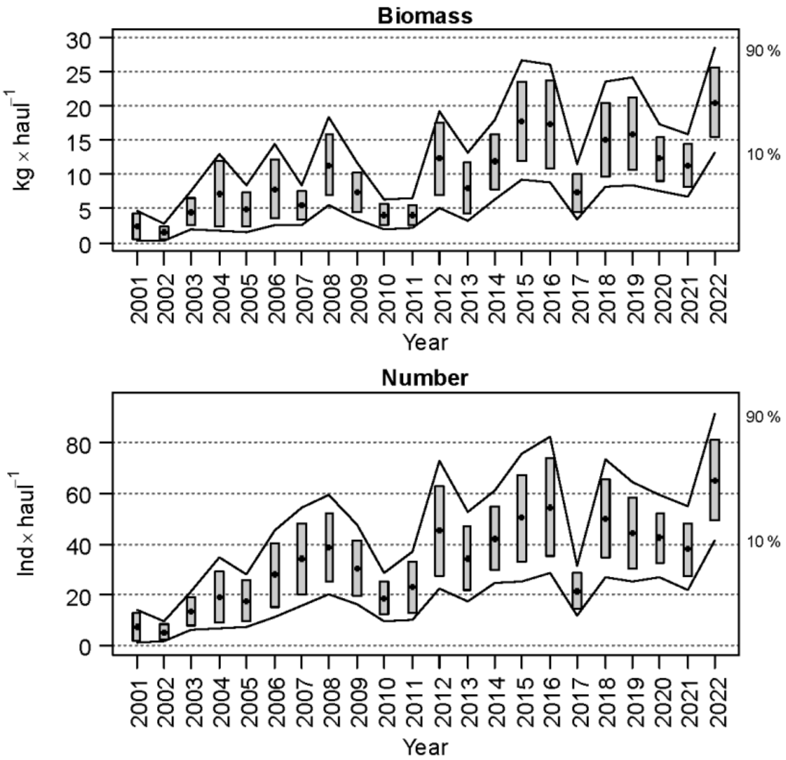

Figure 13. Evolution of biomass and abundance indices of *Trachyrincus scabrus* in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

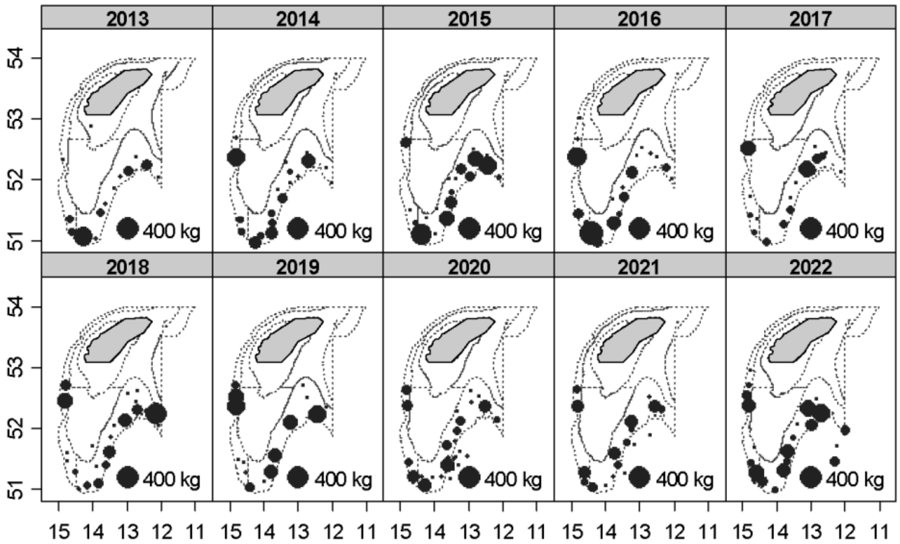

Figure 14. Geographic distribution of *Trachyrincus scabrus* catches (kg/30 min haul) in the Porcupine surveys over the last decade.

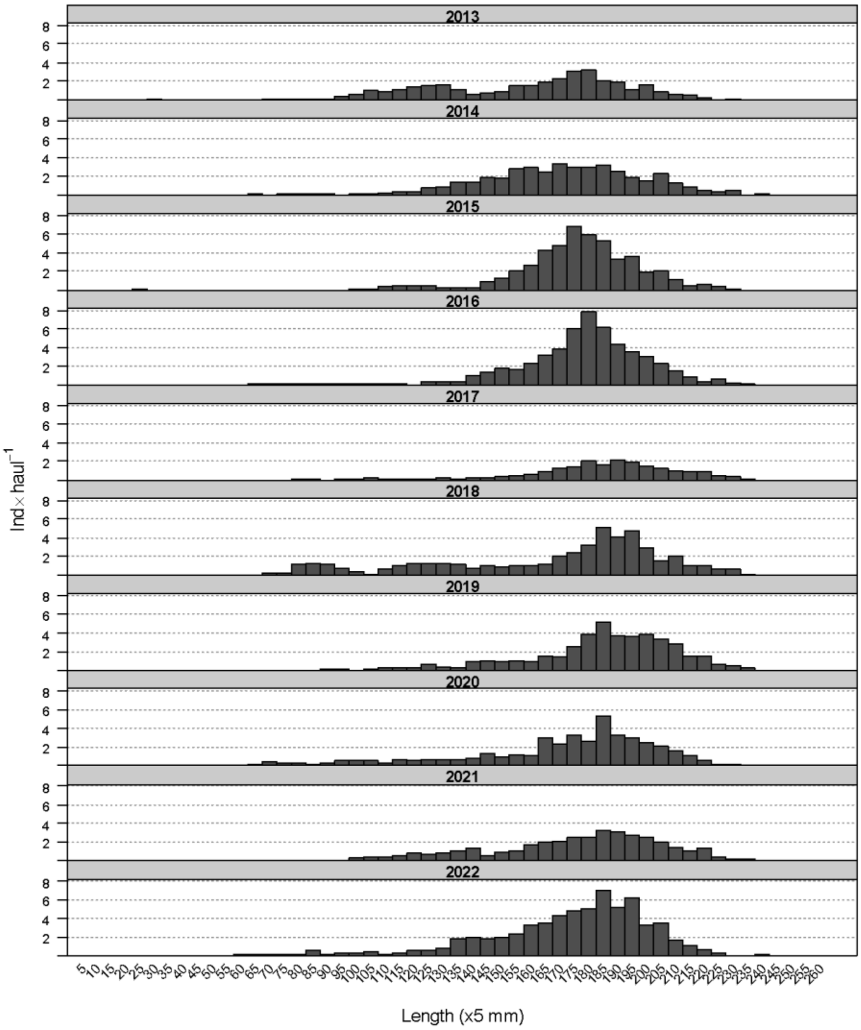

Figure 15. Mean stratified length distributions of *Trachyrincus scabrus* in the Porcupine surveys (2013-2022).

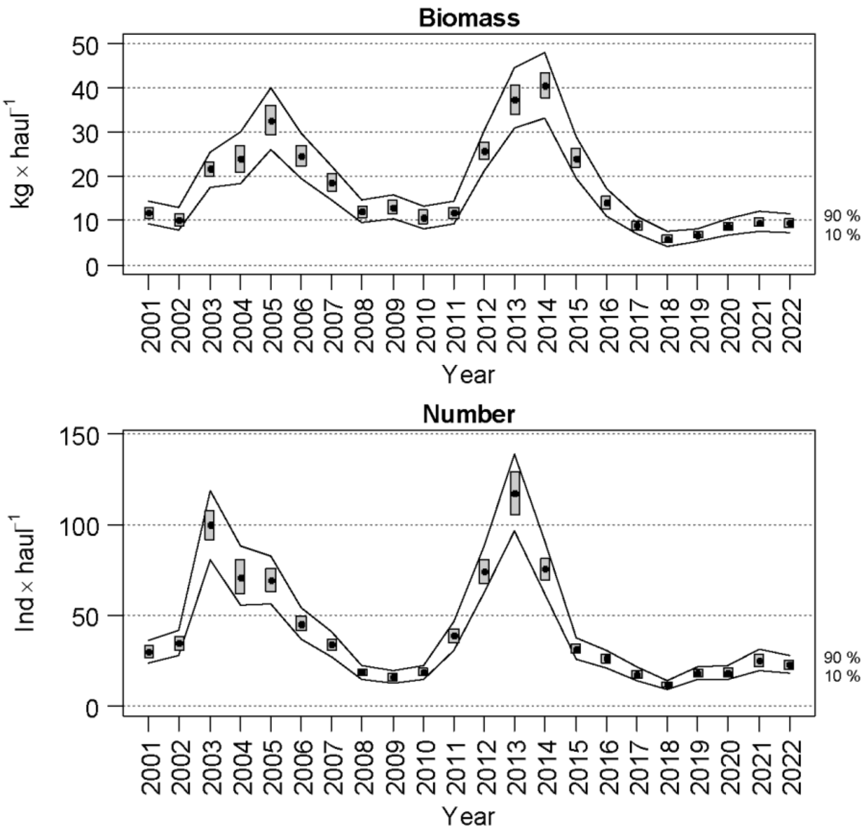

Figure 16. Evolution of biomass and abundance indices of *Phycis blennoides* in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

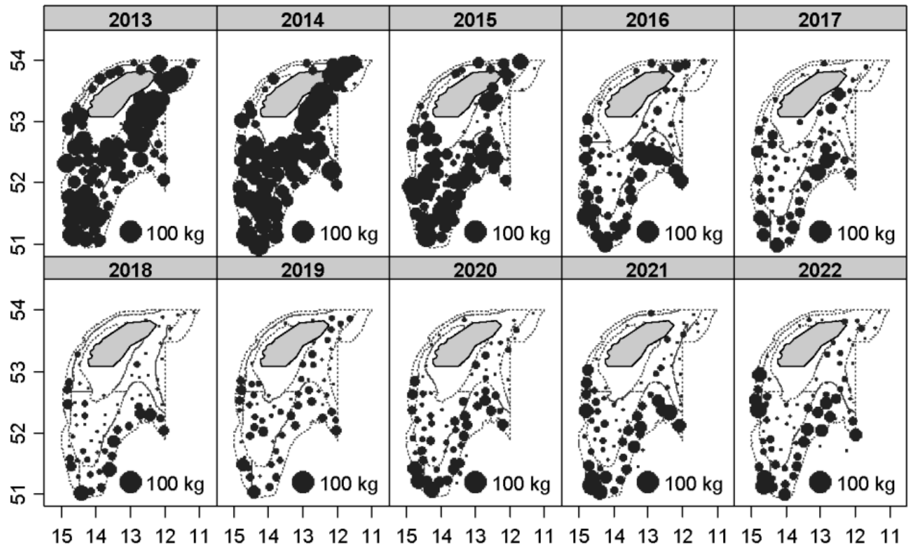

Figure 17. Geographic distribution of *Phycis blennoides* catches (kg×30 min haul^{-1}) in the Porcupine surveys over the last decade.

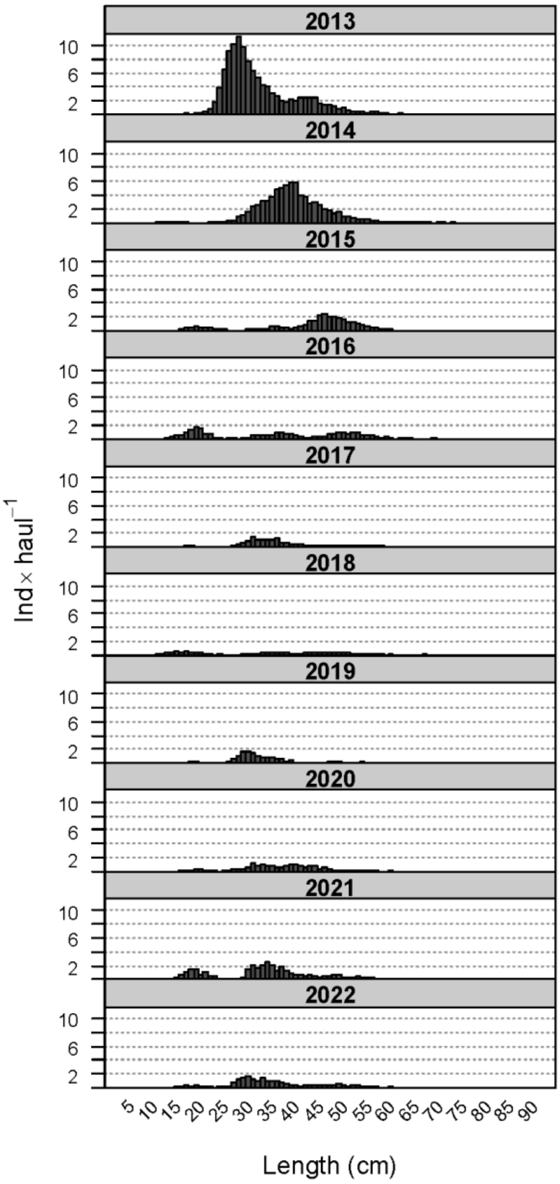

Figure 18. Mean stratified length distributions of *Phycis blennoides* in the Porcupine surveys (2013-2022).

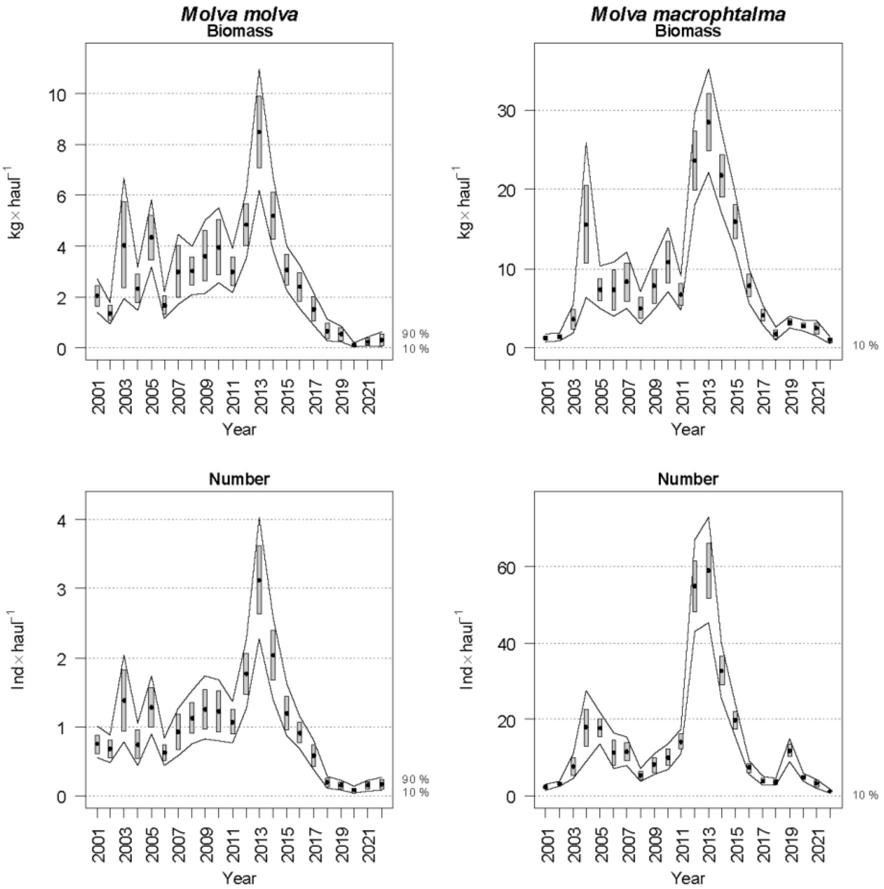

Figure 19. Evolution of biomass and abundance indices of *Molva molva* and *Molva macrophthalma* in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000).

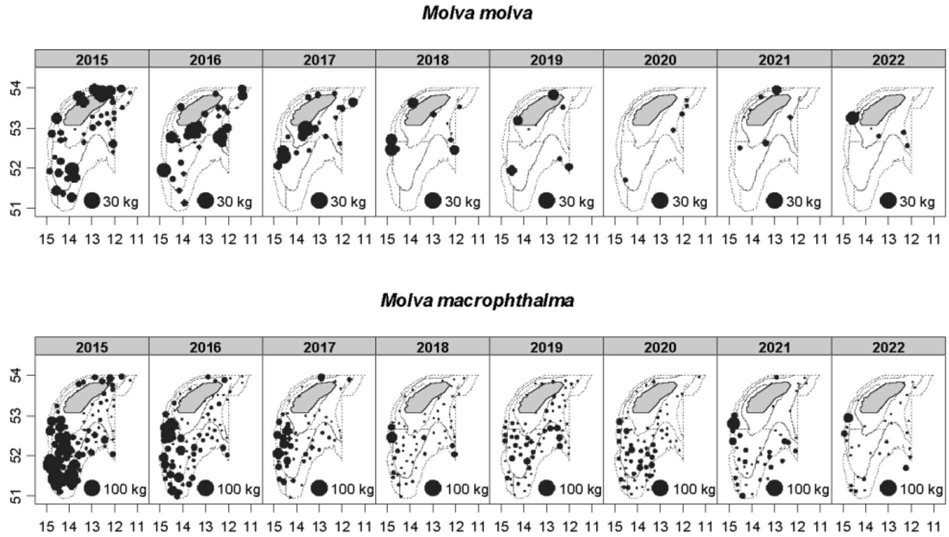

Figure 20. Geographic distribution of *Molva molva* and *Molva macrophthalma* catches (kg×30 min haul^{-1}) in the Porcupine surveys (2015-2022).

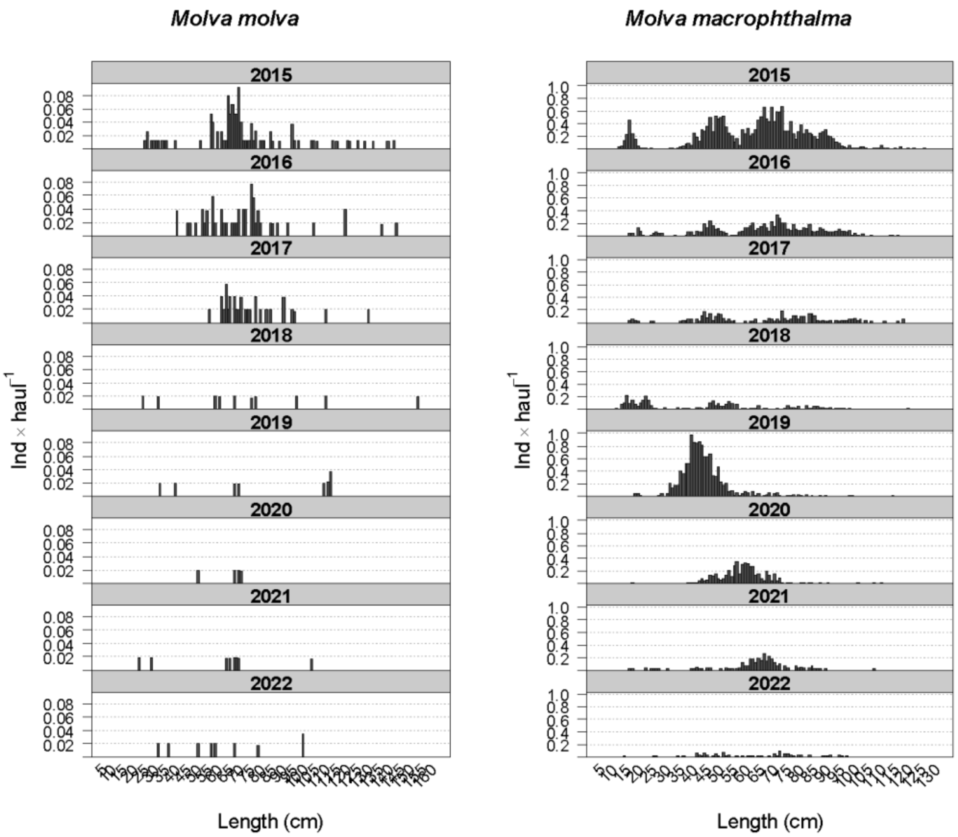

Figure 21. Mean stratified length distributions of *Molva molva* and *Molva macrophthalma* in the Porcupine surveys (2015-2022).

WD ICES WGDEEP, Copenhagen 2023

Update on Norwegian fishery independent information on abundance, recruitment, size distributions, and exploitation of roundnose grenadier (*Coryphaenoides rupestris*) in the Skagerrak and north-eastern North Sea (ICES Division IIIa)

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Introduction

The roundnose grenadier is a long-lived deepwater species which in the relevant study area reaches ages of 70 years or more and attains maturity at the age of 8-12 years (Bergstad 1990). It has a limited area of distribution within the Norwegian deep and in the deep Skagerrak basin (300-720m) (ICES Div. 4a & 3a). Analyses using microsatellite DNA have demonstrated that the Skagerrak grenadier is currently likely to be isolated from grenadier elsewhere in its North Atlantic distribution area (Knutsen *et al*., 2012). In 2003-2005 a major expansion of the previously quite minor targeted grenadier fishery occurred, and this expansion was followed by a complete closure of the fishery from 2006 onwards. Apart from previous targeted exploitation, grenadier is now a minor by-catch in the traditional trawl fishery for *Pandalus borealis* which is currently the major demersal trawl fishery in the area. Most shrimp fishing occurs shallower than the main distribution area of the grenadier.

This Working Document presents results derived from a research vessel bottom trawl survey conducted annually during the past 40 years (1984-2023). While the main objective of the survey is to monitor *Pandalus borealis*, the survey samples the entire depth range and distribution area of roundnose grenadier.

We report temporal variation in survey catch rates in terms of biomass and abundance (kg/hour and number/hour), length distributions, occurrence of recruits, and geographical distribution. We also give an estimate of by-catch in the commercial shrimp fishery from Reference fleet data. Most of the information in this Working Document is an update of a WD first submitted to WGDEEP in 2009 (Bergstad *et al*. 2009). The survey series is currently the only information available to assess temporal variation and trends for the grenadier in this area. A full analysis of the time-series has been published (Bergstad *et al*., 2014), but this working paper extends the series to also include the years 2014-2023.

Material and Methods

Data was collected from the annual *Pandalus borealis* shrimp survey performed by the Institute of Marine Research in the years 1984-2023 (Table 1). The survey is a depth stratified shrimp trawl survey with approximately 25% of the stations deeper than 300 m (depth range 117-534 m). The trawl used has small meshes overall and a 6mm cod-end liner and retains all sizes of grenadiers, including the smallest newly settled juveniles (Bergstad 1990, Bergstad and Gordon 1994). The stations are placed at random within strata and subareas, and the same sites sampled every year. Although some changes occurred over the years (Table 1), the overall standardization was maintained throughout the time series (Bergstad *et al.* 2014).

Catch rates in terms of biomass and abundance were calculated for stations 300 m and deeper, i.e. excluding shallower survey depths where the species only occurs sporadically in small numbers (Bergstad 1990). Stations with zero catches were included, and the catches at non-zero stations were standardized by tow duration.

Annual length distributions were derived for the pooled standardized catches at 300m and beyond. In cases where catches were subsampled, length distributions were raised to the total catch prior to pooling.

Age data from selected surveys in 1987 and 2007-2023 were calculated as cumulative age distributions. Age and length data from 2008-2023 were analyzed for growth parameters.

Standardized mean catches by number of small juveniles of PAFL ≤ 5 cm were calculated to show recruitment during the survey period.

A time series of maps showing geographical distributions by year were plotted, representing scaled catch rates at the actual sample sites for each survey year.

Data from the Norwegian reference fleet (2013-2019) was collected to report bycatch on roundnose grenadier in the Norwegian shrimp fishery.

Results

Biomass and abundance

The estimates of catch rates in terms of biomass (kg/h) and abundance (nos/h) varied substantially through the time series (Fig.1), but elevated levels were observed from 1998 to 2004. The decline from 2005 continued through the time series until 2017 which was the lowest on record. The observations from 2018-2023 remained low, but with a slight increase compared with 2017.

Size and age distributions

The time series of annual length distributions show a major shift in the early 1990s (Fig. 2). From 1992 the proportion of large fish with PAFL>15cm declined to less than 10% which contrasts with the pre-1990 distributions dominated by large fish. From 1992, a pronounced mode of small fish can be followed in subsequent years, with modal length increasing through the time series.

In 2018 there is another shift in the length distributions. The very recent distributions (2018-2023) contrasts with earlier distributions by having very low proportions of large fish. The distributions are dominated by small fish but at low levels compared to the 1990's. The situation in 2023 is the same as in 2022.

Age distributions and growth

The cumulative age distribution from the extracted data from 1987 (Bergstad, 1990) contrasts substantially with the distributions from 2007-2023 in terms of proportions of old fish (e.g. >20 years). In 1987, the proportion of fish > 20 years was over 50% (Table 4). In 2008, i.e. after the relatively large expansion in landings in 2003-2005 and ban on direct fishing introduced in 2006, only 8% of the aged fish were older than 20 years. In subsequent years the proportion of older fish apparently increased, and recent distribution from 2023 now show 21% fish > 20 years (Table 4). This is still very low compared with the 1987 situation.

Age at length was analyzed for the years 2008-2023 (Figure 5) and compared with data from 1987 (Bergstad, 1990) (Table 3). The growth rate coefficient (k) and the length infinity ($L\infty$) for females is in the same range as the data from 1987, but slightly lower for 2008-2023 data compared with data from 1987, especially for females.

Occurrence of juveniles <5cm PAFL

There are no positive signs of recruitment in 2023. There is no indication of a pronounced recruitment pulse as that observed in the early 1990s, neither in the length distributions (Fig 2.), or in the time series of mean abundance of small fish < 5 cm (Fig. 3).

Geographical distribution

The area sampled in given year and the corresponding geographical distribution of grenadier catches is presented in Figure 4. The overall distribution area does not seem to have changed considerably during the time series 1984-2023. Catches of roundnose grenadier are restricted to the Norwegian Deep north to 59°N and extend eastwards into the Skagerrak basin. The highest catches were always found in the eastern Skagerrak part of the Norwegian Deep.

Commercial by-catch

For an assessment of the bycatch of roundnose grenadier in the Norwegian shrimp fishery, data from the Norwegian Reference fleet showed that < 1% of the tows with shrimp trawl caught roundnose grenadier (Table 5). The values for catch weights from the Reference fleet are low and in same level as the reported landings for the recent years. This indicates that the low reported Norwegian landings are realistic and that the landings are the bycatch amount taken by the Norwegian shrimp fishery.

Discussion

Despite high inter annual variability, the catch rates in terms of biomass and abundance from the survey suggest long term pattern of variation through the time series 1984-2023. An increase in biomass and abundance from the late 1980s until 1998-2004 seemed to be followed by a major decline from the mid-2000s onwards. In 2023 abundance and biomass estimates were still at low levels.

The survey catch rate declined in all areas, also where high survey catches were common, i.e. in the eastern part of the Skagerrak (Fig. 4).

The time-series of size distributions also suggest pronounced structural changes during the period 1984-2023. The distributions from the 1980s with a dominance of fish around 15 cm PAFL contrasts with those from the early 1990s when the population was apparently rejuvenated by a pulse in recruitment from 1991-1992 onwards. The recruits from 1991-1992 can be tracked as a mode in the size distributions for 15 years until 2005. The distributions were dominated by old fish until 2012 although with consecutively low concentrations. From 2018, the older fish is almost disappeared and the distributions changed to younger fish primarily but still with low levels.

The difference in age distribution between 1987 and 2023 is primarily seen in the proportion of older fish, i.e. there is almost no fish older than 30 years in 2023 while almost 25% of the fish was older than 30 years in 1987. The most prominent difference between recent situation and that of 1987 concerning growth, was seen for females. It seems that the bulk of very large and old female individuals seen in 1987 is no longer present in recent years (Table 3).

High mean survey biomass coincided with very high commercial landings in 2004-05 (Figure 6). The fishery may have utilized a period of elevated abundance resulting from what appears to be the single large pulse in recruitment in the 40 years surveyed. From recent length distributions no similar pulse in recruitment has been observed.

An interpretation of the patterns observed in the time-series of size and age distributions, the survey abundance index for small juveniles, and the survey index of all sizes combined is that the enhanced fishery in 2003-2005 had the combined effect of eroding both the accumulated fraction of older fish around 30 years that were found in the population in 1987 prior to the fishery and the younger fish resulting mainly from the recruitment pulse in the early 1990s. The very old fish never reappeared, and for three decades, recruitment has been consistently at a level well below the level observed in the single high event in the early 1990s. The recent recruitment has probably been too low to produce any increase in abundance.

The reported landings peaked in 2005 at about 11000 tons (Figure 6) and have since declined to about a ton per year. From 2006 onwards this decline in landings is a result of regulations (Bergstad 2006) as the targeted fishery ceased. By-catches from shrimp fisheries still occur, however. The data from the Norwegian Reference fleet suggests that current levels are minor, probably reflecting low grenadier abundance at relevant depths and introduction of sorting grids to the fishery.
The Norwegian bycatch of roundnose grenadier thus is well described through the reported landings. The Swedish and Danish fishery reports both landings and discards and therefore the bycatch from these fisheries should be counted for in the statistics. The level of landings and discards in recent years has been in total less than 2 tons per year.

Conclusion

The decline in abundance after 2005-2006 suggested by the survey catch rates may reflect the combined effect of the enhanced targeted exploitation in 2003-2005 and the low recruitment in the years following the single recruitment pulse in the early 1990s. The percentage of fish >15cm is now lower than recent years and there is no suggestion of a new recruitment pulse as seen in the 1990s. The current low abundance and truncated age structure in the population thus reflect both the exploitation and recruitment history spanning the past 2-3 decades. Since the targeted fishery has stopped and the by-catch in the shrimp fishery are low, there is a potential for recovery of the roundnose grenadier in Skagerrak. However, rejuvenation and growth of the population would at present seem unlikely due to low recruitment during the recent decades. The survey information suggests that it may be a feature of this population that only a single good recruitment event may be expected in a period of 3 decades.

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Table 1. Summary of data on the bottom trawl survey series, 1984-2023. Rg- rockhopper ground gear. 'Strapping' – maximum width of trawl constrained by rope connecting warps in front of otter doors. MS – RV Michael Sars, HM – RV Håkon Mosby, KB – RV Kristine Bonnevie. Data from 2023 survey is included. All trawls were fitted with a 6mm mesh cod-end 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
2018	JAN	KB	3271	Campelen 1800 20mm/40, Rg and strapping**	27	8	111
2019	JAN	KB	3296	Campelen 1800 20mm/40, Rg and strapping***	27	8	108
2020	JAN	KB	3296	"	26	7	106

Table 1. Continued

YEAR	Survey month	Vessel	IMR Gear code	Additional gear info.	No. trawls >300m	No. trawls >400m	No. trawls survey
2021	JAN	KB	3296	Campelen 1800 20mm/40, Rg and strapping***	27	8	113
2022	JAN	KB	3296	‘’	28	8	119
2023	JAN	KB	3296	‘’	29	8	116

* Path width of the tow constrained by a 10 m rope connecting the warps, 200 m in front of otter boards. ** Path width of the tow constrained to a 15 m rope connecting the warps, 100 m in front of the otter boards. *** Same trawl and strapping but from 2019 there are inserted several floaters on the trawl to lighten the trawl (Nordsjørigging).

Table 2. Mean biomass index and mean abundance index from shrimp survey 1984-2023. Missing data are from surveys that are not representable according to roundnose grenadier catches (few stations > 300 m). Data from 2016 are considered unreliable according to gear inconsistencies.
Mean biomass (kg/h), Mean abundance (n/h), Number (n) and Standard error (SE)

Year	n	(kg/h)	SE(kg/h)	(n/h)	SE(n/h)
1984	10				
1985	21	108.12	38.32	149.95	49.43
1986	24	83.75	32.16	117.83	46.99
1987	35	76.15	13.56	125.80	24.60
1988	31	72.14	13.92	105.19	21.22
1989	31	122.69	43.48	195.94	73.07
1990	26	49.81	18.20	72.66	27.55
1991	28	107.14	22.27	176.86	38.75
1992	27	188.54	67.53	698.52	337.67
1993	30	58.59	19.42	190.33	74.15
1994	27	87.19	21.21	372.96	143.56
1995	29	118.30	32.36	440.62	144.41
1996	27	99.63	31.68	268.01	116.92
1997	25	113.86	66.47	362.72	222.08
1998	23	255.54	87.80	812.82	336.85
1999	27	149.30	42.85	388.83	122.54
2000	25	129.27	30.39	389.06	107.71
2001	18	105.33	51.84	272.99	151.99
2002	24	174.77	66.27	371.70	129.97
2003	13				
2004	17	324.38	125.48	1143.35	487.33
2005	23	193.65	93.81	550.42	260.94
2006	10				
2007	11				
2008	18	95.58	65.81	259.10	208.53
2009	25	72.72	39.81	207.41	121.84
2010	24	33.24	21.47	77.21	54.81
2011	22	26.84	12.61	54.76	27.05
2012	20	16.69	11.97	34.40	23.83
2013	28	11.48	4.92	35.06	16.90
2014	16	25.62	15.76	49.56	28.69
2015	28	7.28	4.59	21.19	12.14
2016	28				
2017	30	6.64	2.41	15.74	6.73
2018	27	12.88	6.60	41.91	26.13
2019	27	14.59	5.77	40.09	18.05
2020	26	18.72	11.48	63.02	38.07
2021	27	9.59	5.03	26.14	14.19
2022	28	23.87	10.94	75.20	35.61
2023	29	19.24	8.89	38.81	19.10

Table 3. Estimated parameters of von Bertalanffy growth function on data from Skagerrak shrimp survey 2008-2023 and Skagerrak survey in 1987 as reported by Bergstad 1990. k=growth coefficient, L_∞=asymptotic length, t_0=theoretical age when length is zero, SE=standard error				
	Estimated parameter			
Parameter	**Shrimp survey 2008-2022**		**Skagerrak survey 1987**	
	Females (SE)	**Males (SE)**	**Females**	**Males**
k	0.085 (±0.004)	0.076 (±0.010)	0.100	0.105
L_∞	16.8 (±0.233)	14.9 (±0.548)	18.1	14.7
t_0	-2.7 (±0.278)	-5.7 (±1.022)	-0.9	-1.5

Table 4. Cumulative percentages (%) for selected ages from 1987 and 2007-2023.					
	Age				
Year	**5**	**10**	**20**	**30**	**50**
1987	9	21	45	75	96
2007	10	23	83	94	96
2008	22	40	92	99	100
2009	14	30	88	93	100
2010	12	29	71	96	99
2011	6	23	65	94	99
2012	10	28	48	96	100
2013	14	28	56	92	99
2014					
2015	7	17	48	95	100
2016					
2017	14	52	81	94	99
2018	23	50	77	99	100
2019	8	37	64	92	100
2020	40	64	83	97	100
2021	20	55	83	97	100
2022	33	53	81	95	99
2023	22	50	79	92	100

Table 5. Proportion of tows with shrimp trawl that caught roundnose grenadier. Data from Norwegian Reference fleet.				
Year	Total number of shrimp trawl	Number of trawl hauls that caught roundnose grenadier	Catch of roundnose grenadier (kg)	% of the total catch
2013	243	0		0
2014	288	2		0,69
2015	1489	14		0.94
2016	4811	23		0,48
2017	3798	20	29	0,53
2018	2849	19		0,67
2019	1233	4	80	0,32

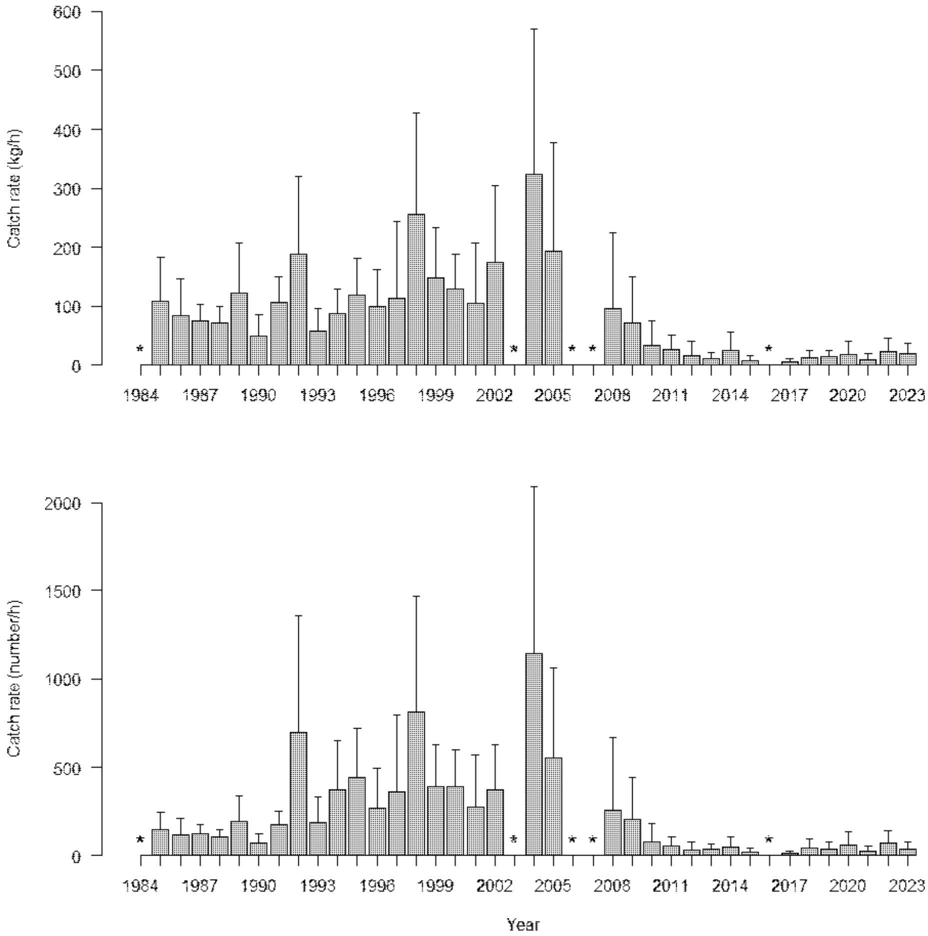


Figure 1. Standardized survey catch rates of roundnose grenadier, 1984-2023. Upper: Biomass (kg/h), Lower: Abundance (number/h). Standard error (2SE) shown by lines on top of bar. *In 1984, 2003, 2006 and 2007, only one single or no trawls were made deeper than 400 m, and data from those years were excluded; in 2016 data from shrimp survey is regarded as unreliable due to inconsistencies with trawling gear and data from that year should be excluded.

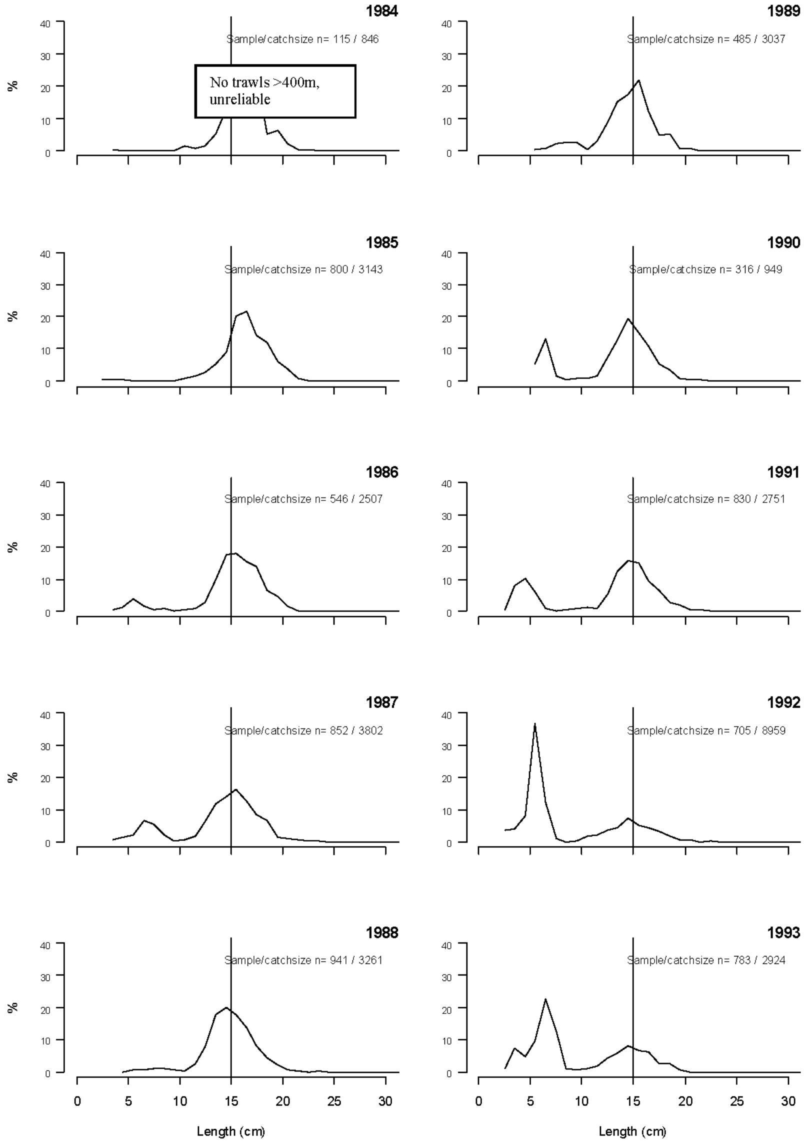
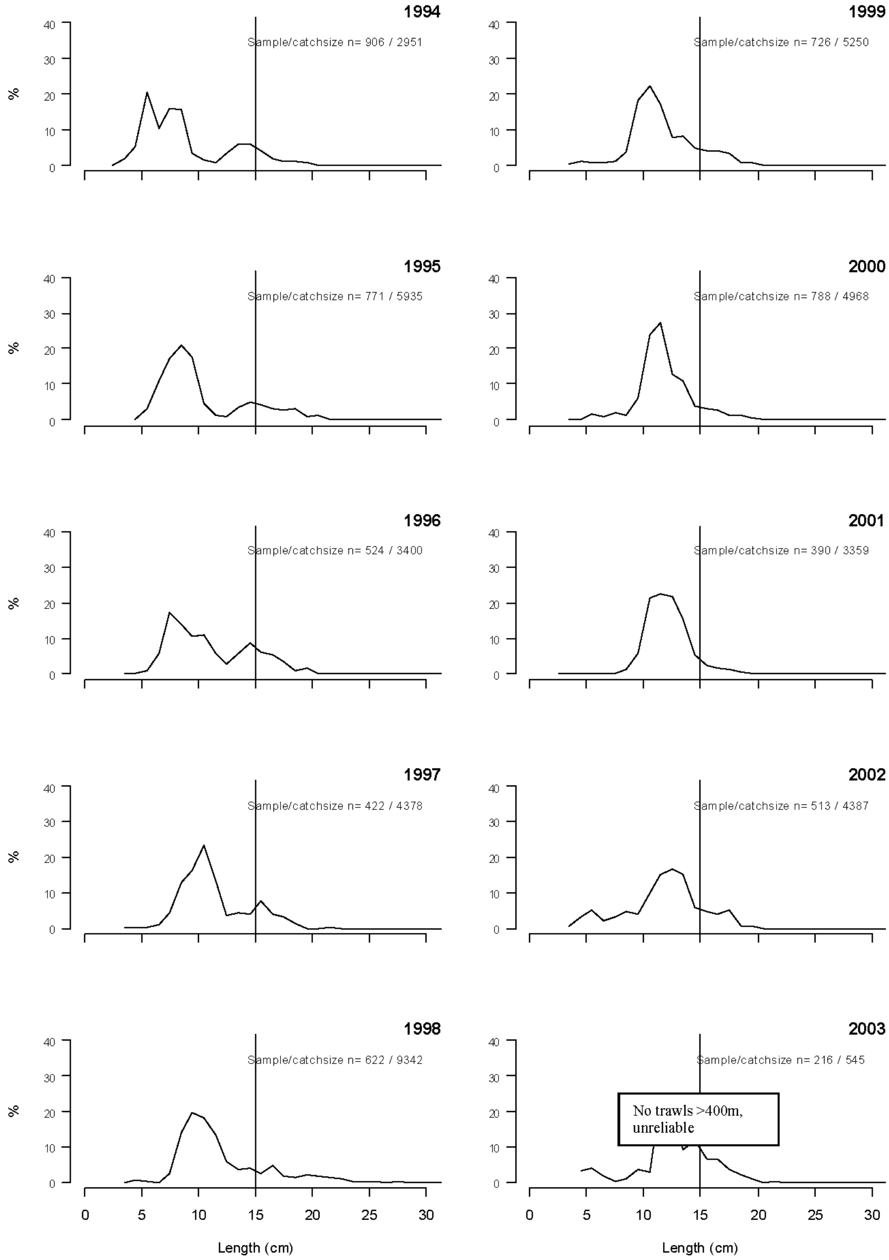


Figure 2. Length distributions of roundnose grenadier from annual *P. borealis* surveys, 1984-2023. Length is measured as PAFL (cm). The length distributions are calculated as percentage number of fish in each centimetre length interval standardized to total catch number and trawling distance for each station each year. *In 1984, 2003, 2006 and 2007, only one single or no trawls were made deeper than 400 m, and data from those years should be excluded; in 2016 data from shrimp survey is regarded as unreliable due to inconsistencies with trawling gear and data from that year should be excluded.



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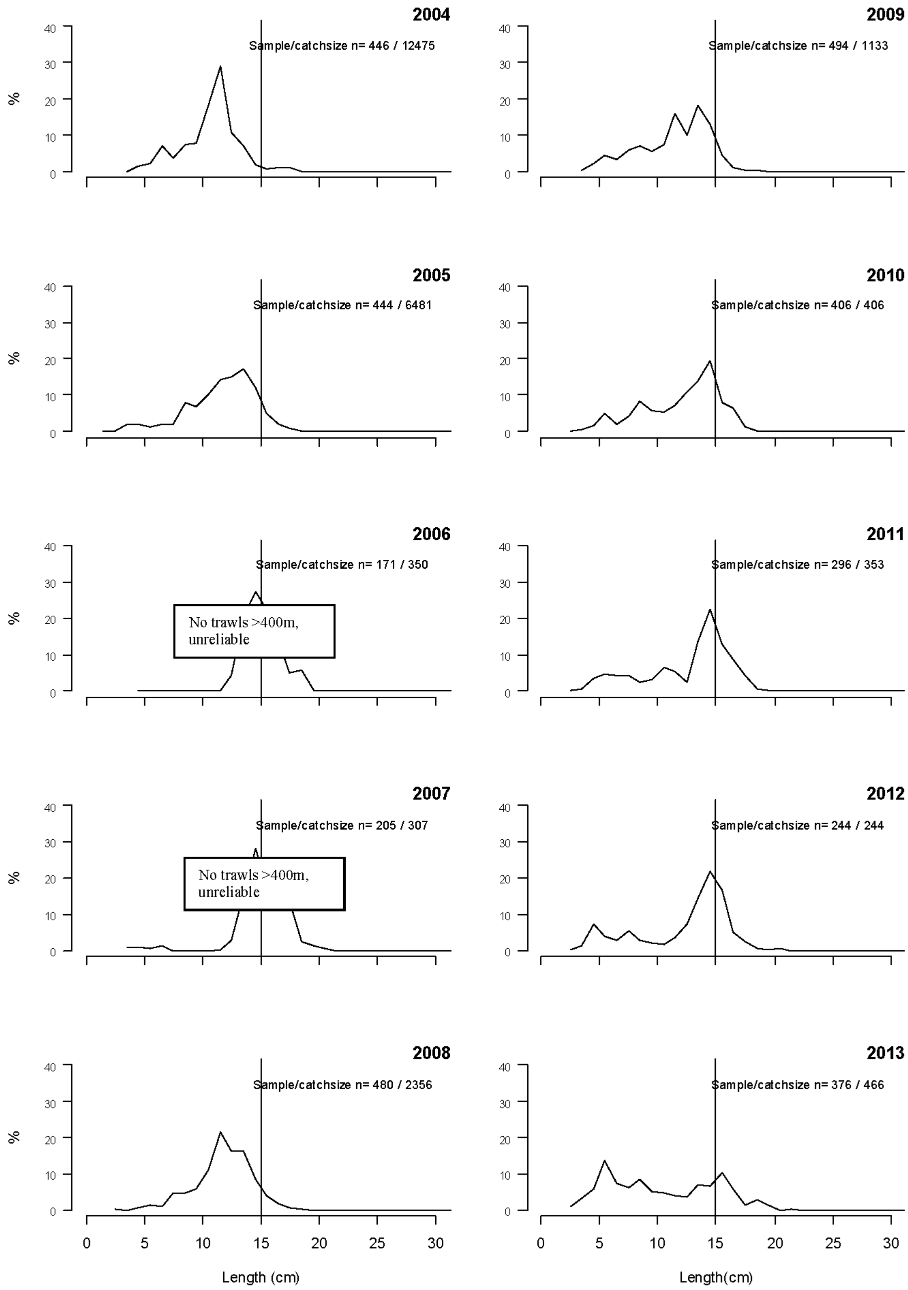

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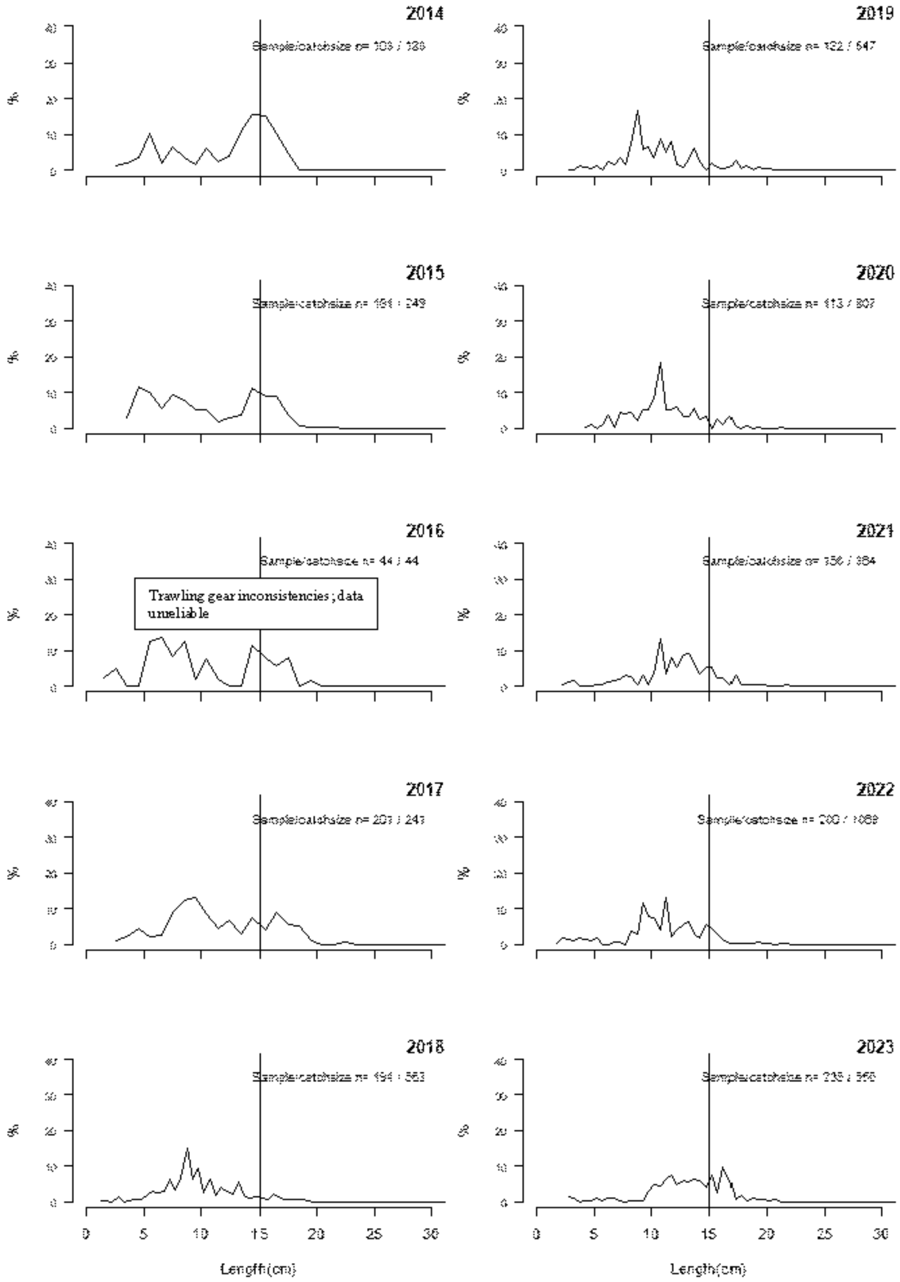

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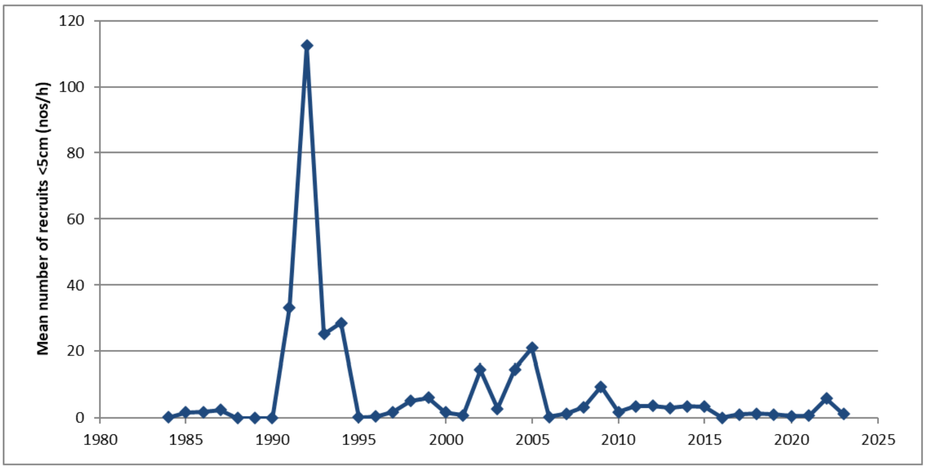


Figure 3. Mean catch rate of roundnose grenadier of PAFL ≤ 5 cm, 1984-2023. Data from shrimp survey, trawls deeper than 300 m. *In 1984,2003,2006 and 2007, no trawls were made deeper than 400 m, and data from these years should be disregarded; in 2016 data from shrimp survey is regarded as unreliable due to inconsistencies with trawling gear and data from that year should be excluded.

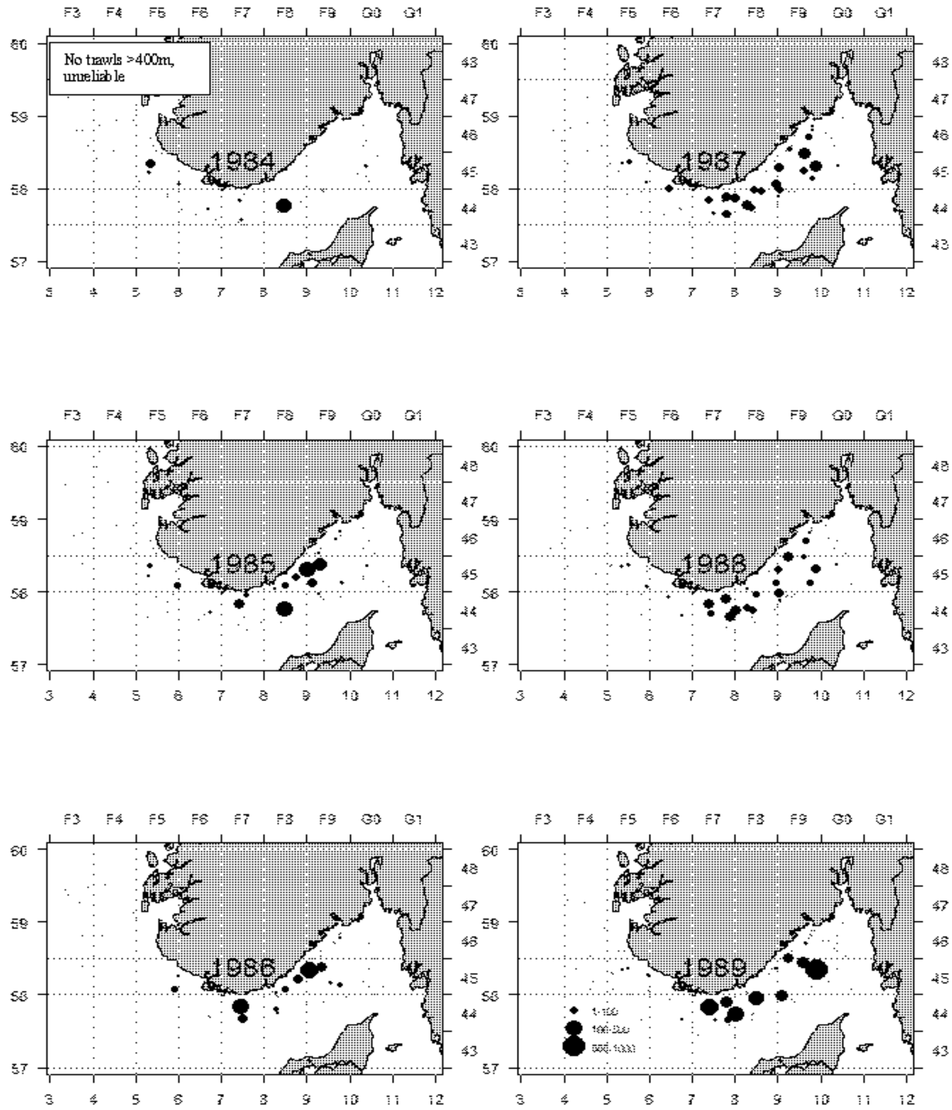
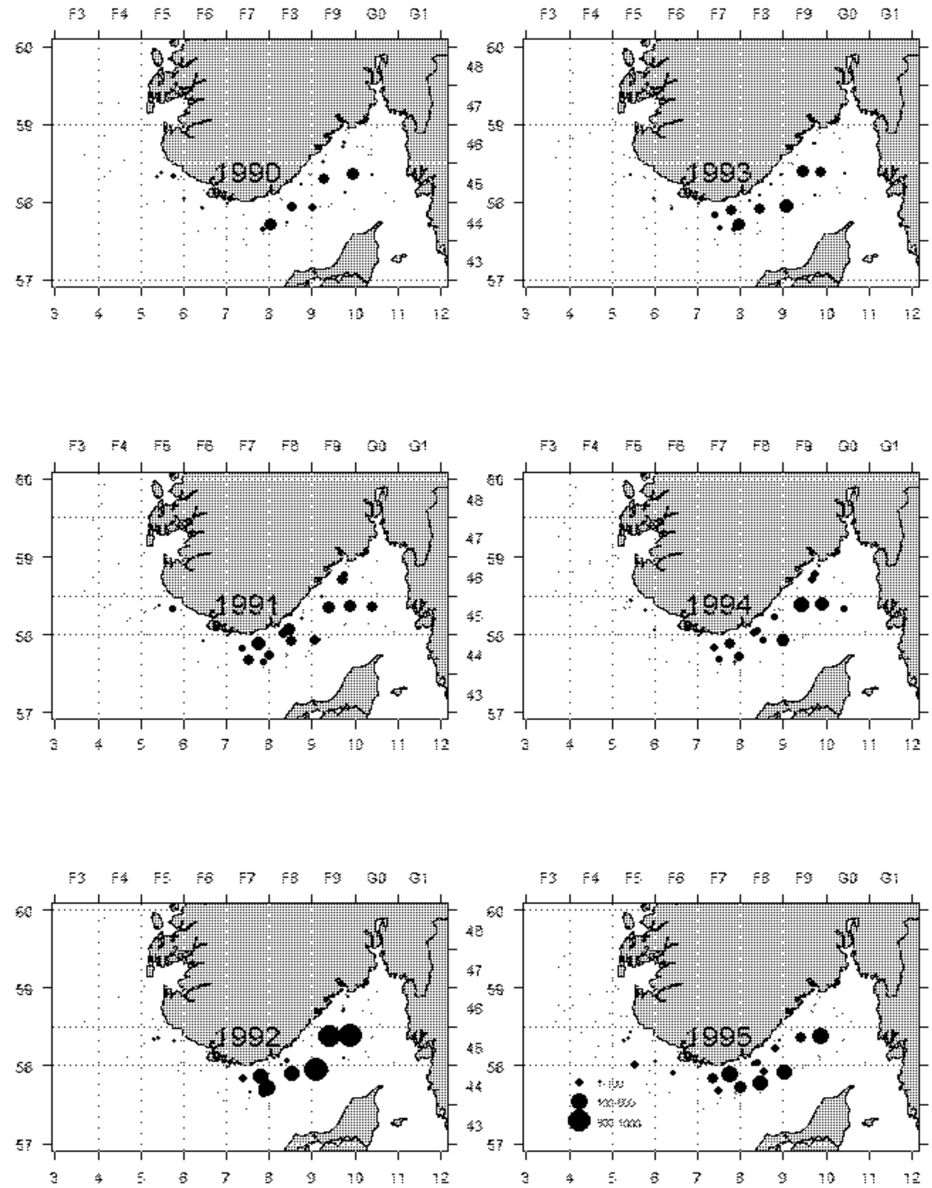


Figure 4. Geographical distribution of catches of roundnose grenadier (kg/h) from 1984-2023. Data from shrimp survey, trawls deeper than 300 m. Grey circles are trawls with no catch of grenadier. *In 1984, 2003, 2006 and 2007, only one single or no trawls were made deeper than 400 m, and data from those years should be excluded; in 2016 data from shrimp survey is regarded as unreliable due to inconsistencies with trawling gear and data from that year should be excluded.



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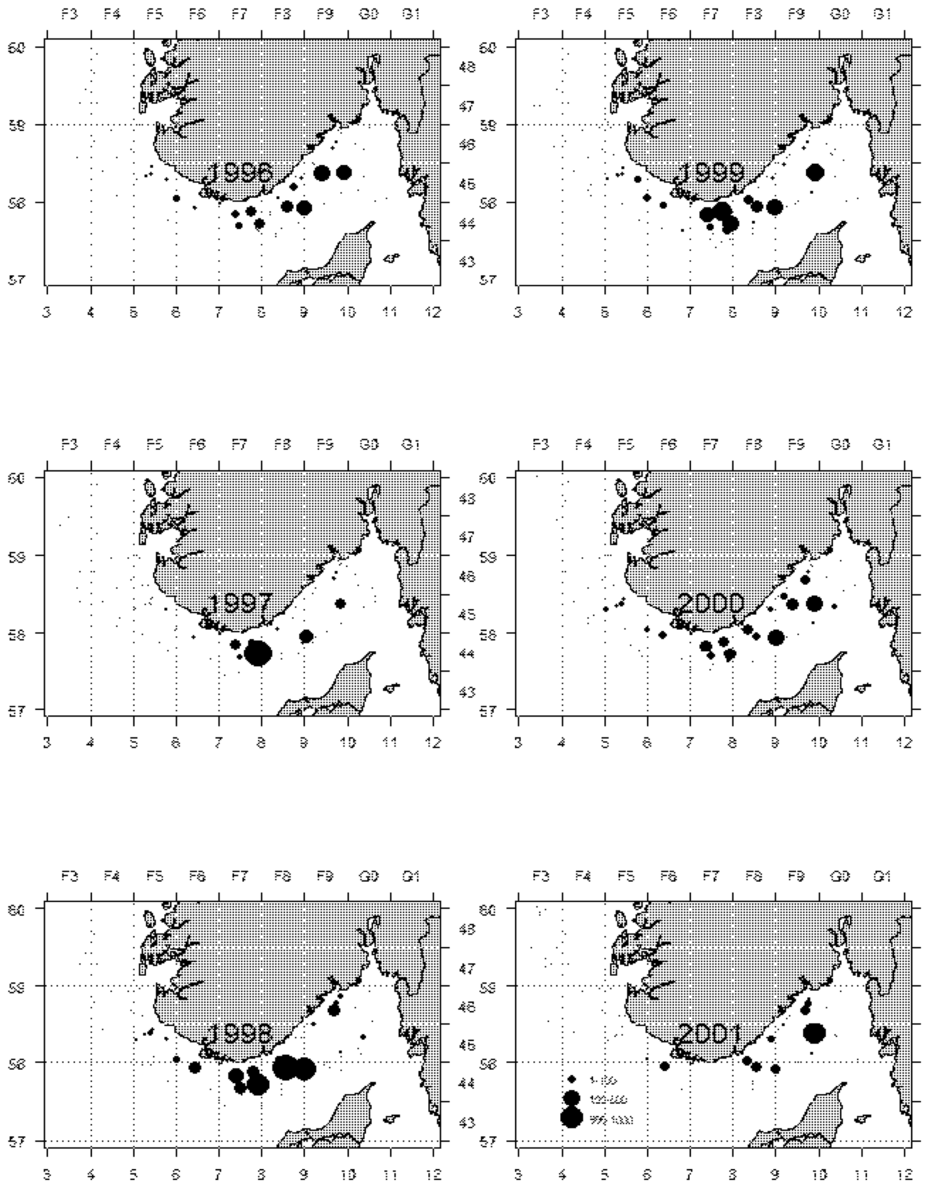

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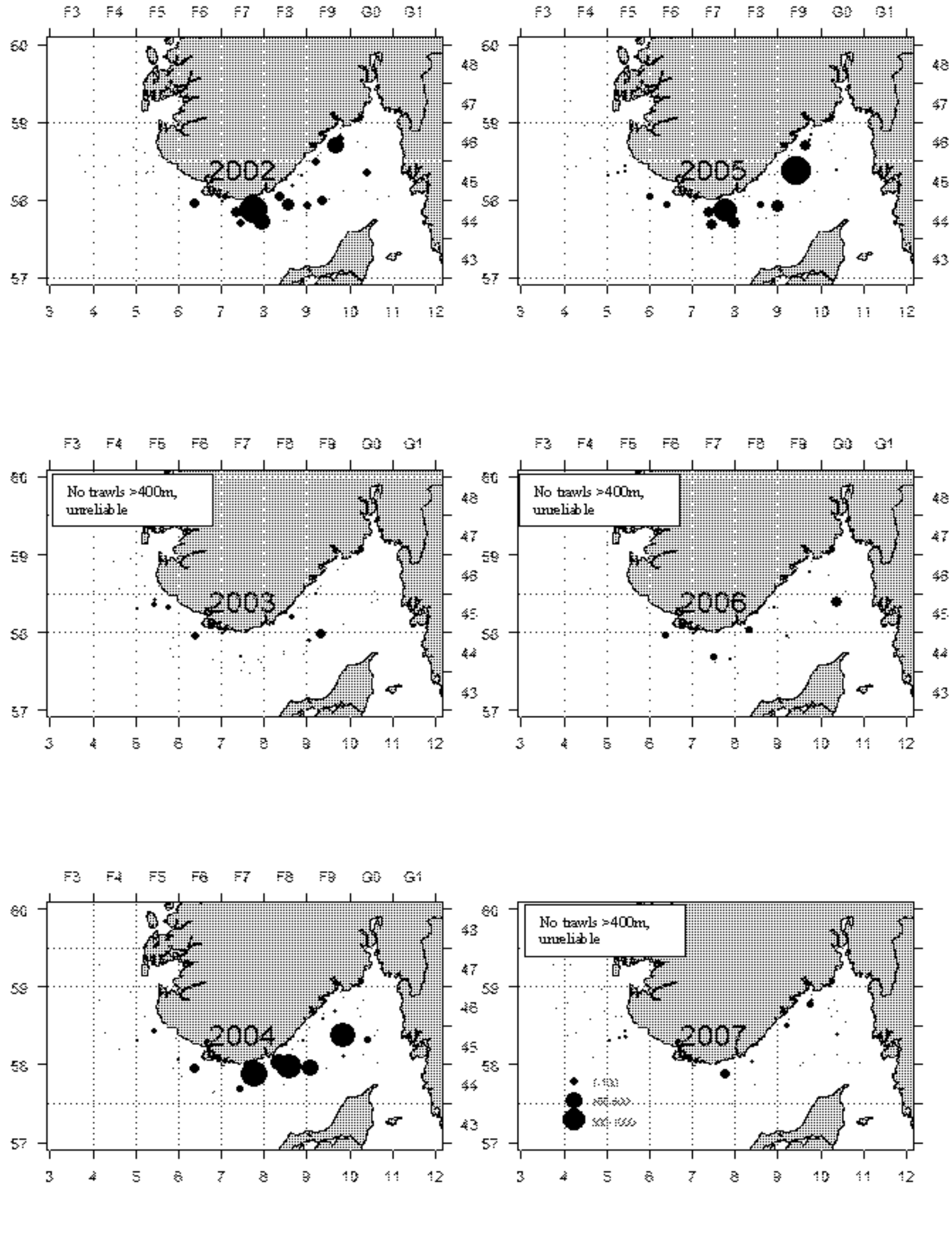

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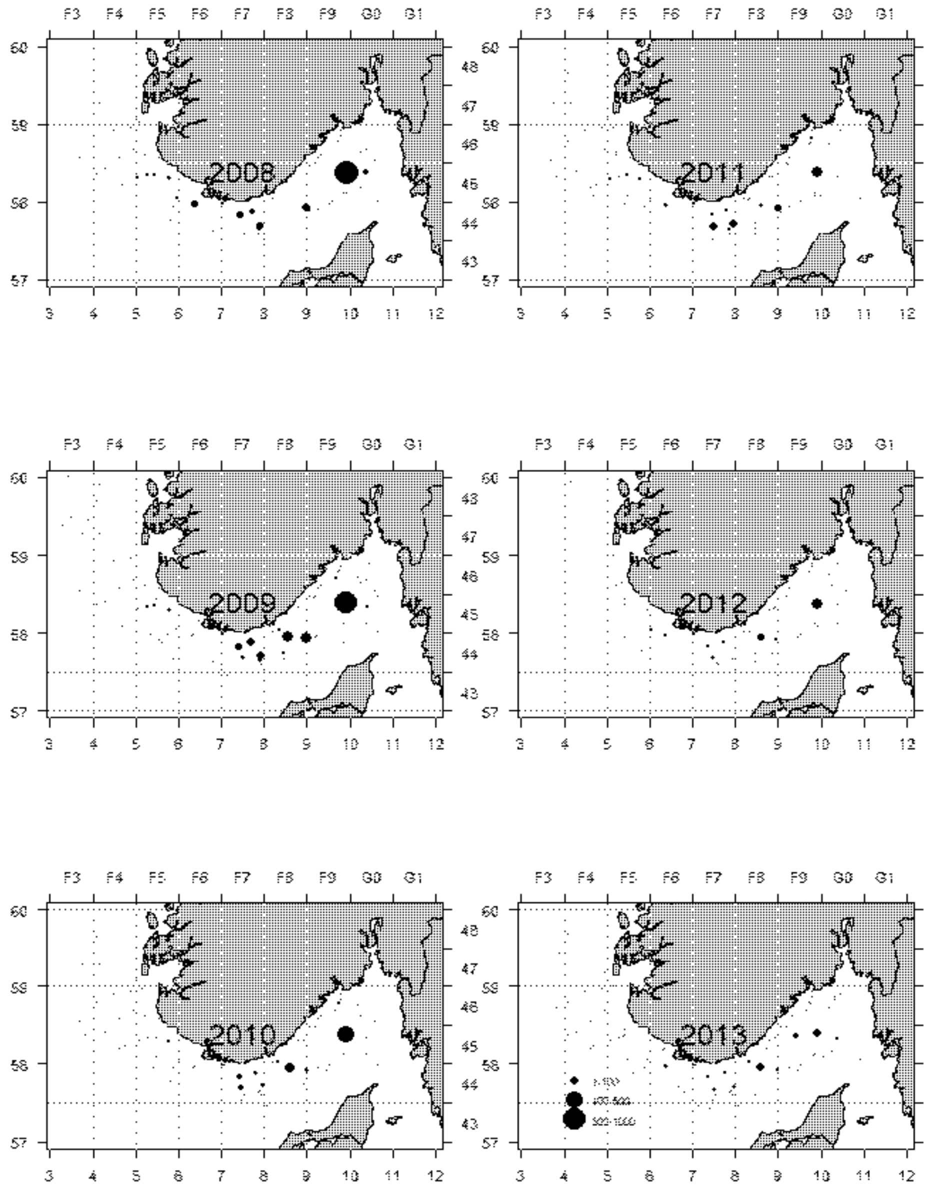

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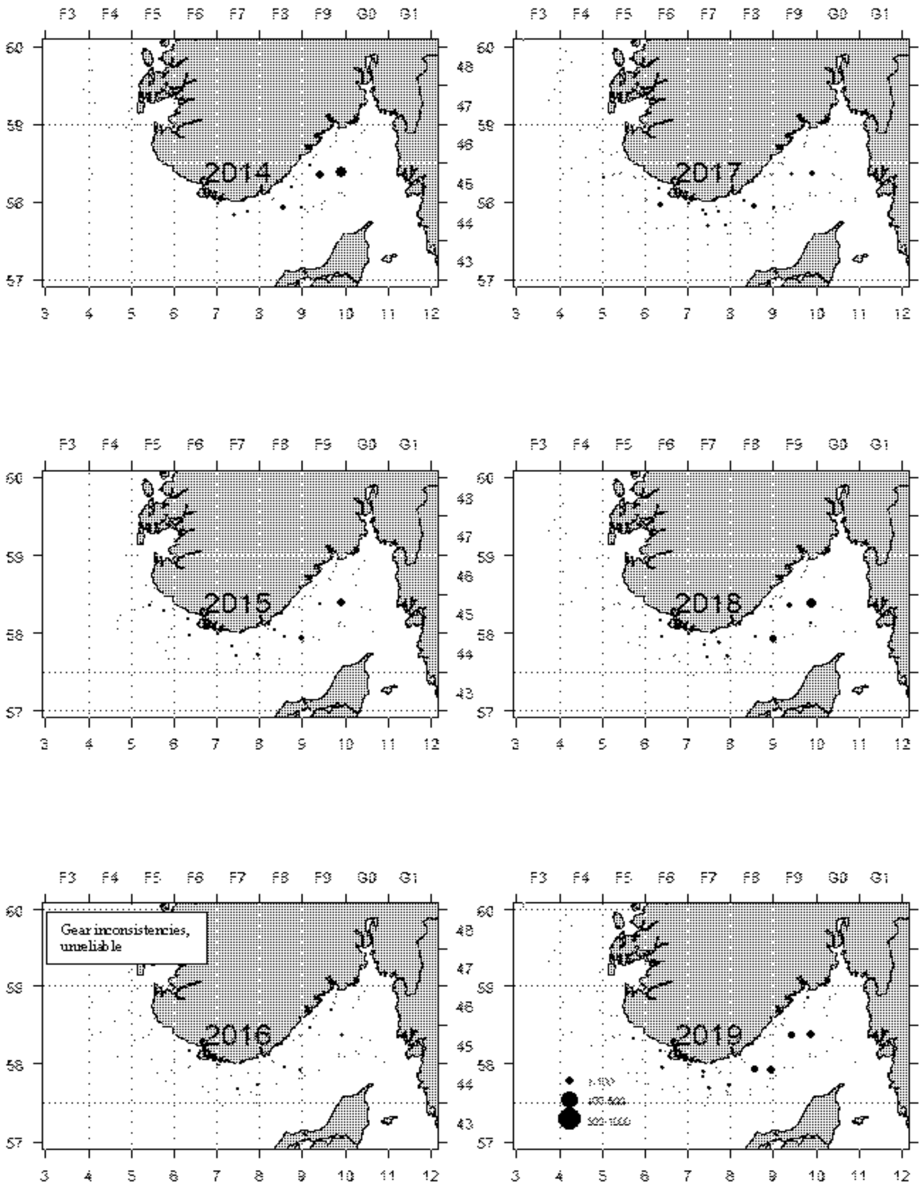

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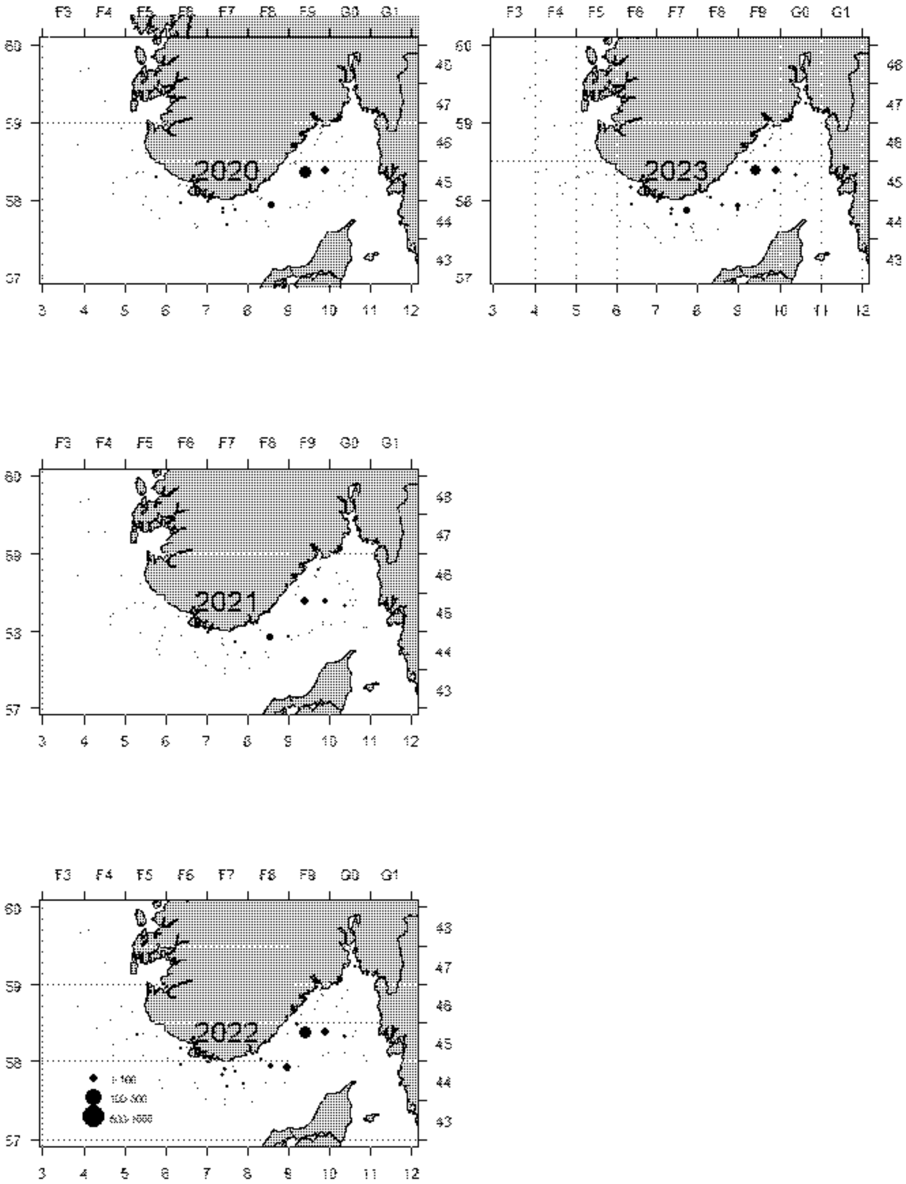

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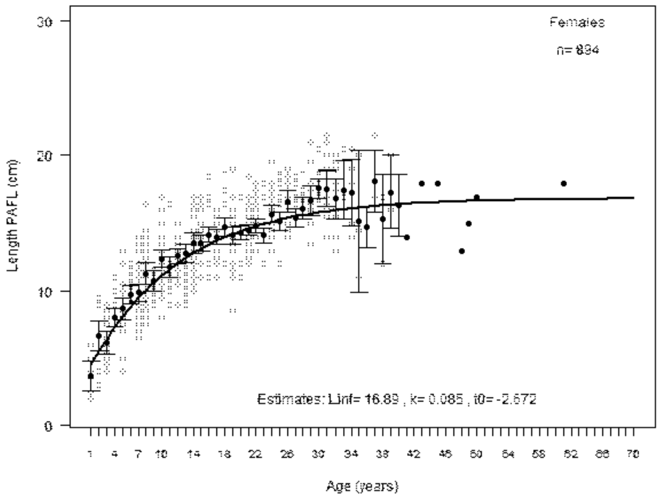

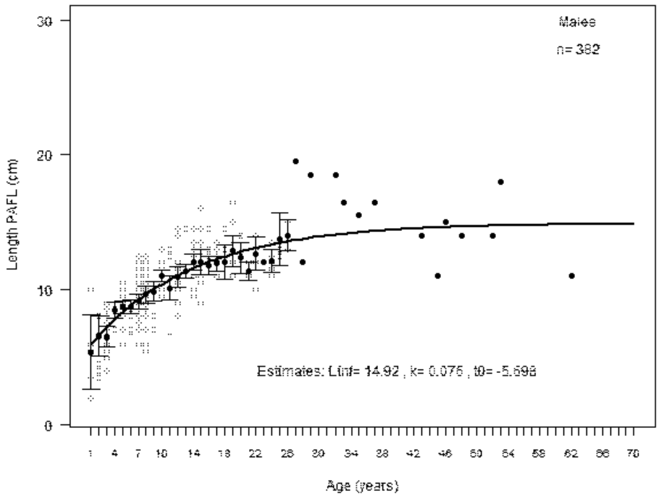

Figure 5. Length at age for female and male roundnose grenadier; data from Skagerrak 2008-2023. Mean values are estimated with ±2SE where there is more than one value. Estimated von Bertalanffy growth curves with parameters for females and males.

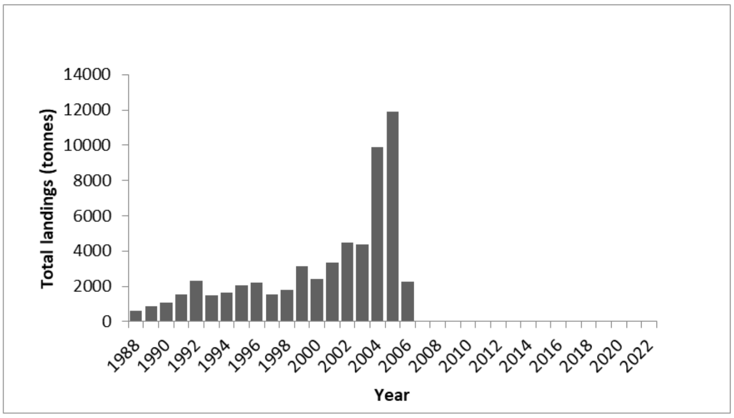

Figure 6. Total reported landings of roundnose grenadier in ICES Division 3a, 1988-2022. Landings from 2007 and later are very small and all less than 2 tons.

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The Blackspot seabream Spanish target fishery of the Strait of Gibraltar: updating the available information

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Abstract

This paper includes the available information of the Blackspot seabream (Pagellus bogaraveo) Spanish target fishery in the Strait of Gibraltar updating the documents presented in previous years with the information from 2022. So, data about landings, fishing effort, CPUEs and landings length frequencies are presented to its inclusion in the 2023 WGDEEP Report.

1. Introduction and fishery description

Since the earlies 1980´s a Spanish artisanal fishery targeting to Blackspot seabream (*Pagellus bogaraveo*, namely "*voraz*") have been developed in the Strait of Gibraltar area (ICES 9a South). This fishery has already been broadly described in previous Working Documents presented to the ICES WGDEEP (Gil *et al.*, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021 and 2022). Blackspot seabream Spanish fishery in the Strait of Gibraltar is almost a mono-specific fishery with a clear target species which represents the 74% from the total landed species which constitutes a fleet component by itself (Silva *et al.*, 2002).

In 2006, 2008, 2010, 2012 and 2016 different trials were attempted to assess this resource within the ICES WGDEEP (ICES, 2006, 2008, 2010, 2012, 2016 and 2018). Finally, 2018 scientific advice was based on abundance indexes (DLS category 3). All the available information from this target fishery (including the biomass index used as the basis for the assessment) were updated with the most recent (2022) data.

Thus, the main objective of this paper is to provide to the 2023 ICES WGDEEP a summary of the available information of this deep-water fishery located in a very narrow place of the ICES area 9.

2. Material and methods

Fishery information from the sale sheets was gathered for the period 1983-2021: monthly landings, monthly number of sales (as a proxy of fishing trip) and the number of days in which those sales were carried out. Moreover, landings length distributions was also estimated from the data collected by IEO monitoring programme (Gil *et al.*, 2000).

Geo-referenced information from SLSEPA devices (a sort of Vessel Monitoring System) on the "*voracera*" fleet operating at the Strait of Gibraltar were more recently available (from 2009 onwards): this monitoring system, locally called "green boxes" (to differentiate them from the EU VMS "blue boxes"), send every three minutes to a control centre several information about the fishing boat: time, positions, course and speed. Data were filtered and analyzed, according to the protocols proposed by Burgos *et al.* in 2013, to estimate fishing effort and catch rates of the Blackspot seabream Spanish target fishery.

3. Results and discussion

- Landings data: Figure 1 shows a continuous increase of Spanish landings from the beginning of the time series to reach a maximum in 1994. Since then landings´ trend decreased till 2002, despite the peaks in 1996 and 1997. Again, it shows an increasing trend from 2003 to 2009, decreasing afterwards except for a slight increase in 2014. Landings since 2018 show the lowest values of the series, with a 2020-2022 mean of about 7 tons (but less than 1 ton in the last year) landed by the Spanish "voracera" fleet.

Until now, discards can be assumed to be zero or negligible. However, the established minimum landing size of 33 centimeters for the species (both for NE Atlantic and Mediterranean Sea) and the landing obligation (EU Regulation 2013/1380) don´t might have an effect on the discards of this target fishery because its high survival exemption.

Hence landings are currently being used as a proxy of catches. However, it should be noted that not all the Spanish catches/landings come exclusively from ICES area 9 but they are considered from the same stock unit because the fishing area (Strait of Gibraltar) is placed between different Advice bodies/Regional Fisheries Organizations (ICES, GCFM and CECAF) boundaries. In fact, since 2015 Spanish Blackspot seabream landings available at InterCatch tool comprise different areas: 27.9.a (ICES), 34.1.11 (CECAF) and 37.1.1 (GFCM).

Data from Moroccan longliners fishing Blackspot seabream in the Strait of Gibraltar area are available since 2001. The information are available on FAO GFCM statistics (WGSAD-SAC and SRC-WW) so, when possible, it is included in the WGDEEP landings estimates because

Moroccan boats target the same population, sharing the main Strait of Gibraltar fishing grounds with Spain (ICES, 2016).

- CPUEs: Nominal biomass index shows ups and downs throughout the historical series (Figure 2). It is important to emphasize that the effort unit chosen (number of sales) may not be appropriate as does not consider the missing effort. So in the most recent years, when the resource is not quite abundant, the missing effort might increase substantially (fishing boats with no catches and no sale sheet records). Therefore, the LPUE trend since the first fishery´s decline (1997) should be interpreted with caution because it cannot be a real image of the resource abundance. Anyway, a severe and continuous decreasing trend is observed since 2016, with CPUEs lower than 40 kilos per fishing trip till about 20 kilos per fishing year in 2021 and less than 10 kilos in 2022.

Table 1 updates the available information from regional VMS (SLSEPA), following the data compilation and process described by Burgos *et al*. in 2013.

Table I. Estimates of fishing effort and CPUEs (2009-2022) from the "*voracera*" fleet targeting Blackspot seabream based on regional VMS (SLSEPA) and fishery statistics (sales sheets).

Data source		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
VMS	Landings (k)	459,010	274,882	190,786	79,163	37,799	94,261	137,444	73,508	24,716	4,402	4,825	1,579	2,614	313
	No. sales	7,200	5,863	4,711	2,946	2,086	2,989	3,079	1,873	1,017	309	248	62	89	36
	Fishing days (fishing trips)	8,373	7,238	6,160	3,686	2,695	4,191	4,234	2,724	1,740	1,046	607	125	266	235
	CPUE 1 (landings/no. sales)	64	47	40	27	18	32	45	39	24	14	19	25	29	9
	CPUE 2 (landings/fishing days)	55	38	31	21	14	22	32	27	14	4	8	13	10	1
	Missing effort (%)	14	19	24	20	23	29	27	31	42	70	59	50	67	80
TOTAL	Landings (k)	579,140	316,365	239,790	126,006	66,159	137,623	166,440	99,726	42,991	7,633	18,693	12,838	8,412	488
	No. sales	8,892	6,932	5,659	3,638	2,222	3,527	3,384	2,418	1,308	429	794	525	404	72
	CPUE 1 (landings/no. sales)	65	46	42	35	30	39	49	41	33	18	24	24	21	7

CPUE 2 (landings/fishing days), where the effort is estimated from the VMS device also declined with lower values than CPUE 1 because the fact of the missing effort. So, as expected, CPUEs estimates from VMS analysis shows the same trend but lower values than the nominal one, from sale sheets (Figure 2).

- Length frequencies: The mean length of landings seems to have decreased in two different periods: from 1995 to 1998 and from 2009 to 2013 (Figure 3). 2021 mean length estimate shows a significant increase (about 5 cm) but data should be revised because is not consistent with previous and following years.

4. Main conclusions

The general trend for the time series of both, landings and CPUEs, continues showing a decreasing pattern over recent years, exhibiting the lowest values of the whole series. This might be a consequence of an overexploitation status of the stock, which is addressing the fishery into a critical situation.

It should be noted that GFCM establish a management plan for the Blackspot seabream fishery of the Strait of Gibraltar in 2022 (GFCM/45/2022/3 on a multiannual management plan for the sustainable exploitation of blackspot seabream in the Alboran Sea, geographical subareas 1 to 3). The update of benchmark assessment (gadget model) for blackspot seabream in the Strait of Gibraltar was presented in the last GCFM WGSAD (December 2022). Results indicated that the stock is depleted with unsustainable exploitation and low fishing mortality. The recommendation was to proceed with immediate reduction of fishing mortality, implementing also a recovery plan (GFCM, 2022).

Acknowledgments

We would like to express our most sincere gratefulness to all those institutions and people for their collaboration in the execution of the monitoring of the Spanish "*voracera*" fishery: Spanish Institute of Oceanography (IEO, CSIC), Consejería de Agricultura y Pesca de la Junta de Andalucía and Tarifa´s Fishermen Brotherhood and 1st sale fishmarket.

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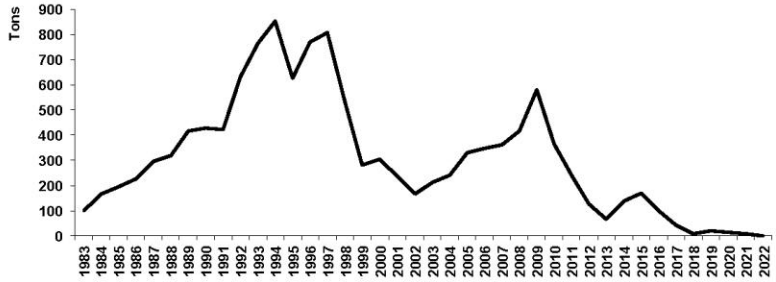

Figure 1. Blackspot seabream Spanish *"voracera"* fishery of the Strait of Gibraltar: total landings (1983-2022).

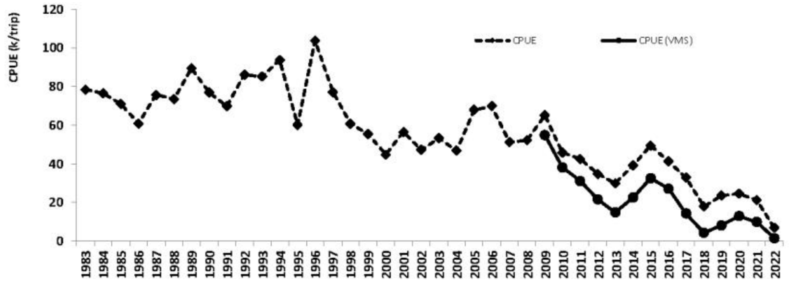

Figure 2. Blackspot seabream Spanish *"voracera"* fishery of the Strait of Gibraltar: nominal (sale sheets) CPUE (1983-2022) and (VMS) CPUE (2009-2022).

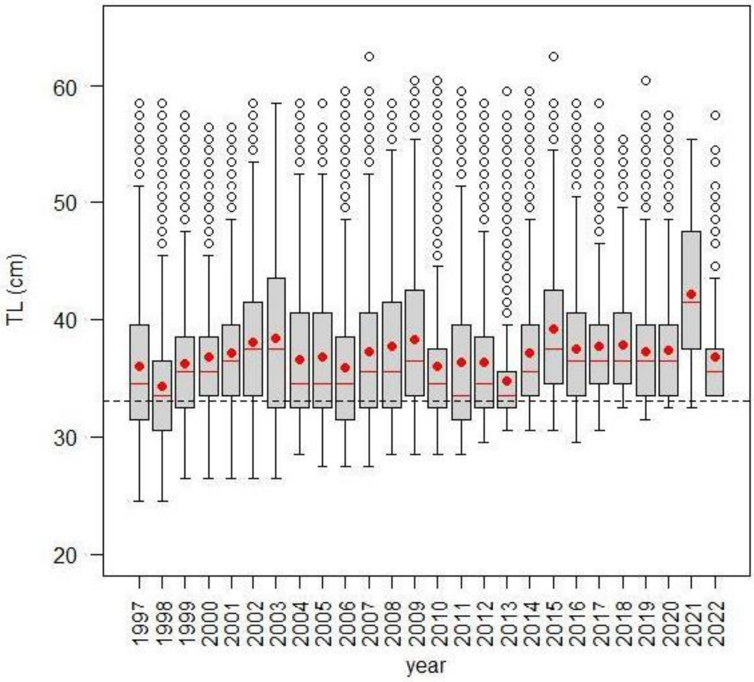

Figure 3. Blackspot seabream Spanish *"voracera"* fishery of the Strait of Gibraltar: landings length distribution descriptive statistics (red dot: mean value, red line: median value, box and whiskers: Interquartile Range plus Q_1-3IQR and Q_3+3IQR, circles: outliers).

Working Document for the ICES Working Group on Biology and Assessment of Deep-sea Fisheries Resources

3rd – 9th April 2023

Greater forkbeard *Phycis blennoides* in Portuguese waters (ICES Division 27.9.a)

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Abstract

This working document updates the information presented in previous WGDEEP meetings for the greater forkbeard *Phycis blennoides* in ICES Division 27.9.a (continental Portugal), particularly fishery dependent data and MSY length-based indicators (LBI). Length-based indicators LBI used to classify the stocks according to conservation/sustainability, yield optimization and MSY were estimated for the exploited population in continental Portugal based on length samples collected under the Portuguese DCF program.

1. General considerations

The greater forkbeard *Phycis blennoides* (Brünnich, 1768) is a demersal species from the family Gadidae. This species is widely distributed in the northeast Atlantic from Norway and Iceland to Cape Blanc in West Africa and in the Mediterranean Sea (Massutí et al., 1996), and occurs preferentially along the continental shelf and slope, at depths ranging between 60 and 1000 m deep (Massutí et al., 1996; Casas and Piñeiro 2000; García et al., 2000).

The greater forkbeard has a discrete recruitment period along the year and is available to fishing at the first years of life (Ragonese et al., 2002). The size of transition from the pelagic to the demersal habitat occurs at lengths around 6 cm in Atlantic waters (Casas and Piñeiro, 2000) and at a smaller size (4.5-5.0 cm total length) in the Mediterranean (Ragonese et al., 2002). In the Gulf of Tunis, age parameters were estimated as TL_{inf} = 57.17 cm, k = 0.193 year^{-1}, t_0 = −1.578 year for females, and TL_{inf} =44.74 cm, k = 0.313 year^{-1}, and t_0 =−1.210 year for males. Females grow faster than males, and the latter did not exceed 45 cm (Romdhani et al., 2016).

1.1. The greater forkbeard in Portuguese waters from ICES Division 27.9.a

In Portuguese continental waters, the length structure and the biology of greater forkbeard, namely reproduction, suggests that it completes the whole life cycle in the area (Lagarto et al., 2017). As in other geographic areas where the species occurs (e.g., in the Mediterranean), a depth effect on specimen's size is observed (Massutí et al., 1996) with larger specimens occurring at higher depths (>600 m deep) (Fig.1).

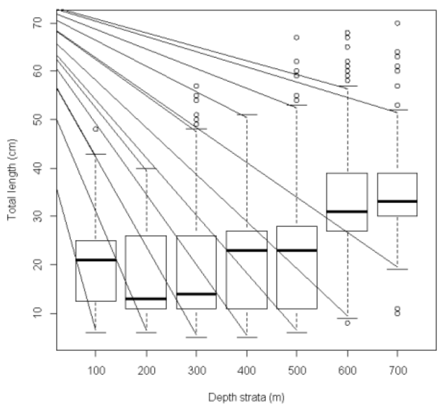

Figure 1. Inter-quartile total length range of *P. blennoides* by depth strata (m) caught during the Portuguese Crustacean Surveys/Nephrops TV Surveys (PT-CTS (UWTV (FU 28-29))) undertaken between 1997 and 2016 (no survey was conducted in 2012). (from Lagarto et al., 2017)

2. Fishery dependent data in Portuguese waters from ICES Division 27.9.a

In continental Portugal there are no fisheries targeting the greater forkbeard. This species is mainly caught as by-catch of other fisheries, particularly from the polyvalent fleet segment or multi-gear fleet, which is responsible for ~98% of the species total landings.

The Portuguese polyvalent segment includes vessels of different sizes usually licensed to operate with more than one fishing gear (e.g. gill and trammel nets, longlines, and traps). At each fishing trip, vessels belonging to this segment may deploy more than one fishing gear, depending on the targeted species and on the fishing grounds. The analysis of logbook data further indicates that, within the polyvalent segment, the greater forkbeard is mainly caught by demersal longlines (Moura and Figueiredo, 2020).

Most greater forkbeard landings are reported at Peniche landing port, in the Centre of Portugal. A marked seasonal pattern on Portuguese landings is observed with higher values between May and July (Lagarto et al., 2017). Although the reasons for this seasonality are unknown, it is considered that they might be related to the dynamics of the fleets and particularly to changes on their target species.

2.1. Commercial landings

Official Portuguese annual greater forkbeard landing estimates in ICES Division 27.9.a are presented in Table 1. It is worth mentioning that landings are likely to be biased due to species misidentification problems. It is admitted that greater forkbeard can be misidentified with its congener *Phycis phycis*. Moreover, the two *Phycis* species, and particularly at the beginning of time series, might be landed under the designation of *Phycis* spp. However, the fraction of *Phycis* spp. landings corresponding to *P. blennoides* is unknown and cannot be estimated as the level of DCF sampling coverage is insufficient.

Historically, the landings of greater forkbeard species are low, either because of its relatively low commercial value or to the low fishing effort at deeper fishing grounds.

Table 1. Official landings (ton) of *Phycis blennoides*, *Phycis phycis* and *Phycis* spp. by fleet from 2003 to 2022. *Phycis* spp. includes landings of *P. blennoides* and *P. phycis*. Source: DGRM (official landings).

	Phycis blennoides				*Phycis phycis*				*Phycis* spp.			
Year	TRAWL	PSEINERS	ARTISANAL	TOTAL	TRAWL	PSEINERS	ARTISANAL	TOTAL	TRAWL	PSEINERS	ARTISANAL	TOTAL
2003	0.08		10.87	10.95	0.75		5.69	6.44	7.87	0.50	314.14	322.51
2004	0.10	0.05	9.84	9.98	0.11		3.59	3.70	7.85	0.60	295.10	303.55
2005	0.17	0.03	14.00	14.20	1.06	0.02	83.49	84.57	5.68	0.13	183.03	188.84
2006	0.17		9.66	9.84	2.11	0.08	176.24	178.43	3.22	0.01	56.05	59.28
2007	0.10	0.02	13.40	13.52	2.69	0.28	215.65	218.62	4.01		25.20	29.21
2008	0.18	0.01	12.05	12.23	4.79	0.10	234.03	238.92	0.14		25.03	25.17
2009	0.10		14.64	14.74	11.20		452.92	464.13			18.61	18.61
2010	0.10		11.53	11.63	14.24		472.11	486.36			8.68	8.69
2011	0.04		13.43	13.48	7.08	0.01	450.68	457.76			5.91	5.91
2012	0.08		5.58	5.66	4.24	0.03	456.11	460.38			5.24	5.24
2013	0.11		7.67	7.78	4.22	0.92	274.22	279.35			3.78	3.78
2014	0.13		6.09	6.22	2.27	0.80	170.97	174.04			2.39	2.39
2015	0.04		7.39	7.43	5.32	0.73	154.72	160.77			1.58	1.58
2016	0.12		6.69	6.81	6.72	1.41	181.31	189.44			1.81	1.81
2017	0.20		8.85	9.05	4.13	1.69	172.38	178.21	0.00		1.27	1.28
2018	0.19		9.23	9.42	2.70	0.35	129.27	132.31			0.64	0.64
2019	0.02		7.12	7.14	2.03	0.313	133.35	135.69			1.34	1.34
2020	0.08		4.80	4.88	1.61	0.30	137.78	139.69			0.99	0.99
2021	0.09		11.16	11.25	1.66	0.53	331.83	334.01			0.66	0.66
2022	0.19		8.47	8.66	0.80	0.13	327.63	328.55			0.86	0.86

2.2. Length data

The greater forkbeard is sampled for length at several landing ports along the Portuguese continental coast under the national data collection program (PNAB/DCF). The total length of specimens sampled from 2014 to 2022 (under DCF market and onboard programs) ranged between 17 and 78 cm (Farias et al., 2021). The length frequency distributions slightly differed between the trawl and the polyvalent fleet segments (the length of specimens caught by trawlers are skewed to sizes smaller than those caught by polyvalent vessels) (Moura and Figueiredo, 2020). Given the very low landing values attributed to the trawl segment, the length frequency distribution of the greater forkbeard exploited population is mainly derived from the polyvalent fleet segment catches.

Length-based indicators (LBI) screening methods were applied to the length frequency distributions of the greater forkbeard landed in continental Portugal for the period 2019-2022. The procedure followed the ICES Technical guidance for providing reference points for stocks in categories 3 and 4 (Table 2) (ICES, 2017). The L_{mat} and L_{inf} estimates adopted were those made available by Spain for sexes combined: 53.89 cm and 91.46 cm, respectively (ICES WGDEEP datacall, 2018). The length-weight relationship parameters (Wt = 0.016 $TL^{2.843}$) were defined by Mendes et al. (2004).

Table 2. Selected indicators for LBI screening plots. Indicator ratios in bold used for stock status assessment with traffic light system (from ICES, 2017).

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above L_{opt} + 10%	0.3–0.4	Pmega	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	> 1	Conservation (immatures)
L_c	Length at first catch (length at 50% of mode)	L_{mat}	L_c/L_{mat}	> 1	
L_{mean}	Mean length of individuals > L_c	$L_{opt} = {}^2/_3\ L_{inf}$	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{max_y}	Length class with maximum biomass in catch	Lopt = ${}^2/_3\ L_{inf}$	L_{maxy} / L_{opt}	≈1	
L_{mean}	Mean length of individuals > L_c	$L_{F=M}$ = ($0.75L_c$+0.25 L_{inf})	L_{mean} / $L_{F=M}$	≥ 1	MSY

Results from the LBI screening method are shown in Tables 3a and 3b and Figure 2.

Table 3a. Results from LBI screening: indicator values.

Year	L_{75}	L_{25}	L_{med}	L_{90}	L_{95}	L_{mean}	L_c	$L_{F=M}$	L_{maxy}	L_{mat}	L_{opt}	L_{inf}	$L_{max5\%}$
2019	51.5	45.5	49.5	58.5	63.5	52.57	46	57.365	51.5	53.89	60.97	91.46	66.47
2020	44.5	42.5	44.5	53.5	53.5	46.03	42	54.365	44.5	53.89	60.97	91.46	53.50
2021	46.5	40.5	43.5	48.5	53.5	46.54	42	54.365	48.5	53.89	60.97	91.46	59.55
2022	62.5	56.5	58.5	64.5	65.5	59.21	46	57.365	58.5	53.89	60.97	91.46	65.50

All LBI estimates increased between 2021 and 2022 (Table 3a).

Table 3b. Results from LBI screening: indicator ratios. Ref., Reference expected values from ICES (2017).

		Conservation					Optimizing Yield	MSY
		L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{95\%}/L_{inf}$	L_{maxy}/L_{opt}	$L_{max5\%}/L_{inf}$	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
Year	Ref.	> 1	> 1	> 0.8	≈ 1	> 0.8	≈ 1 (>0.9)	≥ 1
2019		0.85	0.84	0.69	0.84	0.73	0.86	0.92
2020		0.78	0.79	0.58	0.73	0.58	0.75	0.85
2021		0.78	0.75	0.58	0.80	0.65	0.76	0.86
2022		0.85	1.05	0.72	0.96	0.72	0.97	1.03

Most of the ratios between indicators estimates (Table 3b) are below the proposed expected values (see Table 3). These results are related to the poor representation, on landings, of all the size ranges of the population. Discards are known to occur but are unquantifiable. It is acknowledged that the largest specimens are discarded from the deep-water longline fisheries but numbers are relatively low (Lagarto et al., 2017). In addition, onboard data for this fleet is derived from a small area of the total stock distribution in the Portuguese continental waters. Thus, the fishing effort affecting the largest individuals is relatively low.

Conservation ratio estimates increased in 2022 in relation to previous years and $L_{25\%}/L_{mat}$ and L_{maxy}/L_{opt} were above the reference values in 2022 (Table 3b and Figure 2). The Optimizing Yield indicator ratio increased between 2021 and 2022 to values above the reference, which indicates that the stock is being fished above optimum yield. The indicator for MSY increased from 2020 to 2022 and is now consistent with an adequate exploitation.

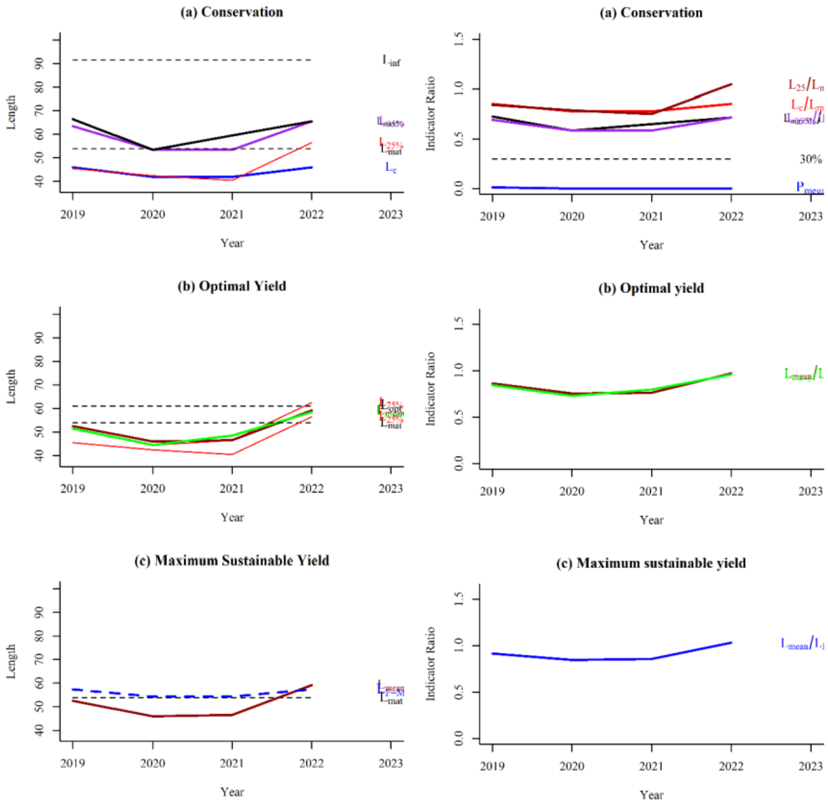

Figure 2. Results from LBI screening.

3. Fishery independent data in Portuguese waters from ICES division 27.9.a

Fishery independent data available from the Portuguese Crustacean Surveys/ Nephrops TV Surveys (PT-CTS (UWTV (FU 28-29))) has been used to estimate a standardized relative biomass index between 1997 and 2018 (Farias et al., 2021). In 2019 and 2020, the PT-CTS (UWTV (FU 28-29)) survey was not performed. In 2021, the R/V Mário Ruivo started to operate, but the survey's spatial coverage was smaller and fishing stations in the area where the species is traditionally more abundant were missing (Moura et al., 2022). The standardized biomass index has not been updated since 2021 (Farias et al., 2021).

4. Conclusions

Two standardized CPUE series based on commercial data suggested that the status of the greater forkbeard population inhabiting the Portuguese continental waters in recent years has been stable (Farias et al., 2021).

The standardized survey biomass estimates, which represents a relatively long time series, were well above the overall mean and showed an increasing trend in the last years of the time series (Farias et al., 2021). For the period between 1997 and 2016, an increasing trend was also observed for the juvenile component of the population, indicating that the fishing pressure over the Portuguese population had not seriously impaired the recruitment (Lagarto et al., 2017).

In general, LBI screening results, particularly the indicator of MSY, are above the reference values, suggesting that the stock is in a fair status.

Given the fact that this species is not targeted by any fishery, the results obtained suggest that the Portuguese fisheries are not impairing the population of greater forkbeard, whose information for the Portuguese waters further indicates that the species is able to complete the whole life cycle in the area.

Worth to mention that the relative low fishing impact of the Portuguese fisheries in deeper grounds reduces the impact over the fraction of larger specimens of the population, as the species tends to be larger at greater depths.

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Comparison between Greater silver smelt in ICES Subarea 5.a and Division 14 assessed using Gadget2 versus Gadget3 implementations

Will Butler, Pamela J. Woods, and Magnús Thorlacius

2023-05-03

Contents

Recently, a new implementation of Gadget has been designed and tested, and is being used for assessment of Greenland halibut (*Reinhardtius hippoglossoides*) and beaked redfish (*Sebastes mentella*) (ICES, 2023). The operational model is essentially the same as in previous implementations with some additional options (Lentin *et al.*, 2022). However, as it is based on the TMB package (Uffe *et al.*, 2017) in R statistical software (R Core Team, 2023), it can use different optimization routines. The Gadget3 model shown here was optimized using the BFGS algorithm, rather than the three-step routine used under Gadget2 implementation, which included simulated annealing, followed by Hooke and Jeeves, and finally BFGS optimizations. The largest benefit of using the Gadget3 implementation rather than the Gadget2 implementation is access to auto-differentiation libraries that greatly speeds the optimization time, which in the past has been a limitation to being able to produce confidence intervals based on a spatial bootstrap method (Elvarsson *et al.*, 2018). Another benefit is that in the future, it is more likely that Gadget3 will be maintained. We propose here to switch the implementation platform of the assessment model for Greater silver smelt in ICES Subarea 14 and Division 5.a (East Greenland and Iceland grounds) to Gadget3 from the Gadget2, as it would alleviate time constraints while producing results that correspond well with results from Gadget2. Fits to survey indices are very similar (Figure 1), as are fits to autumn survey length and age-length distribution data (Figures 2 and 4) and the commercial length and age-length distribution data (Figures 3 and 5) . Model results are also very similar (Figure), and the analytical retrospective analyses, both of which show very low Mohn's rho values, can essentially not be distinguished (Figures 6 vs.).

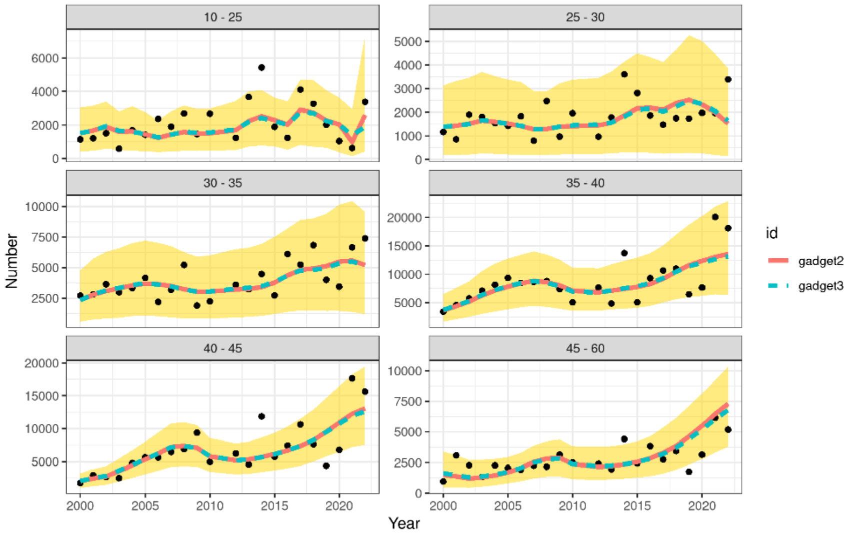


Figure 1: Greater silver smelt in 5a and 14. Comparison of fits to the survey index data implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Red lines indicate Gadget2, blue dashed lines indicate Gadget3.

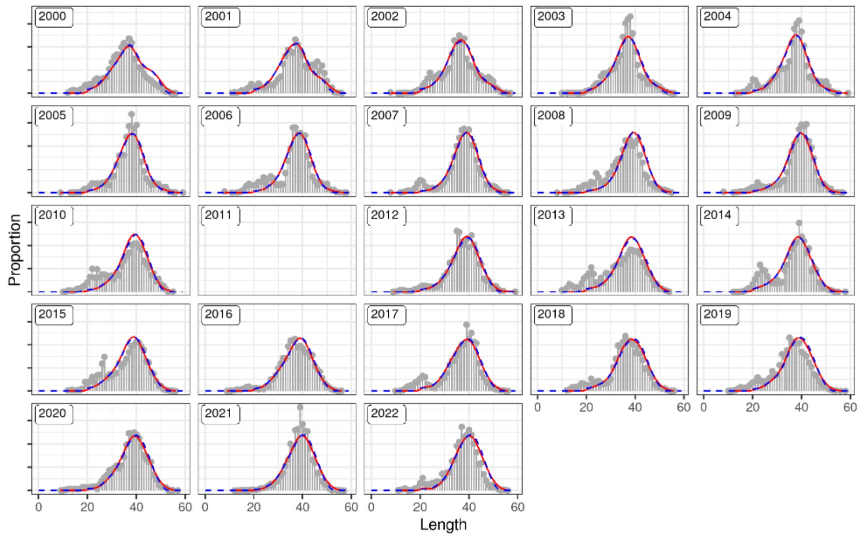


Figure 2: Greater silver smelt in 5a and 14. Comparison of fits to the autumn survey length distribution data implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Red lines indicate Gadget2, blue dashed lines indicate Gadget3.

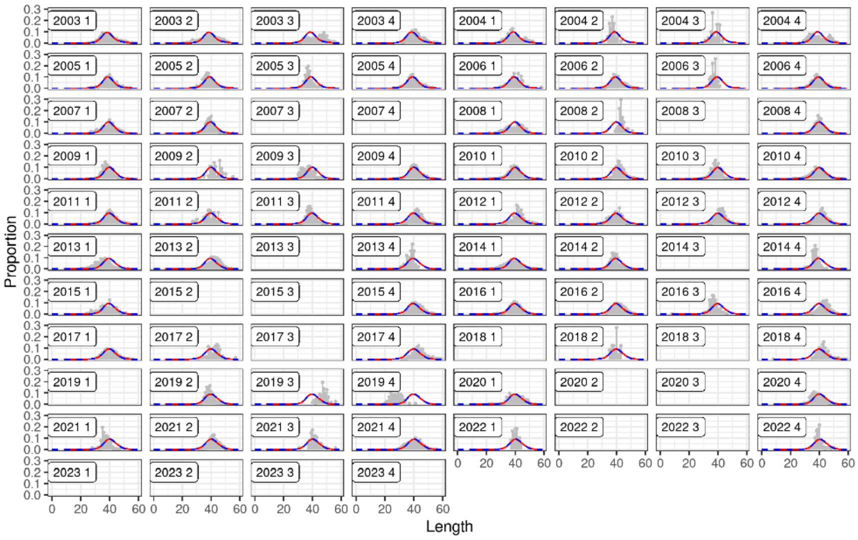


Figure 3: Greater silver smelt in 5a and 14. Comparison of fits to the commercial length distribution data implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Red lines indicate Gadget2, blue dashed lines indicate Gadget3.

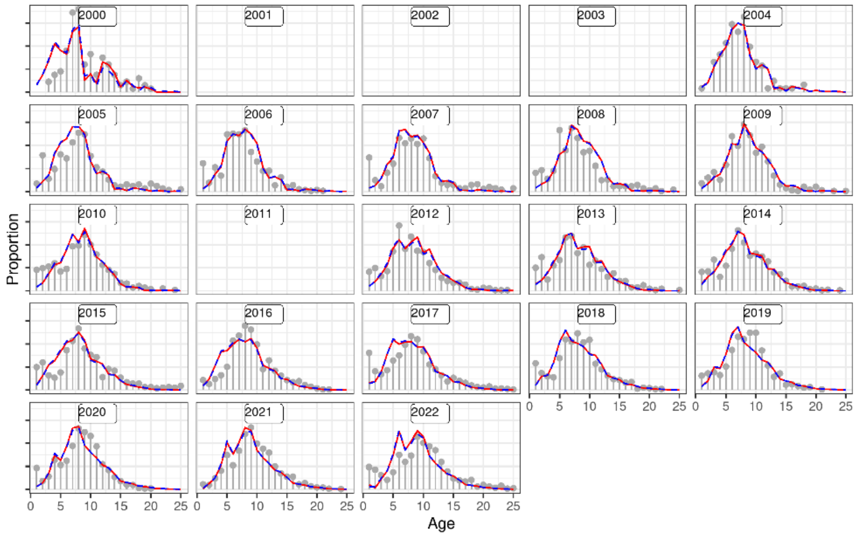


Figure 4: Greater silver smelt in 5a and 14. Comparison of fits to the autumn survey age-length distribution data implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Red lines indicate Gadget2, blue dashed lines indicate Gadget3.

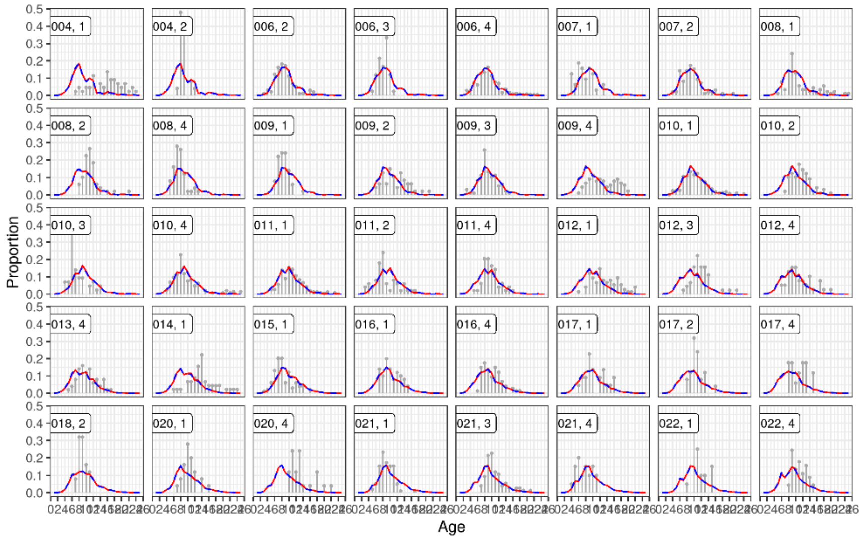
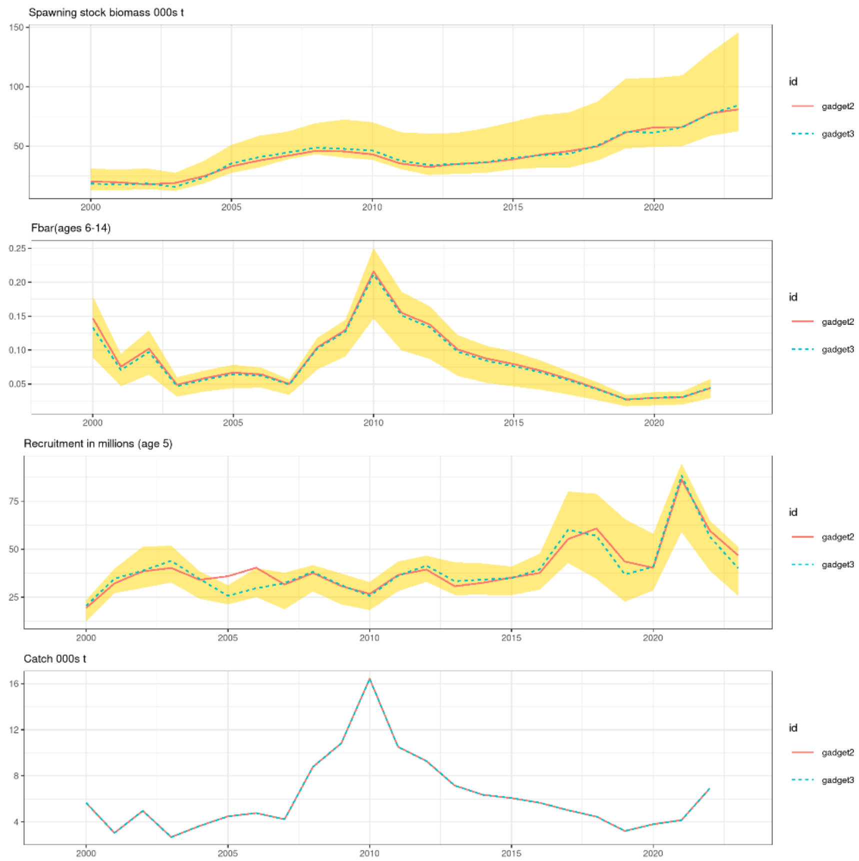


Figure 5: Greater silver smelt in 5a and 14. Comparison of fits to the commercial age-length distribution data implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Red lines indicate Gadget2, blue dashed lines indicate Gadget3.



\begin{figure}
\caption{Greater silver smelt in 5a and 14. Comparison of assesssment results when implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Yellow bands indicate 90% confidence intervals based on a spatial bootstrap generated from the Gadget3 model.} \end{figure}

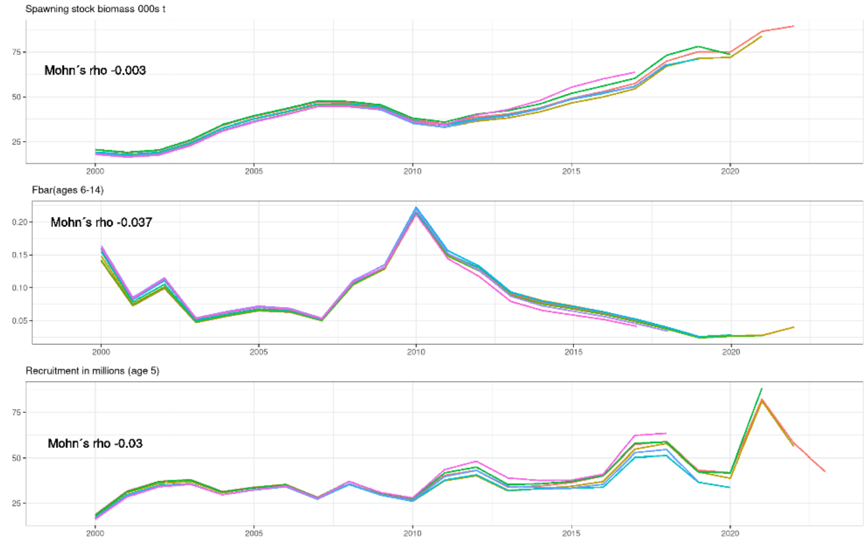
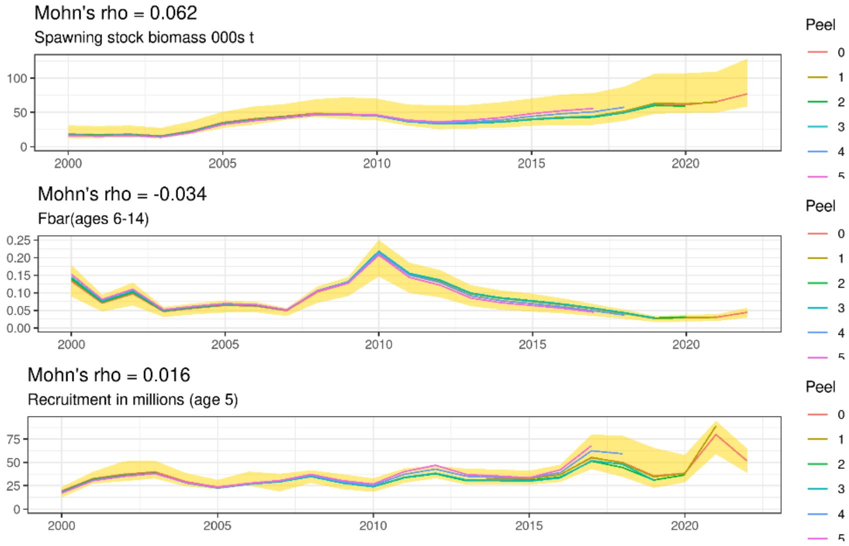


Figure 6: Greater silver smelt in 5a and 14. Analytical retrospective pattern resulting when implemented using Gadget2, implementation platform from previous years.



\begin{figure}
\caption{Greater silver smelt in 5a and 14. Analytical retrospective pattern resulting when implemented using Gadget3, as done in this year's assessment. Yellow bands indicate 90% confidence intervals based on a spatial bootstrap generated from the Gadget3 model.} \end{figure}

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Pagellus bogaraveo in Portuguese continental waters (ICES Division 27.9.a)

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1. Introduction

Pagellus bogaraveo (Brünnich, 1768), the blackspot seabream, distributes between southern Norway and Cape Blanc, in the Mediterranean Sea, and in the Azores, Madeira, and Canary Archipelagos (Desbrosses, 1932; Pinho and Menezes, 2005).

Spawning occurs in shallow waters, where juveniles of age groups 0 and 1 are reported to remain at depths lower than 170 m, close to the coast, in the Azores (Menezes et al., 2001), the Bay of Biscay (Lorance, 2011), and the Mediterranean Sea (Biagi et al., 1998; Félix-Hackradt et al., 2013). When juveniles reach 150–180 mm total length (TL), they migrate along the slope to depths deeper than 200 m, following an ontogenetic migration towards deeper waters (Olivier, 1928; Desbrosses, 1932; Morato et al., 2001; Spedicato et al., 2002). Nevertheless, fish with sizes larger than 40 cm have been occasionally caught in coastal waters (Priol, 1932).

The blackspot seabream is a protandric hermaphrodite – individuals are first functional males and then develop into functional females (Buxton and Garratt, 1990; Krug, 1990; Gil, 2006). In the Azores, the age of first maturity is about 8 years old for females (Krug, 1990). In Cadiz waters, the main spawning period occurs during the 1st quarter (Gil, 2010), whereas in the Azores spawning is from March to April (Martins *et al.*, 2007).

In the Northeast Atlantic, *P. bogaraveo*'s stock structure is still unknown. Genetic studies showed a restricted gene flow among the populations located in the Azores (ICES Division 27.10.a.2) and those on the Portuguese continental slope (ICES Division 27.9.a) and Madeira (CECAF FAO Division 34.1.2) (Stockley *et al.*, 2005; Pinera et al., 2013). Mitochondrial control region showed similar genetic diversity among sampling sites in the NE Atlantic and the Mediterranean, and no differentiation between the Azores and the remaining locations (Robalo et al., 2021). More recently, a genomic study using biological samples from different geographic areas supported the existence of three well-differentiated clusters in the Atlantic: (i) the Azores; (ii) Cadiz; and (iii) the continental Atlantic coast (Cunha et al., submitted). Those results confirmed that the Azorean population is isolated from the other populations and support the separation of the population occurring off Cadiz from the remaining Iberian area.

Despite the poor knowledge on the species stock structure, ICES adopts three management components for management purposes: (a) Subareas 27.6, 27.7, and 27.8; (b) Subarea 27.9; and (c) Subarea 27.10 (Azores) (ICES, 2007). These components were established to better record the available information and do not have implicit the existence of three different stocks of *P. bogaraveo*. There is no evidence of movements between the northernmost component and the southern part of Subarea 27.9 where a targeted fishery takes place in the Strait of Gibraltar (ICES, 2019).

The Spanish longline fishery operating in the Strait of Gibraltar has been managed as a regulated open-access fishery since its initial exploitation, in 1983 (Gil et al., 2019). In 2001, Moroccan longliners started a target fishery in the same area. Therefore, two directed fisheries are presently taking place in the Spanish and Moroccan Exclusive Economic Zone (EEZ) (ICES, 2017).

Total Allowable Catch (TAC), Portuguese quota, and official landings are presented for continental Portugal (ICES Division 27.9.a) for the period between 2014 and 2022 (Table 1).

Table 1. *Pagellus bogaraveo* Total Allowable Catch (TAC) and Portuguese quota and official landings in ICES Subarea 27.9, between 2014 and 2022.

Year	TAC EU ICES Subarea 27.9	Portugal quota ICES Subarea 27.9	Official Portuguese landings ICES Division 27.9.a
2014	780	166	59
2015	374	80	66
2016	183	39	70
2017	174	37	69
2018	165	35	58
2019	149	32	36
2020	149	32	43
2021	119	25	29
2022	119	25	32
2023	114	24	
2024	114	24	

1.1. Fishery in Portugal continental

In continental Portugal, *P. bogaraveo* is mainly caught as by-catch of fisheries targeting other species, although some vessels are licensed to target the species.

Fishery data and information collected through enquiries made to Peniche (Portuguese central western coast) skippers with experience on *P. bogaraveo* fishing has shown that: (i) the species tends to gather at specific fishing grounds with particular seamount-like topographic features, being mainly caught at depths around 250 m; (ii) the fishing grounds substrates are mainly composed by muddy sand, rock, and sand; (iii) the species length range is not different between the different fishing grounds. Some skippers additionally referred that, during winter, the species migrates, driven by environmental factors or biological conditions, such as reproduction (Araújo et al., 2016).

Information on blackspot seabream collected from 1990 to 2018 in the Portuguese Nephrops TV Surveys (PT-CTS (UWTV (FU 28-29))) and the Portuguese Autumn Groundfish Surveys (PT-GFS) conducted by the Portuguese Institute for the Sea and Atmosphere (IPMA) supports the hypothesis of a patchy distribution, as the species is more frequently caught at specific grounds (Farias and Figueiredo, 2019). It is important to note that the PT-CTS (UWTV (FU 28-29)) survey design is considered inadequate to estimate the species abundance or biomass, as the species distributes preferentially at non-trawlable areas.

2. Methodology

1.1. Fishery dependent data

1.1.1. Landings and mean price in continental Portugal

Portuguese landings in ICES Division 27.9.a were characterized. Fishery dependent data were collected from commercial landings for the period between 2009 and 2022.

Pagellus bogaraveo total landings in weight (ton) and value (euro) were analysed by year, fishing segment and NUTS (Nomenclature of Territorial Units for Statistics). The EU NUTS classification system (https://ec.europa.eu/eurostat/web/regions/background) is a regional system that divides each EU Member State's territorial area into units, providing a harmonised hierarchy between regions. Following the criteria adopted under this system, continental Portugal is divided into 5 different NUTS II (level 2), namely: North; Centre; Lisbon Metropolitan Area; Alentejo; and Algarve.

1.1.2. Landings and mean price by fleet and selected NUTS II

Pagellus bogaraveo total landings in weight (ton) and value (euro) were analysed throughout the year, between 2009 and 2022, by fishing segment (polyvalent and trawl), considering the NUTS II with the most representative landings of the species: North, Centre, and Algarve.

1.1.3. Landings in the most important Portuguese continental ports

Pagellus bogaraveo total landings in weight (ton) were analysed throughout the year, between 2009 and 2022, by fishing segment (polyvalent and trawl) for NUTS II landing ports with the highest landings of the species: Matosinhos port belongs to NUTS II North; Aveiro, Nazaré, and Peniche ports belong to NUTS II Centre; and Sagres belongs to NUTS II Algarve.

1.2. LPUE

1.2.1. Reference fleet

Reference fleets for the polyvalent and for the trawl fishing segments were defined for the most important landing port considering total landings and value of the species, Peniche. The criteria adopted for the selection of fishing vessels were defined according to the number of fishing trips with positive landings of the species and the number of months of the year with positive landings of the species, during the period between 2015 and 2022.

For the polyvalent fishing segment, the criteria adopted for the selection of fishing vessel were: more than 9 fishing trips per year and more than 6 months with positive landings of the species.

For the trawl fishing segment, the criteria adopted for the selection of fishing vessel where: more than 9 fishing trips per year and more than 5 months with positive landings of the species.

In 2023, vessels with low or null fishing trips with landings of the species in the period between 2019 and 2022 were excluded.

1.2.2. CPUE adjustment

For each selected vessel, data available at fishing trip level was further analysed. The landed weight of the species (in kg) per fishing trip corresponds to the total weight landed by the vessel after each trip. A trip is defined from the moment the vessel leaves the dock to when it returns to the dock.

The landed weight per fishing trip was considered as an indicator of biomass index, further referred as CPUE. Important to note that discards of the species are negligible in Portuguese continental fisheries.

CPUE data were standardized through the adjustment of generalized linear models (GLM). The model with the best adjustment was selected based on the AIC criterion and on the analysis of residuals.

1.3. Length distribution

Pagellus bogaraveo length sampling data available from the national Data Collection Framework (DCF) for the polyvalent and the trawl segments for continental Portugal were analysed by year in the period between 2014 and 2022. Numbers-at-length were raised to the total landings of the species.

1.4. LBI

Length-based indicators (LBI) screening methods were applied to *P. bogaraveo* length data for continental Portugal. The procedure followed the ICES Technical guidance for providing reference points for stocks in categories 3 and 4 (ICES, 2017b). The L_{mat} and L_{inf} estimates were adopted from Gil et al. (2009) and CopeMed II (2019), respectively. The length-weight relationship parameters ($W = 1.17542e\text{-}05 \times L^{3.0366}$) were estimated based on biological sampling data collected in 2020 and following the procedure in fishR Vignette (Ogle, 2013). Selected indicators, reference points, indicator ratios and their expected values are presented in Table 2 (ICES, 2017b).

Table 2. Selected indicators for LBI screening plots (ICES, 2017b).

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%} / L_{inf}$	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%} / L_{inf}$		
P_{mega}	Proportion of individuals above L_{opt} + 10%	0.3–0.4	Pmega	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%} / L_{mat}$	> 1	Conservation (immatures)
L_c	Length at first catch (length at 50% of mode)	L_{mat}	L_c/L_{mat}	> 1	
L_{mean}	Mean length of individuals > L_c	$L_{opt} = {}^2/_3\, L_{inf}$	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{max_y}	Length class with maximum biomass in catch	Lopt = ${}^2/_3\, L_{inf}$	L_{maxy} / L_{opt}	≈1	

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
L_{mean}	Mean length of individuals > L_c	$L_{F=M}$ = ($0.75L_c$+$0.25L_{inf}$)	L_{mean} / $L_{F=M}$	≥ 1	MSY

2. Results and discussion

2.1. Fishery dependent data

2.1.1. Landings and mean price in continental Portugal

In the period between 2009 and 2022, the species was landed in all five NUTS II of the Portuguese continental coast (Figure 1). Landing ports in central Portugal (NUTS II "Centro") showed the highest landings in weight followed by the Algarve (South Portugal), that was around four times lower, and the North (NUTS II "Norte") that was up to 8 times lower. Similar proportions were found between the NUTS in terms of value of the species (Figure 2).

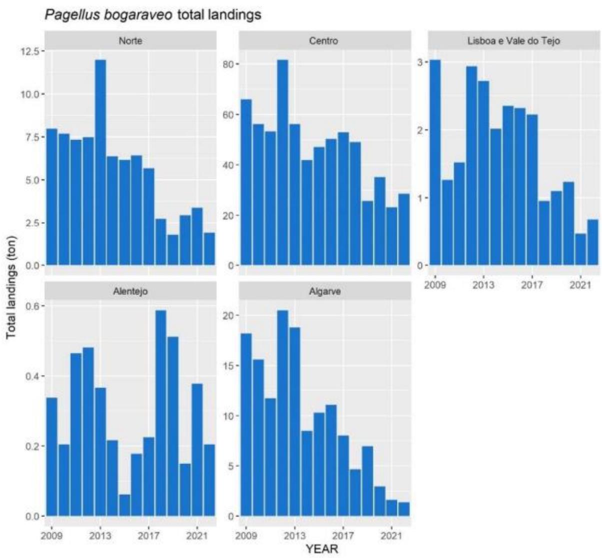

Figure 1. *Pagellus bogaraveo* total landings in tonnes in each NUTS II in continental Portugal between 2009 and 2022.

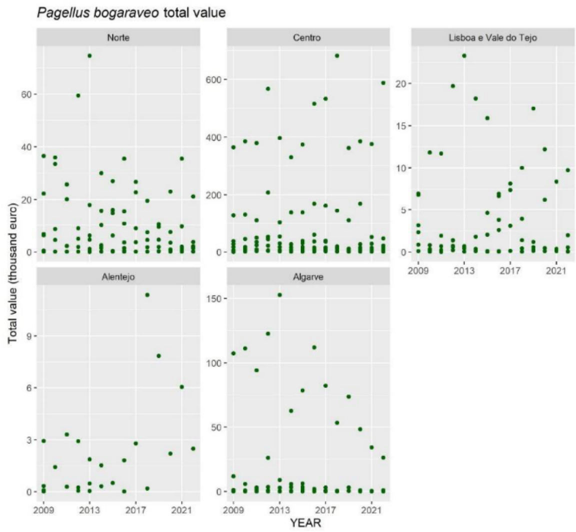

Figure 2. *Pagellus bogaraveo* total value in thousands of euros in each NUTS II in continental Portugal between 2009 and 2022.

In all NUTS II, the polyvalent fishing segment presented the highest landing values, followed by the trawl segment, with purse seine showing nearly negligible landings (Figure 3). These differences were more evident in central Portugal (NUTS II "Centro"), where the polyvalent represented around 60% of the species landings, the trawl segment represented nearly 40%, and the purse-seine fishery less than 1%.

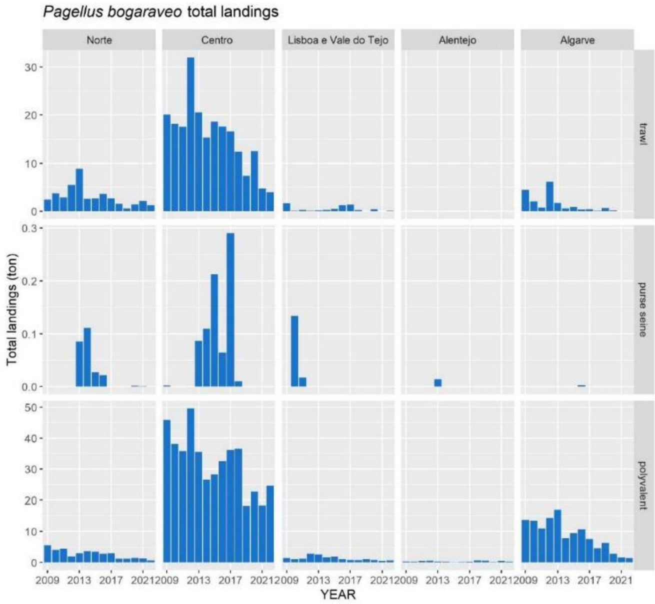

Figure 3. *Pagellus bogaraveo* total landings in tonnes by fishing segment (trawl, purse seine, and polyvalent) in each NUTS II in continental Portugal between 2009 and 2022.

The number of vessels landing *P. bogaraveo* was higher for the polyvalent fishing segment than for the trawl segment in all NUTS II (Figure 4). For the period between 2009 and 2022, a decreasing trend in the number of vessels landing the species was observed in the Centre, Lisbon area, and Algarve (NUTS II "Norte", "Lisboa e Vale do Tejo", and "Centro", respectively), which is probably associated with the continuous EU TAC reduction in Subarea 27.9 since 2004 (ICES, 2017a). However, the number of polyvalent and trawl vessels landing *P. bogaraveo* increased between 2019 and 2020, followed by a decrease in the subsequent years in the North (NUTS II "Norte") and Centre (NUTS II "Centro).

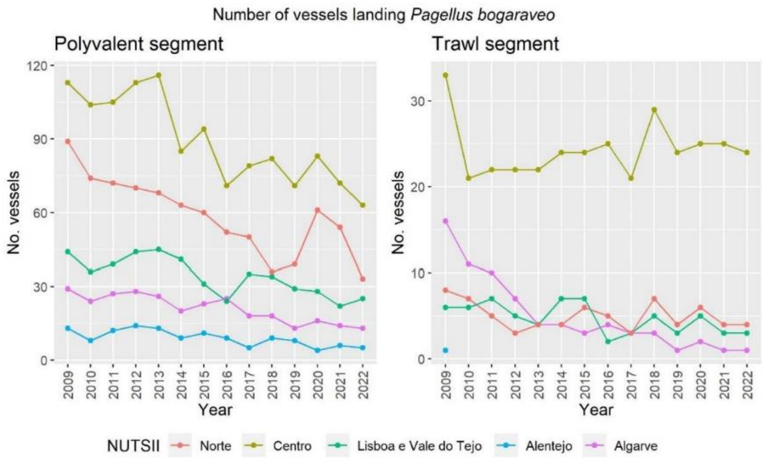

Figure 4. Number of vessels landing *Pagellus bogaraveo* in each NUTS II in continental Portugal, by year and by fishing segment (polyvalent and trawl), from 2009 to 2022.

2.1.2. Landings and mean price by fleet and selected NUTS II

Polyvalent fishing segment landings were higher in the winter months (late and early months of the year), more accentuated in the Centre region (NUTS II "Centro") (Figure 5). In the North (NUTS II "Norte") and Algarve, some years showed a peak in summer months but with little effect in terms of total landings when considering all the regions. From 2009 to 2022, there was a decreasing trend in the species landings in the three considered NUTS II, with the exception of the Centre region were the monthly landings increased between 2021 and 2022.

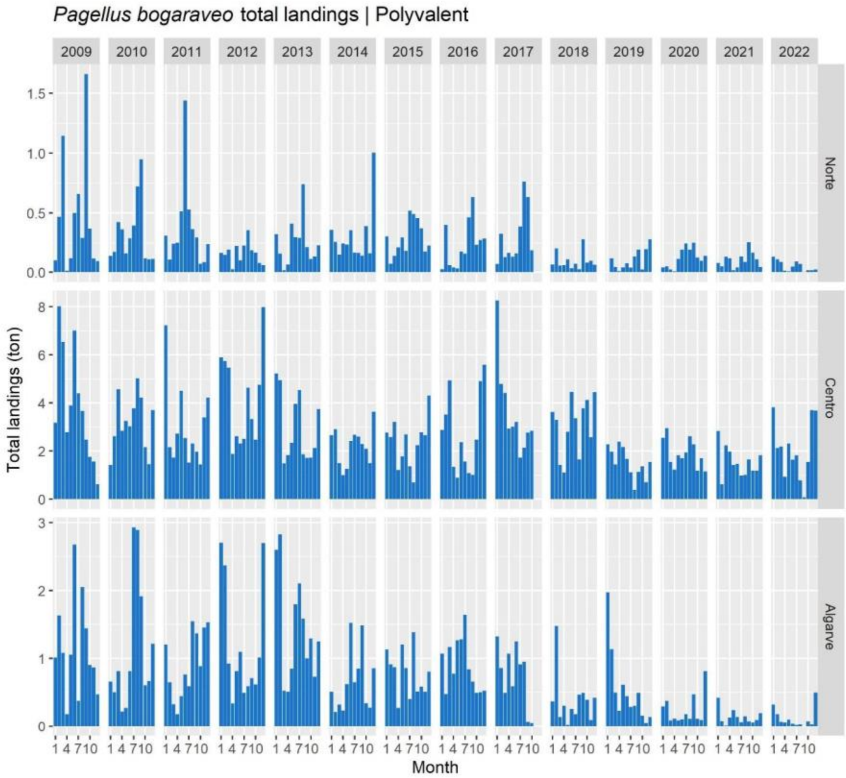

Figure 5. *Pagellus bogaraveo* landings (tons) from the polyvalent fleet by month and year at the three most important NUTS II in continental Portugal, from 2009 to 2022.

The trawl fishing segment shows a sharp decrease in total landings by month from 2012-2013 to 2022 (Figure 6). In the North (NUTS II "Norte") and in the Centre (NUTS II "Centro"), landings were higher at the beginning of the year. In the South (NUTS II "Algarve"), landings occurred mainly in the summer months, being nearly negligible between 2020 and 2022.

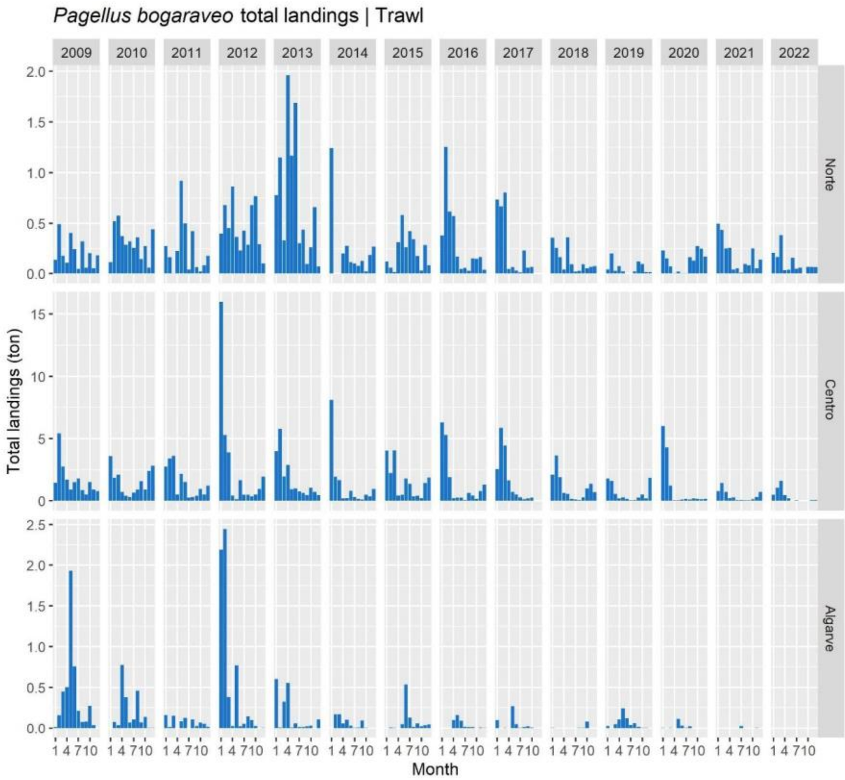

Figure 6. *Pagellus bogaraveo* landings (tons) from the trawl fleet by month and year at the three most important NUTS II in continental Portugal, from 2009 to 2021.

For the three main NUTS II, the mean price per Kg showed variations along the months of the year for the polyvalent fleet (Figure 7) and the trawl fleet (Figure 8), being those variations more noticeable in the polyvalent segment and in the last months of the year, since 2016.

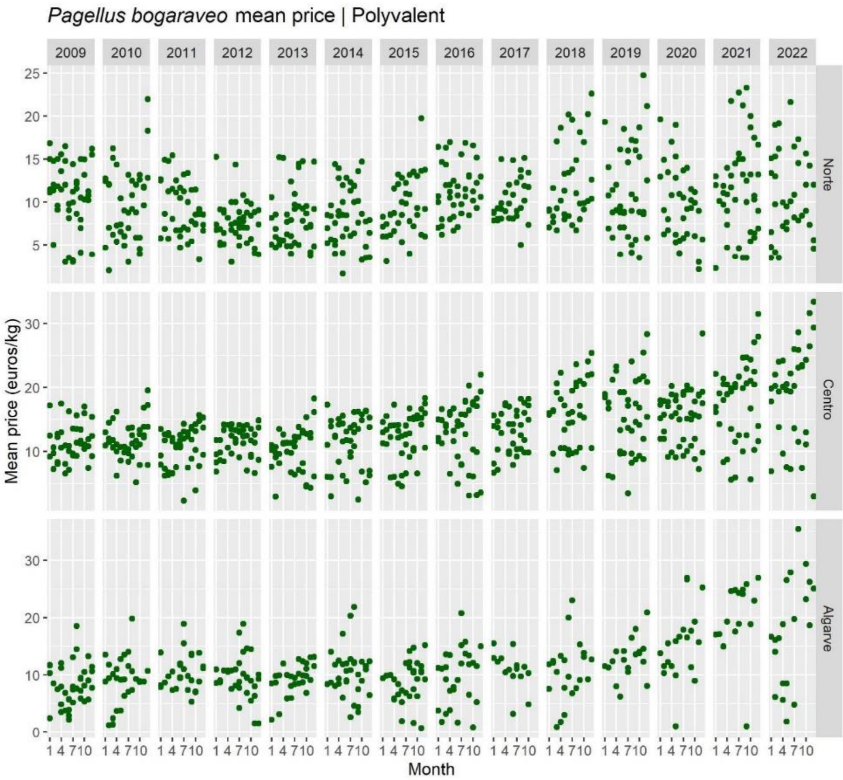

Figure 7. Mean price (in euro per Kg) of *Pagellus bogaraveo* landed by the polyvalent fishing segment by month and year for the three main NUTS II in continental Portugal between 2009 and 2022.

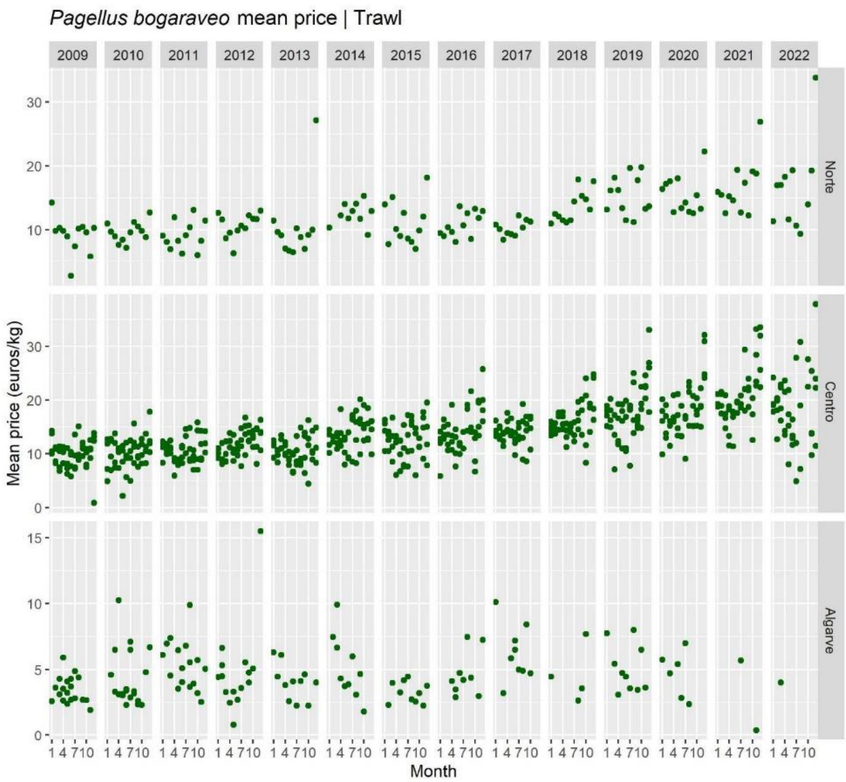

Figure 8. Mean price (in euro per Kg) of *Pagellus bogaraveo* landed by the trawl fishing segment by month and year for the three main NUTS II in continental Portugal between 2009 and 2022.

2.1.3. Landings in the most important Portuguese continental ports

P. bogaraveo landed weight by trip is presented in Figure 9 for the polyvalent segment and in Figure 10 for the trawl segment. Peniche port (Portuguese central western coast) was the most important landing port (landings between 2015 and 2022 represented nearly 50% of the Portuguese landings of the species in ICES Division 27.9.a) for both fishing segments. Extreme values were excluded from the plots for better visualization of data. In the later years, the highest landing values are registered between December and March for the polyvalent segment in Peniche.

P. bogaraveo total landings by most important ports and by fleet segment are summarised in Annex 1.

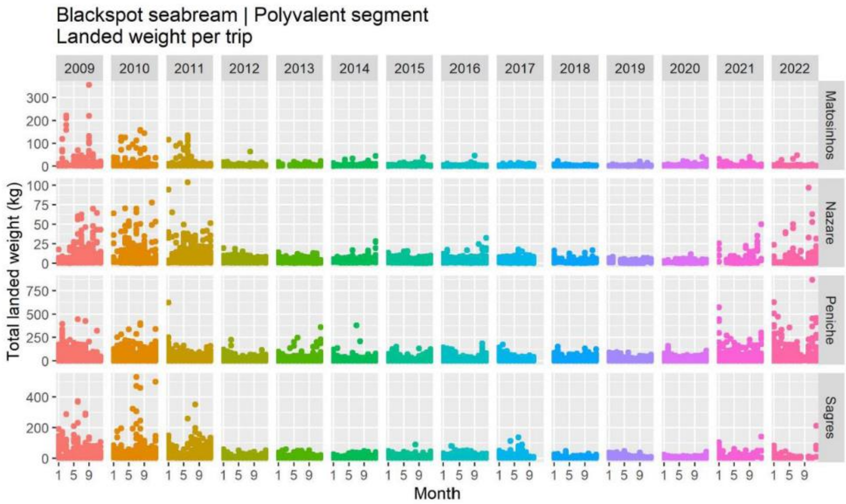

Figure 9. *Pagellus bogaraveo* total landed weight (kg) from the polyvalent fishing segment by month and year at the most important ports in Portugal continental, from 2009 to 2022.

Figure 10. *Pagellus bogaraveo* total landed weight (kg) from the trawl fishing segment by month and year at the most important ports in continental Portugal, from 2009 to 2022.

2.2. LPUE

2.2.1. Reference fleet

A total of 36 fishing vessels were selected for the polyvalent fleet landing in Peniche port and a total of 10 fishing vessels were selected for the trawl fleet landing in Peniche port.

2.2.2. CPUE adjustment

GLM was adjusted to annual log-CPUE estimations for Peniche's polyvalent reference fleet considering a normal distribution and the identity link function. The GLM estimates of the annual CPUE for Peniche's polyvalent reference fleet for the selected model are presented in Figure 11 and Table 3. CPUE for the polyvalent reference fleet has been stable throughout the considered time period, showing a slight decrease from 2018 to 2019 and an increasing trend from 2019 to 2022.

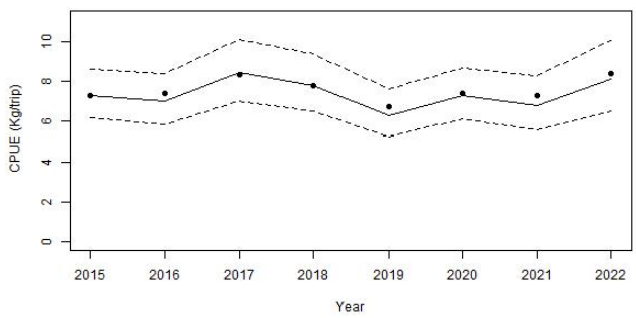

Figure 11. *Pagellus bogaraveo* standardized annual estimates of CPUE for Peniche polyvalent fishing segment reference fleet from 2015 to 2022.

Table 3. *Pagellus bogaraveo* CPUE series estimates for Peniche polyvalent reference fleet. 95% confidence interval.

Year	CPUE obs	CPUE pred.lower	CPUE pred	CPUE pred.upper
2015	7.31	6.18	7.31	8.65
2016	7.40	5.88	7.03	8.40
2017	8.34	7.03	8.44	10.12
2018	7.81	6.51	7.82	9.39
2019	6.71	5.23	6.33	7.65
2020	7.42	6.13	7.28	8.65
2021	7.28	5.61	6.82	8.29
2022	8.38	6.51	8.10	10.08

The analysis of the residuals of the fitted model is presented in Figure 12.

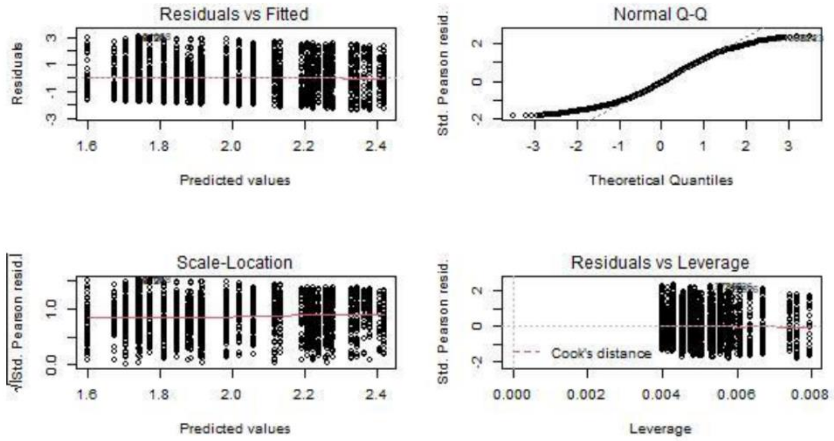

Figure 12. *Pagellus bogaraveo* analysis of the residuals of standardized annual estimates of CPUE for Peniche polyvalent fishing segment reference fleet from 2015 to 2022.

GLM was adjusted to annual log-CPUE estimations for Peniche's trawl reference fleet considering a normal distribution and the identity link function. The model was selected based on AIC and analysis of the residuals. The GLM estimates of the annual CPUE for Peniche's trawl reference fleet for the selected model are presented in Figure 13 and Table 4. CPUE for the trawl reference fleet showed a decreasing trend until 2019, followed by an increasing in that year, and has been stable since 2021.

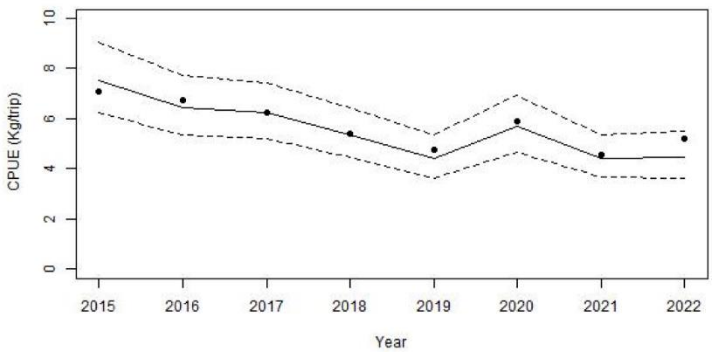

Figure 13. *Pagellus bogaraveo* standardized annual estimates of CPUE for Peniche trawl fishing segment reference fleet from 2015 to 2022.

Table 4. *Pagellus bogaraveo* CPUE series estimates for Peniche trawl reference fleet. 95% confidence interval.

Year	CPUE obs	CPUE pred. lower	CPUE pred	CPUE pred. upper
2015	7.06	6.22	7.51	9.06
2016	6.70	5.32	6.41	7.73
2017	6.21	5.19	6.21	7.43
2018	5.40	4.43	5.35	6.45
2019	4.74	3.59	4.38	5.35
2020	5.87	4.63	5.66	6.92
2021	4.57	3.64	4.40	5.33
2022	5.21	3.63	4.45	5.47

The analysis of the residuals of the fitted model is presented in Figure 14.

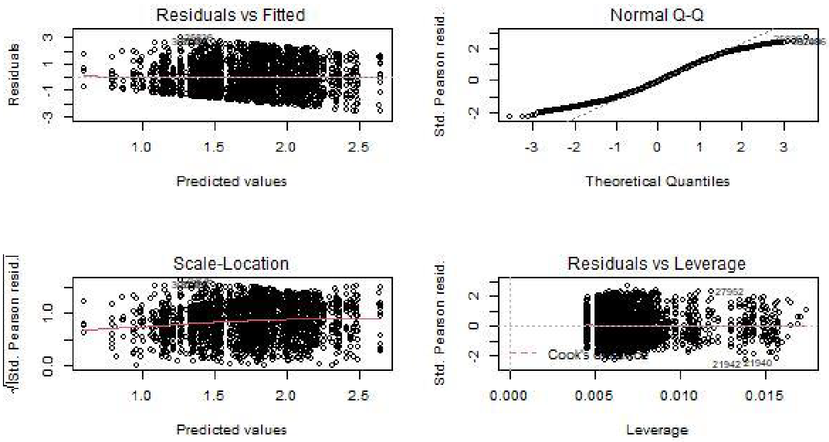

Figure 14. *Pagellus bogaraveo* analysis of the residuals of standardized annual estimates of CPUE for Peniche trawl fishing segment reference fleet from 2015 to 2022.

2.3. Length distribution

P. bogaraveo length distributions were extrapolated from DCF length sampling data available for the polyvalent (Figure 15) and the trawl (Figure 16) fishery segments for Portugal continental by year in the period between 2014 and 2022. The smaller sizes are poorly represented probably because the minimum landing size of *P. bogaraveo* is 33 cm and the discards of specimens bellow that size are negligible given that the species shows a very high survival rate (Serra-Pereira et al., 2019). In 2020, only 4 samples were measured from the polyvalent segment, which corresponded to 72 specimens, and only 4 samples from the trawl segment, which included 52 specimens (Farias and Figueiredo, 2021).

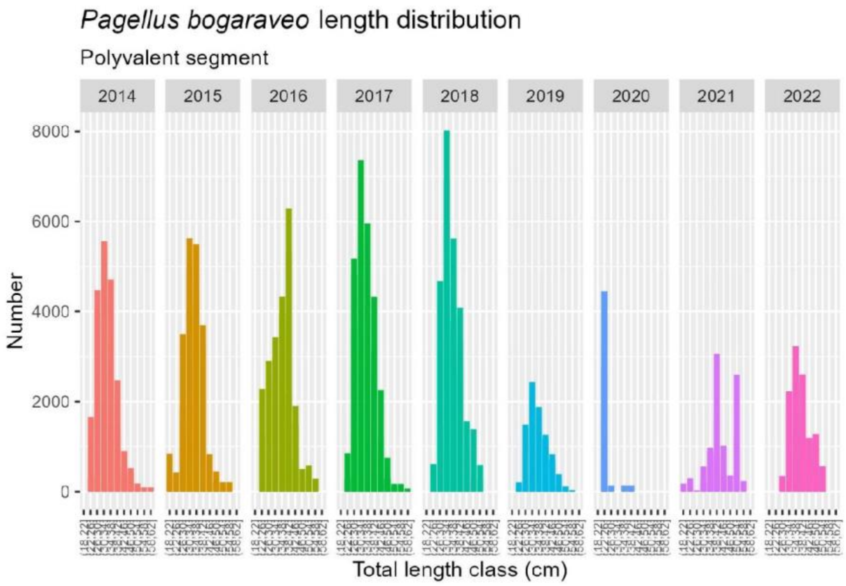

Figure 15. *Pagellus bogaraveo* extrapolated length frequency distributions for the polyvalent fishing segment for the years between 2014 and 2022. (4 cm total length classes)

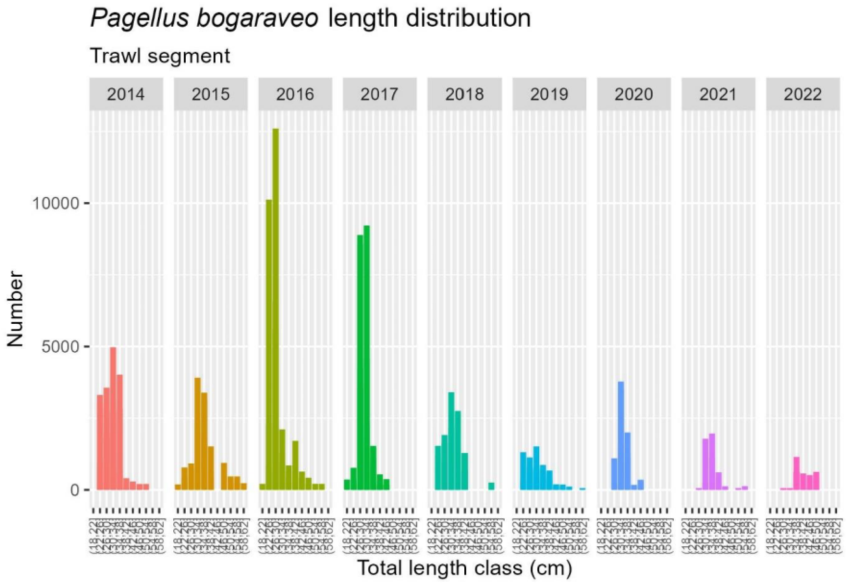

Figure 16. *Pagellus bogaraveo* extrapolated length frequency distributions for the trawl fishing segment for the years between 2014 and 2022. (4 cm total length classes)

Differences in length distribution between the polyvalent segment and the trawl segment result from the fact that polyvalent vessels operate in areas farther from the coast and at higher depths, where larger fish are more common (Farias et al., 2018).

2.4. LBI

Results from the LBI screening method are shown in Tables 5 and 6 and Figures 17 and 18.

Table 5. *Pagellus bogaraveo* in ICES Division 27.9.a. Results from LBI screening.

Year	L_{75}	L_{25}	L_{med}	L_{90}	L_{95}	L_{mean}	L_c	$L_{F=M}$	L_{maxy}	L_{mat}	L_{opt}	L_{inf}	$L_{max5\%}$
2014	36	29	33	39	42	33.39	26	35.00	34	35.1	41.33	62	46.88
2015	38	32	35	41	45	36.50	30	38.00	36	35.1	41.33	62	52.09
2016	38	27	31	42	45	33.52	26	35.00	40	35.1	41.33	62	49.58
2017	36	30	32	40	43	34.95	30	38.00	31	35.1	41.33	62	46.15
2018	38	31	34	41	44	35.78	30	38.00	37	35.1	41.33	62	47.60
2019	39	31	34	43	46	35.28	26	35.00	38	35.1	41.33	62	49.03
2020	34	25	32	37	38	33.35	26	35.00	34	35.1	41.33	62	41.42
2021	43	36	39	52	54	40.29	22	32.00	52	35.1	41.33	62	54.53
2022	43	35	38	47	49	40.60	34	41.00	38	35.1	41.33	62	50.01

All LBI estimates increased between 2020 and 2021, except L_c and $L_{F=M}$, which increased between 2021 and 2022 (Table 5).

Table 6. *Pagellus bogaraveo* in ICES Division 27.9.a. LBI screening ratios.

		Conservation						Optimizing Yield	MSY
		L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{95\%}/L_{inf}$	L_{maxy}/L_{opt}	$L_{max5\%}/L_{inf}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
Year	Ref.	> 1	> 1	> 0.8	≈ 1	> 0.8	>30%	≈ 1 (>0.9)	≥ 1
2014		0.74	0.83	0.68	0.82	0.76	3%	0.81	0.95
2015		0.85	0.91	0.73	0.87	0.84	5%	0.88	1.04
2016		0.74	0.77	0.73	0.97	0.80	5%	0.81	0.96
2017		0.85	0.85	0.69	0.75	0.74	2%	0.85	1.00
2018		0.85	0.88	0.71	0.90	0.77	4%	0.87	1.02
2019		0.74	0.88	0.74	0.92	0.79	6%	0.85	1.01
2020		0.74	0.71	0.61	0.82	0.67	0%	0.81	0.95
2021		0.63	1.03	0.87	1.26	0.88	20%	0.97	1.15
2022		0.97	1.00	0.79	0.92	0.81	16%	0.98	1.16

Most ratio estimates of conservation increased in 2021 in relation to previous years and remained close to the reference values in 2022, including the L_c/L_{mat} which increased had been at lower levels (Table 6). The Optimizing Yield indicator ratio increased between 2020 and 2021 and remained at the same level in 2022, which indicates that the stock is being fished at levels close to optimum yield. The indicator for MSY ($L_{mean}/L_{F=M}$) was above the reference value in most of the years of the series, including 2020 and 2021, being consistent with an adequate exploitation.

The values estimated for the conservation ratios results might reflect some of EU size measures, such as the adopted minimum landing size (MLS). L_c/L_{mat} and $L_{25\%}/L_{mat}$ low estimates might be related with the fact that the L_{mat} of females, which is above the MLS, was assumed in the screening since *P. bogaraveo* is a protandric hermaphrodite.

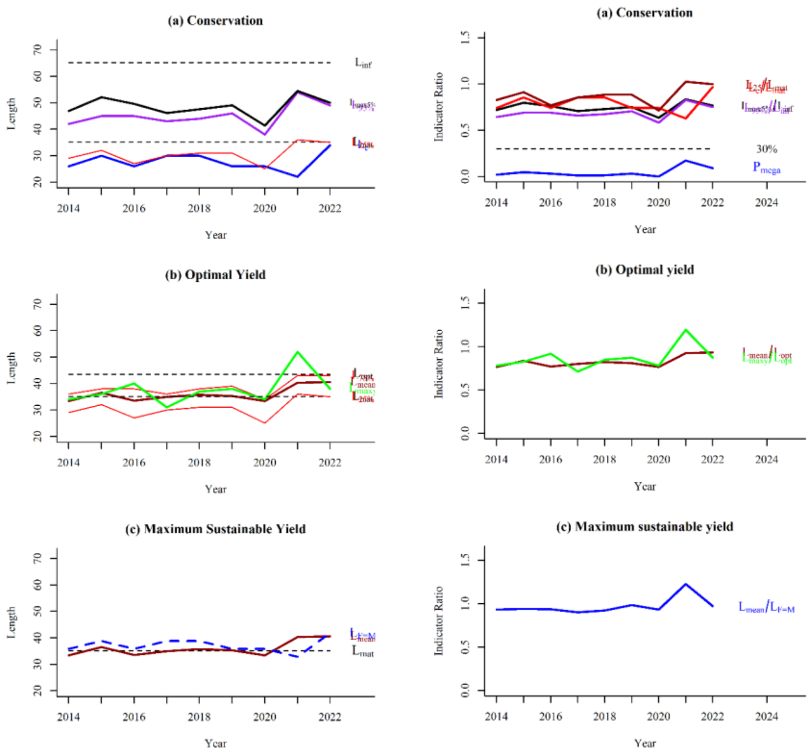

Figure 17. *Pagellus bogaraveo* in ICES Division 27.9.a. Results from LBI screening (left) and LBI screening ratios (left).

Time-series plots show that most of the indicators had low variability between 2014 and 2022.

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ANNEX I

Table 7. *Pagellus bogaraveo* total landed weight (ton) by fleet segment in the six most important landing ports for the species. Ports are organized by NUTS II between 2009 and 2022.

		North			Centre				Lisbon Metrop. Area	Algarve	
Year	Gear	Matosinhos	Povoa do Varzim	Viana do Castelo	Aveiro	Figueira da Foz	Nazare	Peniche	Sesimbra	Sagres	Portimao
2009	Polyvalent	4.24	0.66	0.5734	0.06	0.43	3.42	41.98	0.59	13.47	0.05
	Trawl	2.43	-	-	1.43	0.64	2.69	15.32	1.55	-	4.32
2010	Polyvalent	2.64	0.45	0.8427	0.09	0.50	3.83	33.65	0.91	13.33	0.05
	Trawl	3.73	-	-	1.12	1.05	1.47	14.50	0.05	0.00	1.90
2011	Polyvalent	2.27	0.34	1.8148	0.52	0.20	3.92	31.09	0.97	10.63	0.20
	Trawl	2.90	-	-	3.03	0.79	2.32	11.43	0.32	-	0.74
2012	Polyvalent	1.03	0.29	0.5313	0.53	0.24	3.99	44.85	2.18	13.88	0.05
	Trawl	5.56	-	-	3.63	1.80	5.33	21.29	0.09	-	6.14
2013	Polyvalent	1.55	0.52	0.6831	0.74	0.10	2.60	32.05	2.21	16.70	0.03
	Trawl	8.91	-	-	4.79	1.51	3.34	10.89	0.18	-	1.73
2014	Polyvalent	1.05	0.35	1.9169	0.36	0.02	1.80	24.36	1.55	6.89	0.41
	Trawl	2.62	-	-	1.09	0.48	1.11	12.61	0.31	-	0.62
2015	Polyvalent	1.32	0.80	1.3293	0.55	0.06	2.82	24.88	1.46	8.65	0.07
	Trawl	2.70	-	-	1.99	0.93	1.38	14.30	0.51	-	0.90
2016	Polyvalent	0.86	0.35	1.3854	0.34	0.09	2.28	29.87	0.49	10.45	0.02
	Trawl	3.62	-	-	3.68	0.70	0.95	12.26	1.26	-	0.40
2017	Polyvalent	1.73	0.43	0.775	0.55	0.09	2.43	33.04	0.58	7.35	-
	Trawl	2.71	-	-	2.78	1.12	0.57	12.09	1.41	-	0.46
2018	Polyvalent	0.54	0.19	0.4024	0.20	0.02	1.02	35.40	0.52	4.50	0.00
	Trawl	1.58	-	-	1.07	1.10	0.60	9.66	0.28	-	0.09
2019	Polyvalent	0.49	0.23	0.3601	0.31	0.03	0.49	17.35	0.95	6.25	-
	Trawl	0.63	-	-	0.58	0.44	0.35	6.08	0.02	-	0.66
2020	Polyvalent	0.90	0.14	0.3199	1.37	0.04	0.53	20.72	0.73	2.60	0.10
	Trawl	1.46	-	-	1.51	0.40	0.12	10.54	0.46	-	0.17
2021	Polyvalent	0.62	0.15	0.11	0.48	0.03	0.56	17.33	0.42	1.57	-
	Trawl	2.15	-	-	0.68	1.21	0.61	2.28	0.02	-	0.02
2022	Polyvalent	0.28	0.18	0.10	0.44	0.01	1.02	23.15	0.55	1.18	0.00
	Trawl	1.29	-	-	0.67	0.73	0.59	1.99	0.09	-	0.00

Working Document for the ICES Working Group on Biology and Assessment of Deep-Sea Fisheries Resources

Lisbon, 03rd - 09th May 2023

Scabbard fish in the Madeira archipelago (CECAF 34.1.2)

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Abstract

This working document updates the information existing from the previous WGDEEP meeting of 2022 for the *Aphanopus* spp. in CECAF fishing area 34. Mainly an update on the time-series of annual Portuguese landings (by vessel segment), length distributions and unstandardized CPUE at CECAF area. A standardized biomass index series based on daily landings of commercial horizontal mid-water drifting longline fishery in Madeira was also updated with data from 2022.

1. INTRODUCTION

The fishery for deep-water species carried out in the Madeira EEZ and international adjacent waters (CECAF 34.1.2. area), dates back to the 17th century (Merrett and Haedrich, 1997) and for several decades this was the only fishery targeting scabbard fish in the Northeast Atlantic (Bordalo-Machado and Figueiredo, 2009). This fishery as an important and irreplaceable economic and social value in the Madeira fisheries sector. In Madeira, exploited deep-water fish stocks are overwhelmingly dominated by two scabbard fish species: *Aphanopus carbo* Lowe 1839 and *Aphanopus intermedius* Parin, 1983, which represent about half of the overall landings throughout the year (Delgado et al., 2013, 2018; Hermida and Delgado, 2016). This deep-sea fishery targeting the black and intermediate scabbard fish, off the Madeira archipelago, is recognized as an artisanal and selective activity targeting predominantly adult individuals and presenting a low rate of bycatch (Severino et al., 2009).

Both scabbard fish species occur at a wide depth range, from 200 m in the northern part of the NE Atlantic (Nakamura and Parin, 1993) to 2300 m off the Canary Islands (Pajuelo et al., 2008) for *A. carbo*, although more frequent at 800-1300 m in Madeira (Morales-Nin and Sena-Carvalho, 1996) and to 1350 m for *A. intermedius* (Delgado et al., 2013). *Aphanopus carbo* and *A. intermedius* seem to be adapted to a strong activity of migrating upwards at night to feed on crustaceans, cephalopods, and fishes (Tuset et al., 2010). Furthermore, these two sympatric species move to reproduction areas off Macaronesian archipelagos (i.e., Madeira and the Canary

Islands) and the northwest coast of Africa (Figueiredo et al., 2003; Pajuelo et al., 2008; Perera 2008; Farias et al., 2013). The spawning season of both *Aphanopus* species has been reported to take place from October to December (Figueiredo et al., 2003; Delgado et al., 2013).

The black and intermediate scabbard fish fishery represents one of the most profitable commercial activities on small-scale fisheries in Madeira archipelago. In 2022, the commercial landings in weight of *Aphanopus* spp. reached annual catches of up to 2259 tonnes yielding a total first sale value of approximately 7.5 M€.

WGDEEP does not assess fisheries in Madeira (Eastern Central Atlantic area, CECAF) or in other areas outside the ICES area. Nonetheless, it is admitted that the incorporation of reliable CECAF data could provide a wider perception of the stock dynamics of these migratory species in the northeast Atlantic.

1.1. Fishery in Madeira

In compliance with the Multiannual Union Programme for Data Collection (EU-MAP), the Madeira fishing fleet targeting the deep-water species, *A. carbo* and *A. intermedius*, uses a specialized fishing gear with longlines (LLD_DWF_0_0_0). The fishing gear is a mid-water horizontal drifting longline, set in the water column usually at depths of between 800 and 1300 m (Figure 1).

The fishing gear used to catch the scabbardfishes is a drifting longline always set at least more than 100 m above the bottom of the sea. This is an important aspect of the fishery as, in normal circumstances, the gear does not contact the sea floor thus is not a menace to hypothetical Vulnerable Marine Ecosystems (VME).

This fishery is known by its highly selective nature, concerning the bycatches of non-target species and the length structure of the catches of the targeted species – constituted almost exclusively by adult specimens over 90 cm total length. The catches of sub adult individuals scarcely achieve around 0.5% of the total number of individuals captured.

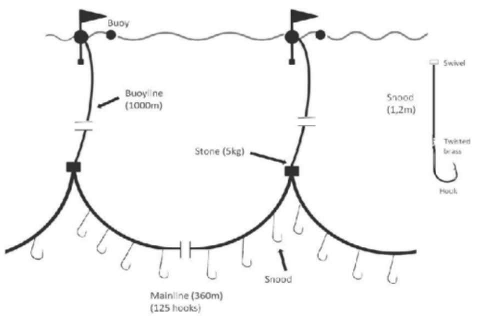

Figure 1 – Mid-water horizontal drifting longline used by the Madeira fishing fleet.

There is a combination of prevailing factors that result in a fishery with such unique features. Such factors are the geographical area of the fishery, where, according to the migratory model proposed by Farias et al. (2013), only adult specimens are available to this type of fishery and the highly selective nature of the fishing methodology itself, namely the fact that the passive fishing gear is operated strictly within a depth layer of the water column, between 800 and 1300 meters deep, without being anchored, and always well above the seafloor. The gear aims to catch the black scabbard fish in its daily vertical migration to feed, thus minimizing the probability of capture of benthic bycatch species.

This fishery, carried out by the fishing vessels targeting the black and intermediate scabbard fish registered in Madeira, which was traditionally performed mostly around the islands of Madeira and Porto Santo and the seamounts inside the Madeira EEZ, has undergone considerable geographic expansion in recent decades in the Northeast Atlantic, mostly from 2005 onwards, and initiated a process of expansion looking for new fishing areas (Figure 2). Progressively, new fishing grounds located in international waters SE of the Azores, off the Canaries and the "rediscovery" of the seamounts within the Madeira EEZ became indispensable for this fishery and bilateral agreements with the Azores and the Canaries were made to allow the fleet access to those areas.

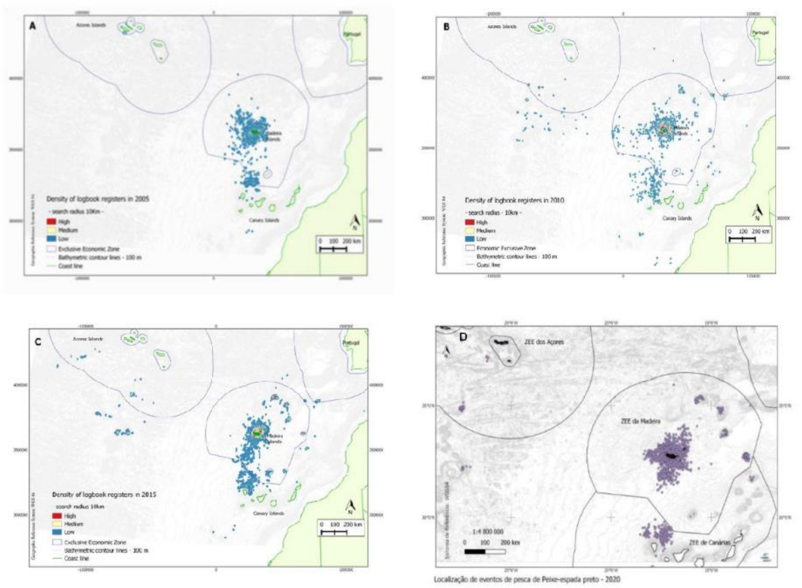

Figure 2 - Density plots illustrating the geographical distribution of the fishing sets with catches in 2005 (A), 2010 (B), 2015 (C) and 2020 (D): density maps estimated with the software Quantum GIS 2.2, module "heatmap" covering a search radius of 10 Km (Regional Directorate of the Sea - Madeira).

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 and intermediate scabbard fish have moved to new fishing grounds, some of them located outside the EEZ of Madeira (SE of the Azores and off the NW of the Canaries) (Figure 2).

From 2019 to the present, most of fishery targeting the black and intermediate scabbard fish have been carried out within the Madeira EEZ. However, the fishing grounds off the Northwest of Canaries continues to be a relevant fishing area for the Madeira fishing fleet, due to the availability of black and intermediate scabbard fish and the lack of interest in these species by the Canary fishing fleet, which makes profitability the capture of them by the fishing fleet from Madeira. The capture of *Aphanopus* spp. in the Azores fishing grounds by the fishing fleet from Madeira has been decreasing since 2015. According to the fishermen fishing in Azores is not profitable due to the distance between Madeira and Azores.

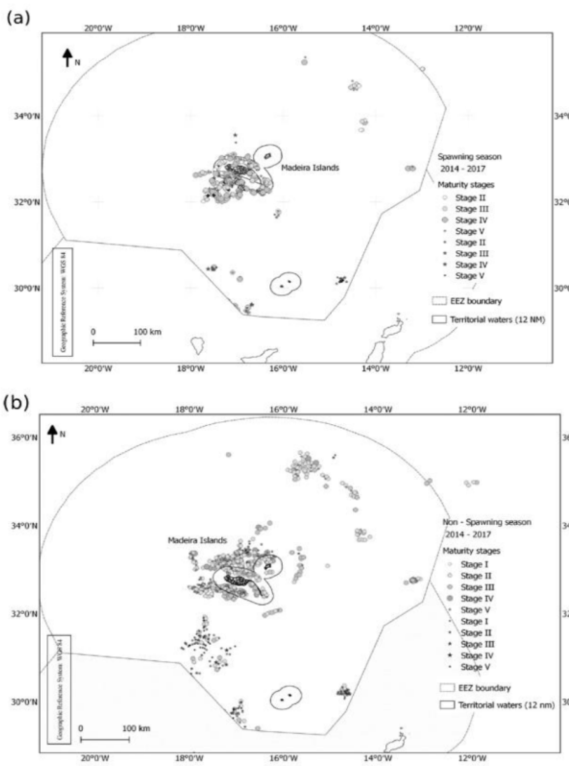

Figure 3 - Map showing both *Aphanopus* species distribution, *A. carbo* (grey circles) and *A. intermedius* (grey stars), during spawning (a) and non-spawning (b) seasons according to the distance from the coast (<12 and >12 nautical miles; 1 n.m. = 1.852 km) (Vasconcelos et al., 2020).

The enlargement of the maritime area covered by the fishing operations was prompted by the decrease of the abundance of the resource in the traditional fishing grounds, near the islands of Madeira and Porto Santo. And also due to the improvement of the fishing fleet of Madeira verified in the last years. This search for new fishing grounds was driven by the need to stabilise catches that suffered a severe decline from 2000 onwards. A relative stabilisation of the fishery was achieved in the last years but the enormous increase in the costs led several vessels to leave the activity.

Though, most of the *Aphanopus* spp. fishery still remains concentrated off the islands of Madeira and Porto Santo, especially during the spawning season from October to December, mainly the fishery operated by the small vessels (< 12 m). Migrations to areas less than 12 n.m. from the coast, were observed for *A. carbo* throughout the spawning season (Figure 3) (interannual database from 2014-2017; Vasconcelos et al., 2020). The mature stages IV and V were the ones that overwhelmingly dominated this migration pattern to shallower areas. This migration of mature adults towards areas near the coast, especially during spawning, occurs simultaneously with a noticeable increase of the proportion of fishing events inside the EEZ (<12 n.m.), making them more susceptible to mid-water drifting longline fishery (Vasconcelos et al., 2020).

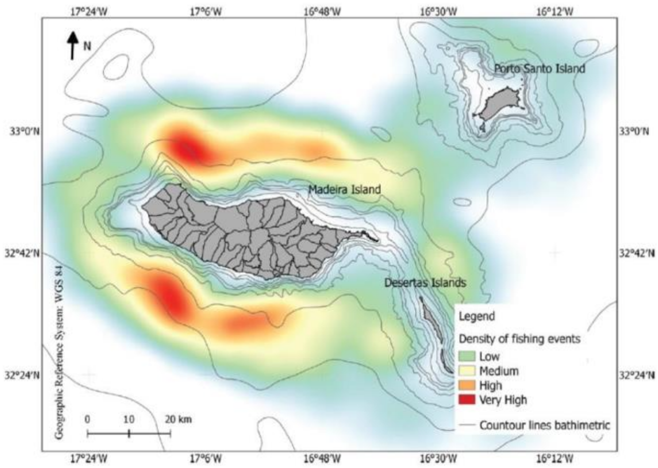

Figure 4 - Kernel density estimation plot showing the mean density values of the fishing events during the spawning season per compartment of 10 km × 10 km generated for the study area and for the period 2014–2017. Low: 1–10; Medium: 11–20; High: 21–30; and Very High: >31 fishing events (Vasconcelos et al., 2020).

There are three main aggregation areas identified off Madeira (Figure 4), where fishing events occurs during spawning, mainly the fishing grounds from Câmara de Lobos and Ribeira Brava at the south coast of Madeira and Porto do Moniz-Seixal at the north coast (Vasconcelos et al., 2020). The fishing grounds are located at an average distance of 2 to 4 n.m. offshore, although the same depths are found over a wider range of 3 to 6 n.m. offshore (Vasconcelos et al., 2020). Most likely, these areas correspond to areas with environmental and sea bottom topography that favour reproduction, as these areas generally correspond to canyons where there are prominent folds in the bathymetry towards the coast and its nearby steep slopes. These represent very closed geological formations with the dimension of extensive canyons, probably protected from strong currents and where high densities of spawning individuals aggregate, facilitating high probability of successful external fertilization (Vasconcelos et al., 2020).

2. METHODS

2.1. Fishery dependent data

2.1.1. Landings and mean price in Madeira archipelago

Portuguese total landings of *Aphanopus* spp. in CECAF area 34 (in weight, ton, and value, euro) were analysed by year. Fishery dependent data were collected from commercial landings for the period between 1990 and 2022.

2.1.2. Landings and mean price in Madeira archipelago by vessel length category

Portuguese landings of *Aphanopus* spp. in CECAF area 34 (in weight, tonnes, and value, euro) were analysed by year and by fishing vessel segment (vessel length category). Fishery dependent data were collected from commercial landings for the period between 2008 and 2022. The active fishing fleet at CECAF area is grouped into the following categories: VL0010 (vessel size less than 10 m), VL1012 (vessel size between 10 and 11.99 m), VL1218 (vessel size between 12 and 17.99 m) and VL1824 (vessel size between 18 and 23.99 m).

2.2. Length distribution

Aphanopus spp. length sampling data available for Madeira were analysed considering both species combined by year for the period between 2009 and 2022. Numbers-at-length were raised to the total landings.

2.3. CPUE

All landings from the commercial mid-water drifting longline fishery at all the fishing ports of Madeira (mainly port of Funchal), in the Northeast Atlantic (32°00′–33°30′N, 15°30′–18°00′W) were considered for this analysis, during the period between 2008 and 2022. From each fishing trip data on total weight landed of the species (in kg), vessel name and corresponding length category, engine power (KW), number of days at sea, number of fishing days and fishing operations, and the total number of hooks were examined. A trip was defined from the moment the vessel leaves the dock to when it gets back to the dock.

The standardized CPUE model based on daily landings of commercial mid-water horizontal drifting longline fishery in Madeira was updated with data from 2022.

3. RESULTS AND DISCUSSION

3.1. Fishery dependent data

3.1.1. Landings and mean price in Madeira archipelago

The annual landings of black and intermediate scabbard fish derived from Madeiran mid-water longliners for the period between 1990 and 2022 are presented in Figure 5.

Catches in CECAF 34 area were updated with fishery data from Madeiran mid-water longliners landings from 1990 to 2022. These catches are recorded by the Regional Fisheries Department of Madeira (Figure 5). CECAF catches have been decreasing after the 1998 peak, but an increase was observed from 2012 onwards. Between 2020 and 2021 a decrease was observed mainly due to the reduction in fishing days caused by the COVID-19 pandemic. In 2022, an increase of 386 tonnes was observed when comparing with 2021.

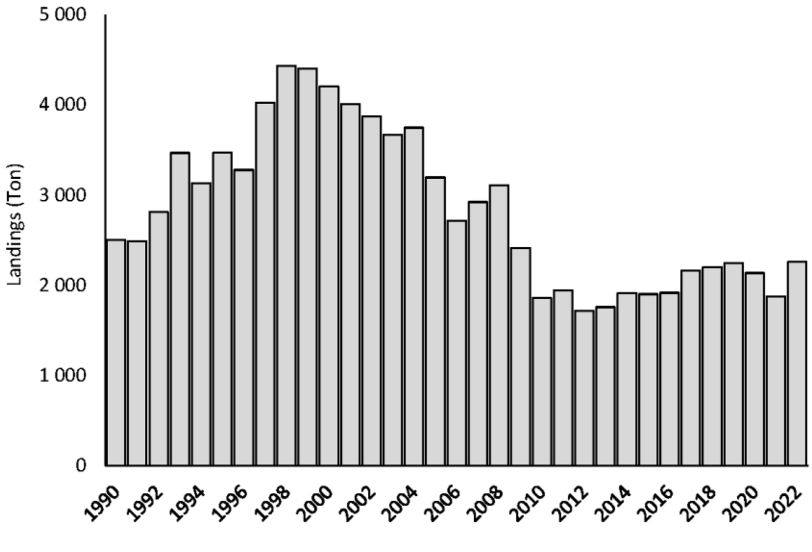

Figure 5 - Time-series of annual Portuguese landings of *Aphanopus* spp. at CECAF area (1990-2022).

The EU TAC and total catches for CECAF 34 area from 2005 to 2022 are presented in Table 1. It was observed a relevant decrease in the EU TAC for the *Aphanopus* spp. fishery in CECAF 34.1.2, from 4285 tons in 2005 to 2259 tons in 2022.

Table 1 - Black scabbard fish TACs and total landings in CECAF area 34, between 2010 and 2022, for both species (*Aphanopus carbo* and *Aphanopus intermedius*).

Year	EU TAC CECAF 34.1.2 area	Landings CECAF 34.1.2. Area
2005	4 285	3 195
2006	4 285	2 717
2007	4 285	2 922
2008	4 285	3 109
2009	4 285	2 413
2010	4 285	1 860
2011	4 071	1 941
2012	3 867	1 716
2013	3 674	1 758
2014	3 490	1 913
2015	3 141	1 902
2016	2 827	1 917
2017	2 488	2 163
2018	2 189	2 199
2019	2 189	2 246
2020	2 189	2 136
2021	2 189	1873
2022	2 189	2259

Following the methodology adopted at WGDEEP 2016 (ICES, 2016), standardised annual catch estimates for the period from 1990 to 2022 of the nineteen fishing 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 DSEIMar/DRM database (Figure 6).

The results do not support that given the diversity of species, which includes different taxonomic groups, lifestyles and both short- and long-lived organisms, the declining trends are reflecting changes on resources abundance which may imply that Madeiran waters are subject to severe over-exploitation. Further studies and a careful interpretation of trend variations of some resources are still required. It may happen that in some cases landing trends are not only related to the resources' abundance in Madeiran waters, but subject to other factors like variations on the market regulation (e.g. small pelagic fishery), environmental, application of TAC's and quotas, among others.

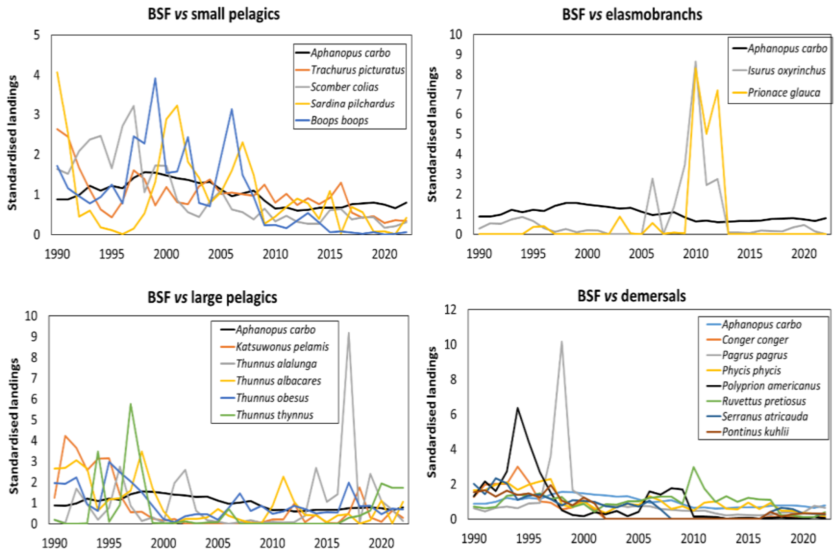

Figure 6 - Trends in standardised landings of scabbard fishes and the 19 other top ranked species in Madeiran landings.

The first sale value of *Aphanopus* spp., in millions of euros, for the period between 2008 and 2022 is presented in Figure 7. This value followed the same trend observed in the annual landings in terms of weight. The reduction in the economic value observed in 2020 and 2021 is related to the decrease in effort due to COVID 19 Pandemic. In 2022, the total first sale value achieved 7.5M€, increasing 1.7M€ in relation to 2021.

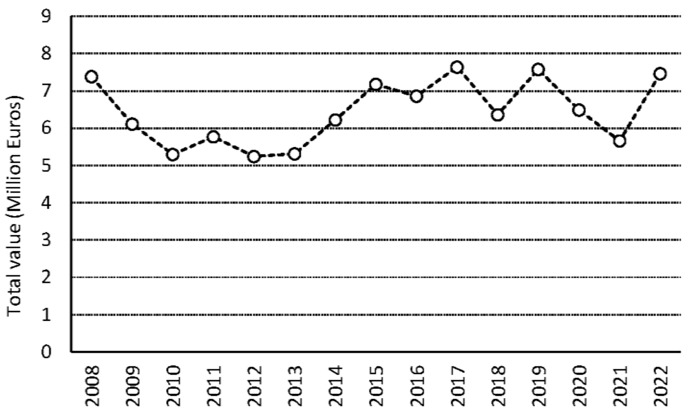

Figure 7 – Economic value of the catches of *Aphanopus* spp., in millions of euros, for CECAF 34.1.2., between 2008 and 2022.

3.1.2. Landings and mean price in Madeira archipelago by vessel length category

The number of vessels in activity in Madeiran longline fleet has steadily decreased during the last two decades (Figure 8).

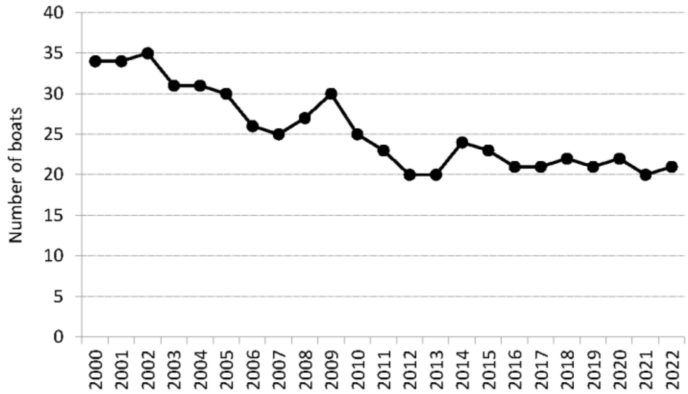

Figure 8 - Number of vessels active in the fishery of *Aphanopus* spp. at CECAF 34.1.2 area between 2000 and 2022.

Though, in the last years, the fishery as achieved a certain stability in the number of active vessels, as the small number of vessels remaining in the fishery are small artisanal vessels (Figure 9). In 2022, 52% of the active vessels were grouped between 12 and 18 m of overall length, thus hardly having operational conditions to make any significant increase in the present total number of hooks used in each fishing set.

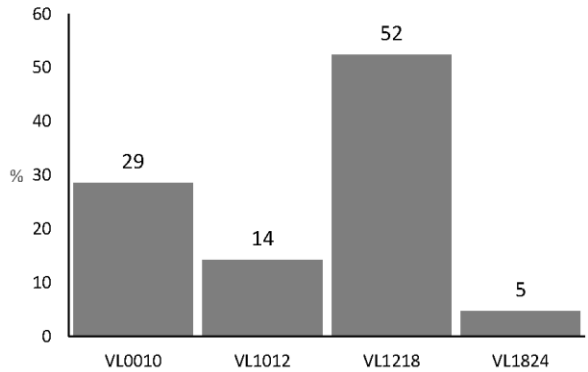

Figure 9 - Composition of the active fleet in the fishery of *Aphanopus* spp. at CECAF 34.1.2 area in 2022 per vessel length category (n=21 vessels).

A time-series of annual Portuguese landings at CECAF 34.1.2 area per vessel length is represented in Figure 10. The majority of the annual landings in Madeira are made by vessels of the length segments VL1218 and VL1824, wherein *ca.* 79% of the total landings in 2022 were captured by VL1218.

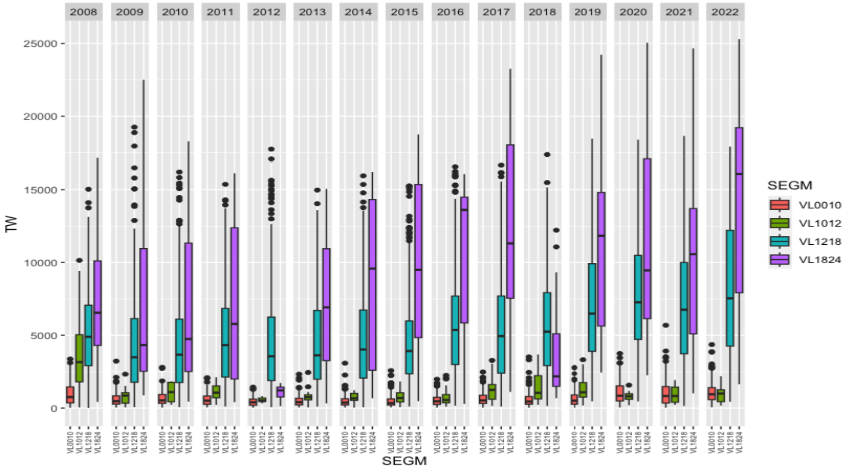

Figure 10 - Time-series of annual Portuguese landings of *Aphanopus* spp. at CECAF 34.1.2 area per vessel length category (SEGM), from 2008 to 2022.

The vessel length category VL1218 presented the highest landing and first sale values, followed by the vessel segment VL1824 (Figure 11). Though the number of vessels in the segment VL1824 represents only 5% of the total active fleet in Madeira, their contribution is higher (*ca.* 12.6%) than both vessel segments VL0010 and VL1012 together (*ca.* 8.5%). In 2022, it was observed an increase in the landings and economic values for all segments being more pronounced in the segment VL1824.

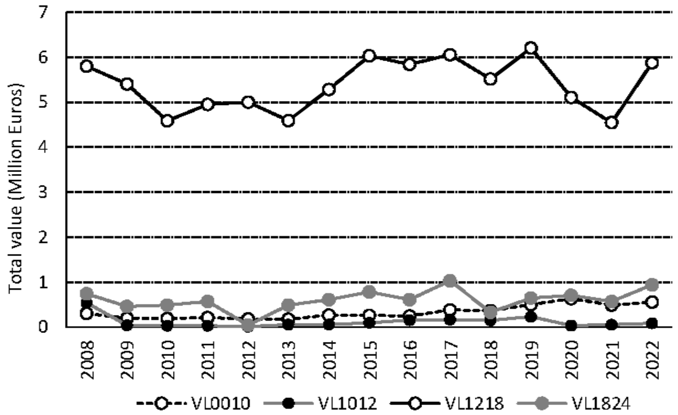

Figure 11 – Economic value of the catches of *Aphanopus* spp., in millions of euros per vessel category between 2008 and 2022.

3.2. Length distribution

The analysis of data indicates neither great changes on the length range between years nor on the mean length (around 114-118 cm total length, TL). From 2010 to 2018 the mean length was between 117 and 118 cm TL, occurring a slight decrease in 2019-2022 (115-116 cm TL).

Annual total length–frequency distributions of the exploited population caught by the Madeiran longline fleet in CECAF 34.1.2 area for the period 2010-2022 are presented in Figure 12. The range of scabbardfish total length varied between 87 cm and 155 cm.

Overall, between 2010 and 2022 there was verified a stability in the composition of lengths and average lengths for scabbardfish species caught by the Madeiran fleet.

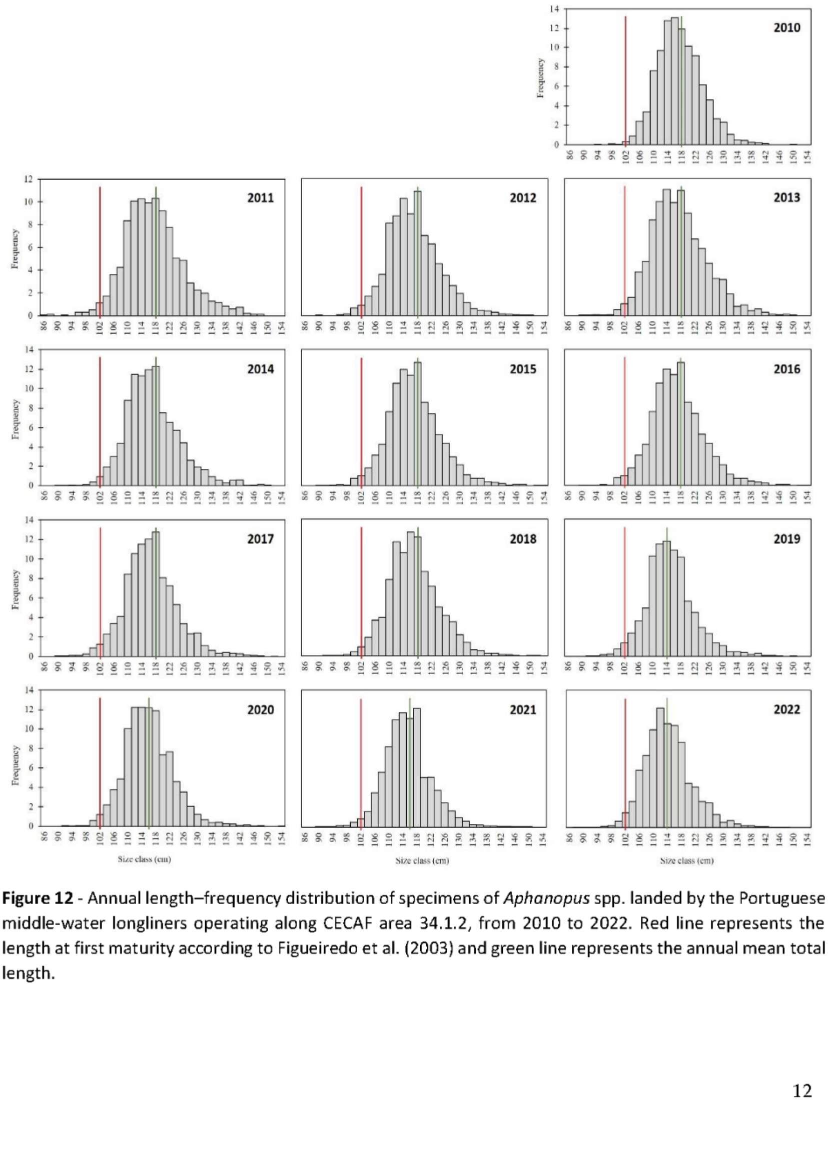

Figure 12 - Annual length–frequency distribution of specimens of *Aphanopus* spp. landed by the Portuguese middle-water longliners operating along CECAF area 34.1.2, from 2010 to 2022. Red line represents the length at first maturity according to Figueiredo et al. (2003) and green line represents the annual mean total length.

3.3. CPUE

Fishing effort in total number of hooks accumulated per year is represented in Figure 13. There was an overall decrease in the available period, reflecting the decline of the number of vessels. The year of 2004 stands for the highest total number of hooks (*ca.* 22.3 M) in the period available, since then effort has declined, and it is rather constant in the last years around 14-11 M hooks per year. In 2022, the total number of hooks was approximately 11.8 M.

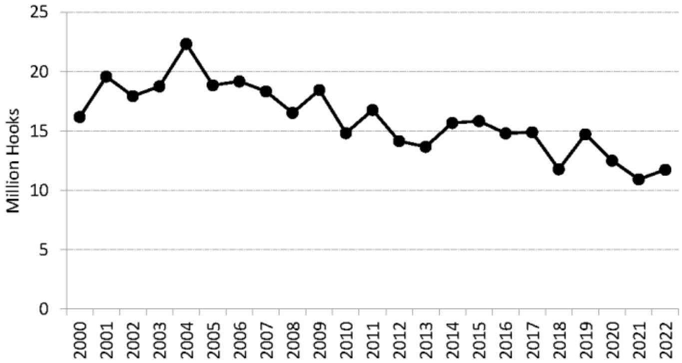

Figure 13 - Time-series of the total annual effort estimated for the CECAF 34.1.2 area (million hooks) for the *Aphanopus* spp. fishery, between 2000 and 2022.

The unstandardized CPUE had an overall decline along the analysed period (Figure 14). The variation observed in the years 2000-2006 was about -45% in CPUE, corresponding to an increase of 16% in the fishing effort. From 2006 to 2008 there was a slight recovery of the landings and of the unstandardized CPUE. The decreasing trend of landings restarted in 2008, but all indicators analysed reached a certain level of stability between 2010 and 2016, and even a recovery was observed since 2020, with an increase of 21 kg/1000 hooks from 2021 to 2022.

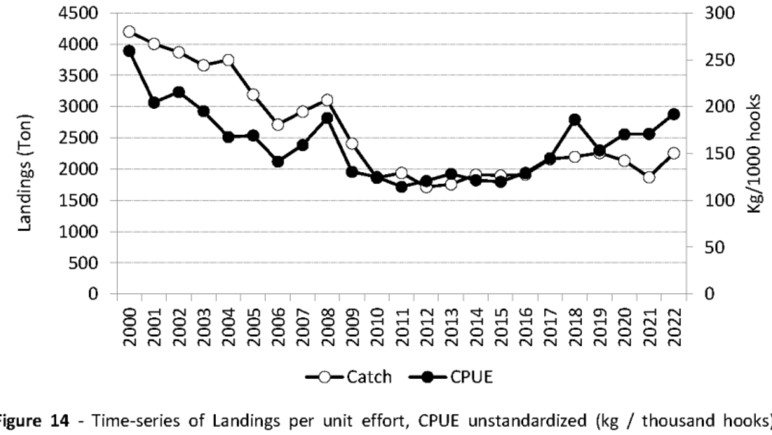

Figure 14 - Time-series of Landings per unit effort, CPUE unstandardized (kg / thousand hooks) of *Aphanopus* spp. in CECAF 34.1.2 area, between 2000 and 2022.

A standardized CPUE model based on daily landings of commercial drifting longline fishery in CECAF 34.1.2 area is being developed for the period of 2008-2022. An exploratory data analysis showed a high correlation between the number of hooks and the number of hauls (Figure 15), but no other variable showed highly correlation with the number hooks per haul.

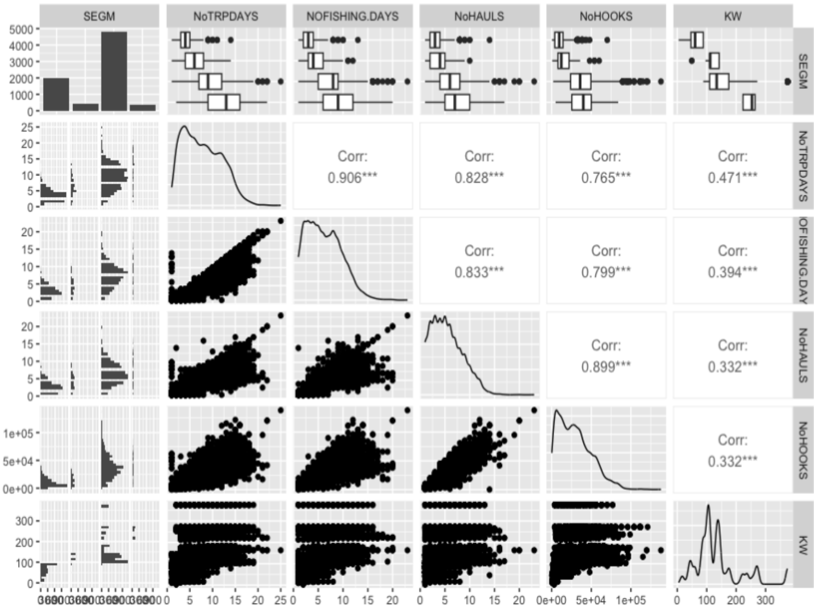

Figure 15 - Exploratory data analysis showing the correlation between the potential variables for the CPUE standardised model of *Aphanopus* spp.

For the period from 2008 to 2022, a standardised CPUE was obtained by adjusting a GLM model based on daily landings of commercial mid-water horizontal drifting longline fishery in CECAF 34.1.2 (Figure 16). The response variable (CPUE) was black and intermediate scabbard fish catches in weight per hook.

The exploratory standardised CPUE data analysis per year and by vessel segment (Figure 16B) showed a recovery in the last five years, especially in the vessel segments smaller than 18 meters, which represents 95% of the Madeira mid-water drifting longline fleet. However, these are just preliminary results and further analysis will be performed.

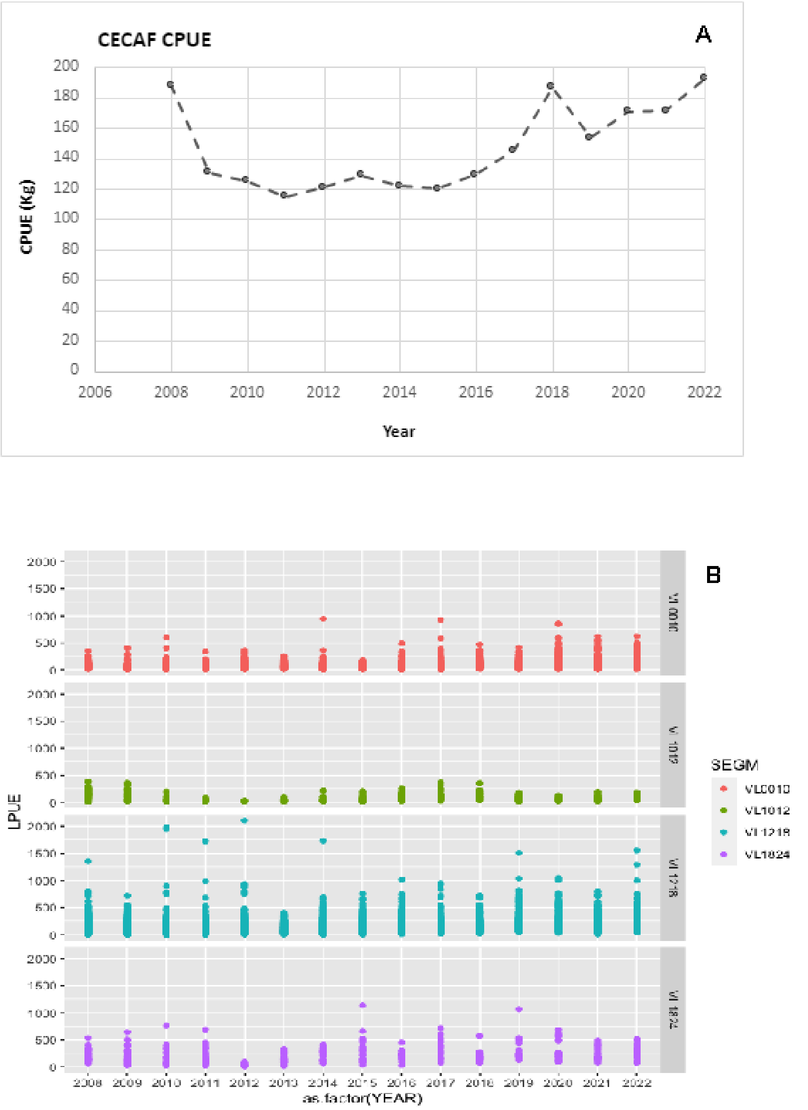

Figure 16 - Time-series of the CPUE (kg/hooks) of *Aphanopus* spp. for all segments combined (A), and standardised CPUE per vessel segment (B).

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Exploratory surplus production models assessment of *Pagellus bogaraveo* **in Subarea 10 (Azores grounds)**

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1. Introduction

Blackspot seabream *Pagellus bograveo* is a sparid fish distributed in the Northeast Atlantic, from south of Norway to Cape Blanc in Mauritania, including Azores, Madeira, and Canary Archipelagos, and the Mediterranean Sea (Froese & Pauly, 2019). This species presents complex life-history and biological dynamics in the face of slow growth, sequential hermaphrodism, and discontinuous essential habitat including coastal areas of the islands and seamounts (Krug, 1990; ICES, 2012). It is considered a deep-water species and, since the stock structure is unknown, three management units have been adopted for assessment purposes in the Northeast Atlantic: (a) Subareas 27.6, 27.7, and 27.8; (b) Subarea 27.9; and (c) Subarea 27.10 (Azores) (ICES, 2007).

The availability and market demand for blackspot seabream to drive the dynamics of the multi-specific demersal, mixed hook, and line fishery in the Azores. Blackspot seabream is the main target species owing to its high selling price (Pinho, 2003; Santos et al., 2019), and ranks first in terms of total landed value in the region (Santos et al., 2020). The status of the stock is uncertain, although recent studies using length-based data-limited assessment suggest being exploited at or above the Maximum Sustainable Yield (MSY) levels (Medeiros-Leal et al., 2023). Consequently, of this historical exploitation, several management measures to limit catch, fishing effort and minimum landing size have implemented along the years (ICES, 2022).

Blackspot seabream stocks can easily be overexploited, as shown by the Bay of Biscay stock collapse in the 1980s (Lorance, 2011). This case was a wake-up call for scientists and fisheries managers to the vulnerability of the species related with the life history traits (protandrous hermaphroditism and late maturity). Surplus production models (SPM) are the only data-limited method that allows for a full assessment of fish stocks. These models provide exploitation and stock status assessment based on MSY reference points and catch forecasts based on alternative scenarios. For this study, were employed two SPMs to assess the stock of blackspot seabream in Azorean waters (ICES 27.10.a.2): 1) Just Another Bayesian Biomass Assessment (JABBA); 2) Stochastic Surplus Production Model (SPiCT).

2. Methodology

2.1. Fishery dependent data

2.1.1. Landings and abundance indeces in Azorean waters.

The data used in this study came from the database of the Department of Oceanography and Fisheries, University of the Azores (DOP/UAz) and were obtained from the Azores Auction Services and collected through fishing inquiries under the DCF. Official landings were recorded from 1985 to 2017 for each fishing trip (n = 3,679,979) and included vessel size, *métier* (*i.e.*, a group of fishing operations targeting a specific assemblage of species, using a specific gear, during a precise period of the year and/or within the specific area; EC, 2008) and catch in kg by species. Between 1990 and 2017, 31,616 fishing inquiries were conducted to harbor-present vessel captains at the moment of landing. These inquiries were undertaken to complete the information for fishing effort and covered all fleet segments, with a focus on those that are not obliged to maintain a logbook (*i.e.*, vessels <10 m in length). Each inquiry included the size of the vessel, the number of days it spent at sea and information about the fishing operation, such as the type of gear used, the average depth at which fishing took place and the catch in kg by species.

LPUE (Kg per landings^{-1} vessel^{-1}) and CPUE (Kg days at sea^{-1} vessel^{-1}) were estimated for blackspot seabream. To reduce the influence of potential drivers (*e.g.*, targeted species, vessel size, fishing gear) on these catch rates, generalized linear models (GLMs) were utilized to calculate standardized abundance indices (Santos et al., 2022; Santos et al., 2023). Details on the procedure for selecting the interactions and explanatory factors that explained most of the variability in the data, model validation and catch standardization can be found in Santos et al. (2022).

2.2. Fishery independent data

2.2.1. Survey derived abundance index.

Survey-derived abundance indices (RPN; individuals per 1000 hooks) were calculated for the period 1996-2019 and came from the Azorean spring bottom longline survey (Pinho et al., 2020). Surveys followed a stratified random design and covered the main islands and major seamounts. To estimate de annual index used in further analysis, were only considered the exploited biomass (LT > 33cm).

2.3. Population parameters

Surplus production models, such as JABBA and SPiCT, are age and size aggregated models that approximate changes in biomass as a function of the biomass of the preceding year, the surplus production biomass, and the removal by the fishery in the form of catch. Somatic growth, reproduction, natural mortality and associated density-dependent process are inseparably captured in the estimated surplus production function that is governed by three parameters: 1) the intrinsic rate of population increase (r); 2) the shape parameter and 3) the unfished equilibrium biomass. However, there is a direct link between age-structured stock parameters and the expected surplus production function, so that stock parameters describing, length-at-age, weight-at-age, maturity-at-age, and selectivity-at-age, natural mortality, and the steepness parameter of the assumed Beverton and Hold SSR can be used to approximate the surplus production (Winker et al., 2020). To estimate the three parameters used as priors in surplus production models were used the R package SPMprior available on github.com/henning-winker/SPMpriors. The life-history parameters used to estimate the priors are presented at Table 1.

Table 1. Input constant parameters used in the age-structured model for blackspot seabream *Pagellus bogaraveo* of the Azores (ICES area 10).

PARAMETERS	VALUE	DEFINITION	OBS.
L_{∞} (cm)	55.12	Asymptotic average maximum length	Medeiros-Leal et al. (2023)
K (year-1)	0.12	Growth coefficient of the von Bertalanffy growth model	Medeiros-Leal et al. (2023)
T_0 (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_{mat} (L_F, cm)	29	Length at size first maturity	Santos et al. (2020)
M	0.3	Natural mortality	Silva et al. (2021)
M/k	1.67	Ratio natural mortality over growth coefficient	Medeiros-Leal et al. (2023)

2.4. Surplus production models

2.4.1. Just Another Bayesian Biomass Assessment (JABBA)

JABBA is a Bayesian state-space surplus production model with a Bayesian framework that reduces uncertainty in the model with reasonable prior information and state-space modelling that estimates both process and observation errors (REF). To reduce the uncertainty of the reference points estimates, sensitivity analysis was performed using priors derived from different steepness (h=0.5 and h=0.6), for five scenarios. Detailed information about each specific scenarios are presented at Table 2.

2.4.2. Stochastic Surplus Production model in Continuous Time (SPiCT)

SPiCT, a stochastic surplus production model in continuous time, incorporates dynamics in both biomass and fisheries, and observation error of both catches and biomass indices (REF). To reduce the uncertainty of the reference points estimates, sensitivity analysis was performed using priors derived from different steepness (h=0.5 and h=0.6), for five scenarios. Detailed information about each specific scenarios are presented at Table 2.

Table 2. Definition of each five scenarios used for the sensitivity analysis (ICES area 10).

Scenario	Definition
1	r + Bmsy/K + All time series
2	r + Bmsy/K + Edit Survey
3	r + Bmsy/K + Edit Survey/CPUE/LPUE
4	r + Bmsy/K + All time series + Uncertainty Catches
5	r + Bmsy/K + Edit Survey/CPUE/LPUE + Uncertainty Catches

3. Results and discussion

3.1.1. Landings and abundance indices (fishery dependent and independent)

Official landings are reported by Azores since 1985. The discard rates are considered negligible because was estimated at 6%, and with a high survivorship that corresponding mortality is likely smaller than 5%. The Azorean landings were TAC constrained from 2013 to 2022 and a decrease of the landings were registered since them (Figure 1).

Pronounced differences in the LPUE after 2000s could indicate that the stock has declined or that productivity of the stocks changed (Figure 1). However, these statements could not be fully accepted, because the LPUE trends indicate a fast and high decline of the productivity after 2000s, meanwhile the CPUE and Survey indices did not follow the same pattern (Figure 1). The most plausible justification for these differences between the three abundance indices is related with changes in the data collection program sample design. Since 2000s the data collection program became the responsibility of the EU Data Collection Framework (DCF), before holding by the Department of Oceanography and Fisheries of University of the Azores. For this reason, was decided to work in further stock assessment analysis with two time-blocs for LPUE indices, the first between 1985-2006 and the second 2007-2017.

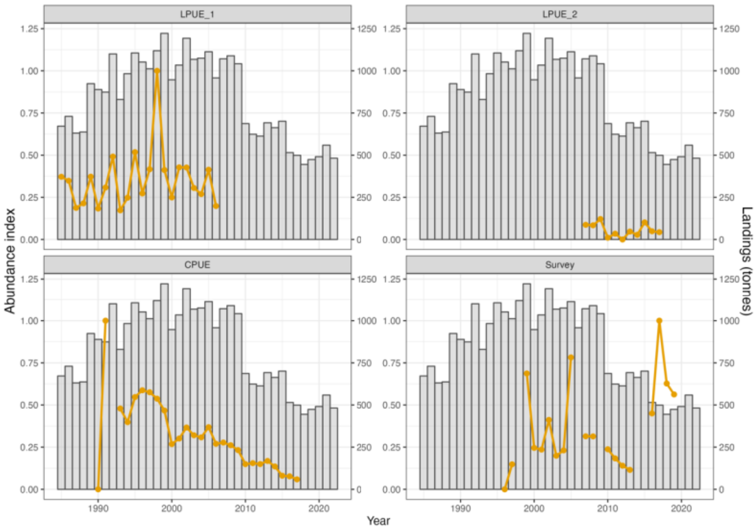

Figure 1. Standardized and scaled to mean LPUE (Kg landings^{-1} vessel^{-1}), CPUE (Kg days at sea^{-1} vessel^{-1}) from the Azorean bottom longline fishery (1985-2017), and exploited biomass (>33 cm) of Annual abundance in number (Relative Population Number) from the bottom longline survey (1996-2019) for blackspot seabream *Pagellus bogaraveo* from the Azorean bottom longline fishery.

3.2. Population parameters

We applied the age-structured stock parameters approach to transform a total of 8 parameters, describing the age-structured and demographics of blackspot seabream, into the surplus production function parameters r and m, which we approximated as function of either exploited biomass (EB_{MSY}) or spawning biomass (SB_{MSY}) (Figure 2). Our results confirmed that the functional of the parameter age-structured yield curve can be closely approximated by the derived parametrization equivalent surplus production curves (Figure 2). The effect of h on r can be inferred from the notable change in central r values for three alternative steepness assumptions (Figure 2).

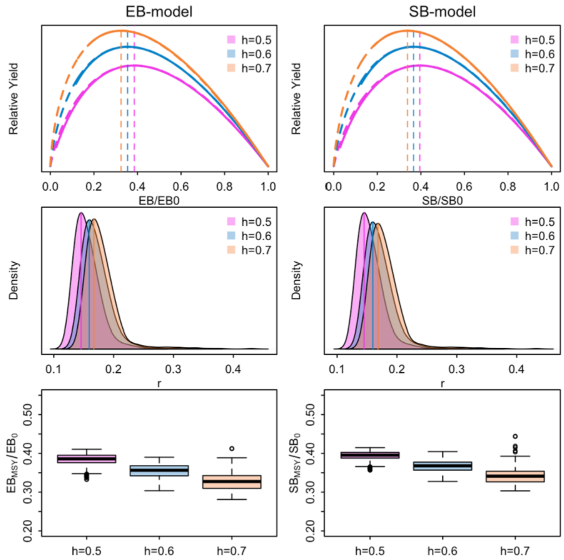

Figure 2. (Top Panel) Showing the functional from of the yield curves produced from the Age-Structured Equilibrium Model (ASME; solid line) and the formulation of the Surplus Production function (solid) as a function of EB/EB0 and SB/SB0 for a range of fixed steepness values of the spawning recruitment relationship(h = 0.5, h = 0.6, h = 0.7) (top panel); (Middle Panel) density distributions of simulated r values from Monte-Carlo simulations based on the EB-model and SB-model; and (Lower Panel) boxplot generated inflection points of EB_{MSY}/EB_0 and SB_{MSY}/SB_0 for each of the fixed steepness h input values.

3.3.3. Surplus production models

3.3.3.1. Just Another Bayesian Biomass Assessment (JABBA)

The sensitivity analysis showed that the reference points results F/F_{MSY}, B/B_{MSY} and MSY were more reliable when the h=0.5 steepness was used. The steepness h= 0.5 also provide an improvement of the residual's diagnostics and retrospectivity analysis (Table 3). Besides that, the scenario 3 model using the h=0.5 presented the best fit of the 10 scenarios and was defined as the base case model, and the next results for the stock assessment purposes are based on this model (Table 3). Results of JABBA model suggests a carrying capacity (K) of 14853 t, a B_{MSY} of 5644 t, F_{MSY} = 0.14 year^{-1} and MSY=811 t for blackspot seabream in Azores. The stock biomass at the end of 2019 was 20% of the B_{MSY} and the fishing mortality was 29% of the F_{MSY}. Biomass presented a continuous decreased period from 1995 to 2010, with a stable period between 2011 to 2015, and a very slight increase since thereafter (Figure 3), while the fishing mortality was above F_{MSY} between 1998 to 2015. The relative biomass (B_{2019}/B_{MSY}) and exploitation level (F_{2019}/F_{MSY}) in 2019 were 0.81 and 0.72 respectively, indicating that the blackspot seabream fishery in the Azores was in a recovering status. The default JABBA plots are shown in Figures

12.4.10. JABBA model presented a good fit of the residual's diagnostics and retrospectivity analysis, and the convergence was achieved (Figure 4).

Table 3. Results of the steepness sensitivity analysis using JABBA model for blackspot seabream *Pagellus bogaraveo* of the Azores (ICES area 10).

		Reference points				Residuals Diagnostics				Retrospective analysis	
Scenarios	Stepness	B/BMSY	F/FMSY	FMSY	MSY	Posteriores	Process dev	Residuals	Runs test	Retro	Hindcast
1	h=0.6	0.88	0.62	0.17	861	Yes	Yes	55.20%	No	Yes	2.47
2	h=0.6	0.87	0.62	0.17	870	Yes	Yes	48.60%	No	Yes	1.88
3	h=0.6	0.80	0.70	0.17	839	Yes	Yes	45.80%	No	Yes	3.88
4	h=0.6	0.92	0.58	0.17	963	Yes	Yes	48.80%	No	Yes	2.48
5	h=0.6	0.76	0.73	0.17	930	Yes	Yes	45.80%	No	Yes	3.85
1	h=0.5	1.14	0.49	0.15	848	Yes	Yes	45.80%	No	Yes	2.5
2	h=0.5	0.84	0.7	0.14	811	Yes	Yes	36.80%	No	Yes	5.06
3	h=0.5	0.84	0.7	0.16	778	Yes	Yes	34.80%	Yes	Yes	5.72
4	h=0.5	0.89	0.65	0.14	814	Yes	Yes	38.60%	No	Yes	2.53
5	h=0.5	0.83	0.7	0.14	890	Yes	Yes	36.90%	Yes	Yes	5.67

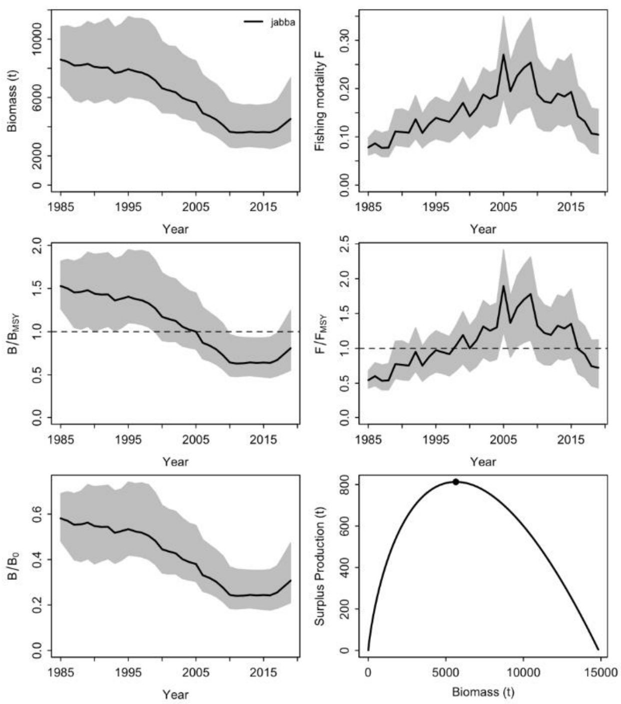

Figure 3. Basic results of JABBA model for the blackspot seabream *Pagellus bogaraveo* from the Azores using standardized CPUE, LPUE and Survey data (ICES, 10.a.2).

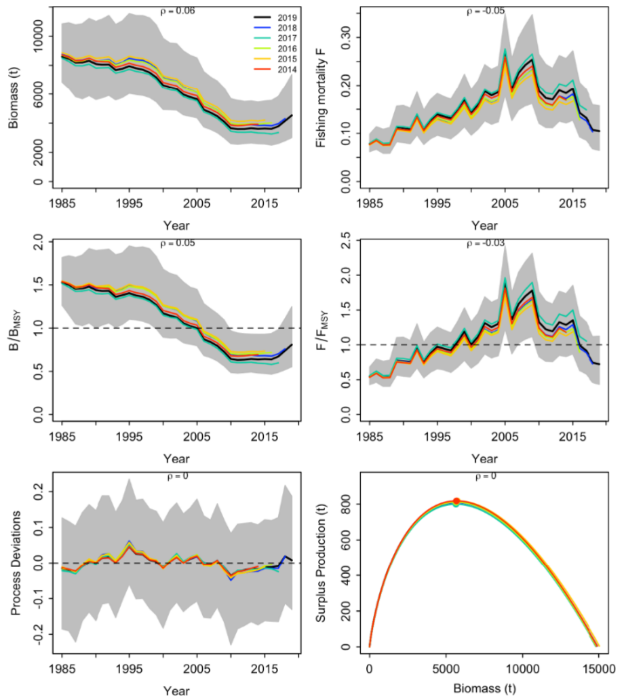

Figure 4. Retrospectivity analysis from JABBA model applied to the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

3.3.3.2. Stochastic Surplus Production model in Continuous Time (SPiCT)

The sensitivity analysis showed that the reference points results F/F_{MSY}, B/B_{MSY} and MSY were more reliable when the h=0.5 steepness was used. The steepness h= 0.5 also provide an improvement of the residual's diagnostics and retrospectivity analysis (Table 4). Besides that, the scenario 3 model using the h=0.5 presented the best fit of the 10 scenarios and was defined as the base case model, and the next results for the stock assessment purposes are based on this model (Table 4). Results of SPiCT model suggests a carrying capacity (K) of 13061 t, a B_{MSY} of 4378 t, F_{MSY} = 0.17 year^{-1} and MSY=753 t for blackspot seabream in Azores. The stock biomass at the end of 2019 was 22 % of the B_{MSY} and the fishing mortality was 12% of the F_{MSY}. Biomass presented a continuous decreased period from 1999 to 2010, with a stable period between 2011 to 2015, and a very slight increase since thereafter (Figure 5), while the fishing mortality was above F_{MSY} until 2015. The relative biomass (B_{2019}/B_{MSY}) and exploitation level (F_{2019}/F_{MSY}) in 2019 were 0.78 and 0.85 respectively, indicating that the blackspot seabream fishery in the Azores was in a recovering status. The default SPiCT plots are shown in Figures 12.4.12. SPiCT model presented a good fit of the residual's diagnostics and retrospectivity analysis, and the convergence was achieved (Figures 6 and 7).

Table 3. Results of the steepness sensitivity analysis using JABBA model for blackspot seabream *Pagellus bogaraveo* of the Azores (ICES area 10).

		Reference points				Residuals Diagnostics				Retrospective analysis	
Scenarios	Stepness	B/BMSY	F/FMSY	FMSY	MSY	Posteriores	Process dev	Residuals	Runs test	Retro	Hindcast
1	h=0.6	1.5	0.07	0.22	1033	Yes			No	No	2.5
2	h=0.6	1.41	0.35	0.23	992	Yes			No	No	5.06
3	h=0.6	0.88	0.73	0.21	783	Yes			Yes	Yes	5.72
4	h=0.6	1.4	0.33	0.23	1136	Yes			No	No	2.53
5	h=0.6	0.88	0.73	0.21	861	Yes			Yes	Yes	5.67
1	h=0.5	1.14	0.49	0.15	848	Yes			No	Yes	2.5
2	h=0.5	1.07	0.52	0.15	849	Yes			No	Yes	5.06
3	h=0.5	0.72	0.91	0.16	752	Yes			Yes	Yes	5.72
4	h=0.5	1.03	0.55	0.15	923	Yes			No	Yes	2.53
5	h=0.5	0.83	0.7	0.14	890	Yes			Yes	Yes	5.67

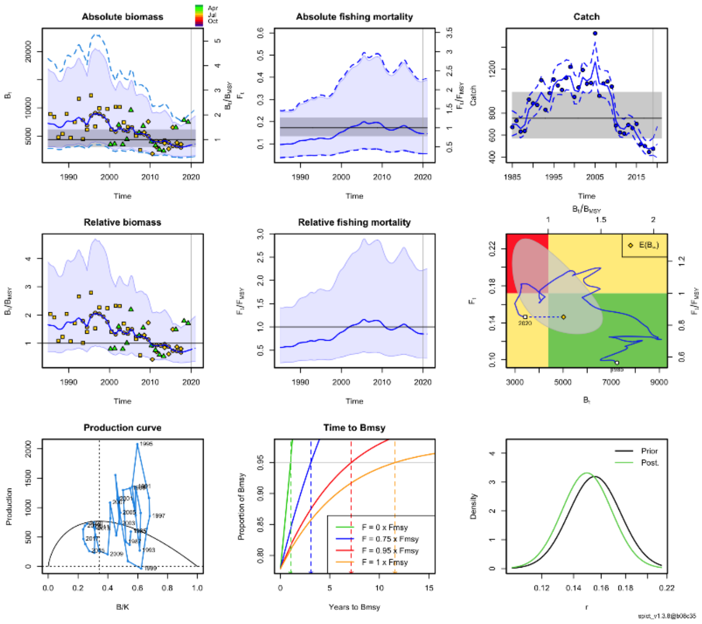

Figure 5. Basic results of SPICT model for the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

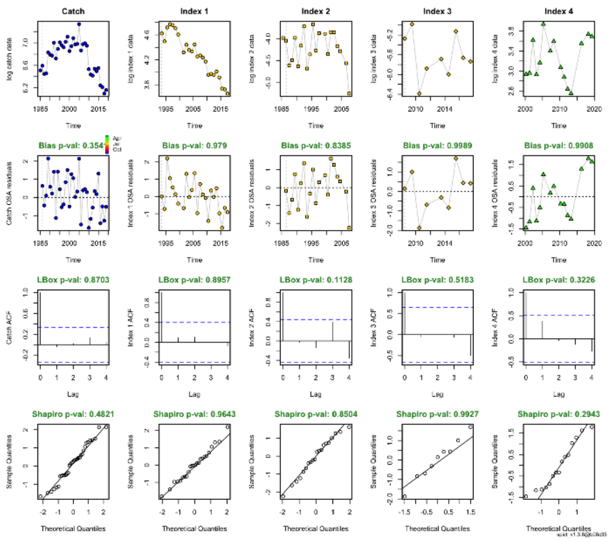

Figure 6. Residual results from SPICT model applied to the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

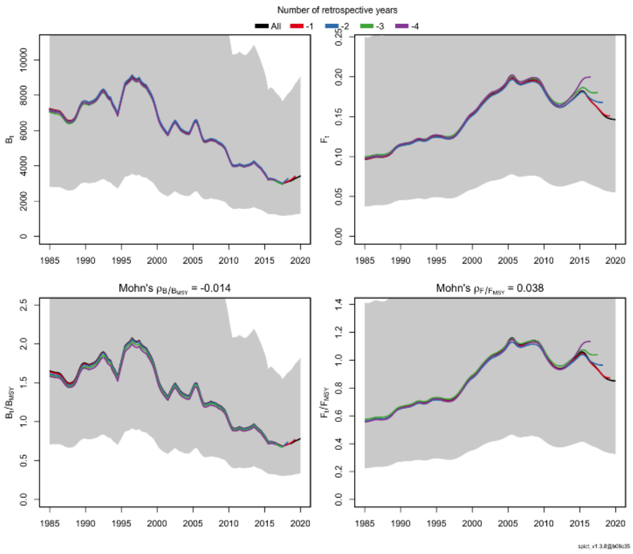

Figure 7. Retrospectivity analysis results from SPICT model applied to the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

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The development of the Norwegian longline fleet's fishery for ling, tusk and blue ling during the period 2000-2022

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Introduction

Ling, tusk and blue ling were fished by Norway for centuries, and the amount landed has been recorded since 1896 (Figure 1). The major catches of these species are taken by longliners, and the catches are to a large degree bycatches. The fishery for these species is influenced by the size of various quotas for other species, especially the quota for Arcto Norwegian cod. Therefore, total catch may not be a good indicator of the condition of these stocks (Figure 2).

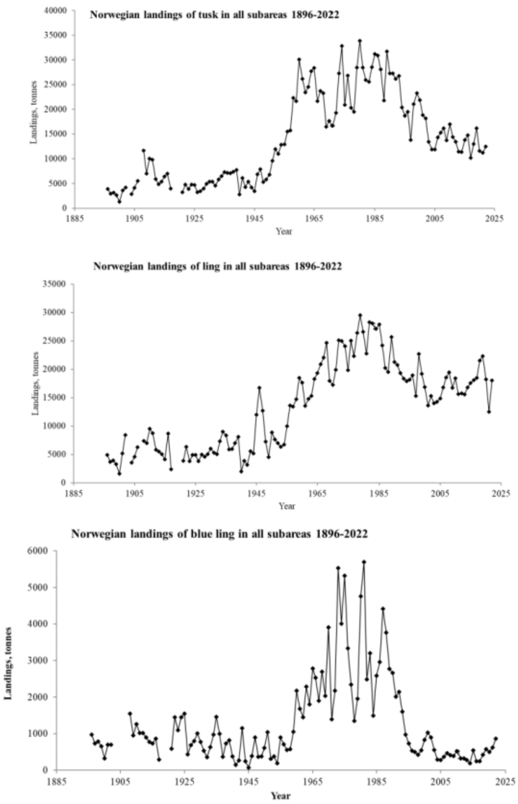


Figure 1. Reported Norwegian landings of tusk, ling and blue ling for the period 1896 -2022.

Scientific surveys do not cover the main habitats of ling, blue ling and tusk. Therefore, these stocks need to be monitored based on commercial data. One possible way to track their abundance, based only on commercial data, would be to develop a catch per unit of effort series for the fishery. But again, the major challenge for any cpue series: It is easy to generate a cpue series, and it is difficult to determine if the series track abundance.

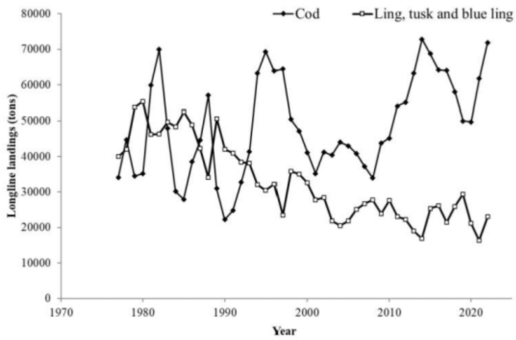


Figure 2. Total landings by longliners of cod (diamonds) and the combined total landings of ling, tusk and blue ling (open squares) for the period 1977- 2022.

Development of the Norwegian fleet of longliners, 1977- 2022

In addition to data on total landings*, the Norwegian Directorate of Fisheries (NDF) provides data on number of fishing vessels participated in the fishery, the gear employed, areas fished and changes in vessel ownership. In Table 1 are the number of long liners during the period 1977 to 2022, the total landed catch by the fleet, and the average annual catch per vessel. The number of vessels increased from 36 in 1977 to a peak of 72 in 2000, and after that the number decreased to 25 in 2014-2017, the last few years the number of vessels has stabilized at 26 vessels fishing more than 8 tons ling, tusk and blue ling.

The number of vessels declined mainly because of changes in the law concerning the quotas for cod. The decrease in the number of vessels was accompanied by a decrease in total catches until 2004; afterwards, the landings have been varying but stable (Figure 3a). The catch-per-vessel was stable from 1980 until 2003. In the period 2003- 2019 there was a steady increase in catch-per-vessel with a sharp decrease in 2021 followed by an increase in 2022 (Figure 3b).

* The data provided by the NDF are; the total landed catch, the logbook data, and the catch along with its location.

In 2012 new regulations were initiated and the number of cod quotas for each vessel increased from 3 to 5. This caused a further reduction in the number of long liners; from 36 in 2012, to 25 in 2015 to 2018. In 2022 there were 26 vessels.

a) b)

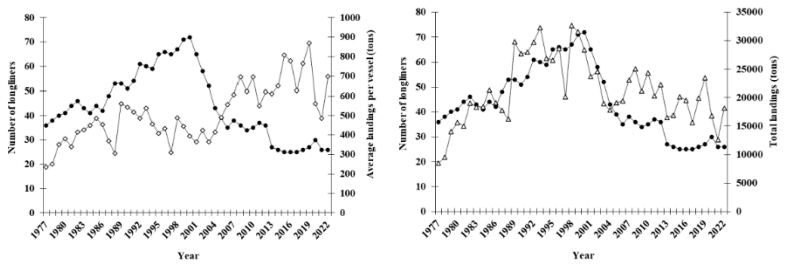


Figure 3. a) The number of long liners (filled circles) and the average landings per vessel of ling and tusk (open diamonds) in the period 1977-2022 and, b) the number of longliners and the total landings of ling and tusk (open triangles).

Logbooks

All available logbooks for the years 2000-2022 are now in the database, and the data have undergone extensive quality control procedures. The data for 2010 is incomplete because of problems getting some of the logbook data, both for the paper logbooks and for the electronic logbooks. In 2010, electronic logbooks were implemented for the longline fleet. The Norwegian Directorate of Fisheries has received the data, but because of lack of quality control, the 2010 data will not be released. Some fishers did not send paper logbooks because they had delivered the data electronically. Because of this, logbooks from only 11 of 35 vessels are available for 2010. The quality of the logbooks varies considerably, and a serious problem is that some lack information on the number of hooks used per day. The data from 2011 are almost complete with data from 35 of 37 vessels. In 2012 to 2022 all logbooks are available, though some days have been deleted due to punching errors.

Days in the fishery

The Norwegian longline logbooks provide information on the geographical distribution of the fleet. In Table 2 are the average number of days a vessel spent fishing for tusk, ling and blue ling, jointly or separately, for all ICES Subareas and Divisions. After 2000, when new quota regulations for cod were introduced, the number of days each vessel fished for three-deep-water species increased, and by 2005 the number of days in the fishery was twice that was in 2000. The data for 2006 show that the number of days in the fishery has decreased by more than 20 percent compared with 2005 and 2007. The data was checked for errors, but none were discovered. The number of fishing days has trended downward since 2007, most likely because of the record large stock of Arcto Norwegian cod. This trend changed dramatically in 2019 when the number of fishing days per vessel increased from 134 days in 2018 to 192 days in the tusk fishery and in the ling fishery it changed from 94 in 2018 to 125 in 2019. However, in 2020 the total number of fishing days had declined to 147.

Division 2a has been the main fishing grounds since 2000, followed by 4a and 5b (Table 2).

Average number of hooks per day

Table 3 are estimates of the average number of hooks used per day in each ICES area and in the total fishery for the 2000-2022. For all areas combined, there was a steady increase in the number of hooks used from 2000 through 2009. This is also the general trend for subareas (Figure 4). The combined time series for 1972-1994 (Bergstad and Hareide, 1996) and the series based on data from 2000-2012 show that the average number of hooks has increased from 10 000 hooks per day in 1972 to around 39 000 in 2022 (Figure 6).

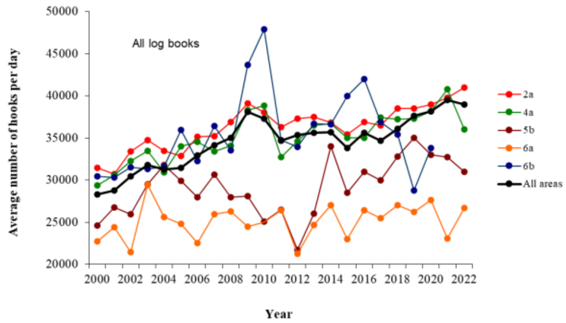


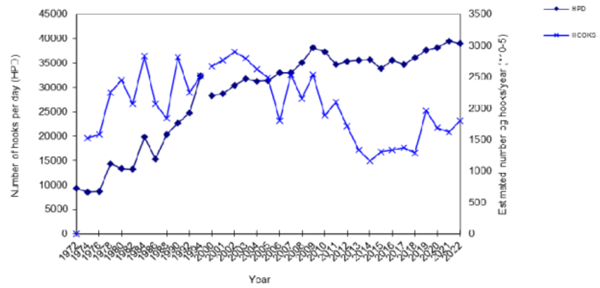
Figure 4. Average number of hooks the Norwegian longliner fleet used per day in each of the ICES subareas and in the total fishery for the years 2000-2022 for the fishery for tusk, ling and blue ling.

Total number of hooks per year

Based on the number of vessels, the number of hooks per day, and the number of days each vessel participated in the fishery, estimates of the total number of hooks used per year were generated (Tables 1, 2 and 3). Table 4 and Figure 5 show the estimated number of hooks (in thousands) set in each of the ICES subareas and in the total for all areas for the years 2000-2022 During the period 1974 to 2013 the total number of hooks per year has varied considerably, after this the number of hooks per year have been stable but with an increase from 2019 and 2021 (Figure 6).

The total number of hooks per year considers; the number of vessels, the number of hooks per day, and the number of days each vessel participated in the fishery, may be a suitable measure of tracked applied effort. Based on this measure of effort, it appears that the average effort for the years 2011-2021 is 40% less than the average effort during the years 2000-2003.

a.



b.

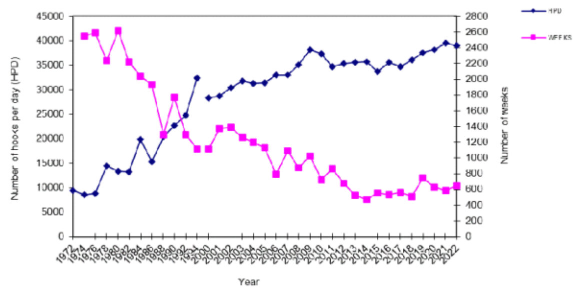


Figure 5. The combined time series for 1972-1994 (Bergstad and Hareide, 1996) and the series based on data from 2000-2022: a) The numbers of hooks used per day, and the total number of hooks used per year; b) The numbers of hooks used per day, and the total number of weeks the long liners participated in the fishery for ling and tusk.

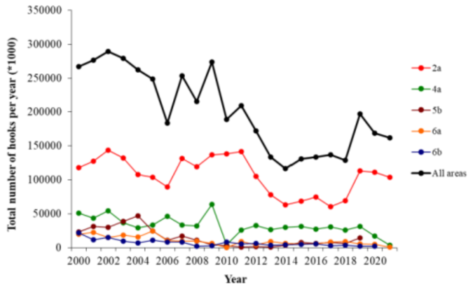


Figure 6. Estimated total number of hooks (in thousands) the Norwegian longliner fleet used in the ICES subareas with highest catches and in the total fishery for the years 2000-2022 for the fishery for tusk, ling and blue ling.

The size of the vessels

There was a steady increase in the average size of the vessels from 34 m in 1977 to 46.6 m in 2022. Figure 7 show the average size of the vessels and the smallest and the largest vessel in the fleet for the period 1977 to 2022.

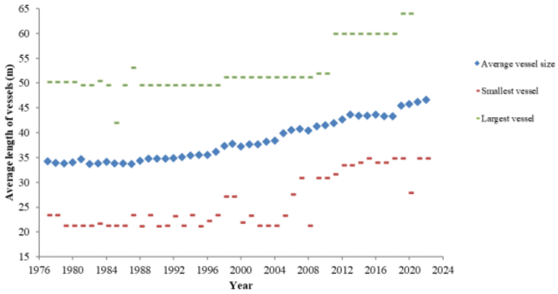


Figure 7. Average size of longliners >21 m for the period 1977-2022.

Fishing area

Approximately 65-70% of the commercial catches of ling are taken by vessels using demersal longlines, either target species or bycatch (Helle and Pennington, 2015), and the remains are taken mainly by gillnets but also some by trawlers. Although the tusk fishery takes place from Rockall to the southern Barents Sea (Helle and Pennington, 2004), between 70 to 80 percent of the catches by Norwegian vessels are from the Norwegian Economic Zone.

Figure 8 shows all the catches of ling registered in the electronic logbooks by longliners in 2013-2020 in areas 1 and 2.

Tusk are mainly caught by longliners (approximately 90 percent of the total catch). Figure 9 shows all catches of tusk registered in the electronic logbooks by longliners in Areas 1 and 2 during the period 2013 to 2022.

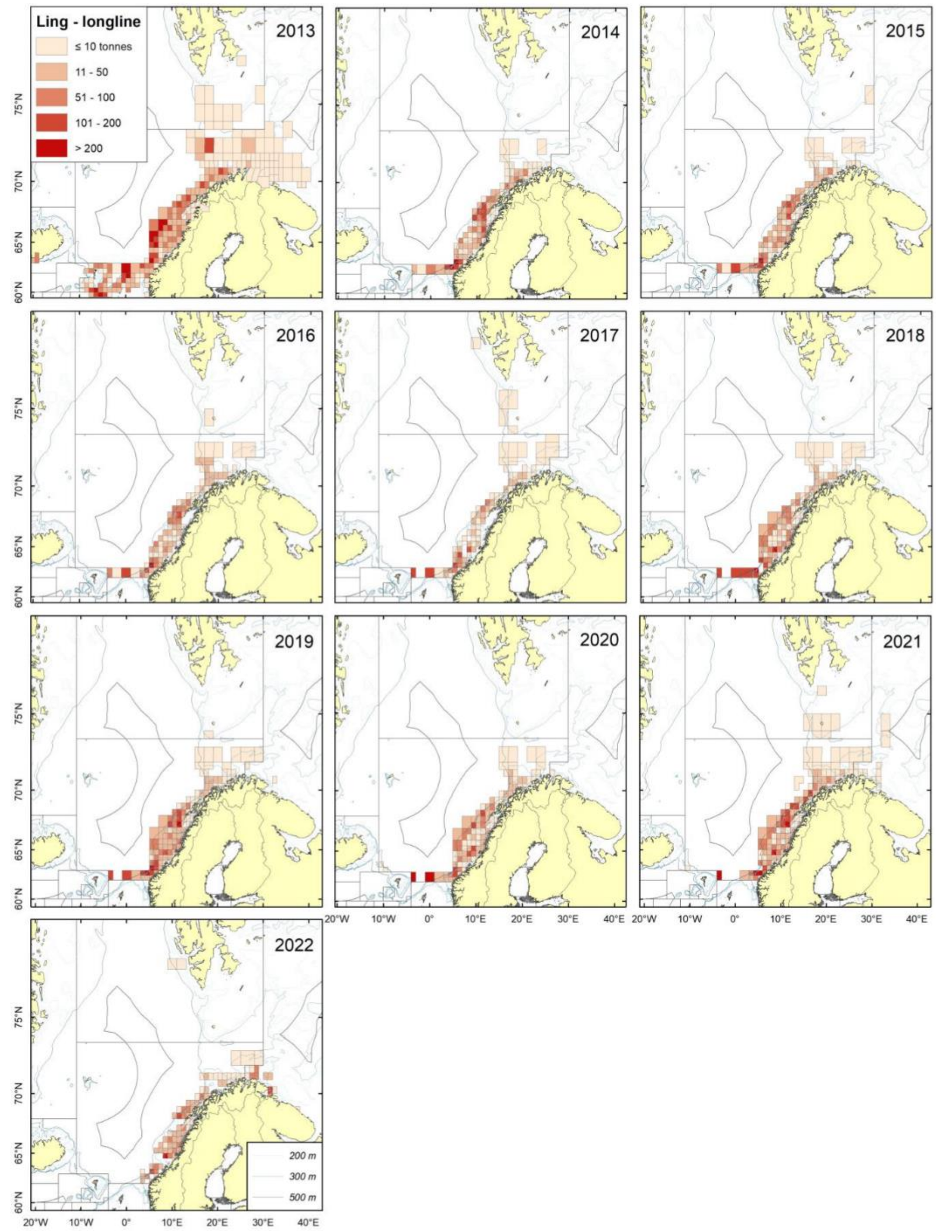


Figure 8. Distribution of the catches using longlines by the Norwegian fishery for ling in 2013 to 2022 in areas 1 and 2.

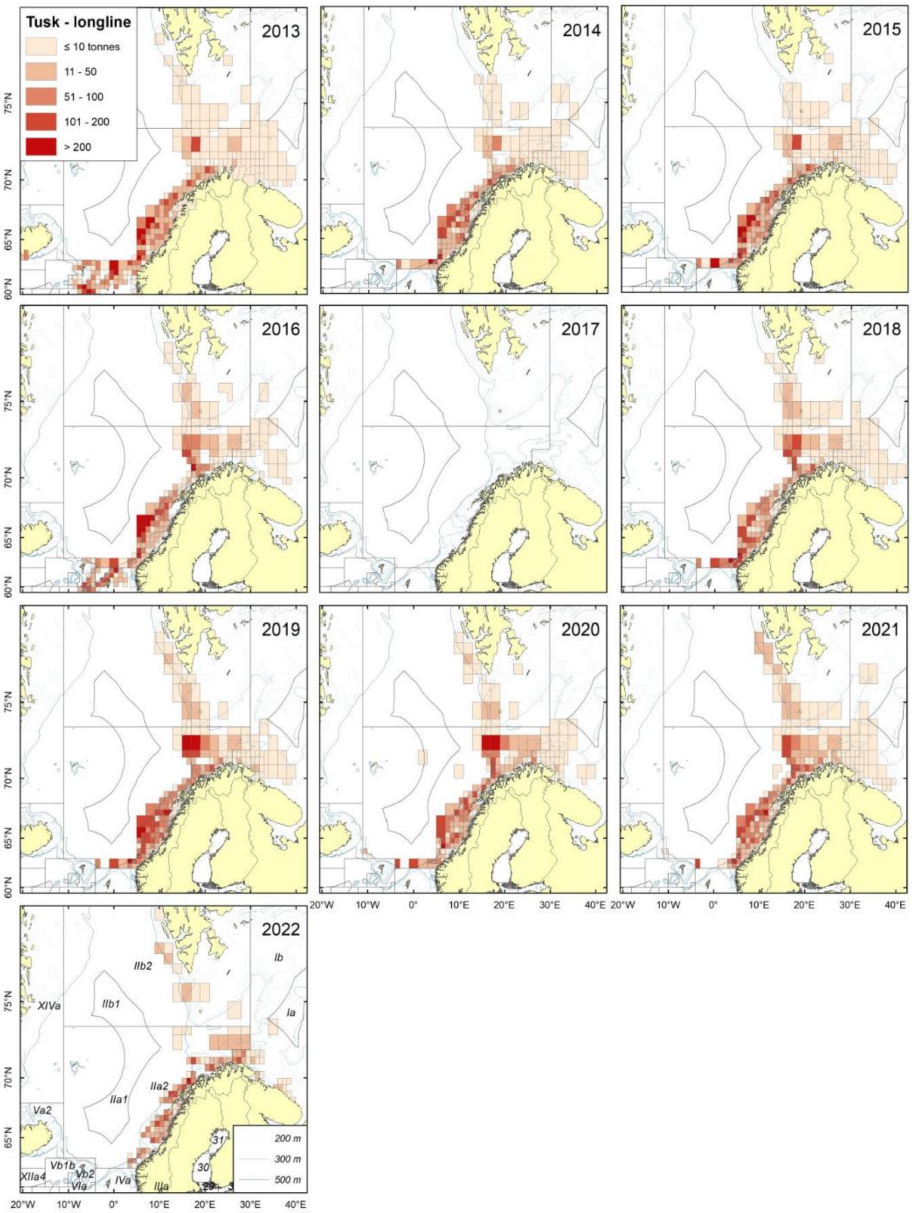


Figure 9. Distribution of the catches using longlines by the Norwegian fishery for tusk in 2013 to 2022 in areas 1 and 2.

CPUE

Based on methods described in Helle *et al.*, 2015 to derive a cpue series were for ling and tusk calculated two ways; using all data available and catches for which ling and tusk were targeted (>30 percent of the daily total catch).

In Figures 11 and 13 are plots of the estimated cpue series for the most important ICES subareas for ling and tusk: based on all the available data, and a cpue series based on only those catches that ling or tusk appear to be targeted; included plots of estimated 95% confidence intervals.

Ling:

Both cpue series for ling in 2a have been relatively stable since 2011, but with a declining trend the last four years for the targeted fishery.

In Areas 4a there was a steady increase in cpue from 2002 until 2016 and were down in 2017 and 2018 but with a slight increase in 2019 and 2020. In 2021 there were little or no fishing in the traditional areas due to no agreement about the TAC in the area. The estimate is therefore based on very limited data and does not present a correct picture of the stock situation. In 2022 the index was at the same level as in 2020.

In 6a and 6b there was also a positive trend from 2002 to 2016 with a varying but stable index. The Norwegian fleet had limited access to the areas in 2021 and there was very little fishery in 2022. There was no fishing in area 6b the two last years.

When all ling data for Areas 3.a, 4, 6, are combined for a cpue series, and ling was targeted a cpue series, both indicate a steady increase since 2003 to 2017 and then a decline in 2018. In 2020 there were an increase. The estimates for 2021 do not represent the normal fishery in the areas and should not be considered valid. In 2022 the index was at the same level as in 2020.

Tusk:

Both cpue series in Area 2a have been relatively stable since 2011.

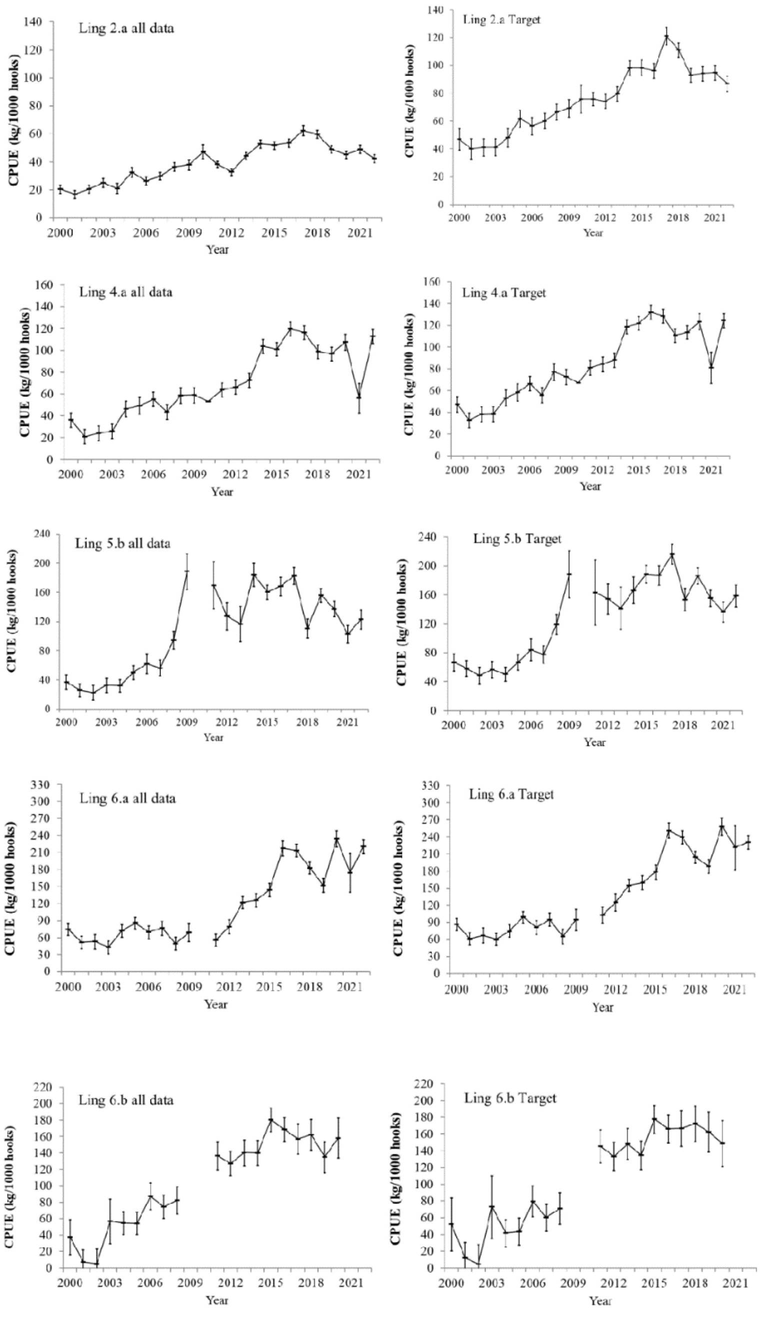
The series in Area 4a based on all the catches indicates at first a stable series and then a slightly decreasing trend for the last six years, while the series based on the targeted fishery shows a clear and positive upward trend from 2002 until 2013, after this there was a declining trend, and this trend is especially clear for the targeted fishery.

The series in Area 5b shows a stable trend from 2000 to 2008, afterwards it increased until 2012, then decreased until 2017 and a relatively large increase in 2018 and a decreasing trend after 2018.

In area 6a a cpue series based on the Norwegian longline data shows an increase in cpue from 2004 to 2008, afterwards it has remained at a high and slightly increasing level when all data are used, and a sharp increase from 2018 to 2019 for the targeted fishery followed by a decrease in 2020 (Figure 13). In 2022 the index was at the same level as during the period 2011-2016.

The combined cpue series for areas 4a, 5b and 6a. shows an increasing trend from 2000 to 2010, after 2010 cpue was at a high and stable level, declined in 2017.. After 2017 the index has been varying but in 2022 the index was at the same level as during the period 2011-2016.

The cpue series for Area 6b when all data were used, a catch from longliners show a decrease from 2000 to 2006. After 2006, the cpue was low but at a stable level. There was no direct fishery for tusk in the last years.


Ling 2.a all data
Ling 2.a Target
Ling 4.a all data
Ling 4.a Target
Ling 5.b all data
Ling 5.b Target
Ling 6.a all data
Ling 6.a Target
Ling 6.b all data
Ling 6.b Target
CPUE (kg/1000 hooks)
Year

11

Figure 11. Estimated cpue (kg/1000 hooks) of ling in Subareas 2a, 4a, 5b, 6a and 6b based on skipper's logbooks during the period 2000-2022. The bars denote the 95% confidence intervals.

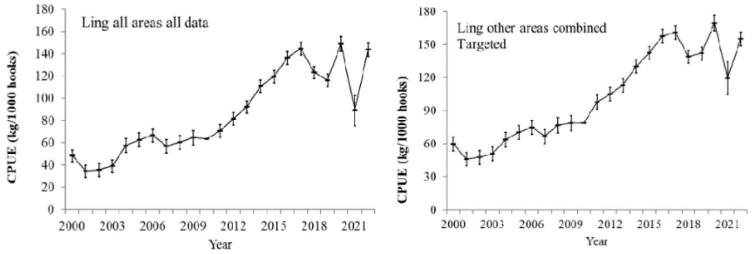


Figure 12. Ling areas combined (3, 4, 6) based on skipper's logbooks during the period 2000-2022. The bars denote the 95% confidence intervals.

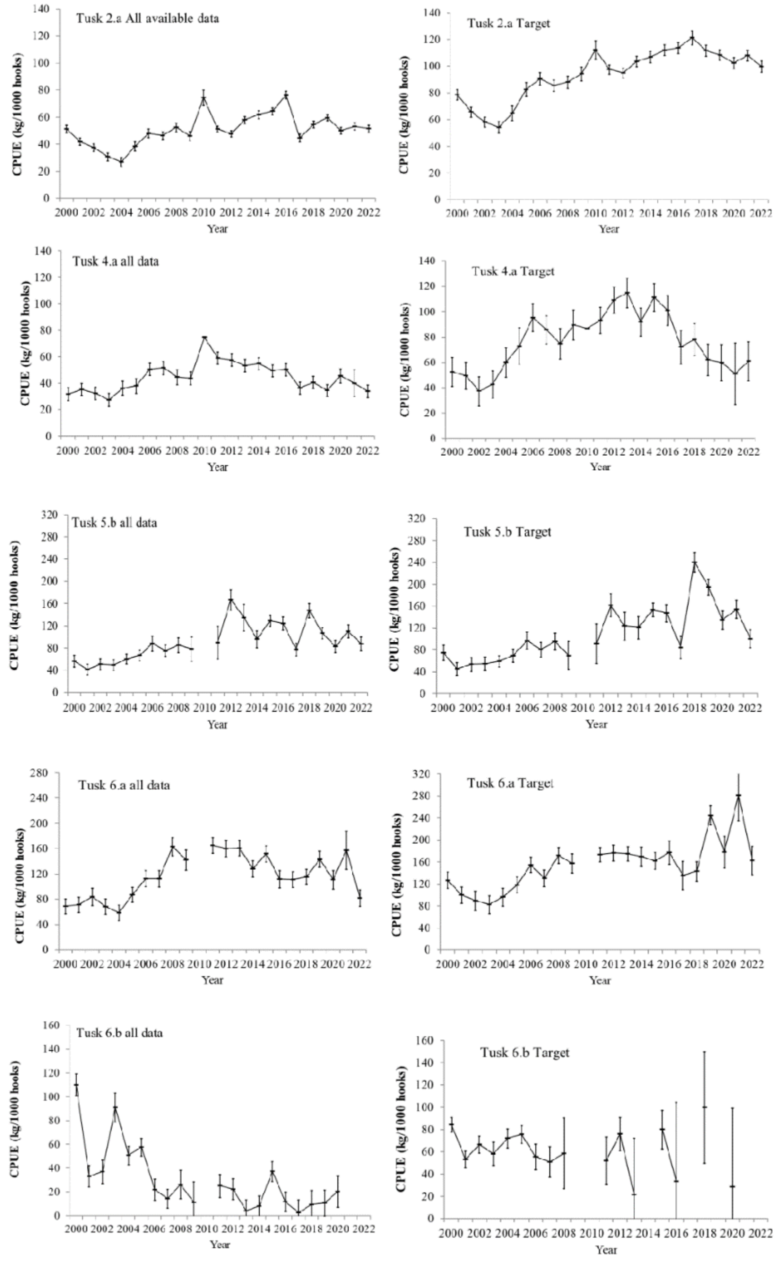


Figure 13. Estimated cpue (kg/1000 hooks) of tusk in Subareas 2a, 4a, 5b, 6a and 6b based on skipper's logbooks during the period 2000-2022. The bars denote the 95% confidence intervals.

13

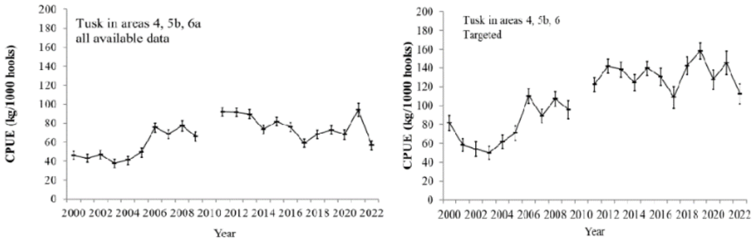


Figure 14. Tusk in other areas combined (4, 5b, 6a) based on skipper's logbooks during the period 2000-2021. The bars denote the 95% confidence intervals.

Blue ling

The cpue series for blue ling based on longline data shows a low and stable level for the Areas 1, 2, 3a and 4. Although there was no direct fishery in these areas, the stock doesn't seem to show any recovery.

A low and steady population for blue ling were in subareas 5a and 14 and in Areas 5b, 6 and 7. When only data from 6a, there was a positive trend from 2004 to 2015, after this the trend has been at a lower level.

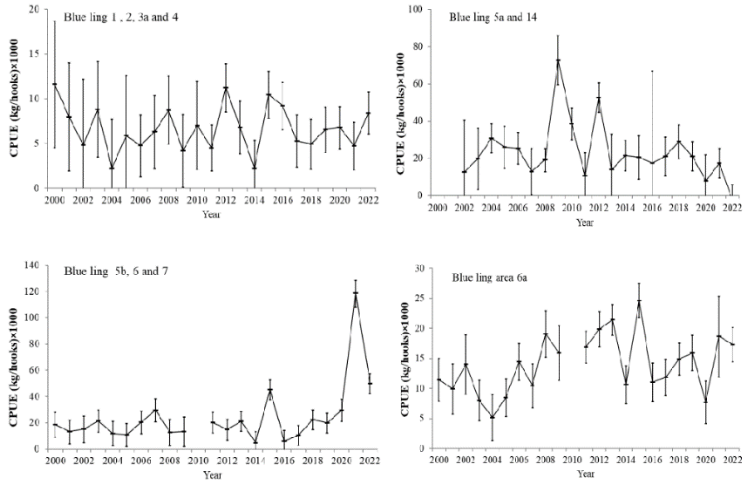


Figure 15. Estimated cpue (kg/1000 hooks) of blue ling in Subareas: 1, 2, 3.a; 4, 5.a; 14, 5.b, 6; 7; and in Subarea 6.a. All data from skipper's logbooks during the period 2000-2022. The bars denote the 95% confidence intervals.

Conclusions and discussion.

Legislation enacted since 2000 for regulating the cod fishery caused a continuous reduction in the number of longliners in the fishery for tusk, ling and blue ling, and by 2009, there were only 34 vessels above 21m in the fishery. Due to recent regulations, the number of vessels was 26 in 2021. Because of this decrease the number of vessels were 58 % fewer since 2000, the total number of hooks employed reduced, the total number of weeks fished, and until 2021, there were a significant reduction in effort. Compared with 2000, a decrease in total effort has occurred even though there was an increase in the number of hooks set per vessel/day until 2021. The large increase in effort in 2019 is probably due to a reduction in cod quotas. This fishery should be monitored and reported to prevent overfishing (Figures 5 and 6).

During the period 1998 through 2003, the total landings declined from 32 675 to 19 000 tons, while the catch-per-vessel remained relatively constant. The total catches were stable during the years 2004 through 2006, but after that, there was a sharp increase in 2007 and 2008. The average catch-per-vessel increased considerably during 2003- 2008, afterwards the catch has been relatively stable.

It should be noted that using the total landings as a measure of stock development can be very misleading. For example, there is a negative correlation between the landings of cod and the total landings of ling, blue ling and tusk (Figure 2), which is due to cod being the most valued species. Therefore, the decrease in total landings does not indicate a reduced stock size, but only an increase in cod quotas.

If a stock is not covered by a scientific survey, then a commercial cpue index is often used to track temporal trends in abundance. It is widely recognised that caution must be used when interpreting a cpue series based on commercial catch data. But by considering: the application and distribution of fishing effort; species specific knowledge, such as when a species is targeted or if it is a preferred species; patterns in the total catch by fleet and by vessel; etc., then based on all these factors, a reliable assessment of a stock's condition.

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Table 1. Summary statistics for the Norwegian longliner fleet during the period 1995-2022 (vessels exceeding 21m).

Year	Number of longliners	Total landed catch by fleet	Catch per vessel (Tons)
1977	36	8471	235
1978	38	9563	252
1979	40	14038	351
1980	41	15651	382
1981	44	15002	341
1982	46	19079	415
1983	43	18338	426
1984	41	18398	449
1985	44	21364	486
1986	42	19080	454
1987	48	17788	371
1988	53	16253	307
1989	53	29816	563
1990	51	27726	544
1991	54	27979	518
1992	61	29718	487
1993	60	32290	538
1994	59	26908	456
1995	65	26571	409
1996	66	28645	434
1997	65	20173	310
1998	67	32675	488
1999	71	31528	444
2000	72	28391	394
2001	65	23681	364
2002	58	24619	424
2003	52	18969	365
2004	43	17815	414
2005	39	19106	490
2006	35	19475	556
2007	38	23060	607
2008	36	25069	696
2009	34	21158	622
2010	35	24360	696
2011	37	20344	550
2012	36	22302	620
2013	27	16522	612
2014	26	16907	650
2015	25	20189	808
2016	25	19478	779
2017	25	15663	627
2018	26	19895	765
2019	27	23498	870
2020	30	16827	561
2021	26	12621	485
2022	26	18134	698

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

All species	1	2a	2b	3a	4a	4b	5a	5b	6a	6b	7c	12	14b	All areas
2000	9	54	2	+	24	2		13	12	10	2	+	6	131
2001	5	64	9		22		1	18	14	6	1	5	3	148
2002	10	74	2		29			20	12	8		1	8	164
2003	12	73	3	1	21	1	3	25	12	6		3	9	169
2004	20	75	11		22		2	34	14	5	1	1	9	195
2005	23	81	14		25		2	21	25	8	0,4		5	203
2006	11	73	3		38		3	11	13	7				159
2007	15	101	21		27	3	2	15	10	6	1			201
2008	7	90	18	1	26		4	11	10	2			2	171
2009	19	103	20	1	49	1	2	4	7	2			3	211
2010	8	104	13		3		1	3		5			5	145
2011	12	103	4		21	3	2	1	9	4				159
2012	9	78	4		26	1	2	2	5	5	1		2	135
2013	6	63	2		22	2	2	1	11	4			1	114
2014	5	66	2		31	1	2	4	9	4			2	126
2015	8	77	4		36	1	2	11	9	5			2	155
2016	4	81	7		31	1	2	8	8	5			3	150
2017	12	66	15		33		2	10	13	3			4	158
2018	4	69	6		27	1	2	7	13	4			4	137
2019	5	109	14		31	1	2	15	8	3			6	194
2020	6	95	7		15		2	11	6	2			3	147
2021	16	100	20		3		2	10	1	0			6	158
2022	9	95	18		34		2	8	7				5	178

Tusk	1	2a	2b	4a	4b	5a	5b	6a	6b	7c	12	14b	All areas
2000	3	34	1	18	1		11	12	4	2	1	2	88
2001	1	57		22		1	18	14	6	1	3	1	124
2002	5	66	2	28			20	12	8			2	141
2003	5	58		19	2	3	25	12	5			1	130
2004	6	60	1	21		2	34	14	5	1		3	148
2005	5	69	2	25		2	21	23	8	0		3	158
2006	1	67	1	37		3	11	13	7				140
2007	5	89	3	26		2	15	10	6	0			157
2008	4	92	4	30		4	14	15	5				169
2009	6	87	2	56	2	2	4	7	2			1	159
2010	4	93	2	2		3			4			2	112
2011	12	103	4	21		2	1	9	4				155
2012	9	78	4	25		2	2	5	4	1		2	132
2013	6	63	2	22		2	1	11	3			1	111
2014	5	66	2	31		2	4	9	3			2	125
2015	8	77	4	36	1	2	11	9	5			2	154
2016	4	81	7	30		2	8	8	5			3	148
2017	12	66	15	31		2	10	13	2			3	154
2018	4	69	6	26		2	7	13	3			4	134
2019	5	109	14	30	1	2	15	8	2			6	192
2020	6	95	7	15		2	11	6	2			3	146
2021	16	99	20	3		2	10	1				6	157
2022	9	91	18	34		2	8	7				5	174

Ling	2a	3a	4a	4b	5a	5b	6a	6b	7c	14b	All areas
2000	23	+	19	1		12	13	4	3		76
2001	40		22	+	1	17	13	5	1		100
2002	50		29			18	11	7			114
2003	40	1	20	1	3	24	12	4			104
2004	37		22		2	34	14	5	1		115
2005	51		25		2	21	23	8	+		126
2006	54		38		3	11	13	7			126
2007	65		27	3	2	15	10	6	1		128
2008	52	1	25		4	11	9	2			104
2009	65	1	49		2	4	7	2			130
2010	70		3		3			7			83
2011	73		21	3	4	2	8	4			113
2012	59		26	1	2	2	5	5	1		98
2013	44		22	1	2	1	11	4			85
2014	53		31	1	2	4	9	4		1	106
2015	54		37	1	2	11	9	5		1	122
2016	55		31	1	2	7	8	5		1	111
2017	27		33		2	10	13	3			88
2018	41		27	1	2	6	13	4			94
2019	66		31	1	2	14	8	3			125
2020	47		15		2	10	6	2			83
2021	53		3		1	9	1				67
2022	53		34		1	7	7				102

Blue ling	2a	4a	5a	5b	6a	6b	12	14b	All areas
2000	1	1		4	9	1	2	+	18
2001	1	+	1	3	6	1	5		15
2002	1	1		4	4	2		+	11
2003	1		1	5	8	2	2	+	14
2004	+	1	2	5	6	+		+	14
2005	+	1	1	1	10			+	14
2006	1	2	2	4	8	+			18
2007	1	2	1	5	6	1			16
2008	2	4	3	4	10			1	25
2009	1	4	2	3	6			1	17
2010	2	1	2					2	7
2011	2	2		1	7				12
2012	1	2		2	5			1	12
2013	1	2		1	8				13
2014	1	3	1	2	5	1		1	12
2015	3	4	1	5	7				20
2016	1	4		3	6				15
2017	1	3		5	7			1	17
2018	1	3		4	8			1	17
2019	4	3		6	6			2	21
2020	6	4		3	4				17
2021	6		1	4	1			1	13
2022	5	9	1	4	6			1	26

Table 3. Average number of hooks that the Norwegian longliner fleet used per day in each of the ICES subareas/divisions and in the total fishery for the years 2000-2022 in the fishery for tusk, ling and blue ling. n is the total number of days with hook information contained in the logbooks.

All		1	2a	2b	3a	4a	4b	5a	5b	6a	6b	7c	12	14b	All areas
2000	Average	31688	31439	35409	30250	29378	30263		24594	22763	30471	29600	18136	2815	28325
	n	353	1916	71	4	685	38		411	435	227	80	22	191	4429
2001	Average	33325	30703	34638		30553	33500		26760	24419	30340	33108	17548	2465	28743
	n	163	2196	315		727	10		613	447	140	37	175	135	4958
2002	Average	35432	33431	34756		32291	33867		25939	21484	31557			9458	30432
	n	263	2031	45		667	15		475	186	149			251	4083
2003	Average	35045	34766	34776	33037	33484	32559	22605	29513	29421	31325		13063	11515	31794
	n	376	1839	67	27	510	34	38	515	302	97		48	228	4081
2004	Average	32431	33475	31859		30934		25815	31804	25636	31559	25250		12474	31285
	n	433	1389	217		439		54	693	308	111	28		105	3777
2005	Average	32671	32861	35082		34039		23100	29885	24807	35949	33429		18960	31438
	n	316	1248	207		331		30	374	369	137	7		91	3110
2006	Average	33182	35140	39298		34561		21526	27943	22504	32273				32959
	n	187	1252	57		673		57	159	248	139				2711
2007	Average	34380	35207	37881	35000	33414	38086	25414	30681	25958	36400	31071			34110
	n	318	2103	328	8	587	58	58	355	249	145	14			4223
2008	Average	36833	36890	39650	36467	34056	31500	32704	27968	26319	33514			9464	35042
	n	96	1500	297	15	395	10	71	188	138	35			45	2790
2009	Average	39184	39142	43744	34636	38299	30167	26106	28123	24455	43645			7034	38127
	n	267	1419	281	11	680	6	33	57	99	31			38	2922
2010	Average	40519	38057	41607		38838		20182	25067		47904			7672	37296
	n	19	1089	135		37		11	30		52			58	1491
2011	Average	37205	36260	35280	35275	32737	37343	28062	26492	26424	34727			25750	34668
	n	411	3622	126	8	740	104	63	24	310	137			4	5549
2012	Average	36434	37298	38357		34639		33647	21702	21249	33934	39064		9091	35381
	n	307	2817	157		933		68	63	196	176	22		59	4765
2013	Average	39500	37500	42000		36500	43000	30900	26000	24700	36700	31000		27500	35600
	n	211	2073	81		710	34	69	34	351	132	10		36	3678
2014	Average	37699	36782	39660		36715	44614	35015	34000	26979	36551			22374	35676
	n	112	1501	44		707	22	46	101	214	97			65	2909
2015	Average	36100	35400	43500		35000	40800	31600	32400	30700	29000			29800	33800
	n	209	1902	91		908	33	54	276	222	130			53	3878
2016	Average	40000	36900	42000		35000	35000	37000	31000	26400	42000			31400	35600
	n	100	2025	175		775	25	50	200	200	125			75	3750
2017	Average	41700	36500	43000		37400	40300	33700	30000	25500	36900			25400	34700
	n	302	1660	374		815	11	54	260	320	78			89	3963
2018	Average	42800	38500	42000		37200	44500	42600	32800	27000	35400			35400	36100
	n	99	1776	142		692	34	51	148	295	96			105	3738
2019	Average	43000	38500	44300		37300	43800	38400	35000	26200	28800			26800	37600
	n	123	2956	381		842	31	63	393	218	79			172	5258
2020	Average	44600	39000	45900		38200		41400	33000	27600	33800			23300	38200
	n	168	2853	221		464		59	315	181	56			88	4405
2021	Average	43700	39800	46400		40800	47800	30000	32700	23100				34300	39500
	n	408	2600	524		80	6	42	250	17				150	4077
2022	Average	46900	41000	48600		36000		35000	31000	26700				31100	39000
	n	233	2353	459		900		45	200	191				120	4500

20

21

Table 4. Estimated total number of hooks (in thousands) that the Norwegian longliner fishery for tusk, ling and blue ling used in each of the ICES subareas/divisions and in the total area for the years 2000-2022.

All	1	2a	2b	3a	4a	4b	5a	5b	6a	6b	7c	12	14b	All areas
2000	20534	117708	5099	218	50765	4358		23020	19667	21939	4262	1306	1216	267161
2001	10831	127724	20263		43691			31309	22221	11833	2152	5703	481	276508
2002	20551	143486	4032		54313			30089	14953	14642			4389	289469
2003	21868	131972	5425	1718	36565	1693	3526	38367	18359	9773		2038	5389	279406
2004	27891	107957	15069		29264		2220	46497	15433	6785	1086		4827	262325
2005	29306	103808	19155		33188		1802	24476	24187	11216	521		3697	248895
2006	12775	89783	4126		45966		2260	10758	10239	7907				183567
2007	19081	131569	29434		33381	4228	1881	17028	9604	8081	1150			253676
2008	9282	119524	25693	1313	31876		4709	11075	9475	2413			681	215719
2009	25313	137075	29746	1178	63806	1026	1775	3825	5820	2968			717	273523
2010	11345	138527	18931		4078		706	2632		8383			1343	189277
2011	16965	141922	5363		26124	4257	2133	1007	9037	5279				209464
2012	11805	104733	5523		32422	1230	2423	1566	3825	6108			655	171952
2013	7821	77963	2772		26500	1419	2039	858	8966	3633			1815	133752
2014	4901	63118	2062		29592	1160	1821	3536	6313	3801			1163	116875
2015	7220	68145	4350	0	31500	1020	1580	8910	6907,5	3625	0	0	1490	130975
2016	4000	74722	7350	0	27125	875	1850	6200	5280	5250	0	0	2355	133500
2017	12510	60225	16125	0	30855		1685	7500	8288	2768	0	0	2540	137065
2018	4451	69069	6552	0	26114	1157	2215	5970	9126	3682	0	0	3682	128588
2019	5805	113306	16745	0	31220	1183	2074	14175	5659	2333	0	0	4342	196949
2020	8028	111150	9639	0	17190	0	2484	10890	4968	2028	0	0	2097	168462
2021	18179	103480	24128	0	3182		1560	8502	601	0	0	0	5351	162266
2022	10975	101270	22745	0	31824		1820	6448	4859	0	0	0	4043	180492

WD01 ICES WGDEEP 2023

Greater forkbeard in Faroese waters (27.5.b).

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Introduction

There is very little catch of greater forkbeard in Faroese waters and a few fish is caught in different surveys. The objective for this document is to provide information on greater forkbeard in Faroese waters (27.5.b).

Methods

The background data is mainly from the annual surveys on the Faroe Plateau in spring (1994-2023) and summer (1996-2022). Some data are also from the deepwater survey (September 2014-2022, no survey in 2021). There are only small amounts of commercial catch, so there is no data individual fish data of this species from landings.

The fishery

There is no directed fishery for greater forkbeard in Faroese waters (5b) and only small amount is landed as bycatch.

Landings

There have always been very little landings of greater forkbeard by the Faroese fishery (Table 10.0d copied from WGDEEP report 2022). The main catch of greater forkbeard in Faroese waters is from Norway and France. The preliminary landing in 5b of greater forkbeard from Faroese in 2021 was 0.1 tons and in 2022 0 (zero) tons of greater forkbeard. NB! In the WGDEEP report 2022 (page 552 and in Table 10.0d page 561) - the landings in 5b of 301 tons in 2011 and 145 tons in 2012 seems to be wrong! In statlant 2011 the Faroese fleet fished 0.310 tons in 5a and in statlant 2012 the Faroese fleet fished 0.062 tons in 5a and 0.083 tons in 5b2 (Table 10.0d copied from WGDEEP report 2022 with only update of year 2011, 2012 and preliminary 2022 data for 5b).

Table 10.0d. 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				0		1	8
2012	6	5			0.083	7	7	25
2013	7	3	0				0	11
2014	7	14	0		0		2	24
2015	5	27					2	34
2016	7	3	0				3	13
2016	7	3	0				3	13
2017	9		0					9
2018	5	7						12
2019	7	10						18
2020	7	24	0					31
2021	6	7	0	0	0	0	0	13
2022*	5.436	21.018	0.2528		0			26.7

Spatial distribution

The spatial distribution of greater forkbeard from the bottom trawl groundfish surveys were mainly on the Faroe Plateau deeper than 200 m (Figure 1 and Appendix 1, 2). In the deepwater survey greater forkbeard was caught around the Banks and on the Wyville-Thomson ridge (Figure 2 left and Appendix 3).

In the Faroese 0-group surveys on the Faroe Plateau in June/July there are 26 registrations of greater forkbeard caught pelagic (Figure 2 right). The length was between 8-54 mm, mainly around 30-40 mm. 11 of there were caught in the period 1991-1999, 14 in the period 2001-2005 and one in 2022.

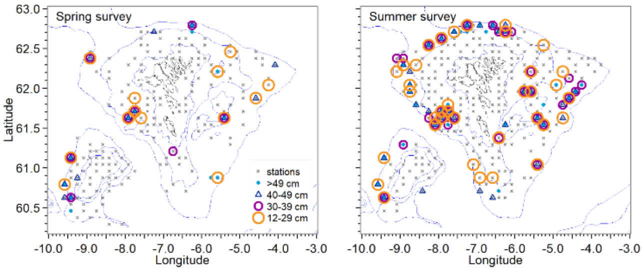


Figure 1. Greater forkbeard 5.b. Spatial distribution of greater forkbeard for all years together divided by size in the annual spring- and summer survey.

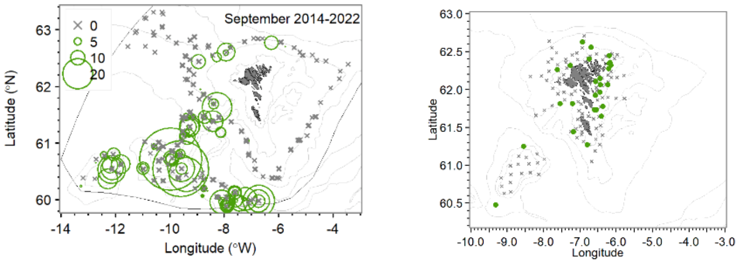


Figure 2. Greater forkbeard 5.b. Spatial distribution of (left) CPUE (kg/h) from the deepwater surveys in September 2014- 2022 (no survey in 2021) and (right) positions of 8-54 mm long greater forkbeard caught pelagic in the 0-group survey in June/July (1983-2022).

Data available

Data available from different surveys in Faroese waters is presented in Table 1. A standardized CPUE is available from the annual spring- and summer surveys on the Faroe Plateau. There are also some data from the deepwater survey and Greenland halibut survey.

Table 1. Greater forkbeard 5.b. Sampling overview from different surveys around the Faroes.

year	length	round weight	gutted weight	gender	maturity	otoliths	aged	gonad	stomach
1994	3	2							
1995	27	5							
1996	26	2							
1997	7	2							
1998	17	2							
1999	27	25							
2000	46	46							
2001	101	86							
2002	55	53							
2003	21	21							
2004	47	47							
2005	24	24							
2006	17	17							
2007	15	15							
2008	13	13							
2009	81	81							
2010	110	109							

2011	92	92							
2012	99	99							
2013	133	117							
2014	257	255	23	37	37	36		2	1
2015	131	130	16	27	27	27			1
2016	89	89	15	18	18	18			
2017	108	108	6	11	11	11			1
2018	96	96		1	1	1			
2019	50	50		7	7	7			
2020	31	31							
2021	36	32		3	3	3			3
2022	39	39		9	9	9		2	2
2023	23	23							
Total	1821	1711	60	113	113	112	0	4	8

Length composition

Annual length-frequency distribution of greater forkbeard from the Faroese groundfish surveys (very few individuals see appendix 4 and 5) and Faroese deep-water surveys for the period 2014-2022 are presented in Figure 3.

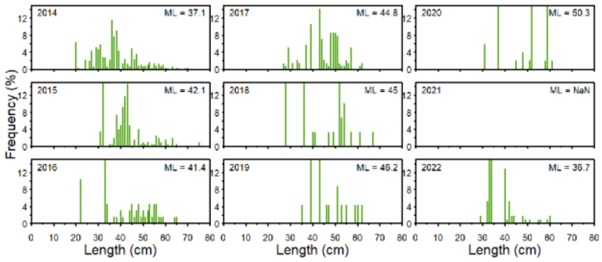


Figure 3. Greater forkbeard 5.b. Length-frequency distribution from the deepwater survey in 2014-2022 (no survey in 2021).

Length-weights

Round weight at length from all surveys showed that 40 cm greater forkbeard was around 0.5 kg and 50 cm around 1.0 kg (Figure 4).

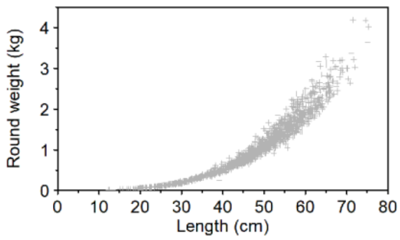


Figure 4. Greater forkbeard 5.b. Length- round weight relation from different surveys.

Catch, effort and research vessel data

Abundance index of greater forkbeard from the annual Faroese groundfish surveys covering the Faroe Plateau is presented in Table 2 and Figure 5.

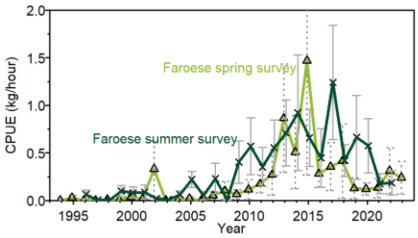
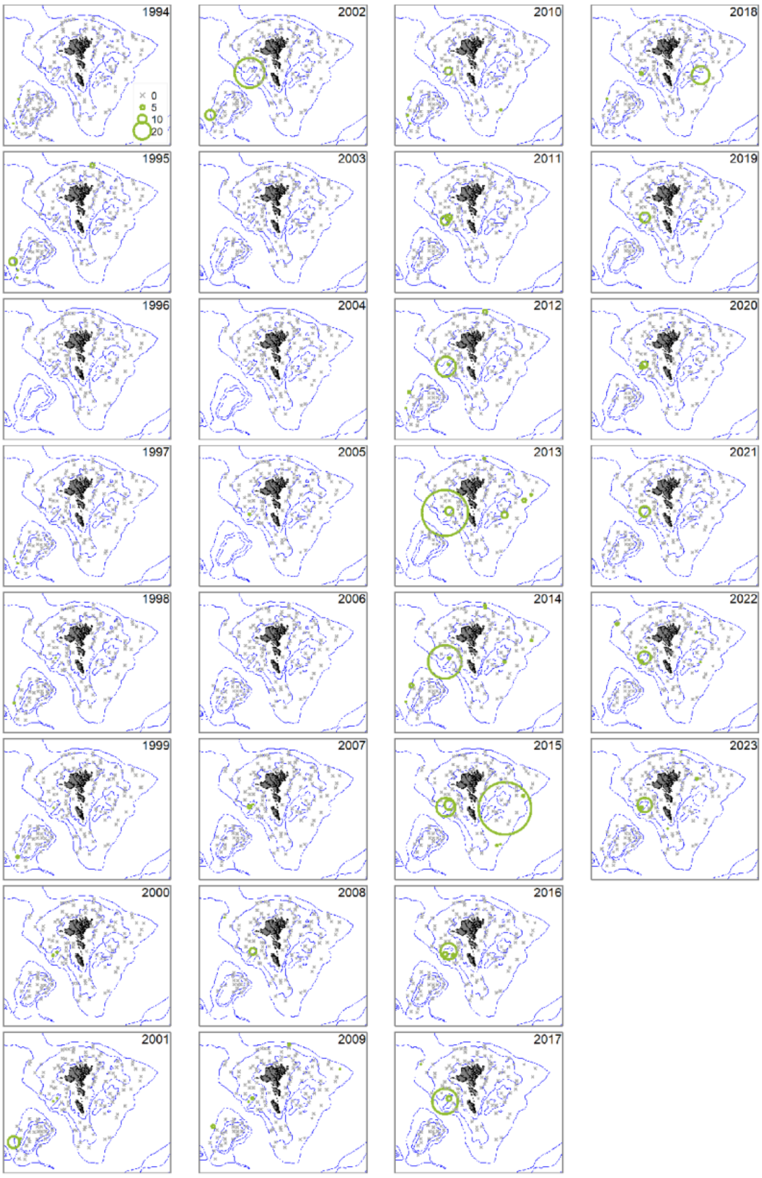


Figure 5. Greater forkbeard 5.b. Standardized cpue (kg/hour) from the Faroese spring- and summer groundfish survey.

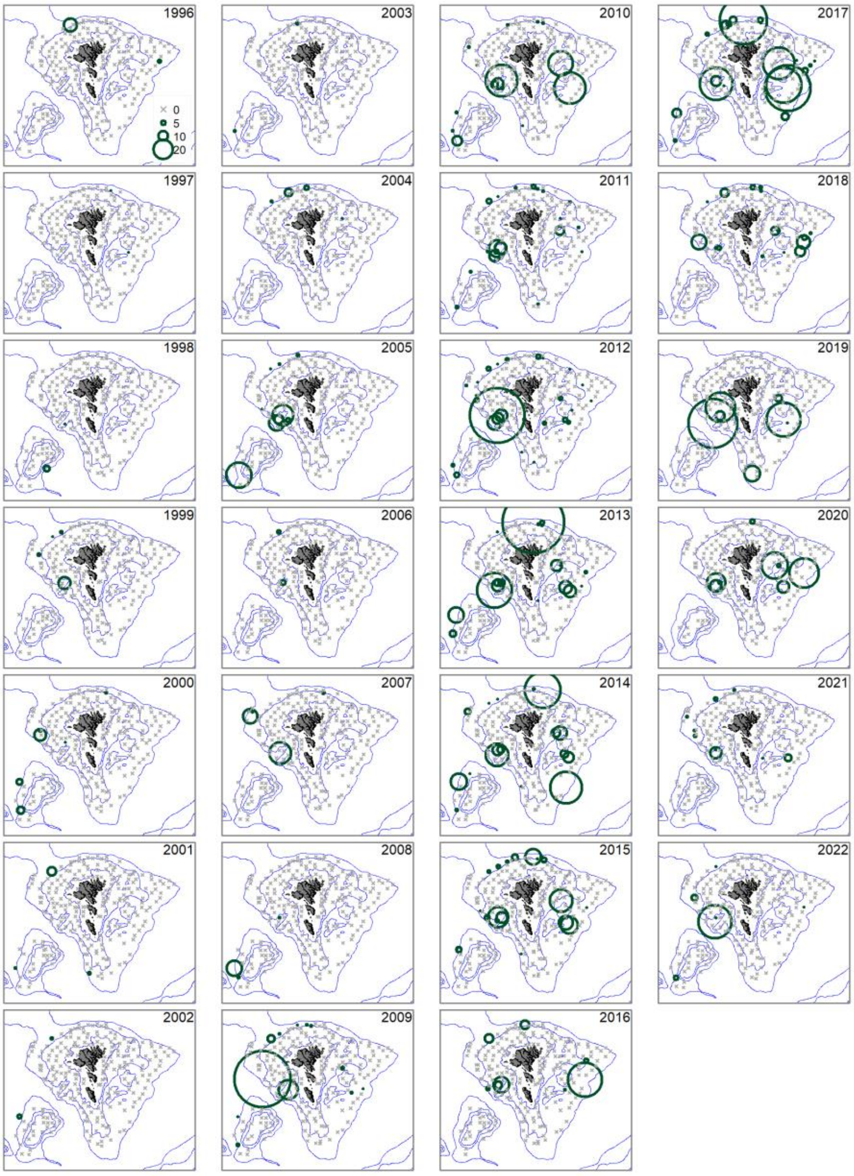
Table 2. Greater forkbeard 5.b. Standardized cpue from Faroe Plateau spring- and summer surveys. N- number of hauls, SE-standard error.

	Spring survey		Summer survey	
year	cpue	se	cpue	se
1994	0.00	0.00		
1995	0.03	0.02		
1996	0.00	0.00	0.06	0.04
1997	0.00	0.00	0.01	0.01
1998	0.01	0.01	0.00	0.00
1999	0.00	0.00	0.10	0.06
2000	0.04	0.02	0.08	0.06
2001	0.02	0.01	0.09	0.07
2002	0.33	0.30	0.02	0.02
2003	0.00	0.00	0.01	0.01
2004	0.00	0.00	0.06	0.04
2005	0.02	0.02	0.22	0.08
2006	0.00	0.00	0.05	0.04
2007	0.05	0.04	0.23	0.16
2008	0.10	0.09	0.01	0.00
2009	0.06	0.05	0.40	0.22
2010	0.12	0.11	0.57	0.30
2011	0.18	0.09	0.35	0.21
2012	0.27	0.21	0.56	0.29
2013	0.86	0.57	0.71	0.35
2014	0.51	0.38	0.92	0.61
2015	1.47	1.21	0.66	0.30
2016	0.28	0.14	0.45	0.31
2017	0.36	0.25	1.24	0.60
2018	0.41	0.39	0.42	0.17
2019	0.13	0.11	0.66	0.44
2020	0.12	0.06	0.58	0.28
2021	0.13	0.10	0.18	0.11
2022	0.26	0.24	0.19	0.13
2023	0.27	0.17		

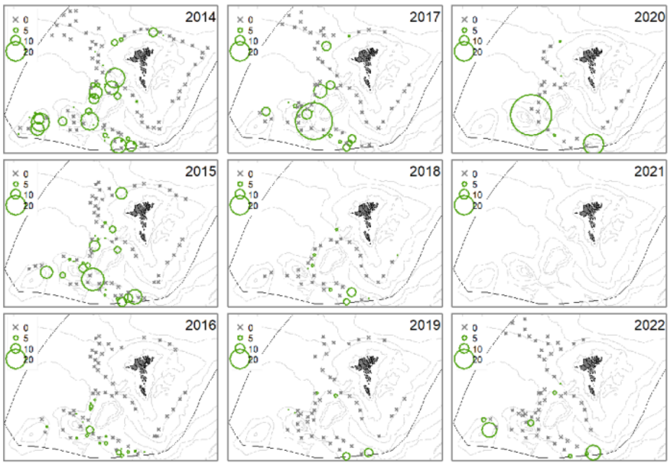
Appendix



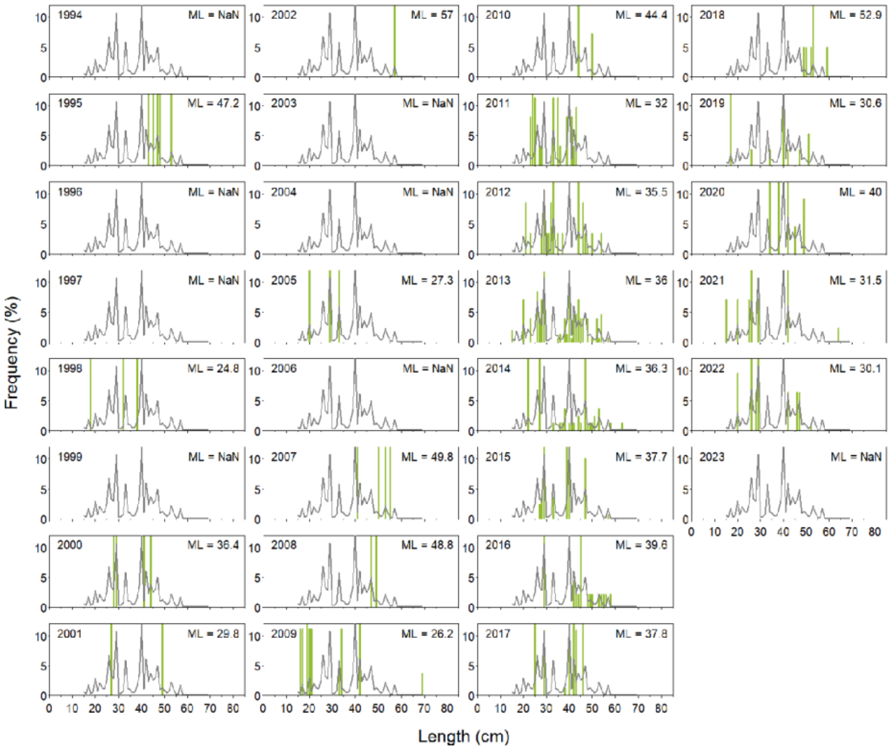
Appendix 1. Greater forkbeard 5.b. Spatial distribution (kg/hour) in the spring survey in February/March.



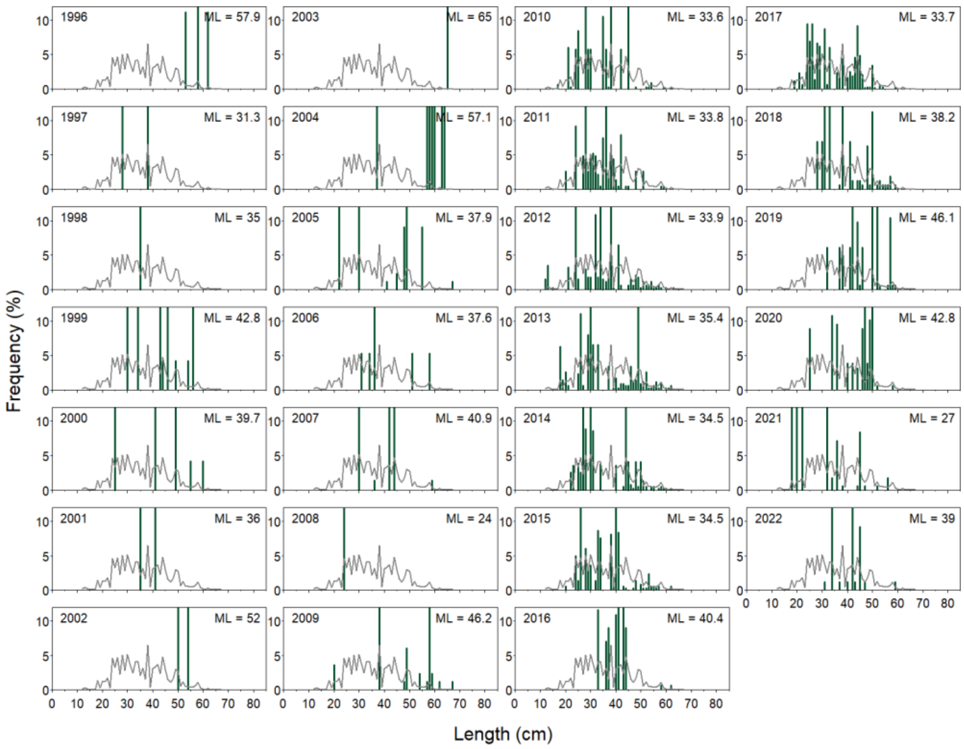
Appendix 2. Greater forkbeard 5.b. Spatial distribution (kg/hour) in the summer survey in August.



Appendix 3. Greater forkbeard 5.b. Spatial distribution (kg/hour) in the deepwater survey in September. No survey in 2021.



Appendix 4. Greater forkbeard 5.b. Length distribution in the spring survey in February/March.



Appendix 5. Greater forkbeard 5.b. Length distribution in the summer survey in August.

WD02 ICES WGDEEP 2023

Black scabbard fish in Faroese waters (27.5.b).

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Introduction

The objective for this document is to provide information on black scabbard fish in Faroese waters (27.5.b).

The fishery

The black scabbard fish fishery in Faroese waters are managed by licences. Since 2013, only one trawler has had licence to fish black scabbard fish as a targeted species. This particular trawler was sold in 2022. In the black scabbard fishery, the commercial trawler used a star trawl with 486 meshes, 160 mm. Mesh size in the net was 80 mm. The usual fishing depth varied between 600-1000 m and the trawling hours varied between six to eight hours, but may last less if the species was very abundant.

The main fishing areas of black scabbard fish in Faroese waters are located on the slope around the Faroe Bank and on the Wyville-Thomsen ridge close to the southernmost Faroese EEZ boarder (Figure 1, Appendix 1).

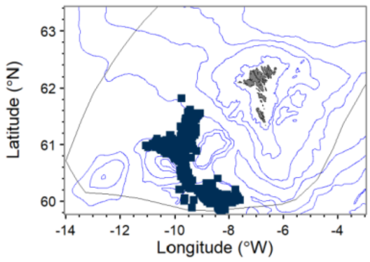

Figure 1. Black scabbard fish 5.b. Spatial distribution of the Faroese commercial trawl fishery of black scabbard fish 2000-2022.

Landings

The mean landings of black scabbard fish in Faroese waters from 1989 to 2018 were 569 t (Figure 2). The highest landings of around 1600-1800 t were in 2002, 2003 and 2008. The preliminary catch data for 2022 showed that the Faroese landings were 13.2 t in 5b2 and 2.9 t in 5b1. French catch was 6.26 t in 5.b.

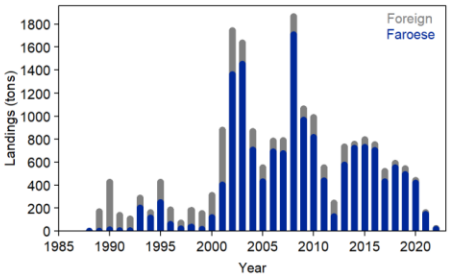

Figure 2. Black scabbard fish 5.b. Nominal landings in Faroese waters.

Spatial distribution

The spatial distribution of black scabbard fish from the deepwater surveys was mainly on the slope north of the Faroe Bank/Bill Bailey bank (Figure 3), which are the main fishing areas. A closer look at different surveys showed that black scabbard fish was only caught in the area north-west of the Faroes and never caught on the Faroe Plateau (Figure 4).

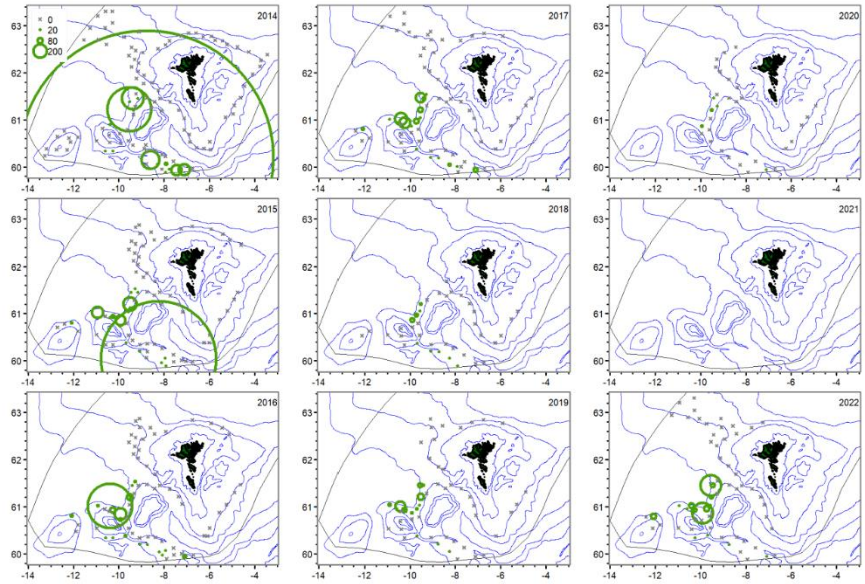

Figure 3. Black scabbard fish 5.b. Spatial distribution of CPUE (kg/h) from the deepwater surveys in 2014-2022 (no survey in 2021).

Length distribution

Annual length-frequency distribution of the Faroese landings data and Faroese deep-water surveys for the period 2014-2022 are presented in Figure 4. The mean length of black scabbard fish in the catches was around 90-92 cm, which is about the same mean length as in the deep-water survey (Figure 4). Numbers of black scabbard fish sampled from the landings and in the deep-water surveys are presented in Table 1. All the sampled fish in the deepwater survey was immature.

Table 1. Black scabbard fish 5.b. Number of fish sampled from the commercial trawler and from the deepwater surveys. * Blue ling survey in April 2018.

	Landings		Deep-water surveys					
Year	Lengths	Weights	Lengths	Round weights	Gender	Maturity	Otoliths	Stomachs
2014	575		4477	785	150	150	150	8
2015	1475		2117	389	78	78	78	9
2016	7603	5077	1271	459	94	94	94	11
2017	4984	4983	874	574	118	118	118	31
2018	4193	4143	598	217	64	64	64	8
2018*			94	94	13	13	13	4
2019	4515	4515	557	483	132	132	132	10
2020	4476	4476	91	67	19	20	20	1
2021	2012	2012	-					
2022	-		1278	474	107	107	107	9

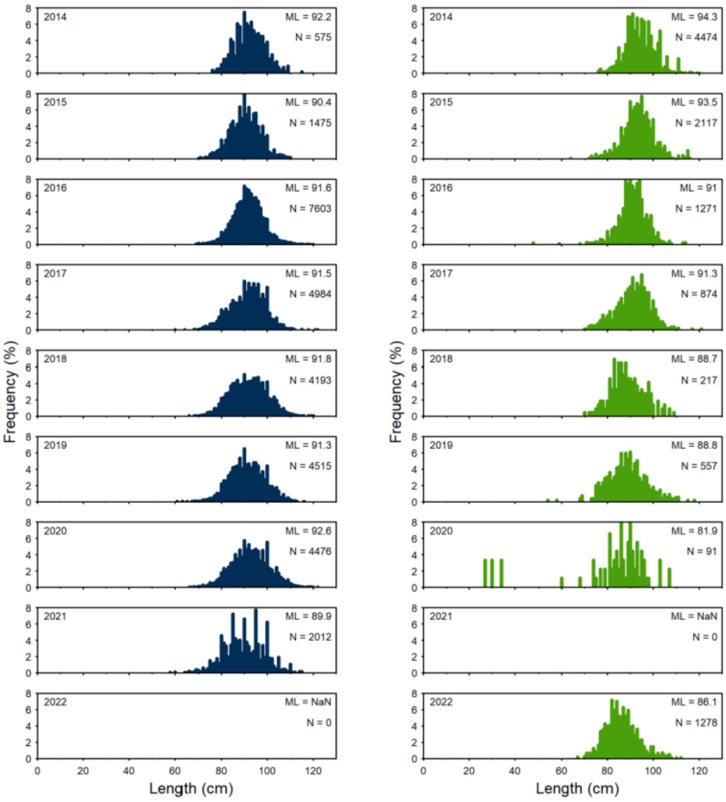

Figure 4. Black scabbard fish 5.b. Length-frequency distribution for the period 2014-2022 from the landings (no samples in 2022) (left) and the deep-water survey (no survey in 2021) (right).

Length-weights

Comparing mean weight at length from the commercial trawler with the deep-water survey showed that the data are similar (Figure 5). Black scabbard fish of 70 cm length had a round weight around 0.4 kg, 100 cm was 1.5 kg; and the largest fish was 114 cm and 2.4 kg.

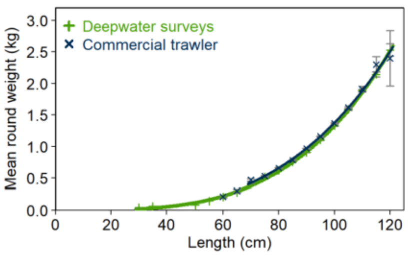

Figure 5. Black scabbard fish 5.b. Length-weight relation comparison between the landings (blue) and the deep-water survey (green).

Commercial cpue

In 2022, the commercial trawler that had a fishery licence for black scabbardfish was sold. This trawler had only 8 black scabbardfish hauls in 2022, so the CPUE-data are not presented. A map of the fishery area is presented in Figure 6.

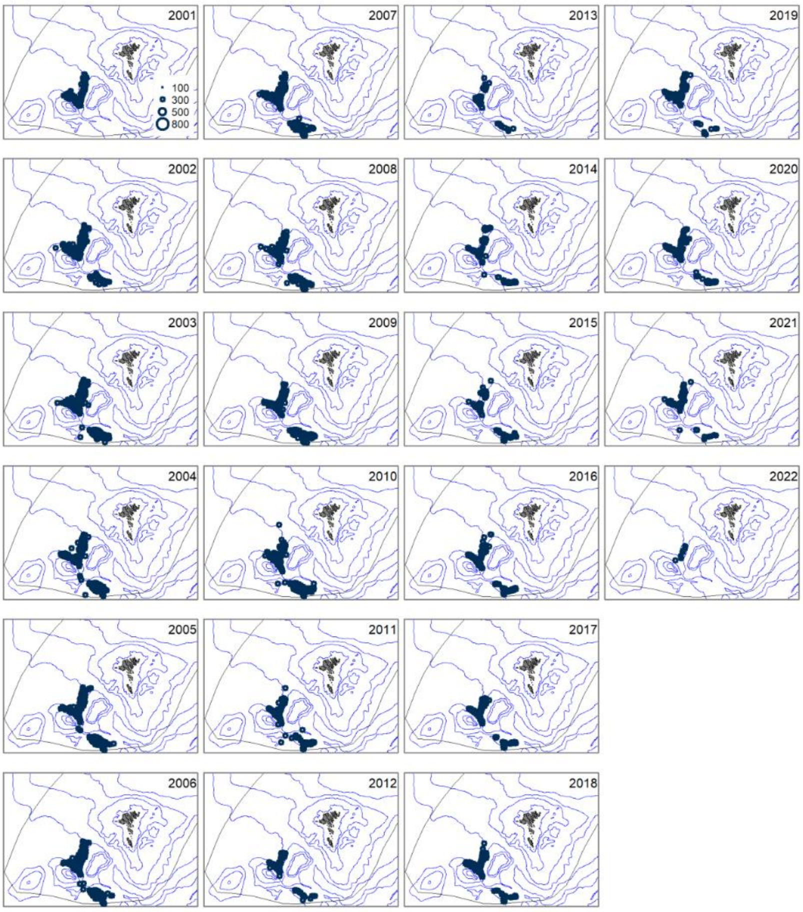

Figure 6. Black scabbard fish 5.b. Spatial distribution (kg/hour) in the commercial trawl fishery per year. Only hauls with more than 30% black scabbard fish of the total catch.

WD03 ICES WGDEEP 2023

Roundnose grenadier in Faroese waters (27.5.b).

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Introduction

The objective for this document is to provide information on roundnose grenadier in Division 27.5.b.

Landings

The landings in Faroese waters (ICES Division 27.5.b) are showed in Table 1.

Table 1. Roundnose grenadier 5.b. Nominal landings in Faroese waters.

Year	Faroes	France	Norway	Germany	Russia	UK (E+W)	UK (Scot.)	Total
1988				1				1
1989	20	181		5	52			258
1990	75	1470		4				1549
1991	22	2281	7	1				2311
1992	551	3259	1	6				3817
1993	339	1328		14				1681
1994	286	381		1				668
1995	405	818						1223
1996	93	983		2				1078
1997	53	1059						1112
1998	50	1617						1667
1999	104	1861	2			29		1996
2000	48	1699		1		43		1791
2001	84	1932						2016
2002	176	774				81		1031
2003	490	1032				10		1532
2004	508	985			6		76	1575
2005	903	884	1		1		48	1837
2006	900	875						1775
2007	838	862						1700
2008	665	447						1112
2009	322	122					2	446
2010	229	381					1	611
2011	63	11						74
2012	16	28						44
2013	24	36						60
2014	33	44						77
2015	24	28						52
2016	30	7						38
2017	9	21						30
2018	0	6						6
2019	19	11						30
2020	20	13						33
2021	12	10						22
2022*	0.732	5.967	0.509				0.345	7.553

Information from deepwater surveys

Overview of the roundnose grenadier sampling from the deepwater surveys in September are showed in Table 2. The mean lengths in the surveys were between 14.8- 17.5 cm (Figure 1). The length- round weight relation is presented in Figure 2. The spatial distribution was mainly on the Wyville-Thomsen ridge (Figure 3).

An investigation of the roundnose grenadier catch according to depth and temperature data showed that roundnose grenadier were distributed in depths deeper than around 600 m and temperatures warmer than 6°C. This is in accordance with the oceanic temperature and depth distribution in Faroese waters.

Table 2. Roundnose grenadier 5.b. Sampling overview from the deepwater survey (no survey in 2021).

Year	Lengths	Round weights	Gender	Maturity	Otoliths	Liver weights	Gonad weights	Stomachs
2014	209	186	72	72	69		18	10
2015	166	103	40	40	40			11
2016	153	139	30	30	30			7
2017	234	174	52	52	52			23
2018	101	92	21	21	21			5
2019	80	80	28	28	25			8
2020	41	31	5	5	5			3
2021	-	-	-	-	-	-	-	-
2022	143	140	46	46	46	11	14	12
Total	1127	945	294	294	288	11	32	79

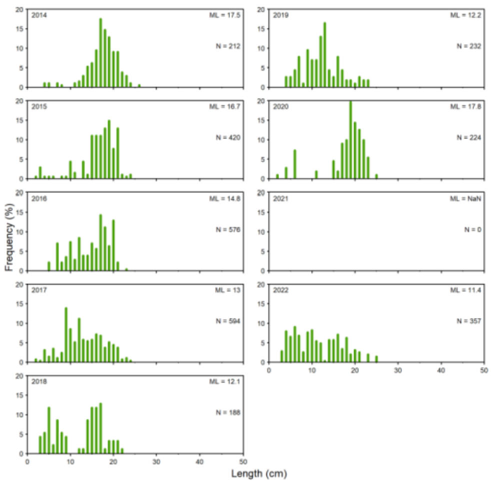


Figure 1. Roundnose grenadier 5.b. Length distribution in the deepwater surveys.

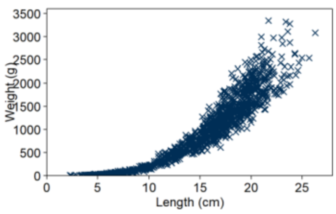


Figure 2. Roundnose grenadier 5.b. Length - round weight relation in the deepwater surveys.

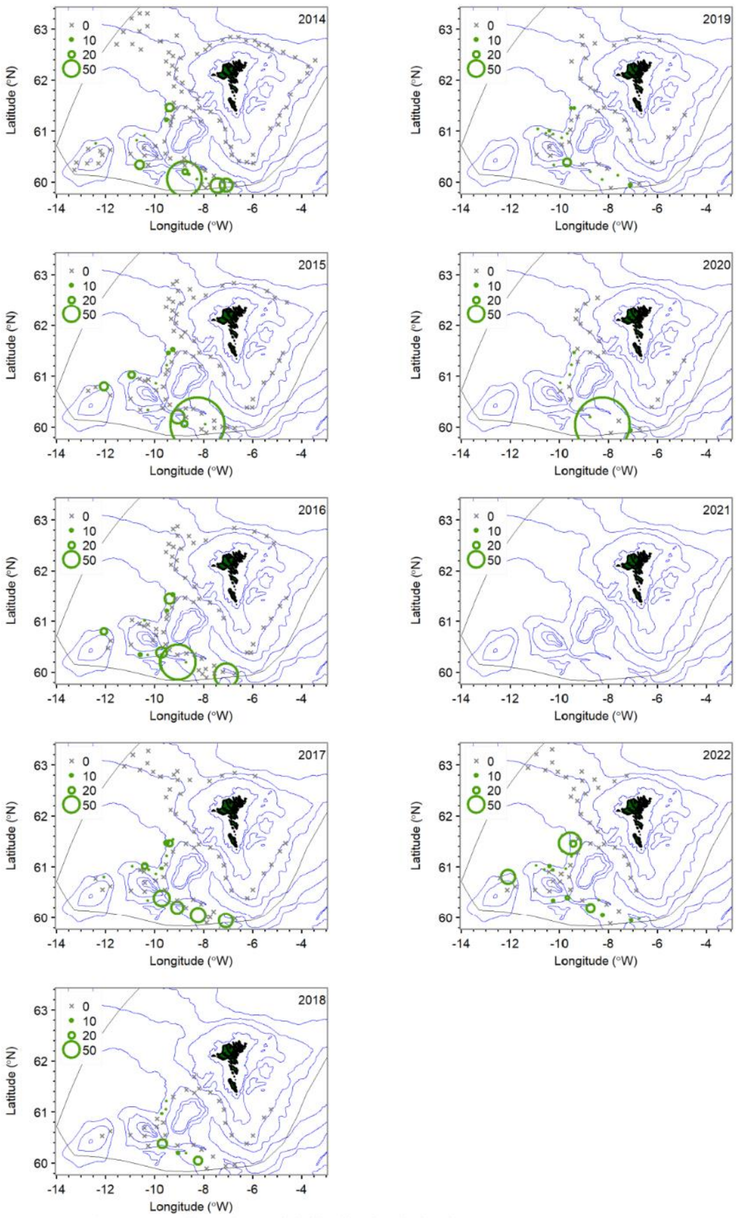


Figure 3. Roundnose grenadier 5.b. Spatial distribution in the deepwater surveys 2014-2022 (no survey in 2021).

WGDEEP 2022, WD xx

CPUE Standardization of Silver smelt in 5b and 6a @ WGDEEP 2022

N.T. Hintzen and H. Olsen

Corresponding author: nhintzen@pelagicfish.eu

24/04/2023

Abstract

At the WKGSS 2020 benchmark of Greater silver smelt in 5b and 6a, a combined and standardized CPUE series for the Faroe and EU fleets has been introduced (Quirijns and Pastoors 2020). On checking the data in preparation for WGDEEP 2023, a few errors were detected in the way CPUE was calculated, which was proposed as a correction for the assessment in WGDEEP 2023. These relate to 1. the rounding of CPUE values as the model fitted is a negative binomial (small impact) 2. the introduction of smoothers for the week and depth effect rather than fitting them as independent covariates througout 3. the introduction of a fleet effect to account for a mis-balance in data availability througout the time-series with almost an absence of PFA data in the early part of the time-series where Faroese data was availabe. Furthermore, the method applied in WGDEEP 2023 has been extended to cover the whole time series up to 2022.

It is noted that the signals in the two separate CPUE series are somewhat different in the most recent year, with a decline observed in the Faroese CPUE and an increase observed in the PFA CPUE.

1 Introduction

At the WKGSS 2020 benchmark of Greater silver smelt in 5b and 6a, a combined and standardized CPUE series for the Faroe and EU fleets has been introduced (Quirijns and Pastoors 2020).

2 Results

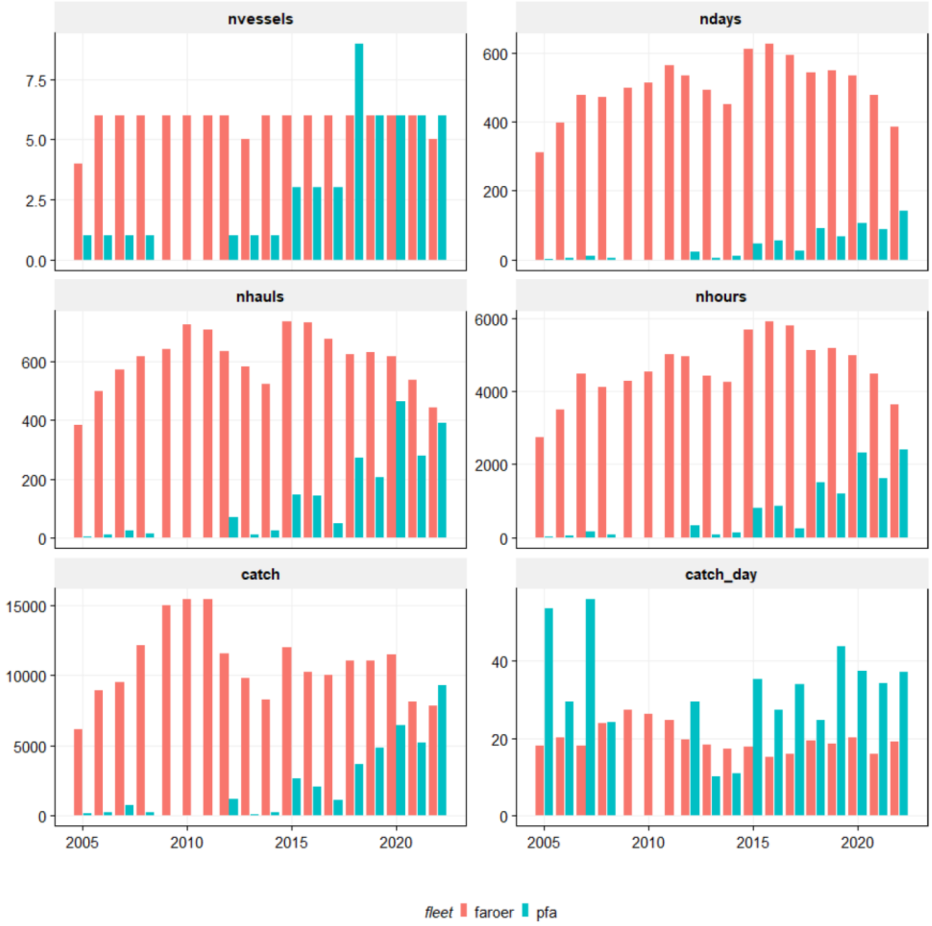


Figure 1: ARU.27.5b6a metrics describing the fisheries

The 'raw' (unstandardized) CPUE is based on the catch per day.

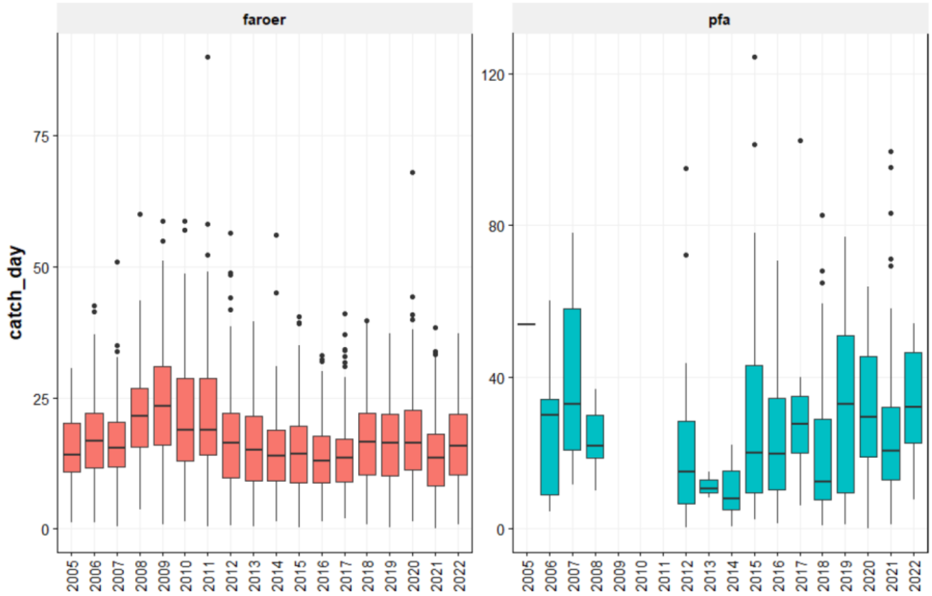


Figure 2: ARU.27.5b6a Catch per unit effort.

For the years 2005-2022, below are the spatial distributions of the used number of hauls by fleet.

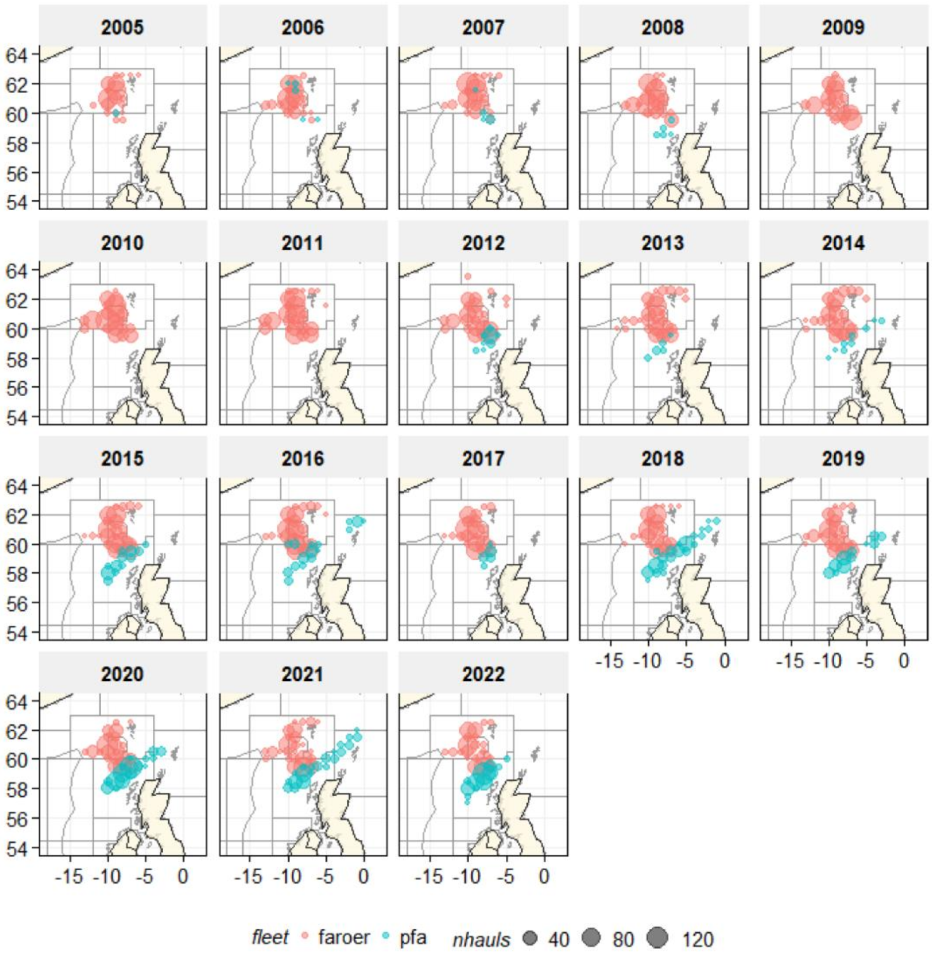


Figure 3: ARU.27.5b6a plot of the number of hauls by rectangle and day

Standardized CPUE index

We applied un updated model for standardization of of CPUE: CPUE ~ year + s(week) + s(depth) + fleet, where CPUE is expressed as catch per day and per rectangle. Catches have first been summed by vessel, year, week and rectangle and the number of hauls and fishing days have been calculated. Then the catches and effort (fishing days) have been summed over all vessels by year, week, fleet and the average depth has been calculated. CPUE was then calculated as the average catch per rectangle and per day by fleet.

The differences in modelling approach are shown below where we compare the model setup used in WGDEEP 2022 with the glm and gam approach.

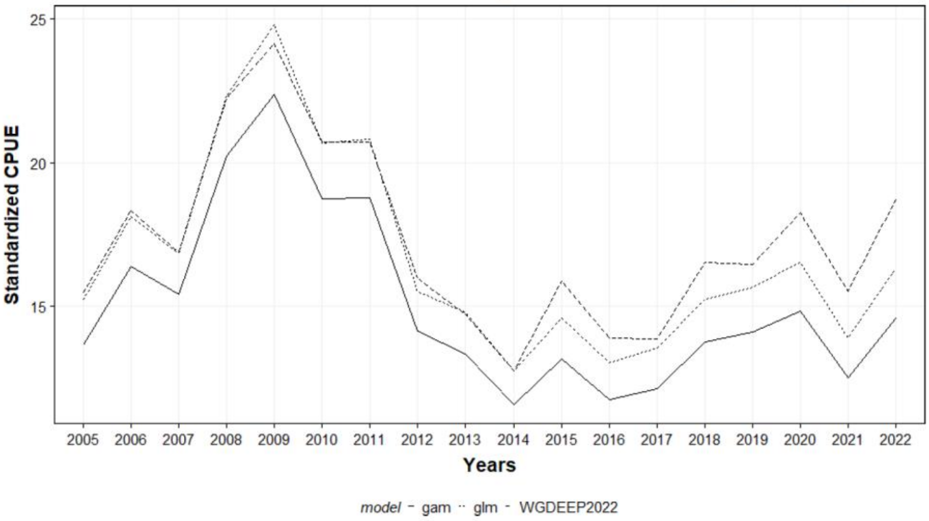


Figure 5: ARU.27.5b6a comparison of standardized CPUE between WGDEEP 2022 and updated model settings

Not only a scaling is visible, but also a change in trend from around 2015 onwards.

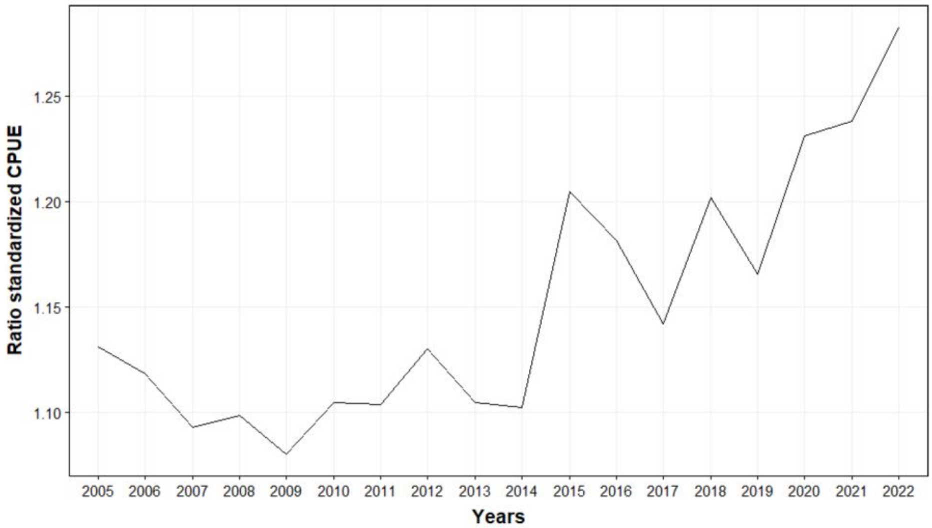


Figure 6: ARU.27.5b6a ratio between WGDEEP 2022 and updated standardized CPUE model settings

Finally, the comparison of the WGDEEP 2022 and WGDEEP 2023 time-series is presented.

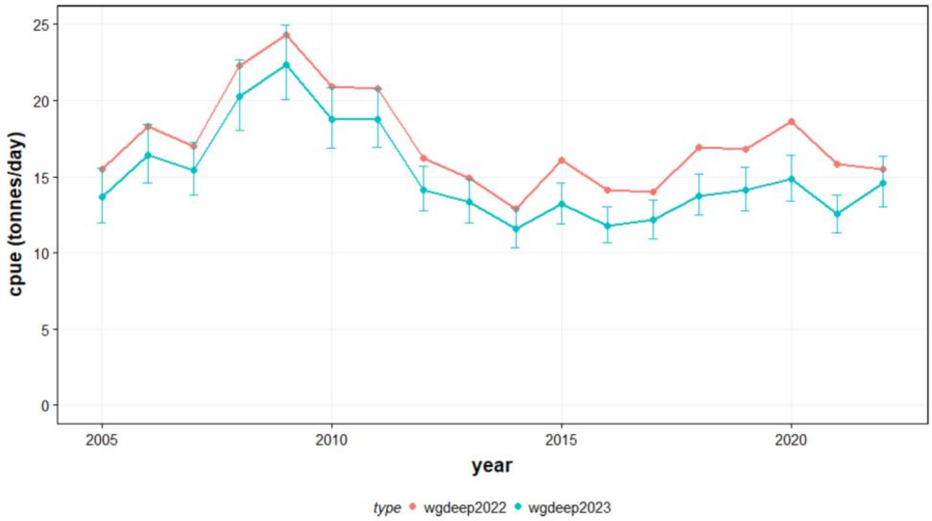
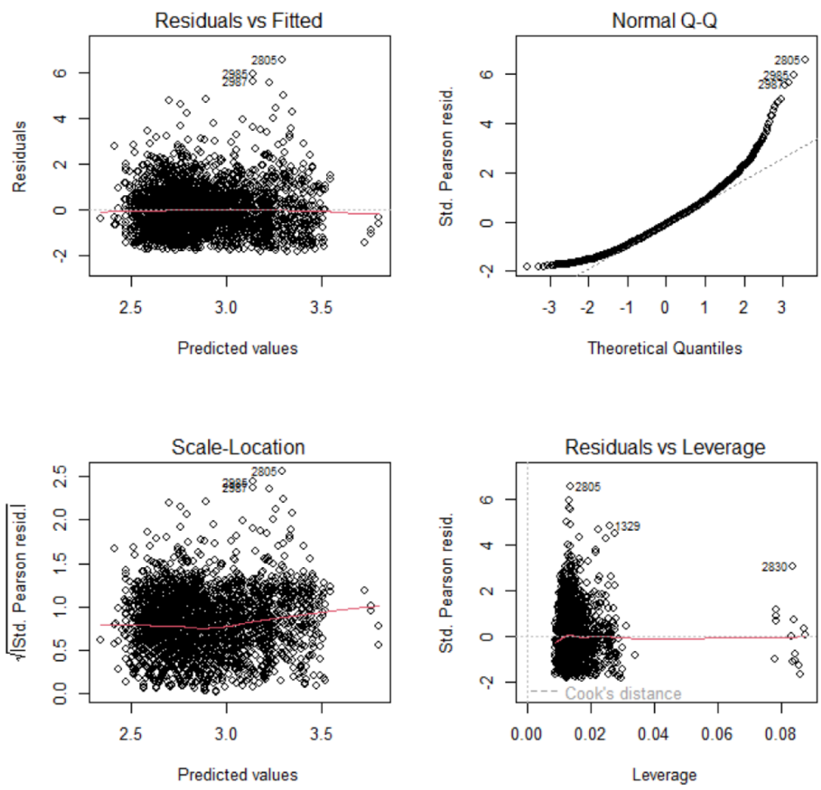


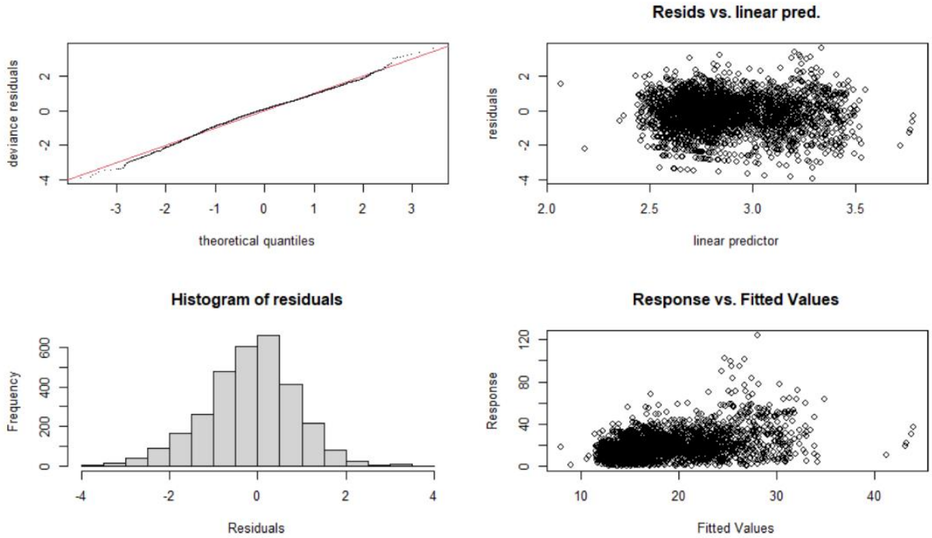
Figure 4: ARU.27.5b6a standardized CPUE (catch per rectangle and day), in comparison with WKGSS series

Model diagnostics




```
Analysis of Deviance Table

Model: Negative Binomial(3.7212), link: log

Response: get(cpuevar)

Terms added sequentially (first to last)

          Df Deviance Resid. Df Resid. Dev Pr(>Chi)
NULL                       3064     3823.0
fyear     17  201.071      3047     3621.9  < 2e-16 ***
fweek     19  160.783      3028     3461.1  < 2e-16 ***
depth_cat  6   11.277      3022     3449.8  0.08017 .
fleet      1  191.585      3021     3258.3  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 7a: ARU.27.5b6a standardized CPUE GLM model diagnostics




```
Method: UBRE   Optimizer: outer newton
full convergence after 5 iterations.
Gradient range [3.912368e-11,1.592991e-10]
(score 0.0805767 & scale 1).
Hessian positive definite, eigenvalue range [0.0002822595,0.0006414133].
Model rank =  37 / 37

Basis dimension (k) checking results. Low p-value (k-index<1) may
indicate that k is too low, especially if edf is close to k'.

           k'  edf k-index p-value
s(week)  9.00 6.16    0.82  <2e-16 ***
s(depth) 9.00 3.85    0.89  <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 7b: ARU.27.5b6a standardized CPUE GAM model diagnostics

Evaluation of explanatory variables

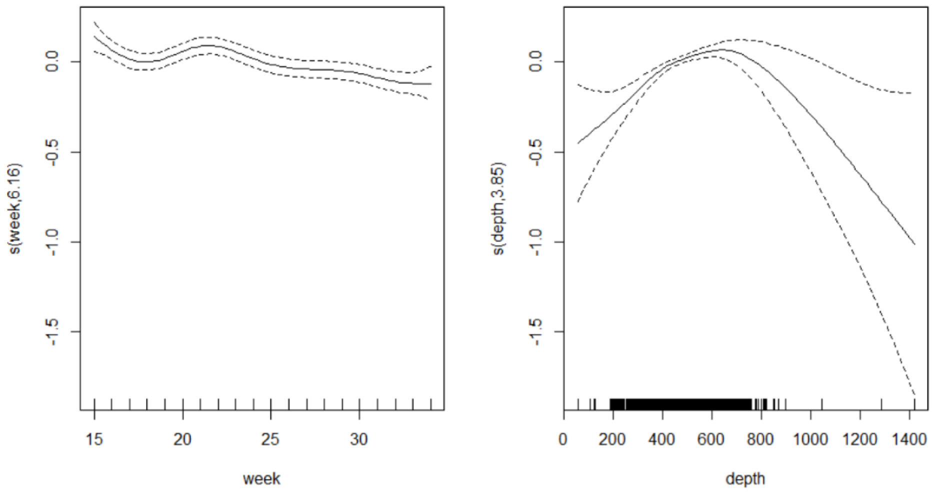


Figure 8: ARU.27.5b6a standardized CPUE explanatory variables

year	cpue	lwr	upr
2005	15.21	13.02	17.78
2006	18.13	15.67	20.97
2007	16.84	14.63	19.38
2008	22.31	19.37	25.69
2009	24.78	21.56	28.48
2010	20.69	18.06	23.72
2011	20.81	18.22	23.77
2012	15.53	13.61	17.73
2013	14.78	12.92	16.92
2014	12.76	11.1	14.66
2015	14.59	12.81	16.62
2016	13.04	11.46	14.84
2017	13.56	11.87	15.49
2018	15.23	13.38	17.34
2019	15.66	13.75	17.84
2020	16.52	14.48	18.85
2021	13.91	12.21	15.84
2022	16.33	14.19	18.79

Table 1: ARU.27.5b6a standardized (GLM) commercial CPUE (tonnes/day) for greater silversmelt, with lower and upper values based on the standard error.

year	cpue	lwr	upr
2005	13.66	11.97	15.59
2006	16.39	14.57	18.43
2007	15.43	13.79	17.25
2008	20.23	18.07	22.65
2009	22.36	20.05	24.94
2010	18.75	16.85	20.87
2011	18.76	16.92	20.79
2012	14.14	12.75	15.68
2013	13.33	11.97	14.84
2014	11.57	10.34	12.94
2015	13.18	11.91	14.58
2016	11.77	10.66	12.99
2017	12.14	10.95	13.46
2018	13.75	12.48	15.15
2019	14.12	12.77	15.61
2020	14.84	13.4	16.43
2021	12.53	11.35	13.83
2022	14.58	13.01	16.33

Table 2: ARU.27.5b6a standardized (GAM) commercial CPUE (tonnes/day) for greater silversmelt, with lower and upper values based on the standard error.

Single fleet analysis

A single fleet analysis was carried out by using the combined raw CPUE datasets and extracting the separate parts for the Faroese and PFA fleets. These data were then processed in a similar fashion as in the combined analysis. It is clear that the Faroese data is substantially more precise that the data from PFA as evident from the confidence intervals. This is likely due to the number of observations, where the dataset from Faroe Islands over all years is based on 10 times the number of hauls compared to the PFA data. In addition, the Faroese fishery is a targeted fishery for silver smelt, while the PFA fishery is a mixed fishery with blue whiting in the daytime and silver smelt in the nighttime.

It is noted that the signals in the two separate CPUE series are somewhat different in the most recent year, with a decline observed in the Faroese CPUE and an increase observed in the PFA CPUE.

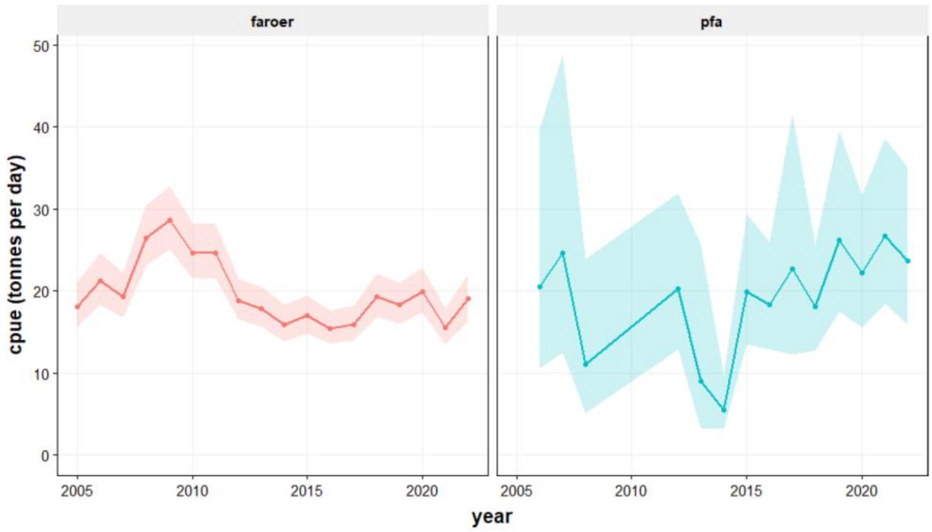


Figure 9: ARU.27.5b6a standardized single fleet CPUE (catch per rectangle and day)

3 Discussion

CPUE standardization using GAM procedures is a common way of dealing with CPUE information. Here we used aggregated data (catch per day) as the main response variable and year, week, depth and fleet as explanatory variables. Both area and period cannot use attributes that are related to the hauls. The standardized CPUE for WGDEEP 2023 shows a marked departure from WGDEEP 2022 time-series owing to the changes in the methodology described above.

Both data sources (Faroese data and PFA data) indicate an increase in CPUE in the last year again after a dip in 2021, although it does not reach the level seen in the late 2000s. The data from the Faroese fisheries are generated from a targetted fishery on silver smelt, while the data from the PFA is from a mixed fishery with blue whiting (blue whiting in the daytime, silver smelt in the nighttime). This probably leads to the higher uncertainties in the CPUE estimates for the PFA compared to the Faroese fleet. It is also noted that the number of observations in the PFA fisheries prior to 2015 is much lower than after 2015, because the self-sampling program only started in 2015.

It is noted that the signals in the two separate CPUE series are somewhat different in the most recent year, with an increase observed in the Faroese CPUE and a decrease observed in the PFA CPUE.

4 References

ICES (2020). Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP). ICES Scientific Reports. Volume 2, Issue 38: 928 pp.

Pastoors, M. A. and F. J. Quirijns (2020). Correcting an error in the CPUE Standardizing of Greater silversmelt for WGDEEP 2020, WD05.

Quirijns, F. J. and M. A. Pastoors (2020). CPUE standardization for greater silversmelt in 5b6a. WKGSS 2020, WD03.

PFA self-sampling report for WGDEEP 2023 (v1)

Niels Hintzen, 30/03/2023 22:24:52

Summary

This report summarizes the self-sampling data collected by the Pelagic Freezer-trawler Association (PFA) with a focus on Argentines or Silversmelts. The self-sampling data consists of two main sources: (1) the historical catch per haul data derived from a limited number private logbooks of skippers, and (2) the self-sampling program that has been initiated from 2015 onwards on an increasing number of freezer-trawlers.

The PFA fishery for argentines takes place in the months April and May, and sometimes into June. The predominant fishing area is ICES division 27.6.a with also some catches being taken in 2.a, 4.a and 5.b. The fishery is combined with the fishery for blue whiting, whereby the catches of blue whiting take place during the day and catch of argentines mostly in the night.

Overall, the self-sampling activities for the argentines fisheries during the years 2016 – 2023 covered 42 fishing trips with 1254 hauls, a total catch of 78562 tonnes and 67255 individual length measurements.

The length compositions of argentines are relatively stable over the years, varying between medians of 34 to 36 cm.

1 Introduction

The Pelagic Freezer-trawler Association (PFA) is an association that has nine member companies that together operate 19 freezer trawlers (in 2023) in six European countries (www.pelagicfish.eu). In 2015, the PFA has initiated a self-sampling program that expands the ongoing monitoring programs on board of pelagic freezer-trawlers by the specialized crew of the vessels. The primary objective of that monitoring program is to assess the quality of fish. The expansion in the self-sampling program consists of recording of haul information, recording the species compositions per haul and regularly taking random length-samples from the catch. The self-sampling is carried out by the vessel quality managers on board of the vessels, who have a long experience in assessing the quality of fish, and by the skippers/officers with respect to the haul information. The scientific coordination of the self-sampling program is carried out by Niels Hintzen (PFA chief science officer) with support of Lina de Nijs (PFA) and Floor Quirijns (contractor).

2 Overview of self-sampling methodology

The PFA self-sampling program has been incrementally implemented on freezer-trawler vessels from the Netherlands, UK, Germany, France, Poland and Lithuania during the years 2015-2017. From 2018 onwards, all vessels in the association are covered by the self-sampling program. The program is designed in such a way that it follows as closely as possible the working practices on board of the different vessels and that it delivers the biological and fisheries information needed for the relevant scientific bodies (e.g. ICES, SPRFMO, CECAF), certification bodies (e.g. MSC) and as a mechanism of feedback for the participating companies.

The following main elements can be distinguished in the self-sampling protocol:

- haul information (date, time, position, weather conditions, environmental conditions, gear attributed, estimated catch, optionally: species composition)
- batch information (total catch per batch=production unit, including variables like species, average size, average weight, fat content, gonads y/n and stomach fill)
- linking batch and haul information (essentially a key of how much of a batch is caught in which of the hauls)
- length information (length frequency measurements, either by batch or by haul)
- biological information (measuring individual fish)

The self-sampling information was initially collected using standardized Excel worksheets. From 2018 onwards a transition is being made from Excel spreadsheet to dedicated data-recording software (M-Catch) with live synchronization to a shore-based system. The information collected during a trip will be sent for data processing by the end of the trip. The self-sampling data is being checked and added to the database by Floor Quirijns and/or Martin Pastoors, who also generate standardized trip reports (using RMarkdown) which are being sent back to the vessel and company. The compiled data for all vessels is being used for specific purposes, e.g. reporting to expert groups, addressing specific fishery or biological questions and supporting detailed biological studies. The PFA publishes an annual report on the self-sampling program.

For this report, the PFA self-sampling data has been filtered for vessel-trip-week combinations using the following criteria:

- hauls in divisions 27.6.a; 27.5.b; 27.4.a
- catch of arg by trip and week at least 10% of the total catch of that trip and week.
- catch of arg by trip and week at least 10 tonnes.

The selection resulted in 99 vessel-trip-week combinations over the years 2016-2022.

A particular challenge in the PFA self-sampling program is dealing with the different length metrics in use. Routinely, on freezer-trawlers, fish will be measured in standard length (SL, until the onset of the tail of the fish). However, for scientific purposes, length is required mostly in total length (TL), or, in the case of the South Pacific RFMO, in fork length (FL). The PFA self-sampling program aims to utilize the appropriate scientific length metric: TL in Europe and Africa, FL in the South Pacific. However, in some instances, the quality managers on board of the vessels have used the wrong length metric for the area they were fishing in. Until 2021, these situations were 'corrected' by applying a direct length-to-length conversion based on data from individual measurements of SL, FL and TL. It was recognized that this approach could lead to holes in the length distributions.

In 2022 a new method of converting length-to-length was implemented, based on the paper by Hansen et al (2018). The method consists of generating simulated length-length-keys similar to the often used age-length-keys. The implementation of the new method means to some differences may exist in length data compared to previous reports.

3 Results

3.1 General

An overview of all the self-sampled trips for arg in 27.6.a, 27.5.b, 27.4.a. The percentage non-target species is defined as the catch of non-pelagic species relative to the catch of pelagic species.

year	nvessels	ntrips	ndays	nhauls	catch	catch/day	nontarget	nlength	nbio
2016	2	2	30	65	3,980	133	3.28%	5,478	0
2017	3	3	33	90	7,464	226	1.23%	6,150	0
2018	7	7	67	172	8,426	126	1.79%	10,931	509
2019	6	7	48	118	10,792	225	0.06%	7,450	7
2020	7	9	104	288	15,342	148	0.53%	14,258	131
2021	5	6	59	139	10,704	181	0.74%	6,607	102
2022	6	8	148	382	21,855	148	1.58%	16,381	16
(all)		42	489	1,254	78,563			67,256	765

Table 3.1.1: PFA deepwater fisheries for argentines. Self-sampling Summary of number of vessels, trips, days, hauls, catch (tonnes), catch per day(tonnes/day), percentage non-target species, number of fish measured and number of biological samples

Catch and number of self-sampled hauls by year and division

division	2016	2017	2018	2019	2020	2021	2022	all	perc
27.6.a	3,980	7,464	8,426	10,792	15,342	10,704	21,855	78,563	100.0%
(all)	3,980	7,464	8,426	10,792	15,342	10,704	21,855	78,563	100.0%

division	2016	2017	2018	2019	2020	2021	2022	all	perc
27.6.a	65	90	172	118	288	139	382	1,254	100.0%
(all)	65	90	172	118	288	139	382	1,254	100.0%

*Table 3.1.2: PFA deepwater fisheries for argentines. Self-sampling Summary of catch (top) and number of hauls (bottom) per year and division. * denotes incomplete year*

Catch and number of self-sampled hauls by year and month

month	2016	2017	2018	2019	2020	2021	2022	all	perc
Apr	0	596	2,316	3,557	9,600	3,669	14,048	33,786	43.0%
May	3,033	6,868	6,110	7,234	4,522	7,035	7,807	42,610	54.2%
Jun	946	0	0	0	1,146	0	0	2,092	2.7%
Oct	0	0	0	0	75	0	0	75	0.1%
(all)	3,980	7,464	8,426	10,792	15,342	10,704	21,855	78,563	100.0%

month	2016	2017	2018	2019	2020	2021	2022	all	perc
Apr	0	4	50	33	143	39	247	516	41.1%
May	54	86	122	85	119	100	135	701	55.9%
Jun	11	0	0	0	19	0	0	30	2.4%
Oct	0	0	0	0	7	0	0	7	0.6%
(all)	65	90	172	118	288	139	382	1,254	100.0%

Table 3.1.3: PFA deepwater fisheries for argentines. Self-sampling summary of catch (top) and number of hauls (bottom) per year and month.

Catch and number of self-sampled hauls by year and country (flag)

flag	2016	2017	2018	2019	2020	2021	2022	all	perc
DEU	1,832	0	2,054	3,617	2,711	1,095	1,350	12,659	16.1%
LIT	0	0	0	0	75	0	0	75	0.1%
NL	2,148	7,464	6,372	7,175	12,556	9,610	20,504	65,830	83.8%
(all)	3,980	7,464	8,426	10,792	15,342	10,704	21,855	78,563	100.0%

flag	2016	2017	2018	2019	2020	2021	2022	all	perc
DEU	27	0	59	46	74	27	44	277	22.1%
LIT	0	0	0	0	7	0	0	7	0.6%
NL	38	90	113	72	207	112	338	970	77.4%
(all)	65	90	172	118	288	139	382	1,254	100.0%

Table 3.1.4: PFA deepwater fisheries for argentines. Self-sampling summary of catch (top) and number of hauls (bottom) per year and month.

Catch by species and year

species	english_name	scientific_name	2016	2017	2018	2019	2020	2021	2022	all	perc
whb	blue whiting	Micromesistius poutassou	2,234	5,030	5,082	6,792	9,116	6,093	11,963	46,310	58.9%
arg	argentines	Argentina spp	1,580	2,248	3,013	3,899	5,946	4,398	9,416	30,501	38.8%
mac	mackerel	Scomber scombrus	15	94	179	95	199	132	131	846	1.1%
hke	hake	Merluccius merluccius	113	89	125	3	39	50	277	696	0.9%
sqr	squid	Loligo vulgaris	0	0	4	0	15	5	47	72	0.1%
mcd	NA	Ceratoscopelus maderensis	0	0	0	0	11	18	2	31	0.0%
hom	horse mackerel	Trachurus trachurus	19	0	1	0	0	1	0	21	0.0%
sqm	Broadtail shortfin squid	Illex coindetii	0	0	0	0	0	4	15	19	0.0%
mzz	other fish	Osteichthyes	0	0	19	0	0	0	0	19	0.0%
boc	boarfish	Capros aper	18	0	0	0	0	0	0	18	0.0%
squ	various squids nei	Loliginidae, Ommastrephidae	0	0	0	3	14	0	0	17	0.0%
pok	saithe	Pollachius virens	0	3	2	0	0	3	0	7	0.0%
gfb	NA	Phycis blennoides	0	0	0	0	1	0	3	4	0.0%
brf	NA	Helicolenus dactylopterus	0	0	0	0	0	0	0	1	0.0%
usk	Tusk	Brosme brosme	0	0	0	0	0	0	0	0	0.0%
oth	NA	NA	0	0	0	0	0	0	0	0	0.0%
(all)	(all)	(all)	3,980	7,464	8,426	10,792	15,342	10,704	21,855	78,563	100.0%

Table 3.1.5: PFA deepwater fisheries for argentines. Self-sampling Summary of total catch (tonnes) by species. OTH refers to all other species that are not the main target species

Haul positions

An overview of all self-sampled hauls in the PFA deepwater fisheries for argentines..

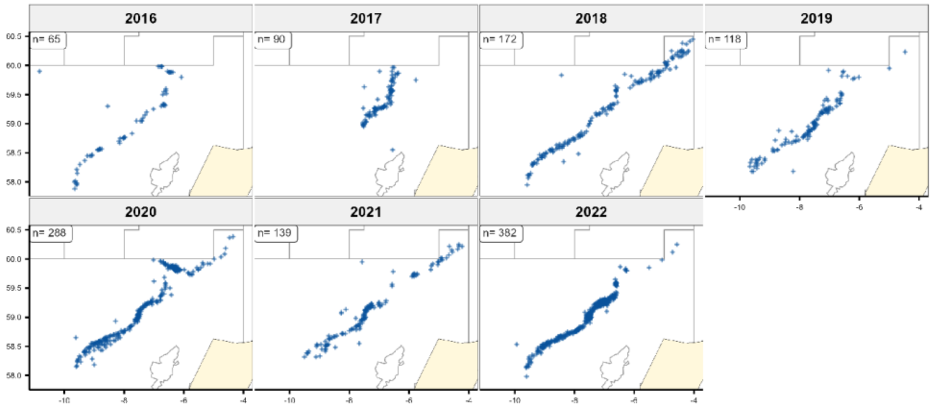


Figure 3.1.1: PFA deepwater fisheries for argentines. Self-sampling haul positions. N indicates the number of hauls.

Catches for the main target species

Summed catches (tonnes) of the main target species aggregated in rectangles.

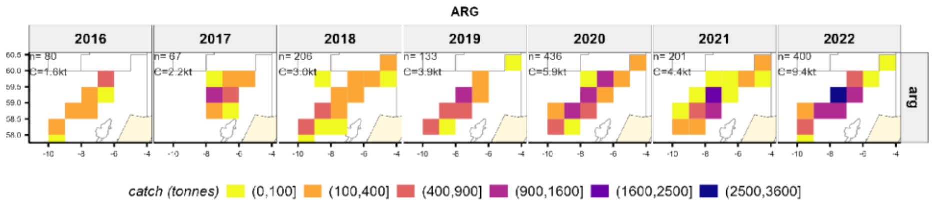


Figure 3.1.2: PFA deepwater fisheries for argentines. Self-sampling catch per species and per rectangle. N indicates the number of hauls. Catch refers to the total catch per year.

Catch rates (catch/day) for the main target species

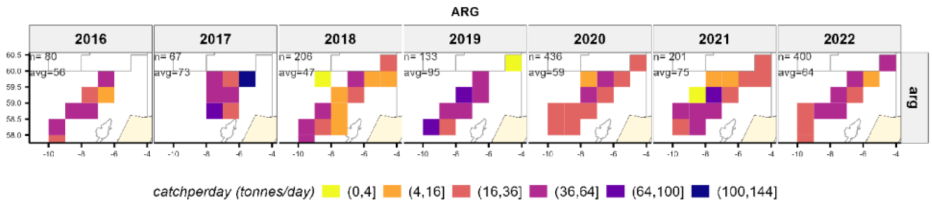


Figure 3.1.3: Average catch per day, per species and per rectangle. N indicates the number of hauls; avg refers to the average catch per day.

Average surface temperature by quarter and by rectangle.

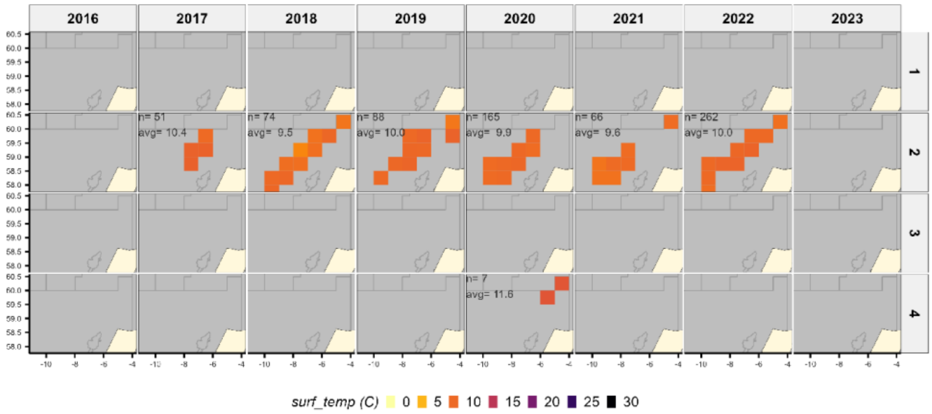


Figure 3.1.4: PFA deepwater fisheries for argentines. Average surface temperature (C) by year and quarter. N indicates the number of hauls. Avg refers to the average temperature.

Average fishing depth.

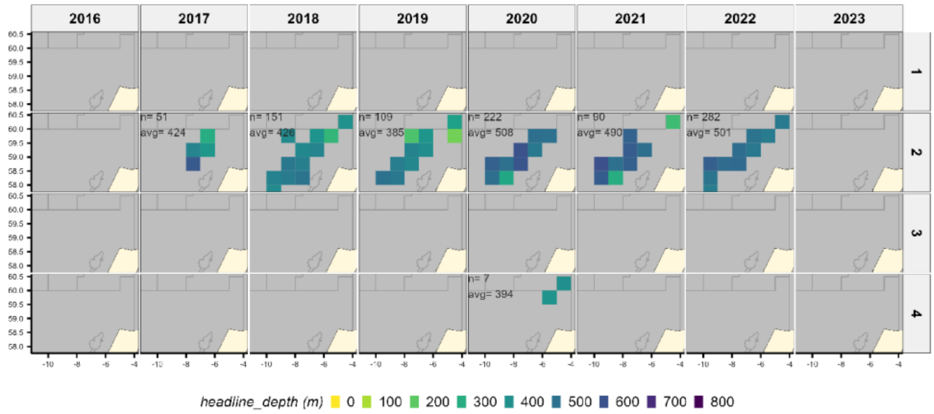


Figure 3.1.5: PFA deepwater fisheries for argentines. Average fishing depth (m) by year and quarter. N indicates the number of hauls. Avg refers to the average fishing depth.

Average wind force.

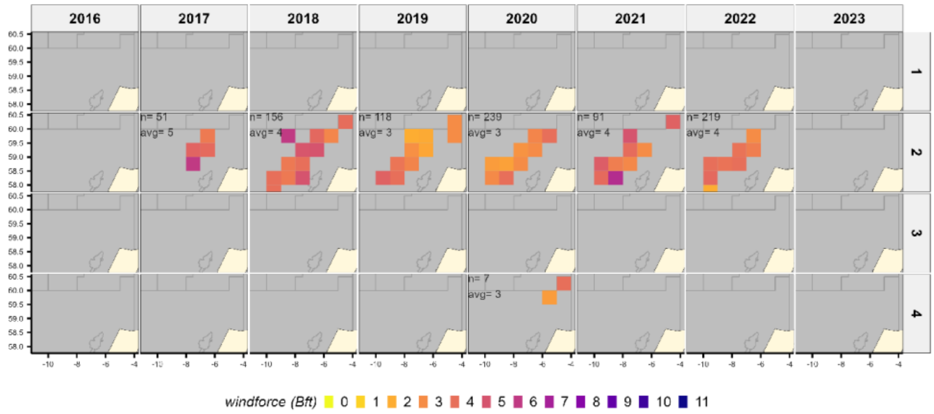


Figure 3.1.6: PFA deepwater fisheries for argentines. Average windforce (Bft) by year and quarter. N indicates the number of hauls. Avg refers to the average windforce.

3.2 Argentines (ARG, Argentinus sp.)

Argentines self-sampling summary.

species	year	nvessels	ntrips	ndays	nhauls	catch	catch/day	nlength	nbio
arg	2016	2	2	28	57	1,580	56	1,063	0
arg	2017	3	3	31	67	2,248	73	668	0
arg	2018	7	7	64	161	3,013	47	968	459
arg	2019	6	7	41	94	3,899	95	3,039	0
arg	2020	7	9	101	273	5,946	59	3,980	32
arg	2021	5	6	59	136	4,398	75	3,099	0
arg	2022	6	8	146	366	9,416	64	6,231	0
(all)	(all)		42	470	1,154	30,501		19,048	491

Table 3.2.1: Argentines. Self-sampling summary with the number of days, hauls, trips, vessels, catch (tonnes), catch rate (ton/day), number of fish measured, number of biological observations.

Argentines. Catch by division

species	division	2016	2017	2018	2019	2020	2021	2022	all	perc
arg	27.6.a	1,580	2,248	3,013	3,899	5,946	4,398	9,416	30,501	100.0%
(all)	(all)	1,580	2,248	3,013	3,899	5,946	4,398	9,416	30,501	100.0%

Table 3.2.2: Argentines. Self-sampling summary with the catch (tonnes) by year and division

Argentines. Catch by month

species	month	2016	2017	2018	2019	2020	2021	2022	all	perc
arg	Apr	0	38	811	720	3,201	1,289	5,739	11,799	38.7%
arg	May	1,333	2,210	2,202	3,179	2,276	3,110	3,677	17,986	59.0%
arg	Jun	248	0	0	0	452	0	0	700	2.3%
arg	Oct	0	0	0	0	16	0	0	16	0.1%
(all)	(all)	1,580	2,248	3,013	3,899	5,946	4,398	9,416	30,501	100.0%

Table 3.2.3: Argentines. Self-sampling summary with the catch (tonnes) by year and month

Argentines. Catch by rectangle

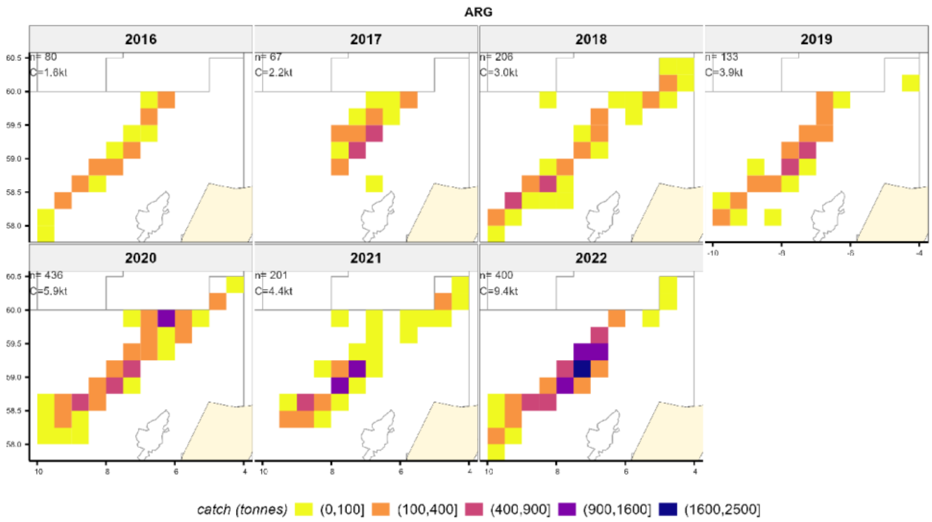


Figure 3.2.1: Argentines. Catch per rectangle. N indicates the number of hauls; Catch refers to the total catch per year.

Argentines. Catchrate (ton/day) by rectangle

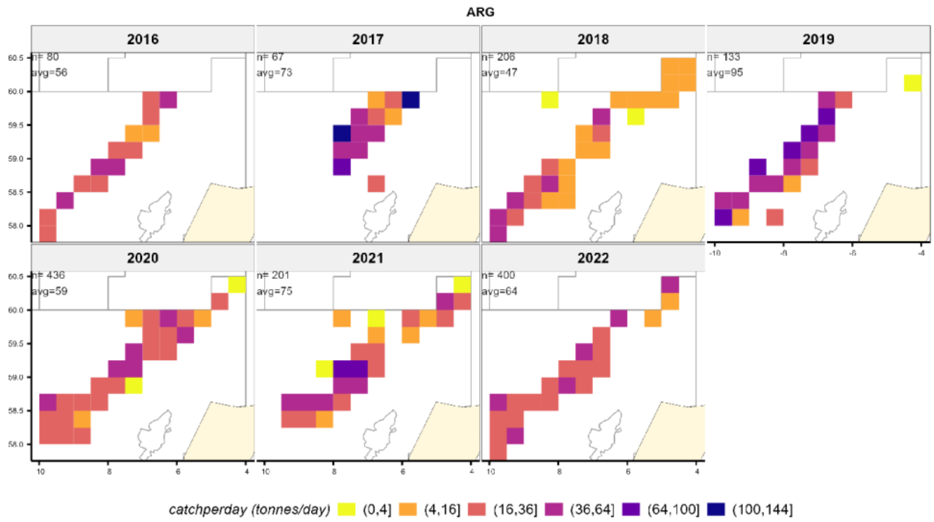


Figure 3.2.2: Argentines. Catchrate (ton/day) per rectangle. N indicates the number of hauls; Avg refers to the average catchrate per rect.

Argentines. Spatio-temporal evolution of catch by month and rectangle

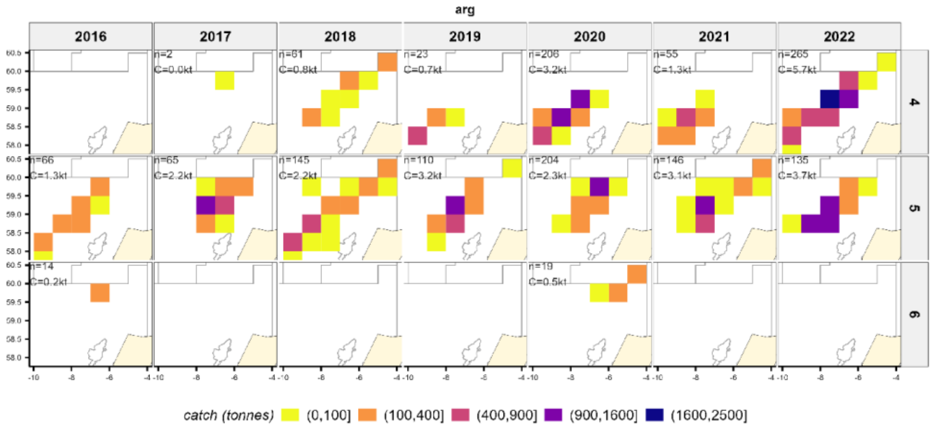


Figure 3.2.3: Argentines. Spatio-temporal evolution of the catches per rectangle and month. N indicates the number of hauls; C refers to the total catch by year and month.

Argentines. Catch proportion at depth

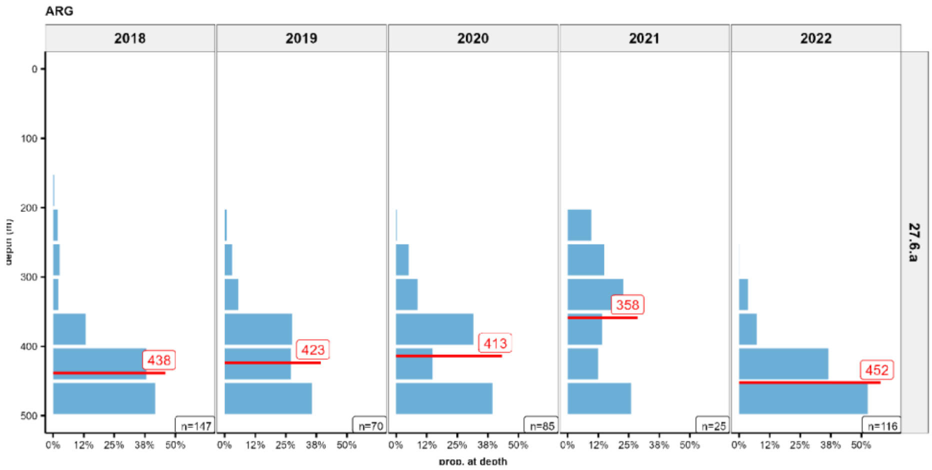


Figure 3.2.4: Argentines. Catch proportion at depth. N indicates the number of hauls.

Argentines. Length distributions of the catch

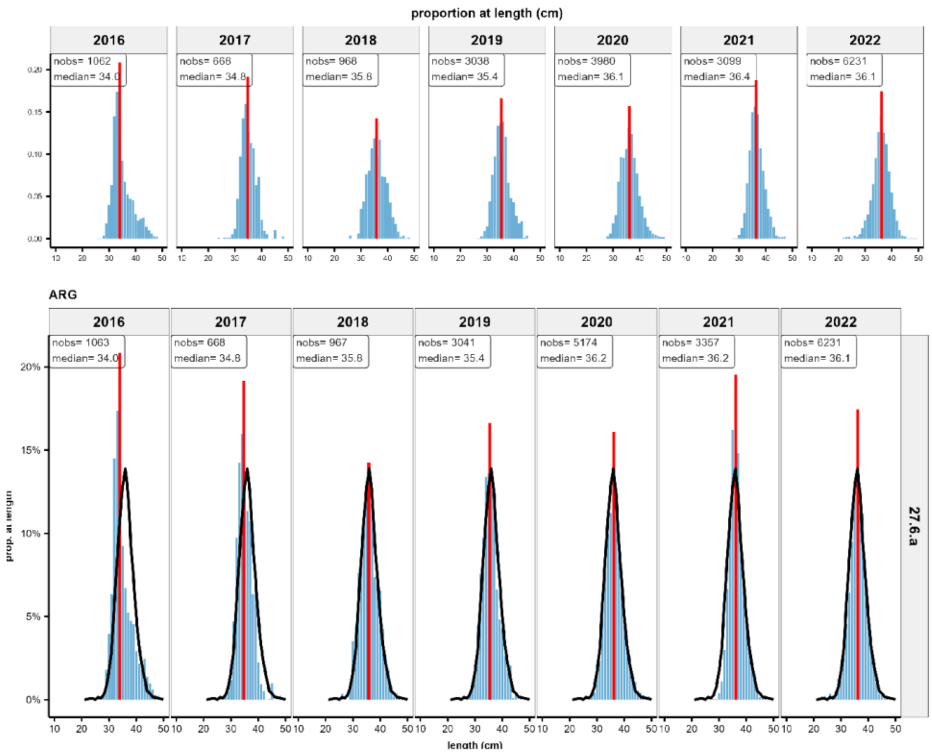


Figure 3.2.5: Argentines. Length distributions by year (top) and by year and division (bottom). Nobs refers to the number of observations; median denotes the median length.

Argentines. Length distributions as proportions by (large) rectangle

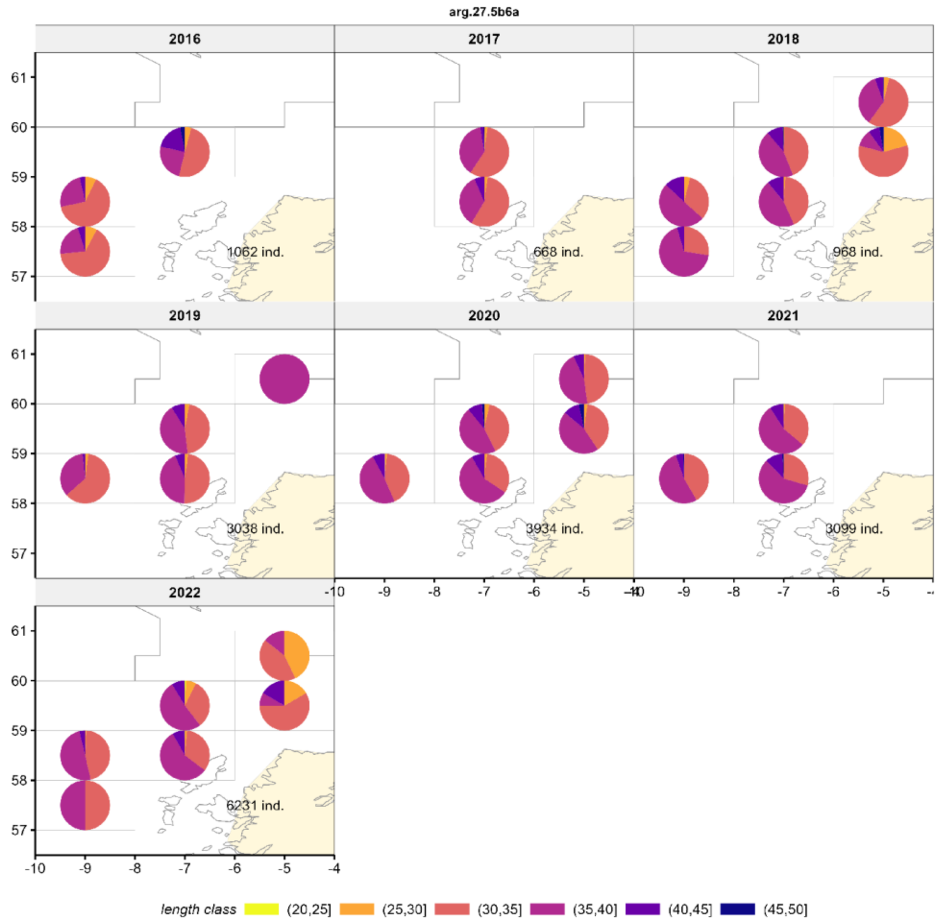


Figure 3.2.6: Argentines. Length distributions as proportions by large rectangle. Ind. refers to the number of length measurements

Argentines. Average length, weight and fat content by year and month

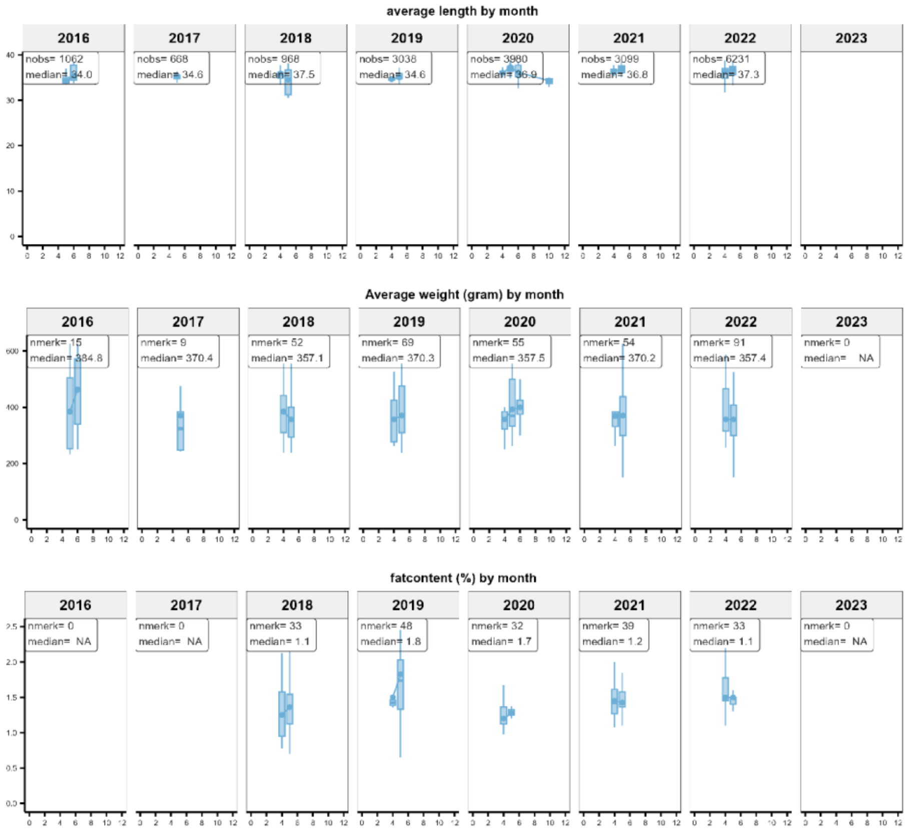


Figure 3.2.7: Argentines. Average length, average weight, and average fat content. Nobs indicates the number of measurements, median indicates the median values

4 Discussion and conclusions

From 2018 onwards, all PFA vessels were participating in the PFA self-sampling program.

The definition of what constitutes 'a fishery' for a certain species is not straightforward to resolve. In this report we selected all vessel-trip-week combinations with:

- hauls in divisions 27.6.a; 27.5.b; 27.4.a
- catch of arg by trip and week at least 10% of the total catch of that trip and week.
- catch of arg by trip and week at least 10 tonnes.

Since 2020, the measurements of average weight and fat content are included in the self-sampling report. Weights and fat content are routinely being collected for some of the target species (e.g. herring, mackerel) on the basis of production units (batches). The measurements are being carried out both when the species is the main target of the fishery and when it is a bycatch in other fisheries.

5 Acknowledgements

The skippers, officers and the quality managers of many of the PFA vessels are putting in a lot of effort to make the PFA the self-sampling work. Without their efforts, there would be no self-sampling.

6 References and publications

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7 More information

Please contact Niels Hintzen (nhintzen@pelagicfish.eu) if you would have any questions on the PFA self-sampling program or the specific results presented here.

Working Document No. 06 ICES WGDEEP May 3-9, 2023

Survey results of roughhead grenadier, roundnose grenadier, greater argentine, tusk, blue ling, black scabbard fish, ling, and orange roughy in ICES division 14b in the period 1998-2016 and 2022.

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Abstract
A stratified bottom trawl survey in East Greenland (ICES 14.b) has been conducted by the Greenland Institute of Natural Resources (GINR) from 1998 to 2016 (no survey was conducted in 2001), at depths between 400 to 1500 m with R/V Paamiut, using an Alfredo II bottom trawl gear. In 2017, R/V Paamiut was retired and in 2022 the survey was conducted with a new vessel owned by the GINR, R/V Tarajoq using also a new trawl gear, Bacalao 476. There was unfortunately not any comparative trawling between the old vessel R/V Paamiut and R/V Tarajoq. Survey results include biomass and abundance estimates and length frequency distributions, which are presented for roughhead grenadier (*Macrourus berglax*), roundnose grenadier (*Coryphaenoides rupestris*), greater argentine (*Argentina silus*), tusk (*Brosme brosme*), blue ling (*Molva dypterygia*), black scabbardfish (*Aphanopus carbo*), ling (*Molva molva*), and orange roughy (*Hoplostethus atlanticus*). Only roughhead grenadier and roundnose grenadier from ICES division 14.b have previously been reported to NWWG (Nogueira et al. 2023). This document contains the available information on the species mentioned above, in ICES division 14.b from scientific surveys from 1998 to 2016, and from 2022.

1. Introduction

During the period 1987-1989 the Japan Marine Fishery Resources Research Centre (JAMARC) and the Greenland Institute of Natural Resources (GINR) jointly conducted 3 bottom trawl surveys at East Greenland as part of a joint venture agreement on fisheries development and fisheries research in Greenland waters (Jørgensen and Akimoto 1990; Yatsu and Jørgensen 1988abc; Yatsu and Jørgensen 1989). The surveys were primarily aimed at Greenland halibut (*Reinhardtius hippoglossoides*) and redfish (*Sebastes* spp.) and covered various areas between Cape Farewell and 72°N at depths down to 1500 m. During the period 1989-1996 the GINR conducted annual shrimp trawl surveys with R/V Paamiut off East Greenland (Anon. 1997), but the surveys only covered depths down to 600 m with a poor coverage of depths > 400 m. In 1998, GINR initiated a bottom trawl surveys series with R/V Paamiut, which has been rigged for deep sea trawling. The survey has been carried out between 1998 and 2016 (except in 2001), and in 2017 R/V Paamiut was retired. A new survey was conducted in 2022, with the new R/V Tarajoq, owned by the GINR, using a new gear. There has unfortunately not been any comparative trawling between the Japanese R/V Shinkai Maru and R/V Paamiut, and between R/V Paamiut and R/V Tarajoq making comparisons between the surveys difficult, and there is very little overlap in the depth range between the shrimp trawl survey and the present survey. There was no survey off East Greenland in 2001. The vessel (R/V Paamiut) used for the surveys from 1998-2016 was retired in 2018 before paired trawling experiments with a replacement vessel could be conducted. In 2022, the new vessel owned by GINR, R/V Tarajoq with a Bacalao 476 trawl began a new survey series.

2. Materials and methods

The Greenland halibut surveys in East Greenland (ICES 14.b) were initiated in 1998. Until 2008, the survey was conducted in June, and had in almost all years suffered under the ice coverage found at the east coast of Greenland during early summer. Therefore, from 2008 and onwards surveys have taken place in August/September without ice induced problems. Also, in 2008 the survey was combined with a new shrimp/fish survey using a different trawl gear at more shallow waters than the Greenland halibut survey. The combination of the two surveys led to a change in trawling hours so that most of the stations since 2008 were taken during night-time. In 2022 the Greenland halibut survey was conducted between September 23 and October 7.

Stratification

The survey was planned to cover ICES Division 14.b from between the 3-nm line and the 200-nm line or the midline to Iceland at depths from 400 to 1500 m. The survey area was stratified in 5 Subareas Q1-Q5 (Table 1). Area Q1 consists of one depth stratum 401-600 m on Dohrn Bank in the northern part of the survey area. Area Q2 is the shelf area in the northern part of the survey area and is sub-divided in the depth strata 401-600, 601-800, 801-1000 and 1001-1500 m. Area Q3 is a large area with depths generally below 800 m. The stratification in the area has not been changed: 401-600, 601-800 and 801-1000 m. The slope, >1000 m, has not been covered due to steep and rough bottom. Area Q4 is not covered due to steep and rough bottom. Area Q5 is sub-divided in the depth strata 401-600, 601-800, 801-1200, 1201-1400 and 1401-1500 m. One area, Q6, off Southeast Greenland has been included in previous survey plans, but it has never been possible to make any hauls in the area due to ice and rough bottom. Therefore, Q6 has been excluded from the survey area since 2004. Survey areas of all Q-areas are presented in Table 1. In 2022, the Stratified Random Bottom Trawl Survey has been changed to a fix station allocation design due to many stations being moved and problems finding suitable fishing grounds because of rough sea bed.

Sampling design

From 1998 to 2016, the survey was planned as a Stratified Random Bottom Trawl Survey with a total of 70 hauls, which gives an overall coverage on 527 km^2 per haul. Each stratum was allocated at least two hauls. The remaining hauls were allocated in order to minimize the variance in the estimation of the biomass of Greenland halibut; *i.e.* strata with great variation in the catches of Greenland halibut in the previous year's surveys were assigned relatively more hauls than strata with little variation in the catches.

In 2004 a new method of choosing stations was introduced. The method combines the use of a minimum between-stations-distance rule (buffer zone) with a random allocation scheme (Kingsley et al. 2004). In Q5 depth stratum 801-1200 m had only 7 positions suitable for trawling. The positions of the 3 hauls allocated to this stratum were chosen at random between the 7 trawlable positions.

In 2022, the Stratified Random Bottom Trawl Survey has been changed to a fix station allocation design due to many stations being moved and problems finding suitable fishing grounds because of rough sea bed.

Vessel and gear and handling of the catch

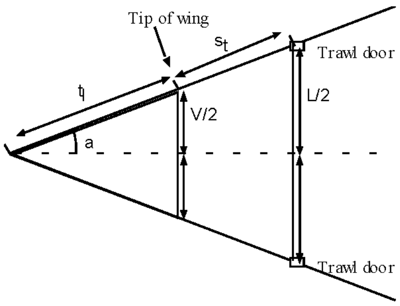
From 1998 to 2017, the survey was conducted by the 1084 GT trawler Paamiut, using an Alfredo III trawl with a mesh size on 140 mm and a 30-mm mesh-liner in the cod-end. The ground gear was of the rock hopper type. The trawl doors were changed to "Injector" type doors weighing 2700 kg in 2004, but this has not affected the performance of the trawl. Figures of rigging and bobbins chain together with further information about the gear is given in Jørgensen (1998). A Furuno net sonde mounted on the head rope measured net height. Scanmar sensors measured the distance between the trawl doors. In 2022, R/V Tarajoq (2896 GT) began a new survey series using a Bacalao 476 trawl with a mesh size of 136 mm and a 30-mm mesh-liner in the cod-end (Table 2). The same doors as on R/V Paamiut are used on R/V Tarajoq.

Swept area calculation

Nominal swept area for each tow was calculated as the straight-line distance between its GPS start and end positions multiplied by the wingspread. The distance between the trawl doors is recorded 3 or 5 times during each tow; provided it was recorded at least 3 times. Wingspread with the Alfredo trawl, taken as the distance between the outer bobbins, was calculated as:

Distance between outer bobbins = 10.122 + distance between trawl doors * 0.142

This relationship was estimated based on flume tank measurements of the trawl and rigging (Jørgensen 1998).
In 2022, the gear was changed to Bacalao 476 gear. The wingspread for a tow was calculated from the mean door spread and the geometry of the trawl as if the shape would be a triangle. V has been calculated as follows; Where the trawl and the trawl plus bridles are assumed to form two similar triangles, bridles and wings making a straight line:



and the lengths of the bridles (s) and the trawl wings (t) are known. The wingspread V is then calculated as:
$V = (t_l * L) / (t_l + s_t)$
where L is the distance between the doors (doorspread). The trawl wing is 26.83 meters and the length of the bridles is 129 m. Because the shape of the Bacalao gear is not a triangle, a constant based on the sensors measurements during the Canadian survey at the same depths was applied. Scanmar sensors measured wingspread during the deep

Canadian survey in Subarea 0A. The difference between our estimation and the sensors measurement in each depth strata has been added as a constant in our wingspread calculations.

Trawling procedure

Towing time is usually 30 min, but towing times down to 15 min are accepted. Towing speed is between 2.5-3.0 kn and is estimated from the start and end positions of the haul. Since 2008, trawling takes place day and night. Previously, trawling was conducted only during day time.

3. Results and discussion

The available data from scientific surveys reveal that the evaluated species are present in ICES division 14.b in very different quantities. Below data are presented for each species with focus on the most recent year the species has been registered. Overall length distributions are shown only for years when more than 20 specimens of a given species were available. In total 73 hauls were made in 2022 (Table 4), with good coverage of all areas.

Roughhead grenadier (*Macrourus berglax*, RHG)

Roughhead grenadier was caught in 59 of the 73 hauls in 2022. Catches ranged from 0.246 kg to 736.33 kg, taken at 677 m in Q2 (Appendix, 1). The species was found in all strata. The vast majority of the biomass was found in Q2, similar to other years (Table 6). The biomass has been at a similar level from 1998 to 2007, where it ranged between 3151 tonnes to 5702 tonnes (Table 5, Fig. 1). The biomass then increased from 2008 until 2016 where it ranged between 5871 tonnes to 9208 tonnes (Table 5, Fig. 1). This increase could be linked to the change in survey design, where most stations from 2008 and onwards were taken during night time. The biomass since 2008 appears stabil although fluctuating (Fig. 1). In 2022, the biomass was 12915 t (S.E. = 3861, Table 5).In 2022, the abundance was estimated $7338*10^3$ (S.E. = $1703*10^3$) and follows a similar distribution pattern as the biomass (Table 6). The overall length distribution in 2022 was dominated by a clear mode at 20 cm similar to previous years (Fig. 4). From 2010 to 2016, a smaller second mode around 30 cm was present in the time series, and it became very high in numbers in 2022. The higher numbers found in the second mode in 2022 could be due to changes in the gear selectivity.

Roundnose grenadier (*Coryphaenoides rupestris* ; RNG)

Roundnose grenadier was caught in 18 of the 73 hauls and catches were generally very low, and were only found in Q2 at 1001-1500 and Q5 between depth of 601 to 1500 m (Table 7 and 8). The total biomass estimate for roundnose grenadier in 2022 is 84 t (S.E. = 17) (Table 7, which is very low. The abundance estimate follows the same pattern with a total estimate of $1364*10^3$ (S.E. = $436*10^3$), (Table 7, Fig. 6). The majority of the fish are found in the deeper parts (800 – 1000 m) of Q2 (Table 8). In 2022, there was a mode in the length distribution around 3 cm (Fig. 8), which may indicate there are currently only smaller individuals and less larger ones (which were previously regularly visible in the length distribution).

Greater argentine (*Argentinus silus*; ARU)

In 2022, greater argentine was caught in 24 of the 74 hauls. Catches ranged from 0.35 kg to 94.04 kg. The vast majority of the biomass was found in Q2 and Q5 at depth less that 1100 m (Table 10, Fig. 11). Biomass for greater argentine has been increasing from 1998 t (6.4 tonnes) to 2016 (808.1 tonnes), peaking in 2014 (2166.7 tonnes)

(Table 9, Fig. 9). In 2022, the biomass was 1061.44 t (SE = 713.84).tonnes In 2022, the abundance was estimated to 2260.9*10^3 (S.E. = 1653.7*10^3) and generally follows the same patterns as biomass (Table 10).
The overall length distribution shows that from 2003-2011 and 2014-2016 catches were dominated by a mode around 30-40 cm, whereas a second mode around 20 cm was evident in years 2012-2013 (Fig. 12). In 2022, only one mode around 38 cm was found.

Tusk (*Brosme brosme*, USK)

In 2016, tusk was caught in 17 of the 74 hauls. Catches ranged from 0.9 kg to 13 kg. The species was caught in all subareas but the majority of the biomass was in Q2 similar to previous years (Table 12, Fig. 15) Biomass for tusk has been low until 2010 (mean biomass = 18.2 t), with no catches in 1998, 1999 and 2005. From 2010 untill 2016, the biomass has been distinctly higher (mean biomass = 275 tonnes) ranging from 78.8 tonnes (2014) to 504.0 tonnes (2013) (Table 11, Fig. 13). In 2016, the biomass was 296.83 (SE = 77.86).tonnes
In 2022, the abundance was estimated 153.34*10^3 (S.E. = 53*10^3) (Table 12). The overall length distribution for all years are based on relatively low sample sizes (N<100), individual size ranged from 43 cm to 82, and we can not distinguish any mode (Fig. 16). Larger individuals were caught with the new gear in 2022.

Blue ling (*Molva dypterygia*, BLI)

In 2022, blue ling was caught in 12 out of 73 hauls. Catches ranged from 2.25 kg to 28.74 kg. The species was caught in all subareas, but with the vast majority in Q2 in depths between 600 and 800 m (Table 14, Fig. 19). Biomass for blue ling has been low from 1998 to 2005 (mean biomass =138.4 tonnes). From 2006 until 2016, the biomass has been distinctly higher (mean biomass = 786.5 tonnes) ranging from 158 tonnes (2007) to 1365 tonnes (2012) (Table 13, Fig. 17). In 2022, the biomass was 447 t (SE = 164).In 2022, the abundance was estimated to 178*10^3 (S.E. = 69*10^3) and generally follows biomass estimates. No mode can be observed in the length distribution. The size of the individuals ranged from 21 to 124 cm. (Fig. 20).

Black scabbardfish (*Aphanopus carbo*, BSF)

Black scabbardfish are rarely caught in this survey.There were no catches in the years 1998, 1999, 2000, 2002, 2003, 2006 and 2016, and neither in 2022. In 2013 and 2015, the species was caught only in 1 station, whereas it was found in 4-6 stations in 2011, 2012 and 2014. For these years, catches ranged from 0.7 kg to 21.7 kg. In 2015, it was only registered in Q5 at depths between 801-1200 m (Table 15, Fig. 23), where the majority of the biomass also has been observed in previous years (Fig. 23). In 2008 and 2010-2012, the biomass was estimated between 32.8 t and 56.4 t, whereas all other years the biomass was less than 7.9 t (Table 15). This is most likely because this pelagic and deep living pelagic fish is not targeted by the applied type of bottom trawl and hence the estimated biomasses (Fig. 21) are not truly representative of actual biomass in the investigated area. Overall length distributions from 2011 and 2012 show a wide mode between 70 cm and 110 cm.

Ling (*Molva molva*; BSF)

Ling are not commonly caught in this survey. There were no catches from 1998 to 2004, 2008, 2013-2014 and 2016. In 2022, only 1 individual was caught in 1 haul out of 74 hauls in Q2 at depths between 601-800 m (Table 16). Except from 2011, where the estimated biomass was 267.8 t (S.E. = 14.8 tonnes) (Table 16), yearly estimates are 10-fold less or zero evidencing that ling do not commonly occur in the investigated area (Table 16, Fig. 24, Fig. 26). In 2022, the estimated biomass was 6 t, estimated abundance was 2*10^3 (Table 17). The overall length distribution shows that specimens were shorter in 2011 (mode 40-50 cm) than in 2010 (mode=90-100) and further that less fish were caught in 2011 (Fig. 24) where, in contrast, the estimated biomass was more than 10 times higher. This is explained by the fact that in 2011 all ling were caught in Q3 at 601-800 m – a depth stratum which comprises 26.3 % of the total area of all strata combined (Table 1). The size of the individual caught in 2022 was 82 cm.

Orange roughy (*Hoplostethus atlanticus*; ORY)

Orange roughy is not commonly caught in this survey. The species was only caught in 2008, 2013, 2014 and 2015 (Fig. 27). In 2014 and 2015, estimated biomass was 1.7 t and 1.1 t, respectively, and in all other years it was zero or very close to zero (Table 18, Fig. 27). In 2015, all fish were caught in Q3 at depths between 801-1200 m . No length distributions are shown as too few specimens (N<20) were caught.

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Table 1. Areas (km^2) and their percentage distribution for subareas and depth strata (m). Q4 areas are not included.

Subarea	Depth strata	Area	% distribution
Q1	401-600	6975	18.7
Q2	401-600	1246	3.3
Q2	601-800	1475.4	3.9
Q2	801-1000	1988.3	5.3
Q2	1001-1500	6689.4	17.9
Q3	401-600	9830.2	26.3
Q3	601-800	3788.1	10.1
Q3	801-1000	755.4	2.0
Q3	1001-1200	191.1	0.5
Q3	1201-1400	213.3	0.6
Q3	1401-1500	312.9	0.8
Q4	401-600	2053.6	
Q4	601-800	665.7	
Q4	801-1000	336.2	
Q4	1001-1200	549.9	
Q4	1201-1400	1147	
Q4	1401-1500	940.5	
Q5	401-600	1819.4	4.9
Q5	601-800	257.1	0.7
Q5	801-1200	255.6	0.7
Q5	1201-1400	985.5	2.6
Q5	1401-1500	614.5	1.6
Sum (without Q4)		37397.2	100

Table 2.- General survey information and gear specifications for the surveys 1998-2016 on board R/V Paamiut and for the survey in 2022 with R/V Tarajoq.

Procedure	Specifications	
Vessel	R/V Paamiut	R/V Tarajoq
TRB	1084 GT	2896 GT
Dimensions	LOA 58.61m, Beam 11.21 m	LOA 61.4 m, Beam 16.3 m
Main engine	2000BHP, Diesel 257, 1471KW	3943/4896 BHP, Diesel 475, 2900/3600 KW
Survey Area	14b (401- 1500 m)	14b (401- 1500 m)
Years	1998-2016 (no survey 2001)	2022
Time of year	August/September	September/October
Number of days	15	15
Towing speed (knots)	3	3
Tow duration	30 min	30 min
Gear	Alfredo 3	Bacalao 476
Vertical trawl opening (m)	5.6	4.5*
Distance between doors	120 -145 m	151.8*
Winds spread	10.122 + distance between the doors * 0.142.	$V = (t_l * L) / (t_l + s_t)$ + constant
Mesh size (mm)	140 mm	136
Door	until 2003:Greenland Perfect (370*250 cm) from 2004: Shark injector (353*273)	Shark injector (353*273)
Door type (kg)	2400 kg with extra 20 kg	2850
Mesh size (mm)	44	44
Mesh-line in the cod-end	30 mm	30
Sampling design	Buffered Random Stratified	Fix stations
Number of Stations	100	74 fix + 70 extra (min 80)
Number of strata	10	10
Trawling schedule	24 hours	
Criteria for rejecting a haul	Snag of the trawling gear in the bottom Damage in the cod-end or severe damages in large sections of the wings or belly Less than 15 minutes of effective trawling time Gear malfuntion	
Criteria for change haul position	Wrong depth interval Poor bottom conditions	
Samling species	All fish species and invertebrates	
Target species	Greenland halibut	

Table 3.- Number of valid hauls for the period 1998 - 2003. No survey was conducted in 2001.

Subarea	Depth stratum (m)	Area (km2)	1998	1999	2000	2002	2003
Q1	401-600	7444.1	6	4	3	1	4
Q1	601-800	622	3	3	3	3	3
Q1	801-1000	652.3	3	3	3	2	2
Q1	1001-1200	881.8	2	2	2	2	1
Q1	1201-1400	741.4	2	2	2	2	1
Q1	1401-1500	462.3	2	2	2	2	2
Q2	401-600	777	2	2	2	2	3
Q2	601-800	853.4	4	3	3	3	3
Q2	801-1000	1336	5	4	3	4	3
Q2	1001-1200	1699.3	2	2	2	2	2
Q2	1201-1400	1742	2	2	2	0	2
Q2	1401-1500	1162.6	1	2	2	2	1
Q3	401-600	9830.2	6	7	9	3	1
Q3	601-800	3788.1	3	4	4	1	5
Q3	801-1000	755.4	2	0	2	0	2
Q5	401-600	1819.4	2	2	1	0	0
Q5	601-800	257.1	0	2	2	2	1
Q5	801-1000	106.7	0	2	2	2	2
Q5	1001-1200	148.9	2	2	2	2	1
Q5	1201-1400	985.5	2	2	2	3	1
Q5	1401-1500	614.5	3	2	2	2	0
TOTAL			54	54	55	40	40

Table 4.- Number of valid hauls for the period 2004-2016 with R/V Paamiut (no survey in 2001) and in 2022 with R/V Tarajoq, after a new stratification scheme was introduced.

Subarea	Depth stratum (m)	Area (km2)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2022	Total
Q1	401-600	6975	2	0	0	2	4	4	2	8	7	10	7	11	12	0	5	74
Q2	401-600	1246	4	4	5	3	5	4	4	2	4	5	5	5	5	0	7	62
Q2	601-800	1475.4	5	5	6	5	7	5	5	6	9	5	7	7	7	0	5	84
Q2	601-1000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Q2	801-1000	1988.3	8	9	12	9	3	9	8	8	9	8	7	8	10	0	8	116
Q2	1001-1500	6689.4	3	3	4	3	4	5	5	4	7	4	7	7	7	0	5	68
Q3	401-600	9830.2	9	1	2	2	2	5	5	6	4	9	7	8	11	0	4	75
Q3	601-800	3788.1	4	8	2	6	6	10	6	7	7	11	12	10	14	0	11	114
Q3	801-1000	755.4	0	2	0	0	2	3	3	5	4	4	5	5	6	0	5	44
Q4	801-1200	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Q5	401-600	1819.4	3	0	1	2	3	2	0	1	2	1	2	3	3	0	4	27
Q5	601-800	257.1	3	1	3	2	3	4	1	3	3	6	6	6	6	0	6	53
Q5	801-1000	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
Q5	801-1200	255.6	3	4	3	4	0	4	3	3	4	5	6	2	5	0	2	48
Q5	1201-1400	985.5	5	6	3	5	3	6	5	8	5	9	3	7	9	6	9	89
Q5	1401-1500	614.5	3	4	2	3	1	3	3	5	2	3	3	5	5	4	2	48
		TOTAL	52	47	43	46	47	64	50	66	67	80	78	84	100	10	73	

Table 5.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of roughhead grenadier (*Macrourus berglax*, RHG) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Roughhead grenadier			
Year	**Vessel**	**Biomass**	**SE**	**Abundance**	**SE**
1998	PA	3480.9	546.2	4027.81	639.14
1999	PA	4741.67	803.82	5268.51	979.85
2000	PA	3434.36	351.12	3894.76	380.16
2001	PA	-	-	-	-
2002	PA	4523.51	2095.86	5409.19	3429.93
2003	PA	3100.01	609.13	3421.35	741.1
2004	PA	3150.55	532.5	2813.58	266.75
2005	PA	4237.93	872.42	5230.35	1225.6
2006	PA	3972.49	597.02	4600.06	620.9
2007	PA	3435.29	637.47	3590.22	445.99
2008	PA	6841.49	983.99	6590.11	818.97
2009	PA	7256.96	1425.21	6836.17	1173.32
2010	PA	9201.84	2292.12	7532.03	1162.02
2011	PA	5855.39	1032.07	5678.71	1055.34
2012	PA	7926.09	1330.41	7060.19	1030.43
2013	PA	7604.93	1765.46	5756.69	1212.99
2014	PA	6816.97	1043.22	5426.8	713.5
2015	PA	8751.71	2292.95	5647.58	1239.19
2016	PA	6953.35	1190.37	6004.64	1043.39
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	12913.87	3860.92	7337.53	1703.26

Table 6. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE with SE of roughhead grenadier (RHG) by subarea and depth stratum in 2022.

Subarea	**Stratum (m)**	**Area (sq.km)**	**Tow number**	**Mean Catch**	**Biomass**	**SE**	**Mean Number**	**Abundance**	**SE**
Q1	0401-0600	6975	12	10.625	74	67	9	64	46
Q2	0401-0600	1246	5	145.899	182	90	167	208	96
Q2	0601-0800	1475	7	3761.844	5550	2687	1739	2565	1123
Q2	0801-1000	1988	10	1018.74	2026	1358	551	1096	639
Q2	1001-1500	6689	7	695.394	4652	2412	432	2893	1101
Q3	0401-0600	9830	11	10.56	104	50	12	114	50
Q3	0601-0800	3788	14	19.726	75	27	31	118	20
Q3	0801-1000	755	6	25.514	19	7	39	30	10
Q5	0401-0600	1819	3	41.222	75	75	33	60	60
Q5	0601-0800	257	6	27.582	7	7	29	8	7
Q5	0801-1200	256	5	48.005	12	8	76	19	12
Q5	1201-1400	986	9	73.759	73	29	93	92	27
Q5	1401-1500	614	5	106.683	66	17	116	71	11
TOTAL		36678	100	105.26	12915	3861	46.44	7338	1703

Table 7.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of roundnose grenadier (*Coryphaenoides rupestris*, RNG) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Roundnose grenadier			
Year	Vessel	Biomass	SE	Abundance	SE
1998	PA	2877.29	1299.84	6166.28	2654.39
1999	PA	4303.63	463.11	9661.55	1012.45
2000	PA	2294.69	1237.14	5630.96	2486.13
2001	PA	-	-	-	-
2002	PA	1771.06	1224.19	7065.28	4542.48
2003	PA	4459.12	2097	13593.18	4742.32
2004	PA	1151.83	792	4369.14	1841.27
2005	PA	1174	337.77	5883.41	1813.27
2006	PA	689.04	300.31	3781.2	967.65
2007	PA	878.79	250.81	8312.51	2493.72
2008	PA	772.93	242.56	4296.04	1277.88
2009	PA	215.67	52.05	1452.29	368.99
2010	PA	416.21	93.74	2525.65	478.99
2011	PA	3202.25	2821.1	9207.74	6687.45
2012	PA	5379.46	4774.44	15325.86	13521.71
2013	PA	294.99	151.77	1469.95	694.61
2014	PA	106.1	36.39	826.32	322.61
2015	PA	999.46	815.95	3065.97	2106.33
2016	PA	170.25	46.08	530.16	127.62
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	83.68	16.92	1363.29	436.43

Table 8. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE with SE of roundnose grenadier (*Coryphaenoides rupestris*, RNG)by subarea and depth stratum

Subarea	Stratum (m)	Area (sq.km)	Tow number	Mean Catch	Biomass	SE	Mean Number	Abundance	SE
Q1	0401-0600	6975	12	0	0	0	0	0	0
Q2	0401-0600	1246	5	0	0	0	0	0	0
Q2	0601-0800	1475	7	0	0	0	0	0	0
Q2	0801-1000	1988	10	0	0	0	0	0	0
Q2	1001-1500	6689	7	2.463	16	11	4	27	17
Q3	0401-0600	9830	11	0	0	0	0	0	0
Q3	0601-0800	3788	14	0	0	0	0	0	0
Q3	0801-1000	755	6	0	0	0	0	0	0
Q5	0401-0600	1819	3	0	0	0	0	0	0
Q5	0601-0800	257	6	14.16	4	3	27	7	6
Q5	0801-1200	256	5	35.336	9	4	4435	1134	432
Q5	1201-1400	986	9	52.526	52	12	183	180	55
Q5	1401-1500	614	5	4.507	3	2	27	16	9
TOTAL		36678	100	0.46	84	17	11.9	1364	436

Table 9.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of greater silver smelt (*Argentinus silus*, ARU) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Argentina silus			
Year	**Vessel**	**Biomass**	**SE**	**Abundance**	**SE**
1998	PA	5.39	3.14	11.69	7.73
1999	PA	2.13	2.13	5.32	5.32
2000	PA	6.5	3.54	18.2	9.49
2001	PA	-	-	-	-
2002	PA	53.79	36.23	197.17	141.11
2003	PA	162.26	93.46	493.99	293.54
2004	PA	96.91	36.05	302.86	116.52
2005	PA	55.11	19.63	186.41	67.75
2006	PA	167.25	58.48	471.75	176.95
2007	PA	126.62	45.78	384.07	143.34
2008	PA	240.62	105.47	608.6	279.75
2009	PA	347.48	155.47	747.82	343.53
2010	PA	370.78	100.95	753.41	206.27
2011	PA	432.1	145.02	1145.74	405.38
2012	PA	481.74	166.49	954.86	294.72
2013	PA	643.7	173.47	1239.71	309.73
2014	PA	2046.61	842.8	4127.26	1594.59
2015	PA	257.55	71.72	506.79	119.83
2016	PA	808.11	360.38	1609.62	889.75
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	1061.44	713.84	2260.91	1653.76

Table 10. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE of of greater silver smelt (*Argentinus silus*, ARU) by subarea and depth stratum in 2022.

Subarea	Stratum (m)	Area (sq.km)	Tow number	Mean Catch	Biomass	SE	Mean Number	Abundance	SE
Q1	0401-0600	6975	12	0	0	0	0	0	0
Q2	0401-0600	1246	5	63.82	80	46	107	133	81
Q2	0601-0800	1475	7	44.425	66	38	74	109	60
Q2	0801-1000	1988	10	5.185	10	2	11	23	5
Q2	1001-1500	6689	7	0.961	6	6	1	10	10
Q3	0401-0600	9830	11	0	0	0	0	0	0
Q3	0601-0800	3788	14	0	0	0	0	0	0
Q3	0801-1000	755	6	0	0	0	0	0	0
Q5	0401-0600	1819	3	430.82	784	709	982	1787	1648
Q5	0601-0800	257	6	447.65	115	53	772	198	87
Q5	0801-1200	256	5	2.796	1	0	7	2	1
Q5	1201-1400	986	9	0	0	0	0	0	0
Q5	1401-1500	614	5	0	0	0	0	0	0
TOTAL		36678	100	19.46	1062	714	45.09	2262	1654

Table 11. Total biomass (tonnes) with SE, and abundance (10^3) with SE, of tusk (*Brosme brosme*, USK) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Brosme brosme			
Year	Vessel	Biomass	SE	Abundance	SE
1998	PA	0	0	0	0
1999	PA	0	0	0	0
2000	PA	3.75	3.75	0.99	0.99
2001	PA	-	-	-	-
2002	PA	61.06	34.27	194.13	108.82
2003	PA	2.21	1.6	8.82	4.41
2004	PA	4.36	4.36	9.69	9.69
2005	PA	0	0	0	0
2006	PA	16.47	7.74	19.3	7.93
2007	PA	18.42	14.94	11.95	7.28
2008	PA	69.25	29.48	166.13	93.72
2009	PA	47.4	22.34	112.41	54.81
2010	PA	225.8	113.64	369.05	206.85
2011	PA	113.62	48.34	92.71	39.91
2012	PA	349.74	261.82	138.21	67.2
2013	PA	504.06	159.77	286.14	68.41
2014	PA	188.3	111.11	126.96	50
2015	PA	277.94	87.08	186.26	47.79
2016	PA	371.81	92.08	325.44	81.58
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	296.83	77.86	153.34	53.66

Table 12. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE of of tusk (*Brosme brosme*, USK) by subarea and depth stratum in 2022.

Subarea	Stratum (m)	Area (sq.km)	Tow number	Mean Catch	Biomass	SE	Mean Number	Abundance	SE
Q1	0401-0600	6975	12	7.863	55	55	7	47	47
Q2	0401-0600	1246	5	92.869	116	37	25	32	9
Q2	0601-0800	1475	7	29.252	43	23	17	25	15
Q2	0801-1000	1988	10	4.602	9	6	3	5	3
Q2	1001-1500	6689	7	0	0	0	0	0	0
Q3	0401-0600	9830	11	5.592	55	29	4	35	18
Q3	0601-0800	3788	14	0	0	0	0	0	0
Q3	0801-1000	755	6	0	0	0	0	0	0
Q5	0401-0600	1819	3	8.593	16	16	4	8	8
Q5	0601-0800	257	6	13.081	3	1	9	2	1
Q5	0801-1200	256	5	0	0	0	0	0	0
Q5	1201-1400	986	9	0	0	0	0	0	0
Q5	1401-1500	614	5	0	0	0	0	0	0
TOTAL		36678	100	2.12	297	78	1.46	154	54

Table 13.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of blue ling (*Molva dypterygia*, BLI) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Molva dypteria			
Year	Vessel	Biomass	SE	Abundance	SE
1998	PA	87.47	42.49	34.41	11.78
1999	PA	163.48	69.45	65.93	27.83
2000	PA	211.09	114.02	161.13	75.62
2001	PA	-	-	-	-
2002	PA	76.26	17.34	86.61	15.93
2003	PA	101.38	31.39	96.62	35.86
2004	PA	81.59	32.72	89.16	42.79
2005	PA	111.08	30.99	83.28	15.38
2006	PA	570.07	264.94	355.56	131.03
2007	PA	158.35	57.06	136.59	57.59
2008	PA	870.02	404.82	1013.83	574.84
2009	PA	1239.68	617.42	860.55	353.19
2010	PA	892.11	157.68	689.48	193.73
2011	PA	588.19	232.69	665.09	318.57
2012	PA	1339.72	194.16	976.82	369.4
2013	PA	1248.22	412.14	571.84	159.41
2014	PA	865.88	288.05	471.72	127.73
2015	PA	417.65	162.08	204.49	74.07
2016	PA	432.5	155.17	182.92	66.68
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	446.04	164.23	176.81	69.22

Table 14. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE of of blue ling (*Molva dypterygia*, BLI) by subarea and depth stratum in 2022.

Subarea	Stratum (m)	Area (sq.km)	Tow number	Mean Catch	Biomass	SE	Mean Number	Abundance	SE
Q1	0401-0600	6975	12	7.013	49	49	2	16	16
Q2	0401-0600	1246	5	31.105	39	17	8	10	4
Q2	0601-0800	1475	7	149.958	221	143	49	73	50
Q2	0801-1000	1988	10	0	0	0	0	0	0
Q2	1001-1500	6689	7	0	0	0	0	0	0
Q3	0401-0600	9830	11	7.105	70	47	2	24	16
Q3	0601-0800	3788	14	0	0	0	0	0	0
Q3	0801-1000	755	6	0	0	0	0	0	0
Q5	0401-0600	1819	3	35.538	65	40	30	54	42
Q5	0601-0800	257	6	0	0	0	0	0	0
Q5	0801-1200	256	5	10.252	3	3	4	1	1
Q5	1201-1400	986	9	0	0	0	0	0	0
Q5	1401-1500	614	5	0	0	0	0	0	0
TOTAL		36678	100	4.48	447	164	1.89	178	69

Table 15.Total biomass (tonnes) with SE, and abundance (10^3) with SE, of black scabbardfish (*Aphanopus carbo*, BSF) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Aphanophus carbo			
Year	**Vessel**	**Biomass**	**SE**	**Abundance**	**SE**
1998	PA	0	0	0	0
1999	PA	0	0	0	0
2000	PA	0	0	0	0
2001	PA	-	-	-	-
2002	PA	0	0	0	0
2003	PA	0	0	0	0
2004	PA	0.82	0.82	4.08	4.08
2005	PA	1.71	1.71	1.37	1.37
2006	PA	0	0	0	0
2007	PA	2.33	1.98	7.49	5.35
2008	PA	37.53	33.34	33.79	27.28
2009	PA	2.66	2.66	3.1	3.1
2010	PA	56.38	25.08	82.79	35.31
2011	PA	39.86	26.67	56.44	35.99
2012	PA	33.12	9.57	34.13	12.07
2013	PA	1.81	1.81	2.05	2.05
2014	PA	7.91	4.87	6.85	3.52
2015	PA	1.52	1.52	2.15	2.15
2016	PA	0	0	0	0
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	0	0	0	0

Table 16. Total biomass (tonnes) with SE, and abundance (10^3) with SE, of blue ling (*Molva molva*, LIN) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

Year	Vessel	Biomass	SE	Abundance	SE
1998	PA	0	0	0	0
1999	PA	0	0	0	0
2000	PA	0	0	0	0
2001	PA	-	-	-	-
2002	PA	0	0	0	0
2003	PA	0	0	0	0
2004	PA	0	0	0	0
2005	PA	15.69	15.69	9.26	9.26
2006	PA	29.89	29.89	6.29	6.29
2007	PA	14.61	10.34	25.32	19.91
2008	PA	0	0	0	0
2009	PA	3.09	3.09	3.67	3.67
2010	PA	19.23	0	8.21	0
2011	PA	267.64	251.03	491.56	484.77
2012	PA	19.92	19.92	6.04	6.04
2013	PA	0	0	0	0
2014	PA	0	0	0	0
2015	PA	23.43	14.85	9.18	6.1
2016	PA	0	0	0	0
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	6.43	6.43	2.12	2.12

Table 17. Mean Catch (kg/km2), biomass (tonnes) with SE, mean numbers (num/km2) and abundance (10^3) with SE of of blue ling (*Molva molva*, LIN) by subarea and depth stratum in 2022.

Subarea	Stratum (m)	Area (sq.km)	Tow number	Mean Catch	Biomass	SE	Mean Number	Abundance	SE
Q1	0401-0600	6975	12	0	0	0	0	0	0
Q2	0401-0600	1246	5	0	0	0	0	0	0
Q2	0601-0800	1475	7	4.357	6	6	1	2	2
Q2	0801-1000	1988	10	0	0	0	0	0	0
Q2	1001-1500	6689	7	0	0	0	0	0	0
Q3	0401-0600	9830	11	0	0	0	0	0	0
Q3	0601-0800	3788	14	0	0	0	0	0	0
Q3	0801-1000	755	6	0	0	0	0	0	0
Q5	0401-0600	1819	3	0	0	0	0	0	0
Q5	0601-0800	257	6	0	0	0	0	0	0
Q5	0801-1200	256	5	0	0	0	0	0	0
Q5	1201-1400	986	9	0	0	0	0	0	0
Q5	1401-1500	614	5	0	0	0	0	0	0
TOTAL		36678	100	0.18	6	6	0.06	2	2

Table 18. Total biomass (tonnes) with SE, and abundance (10^3) with SE, of Orange roughy (*Hoplostethus atlanticus*, ORY) for the period 1998-2016 (no survey in 2001) on board R/V Paamiut (PA) and for 2022 on board R/V Tarajoq (TJ).

		Hoplostethus atlanticus			
Year	**Vessel**	**Biomass**	**SE**	**Abundance**	**SE**
1998	PA	0	0	0	0
1999	PA	0	0	0	0
2000	PA	0	0	0	0
2001	PA	-	-	-	-
2002	PA	0	0	0	0
2003	PA	0	0	0	0
2004	PA	0	0	0	0
2005	PA	0	0	0	0
2006	PA	0	0	0	0
2007	PA	0	0	0	0
2008	PA	0.16	0.16	0.92	0.92
2009	PA	0	0	0	0
2010	PA	0	0	0	0
2011	PA	0	0	0	0
2012	PA	0	0	0	0
2013	PA	0.02	0.02	0.69	0.69
2014	PA	1.74	1.74	2.33	2.33
2015	PA	1.09	1.09	2.15	2.15
2016	PA	0	0	0	0
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	-	-	-	-
2022	TJ	0	0	0	0

Figure 1. Roughhead grenadier (RHG) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

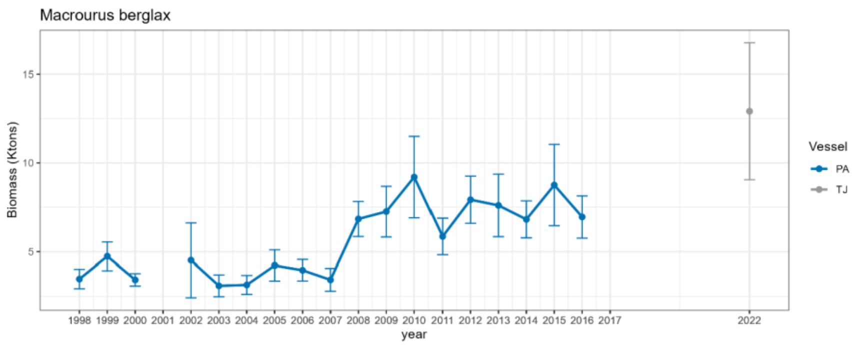


Figure 2. Roughhead grenadier (RHG) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

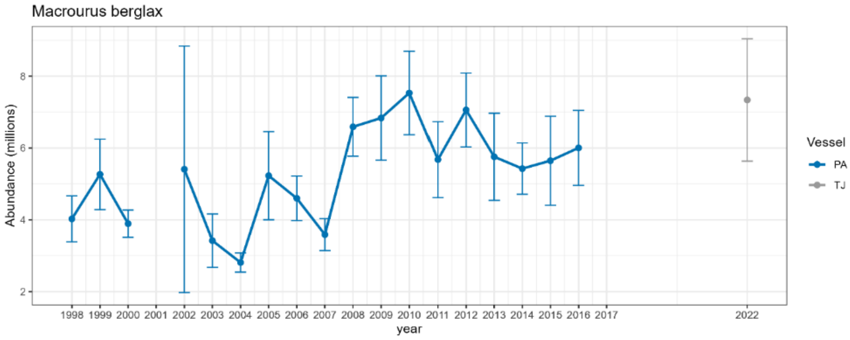


Figure 3. Distribution of survey catches of roughhead grenadier (RHG) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

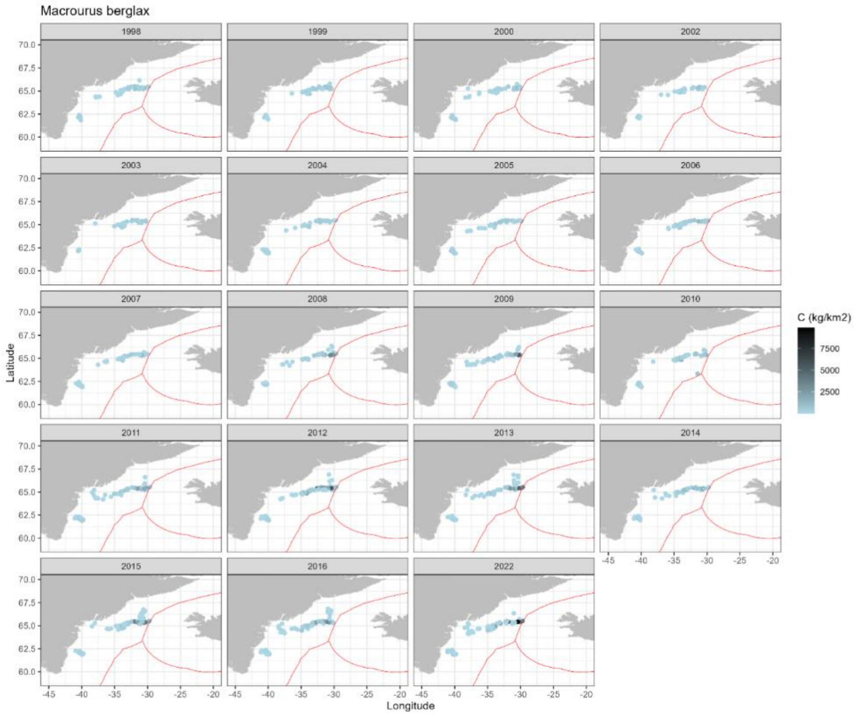


Fig. 4. Length frequency distribution per swept area of roughhead grenadier (RHG) for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

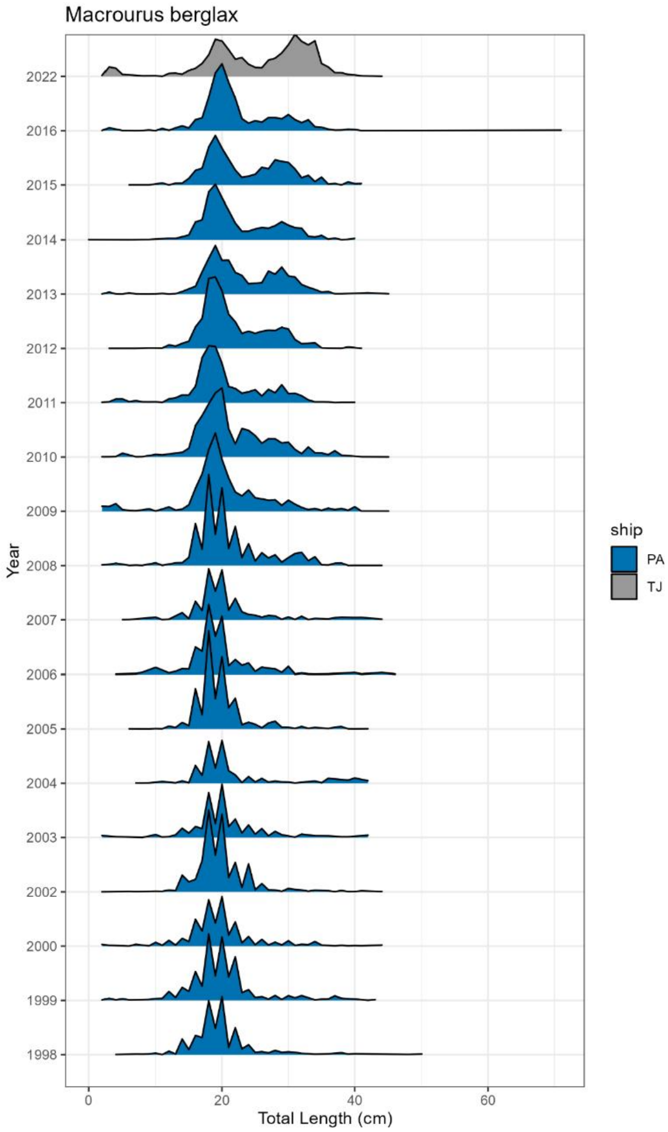


Figure 5.- Roundnose grenadier (RNG) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

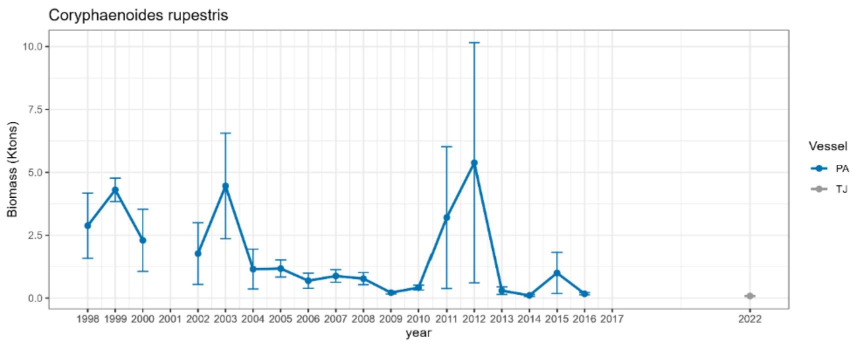


Figure 6.- Roundnose grenadier (RNG) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

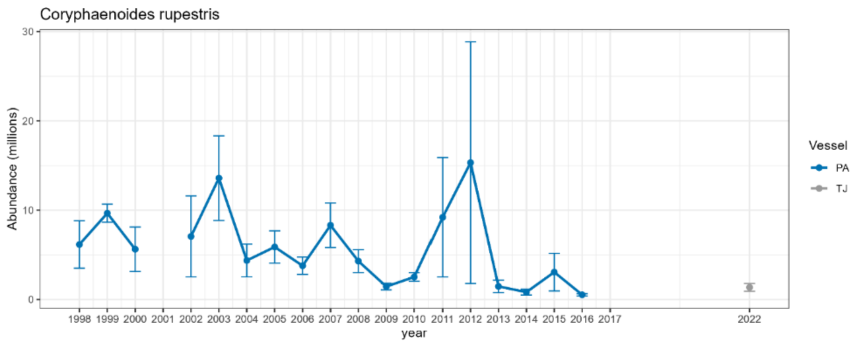


Figure 7. Distribution of survey catches of roundnose grenadier (RNG) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

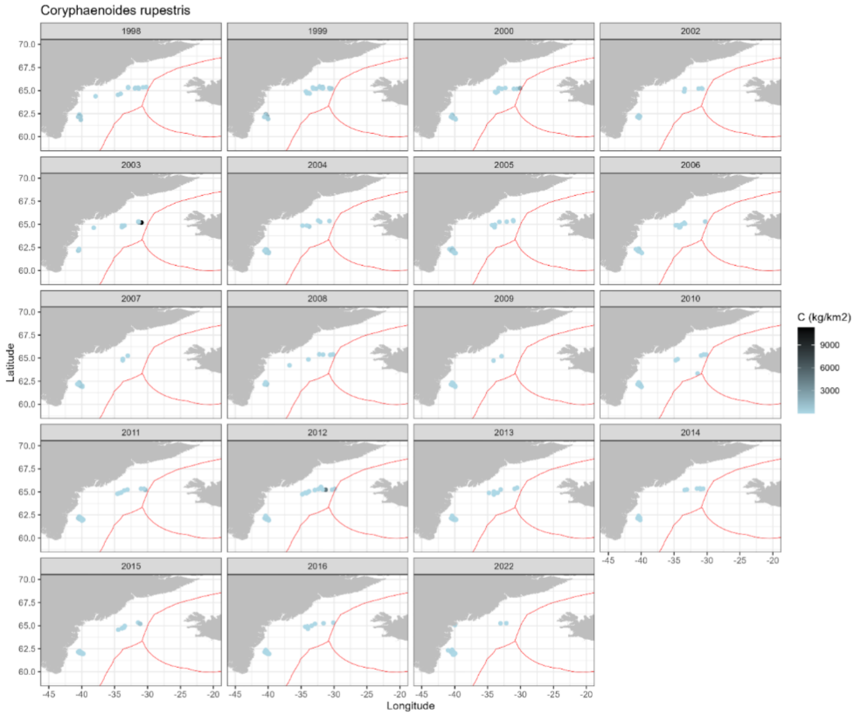


Fig. 8. Length frequency distribution per swept area of roundnose grenadier (RNG) for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

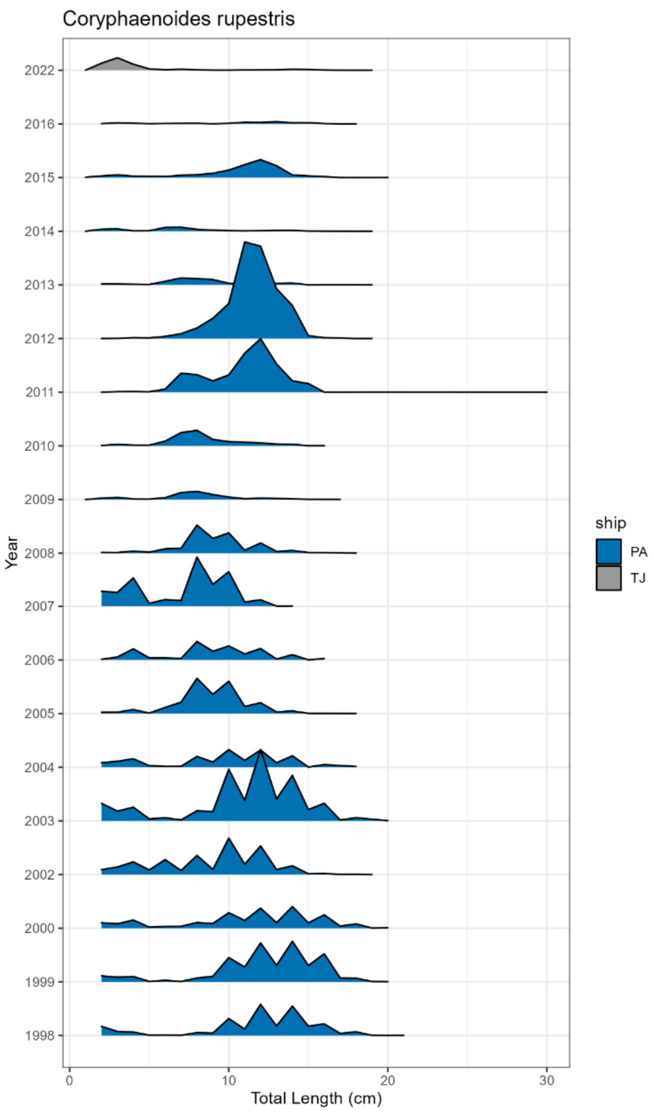


Figure 9. Greater argentine (ARU) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

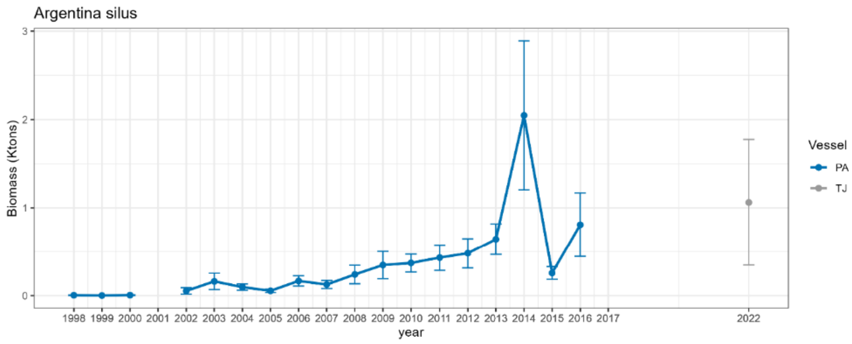


Figure 10. Greater argentine (ARU) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

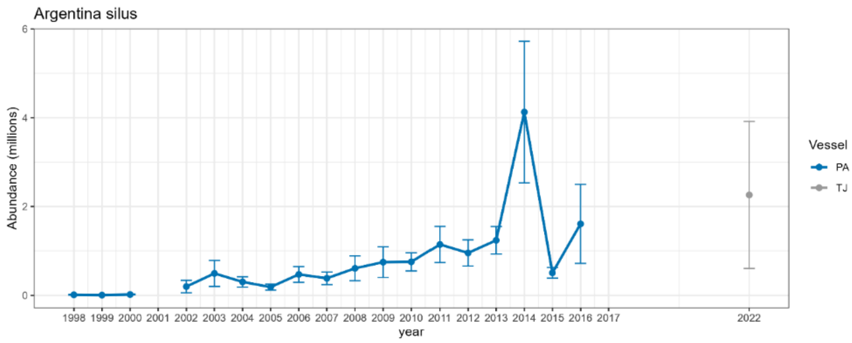


Figure 11. Distribution of survey catches of greater argentine (ARU) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

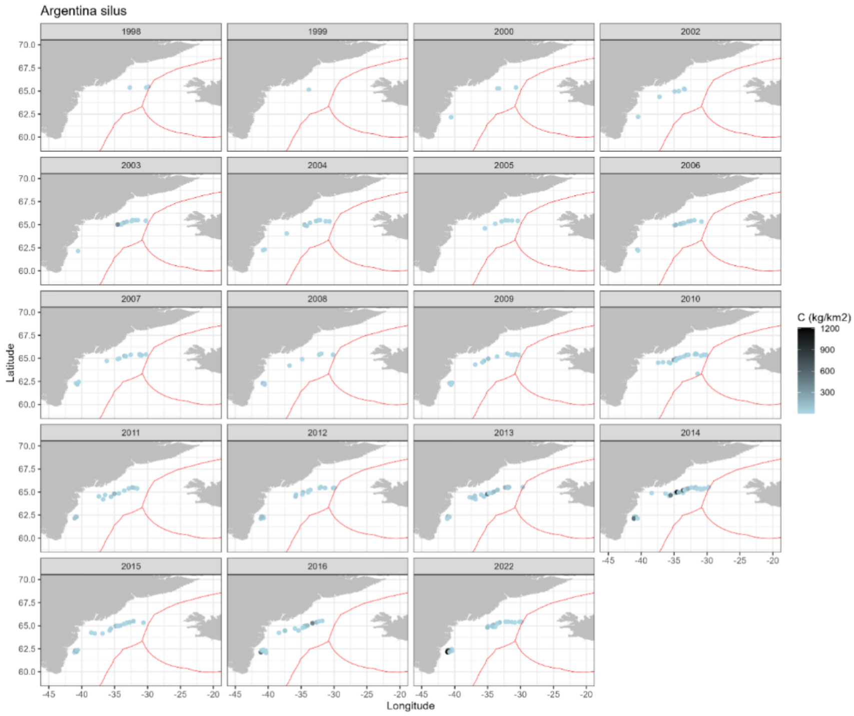


Fig. 12. Length frequency distribution per swept area of greater argentine (ARU) for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

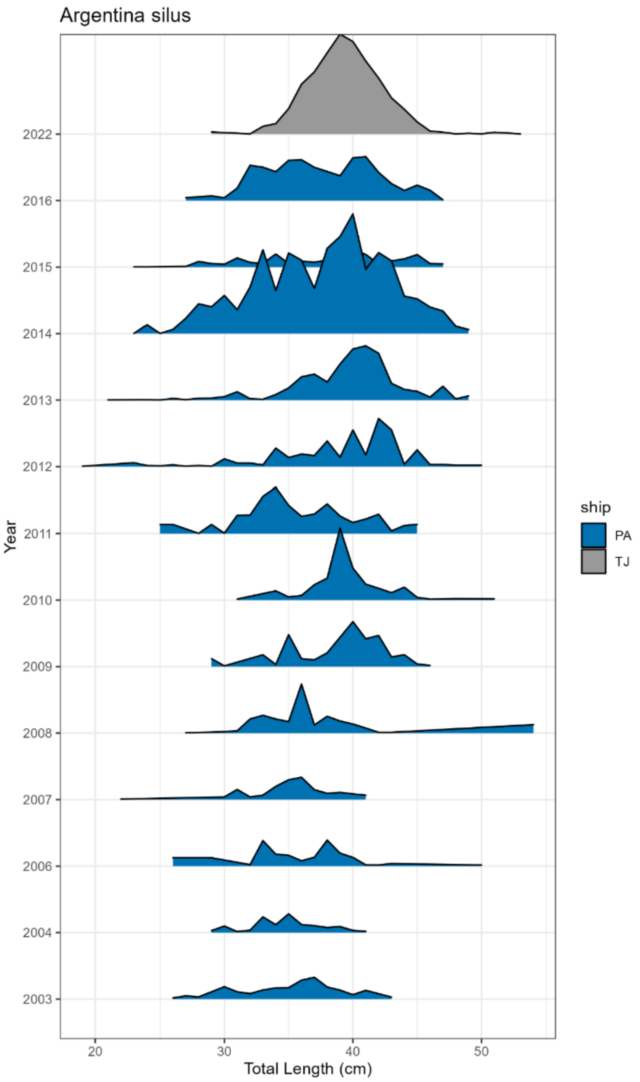


Figure 13. Tusk (USK) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

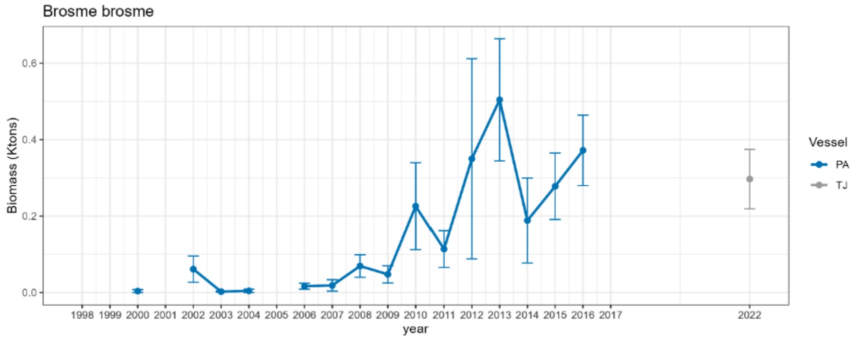


Figure 14. Tusk (USK) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

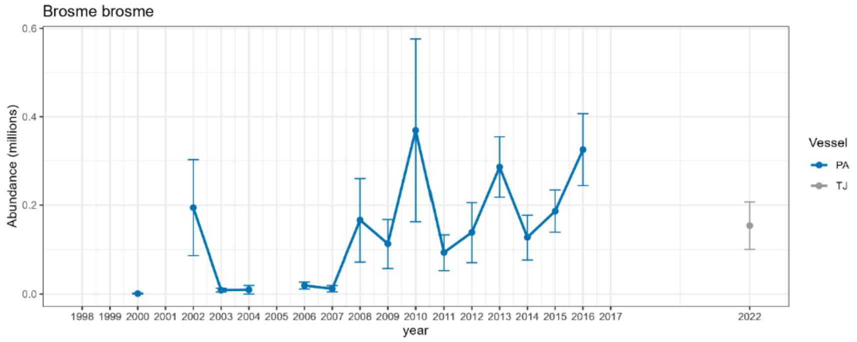


Figure 15. Distribution of survey catches of tusk (USK) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

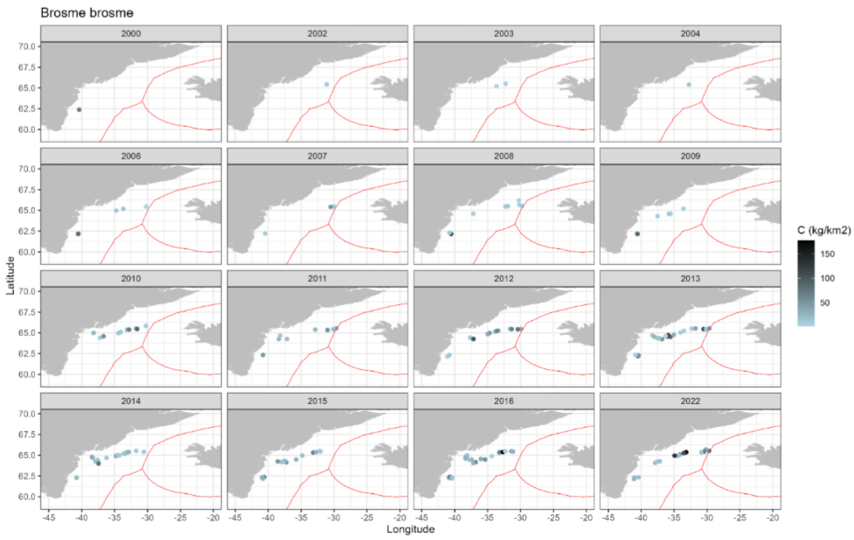


Fig. 16. Length frequency distribution per swept area of tusk (USK) for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq

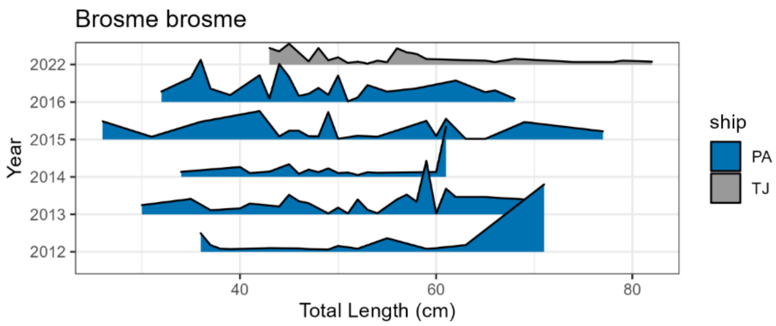


Figure 17. Blue ling (BLI) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

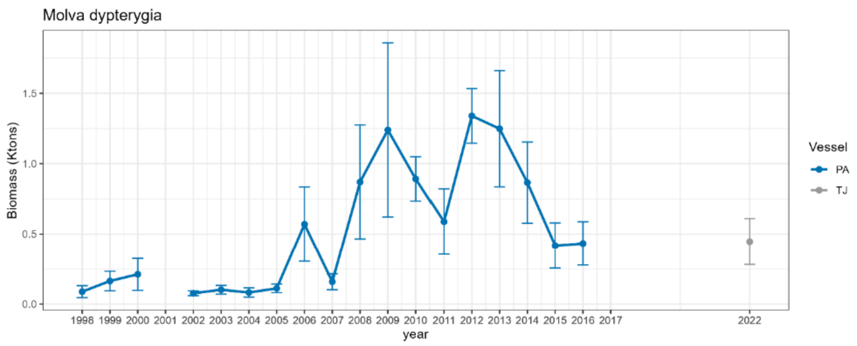


Figure 18. Blue ling (BLI) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

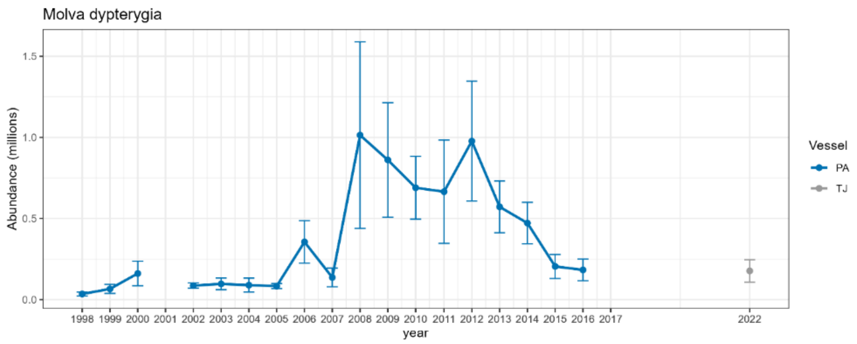


Figure 19. Distribution of survey catches of blue ling (BLI) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

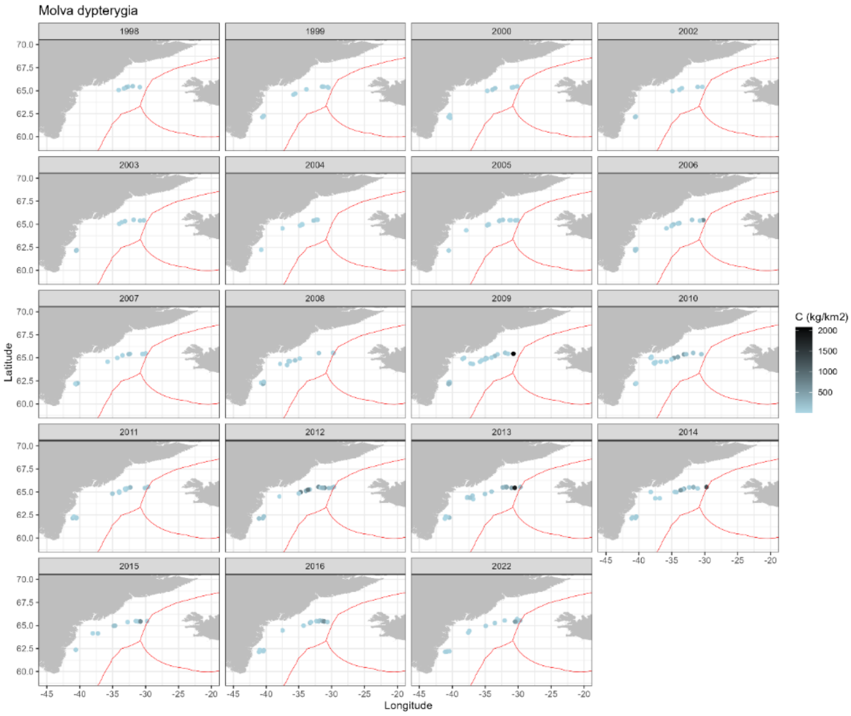


Fig. 20. Length frequency distribution per swept area of blue ling (BLI) for the period 1998-2019 on board R/V Paamiut and on 2022 on board R/V Tarajoq

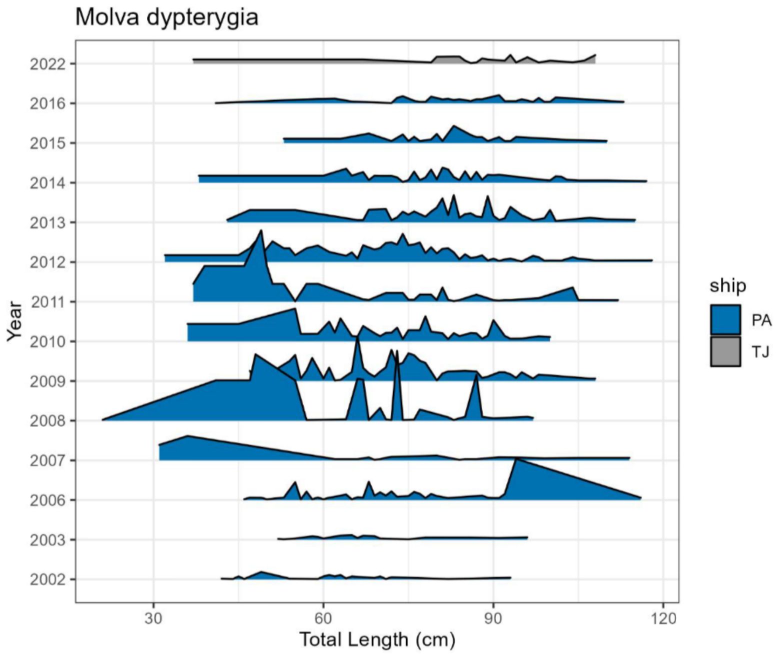


Figure 21.- Black scabbardfish (BSF) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

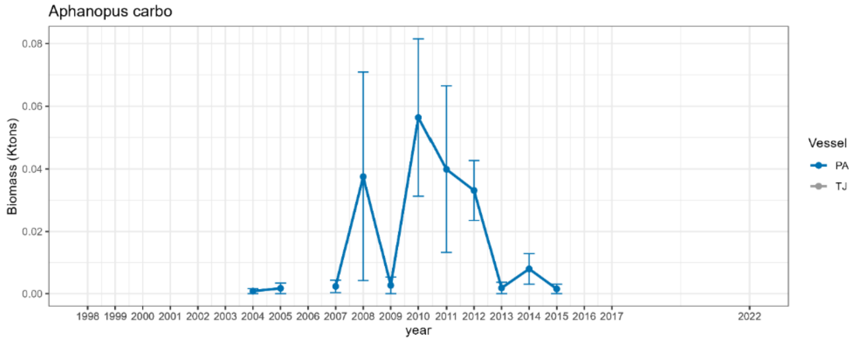


Figure 22.- Black scabbardfish(BSF) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

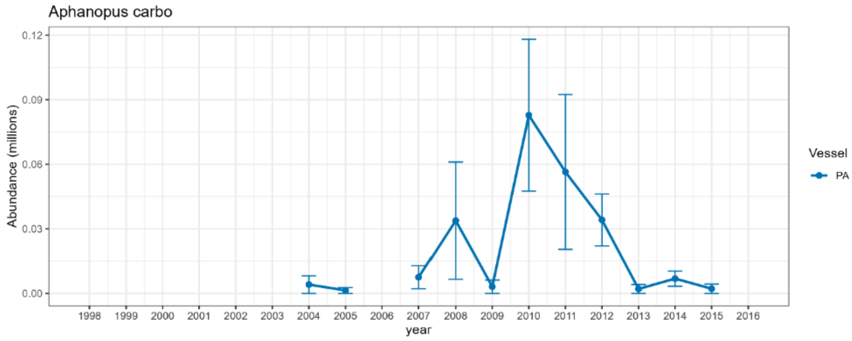


Figure 23. Distribution of survey catches of black scabbardfish (BSF) off East Greenland (ICES 14.b) from 1998-2016 and 2022.

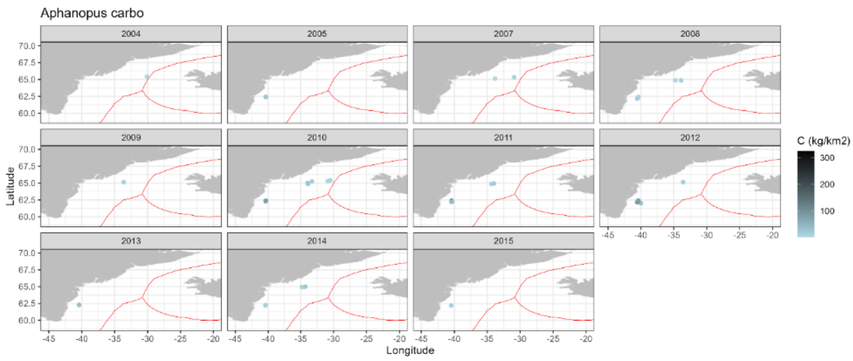


Figure 24.- Ling (LIN) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

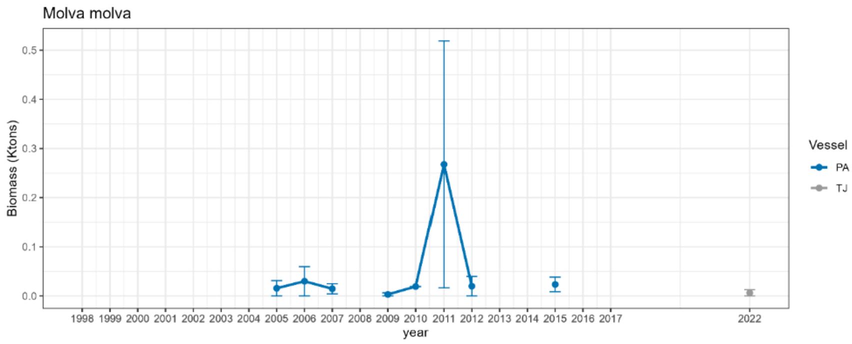


Figure 25.- Ling (LIN) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

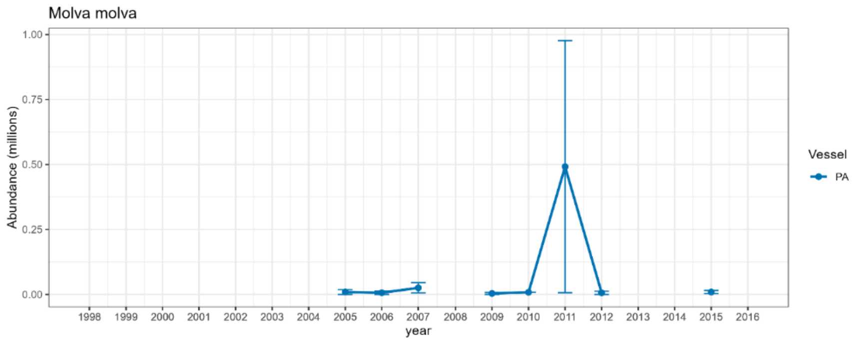


Figure 26. Distribution of survey catches of ling (LIN) off East Greenland (ICES 14.b) from 1998-2016 and 2022**.**

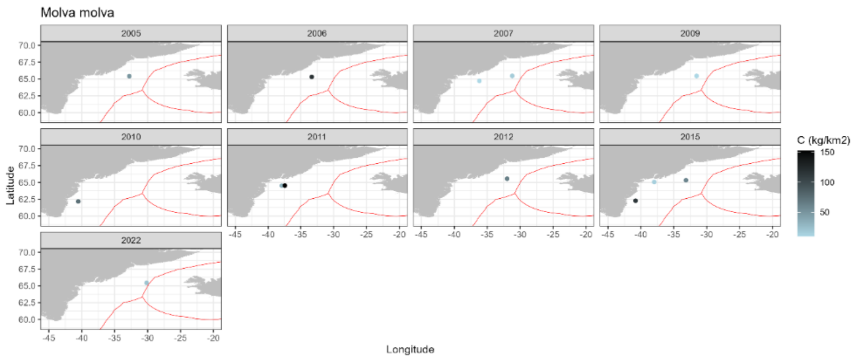


Figure 27.- Orange roughy (ORY) biomass (tonnes) calculated by swept area method in tonnes and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

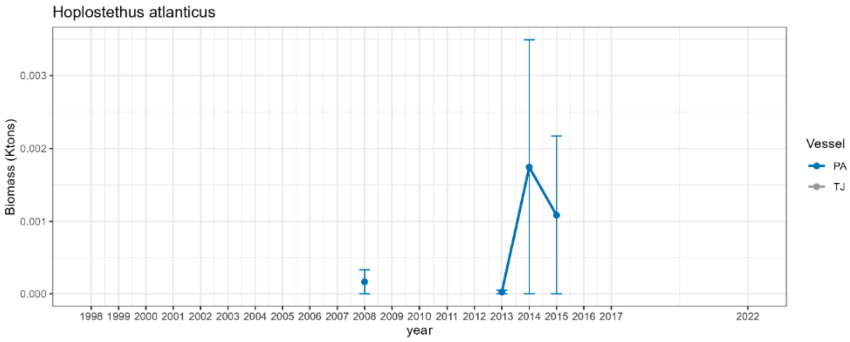


Figure 28.- Orange roughy (ORY) abundance ('000s) calculated by swept area method and +/- S.E. by year for the period 1998-2016 on board R/V Paamiut and on 2022 on board R/V Tarajoq.

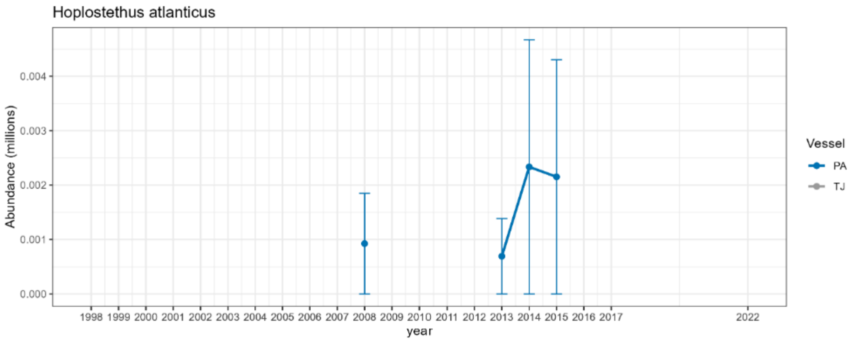
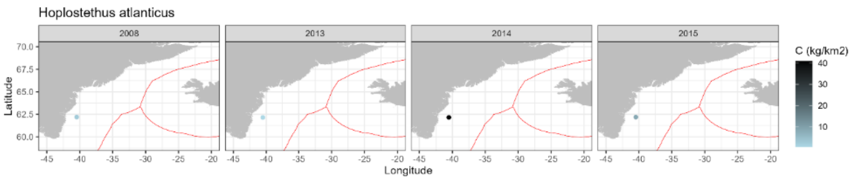


Figure 29. Distribution of survey catches of orange roughy (ORY) off East Greenland (ICES 14.b) in 1998-2016 and 2022.



Appendix 1. Catch weight and numbers (not standardized to kg/km2) of roughhead grenadier, roundnose grenadier, greater silver smelt and tusk by haul, in 2019. Depth in meters, swept area in km2 and bottom temperature in ºC.

						RHG		RNG		ARS		USK	
St. No	Swept Area	Subarea	Stratum	Depth	Bottom Temp.	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
1	0.0773	Q2	0801-1000	826.5	5.3	20.3	12	0	0	0.3	1	0	0
2	0.0731	Q2	0601-0800	634.5	2.21	244.5	146	0	0	0	0	4.8	4
3	0.0894	Q1	0401-0600	412.5	0.93	4.4	3	0	0	0	0	3.5	3
4	0.092	Q1	0401-0600	458	0.81	0	0	0	0	0	0	0	0
5	0.0923	Q1	0401-0600	507	0.71	0	0	0	0	0	0	0	0
6	0.0832	Q1	0401-0600	498	0.88	0.4	1	0	0	0	0	0	0
7	0.0764	Q1	0401-0600	448.5	0.72	0	0	0	0	0	0	0	0
11	0.1389	Q2	0601-0800	677.5	3.48	736.3	344	0	0	1.5	4	0	0
12	0.0548	Q2	0601-0800	618	3.83	541.8	223	0	0	0	0	3.8	1
13	0.1065	Q2	0801-1000	833.5	3.26	57.2	30	0	0	0.4	1	1.7	1
14	0.0742	Q2	1001-1500	1378	2.41	1.8	14	0	0	0	0	0	0
15	0.1033	Q2	0801-1000	838	2.97	23.8	17	0	0	0.8	2	0	0
16	0.096	Q2	0801-1000	883.5	1.46	553.7	265.2	0	0	0.6	1	0	0
17	0.1121	Q2	0401-0600	523	3.61	12.8	16	0	0	0	0	0	0
20	0.0976	Q2	0801-1000	964	3.04	58	54	0	0	1.1	2	0	0
21	0.0865	Q2	1001-1500	1422	1.93	10.1	8	0.7	1	0	0	0	0
22	0.0615	Q2	1001-1500	1073.5	2.67	131.4	68	0.6	1	0	0	0	0
23	0.0681	Q2	0401-0600	449.5	4.01	27	28	0	0	6.1	10	11.7	3
24	0.0888	Q2	0401-0600	466.5	3.69	17.8	23	0	0	2.2	3	9.7	3
25	0.1079	Q2	0801-1000	861.5	4.65	1.3	2	0	0	0.4	1	0	0
26	0.1019	Q2	0401-0600	441.5	5.45	0.4	1	0	0	20	35	5.6	2
27	0.1003	Q2	1001-1500	1075	2.02	201.8	90	0	0	0.7	1	0	0
28	0.0968	Q2	1001-1500	1208	3.2	8.3	12	0	0	0	0	0	0
29	0.1035	Q2	0801-1000	958.5	2.23	66.9	40	0	0	0.5	1	0	0
30	0.0986	Q2	0601-0800	689	4.8	21.3	12	0	0	8.2	14	1.1	1
31	0.0891	Q2	0801-1000	881.5	3.85	9.2	8	0	0	0	0	1.9	1
32	0.1003	Q2	0401-0600	470	4.49	1.4	1	0	0	0.9	1	13	3
33	0.1013	Q2	0601-0800	739	4.82	6.2	3	0	0	12.9	20	0	0
34	0.1081	Q2	1001-1500	1417.5	2.74	3.4	2	0	0	0	0	0	0
36	0.1015	Q2	1001-1500	1262.5	3.05	47	61	0	0	0	0	0	0
42	0.085	Q3	0601-0800	644.5	3.46	0.8	3	0	0	0	0	0	0
43	0.0974	Q3	0601-0800	680.5	3.45	5.2	4	0	0	0	0	0	0
44	0.0934	Q3	0601-0800	692	3.73	1.8	2	0	0	0	0	0	0
46	0.0884	Q3	0801-1000	842.5	3.72	0.7	1	0	0	0	0	0	0
49	0.0873	Q3	0601-0800	634.5	3.66	1.8	3	0	0	0	0	0	0
50	0.0905	Q3	0601-0800	780.5	3.72	0.8	4	0	0	0	0	0	0
56	0.0961	Q3	0801-1000	866	3.65	2.3	4	0	0	0	0	0	0
57	0.0967	Q3	0401-0600	426.5	3.75	0	0	0	0	0	0	0	0
59	0.0944	Q3	0401-0600	573.5	3.66	4.1	4	0	0	0	0	0	0
61	0.0989	Q3	0801-1000	849	3.61	1.4	2	0	0	0	0	0	0
62	0.0885	Q3	0801-1000	891	3.65	2.1	3	0	0	0	0	0	0
63	0.0898	Q3	0801-1000	817	3.65	5.2	8	0	0	0	0	0	0
64	0.1001	Q3	0401-0600	492.5	3.75	1.5	2	0	0	0	0	0	0
65	0.097	Q3	0401-0600	444	3.81	1.1	2	0	0	0	0	2	1
66	0.0879	Q3	0401-0600	578	3.71	0	0	0	0	0	0	0.9	1
67	0.0989	Q3	0601-0800	663.5	3.67	0.6	1	0	0	0	0	0	0
68	0.0948	Q3	0401-0600	520	3.65	2.4	2	0	0	0	0	1.9	1
69	0.0805	Q3	0401-0600	414.5	3.71	0	0	0	0	0	0	0	0
70	0.11	Q3	0401-0600	432	3.74	0	0	0	0	0	0	0	0
71	0.1007	Q3	0401-0600	424.5	3.77	0	0	0	0	0	0	0	0
80	0.0797	Q5	0401-0600	420.5	4.53	0	0	0	0	0.8	1	0	0
81	0.0752	Q5	0801-1200	912	4.55	0.7	2	1	52	0.4	1	0	0
82	0.0732	Q5	0601-0800	700.5	4.85	0	0	3.7	7	3.1	7	1.4	1
83	0.0717	Q5	0801-1200	897.5	4.65	3.5	5	3.3	502.8	0.4	1	0	0
86	0.0936	Q5	0601-0800	633	5.01	0	0	0	0	14.6	26	0	0
88	0.085	Q5	0601-0800	668.5	5.15	0.2	1	0.5	1	61.6	118.4	1.4	1
89	0.0854	Q5	0601-0800	647.5	5.03	9.2	9	0	0	74.2	113	1.4	1
91	0.0802	Q5	0401-0600	426.5	4.99	9.9	8	0	0	97	224	2.1	1
93	0.0709	Q5	0401-0600	436.5	5.03	0	0	0	0	5.2	10	0	0
94	0.0799	Q5	0801-1200	876	4.84	0	0	1	197.2	0	0	0	0
95	0.0629	Q5	0801-1200	988.5	4.63	8.4	13	4.4	476.3	0	0	0	0
96	0.0928	Q5	1201-1400	1316.5	3.23	6.8	9	3.7	24	0	0	0	0
97	0.0949	Q5	1201-1400	1290	3.38	4.1	8	9.6	44	0	0	0	0
98	0.0847	Q5	1201-1400	1344.5	3.28	9.3	11	3.6	9	0	0	0	0
99	0.0701	Q5	1201-1400	1332.5	3.31	16.3	16	6	10	0	0	0	0
100	0.0973	Q5	1201-1400	1296.5	3.39	2.3	4	6.2	21	0	0	0	0
101	0.0922	Q5	1201-1400	1268.5	3.71	0	0	2	4	0	0	0	0
104	0.0968	Q5	1401-1500	1445	3.25	3.8	6	0.2	7	0	0	0	0
105	0.0761	Q5	1401-1500	1418	2.93	13.6	9	0.3	1	0	0	0	0
106	0.076	Q5	1401-1500	1434	3.03	3.9	7	0	0	0	0	0	0
107	0.0768	Q5	1401-1500	1426	2.98	9.2	12	0	0	0	0	0	0
108	0.0849	Q5	1401-1500	1442	3.26	12.4	13	1.3	4	0	0	0	0
109	0.0827	Q5	1201-1400	1229	3.35	2.9	6	1.1	4	0	0	0	0

Appendix 2. Catch weight and numbers (not standardized to kg/km2) of blue ling, black scabbardfish, ling, and orange roughy by haul, in 2019. Depth in meters, swept area in km2 and bottom temperature in ºC.

St. No	Swept Area	Subarea	Stratum	Depth	ottom Tem	BLI Weight (kg)	BLI Number	BSF Weight (kg)	BSF Number	LIN Weight (kg)	LIN Number	HAT Weight (kg)	HAT Number
1	0.0773	Q2	0801-1000	826.5	5.3	0	0	0	0	0	0	0	0
2	0.0731	Q2	0601-0800	634.5	2.21	8.5	2	0	0	0	0	0	0
3	0.0894	Q1	0401-0600	412.5	0.93	3.1	1	0	0	0	0	0	0
4	0.092	Q1	0401-0600	458	0.81	0	0	0	0	0	0	0	0
5	0.0923	Q1	0401-0600	507	0.71	0	0	0	0	0	0	0	0
6	0.0832	Q1	0401-0600	498	0.88	0	0	0	0	0	0	0	0
7	0.0764	Q1	0401-0600	448.5	0.72	0	0	0	0	0	0	0	0
11	0.1389	Q2	0601-0800	677.5	3.48	15.1	5	0	0	3	1	0	0
12	0.0548	Q2	0601-0800	618	3.83	28.7	10	0	0	0	0	0	0
13	0.1065	Q2	0801-1000	833.5	3.26	0	0	0	0	0	0	0	0
14	0.0742	Q2	1001-1500	1378	2.41	0	0	0	0	0	0	0	0
15	0.1033	Q2	0801-1000	838	2.97	0	0	0	0	0	0	0	0
16	0.096	Q2	0801-1000	883.5	1.46	0	0	0	0	0	0	0	0
17	0.1121	Q2	0401-0600	523	3.61	4	2	0	0	0	0	0	0
20	0.0976	Q2	0801-1000	964	3.04	0	0	0	0	0	0	0	0
21	0.0865	Q2	1001-1500	1422	1.93	0	0	0	0	0	0	0	0
22	0.0615	Q2	1001-1500	1073.5	2.67	0	0	0	0	0	0	0	0
23	0.0681	Q2	0401-0600	449.5	4.01	0	0	0	0	0	0	0	0
24	0.0888	Q2	0401-0600	466.5	3.69	5.4	1	0	0	0	0	0	0
25	0.1079	Q2	0801-1000	861.5	4.65	0	0	0	0	0	0	0	0
26	0.1019	Q2	0401-0600	441.5	5.45	0	0	0	0	0	0	0	0
27	0.1003	Q2	1001-1500	1075	2.02	0	0	0	0	0	0	0	0
28	0.0968	Q2	1001-1500	1208	3.2	0	0	0	0	0	0	0	0
29	0.1035	Q2	0801-1000	958.5	2.23	0	0	0	0	0	0	0	0
30	0.0986	Q2	0601-0800	689	4.8	0	0	0	0	0	0	0	0
31	0.0891	Q2	0801-1000	881.5	3.85	0	0	0	0	0	0	0	0
32	0.1003	Q2	0401-0600	470	4.49	5.9	1	0	0	0	0	0	0
33	0.1013	Q2	0601-0800	739	4.82	0	0	0	0	0	0	0	0
34	0.1081	Q2	1001-1500	1417.5	2.74	0	0	0	0	0	0	0	0
36	0.1015	Q2	1001-1500	1262.5	3.05	0	0	0	0	0	0	0	0
42	0.085	Q3	0601-0800	644.5	3.46	0	0	0	0	0	0	0	0
43	0.0974	Q3	0601-0800	680.5	3.45	0	0	0	0	0	0	0	0
44	0.0984	Q3	0601-0800	692	3.73	0	0	0	0	0	0	0	0
46	0.0884	Q3	0801-1000	842.5	3.72	0	0	0	0	0	0	0	0
49	0.0873	Q3	0601-0800	634.5	3.66	0	0	0	0	0	0	0	0
50	0.0905	Q3	0601-0800	780.5	3.72	0	0	0	0	0	0	0	0
56	0.0961	Q3	0801-1000	866	3.65	0	0	0	0	0	0	0	0
57	0.0967	Q3	0401-0600	426.5	3.75	0	0	0	0	0	0	0	0
59	0.0944	Q3	0401-0600	573.5	3.66	3.6	1	0	0	0	0	0	0
61	0.0989	Q3	0801-1000	849	3.61	0	0	0	0	0	0	0	0
62	0.0885	Q3	0801-1000	891	3.65	0	0	0	0	0	0	0	0
63	0.0898	Q3	0801-1000	817	3.65	0	0	0	0	0	0	0	0
64	0.1001	Q3	0401-0600	492.5	3.75	0	0	0	0	0	0	0	0
65	0.097	Q3	0401-0600	444	3.81	0	0	0	0	0	0	0	0
66	0.0879	Q3	0401-0600	578	3.71	2.3	1	0	0	0	0	0	0
67	0.0989	Q3	0601-0800	663.5	3.67	0	0	0	0	0	0	0	0
68	0.0948	Q3	0401-0600	520	3.65	0	0	0	0	0	0	0	0
69	0.0805	Q3	0401-0600	414.5	3.71	0	0	0	0	0	0	0	0
70	0.11	Q3	0401-0600	432	3.74	0	0	0	0	0	0	0	0
71	0.1007	Q3	0401-0600	424.5	3.77	0	0	0	0	0	0	0	0
80	0.0797	Q5	0401-0600	420.5	4.53	0	0	0	0	0	0	0	0
81	0.0752	Q5	0801-1200	912	4.55	0	0	0	0	0	0	0	0
82	0.0732	Q5	0601-0800	700.5	4.85	0	0	0	0	0	0	0	0
83	0.0717	Q5	0801-1200	897.5	4.65	0	0	0	0	0	0	0	0
86	0.0986	Q5	0601-0800	633	5.01	0	0	0	0	0	0	0	0
88	0.085	Q5	0601-0800	668.5	5.15	0	0	0	0	0	0	0	0
89	0.0854	Q5	0601-0800	647.5	5.03	0	0	0	0	0	0	0	0
91	0.0802	Q5	0401-0600	426.5	4.99	2.5	6	0	0	0	0	0	0
93	0.0709	Q5	0401-0600	436.5	5.03	5.3	1	0	0	0	0	0	0
94	0.0799	Q5	0801-1200	876	4.84	0	0	0	0	0	0	0	0
95	0.0629	Q5	0801-1200	988.5	4.63	2.6	1	0	0	0	0	0	0
96	0.0928	Q5	1201-1400	1316.5	3.23	0	0	0	0	0	0	0	0
97	0.0949	Q5	1201-1400	1290	3.38	0	0	0	0	0	0	0	0
98	0.0847	Q5	1201-1400	1344.5	3.28	0	0	0	0	0	0	0	0
99	0.0701	Q5	1201-1400	1332.5	3.31	0	0	0	0	0	0	0	0
100	0.0973	Q5	1201-1400	1296.5	3.39	0	0	0	0	0	0	0	0
101	0.0922	Q5	1201-1400	1268.5	3.71	0	0	0	0	0	0	0	0
104	0.0968	Q5	1401-1500	1445	3.25	0	0	0	0	0	0	0	0
105	0.0761	Q5	1401-1500	1418	2.93	0	0	0	0	0	0	0	0
106	0.076	Q5	1401-1500	1434	3.03	0	0	0	0	0	0	0	0
107	0.0768	Q5	1401-1500	1426	2.98	0	0	0	0	0	0	0	0
108	0.0849	Q5	1401-1500	1442	3.26	0	0	0	0	0	0	0	0
109	0.0827	Q5	1201-1400	1229	3.35	0	0	0	0	0	0	0	0

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Commercial catches of roughhead grenadier, roundnose grenadier, greater argentine, tusk, blue ling, black scabbardfish, ling, and orange roughy in ICES 14 in the period 1999-2022.

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Abstract

Yearly and monthly logbook information, and CPUE distribution from 1999 to 2022 for roughhead grenadier (*Macrourus berglax*; RHG), roundnose grenadier (*Coryphaenoides rupestris*; RNG), greater argentine (*Argentina silus*; ARU), tusk (*Brosme brosme*; USK), blue ling (*Molva dypterygia*; BLI), black scabbardfish (*Aphanopus carbo*; BSF), ling (*Molva molva*; LIN), and orange roughy (*Hoplostethus atlanticus*; ORY), in East Greenland, ICES 14, are presented in this document. Also catches by gear and by division (14a and 14b). Data presented are a mix of targeted catches and bycatch of the Greenland halibut fishery in East Greenland in 14b.

1. Introduction

Commercial trawl and longline fisheries operate in ICES Division 14.b off East Greenland. This document presents information recorded in logbooks of these fisheries in the time period from 1999 to 2022. The species presented here are roughhead grenadier (*Macrourus berglax*; RHG), roundnose grenadier (*Coryphaenoides rupestris*; RNG), greater argentine (*Argentina silus*; ARU), tusk (*Brosme brosme*; USK), blue ling (*Molva dypterygia*; BLI), black scabbardfish (*Aphanopus carbo*; BSF), ling (*Molva molva*; LIN), and orange roughy (*Hoplostethus atlanticus*; ORY). The numbers presented in previous working documents have been updated.

Catch quotas have been set for the following of these species: grenadiers (RNG and RHG combined), tusk, blue ling, and greater argentine. The total allowable catch (TAC) for grenadiers was 3 000 tonnes (t) in 2007, 2 000 t in 2008-2009, and 1 000 tons in 2010-2022. For tusk the TAC was 500 t in 2014 and 1 500 t from 2015-2022. For blue ling the TAC was 500 t in 2014 and no quota has been set since. For greater Argentine the TAC was 10 000 t in 2013-2015 and no quota has been set since. The TAC is set by the Government of Greenland.

2. Materials and Methods

Logbooks have been mandatory for vessels greater than 30 ft (9.4 m) since 2008. Data about all logbooks records are reported to the Greenland Fishery License Authority (GFLK). Trawlers and longliners gather information about their fishery, including effort and location for individual fishing events, and send the data to GFLK on a weekly basis. Data presented here is a mix of targeted catches (greater Argentine fishery from 2015 and 2018 abd tusk fishery from 2014) and bycatch during the fishery for Greenland halibut in ICES Division 14.b (from 1999). From 2005 (except 2006) small catches for grenadiers come from 14a due to the expansion of the Greenland halibut fishery to a norther fishing ground between 67°N and 68°30'N.

3. Results and discussion

Roughhead grenadier (*Macrourus berglax*; RHG)

Only 0.01 t, in 2000, of grenadier were caught between 1999 and 2004. From 2005 to 2013 catches remained very low (mean catches 2005-2013 = 7.8 t), whereas it increased to an average of 71.2 tons between 2014 and 2018. In 2019, catches dropped to only 1 t. Catches have been increasing from 2020 (23.17 t) to 2022 reaching the highest catches since 1999 (85.23t) (Table 1 , 2 and 4, Fig. 1 and 2). From 2014 reported catches of roughhead grenadier on long lines are much higher, which might be linked to the onset of targeted long line fishery after tusk in 2014 (Table 3). There are no explanations for the drastic drop to only 1.0 tons in 2019, which has been reported by only a single vessel. Possibly, this is due to misidentification. Most of the catches are from 14b, a few catches were found years 2013, 2016-2017 and 2021 in 14a, due to the expansion of the Greenland halibut fishery to a northern fishing ground (Table 2, Fig.2 and 3).
From the surveys documents (Nielsen et al., 2019, Nogueira and Christiansen, 2023), it was established that roughhead grenadier is much more common than roundnose grenadier in ICES 14b. Therefore, it is likely that there is misidentification of grenadier species confounding the logbook data of roundnose grenadier and roughhead grenadier. Regardless of this, the TAC of 1.000 tons for grenadiers in East Greenland (roughhead and roundnose combined) is not reached any years.

Roundnose grenadier (*Coryphaenoides rupestris*; RNG)

Catches of roundnose grenadier have been relatively stable (annual mean catch=91.4 tons) throughout the evaluated time period (1999 to 2022) ranging from 30.6 tons (2008) to 167.4 tons (2021) (Table 1 and 5, Fig.1). Most of the catches are also from 14b, a few catches are found from 2005 in 14a, due to the expansion of the Greenland halibut fishery, this year, to a northern fishing ground (Table 2, Fig.4 and 5).The majority of this is caught as bycatch by trawlers, whereas longlines conduct a smaller fraction most of the years, only years 2019 and 2021 catches with lonliners are higher than with trawlers (Table3).
As mentioned for roughhead grenadier, the catch of roudnose grenadier is possibly overestimated due to incorrect species identification.

Greater argentine (*Argentina silus*; ARU)

From 1990 to 2013, there are only reported catches in 2002 (0.4 t). From 2014 to 2022 catches have been very low except years 2017 and 2018 (666.6 t and 425.1 t), which is due to the onset of targeted pelagic trawl fishery for the species since 2015. This targeted fishery ceased in 2019 thus low catches, since then are reported (Table 1, 3 and 6, Fig. 1 and 6).

Tusk (*Brosme brosme*; USK)

Catches of tusk have been low between 1999 to 2013 were much lower (mean annual catch=30.1 tons) compared to catches from 2015 to 2022 (mean annual catch =527.34 tons) (Table 1, 3 and 7, Fig. 1 and 7). The catch is dominated by long lines throughout the time series (Table 3). The increase in catches corresponds with the initiation of targeted fishery in 2014 where TAC was 500 tons, which was increased by the Greenland government to 1500 tons, from 2015 to 2022.

Blue ling (*Molva dypterygia*; BLI)

Catches of blue ling have been low from 1999 to 2009 (annual mean catch =3.2 tons), increasing since then, and picking in 2015 (65.4 t). Catches increased from 2010 (annual mean catch =22.6 tons, Table 1,3 and 8 Fig. 1 and 8). Blue ling was mostly caught in trawl fisheries and the composition between longline and trawl catches remains relatively constant except in 2015, where the largest trawl catch of 65.5 tons was reported (Table 3).

Black scabbardfish (*Aphanopus carbo*; BSF)

Black scabbardfish was only caught in 2010 (30kg) and 2011 (180 kg) in the month of September (Table 1 and 7, Figure 1 and 9).

Ling (*Molva molva*; LIN)

Catches of ling were fluctuating between years with no apparent trend over time (Fig. 7). In 2005, 2006, 2015 and 2016 catches were above 15 tons, whereas catches were below 5 tons in 2000-2003, 2007, 2009-2013 and 2017-2022 (Table 1 , 3 and 10 Fig. 1 and 10). The majority of catches are from trawler, expect in 2015 (Table 3).

Orange roughy (*Hoplostethus antlanticus*; ORY)

Orange roughy was caught only in 2007 and 2010 (0.4 and 0.8 t respectively, Table 1 and 11, Figure 1 and 11).

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Table 1. Total annual commercial catches (tons) of roughhead grenadier (*Macrourus berglax*; RHG), roundnose grenadier (*Coryphaenoides rupestris*; RNG), greater Argentine (*Argentina silus*; ARU), tusk (*Brosme brosme),* blue ling (*Molva dypterygia*; BLI),; USK), black scabbardfish (*Aphanopus carbo*; BSF), ling (*Molva molva*; LIN), and orange roughy (*Hoplostethus atlanticus*; ORY), in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	RHG	RNG	ARU	USK	BLI	BSF	LIN	ORY
1999	0	129.4	0	5.2	0.1	0	8	0
2000	0.01	95.1	0	0	1.4	0	0	0
2001	0	84.5	0	23.3	0.6	0	0.7	0
2002	0	54.7	0.45	0	0.2	0	0.3	0
2003	0	54.2	0	2.2	2.6	0	0.2	0
2004	0	101.4	0	17	7	0	7.1	0
2005	20	61.4	0	39.3	5.6	0	17.7	0
2006	4.4	64.4	0	102.2	5.9	0	18.6	0
2007	3.8	43	0	18.7	1.3	0	1.5	0.4
2008	11.4	30.6	0	20.7	4.8	0	11	0
2009	3.5	44.2	0	15.9	5.4	0	4.6	0
2010	11.4	59.8	0	15.1	7.4	0.03	3.1	0.8
2011	2.2	136.4	0	91.1	8	0.2	4.8	0
2012	13.4	123.3	0	74.6	13	0	5.1	0
2013	0.3	128	0	27.6	15.7	0	2.4	0
2014	61.6	99.7	4.16	167.3	13.9	0	8	0
2015	38.2	139.7	12.21	878.8	65.4	0	20.4	0
2016	75.1	63.5	16.62	562.4	8.6	0	15.2	0
2017	92.8	93.1	666.75	763.2	11.9	0	4.5	0
2018	89.1	128.6	425.19	684.5	33.6	0	4.6	0
2019	0.9	157.1	3.37	386.6	45.4	0	1.9	0
2020	23.2	46.9	28.1	216	26.8	0	1.5	0
2021	55.5	167.4	15.39	720.1	17	0	1.4	0
2022	86.2	134	0.82	367.2	27.3	0	0.7	0

Table 2. Total annual commercial catches (tons) of roughhead grenadier (*Macrourus berglax*; RHG), roundnose grenadier (*Coryphaenoides rupestris*; RNG), greater Argentine (*Argentina silus*; ARU), tusk (*Brosme brosme),* blue ling (*Molva dypterygia*; BLI),; USK), black scabbardfish (*Aphanopus carbo*; BSF), ling (*Molva molva*; LIN), and orange roughy (*Hoplostethus atlanticus*; ORY), in the Greenlandic EEZ zone of ICES in Division 14a and 14b from 1999 to 2022.

	RHG		RNG		ARU	USK		BLI		BSF		LIN	ORY	
Year	14a	14b	14a	14b	14b	14a	14b	14a	14b	14a	14b	14b	14a	14b
1999	0	0	0	129.41	0	0	5.19	0	0.15	0	0	8.05	0	0
2000	0	0.01	0	95.14	0	0	0	0	1.4	0	0	0	0	0
2001	0	0	0	84.52	0	0	23.34	0	0.56	0	0	0.73	0	0
2002	0	0	0	54.73	0.45	0	0	0	0.24	0	0	0.34	0	0
2003	0	0	0	54.24	0	0	2.19	0	2.62	0	0	0.2	0	0
2004	0	0	0	101.45	0	0	16.95	0	7.05	0	0	7.1	0	0
2005	0	19.99	0.18	61.22	0	0	39.32	0	5.64	0	0	17.69	0	0
2006	0	4.37	0	64.42	0	0	102.19	0	5.92	0	0	18.62	0	0
2007	0	3.85	0.01	43.01	0	0	18.66	0	1.27	0	0	1.53	0	0.4
2008	0	11.41	0	30.59	0	0	20.71	0	4.83	0	0	11.05	0	0
2009	0	3.48	0.09	44.07	0	0	15.93	0	5.38	0	0	4.64	0	0
2010	0	11.38	0.04	59.76	0	0	15.1	0	7.45	0	0.03	3.14	0	0.82
2011	0	2.21	0.18	136.25	0	0	91.11	0	7.95	0	0.18	4.79	0	0
2012	0	13.41	0.51	122.82	0	0	74.6	0	13.02	0	0	5.1	0	0
2013	0.01	0.26	0.09	127.94	0	0	27.63	0	15.7	0	0	2.36	0	0
2014	0	61.61	0.9	98.81	4.16	0	167.33	0	13.86	0	0	7.97	0	0
2015	0	38.19	0	139.69	12.21	0	878.76	0	65.42	0	0	20.45	0	0
2016	0.58	74.53	0	63.5	16.62	0	562.4	0	8.63	0	0	15.19	0	0
2017	0.04	92.77	0.44	92.65	666.75	0	763.16	0	11.94	0	0	4.48	0	0
2018	0	89.11	1.7	126.92	425.19	0	684.53	0.03	33.55	0	0	4.58	0	0
2019	0	0.94	0.16	156.93	3.37	0	386.65	0	45.41	0	0	1.89	0	0
2020	0	23.17	0.49	46.45	28.1	0	215.99	0	26.76	0	0	1.53	0	0
2021	1.96	53.54	1.39	166.04	15.39	0	720.1	0	17.04	0	0	1.42	0	0
2022	1	85.25	22.7	111.28	0.82	0	367.24	0	27.29	0	0	0.71	0	0

Table 3. Total annual commercial catches (tons) by gear of roughhead grenadier (*Macrourus berglax*; RHG), roundnose grenadier (*Coryphaenoides rupestris*; RNG), greater Argentine (*Argentina silus*; ARU), tusk (*Brosme brosme),* blue ling (*Molva dypterygia*; BLI),; USK), black scabbardfish (*Aphanopus carbo*; BSF), ling (*Molva molva*; LIN), and orange roughy (*Hoplostethus atlanticus*; ORY), in the Greenlandic EEZ zone of ICES (Divisions 14a and 14b) from 1999 to 2022.

	RHG			RNG			ARY	USK				BLI				BSF	LIN			ORY
Year	BTM	LL	GN	BTM	LL	Other	BTM	BTM	GN	LL	Other	BTM	GN	LL	Other	BTM	BTM	LL	Other	BTM
1999	0	0	0	129.37	0.04	0	0	1.02	0	4.17	0	0	0	0.15	0	0	8.05	0	0	0
2000	0.01	0	0	78.04	17.1	0	0	0	0	0	0	1.4	0	0	0	0	0	0	0	0
2001	0	0	0	71.96	12.56	0	0	23.34	0	0	0	0.56	0	0	0	0	0.73	0	0	0
2002	0	0	0	52.01	0	2.72	0.45	0	0	0	0	0.24	0	0	0	0	0.34	0	0	0
2003	0	0	0	54.24	0	0	0	2.19	0	0	0	2.62	0	0	0	0	0.2	0	0	0
2004	0	0	0	101.45	0	0	0	16.95	0	0	0	7.05	0	0	0	0	7.1	0	0	0
2005	19.99	0	0	61.4	0	0	0	39.12	0	0	0.2	5.64	0	0	0	0	17.69	0	0	0
2006	4.37	0	0	64.42	0	0	0	100.3	0	1.89	0	5.92	0	0	0	0	18.62	0	0	0
2007	3.85	0	0	42.37	0.65	0	0	11.39	0	7.27	0	0.27	0	1.01	0	0	1.53	0	0	0.4
2008	11.41	0	0	28.91	1.69	0	0	12.74	0	7.97	0	3.64	0	1.19	0	0	10.91	0.14	0	0
2009	3.48	0	0	37.03	0	7.13	0	0	0	0.04	15.89	3.91	0	0	1.48	0	3.41	0	1.22	0
2010	11.38	0	0	53.5	6.31	0	0	0	0	13.94	1.17	2.29	0	5.16	0	0.03	3.14	0	0	0.82
2011	2.21	0	0	130.91	5.52	0	0	0.03	0	91.07	0	5.73	0	2.22	0	0.18	2.98	1.81	0	0
2012	13.34	0.06	0	115.68	7.65	0	0	0	0	59.51	15.09	4.92	0	7.83	0.27	0	4.46	0.64	0	0
2013	0.26	0.01	0	125.89	2.13	0	0	0.46	0	14.37	12.81	15.7	0	0	0	0	0.02	1.86	0.47	0
2014	16.03	21.18	24.4	94.04	5.67	0	4.16	0.04	4.13	163.17	0	8.76	0.74	4.36	0	0	5.39	2.58	0	0
2015	3.48	34.71	0	104.9	34.79	0	12.21	0.57	0	876.76	1.43	64.84	0	0.58	0	0	2.57	17.87	0	0
2016	4.72	70.39	0	55.12	8.38	0	16.62	2.45	0	559.94	0	7.13	0	1.51	0	0	2.09	13.1	0	0
2017	0.41	92.4	0	87.82	5.27	0	666.75	1	0	762.17	0	6.98	0	4.95	0	0	1.02	3.46	0	0
2018	0.6	88.51	0	123.06	5.56	0	425.19	101.44	0	583.09	0	31.9	0	1.68	0	0	4.05	0.52	0	0
2019	0.94	0	0	61.92	95.17	0	3.37	2.25	0	384.4	0	26.79	0	18.62	0	0	1.71	0.17	0	0
2020	8.59	14.57	0	43.42	3.51	0	28.1	2.84	0	213.15	0	24.89	0	1.87	0	0	1.3	0.23	0	0
2021	10.88	44.62	0	54.97	112.46	0	15.39	4.03	0	716.08	0	10.71	0	6.33	0	0	0.88	0.54	0	0
2022	16.96	69.29	0	81.98	51.99	0	0.82	1.47	0	365.77	0	21.73	0	5.56	0	0	0.71	0	0	0

Table 4. Total monthly commercial catches (tons) of roughhead grenadier (RHG) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0.01	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	3.97	10.14	0.22	5.66	0	0	0
2006	0	0	0	0	1.3	1.76	0.21	1.1	0	0	0	0
2007	0	0	0	0	1.69	1.53	0.58	0	0.05	0	0	0
2008	0	0	0	0.39	1.9	1.53	2.71	2.68	1.42	0.77	0	0
2009	0	0	0.13	0.69	1.42	0.37	0	0.05	0.69	0	0.14	0
2010	0	0	0	0	2.16	1	4.05	1.2	0.13	2.82	0	0
2011	0	0	0	0	0	0	0.86	1.35	0	0	0	0
2012	0	0	0	9.05	4.19	0.17	0	0	0	0	0	0
2013	0	0	0	0	0	0.01	0.26	0	0	0	0	0
2014	0	0	0	21.36	28.94	0.34	7.18	0.19	0	0	0	3.61
2015	0	0	17.07	17.65	0	0	0	0	3.48	0	0	0
2016	0.8	25.33	30.85	13.41	0	2.45	1.86	0.4	0	0	0	0
2017	0	0	51.1	41.3	0	0	0	0	0	0.41	0	0
2018	0	0	50.48	37.1	1.53	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0.33	0.62	0	0
2020	0	0.87	0.83	0.54	0.91	2.65	13.59	2.54	0.54	0.62	0.08	0
2021	0	0	0	0.04	3.9	12.55	27.24	8	0.88	1.03	1.32	0.54
2022	0	0.2	15.07	14.1	1.17	0.21	0.58	5.86	8.79	39.62	0.66	0
Total	0.8	26.4	165.53	155.63	49.11	28.54	69.27	23.59	21.97	45.89	2.2	4.15

Table 5. Total monthly commercial catches (tons) of roundnose grenadier (RNG) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	12.78	23.72	20.2	23.52	0.15	5	4.42	4.75	7.04	14.47	11.53	1.83
2000	0.2	21.28	13.37	9.63	5.66	11.76	8.06	10.77	8.27	1.06	3.78	1.29
2001	0	0.01	1.8	0.68	2.71	17.96	26.91	23.9	3.4	2.43	2.37	2.35
2002	0.04	0	2.26	5	3.59	16.32	18.52	4.7	0.94	0.34	2.29	0.73
2003	0	0	1.06	3.25	11.09	10.74	9.78	7.21	4.45	4.68	1.72	0.25
2004	0	0	0.05	7.45	6.31	19.24	31.03	20.36	7.6	3.84	3.31	2.25
2005	0	0	0.04	1.48	2.63	16.29	27.05	10.1	3.06	0.92	0	0.06
2006	0	0.02	0.06	3.51	14.62	8.5	6.52	25.41	2.85	0.38	2.15	0.4
2007	0	0.06	0.26	3.77	12.82	9.06	8.16	4.63	1.59	1.23	0.98	0.45
2008	1.51	0.05	0.2	5.55	6.61	6.32	3.33	3.68	1.43	1.6	0.31	0
2009	0	0	0.86	3.48	9.3	8.48	9.61	4.73	3.55	1.97	1.83	0.35
2010	0	0	0.46	7.43	12.05	8.88	10.28	9.35	6.99	1.35	2.99	0.03
2011	0	0	2.55	7.34	18.88	42	36.48	15.84	5.48	3.8	3.02	1.03
2012	0	0	2.19	9.19	35.59	29.27	19.62	19.94	4.02	3.22	0.26	0
2013	0	0	3.02	15.42	27.68	38.25	21.04	12.41	1.25	5.8	2.89	0.26

2014	0	0.54	4.22	11.99	16.57	19.43	16.31	5.47	8.45	12.14	1.46	3.13
2015	3	0.58	22.35	42.83	16.88	4.6	12.83	12.27	13.27	3.24	1.73	6.09
2016	0	0.81	4.6	10.54	14.43	10.7	15.79	4.53	1.73	0.37	0	0
2017	0	0.67	11.38	17.9	17.13	8.15	20.11	7.83	3.51	5.44	0.41	0.56
2018	0	1.68	17.43	23.29	9.42	11.06	46.75	16.52	1.18	1.26	0.04	0
2019	0	0.73	10.4	10.88	2.45	77.73	38.78	6.88	3.17	6.02	0.06	0
2020	0	0.25	3.96	2.16	4.91	6.12	6.54	8.29	11.34	0.11	1.3	1.96
2021	0	0	0	5.79	15.16	63.52	32.23	27.81	7.88	5.05	9.44	0.54
2022	0.03	0.49	2.68	3.46	6.47	30.82	49.23	12.97	24.58	1	0.61	1.64
Total	17.56	50.89	125.4	235.54	273.11	480.2	479.38	280.35	137.03	81.72	54.48	25.2

Table 6. Total monthly commercial catches (tons) of greater argentine (ARU) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	12.78	23.72	20.2	23.52	0.15	5	4.42	4.75	7.04	14.47	11.53	1.83
2000	0.2	21.28	13.37	9.63	5.66	11.76	8.06	10.77	8.27	1.06	3.78	1.29
2001	0	0.01	1.8	0.68	2.71	17.96	26.91	23.9	3.4	2.43	2.37	2.35
2002	0.04	0	2.26	5	3.59	16.32	18.52	4.7	0.94	0.34	2.29	0.73
2003	0	0	1.06	3.25	11.09	10.74	9.78	7.21	4.45	4.68	1.72	0.25
2004	0	0	0.05	7.45	6.31	19.24	31.03	20.36	7.6	3.84	3.31	2.25
2005	0	0	0.04	1.48	2.63	16.29	27.05	10.1	3.06	0.92	0	0.06
2006	0	0.02	0.06	3.51	14.62	8.5	6.52	25.41	2.85	0.38	2.15	0.4
2007	0	0.06	0.26	3.77	12.82	9.06	8.16	4.63	1.59	1.23	0.98	0.45
2008	1.51	0.05	0.2	5.55	6.61	6.32	3.33	3.68	1.43	1.6	0.31	0
2009	0	0	0.86	3.48	9.3	8.48	9.61	4.73	3.55	1.97	1.83	0.35
2010	0	0	0.46	7.43	12.05	8.88	10.28	9.35	6.99	1.35	2.99	0.03
2011	0	0	2.55	7.34	18.88	42	36.48	15.84	5.48	3.8	3.02	1.03
2012	0	0	2.19	9.19	35.59	29.27	19.62	19.94	4.02	3.22	0.26	0
2013	0	0	3.02	15.42	27.68	38.25	21.04	12.41	1.25	5.8	2.89	0.26
2014	0	0.54	4.22	11.99	16.57	19.43	16.31	5.47	8.45	12.14	1.46	3.13
2015	3	0.58	22.35	42.83	16.88	4.6	12.83	12.27	13.27	3.24	1.73	6.09
2016	0	0.81	4.6	10.54	14.43	10.7	15.79	4.53	1.73	0.37	0	0
2017	0	0.67	11.38	17.9	17.13	8.15	20.11	7.83	3.51	5.44	0.41	0.56
2018	0	1.68	17.43	23.29	9.42	11.06	46.75	16.52	1.18	1.26	0.04	0
2019	0	0.73	10.4	10.88	2.45	77.73	38.78	6.88	3.17	6.02	0.06	0
2020	0	0.25	3.96	2.16	4.91	6.12	6.54	8.29	11.34	0.11	1.3	1.96
2021	0	0	0	5.79	15.16	63.52	32.23	27.81	7.88	5.05	9.44	0.54
2022	0.03	0.49	2.68	3.46	6.47	30.82	49.23	12.97	24.58	1	0.61	1.64
Total	17.56	50.89	125.4	235.54	273.11	480.2	479.38	280.35	137.03	81.72	54.48	25.2

Table 7. Total monthly commercial catches (tons) of tusk (USK) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0	4.72	0.48	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	4.72	5.52	10.93	1.58	0.6	0
2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	2.19	0	0	0
2004	0	0	0	0	0.04	0.04	2.28	1.21	4.5	2.35	5.4	1.14
2005	0	0	1.77	0.07	1.64	3.25	3.3	0.32	6.18	9.86	12.73	0.2
2006	0	0	2.45	2.55	4.08	0.8	0.47	6.78	1.05	1.55	3.11	79.4
2007	0	0	0	0	0.03	3.95	7.45	0.23	4.28	2.73	0	0
2008	12.74	0	0	0	1.47	0.6	0	3.69	0	2.2	0	0
2009	0.04	0	0	0.97	1.15	0.14	5.48	8.16	0	0	0	0
2010	0	0	0	0	0.1	0.7	4.67	5.57	4.06	0	0	0
2011	0	0	0.03	0	2.87	5.53	12.92	5.97	15.28	48.51	0	0
2012	0	0	0	0	1.8	13.49	9.99	33.88	11.55	3.88	0	0
2013	0	0	1.34	15.99	1.3	0.75	0.9	0	0.35	6.2	0.8	0
2014	0	0.04	0	4.06	1.52	53.2	29.16	49.65	29.27	0.39	0.04	0
2015	43.24	0	0	0	9.42	46.12	59.75	468.18	251.98	0	0.07	0
2016	0	0	1.38	24.23	48.96	95.1	180.42	34.05	147.58	13.72	3.62	13.3
2017	11.38	44.1	151	1.24	0.14	240	75.79	95.68	103.94	0.98	15.74	22.7
2018	0.79	0	108	52.71	7.96	296.1	44.34	23.54	113.42	9.33	5.26	23.5
2019	8.89	39.2	11.9	59.88	15.14	113.2	92.04	39.91	4.36	0.4	0.12	1.58
2020	7.6	9.22	5.85	86.3	34.46	4.82	45.9	10.57	2.7	3.26	0.46	4.86
2021	0	3.66	25.7	54.43	200.32	198.4	157.48	58.34	10.11	7.02	4.66	0
2022	0.15	0.07	18.2	48.89	28.76	16.87	8.19	4.2	68.78	156.3	3.31	13.5
Total	84.83	96.3	328	351.32	361.16	1093	749.97	855.93	792.51	270.3	55.92	160

Table 8. Total monthly commercial catches (tons) of blue ling (BLI) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1999	0	0	0	0	0	0	0.15	0	0	0	0	0
2000	0	0	0	0	0	0	0	0.16	1.07	0	0.16	0
2001	0	0	0	0	0	0	0.56	0	0	0	0	0

2002	0	0	0.1	0.03	0	0.06	0	0	0.05	0	0	0
2003	0	0	0	0	0.26	0.14	0.95	1.27	0	0	0	0
2004	0	0	0	0.43	0.55	0.15	2.16	1.01	0.83	0.82	0.22	0.88
2005	0	0	0	1	0.13	1.27	2.07	0.38	0.8	0	0	0
2006	0	0	0	0	0	0	0	0.35	0	0.54	1.35	3.67
2007	0	0	0	0	0	0.19	0	0.27	0.74	0.08	0	0
2008	2.83	0	0	0	0.2	0.12	0	0.81	0.09	0.73	0.05	0
2009	0	0	0	0.47	2.7	2.03	0	0	0.18	0	0	0
2010	0	0	0	0	0.44	0.19	0	1.55	4.73	0.26	0.22	0.06
2011	0	0	0.07	0	0.33	2.44	0.22	0.95	0.9	1.96	0.96	0.12
2012	0	0	0.67	2.1	1.82	1.26	0.06	1.93	3.32	1.88	0	0
2013	0	0	1.11	1.09	1.22	0.3	0.15	2.1	0.1	6.98	2.65	0
2014	0	0.59	1.44	0.57	2.13	1.88	0.47	2.88	1.34	2.37	0	0.19
2015	0	1.52	1.92	0.46	0.63	0.4	0.71	0.08	26.05	32.91	0	0.74
2016	0	1	0.92	0.44	1.41	0.13	0.33	0	4.4	0	0	0
2017	0	0.37	3.72	1.81	0.08	0.79	2.1	0.6	1.24	1.23	0	0
2018	1.65	0.61	3.34	8.82	1.77	0.22	0.51	0.1	0.65	15.01	0.91	0
2019	0	0.14	1.12	0.1	0.2	0.58	16.79	6.81	7.24	11.5	0.34	0.6
2020	0	0.27	0.99	0.14	0.2	0.95	4.54	3.46	5.23	5.62	5.38	0
2021	0.27	0	0	0.03	0.03	5.09	5.61	0.23	0.83	1.33	2.51	1.11
2022	0.62	0.11	0.75	0	0.06	0.57	0	0.07	3.98	16.81	2.87	1.43
Total	5.37	4.61	16.15	17.49	14.16	18.76	37.38	25.01	63.77	100.03	17.62	8.8

Table 9. Total monthly commercial catches (tons) of black scabbardfish (BSF) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0.03	0	0	0
2011	0	0	0	0	0	0	0	0	0.18	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0

2021	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0.21	0	0	0

Table 10. Total monthly commercial catches (tons) of ling (LIN) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0.16	0.76	0.57	0.58	2.04	3.83	0.1
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0.52	0.22	0	0	0
2002	0	0	0	0	0	0.25	0.08	0	0	0	0	0
2003	0	0	0	0	0.12	0	0	0	0	0.06	0.03	0
2004	0	0	0	0	0.06	0.13	0.41	0.39	0.52	5.6	0	0
2005	0	0	0.06	0	2.69	0.07	0	4.05	0.7	8.39	1.73	0
2006	0	0	0	0	0.1	0.05	0	0.25	0	0	0	18.22
2007	0	0	0	0.4	0.21	0.16	0.43	0.34	0	0	0	0
2008	10.09	0	0	0	0.14	0	0	0.82	0	0	0	0
2009	0	0	0	0	1.68	0.85	1.26	0.52	0.11	0.22	0	0
2010	0	0	0.11	0.52	0.73	0.11	0.11	0	0	0	1.55	0
2011	0	0	0.62	0.78	0	0	1.64	1.76	0	0	0	0
2012	0	0	0.24	0.2	1.08	0.27	0.09	2.22	0.67	0.1	0.24	0
2013	0	0	0.02	1.36	0	0	0	0	0	0.97	0	0
2014	0	0	0	0.02	0	2.29	3.02	2.44	0.21	0	0	0
2015	9.45	0.11	0	0	0.72	1.9	1.76	3.42	3.09	0	0	0
2016	0	0	0	0.36	0.09	3.54	8.5	0.13	0.95	0.35	0	1.28
2017	0.57	0.34	0	0.36	0.23	0.86	0.74	1.18	0.21	0	0	0
2018	0	0.54	0.07	0	0	0.66	0	3.21	0.11	0	0	0
2019	0	0	0	0	0	0.03	0.04	0.26	0	0	1.56	0
2020	0	0.17	0	0.1	0.13	0.03	0	0	0	0	0	1.1
2021	0	0.13	0.06	0.23	0.45	0.08	0.01	0.03	0	0	0.43	0
2022	0.04	0	0.08	0	0	0.03	0.36	0.2	0	0	0	0
Total	20.15	1.29	1.26	4.33	8.43	11.47	19.21	22.31	7.37	17.73	9.37	20.7

Table 11. Total monthly commercial catches (tons) of orange roughy (ORY) in the Greenlandic EEZ zone of ICES 14 from 1999 to 2022.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0.32	0.08	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0.82	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0

2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0.32	0.9	0	0	0	0	0	0

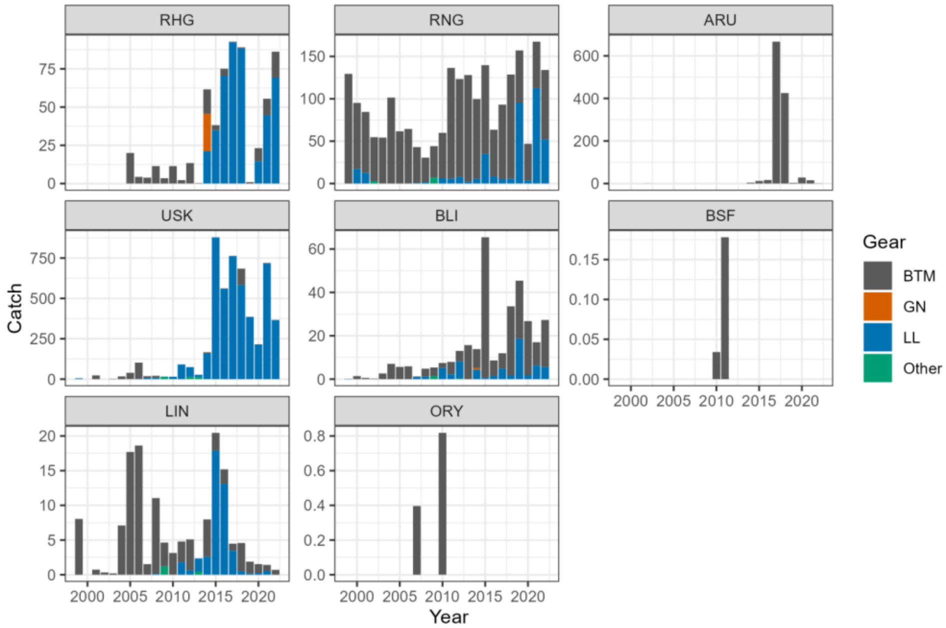

Figure 1. Total annual commercial catches by gear, in tonnes (t) of roughhead grenadier (RHG), roundnose grenadier (RNG), greater argentine (ARU), tusk (USK), blue ling (BLI), black scabbardfish (BSF), ling (LIN), and orange roughy (ORY)in the Greelandic EEZ zone of ICES 14 from 1999 to 2022. Note the different scales of the y axes. Catches for black scabbardfish and orange roughy were very low and can be seen in Table 1.

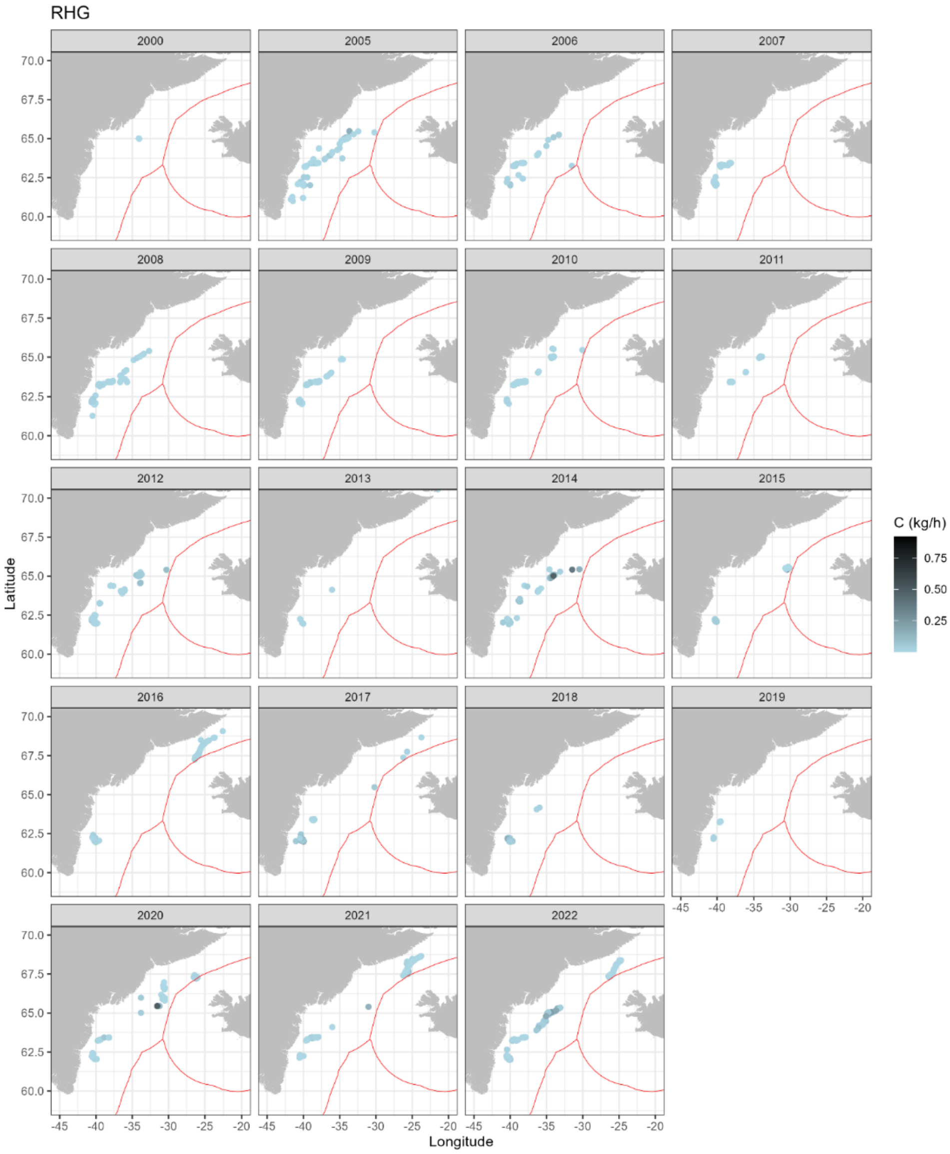

Figure 2: Roughhead grenadier (*Macrourus berglax*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

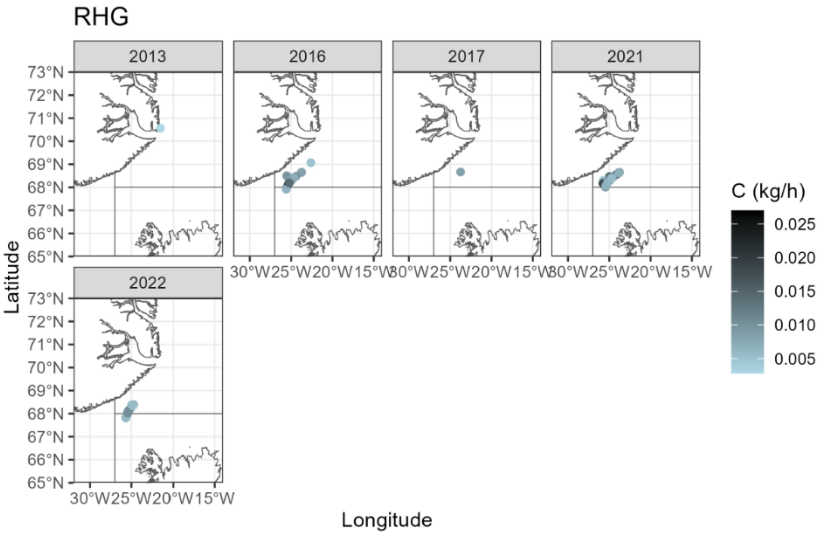

Figure 3: Roughhead grenadier (*Macrourus berglax*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.a.

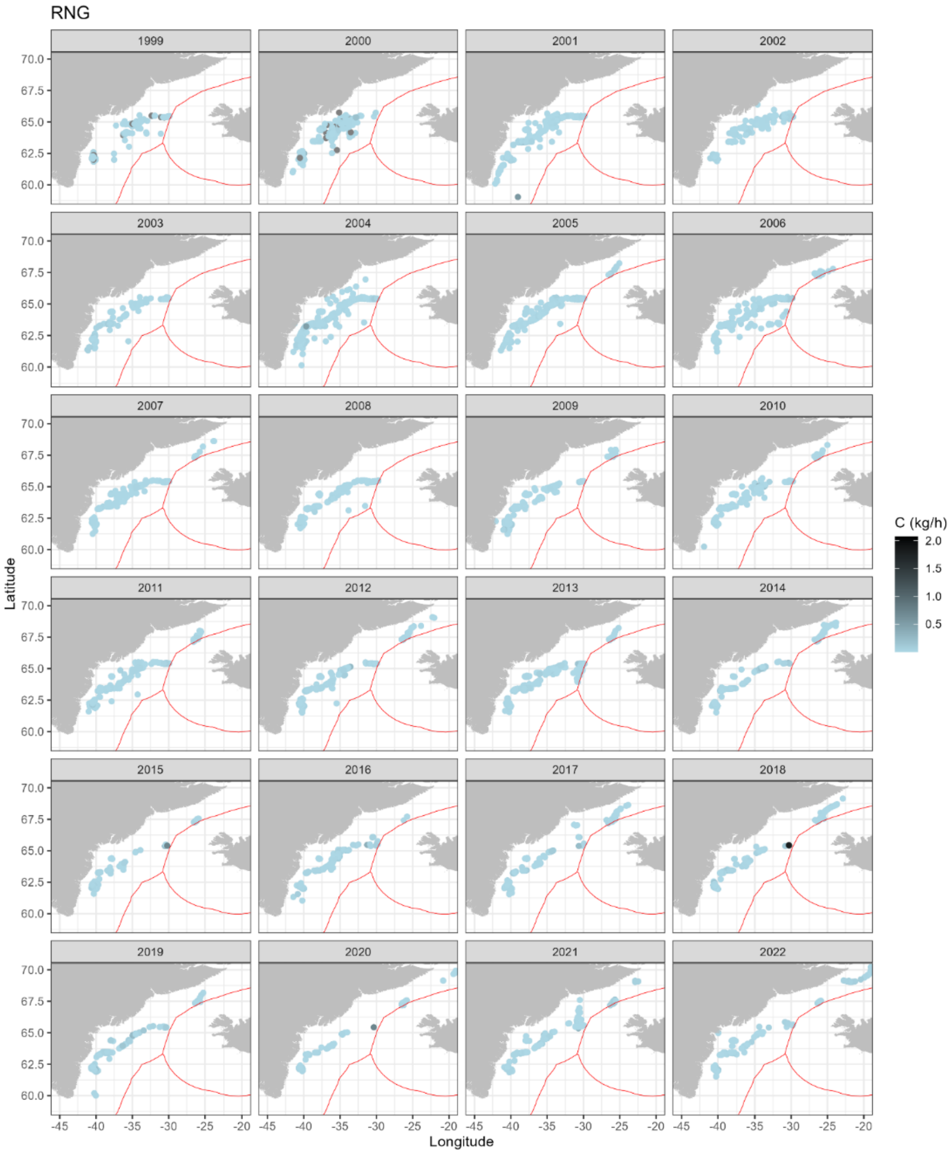

Figure 4: Roundnose grenadier (*Coryphaenoides rupestris*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

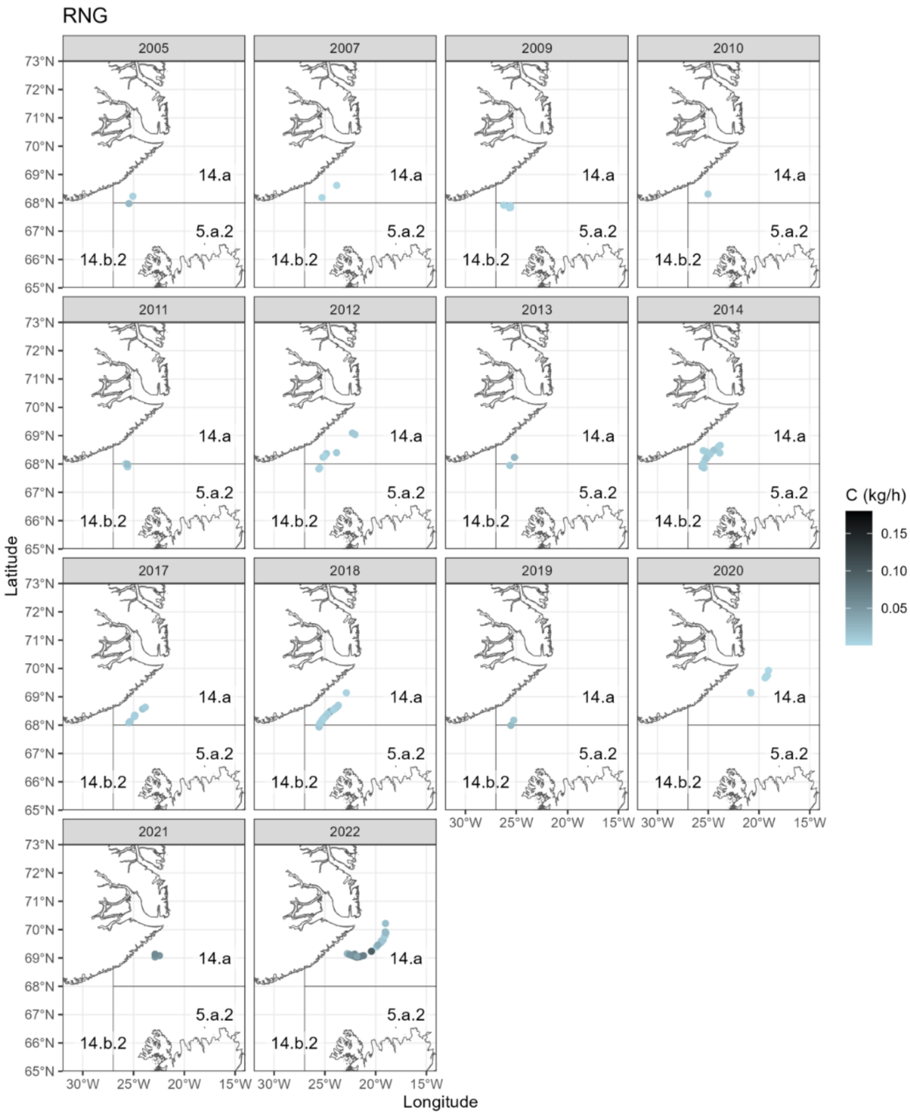

Figure 5: Roundnose grenadier (*Coryphaenoides rupestris*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.a.

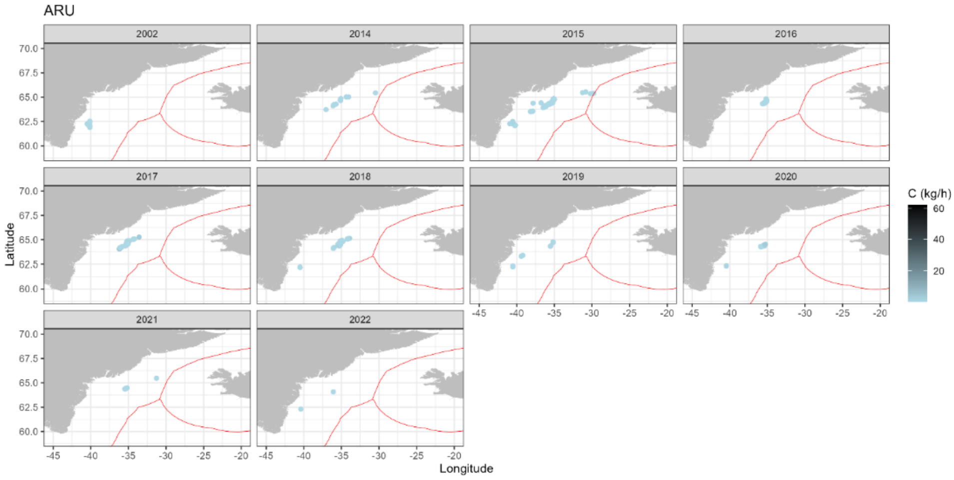

Figure 6: Greater argentine (*Argentina silus*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

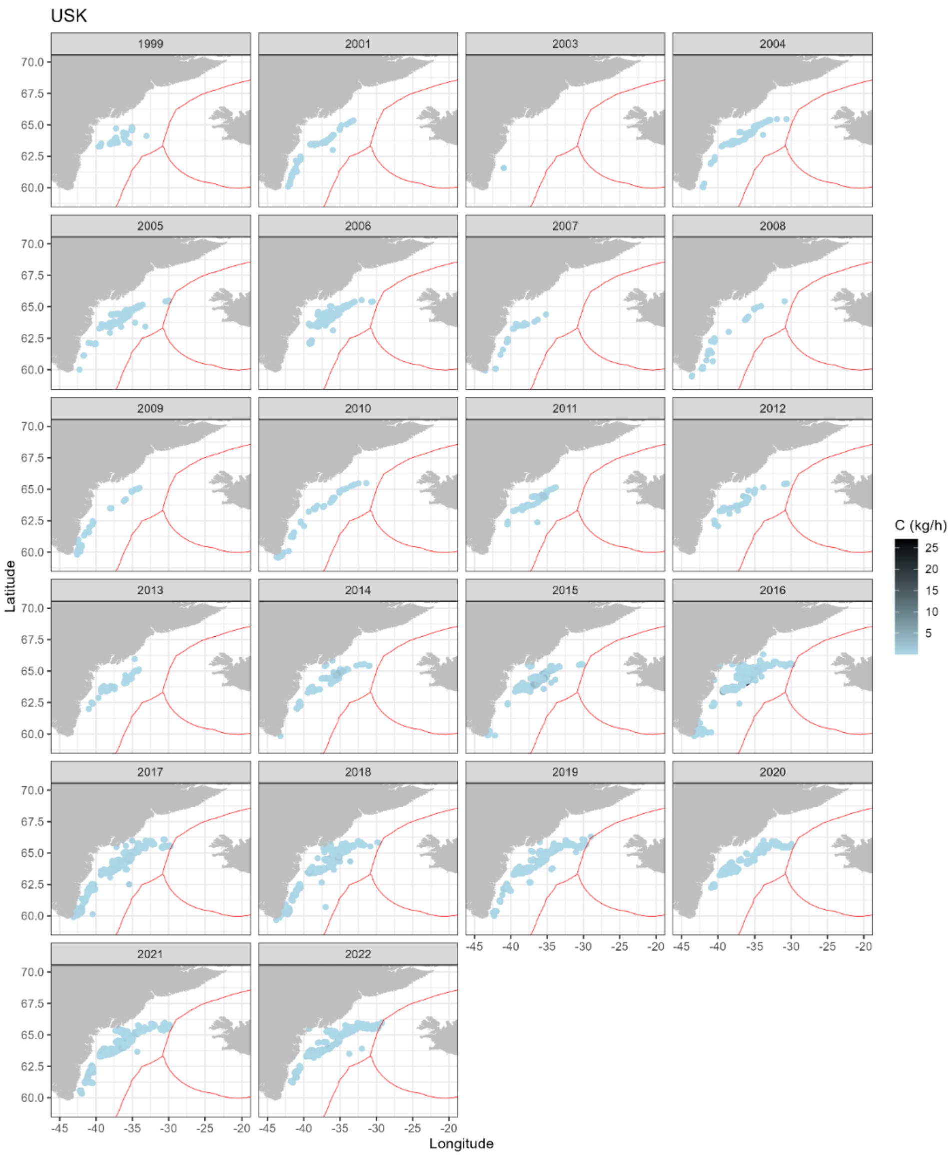

Figure 7: Tusk (*Brosme brosme*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

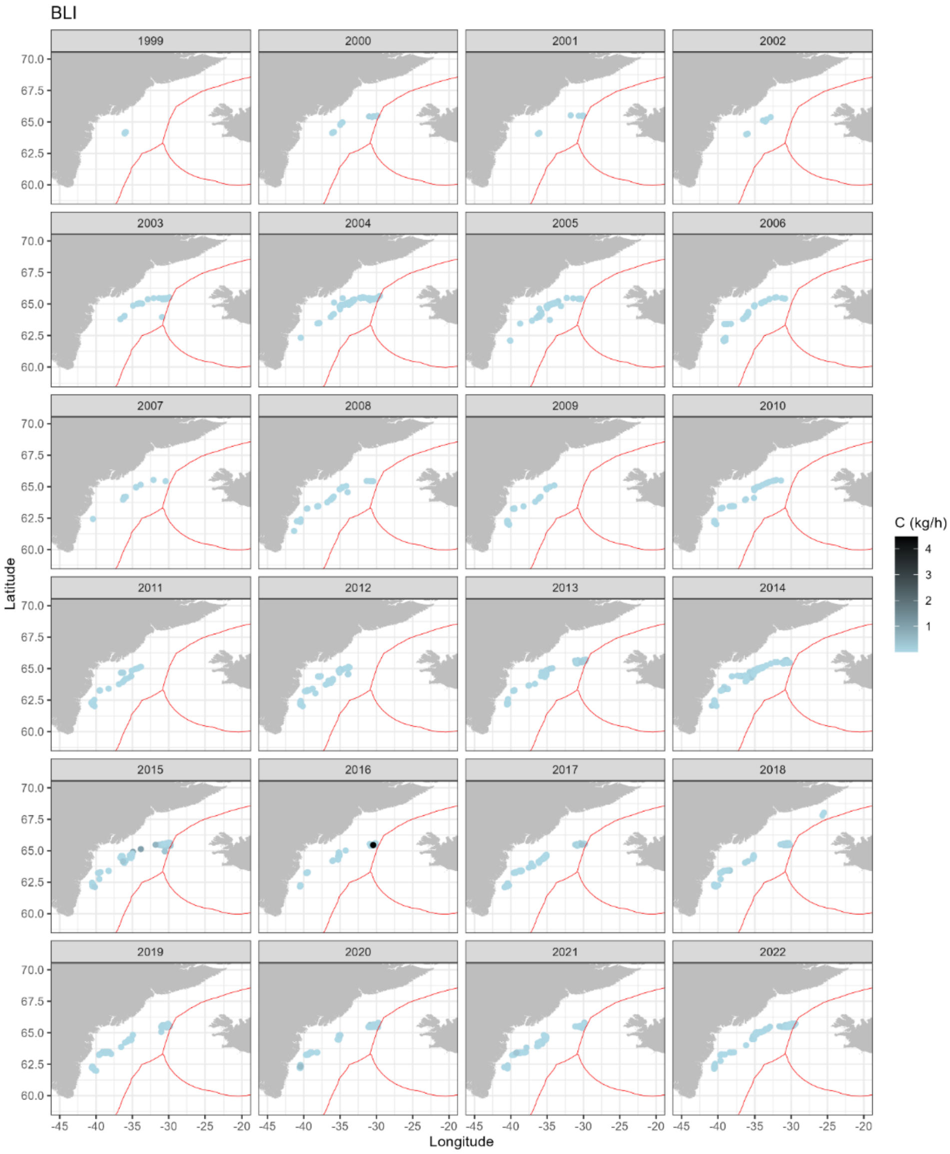

Figure 8: Blue ling (*Molva dypterygia*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

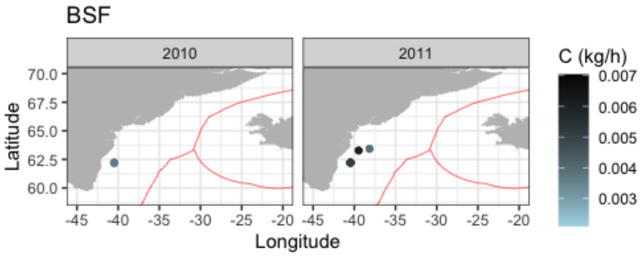

Figure 9: Black scabbardfish (*Aphanopus carbo*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

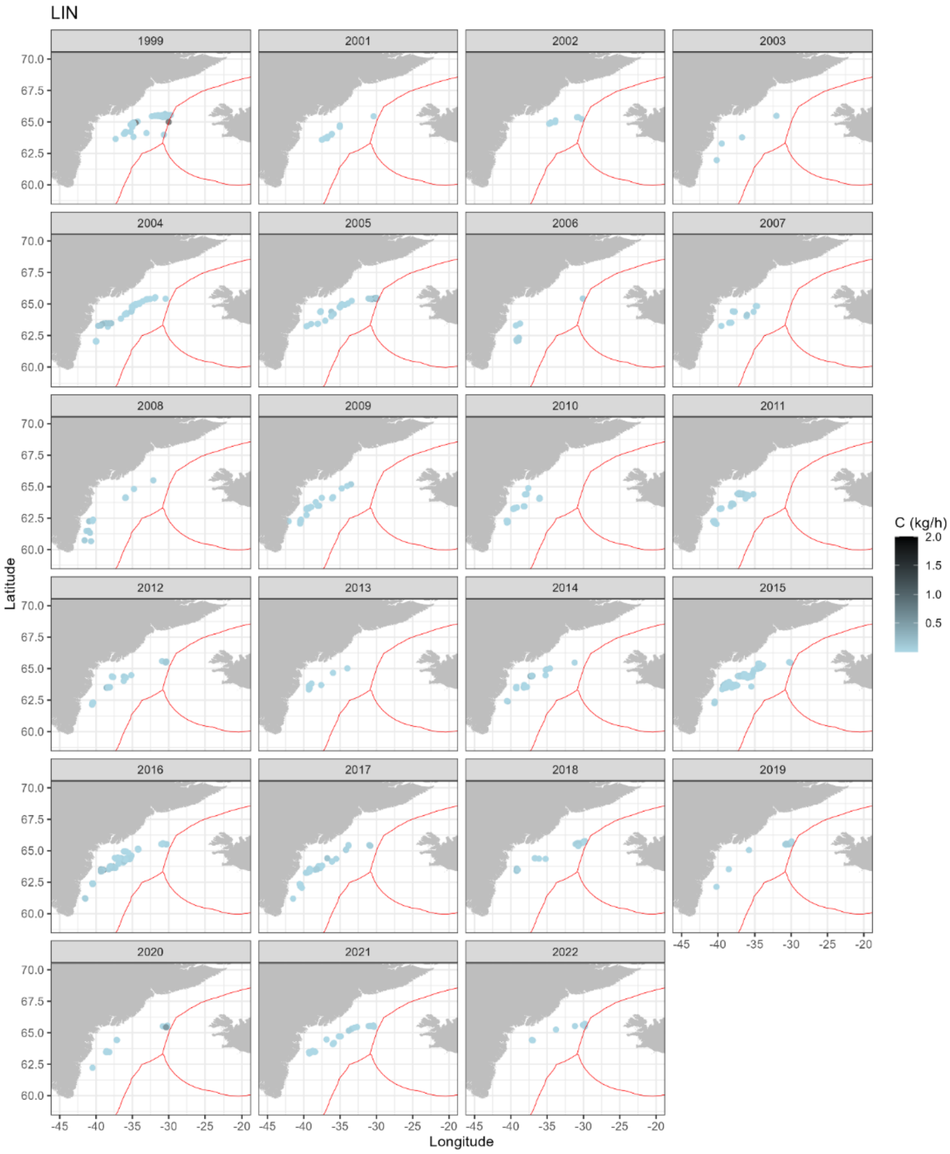

Figure 10: Ling (*Molva molva*) CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

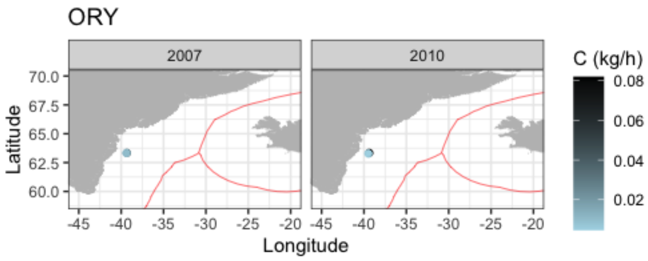

Figure 11: Orange roughy (*Hoplostethus antlanticus)* CPUE (kg/h) distribution in the Greenlandic EEZ of ICES 14.b.

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Not to be cited without prior reference to the authors

Refining stock distribution of the current bli.27.nea ICES assessment unit, based on new evidence of genetic and demographic population structure

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Working document

1. Background

Blue ling *(Molva dypterygia*) is caught over a wide area in northeast Atlantic. At present there are three stock areas for blue ling within WGDEEP (bli.27.nea, bli.27.5b67 and bli.27.5a14).

The stock area bli.27.nea consists of subareas 1, 2, 8, 9, 12 and divisions 3a and 4.a. Historically (within WGDEEP) it was defined as the combination of areas where some blue ling landings were reported from bycatch fisheries without major directed fisheries. Geographically, this stock area is split in three regions (Figure 1). Subareas 8 and 9 is the southernmost. New information suggests that landings from subareas 8 and 9 are Spanish ling (*Molva macrophthalma*) and historical records of blue ling are questionable, see section with Figure 2. Therefore, landings of blue ling from these subareas have been attributed to this Spanish ling since 2010 and, accordingly, the landing tables of the assessment unit bli.27.nea for subareas 8 and 9 have not been updated. There is a need for information and suitable identification sheets to be provided to fisheries for landings from these subareas to be reported as the right species (*M. macrophthalma*, Spanish, FAO code SLI).

Subarea 12 includes parts of the Mid-Atlantic Ridge (in ICES divisions 12.a.1, 12.a.4 and 12.c) and the western slope of the Hatton Bank (in ICES Division 12.b). Since 2014, landings from Subarea 12 have decreased from 80 to 0 tons in 2022. However, based upon the continuity of bathymetric features and lesser abundance, blue ling from the western Hatton Bank (Division 12.b) is likely to be related to those from the northern Hatton Bank (ICES Division 6.b) and blue ling from other divisions of Subarea 12 is more likely to be related to those from Icelandic and east Greenland waters. Following this, it would be more appropriate that blue ling in Division 12.b is combined with stock unit bli.27.5b67, forming a new unit bli.27.5b6712b). Other divisions of 12 should be added to the stock unit bli.5a14, becoming bli.27.5a12ac14.

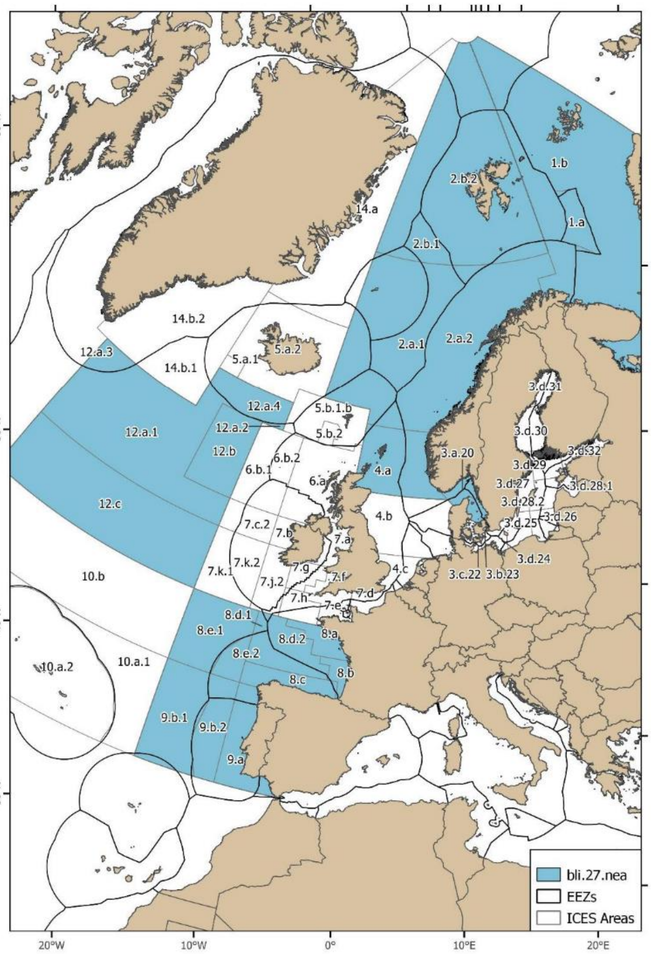

Figure 1. Map showing ICES areas covering the stock unit of Blue ling in subareas 1, 2, 8, 9, 12 and divisions 3a and 4.a (bli.27.nea).

In subareas 1, 2 and divisions 3a and 4a, blue ling inhabit the components of Barents Sea, the western slope of northern Norway, North Sea and the Skagerrak, where the bulk of the catch is from Norwegian fisheries in subareas 2a and 4a. Catches in the North Sea (Subarea 4) come from the Norwegian deep, in the eastern side of the North Sea. There are also some small catches reported from Division 4.b (Denmark and Germany).

In recent years, landings from this stock area are exclusively from subareas 1,2,4 and Division 3a. Norway contributes by far to the landings in Divisions 2.a (77%) and 4.a (77%).

There were landings reported to Intercatch from subareas 8 and 9 in 2022. These landings represent 11% of the total landings from the stock area (75 tonnes). These catches are from France (15%) and Spain (85%). Such landings are ascribed to *M. macrophthalma* and have not been included in the bli.27.nea assessment since 2010. The allocation of catch from Subarea 8 of the Spanish ling comes from the French EVHOE survey, where all individuals of the genus *Molva* caught are checked for correct taxonomic identification. There is a clear distinguishing criterion between blue ling (*Molva dypterygia*) and the Spanish ling *(Molva macrophthalma*) with the latter having the pelvic fin extending beyond the pectoral (Figure 2). All individuals caught in subarea 8 were *M. macrophthalma.*

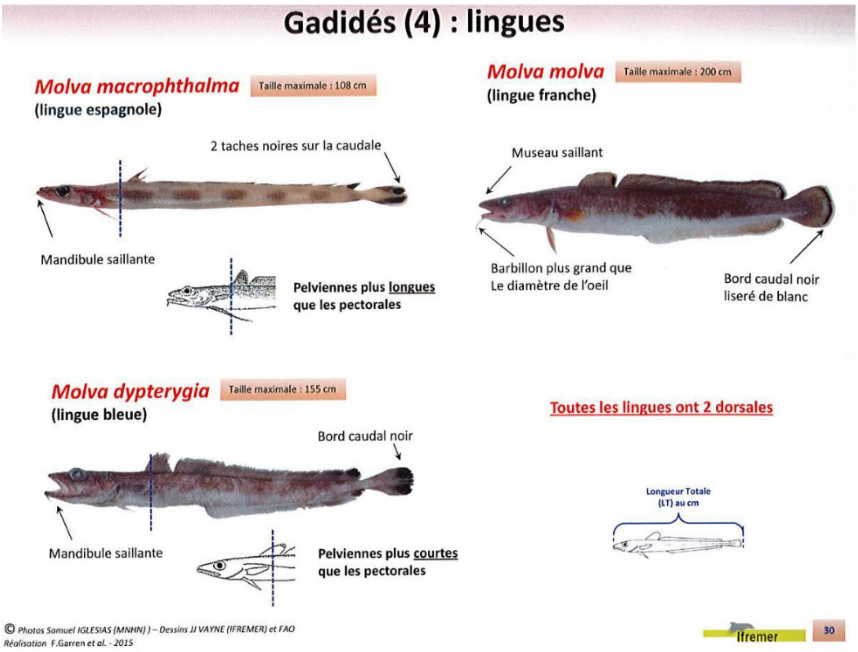

Figure 2. Identification sheet for ling (genus *Molva*) used in French surveys (from Garren, 2020)

2. Fisheries

In Subarea 12 catches have been from multispecies fishery fleets fishing for several deepwater species, primarily roundnose grenadier, black scabbardfish and blue ling, with a component of deepwater sharks and orange roughy in the 1990s. Before the 1990s, the bulk of the landings from Subarea 12 was from target fisheries of seasonal spawning aggregations, like in divisions 5.a and 6.ab. Known spawning areas are now closed seasonally to protect the spawning stock.

There was a directed fishery for blue ling in Division 2.a on spawning areas; mainly Norwegian vessels fishing with nets. The directed fishery was banned in 2009 and has since been regulated by a 10% allowed bycatch from other fisheries. The fishery in divisions 2.a and 4.a is now a bycatch fishery from longlines and nets.

3. Blue ling population structure

3.1. Recent population genetic study

Genetics information is scarce for this species. However, there is new information on population structure of blue ling (McGill *et al*, 2023). Samples from the Atlantic basin covering (Greenland, Rockall, Rosemary Bank, Anton Dohrn and Atlantic slope, i.e. to the West of Scotland) and along the Norwegian Coast, in Division 2.a by 69°N, in Division 4.a by 59-61 °N and South Norway in Division 3.a) were analyzed with Principal Component Analysis (PCA) and the Structure software (Pritchard *et al.*, 2000) and the results showed two distinct genetic units (Figure 3). Although there was found some genetic flow between the two areas, there was clearly two separate units. This information supports changing the current stock area to units reflecting better the actual population structure. Further, the current bli.27.nea include subareas 1 and 2 to the East and Subarea 12 to the West, whilst these subareas are separated by the two other assessments units considered by ICES.

Overall, the population genetic study indicated that blue ling from the Atlantic Basin and Norwegian water are distinct, which implies that Subarea 12, which is included in bli.27.nea should be separated from subareas 1 to 4.

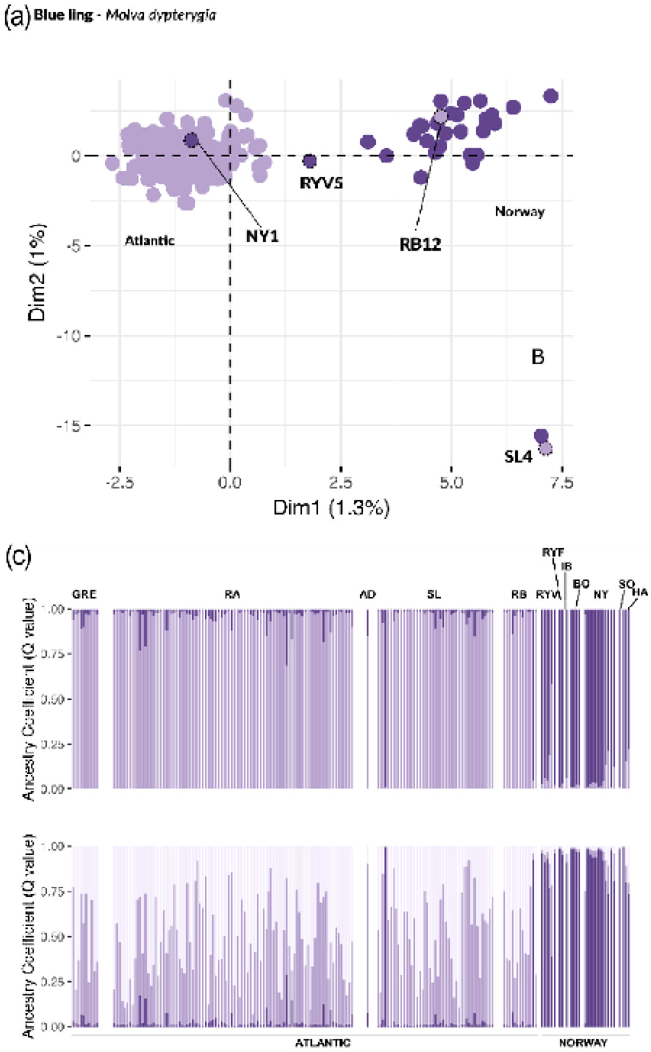

Figure 3. Genetic population structure of blue ling, based on sampling in the Atlantic basin, Norwegian Sea and North Sea. PCA plot (a) and Structure plot (c) (redrawn McGill *et al.*, 2023).

3.2. Population structure in the Atlantic basin.

The population genetic study from Gill *et al.* (2023) did not reveal structure within the Atlantic basin. This would probably need genotyping more individuals from more locations from the Atlantic. The population structure in this basin was considered for long. 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 was supported by differences in length and age structures between areas as well as in growth and maturity. Egg and larvae data from early studies also suggested the existence of many spawning grounds in each of areas of the northern and southern stocks and this was considered as indications of stock separation. These now historical approaches are the basis for distinguishing the two major current stock units: bli.27.5a14 and bli.27.5b67. To the the west of the British Isles in Subarea 6, small blue ling below 60 cm are not caught by fisheries nor surveys. Fish appear in survey and commercial catch at 60–80 cm possibly suggesting migration of juveniles from other areas. Spawning grounds are known to occur in Subarea 6, along the Scottish slope, on Rockall, Hatton, Lousy and Rosemary Banks (Figure 4, left panel) in Division 5.a, Icelandic grounds, (Figure 4, right panel). Spawning areas have also been identified in Faroese waters (Figure 5).

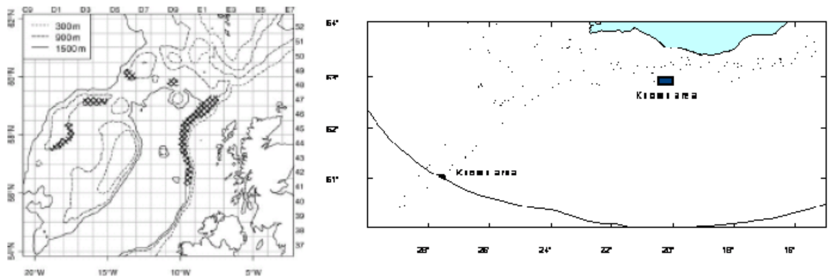

Figure 4. Spatial distribution of blue ling spawning grounds along the Scottish slope, on the Hatton, Lousy and Rosemary Banks (left) and to the South of Iceland (right).

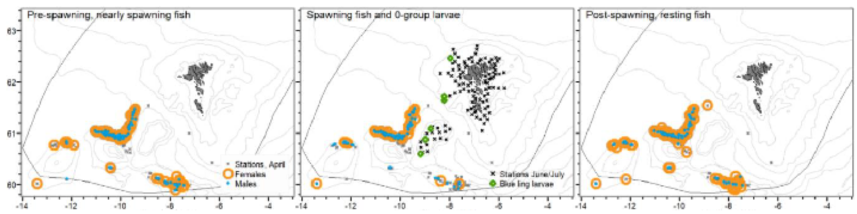

Figure 5. Spatial distribution of blue ling spawning areas in Faroese waters. Data from the blue ling surveys in April, 1995-2003. Observations of nearly spawning fish (left), spawning fish and observations of larvae (middle) and resting fish (right). Larvae data from 0-group survey June/July 1995-2017.

Small blue ling are observed in survey in Icelandic and Greenland waters. In recent decades Icelandic surveys have shown a sudden drop in small blue ling abundance, denoted recruitment (Figure 6.D) in 2008-2010 and remained at low level since. This low recruitment was followed by a decrease in biomass of fish larger than 40 cm from 2012 (Figure 6.B) which was also visible in fish larger than 70 cm TL (Figure 6.C). This suggest that small blue ling observed in Icelandic, actually represent the recruitment to this stock. Small blue ling from 21 cm has also been of observed in survey in Greenland waters since 2002 (Nogueira and Christiansen, 2023). Lastly blue ling smaller than 40 cm TL have also been observed in Faroese surveys, but in a few locations and very small numbers. Pelagic larvae (2-3 cm in length) have also been caught in the annual 0-group trawl survey in June/July (Figure 5, central panel) but in very small numbers only (Ofstad, 2018).

Overall the number of blue ling smaller than 60 cm observed in surveys in the area of the bli.27.5b67 seems very small in comparison to the adult stock, which current biomass is estimated to near 100 000 tonnes. How larvae drift and juveniles migrate to adult grounds, where they recruit to fisheries, is unknown.

If blue ling from Division 5b and subareas 6 and 7 (bli.27.5b67) was demographically connected to bli.27.5a14, the decline in biomass of fish larger than 70 cm observed for bli.27.5a14 from 2012-13 should also have occurred quite at the same time in bli.27.5b67, where blue ling recruit to the fishery at 60-70 cm. No such decline was observed, in contrast the biomass increased rather continuously since the early 2000s (Figure 7), which may have been driven by decreasing catches in the 2000, but after 2010 catches stabilized and eventually started increasing in recent years. Further, the current exploitation level is estimated to be well below MSY for bli.27.5b67 (ICES, 2022a), whilst it is above for bli.27.5a14 (ICES, 2022b). This suggest that the two stock units bli.27.5a14 and bli.27.5b67 are demographically disconnected and support the ICES practice to recognize these two major units in the Atlantic basin.

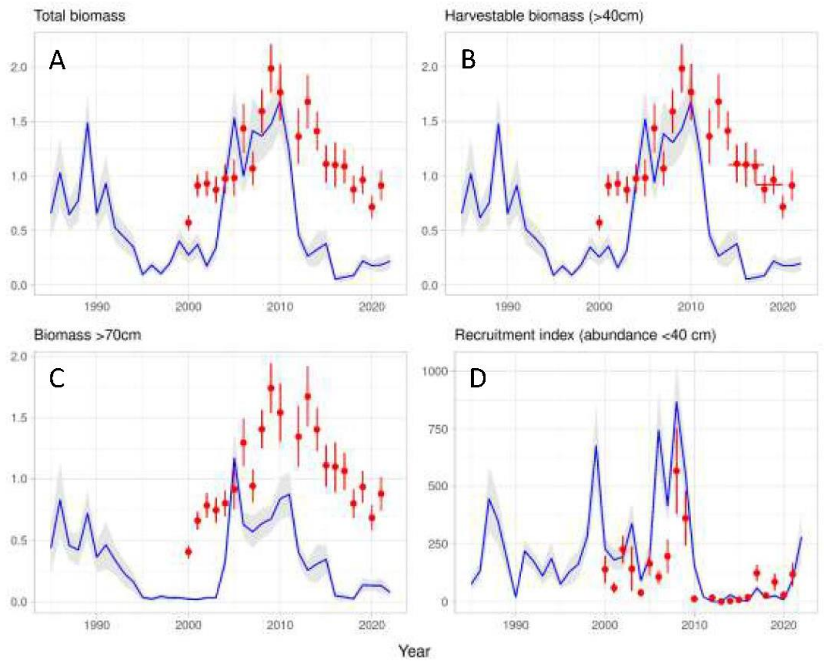

Figure 6. Biomass (thousand tonnes) and abundance (numbers) indices of blue ling in the Icelandic autumn survey since 2000 (red points) and the spring survey since 1985 (blue lines). Total biomass index (top-left), biomass of 40 cm and larger (top-right), biomass of 70 cm and larger (bottom-left) and abundance of small blue ling smaller than 40 cm, considered recruitment. Vertical red lines and shaded area represent standard error of the estimate. Redrawn from ICES (2022c).

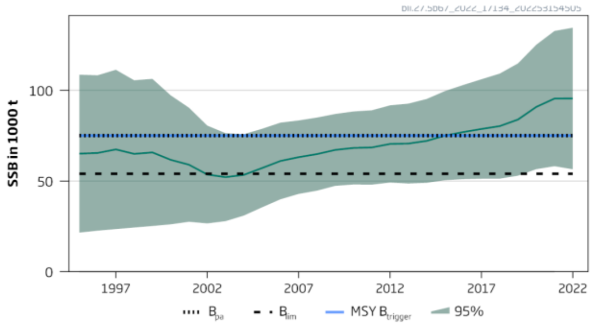

Figure 7. Estimated biomass of the bli.27.5b67 stock (ICES, 2022a).

The remaining issue is how to treat Subarea 12 from which the genetic population study had not samples (Gill *et al.,* 2023). Further, considering that this study did not found difference between samples from south Greenland and those from Rockall and Hatton, blue ling from Subarea 12 may be expected to belong to the same genetic pool.

Blue ling occurs at unknown level in different parts of Subarea 12. Current catches are minor but historical catches suggest that Subarea 12 may accommodate a significant biomass of the species (although the current level of this biomass with respect to the possible carrying capacity of the area in unknown), with 400 to 1300 tonnes landed annually from 1995 to 2005 (ICES, 2002). We suggest treated this subarea based on the continuity of bathymetric features (Figure 8 and 9). Considering that the species has a clearly demersal behavior, migration are expected to follow suitable bottom habitats. Blue ling in Division 12.b occurs on the western Hatton bank, out of this Bank (to the West) the seafloor is too deep for the species. The western Hatton Bank is in continuity with the Rockall and Hatton Banks in Division 6.b. so that blue ling from 12.b is most likely to be related to blue ling from 6.b. Division 12.a.2, is a small area where the seafloor is deeper than 1500 m, so too deep for the species.

3.3 Bathymetric and hydrological features

Oceanographic barriers may play a role in the ability for fish to move across major basins across the Northeast Atlantic. The overflow of Norwegian Sea currents across the Wyville-Thomson Ridge and its confluence with slower currents from subtropical Atlantic Ocean to the south, reaching as far as the Shetlands, associated to the regional topography, offers favourable conditions for the incidence of stratified waters (Hänninen, 2020; Kurekin *et al*., 2020). These hydrographic conditions create barriers to genetic flow and subsequently isolated fish populations (Knutsen *et al*. 2009; Longmore *et al*., 2011).

Some evidence exists, postulating that the Wyville Thomson Ridge separates fish communities distributed along the Norwegian basin and in the Skagerrak, from those to the West of the British Isles (Campbell *et al.* 2011). The general oceanic circulation patterns in the North Atlantic are suggestive that fish populations present in the Rockall and Faeroe Banks are separated from those in the Icelandic Basin, and the latter is itself separated from the Norwegian Basin by the Iceland-Faeroe Ridge (Gordon, 1986).

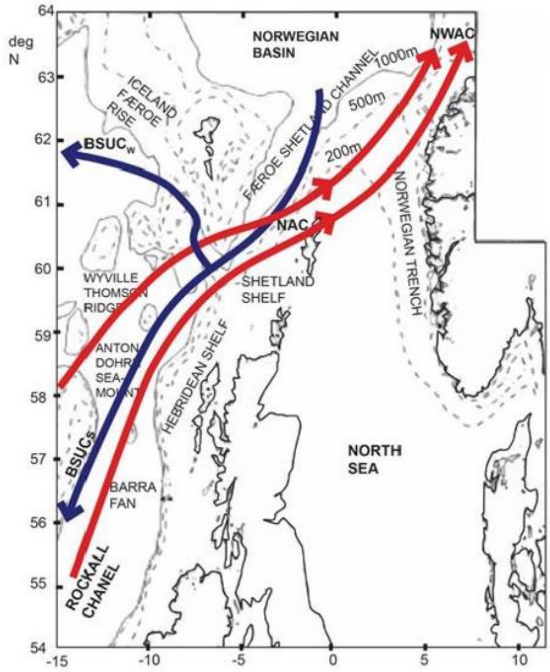

Figure 8. Hydrological circulation in the Norwegian Sea, Rockall-Hatton and Faroe area.

Suitable bottom depths for blue ling in other divisions of Subarea 12 are areas of the Mid-Atlantic Ridge to the West of Division 12.a.4 and in Division 12.a.1 (Figure 9). Blue ling occurring on these grounds is likely to be related to blue ling in Division 5.a. Blue ling is unlikely to occur in divisions 12.a.3 and 12.c, which are too deep.

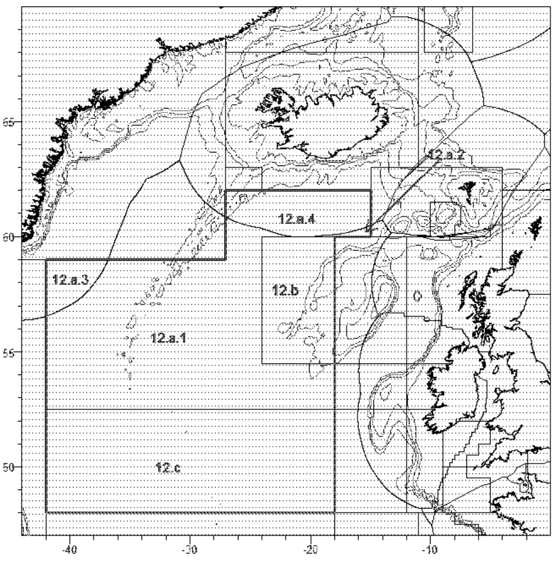

Figure 9. Subarea 12 (brown thick line) and its divisions, over the bathymetry of the Northeast Atlantic (contour lines 200, 500, 1000 and 1500 m). Depths drawn from GEBCO 2022.

Nevertheless, to the very south of the Rockall Hatton area, a small area may include suitable bottom depth for blue ling (see to the South of Division 12.b on Figure 8). Therefore, landings reported in Division 12.a.1, which is included in the NEAFC RA, may come either from this area of from the Mid-Atlantic Ridge and may belong to one stock or the other. Therefore, to be able to ascribe catches of blue ling from Division 12.a.1 to the right stock additional information is needed.

4. Conclusion

A stock area covering wide and disconnected areas is not appropriate. Available evidences suggest that stocks units more aligned to the actual population structure can easily be achieved.

Overall available data suggest that:

- Divisions 12.a.1 and 12.a.4 should be pasted to the area of the assessment unit bli.27.5a14. For simplicity, division 12.a.3 and 12.c may be included in the same stock unit, although blue ling is unlikely to occur in these divisions. The assessment unit bli.27.5a14, would become bli.27.5a12ac14, labelled "Blue ling (*Molva dypterygia*) in subareas 12 and 14 and Division 5.a (Mid-Atlantic Ridge, East Greenland and Iceland grounds)".
- Division 12.b should be pasted to the stock area of the assessment unit bli.27.5b67, which would become bli.27.5b6712b, labelled "Blue ling (*Molva dypterygia*) in subareas 6–7 and division 5.b and 12.b (Celtic Seas, Hatton Bank and Faroes grounds)". For simplicity, the small

Division 12.a.2, may be included in the same unit as this would avoid creating a potential loophole with a small area not covered by a TAC for blue ling.

- Blue ling does not occur to any significant level in subareas 8 and 9, which should therefore not be part of any blue ling stock assessment unit.
- The remaining areas of the current bli.27.nea "Blue ling (*Molva dypterygia*) in subareas 1, 2, 8, 9, and 12, and in divisions 3.a and 4.a (Northeast Atlantic)" form a suitable stock assessment unit bli.27.1-4 which can be labelled "Blue ling (*Molva dypterygia*) in subareas 1 and 2 and divisions 3.a and 4.a (Norwegian Sea, North Sea and Skagerrak)"

It is worth noting that this revision of the stock assessment units for blue ling results in the same number of ICES stocks as previously, the distribution of the new assessment units is clearly better aligned on the meta-population structure of the species than the previous one. The remaining issue of the attribution of catches from Division 12.a.1 to the right stock can be solved be one of the following options:

- **Availablity of catches at the resolution of ICES rectangle for catches coming from the NEAFC RA**. If this data can be made available and included in the WGDEEP data call then the attribution of catch to the right stock is straightforward
- **Addition of one ICES Division**. An additional ICES Division, covering the south of 12.b down to 48°N. This could be labelled, Division 12.d or Division 12.a.5 and have the following limits: Southwest corner at 24°West and 48° North; Northeast corner at 18° West 60°North.
- **Extend Division 12.b towards the South down to 48°N.** This would have the same effect as the previous option, without increasing the number of ICES divisions.

Whichever, approach is the easier to implement should be used as the three options all allow to ascribe catch to the right stock assessment unit.

4.1 Consequence for stock assessment

There was no catch from Subarea 12 in 2022. Catches were smaller than 30 tonnes per year since 2015, which is minor compared to more than 1500 and 3000 tonnes per year caught for bli.27.5b67 and bli.27.5a14 respectively. Fisheries in Subarea 12 seem to have ceased and therefore integrating parts of this Subarea to the two other stock units 5b6-7 and 5a14 would not impact current assessments substantially. Since 2010, landings of Spanish ling from subareas 8 and 9, reported as blue ling have not been included in the advice so that the exclusion of these subareas from the stock unit will not have any impact on subsequent advices either.

Excluding subareas 8 and 9 is recommended because according to survey blue ling does not occur in these subareas where the closely related Spanish ling occurs. The latter has probably a different ecology, in particular it is not known to form spawning aggregation susceptible to be targeted by fisheries. Further, in the EVHOE survey in Subarea 8, small (< 40 cm TL) and adult Spanish ling are caught in the same hauls.

Important note

This working document was presented and discussed during the 2023 meeting of WGDEEP. In additions to authors, all members of the group considered the issue thoroughly and contributed to define the most suitable solution to the stock delineation of blue ling in the ICES area, which lead to add several considerations to the text during the meeting. This final version was approved by the group.

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Working Document to be presented to the Working Group on the
Biology and Assessment of Deep Sea Fisheries Resources

ICES WGDEEP, 3rd - 9th May 2023, Lisbon, Portugal

Results on greater forkbeard (*Phycis blennoides*), Spanish ling (*Molva macrophthalma*), roughsnout grenadier (*Trachyrincus scabrus*), bluemouth (*Helicolenus dactylopterus*) and other scarce deep water species on the 2022 Northern Spanish Shelf Groundfish Survey

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Abstract

This working document presents the results on the most significant deep fish species on the Spanish Groundfish Survey on the northern Spanish shelf in 2022. Biomass, abundance, length ranges and geographic distributions were analyzed for greater forkbeard (*Phycis blennoides*), Spanish ling (*Molva macrophthalma*), roughsnout grenadier (*Trachyrincus scabrus*), bluemouth (*Helicolenus dactylopterus*) and other scarce deep sea species. The biomass of *T. scabrus* increased slightly whereas it increased sharply for *P. blennoides, M. macrophthalma* and especially for *H. dactylopterus. Aphanopus carbo, Beryx spp.* and *Pagellus bogaraveo* were scarce as usual and *Coryphaenoides rupestris* has not been found since 2019. Recruitment was significant for *P. blennoides, M. macrophthalma* and *H. dactylopterus*.

Introduction

The bottom trawl survey on the Northern Spanish Shelf has been carried out every autumn since 1983, except in 1987, to provide data and information for the assessment of the commercial fish species and the ecosystems on the Galician and Cantabrian shelves (ICES Divisions 8c and 9a North).

The aim of this working document is to update the results (abundance indices, length frequencies and geographic distribution) of the most common deep water fish species on the bottom trawl surveys on the Northern Spanish Shelf after the results presented previously (Blanco *et al.* 2022, 2019, Fernández-Zapico *et al.* 2020, 2018, Ruiz-Pico *et al.* 2021). The species analyzed are *Phycis blennoides* (greater forkbeard), *Molva macrophthalma* (spanish ling), *Trachyrincus scabrus* (roughsnout grenadier), *Helicolenus dactylopterus* (bluemouth), and some other scarce species as *Aphanopus carbo* (black scabbardfish), *Coryphaenoides rupestris* (roundnose grenadier), *Beryx spp.* (alfonsinos) and *Pagellus bogaraveo* (blackspot seabream). Although results on *Helicolenus dactylopterus* were not included in the ICES data call, they are also updated considering its remarkable abundance and geographical distribution in the surveyed area, and the fact that these indices were used in the WGDEEP report when reviewing the abundance and status of the stock on the north-eastern Atlantic.

Material and methods

The area covered in the Northern Spanish Shelf Groundfish Survey on the Cantabrian Sea and Off Galicia (Divisions 8c and Northern part of 9a; SPNGFS) extends from longitude 1° W to 10° W and from latitude 42° N to 44.5° N, following the standard IBTS methodology for the western and southern areas (ICES, 2017). The sampling design is random stratified with five geographical sectors (MF: Miño-Finisterre, FE: Finisterre-Estaca de Bares, EP: Estaca de Bares - Peñas, PA: Peñas - Ajo, AB: Ajo - Bidasoa) and three depth strata (70-120 m, 121-200 m and 201-500) (Figure 1, ICES, 2017). The shallower depth stratum was changed in 1997 from 30-100 m to 70-120 m, due to the small area and scarcity of trawlable shallower grounds.

Nevertheless, some extra hauls are carried out every year, if possible, to cover shallower (<70 m) and deeper (>500 m) grounds. These additional hauls are plotted in the distribution maps, although they are not included in the calculation of the stratified abundance indices since the coverage of these grounds (shallower and deeper) are not considered representative of the area. However, the information from these depths is considered relevant due to the changes in the depth distribution of fishing activities in the area (Punzón et al. 2011) and these hauls are also used to define the depth range of the species.

The standardized indices of the deep water fishes analyzed in this report probably underestimate its real biomass due to the fact that most of its catches might happen out of the standard stratification area, in additional hauls deeper than 500 m. For this reason, the catches in standard and deeper additional hauls were plotted in this report.

Results

In this last survey 129 valid hauls were carried out, 114 of these were standard hauls and 15 additional hauls (3 of them shallower than 70 m and 12 of them between 500 m and 800 m) (Figure 1).
The total stratified fish catch in biomass per haul increased strongly in 2022, staying within the high values of the time series (Figure 2).

In 2022, as usual, most of the biomass of *P. blennoides, T. scabrus, A. carbo* and *Beryx spp.* was found in the additional deep water hauls (>500 m) in contrast to *H. dactylopterus* which was mainly found in standard hauls. *P. bogaraveo* was scarcely found, mostly out of the stratification in the shallow area (<70 m). However, the species *M. macrophthalma*, traditionally found mainly in additional deep water hauls, increased its presence in standard hauls in the last two years.

The biomass of the species *T. scabrus* increased slightly whereas it increased sharply for *P. blennoides, M. macrophthalma* and especially for *H. dactylopterus*, reaching the highest value of the time series for the last two species. Bluemouth also rose in abundance terms, reaching likewise the highest value in the overall time series. Recruitment was significant for *P. blennoides, M. macrophthalma* and *H. dactylopterus*, being also noticeable the sharply rise on juveniles abundance for the latter species. Only a few specimens of *A. carbo, Beryx spp.* and *P. bogaraveo* were found but *C. rupestris* was not since 2019.

***Phycis blennoides* (greater forkbeard)**

In 2022, 21% of the hauls where *P. blennoides* was found were additional hauls deeper than 500 m and contained 77% of the biomass. This last year the biomass in standard hauls increased steadily, reaching the highest value of the previous eight years. The biomass in additional deep hauls increased even more compared to the previous year, reaching the highest value of the time series (Figure 3).

The geographical distribution of *P. blennoides* remained similar to previous years, being widespread in the sampling area (Figure 4).

The length distribution in standard hauls was similar to the previous year, with a great recruitment again and a mode in 18 cm (Figure 5).

The largest individuals,which ranged from around 24 cm to 66 cm, were found mostly in the additional deeper hauls, with a mode in 38 cm (Figure 6).

***Molva macrophthalma* (Spanish ling)**

In 2022, the biomass of *M. macrophtalma* increased sharply again in standard hauls, reaching the highest value of the time series, as it had already happened the previous year, whereas it decreased slightly in additional hauls deeper than 500 m (Figure 7). Unlike other years in the time series, although following the line of last year, most of the biomass (65 %) was found in standard hauls (70 - 500 m) which were 85 % of the total hauls with *M. macrophtalma.*

The species kept on being widespread in the study area but presented more spots this last survey (Figure 8).

The strong increase of recruitment in standard hauls shown the previous year is repeated in this last survey, showing a mode in 24 cm, and it is noticeable in the increment on the range of sizes, showing a second class of size, with a mode in 39 cm (Figure 9).

In contrast, in additional deeper hauls larger specimens, up to 123 cm, were found (Figure 10).

***Trachyrincus scabrus* (roughsnout grenadier)**

T. scabrus has been found mostly in additional hauls (>500 m) in the last decade. In 2022, this species was caught in five hauls, being all of them deep hauls, out of the standard stratification, and catches increased slightly compared to the previous year (Figure 11).

The geographical distribution showed more or less the same pattern during the time series, being captured in the deep hauls throughout the study area. However, the point of biomass usually caught in recent years on southern MF sector, was not caught this last survey (Figure 12).

Specimens ranged from 40 mm to 245 mm, although more abundance of large specimens (145 to 200 mm) was found, with a mode in 180 mm (Figure 13).

***Helicolenus dactylopterus* (bluemouth)**

Although bluemouth is not requested for ICES DCF Data Call, the biomass and abundance are significant in the area and useful for the assessment of the stock (ICES, 2017).

H. dactylopterus has mainly been found in standard hauls, therefore the catches of the additional deeper hauls are not plotted.

In 2022, both the biomass and abundance rose sharply, increasing five times the biomass value of the previous year and almost four times that of abundance. Both values, which were already high the previous year comparing to the time series, have reached the highest values in the overall time series (Figure 14).

The geographical distribution of *H. dactylopterus* remained similar to the previous year, with greater biomass in the Galician area, but striking in this last survey, and the usual spot in the easternmost Ajo-Bidasoa sector (Figure 15).
Length distribution showed a moderate sign of recruitment, with a small mode in 6 cm, and also a strong increment in the abundance of a second size class individuals ranged among 11 cm and 37 cm, with a marked mode in 12-13 cm (Figure 16).

Other scarce deep water species

Other species scarcely caught in the survey were *Aphanopus carbo*, *Beryx spp.* and *Pagellus bogaraveo.* They have been mainly found out of the standard stratification, the first three species in deeper additional hauls (>500 m) whereas *P. bogaraveo* in shallower additional hauls (< 70 m).
The species *C. rupestris* has continued to be absent since 2019.
A. carbo was caught in three hauls among 559 m and 608 m in easternmost Cantabrian sea (Figure 17 and Figure 18), with a total of six specimens which ranged from 87 to 104 cm.
Beryx spp. were found in two hauls between 540 m and 589 m in Galician waters and in three hauls among 530 m and 609 m in the Cantabrian sea (Figure 19 and Figure 20). Five specimens were *B. decadactylus*, ranged among 25 and 32 cm, and one was *B. splendens* with 29 cm.
Forty nine specimens of *P. bogaraveo* between 8 and 28 cm were found among 40 and 92 m depth in three hauls in the Cantabrian Sea (Figure 21 and Figure 22).

Acknowledgements

We would like to thank R/V *Miguel Oliver* crew and the scientific team from IEO that made possible SPNSGFS Surveys.
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Figures

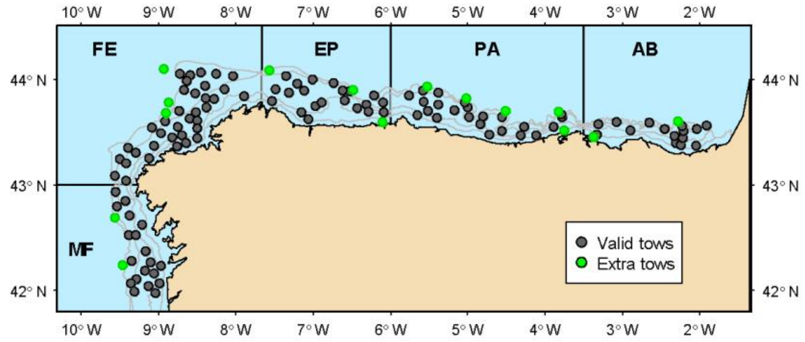

Figure 1 Stratification design and hauls on the Northern Spanish shelf groundfish survey in 2022; Depth strata are: A) 70-120 m, B) 121 – 200 m and C) 201 – 500 m. Geographic sectors are MF: Miño-Finisterre, FE: Finisterre-Estaca, EP: Estaca-cabo Peñas, PA: Peñas-cabo Ajo, and AB: Ajo-Bidasoa

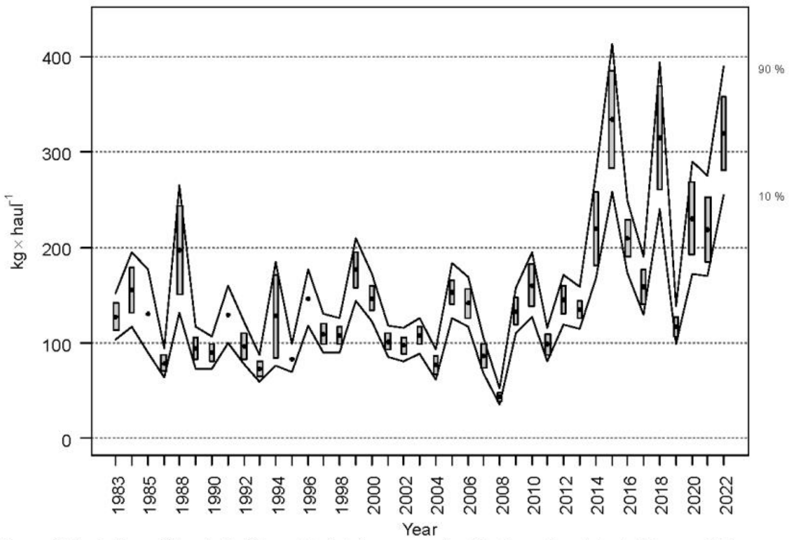

Figure 2 Evolution of the total fish catch in biomass on the Northern Spanish shelf groundfish survey, only standard hauls (>70 m & <500 m considered within the standard sampling stratified to the area.

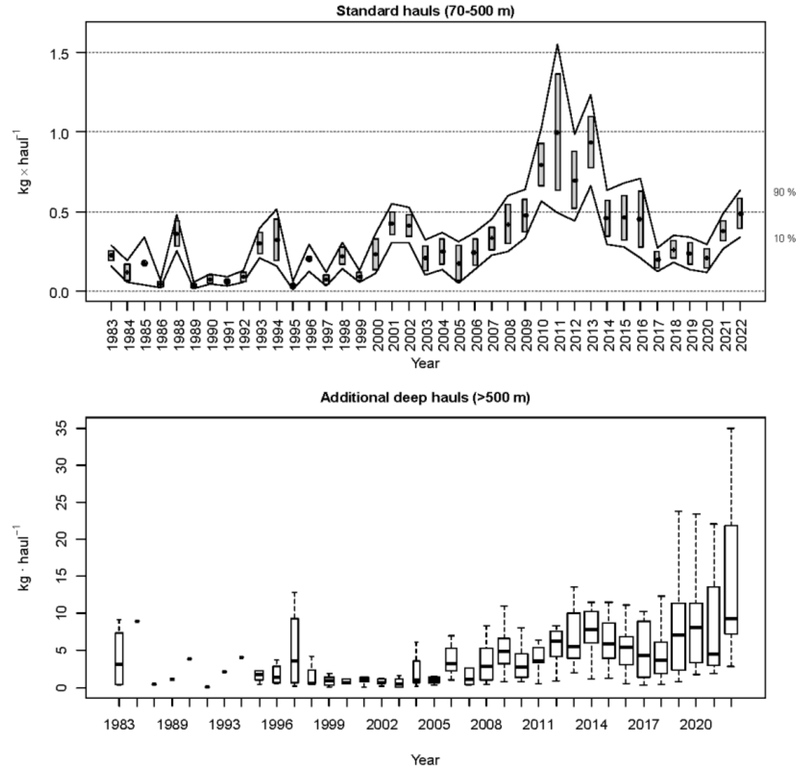

Figure 3 Evolution of *Phycis blennoides* stratified biomass index in standard hauls and additional deep hauls during the North Spanish shelf bottom trawl survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed.

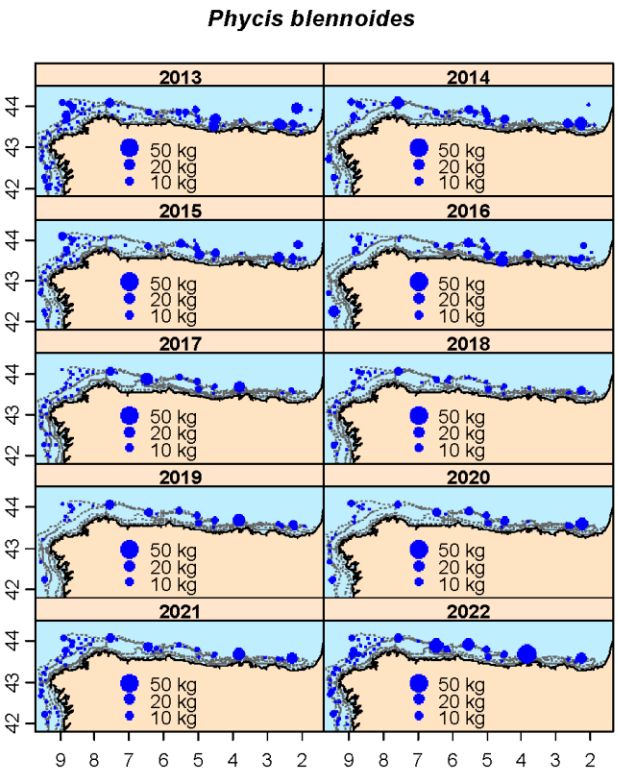

Figure 4 Geographic distribution of *Phycis blennoides* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl surveys in the last decade

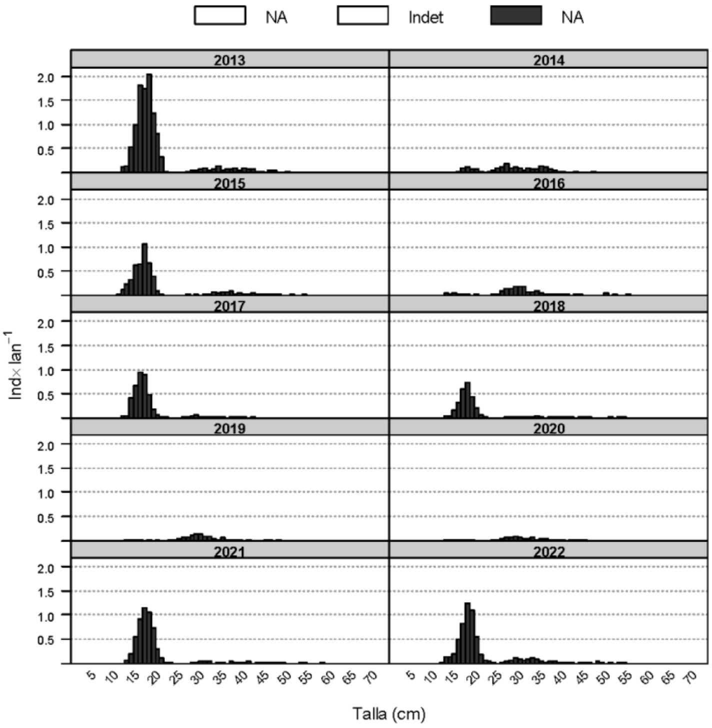

Figure 5 Mean stratified length distributions of *Phycis blennoides* in Northern Spanish Shelf surveys in the last decade

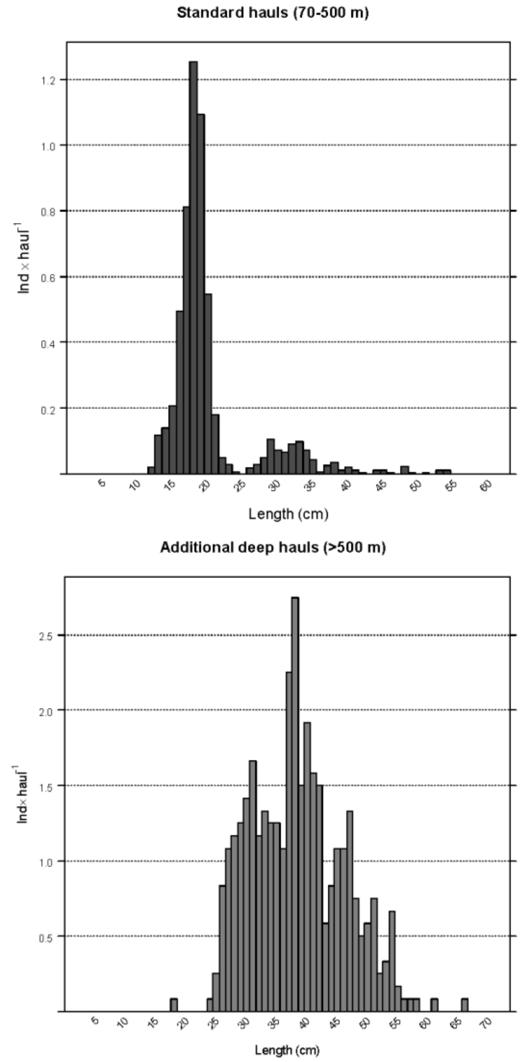

Figure 6 Mean length distributions of *Phycis blennoides* in additional hauls (>500 m) and in the standard hauls (70-500 m) in the North Spanish Shelf survey 2022

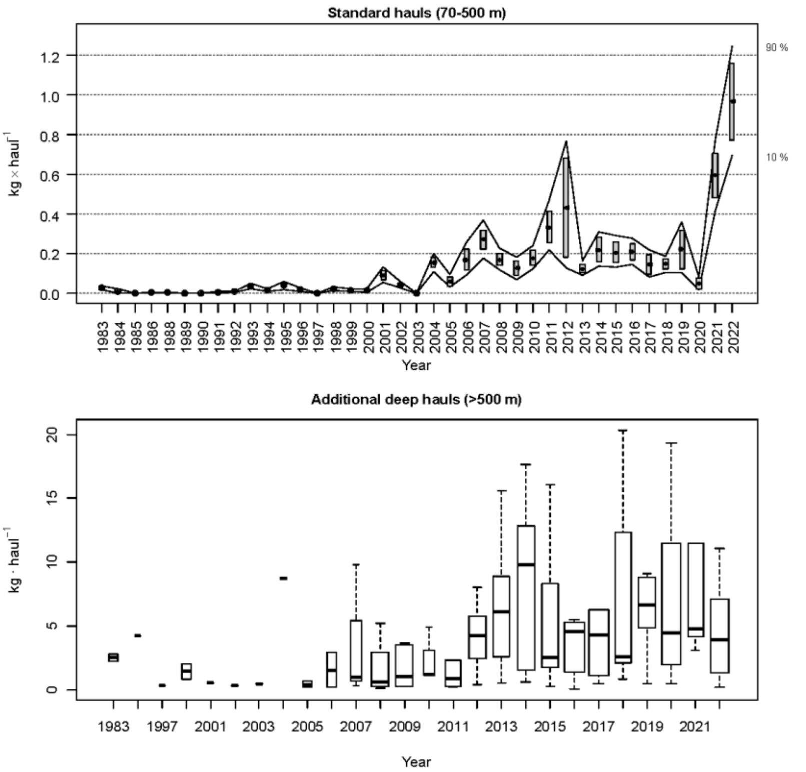

Figure 7 Evolution of *Molva macrophtalma* stratified biomass index in standard hauls and additional deep hauls during the North Spanish shelf bottom trawl survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed.

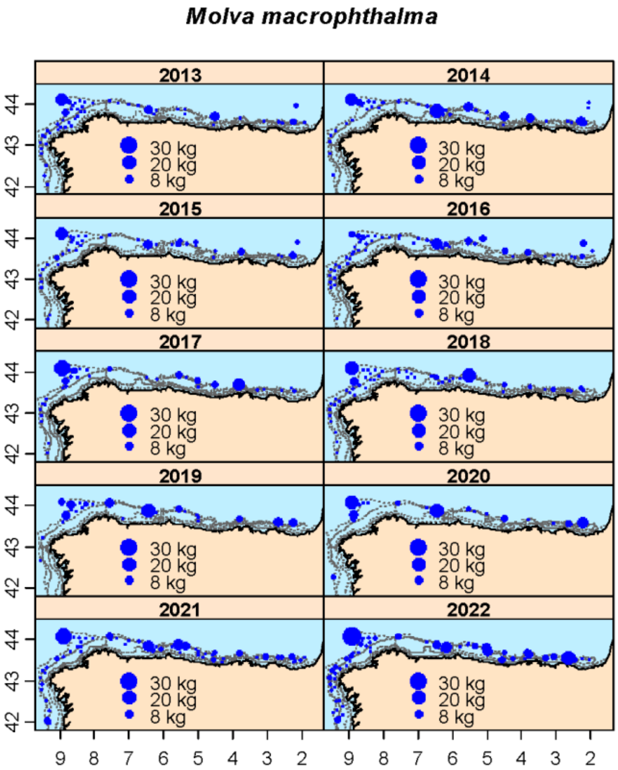

Figure 8 Geographic distribution of *Molva macrophtalma* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl surveys in the last decade

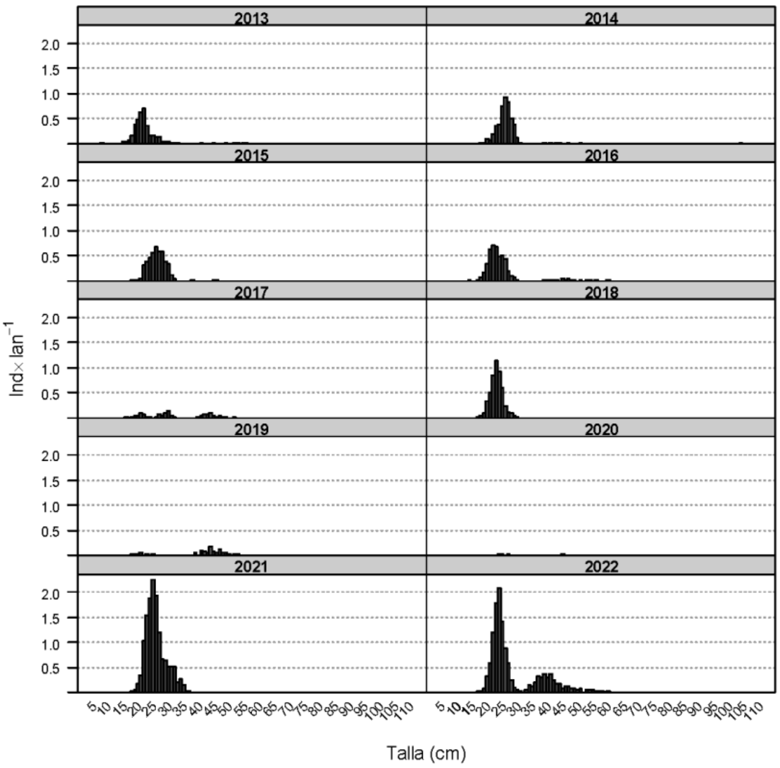

Figure 9 Mean stratified length distributions of *Molva macrophtalma* in Northern Spanish Shelf surveys in the last decade

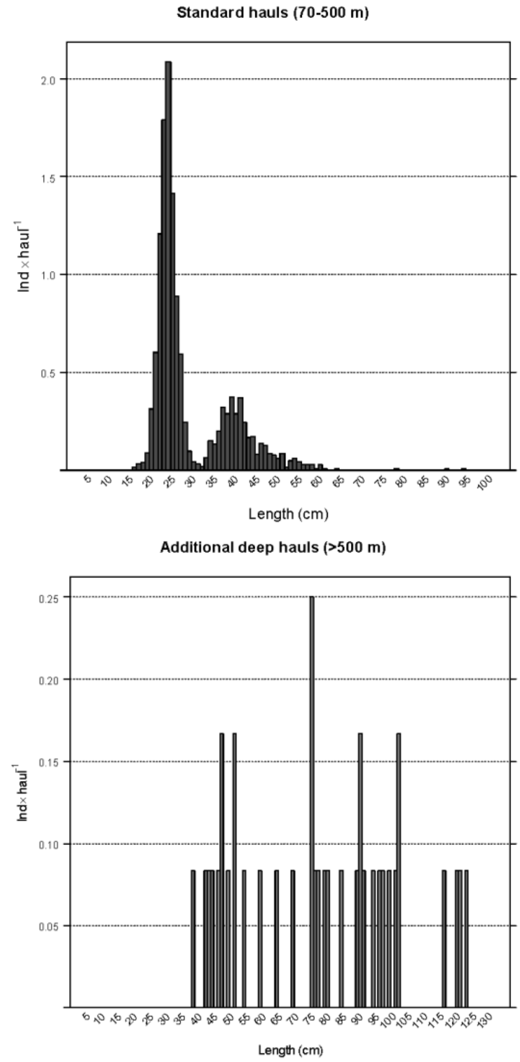

Figure 10 Mean length distributions of *Molva macrophtalma* in additional hauls (>500 m) and in the standard hauls (70-500 m) in the North Spanish Shelf survey 2022

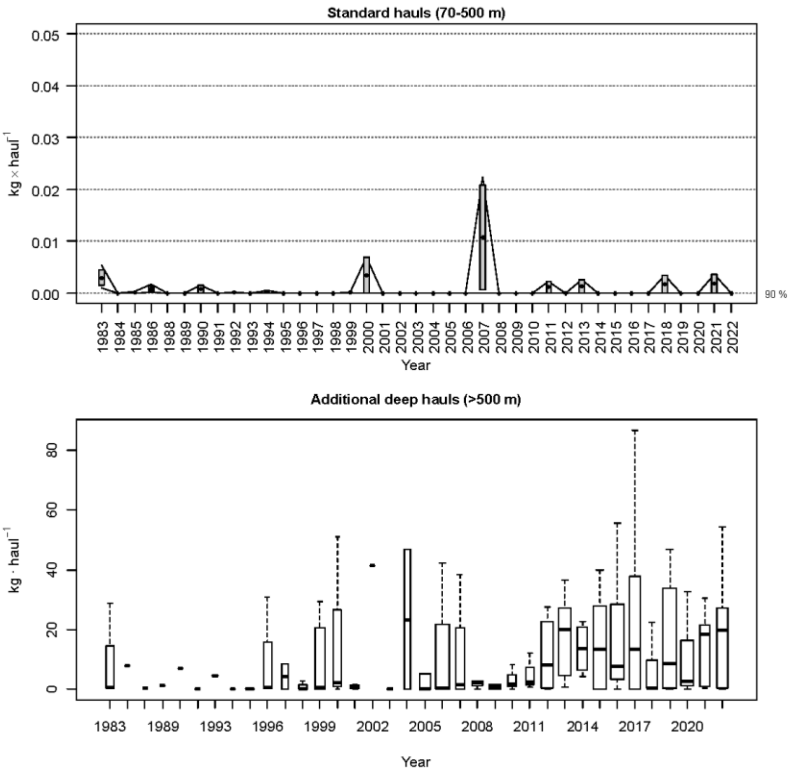

Figure 11 Evolution of *Trachyrincus scabrus* stratified biomass index in standard hauls and additional deep hauls during the North Spanish shelf bottom trawl survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed.

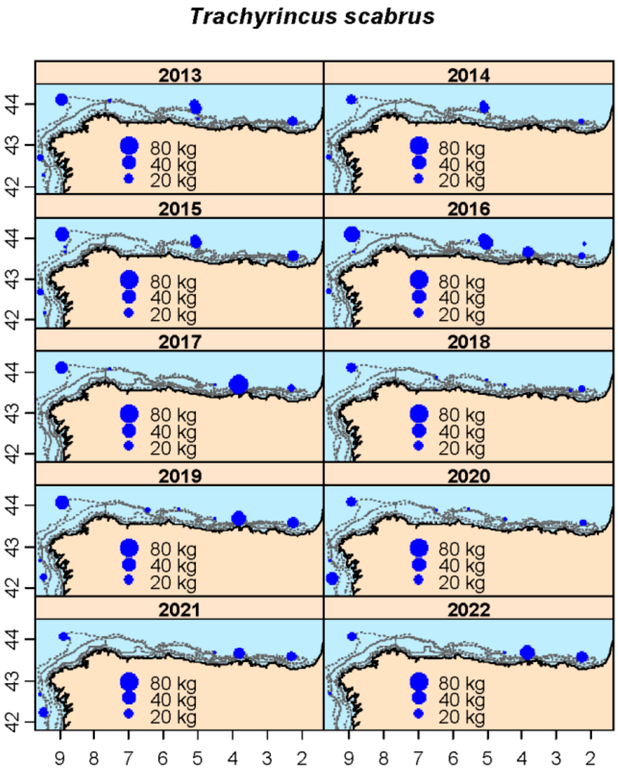

Figure 12 Geographic distribution of *Trachyrincus scabrus* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl surveys in the last decade

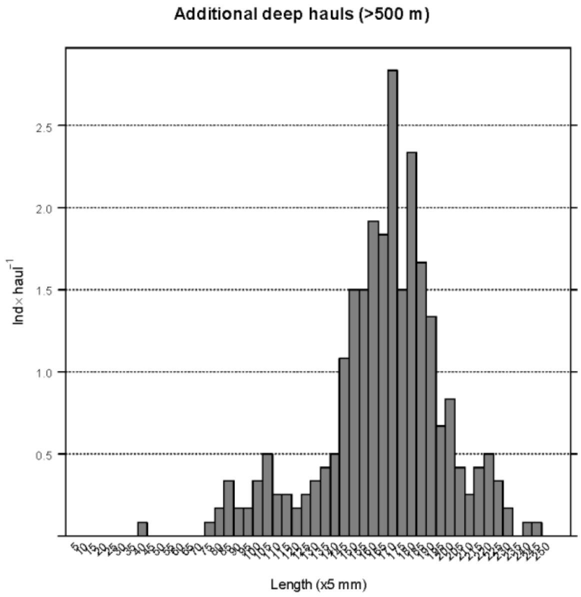

Figure 13 Mean length distributions of *Trachyrincus scabrus* in additional hauls (>500 m) in the North Spanish Shelf survey 2022

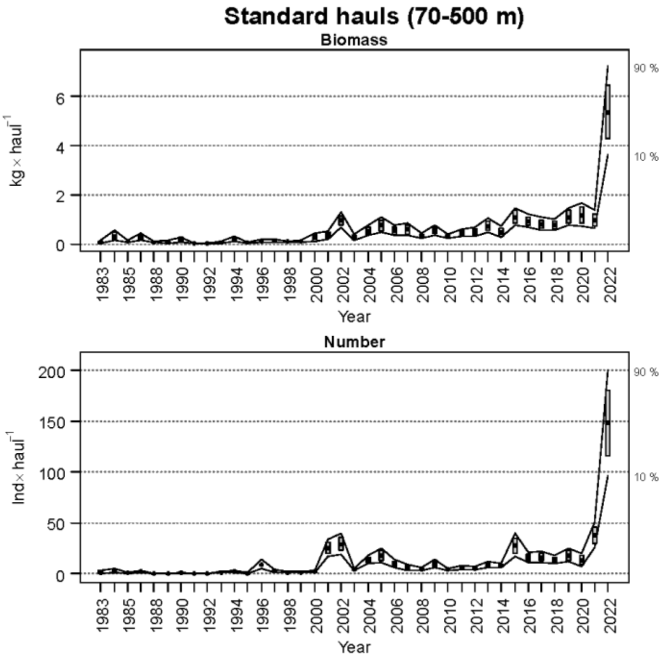

Figure 14 Evolution of *Helicolenus dactylopterus* mean stratified biomass and abundance in Northern Spanish Shelf surveys time series. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

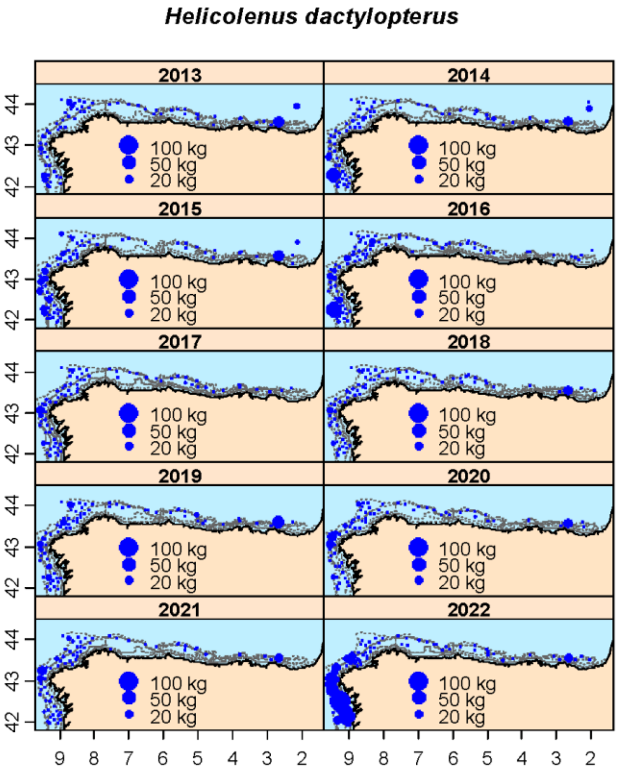

Figure 15 Geographic distribution of *Helicolenus dactylopterus* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl surveys in the last decade

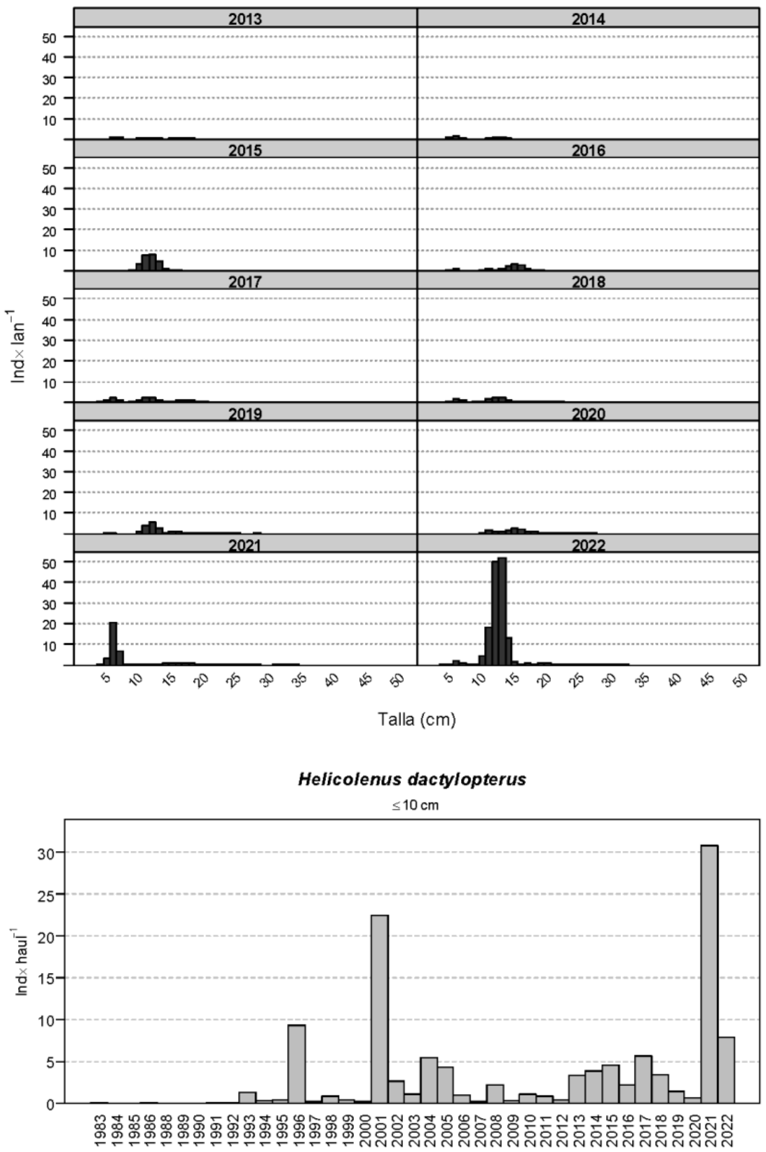

Figure 16 upper plot) Mean stratified length distribution of *Helicolenus dactylopterus* in Northern Spanish Shelf surveys during the last decade
lower plot) *H. dactylopterus* recruitment (< 10 cm) along the north Spanish shelf ground fish survey time series

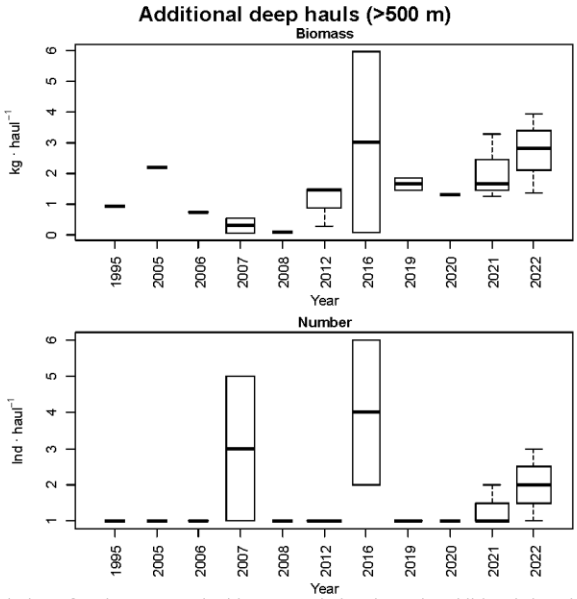

Figure 17 Evolution of *Aphanopus carbo* biomass and abundance in additional deep hauls during the North Spanish shelf bottom trawl survey time series. Boxplots represent the median and interquartiles of the biomass and abundance catches in the deep hauls performed.

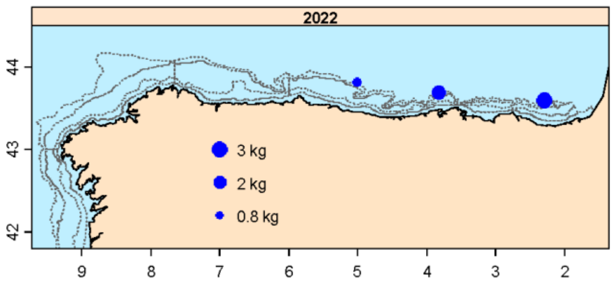

Figure 18 Geographic distribution of *Aphanopus carbo* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl survey 2022

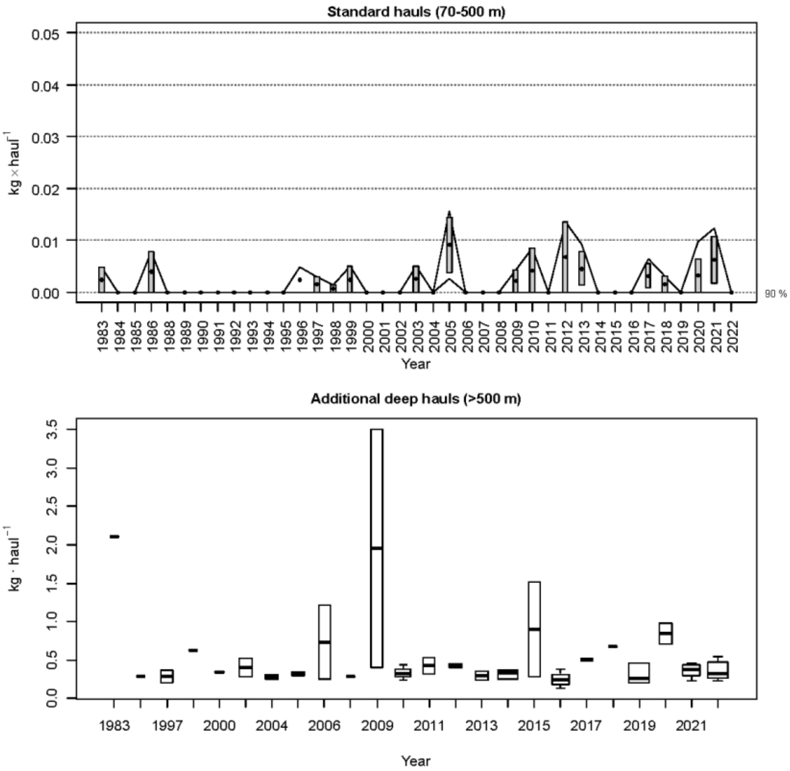

Figure 19 Evolution of *Beryx spp.* stratified biomass index in standard hauls and additional deep hauls during the North Spanish shelf bottom trawl survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed.

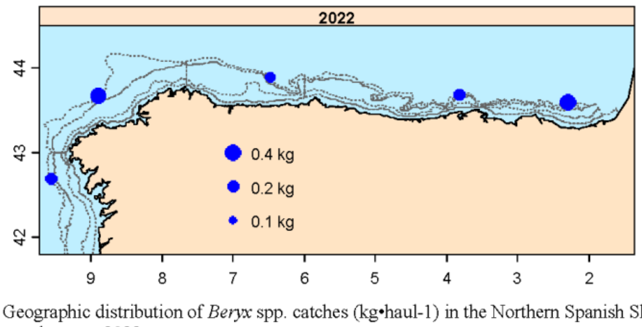

Figure 20 Geographic distribution of *Beryx* spp. catches (kg•haul-1) in the Northern Spanish Shelf bottom trawl survey 2022

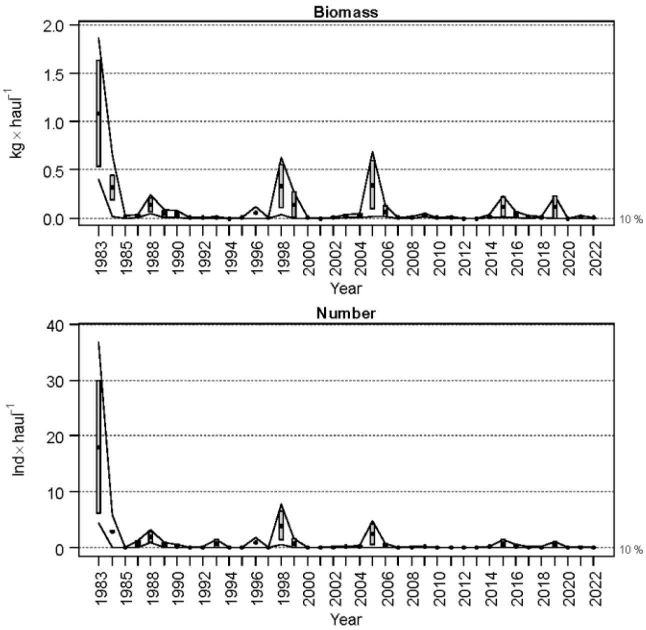

Figure 21 Evolution of *Pagellus bogaraveo* mean stratified biomass and abundance in Northern Spanish Shelf surveys time series. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

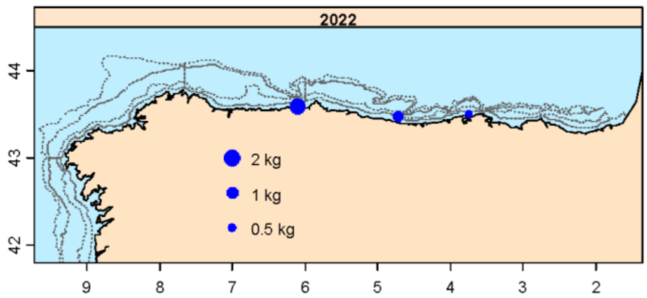

Figure 22 Geographic distribution of *Pagellus bogaraveo* catches (kg·haul^{-1}) in the Northern Spanish Shelf bottom trawl survey 2022

Working Document to be presented to the Working Group on the
Biology and Assessment of Deep Sea Fisheries Resources

ICES WGDEEP 3rd - 9th May 2023, Lisbon, Portugal

Results on silver smelt (*Argentina silus* and *A. sphyraena*), bluemouth (*Helicolenus dactylopterus*), greater forkbeard (*Phycis blennoides*), roughsnout grenadier (*Trachyrincus scabrus*), Spanish ling and ling (*Molva macrophthalma* and *Molva molva*) from the 2022 Spanish Groundfish Survey on the Porcupine Bank (NE Atlantic)

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Abstract

This working document presents the results of the most significant deep-sea fish species caught in 2022 on the Porcupine Spanish Groundfish Survey (SP-PORC-Q3). Biomass, abundance, geographical distribution and length ranges were analysed for silver smelt (*Argentina silus* and *A. sphyraena*), bluemouth (*Helicolenus dactylopterus*), greater fork-beard (*Phycis blennoides*), roughsnout grenadier (*Trachyrincus scabrus*), Spanish ling and ling (*Molva macrophthalma* and *Molva molva*) and other scarce deep sea species. Overall, the biomass of these target species increased in this last survey, except for *P. blennoides* and *M. macrophthalma*. Despite that raise, the recruitment was poor.

Introduction

The Spanish bottom trawl survey on the Porcupine Bank (ICES Divisions 7c and 7k) has been carried out annually on the third-quarter (September) since 2001 to study the distribution, relative abundance and biological parameters of commercial fish in the area (ICES 2017).

The aim of this working document is to update the results (abundance indices, length frequency and geographic distributions) of the most common deep-sea fish species on the Porcupine bottom trawl surveys after the results presented previously (Baldó *et al.* 2008, Velasco *et al.* 2009, 2011, 2012, 2013, Fernández-Zapico *et al.* 2015, 2017, 2021, 2022, Ruiz-Pico *et al.* 2016, 2018, 2019, 2020). The species analysed were: *Argentina silus* (greater silver smelt), *Argentina sphyraena* (lesser silver smelt), *Helicolenus dactylopterus* (bluemouth), *Phycis blennoides* (greater forkbeard), *Trachyrincus scabrus* (roughsnout grenadier), *Molva molva* (ling) and *Molva macrophthalma* (Spanish ling) and some other scarce deep sea species as *Aphanopus carbo* (black scabbardfish), *Brosme brosme* (tusk) *Coryphaenoides rupestris* (roundnose grenadier), *Hoplostethus atlanticus* and *Beryx* spp.

Material and methods

The Spanish Ground Fish Survey on the Porcupine Bank (SP-PORC-Q3) has been annually carried out since 2001 onboard the R/V "*Vizconde de Eza*", a stern trawler of 53 m and 1800 Kw. The area covered extends from longitude 12° W to 15° W and from latitude 51° N to 54° N, following the standard IBTS methodology for the western and southern areas (ICES 2017). The sampling design was random stratified to the area (Velasco and Serrano, 2003) with two geographical sectors (Northern and Southern) and three depth strata (< 300 m, 300 – 450 m and 450 - 800 m) (Figure 1). Hauls allocation is proportional to the strata area following a buffered random sampling procedure (as proposed by Kingsley et al., 2004) to avoid the selection of adjacent 5×5 nm rectangles. Extra hauls were performed within the standard stratification to improve coverage in gaps left by random sampling and outside the standard stratification to explore the continuity of the fish community in Porcupine Seabight.

More details on the survey design and methodology are presented in ICES (2017).

The tow duration is 20 min since 2016, but the results were extrapolated to 30 min of trawling time to keep up the time series.

Results and discussion

In 2022, 80 valid standard hauls and 11 extra hauls were carried out, 6 of them below 1000 m in the Porcupine Seabight (Figure 1).

The total stratified catch per haul increased in 2022 reaching the highest value of the time series (Figure 2). Fish represented 95% of the total catch, and the selected deep water fish represented 13% of that total fish catch, with the following percentages per species: *Argentina silus* (38%), *Helicolenus dactylopterus* (31%), *Argentina sphyraena* (14%), *Trachyrincus scabrus* (11%), *Phycis blennoides* (5%), *Molva macrophthalma* (0.5%) and *Molva molva* (0.2%).

In 2022, the biomass of two *Argentina* species, *H. dactylopterus* and *T. scabrus* increased and even reached the highest values of the time series in the two last species. However, the biomass of *P. blennoides* and the two *Molva* species remained among the low values of the time series. Overall, recruitment decreased or remained at low values similar to those of the previous year. The species *Aphanopus carbo, Brosme brosme, Coryphaenoides rupestris, Hoplostethus atlanticus* and *Beryx spp.* were scarce and were found mainly outside the standard stratification, except *Beryx spp.*

***Argentina silus* (greater silver smelt) and *Argentina sphyraena* (lesser silver smelt)**

In 2022, the biomass and abundance of both species of *Argentina* increased, to high values of the time series for *A. sphyraena* whereas only to low-medium values for *A. silus*, the species that historically contributes most to the genus in the survey (Figure 3; Figure 4; Figure 5).

Both species were more abundant in the north of the bank, in particular in the northeast area in this last survey. *A. silus* was also found in the south of the study area, as usual, but mainly in the deeper southeastern strata in this last survey (Figure 6 and Figure 7).

The sizes of both species kept a similar distribution to previous years, *A. sphyraena* with a single mode around 23 cm and *A. silus* with two smaller modes, one rough of 22 cm and a smooth one around 30 cm (Figure 8).

***Helicolenus dactylopterus* (bluemouth)**

Although bluemouth is not requested in the ICES DCF Data Call, biomass and abundance are significant in the area and useful for the assessment of the species (ICES, 2015).

Biomass and abundance of *H. dactylopterus* followed the upward trend of the last three years reaching an all-time record high this last survey (Figure 9). However, recruitment has been falling for the last two years and was even lower in this last survey (Figure 10).

H. dactylopterus was found throughout the study area, even in the northwest of the bank where the largest biomass patches were found. However, recruits were hardly found in their usual areas, the Irish shelf and the southeastern area of the bank (Figure 11).

In the size distribution of H. dactylopterus in this latest survey only one mode was found, but a record size of about 17 cm (Figure 12). The few recruits were mainly of 7 and 8 cm, unlike the previous year when 11-12 cm specimens were more abundant.

***Trachyrincus scabrus* (roughsnout grenadier)**

T. scabrus increased sharply breaking the downward trend of the three previous years and reaching the highest value in the time series (Figure 13).

The species was found in the deepest southeastern and western area, as usual, but more abundantly in this lastest survey (Figure 14).

The length distribution in 2022 showed a marked mode around 18 cm in contras to the smooth outline of the previous year. Specimens of 11 to 13 cm were scarce in this last survey, but a few more recruits of 6 and 11 cm were found (Figure 15).

***Phycis blennoides* (greater fork-beard)**

Biomass and abundance of *P. blennoides* decreased slightly and remained among the lowest values of the time series (Figure 16).

Biomass patches were widely found in the south, west and east, but scarcely in the north, as in previous years (Figure 17).

Most specimens were from 28 cm to 35 cm in this last survey and fewer recruits were found in contrast to the previous year (Figure 18).

***Molva molva* (ling) and *Molva macrophthalma* (Spanish ling)**

These two species were analysed comparatively in this working document, as in previous reports.

M. molva was scarcer than *M. macrophthalma* in the area. Both species have been on a downward trend since 2014 and has not yet been reverted. In this last survey, the biomass and abundance of *M. macrophthalma* decreased further, reaching the lowest value of the time series (1.02 kg haul^{-1} and 1.27 ind. haul^{-1}), whereas *M. molva* increased slightly (Figure 19).

The few biomass patches of *M. molva* were found in the west and southeast of the bank whereas *M. macrophthalma* was found in the west but further south and in the south of the study area, though scarcer than in previous years (Figure 20).

Only 9 specimens of *M. molva* were found, ranging from 31 to 99 cm. Specimens of *M. macrophthalma*, a few more, sized from 14 to 97 cm (Figure 21).

Other deep-sea fish species

The deep water species *Aphanopus carbo, Brosme brosme, Coryphaenoides rupestris, Hoplostethus atlanticus* and *Beryx spp.* were scarcely or not found in the standard stratification of the study area, but were found outside of it, except for *Beryx* spp.

In 2022, the species *C. rupestris* and *H. atlanticus* were only found in deep hauls carried out in the Porcupine Seabight, outside the stratification, the first species in five hauls from 1039 and 1477 m and the second one in three hauls between 1302 and 1477 m.

The species *A. carbo* was found from 626 and 1492 m, mainly in deep hauls in the Porcupine Seabight, but also in four hauls in the standard stratification.

The species *Brosme brosme* was not found in the three previous years, but in this last survey was found again, one specimen in one haul in the standard stratification at 489 m and also two specimens in one haul in the Porcupine Seabight at 1032 m.

Species of the genus *Beryx* were found in the standard stratification, *Beryx splendes* in the southern part of the bank (three specimens of 25, 29 and 30 cm) and *Beryx decadatylus* in the east area, but only two specimens of 28 and 30 cm, in one haul.

Acknowledgements

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Figures

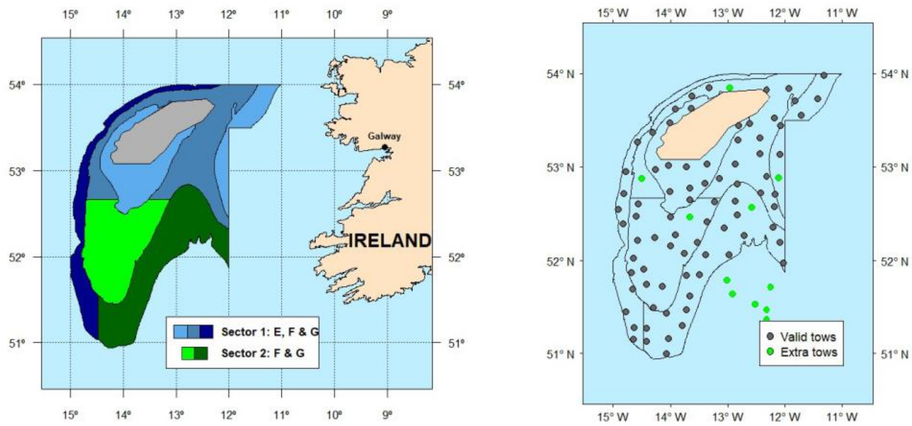

Figure 1. Left: Stratification design used in Porcupine surveys from 2003, previous data were re-stratified. Depth strata are: E) shallower than 300 m, F) 301 – 450 m and G) 451 – 800 m. The grey area in the middle of Porcupine bank corresponds to a large non-trawlable area, not considered for area measurements and stratification. Right: Distribution of hauls performed in the last survey.

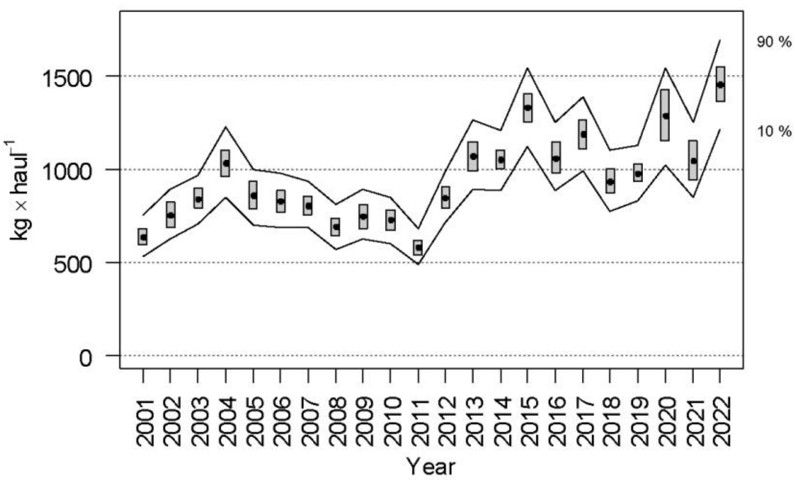

Figure 2. Evolution of the total fish catch in biomass in the Porcupine surveys.

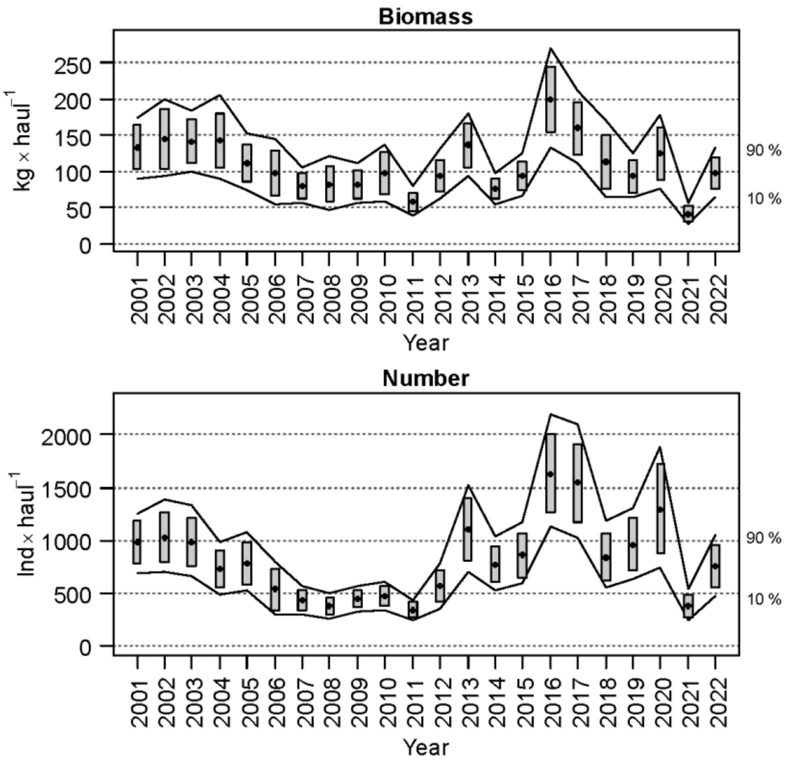

Figure 3. Evolution of biomass and abundance indices *Argentina* spp. (mainly *Argentina silus*) in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000).

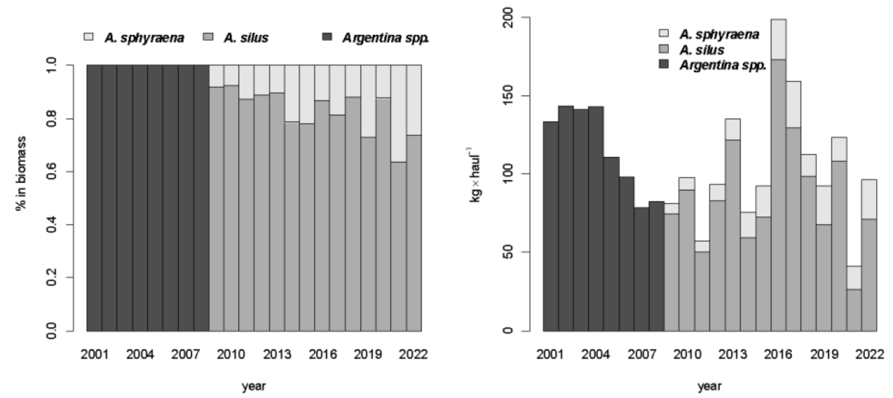

Figure 4. Share and abundance of Argentine species in the Porcupine surveys.

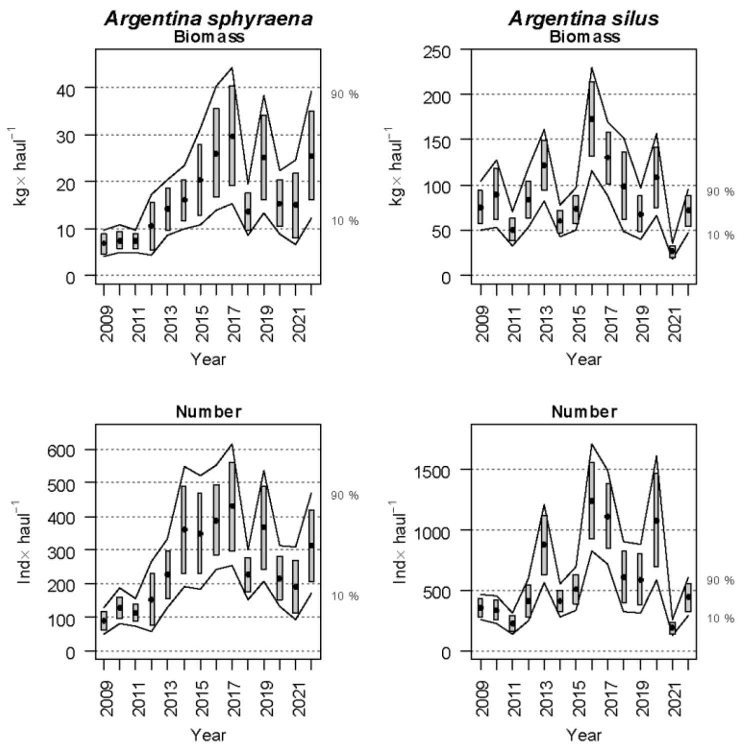

Figure 5. Evolution of biomass and abundance indices of *Argentina sphyraena* and *Argentina silus* in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

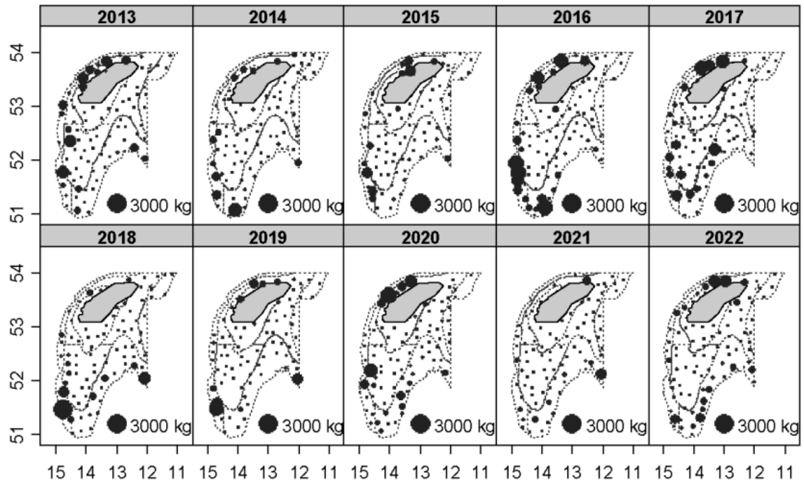

Figure 6. Geographic distribution of *Argentina* spp. catches (kg/30 min haul) in Porcupine surveys over the last decade.

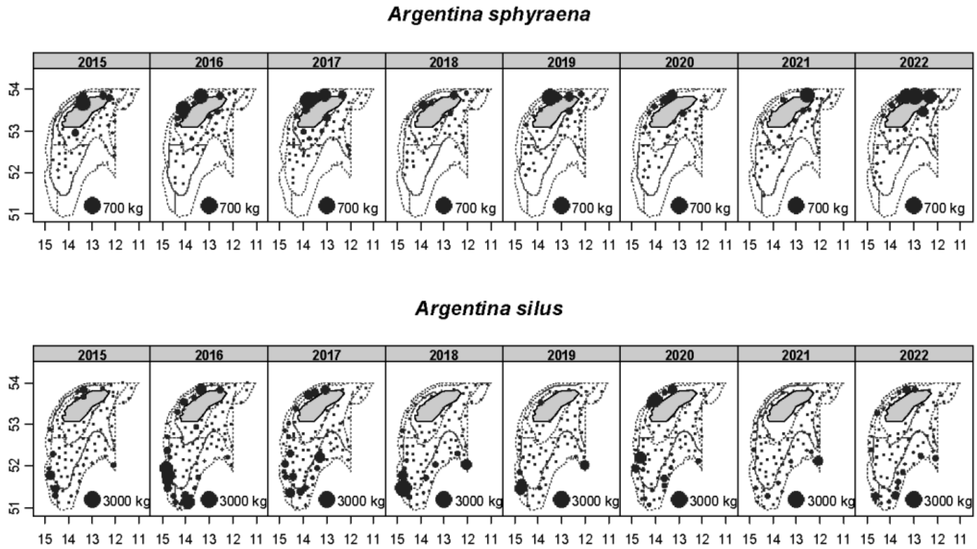

Figure 7. Geographic distribution of *Argentina sphyraena* and *Argentina silus* catches (kg/30 min haul) in Porcupine surveys (2015 - 2022).

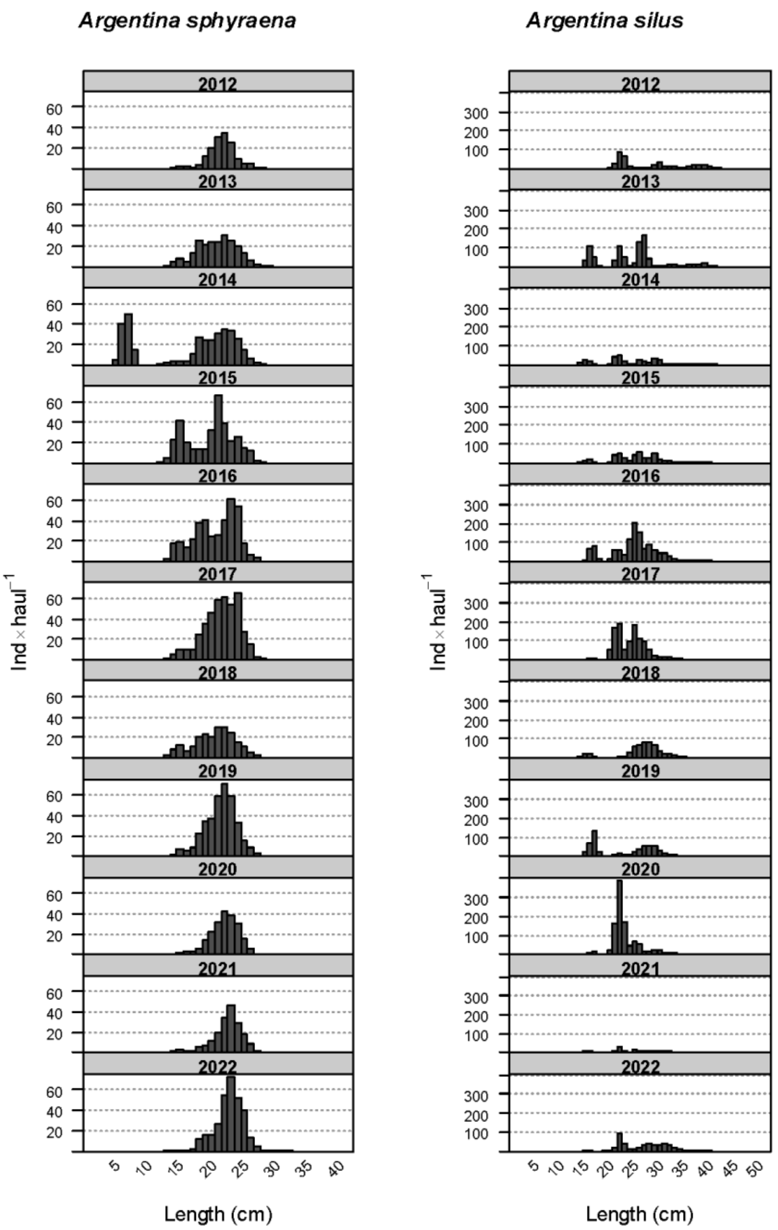

Figure 8. Mean stratified length distributions of *Argentina sphyraena* and *Argentina silus* in the Porcupine surveys (2012-2022).

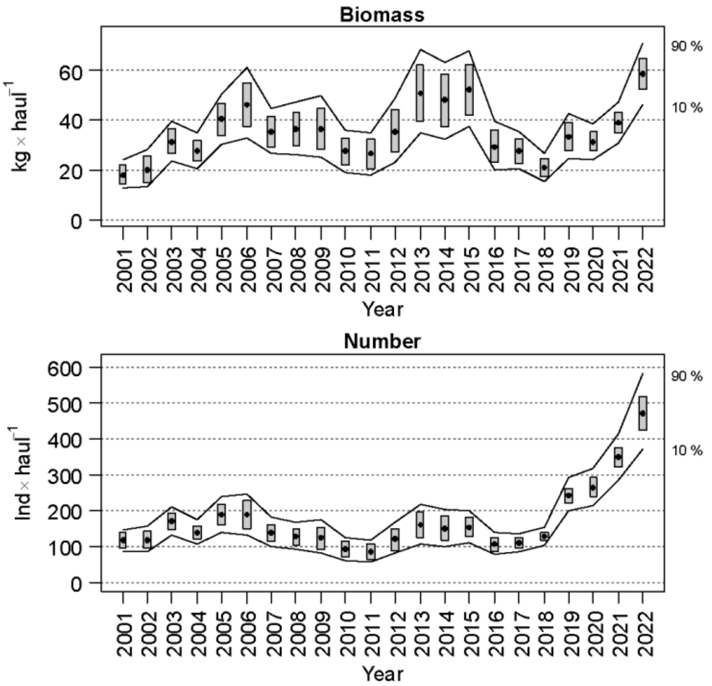

Figure 9. Evolution of biomass and abundance indices of *Helicolenus dactylopterus* in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

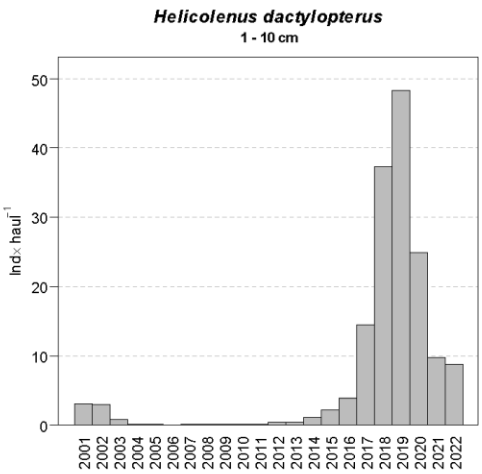

Figure 10. Mean stratified abundance of *Helicolenus dactylopterus* recruits (1-10 cm) in the Porcupine surveys.

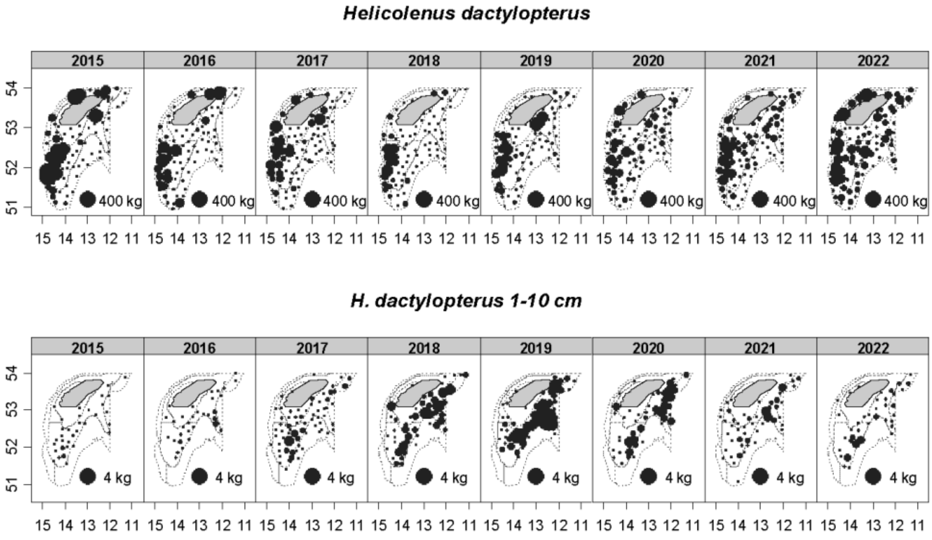

Figure 11. Geographic distribution of *Helicolenus dactylopterus* catches (kg×30 min haul-1) and recruits (1-10 cm) in the Porcupine surveys (2015-2022).

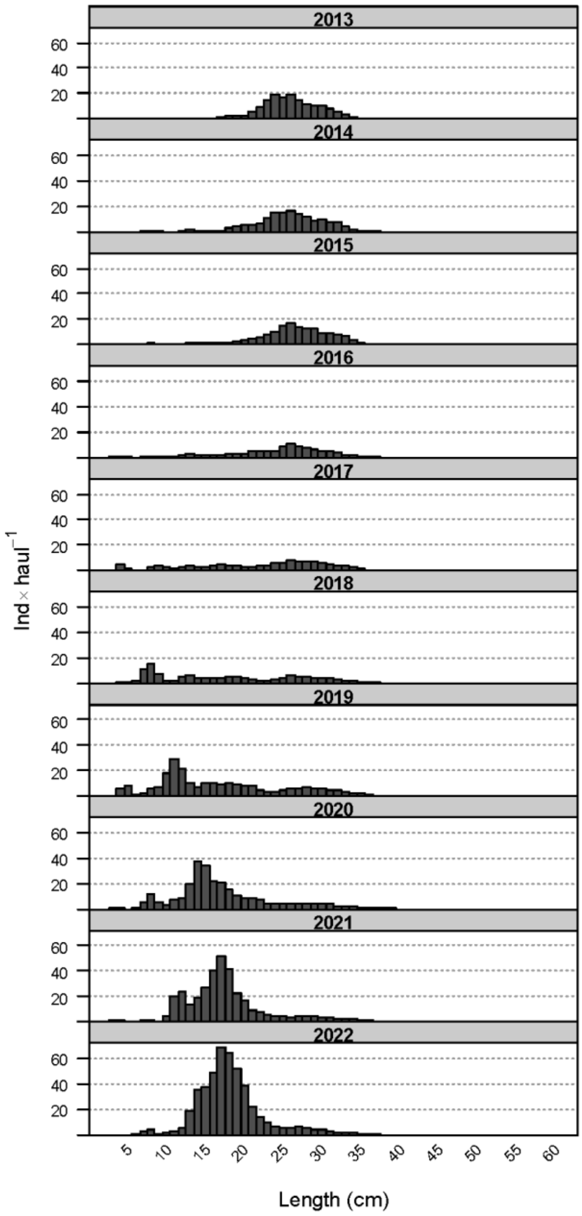

Figure 12. Mean stratified length distributions of *Helicolenus dactylopterus* in the Porcupine surveys (2013-2022).

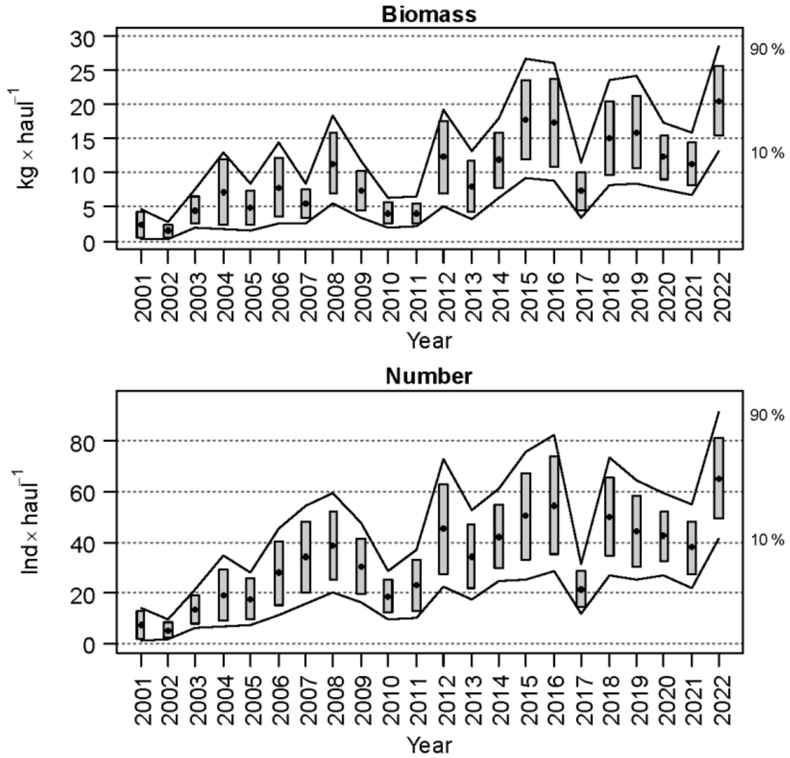

Figure 13. Evolution of biomass and abundance indices of *Trachyrincus scabrus* in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000).

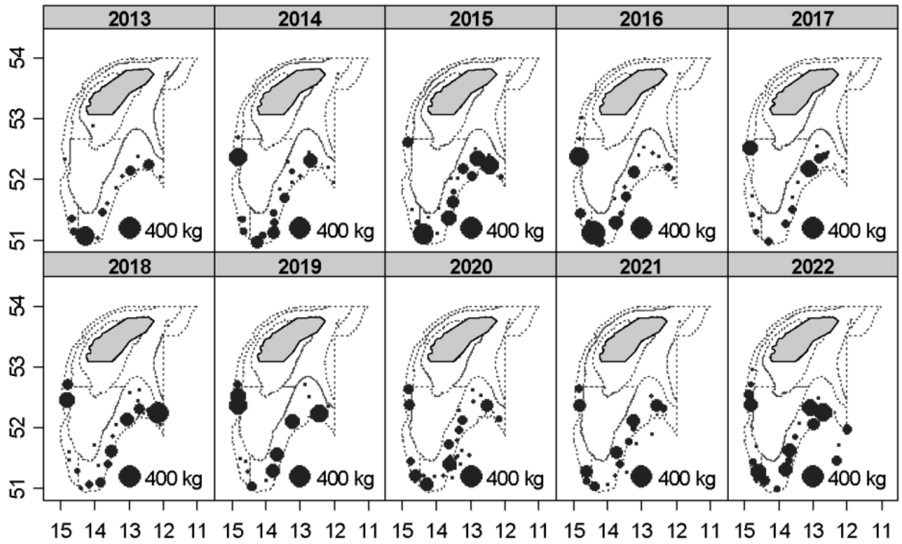

Figure 14. Geographic distribution of *Trachyrincus scabrus* catches (kg/30 min haul) in the Porcupine surveys over the last decade.

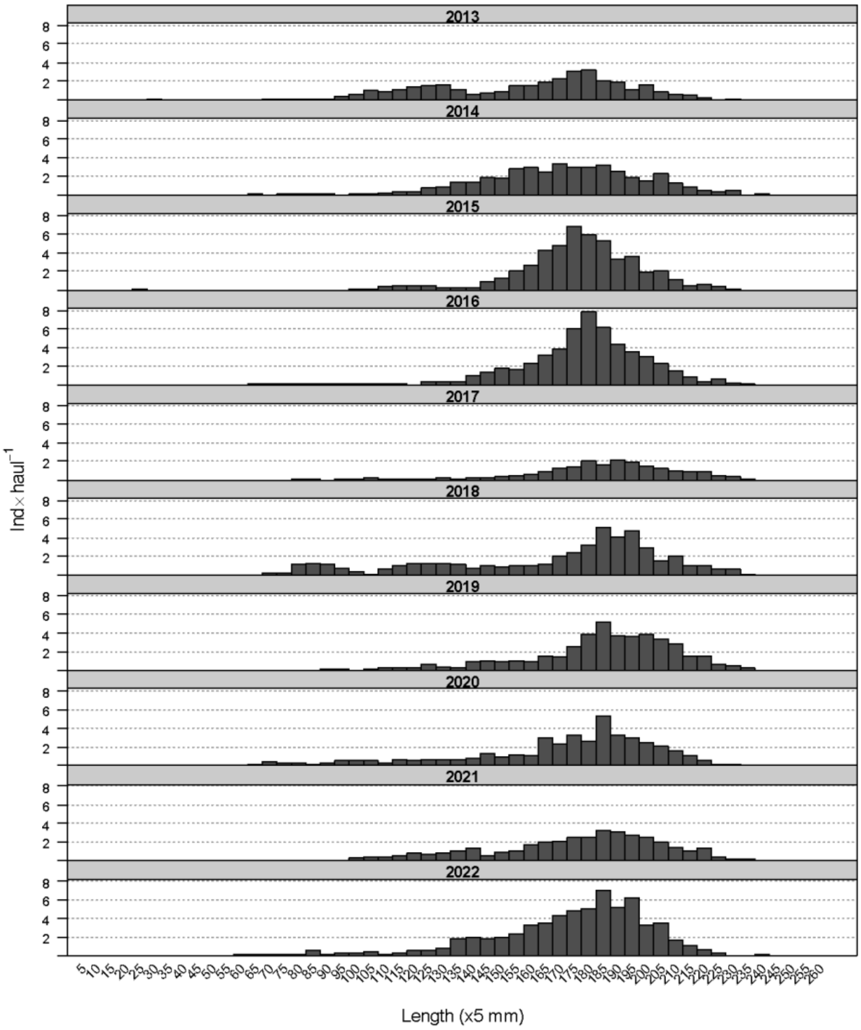

Figure 15. Mean stratified length distributions of *Trachyrincus scabrus* in the Porcupine surveys (2013-2022).

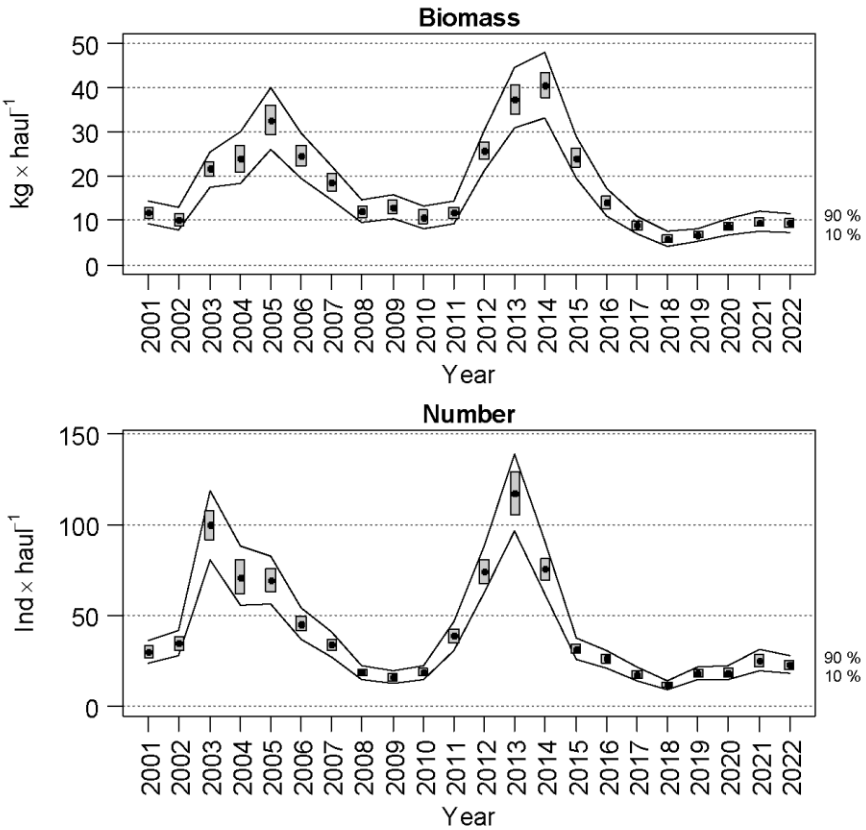

Figure 16. Evolution of biomass and abundance indices of *Phycis blennoides* in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

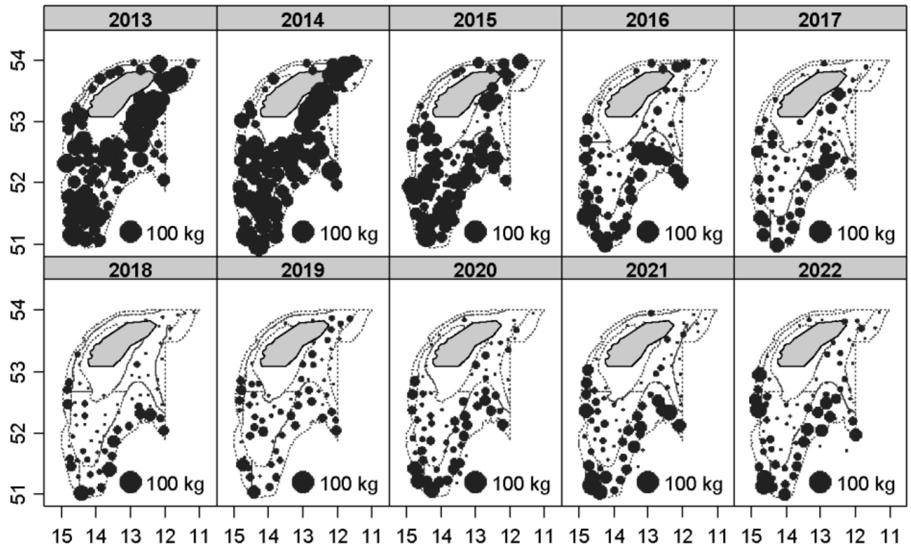

Figure 17. Geographic distribution of *Phycis blennoides* catches (kg×30 min haul^{-1}) in the Porcupine surveys over the last decade.

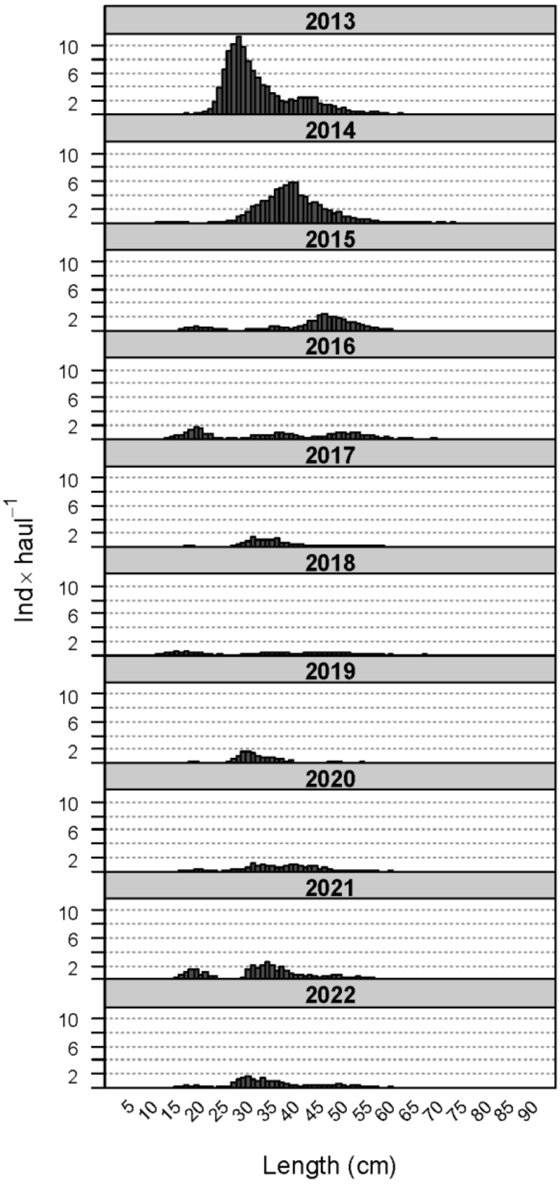

Figure 18. Mean stratified length distributions of *Phycis blennoides* in the Porcupine surveys (2013-2022).

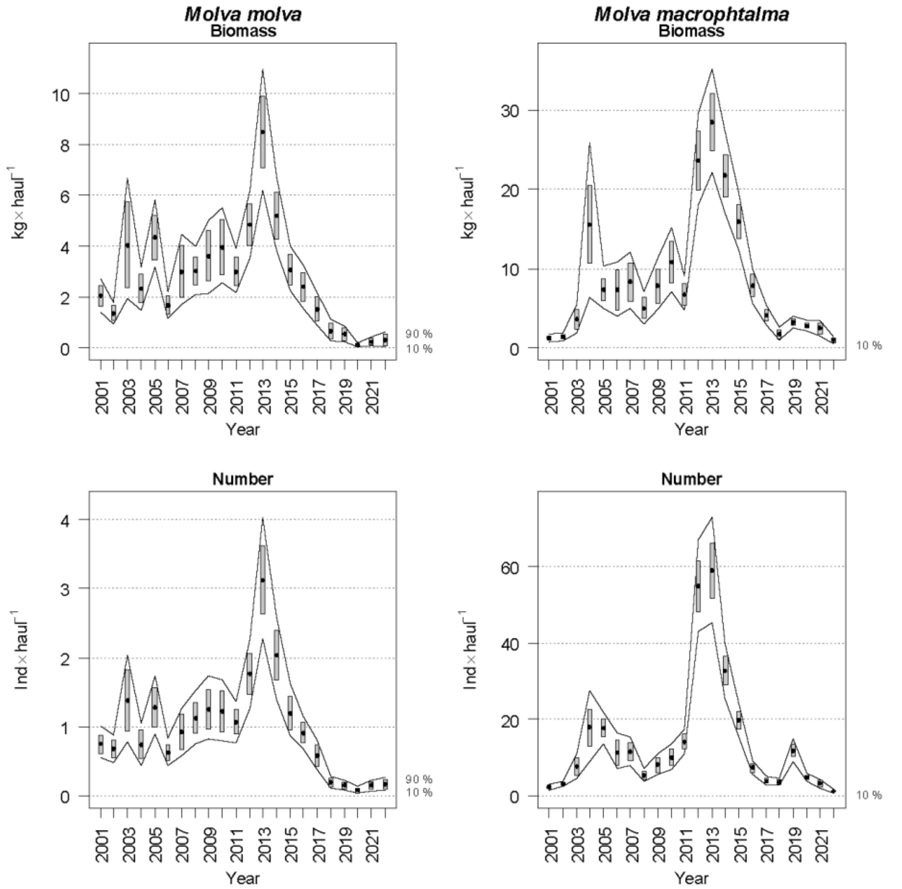

Figure 19. Evolution of biomass and abundance indices of *Molva molva* and *Molva macrophthalma* in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

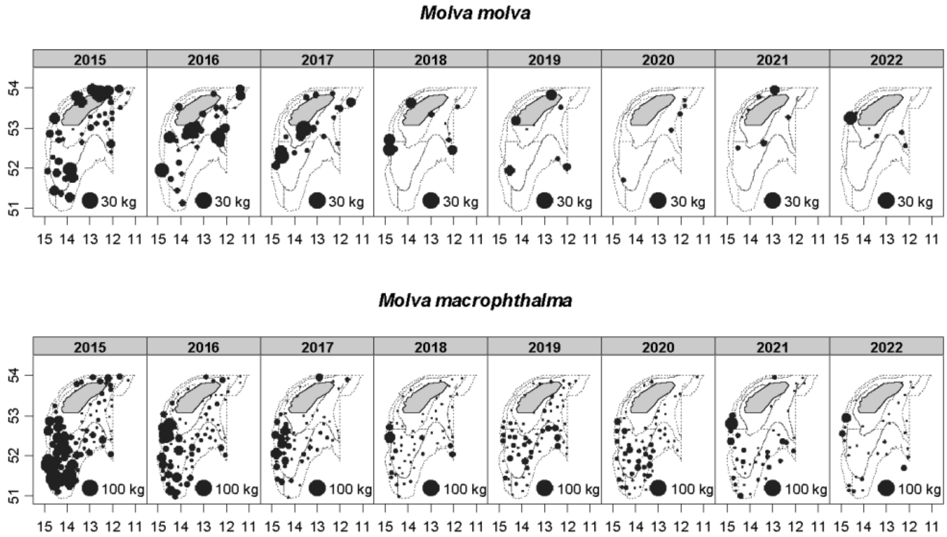

Figure 20. Geographic distribution of *Molva molva* and *Molva macrophthalma* catches (kg×30 min haul^{-1}) in the Porcupine surveys (2015-2022).

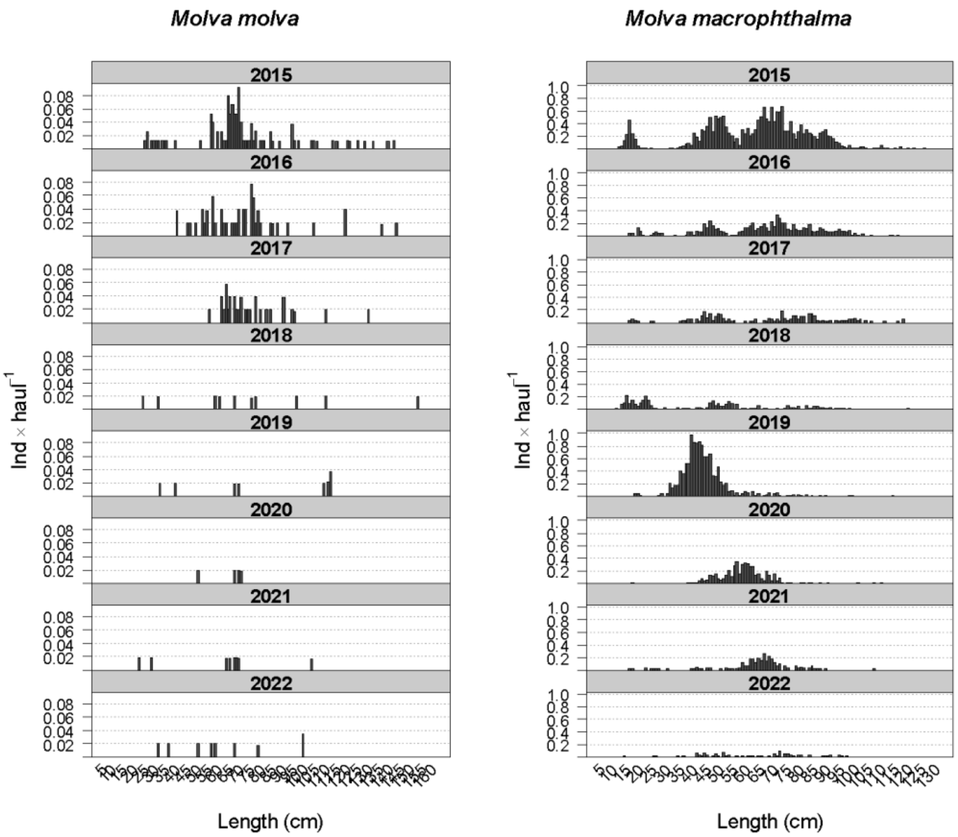

Figure 21. Mean stratified length distributions of *Molva molva* and *Molva macrophthalma* in the Porcupine surveys (2015-2022).

WD ICES WGDEEP, Copenhagen 2023

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Update on Norwegian fishery independent information on abundance, recruitment, size distributions, and exploitation of roundnose grenadier (*Coryphaenoides rupestris*) in the Skagerrak and north-eastern North Sea (ICES Division IIIa)

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Introduction

The roundnose grenadier is a long-lived deepwater species which in the relevant study area reaches ages of 70 years or more and attains maturity at the age of 8-12 years (Bergstad 1990). It has a limited area of distribution within the Norwegian deep and in the deep Skagerrak basin (300-720m) (ICES Div. 4a & 3a). Analyses using microsatellite DNA have demonstrated that the Skagerrak grenadier is currently likely to be isolated from grenadier elsewhere in its North Atlantic distribution area (Knutsen *et al*., 2012). In 2003-2005 a major expansion of the previously quite minor targeted grenadier fishery occurred, and this expansion was followed by a complete closure of the fishery from 2006 onwards. Apart from previous targeted exploitation, grenadier is now a minor by-catch in the traditional trawl fishery for *Pandalus borealis* which is currently the major demersal trawl fishery in the area. Most shrimp fishing occurs shallower than the main distribution area of the grenadier.

This Working Document presents results derived from a research vessel bottom trawl survey conducted annually during the past 40 years (1984-2023). While the main objective of the survey is to monitor *Pandalus borealis*, the survey samples the entire depth range and distribution area of roundnose grenadier.

We report temporal variation in survey catch rates in terms of biomass and abundance (kg/hour and number/hour), length distributions, occurrence of recruits, and geographical distribution. We also give an estimate of by-catch in the commercial shrimp fishery from Reference fleet data. Most of the information in this Working Document is an update of a WD first submitted to WGDEEP in 2009 (Bergstad *et al*. 2009). The survey series is currently the only information available to assess temporal variation and trends for the grenadier in this area. A full analysis of the time-series has been published (Bergstad *et al*., 2014), but this working paper extends the series to also include the years 2014-2023.

Material and Methods

Data was collected from the annual *Pandalus borealis* shrimp survey performed by the Institute of Marine Research in the years 1984-2023 (Table 1). The survey is a depth stratified shrimp trawl survey with approximately 25% of the stations deeper than 300 m (depth range 117-534 m). The trawl used has small meshes overall and a 6mm cod-end liner and retains all sizes of grenadiers, including the smallest newly settled juveniles (Bergstad 1990, Bergstad and Gordon 1994). The stations are placed at random within strata and subareas, and the same sites sampled every year. Although some changes occurred over the years (Table 1), the overall standardization was maintained throughout the time series (Bergstad *et al.* 2014).

Catch rates in terms of biomass and abundance were calculated for stations 300 m and deeper, i.e. excluding shallower survey depths where the species only occurs sporadically in small numbers (Bergstad 1990). Stations with zero catches were included, and the catches at non-zero stations were standardized by tow duration.

Annual length distributions were derived for the pooled standardized catches at 300m and beyond. In cases where catches were subsampled, length distributions were raised to the total catch prior to pooling.

Age data from selected surveys in 1987 and 2007-2023 were calculated as cumulative age distributions. Age and length data from 2008-2023 were analyzed for growth parameters.

Standardized mean catches by number of small juveniles of PAFL ≤ 5 cm were calculated to show recruitment during the survey period.

A time series of maps showing geographical distributions by year were plotted, representing scaled catch rates at the actual sample sites for each survey year.

Data from the Norwegian reference fleet (2013-2019) was collected to report bycatch on roundnose grenadier in the Norwegian shrimp fishery.

Results

Biomass and abundance

The estimates of catch rates in terms of biomass (kg/h) and abundance (nos/h) varied substantially through the time series (Fig.1), but elevated levels were observed from 1998 to 2004. The decline from 2005 continued through the time series until 2017 which was the lowest on record. The observations from 2018-2023 remained low, but with a slight increase compared with 2017.

Size and age distributions

The time series of annual length distributions show a major shift in the early 1990s (Fig. 2). From 1992 the proportion of large fish with PAFL>15cm declined to less than 10% which contrasts with the pre-1990 distributions dominated by large fish. From 1992, a pronounced mode of small fish can be followed in subsequent years, with modal length increasing through the time series.

In 2018 there is another shift in the length distributions. The very recent distributions (2018-2023) contrasts with earlier distributions by having very low proportions of large fish. The distributions are dominated by small fish but at low levels compared to the 1990's. The situation in 2023 is the same as in 2022.

Age distributions and growth

The cumulative age distribution from the extracted data from 1987 (Bergstad, 1990) contrasts substantially with the distributions from 2007-2023 in terms of proportions of old fish (e.g. >20 years). In 1987, the proportion of fish > 20 years was over 50% (Table 4). In 2008, i.e. after the relatively large expansion in landings in 2003-2005 and ban on direct fishing introduced in 2006, only 8% of the aged fish were older than 20 years. In subsequent years the proportion of older fish apparently increased, and recent distribution from 2023 now show 21% fish > 20 years (Table 4). This is still very low compared with the 1987 situation.

Age at length was analyzed for the years 2008-2023 (Figure 5) and compared with data from 1987 (Bergstad, 1990) (Table 3). The growth rate coefficient (k) and the length infinity ($L\infty$) for females is in the same range as the data from 1987, but slightly lower for 2008-2023 data compared with data from 1987, especially for females.

Occurrence of juveniles <5cm PAFL

There are no positive signs of recruitment in 2023. There is no indication of a pronounced recruitment pulse as that observed in the early 1990s, neither in the length distributions (Fig 2.), or in the time series of mean abundance of small fish < 5 cm (Fig. 3).

Geographical distribution

The area sampled in given year and the corresponding geographical distribution of grenadier catches is presented in Figure 4. The overall distribution area does not seem to have changed considerably during the time series 1984-2023. Catches of roundnose grenadier are restricted to the Norwegian Deep north to 59°N and extend eastwards into the Skagerrak basin. The highest catches were always found in the eastern Skagerrak part of the Norwegian Deep.

Commercial by-catch

For an assessment of the bycatch of roundnose grenadier in the Norwegian shrimp fishery, data from the Norwegian Reference fleet showed that < 1% of the tows with shrimp trawl caught roundnose grenadier (Table 5). The values for catch weights from the Reference fleet are low and in same level as the reported landings for the recent years. This indicates that the low reported Norwegian landings are realistic and that the landings are the bycatch amount taken by the Norwegian shrimp fishery.

Discussion

Despite high inter annual variability, the catch rates in terms of biomass and abundance from the survey suggest long term pattern of variation through the time series 1984-2023. An increase in biomass and abundance from the late 1980s until 1998-2004 seemed to be followed by a major decline from the mid-2000s onwards. In 2023 abundance and biomass estimates were still at low levels.

The survey catch rate declined in all areas, also where high survey catches were common, i.e. in the eastern part of the Skagerrak (Fig. 4).

The time-series of size distributions also suggest pronounced structural changes during the period 1984-2023. The distributions from the 1980s with a dominance of fish around 15 cm PAFL contrasts with those from the early 1990s when the population was apparently rejuvenated by a pulse in recruitment from 1991-1992 onwards. The recruits from 1991-1992 can be tracked as a mode in the size distributions for 15 years until 2005. The distributions were dominated by old fish until 2012 although with consecutively low concentrations. From 2018, the older fish is almost disappeared and the distributions changed to younger fish primarily but still with low levels.

The difference in age distribution between 1987 and 2023 is primarily seen in the proportion of older fish, i.e. there is almost no fish older than 30 years in 2023 while almost 25% of the fish was older than 30 years in 1987. The most prominent difference between recent situation and that of 1987 concerning growth, was seen for females. It seems that the bulk of very large and old female individuals seen in 1987 is no longer present in recent years (Table 3).

High mean survey biomass coincided with very high commercial landings in 2004-05 (Figure 6). The fishery may have utilized a period of elevated abundance resulting from what appears to be the single large pulse in recruitment in the 40 years surveyed. From recent length distributions no similar pulse in recruitment has been observed.

An interpretation of the patterns observed in the time-series of size and age distributions, the survey abundance index for small juveniles, and the survey index of all sizes combined is that the enhanced fishery in 2003-2005 had the combined effect of eroding both the accumulated fraction of older fish around 30 years that were found in the population in 1987 prior to the fishery and the younger fish resulting mainly from the recruitment pulse in the early 1990s. The very old fish never reappeared, and for three decades, recruitment has been consistently at a level well below the level observed in the single high event in the early 1990s. The recent recruitment has probably been too low to produce any increase in abundance.

The reported landings peaked in 2005 at about 11000 tons (Figure 6) and have since declined to about a ton per year. From 2006 onwards this decline in landings is a result of regulations (Bergstad 2006) as the targeted fishery ceased. By-catches from shrimp fisheries still occur, however. The data from the Norwegian Reference fleet suggests that current levels are minor, probably reflecting low grenadier abundance at relevant depths and introduction of sorting grids to the fishery.
The Norwegian bycatch of roundnose grenadier thus is well described through the reported landings. The Swedish and Danish fishery reports both landings and discards and therefore the bycatch from these fisheries should be counted for in the statistics. The level of landings and discards in recent years has been in total less than 2 tons per year.

Conclusion

The decline in abundance after 2005-2006 suggested by the survey catch rates may reflect the combined effect of the enhanced targeted exploitation in 2003-2005 and the low recruitment in the years following the single recruitment pulse in the early 1990s. The percentage of fish >15cm is now lower than recent years and there is no suggestion of a new recruitment pulse as seen in the 1990s. The current low abundance and truncated age structure in the population thus reflect both the exploitation and recruitment history spanning the past 2-3 decades. Since the targeted fishery has stopped and the by-catch in the shrimp fishery are low, there is a potential for recovery of the roundnose grenadier in Skagerrak. However, rejuvenation and growth of the population would at present seem unlikely due to low recruitment during the recent decades. The survey information suggests that it may be a feature of this population that only a single good recruitment event may be expected in a period of 3 decades.

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Table 1. Summary of data on the bottom trawl survey series, 1984-2023. Rg- rockhopper ground gear. 'Strapping' – maximum width of trawl constrained by rope connecting warps in front of otter doors. MS – RV Michael Sars, HM – RV Håkon Mosby, KB – RV Kristine Bonnevie. Data from 2023 survey is included. All trawls were fitted with a 6mm mesh cod-end 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
2018	JAN	KB	3271	Campelen 1800 20mm/40, Rg and strapping**	27	8	111
2019	JAN	KB	3296	Campelen 1800 20mm/40, Rg and strapping***	27	8	108
2020	JAN	KB	3296	"	26	7	106

Table 1. Continued

YEAR	Survey month	Vessel	IMR Gear code	Additional gear info.	No. trawls >300m	No. trawls >400m	No. trawls survey
2021	JAN	KB	3296	Campelen 1800 20mm/40, Rg and strapping***	27	8	113
2022	JAN	KB	3296	‘’	28	8	119
2023	JAN	KB	3296	‘’	29	8	116

* Path width of the tow constrained by a 10 m rope connecting the warps, 200 m in front of otter boards. ** Path width of the tow constrained to a 15 m rope connecting the warps, 100 m in front of the otter boards. *** Same trawl and strapping but from 2019 there are inserted several floaters on the trawl to lighten the trawl (Nordsjørigging).

Table 2. Mean biomass index and mean abundance index from shrimp survey 1984-2023. Missing data are from surveys that are not representable according to roundnose grenadier catches (few stations > 300 m). Data from 2016 are considered unreliable according to gear inconsistencies.
Mean biomass (kg/h), Mean abundance (n/h), Number (n) and Standard error (SE)

Year	n	(kg/h)	SE(kg/h)	(n/h)	SE(n/h)
1984	10				
1985	21	108.12	38.32	149.95	49.43
1986	24	83.75	32.16	117.83	46.99
1987	35	76.15	13.56	125.80	24.60
1988	31	72.14	13.92	105.19	21.22
1989	31	122.69	43.48	195.94	73.07
1990	26	49.81	18.20	72.66	27.55
1991	28	107.14	22.27	176.86	38.75
1992	27	188.54	67.53	698.52	337.67
1993	30	58.59	19.42	190.33	74.15
1994	27	87.19	21.21	372.96	143.56
1995	29	118.30	32.36	440.62	144.41
1996	27	99.63	31.68	268.01	116.92
1997	25	113.86	66.47	362.72	222.08
1998	23	255.54	87.80	812.82	336.85
1999	27	149.30	42.85	388.83	122.54
2000	25	129.27	30.39	389.06	107.71
2001	18	105.33	51.84	272.99	151.99
2002	24	174.77	66.27	371.70	129.97
2003	13				
2004	17	324.38	125.48	1143.35	487.33
2005	23	193.65	93.81	550.42	260.94
2006	10				
2007	11				
2008	18	95.58	65.81	259.10	208.53
2009	25	72.72	39.81	207.41	121.84
2010	24	33.24	21.47	77.21	54.81
2011	22	26.84	12.61	54.76	27.05
2012	20	16.69	11.97	34.40	23.83
2013	28	11.48	4.92	35.06	16.90
2014	16	25.62	15.76	49.56	28.69
2015	28	7.28	4.59	21.19	12.14
2016	28				
2017	30	6.64	2.41	15.74	6.73
2018	27	12.88	6.60	41.91	26.13
2019	27	14.59	5.77	40.09	18.05
2020	26	18.72	11.48	63.02	38.07
2021	27	9.59	5.03	26.14	14.19
2022	28	23.87	10.94	75.20	35.61
2023	29	19.24	8.89	38.81	19.10

Table 3. Estimated parameters of von Bertalanffy growth function on data from Skagerrak shrimp survey 2008-2023 and Skagerrak survey in 1987 as reported by Bergstad 1990. k=growth coefficient, L_∞=asymptotic length, t_0=theoretical age when length is zero, SE=standard error

	Estimated parameter			
Parameter	**Shrimp survey 2008-2022**		**Skagerrak survey 1987**	
	Females (SE)	**Males (SE)**	**Females**	**Males**
k	0.085 (±0.004)	0.076 (±0.010)	0.100	0.105
L_∞	16.8 (±0.233)	14.9 (±0.548)	18.1	14.7
t_0	-2.7 (±0.278)	-5.7 (±1.022)	-0.9	-1.5

Table 4. Cumulative percentages (%) for selected ages from 1987 and 2007-2023.

	Age				
Year	**5**	**10**	**20**	**30**	**50**
1987	9	21	45	75	96
2007	10	23	83	94	96
2008	22	40	92	99	100
2009	14	30	88	93	100
2010	12	29	71	96	99
2011	6	23	65	94	99
2012	10	28	48	96	100
2013	14	28	56	92	99
2014					
2015	7	17	48	95	100
2016					
2017	14	52	81	94	99
2018	23	50	77	99	100
2019	8	37	64	92	100
2020	40	64	83	97	100
2021	20	55	83	97	100
2022	33	53	81	95	99
2023	22	50	79	92	100

Table 5. Proportion of tows with shrimp trawl that caught roundnose grenadier. Data from Norwegian Reference fleet.

Year	Total number of shrimp trawl	Number of trawl hauls that caught roundnose grenadier	Catch of roundnose grenadier (kg)	% of the total catch
2013	243	0		0
2014	288	2		0,69
2015	1489	14		0.94
2016	4811	23		0,48
2017	3798	20	29	0,53
2018	2849	19		0,67
2019	1233	4	80	0,32

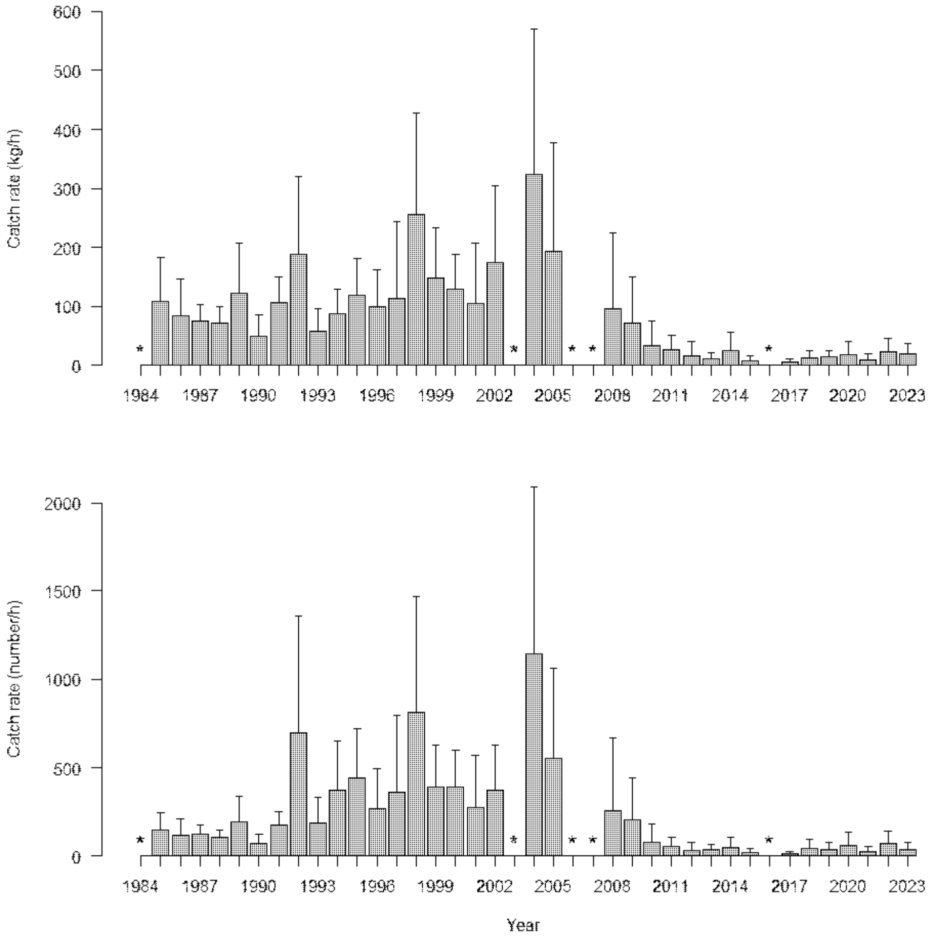


Figure 1. Standardized survey catch rates of roundnose grenadier, 1984-2023. Upper: Biomass (kg/h), Lower: Abundance (number/h). Standard error (2SE) shown by lines on top of bar. *In 1984, 2003, 2006 and 2007, only one single or no trawls were made deeper than 400 m, and data from those years were excluded; in 2016 data from shrimp survey is regarded as unreliable due to inconsistencies with trawling gear and data from that year should be excluded.

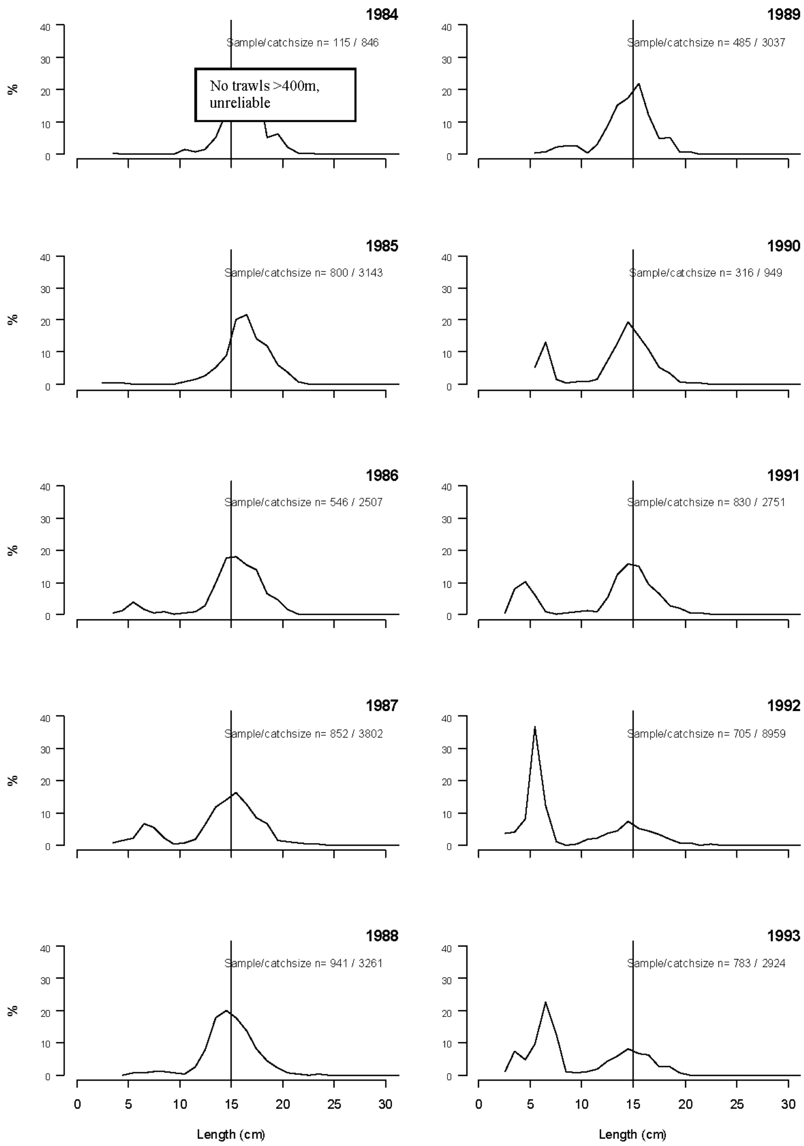
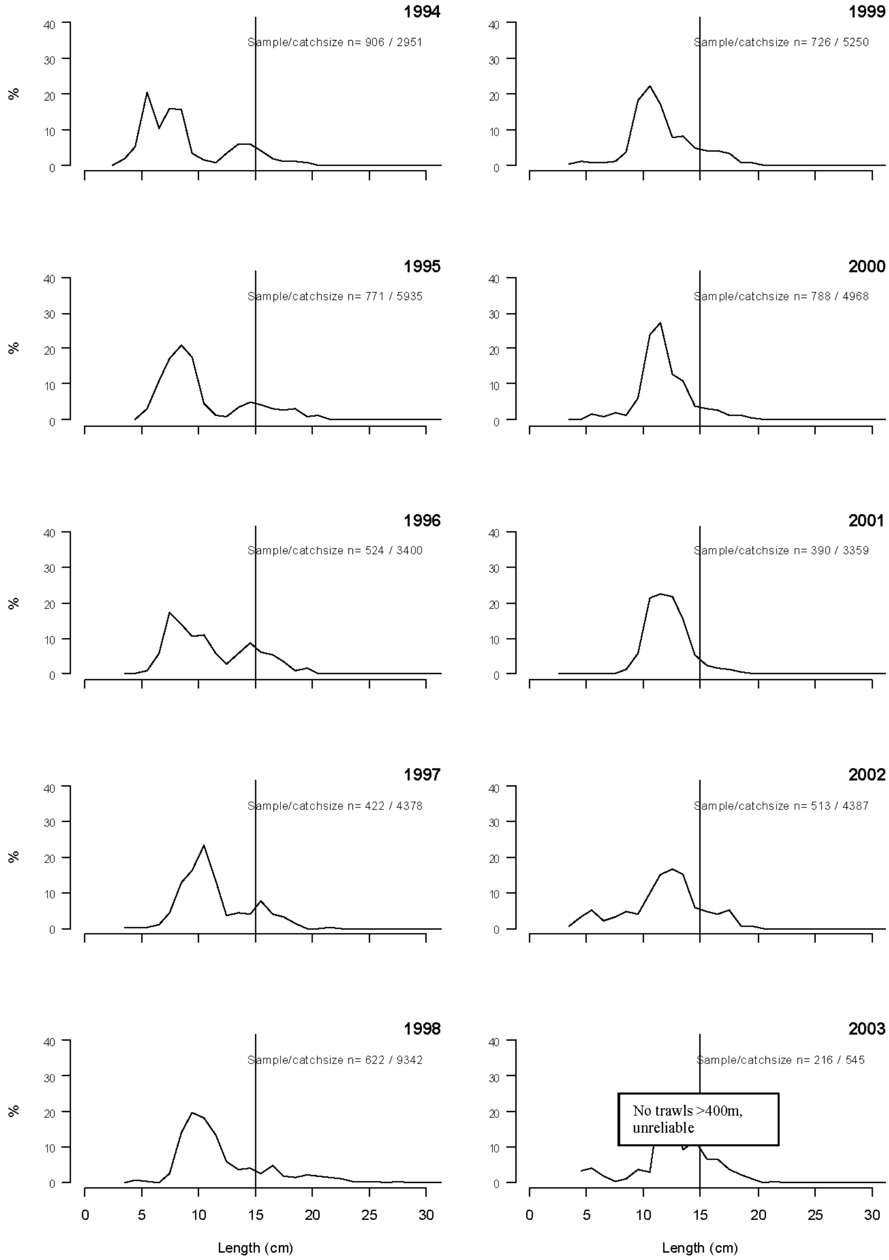


Figure 2. Length distributions of roundnose grenadier from annual *P. borealis* surveys, 1984-2023. Length is measured as PAFL (cm). The length distributions are calculated as percentage number of fish in each centimetre length interval standardized to total catch number and trawling distance for each station each year. *In 1984, 2003, 2006 and 2007, only one single or no trawls were made deeper than 400 m, and data from those years should be excluded; in 2016 data from shrimp survey is regarded as unreliable due to inconsistencies with trawling gear and data from that year should be excluded.



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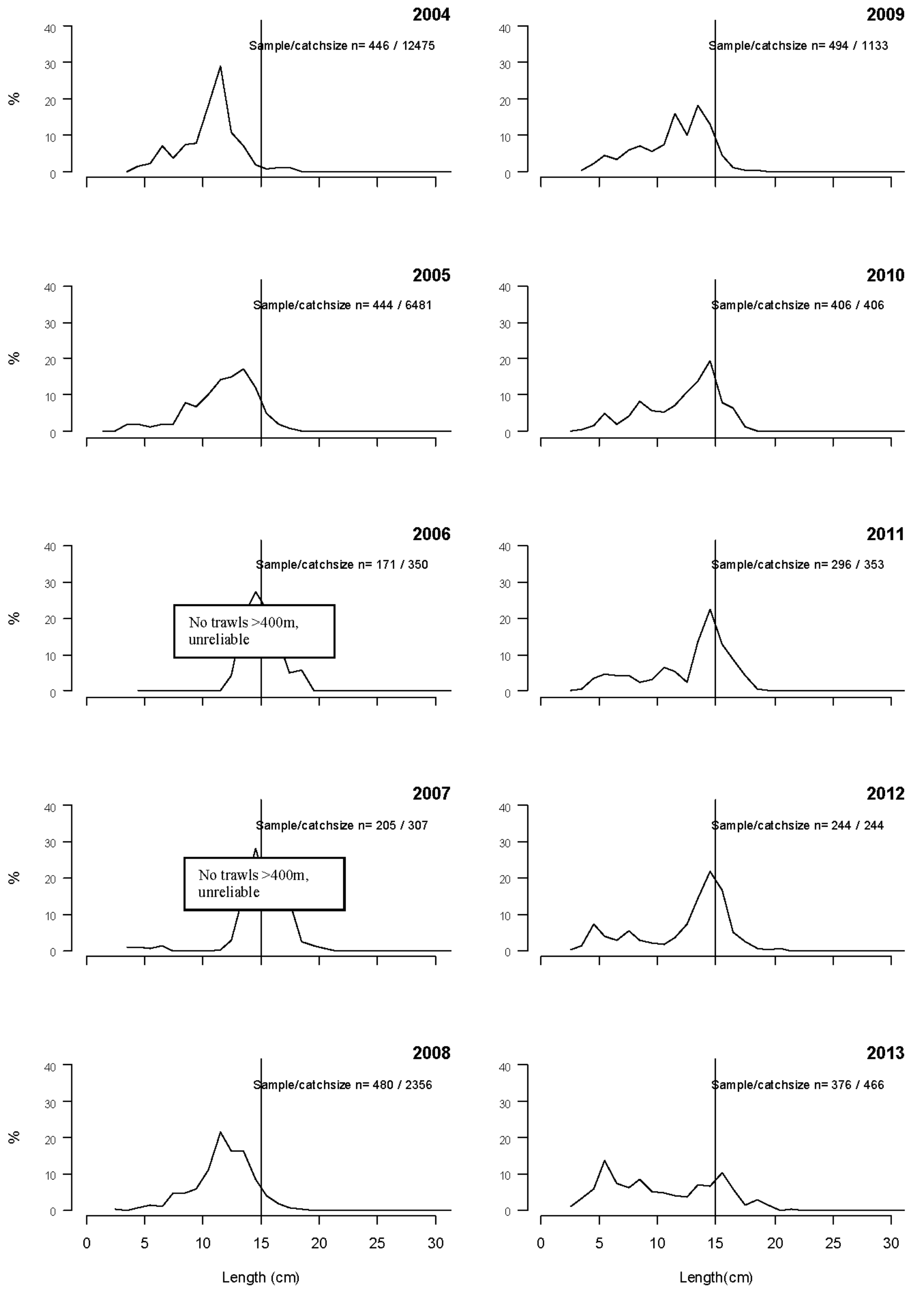

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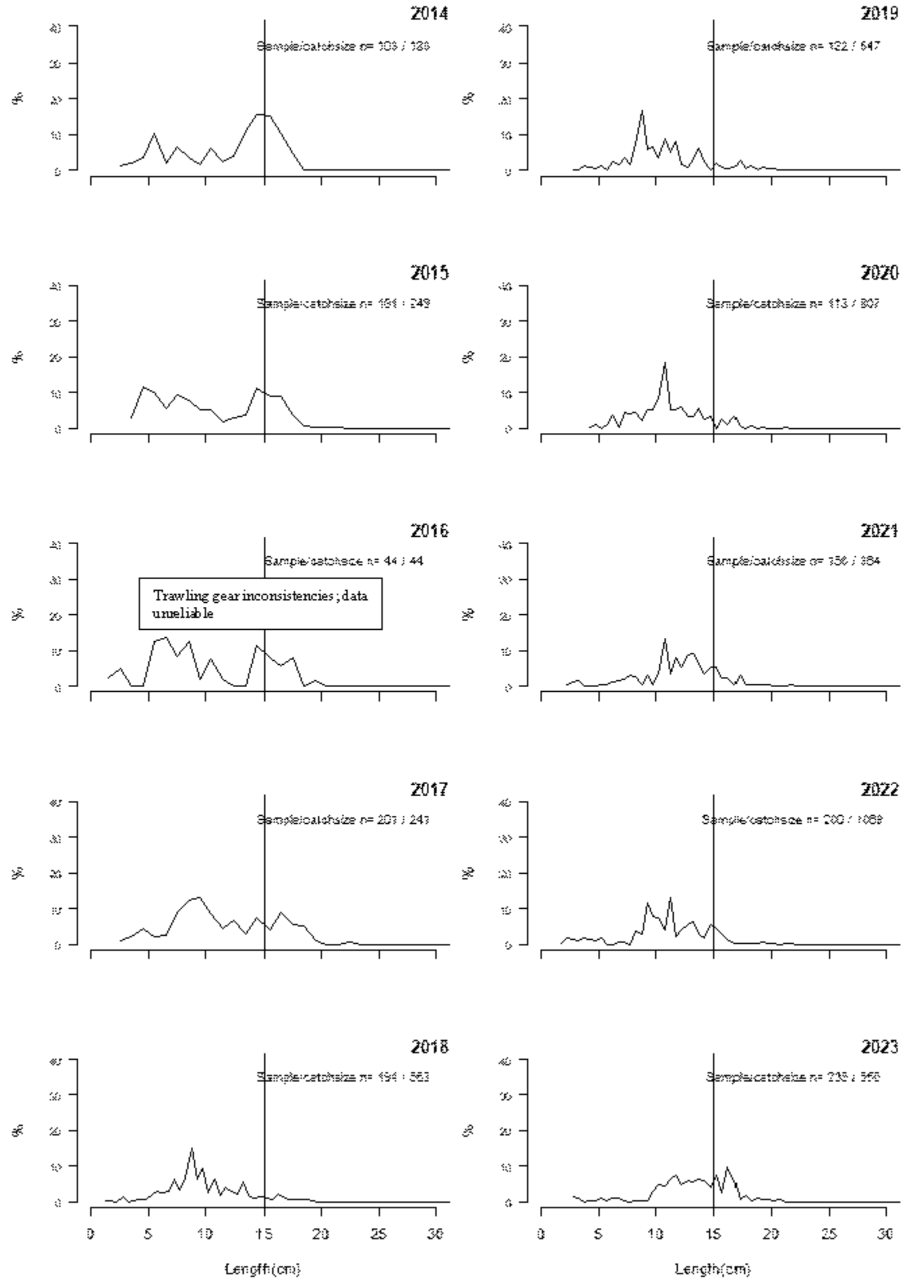

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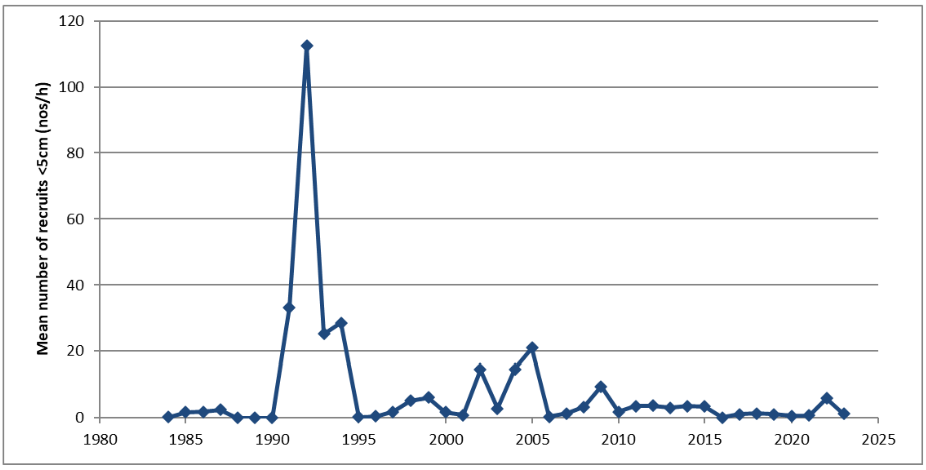


Figure 3. Mean catch rate of roundnose grenadier of PAFL ≤ 5 cm, 1984-2023. Data from shrimp survey, trawls deeper than 300 m. *In 1984,2003,2006 and 2007, no trawls were made deeper than 400 m, and data from these years should be disregarded; in 2016 data from shrimp survey is regarded as unreliable due to inconsistencies with trawling gear and data from that year should be excluded.

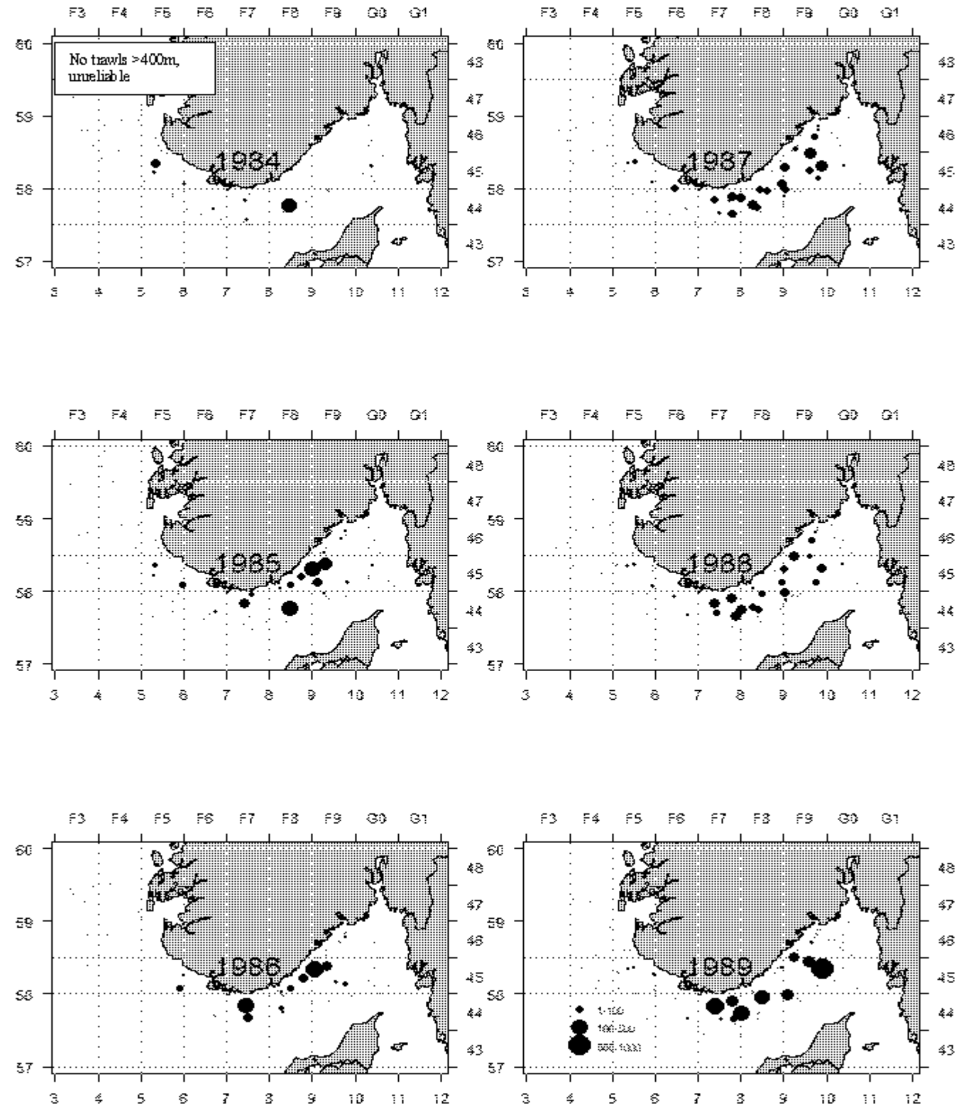
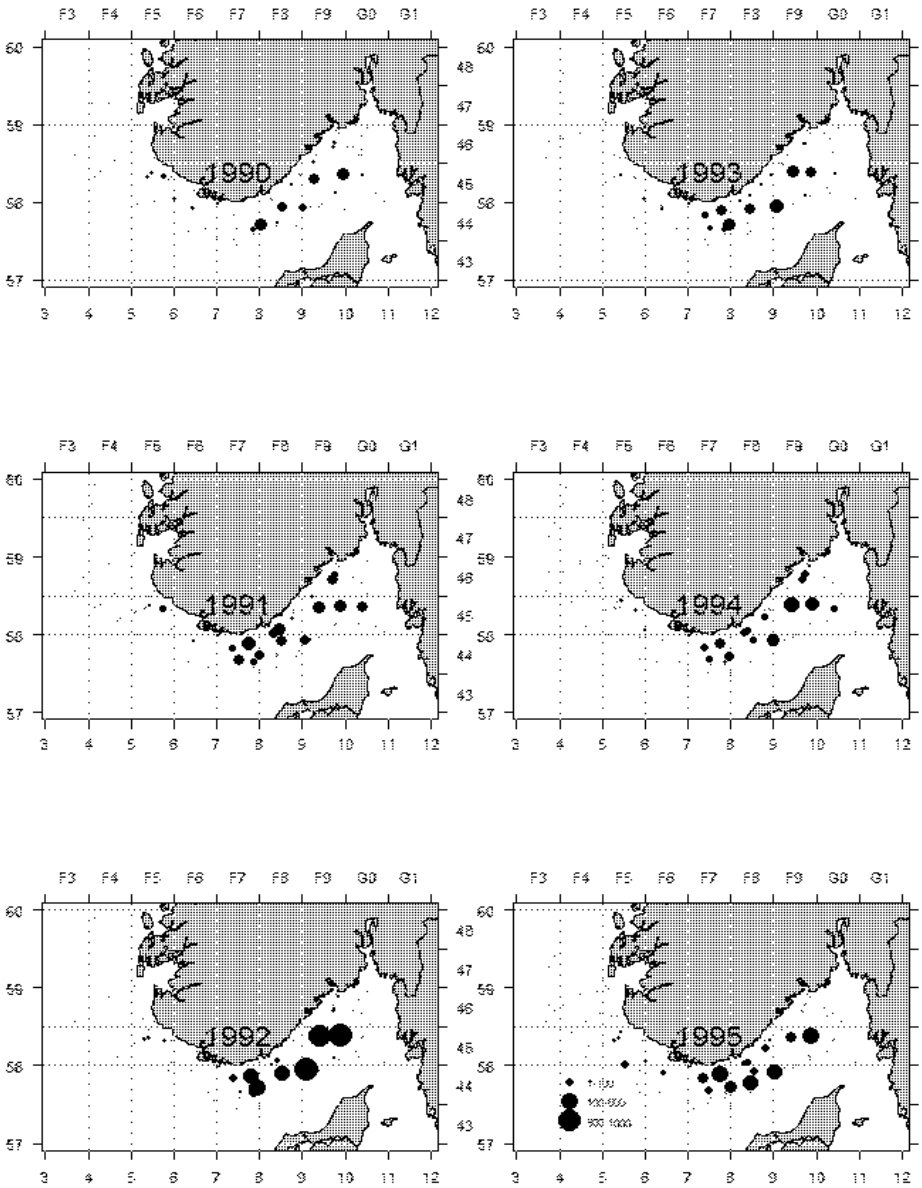


Figure 4. Geographical distribution of catches of roundnose grenadier (kg/h) from 1984-2023. Data from shrimp survey, trawls deeper than 300 m. Grey circles are trawls with no catch of grenadier. *In 1984, 2003, 2006 and 2007, only one single or no trawls were made deeper than 400 m, and data from those years should be excluded; in 2016 data from shrimp survey is regarded as unreliable due to inconsistencies with trawling gear and data from that year should be excluded.



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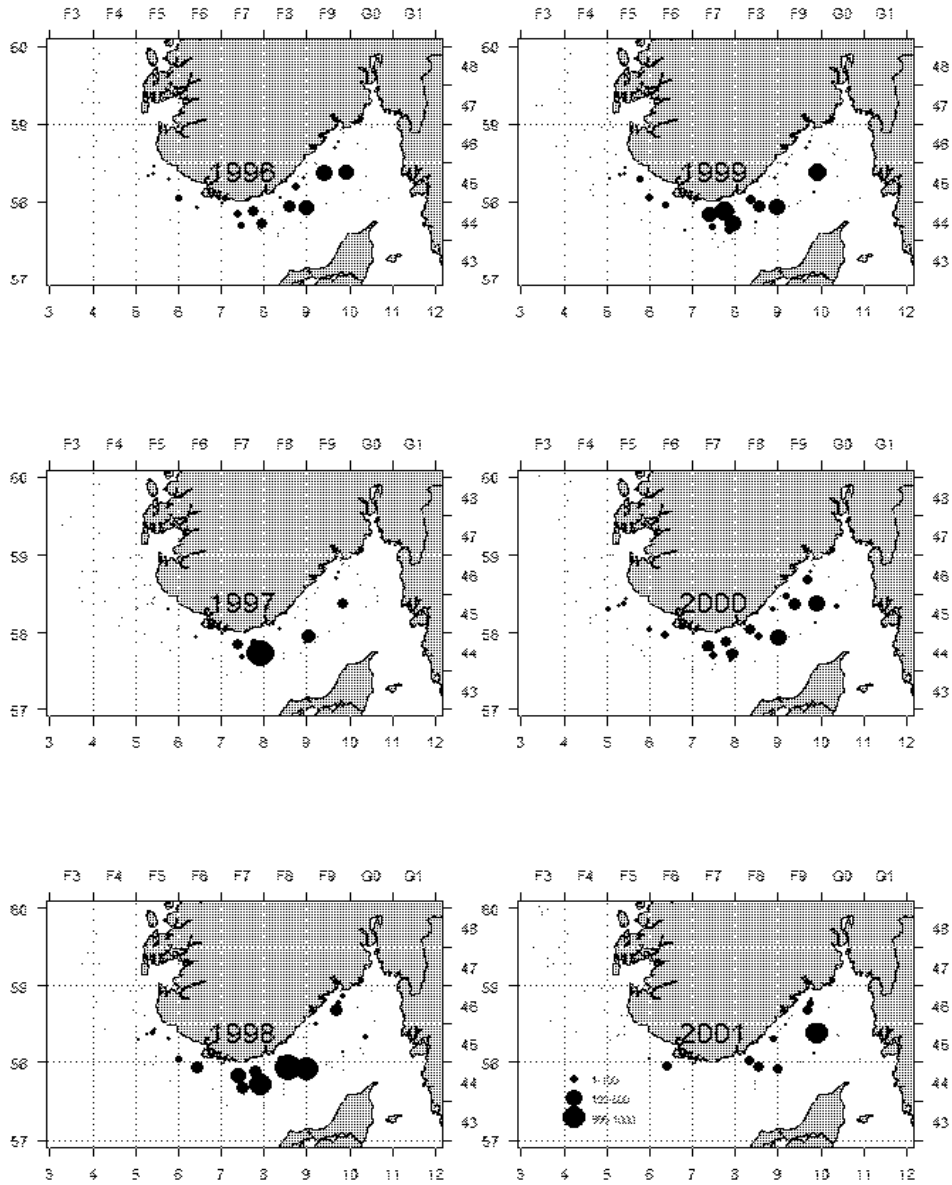

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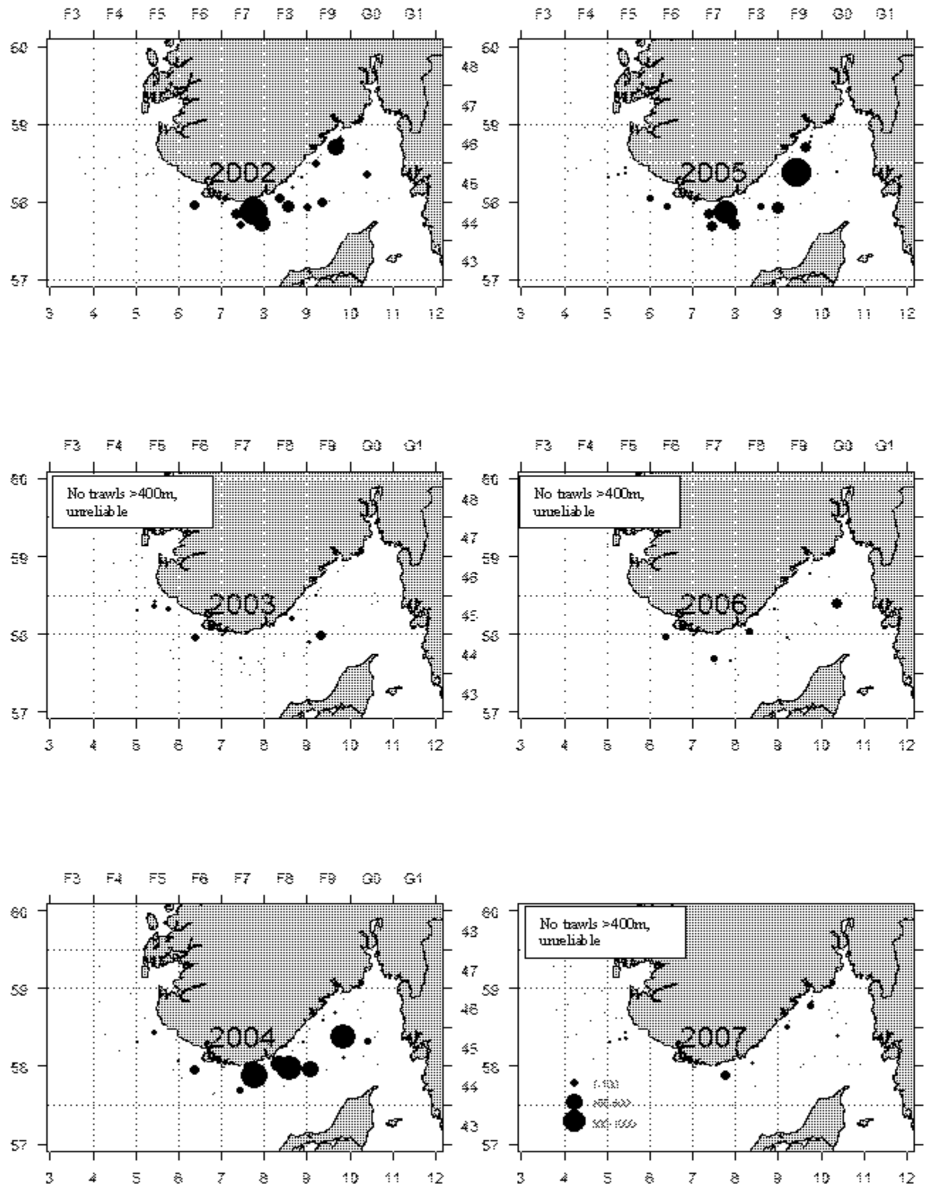

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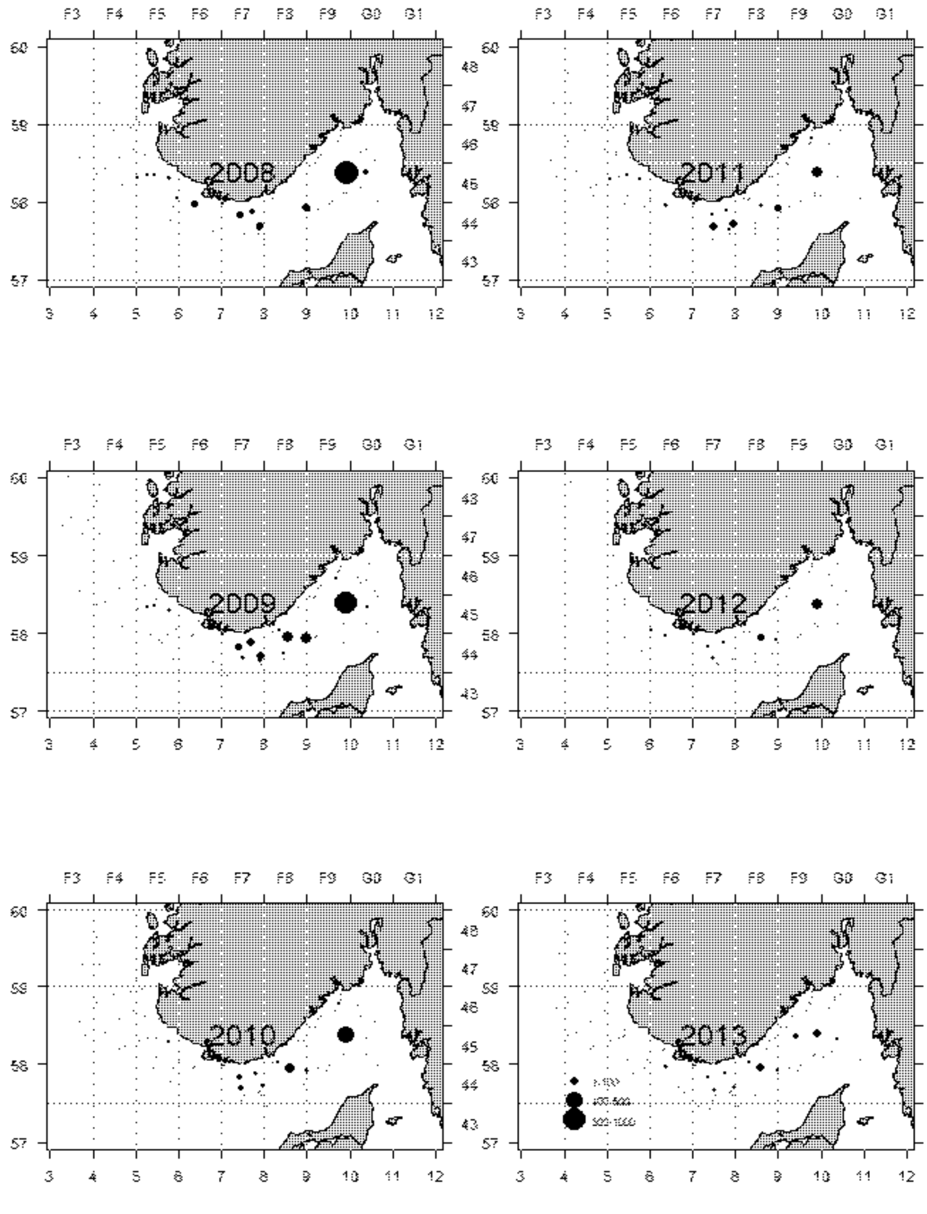

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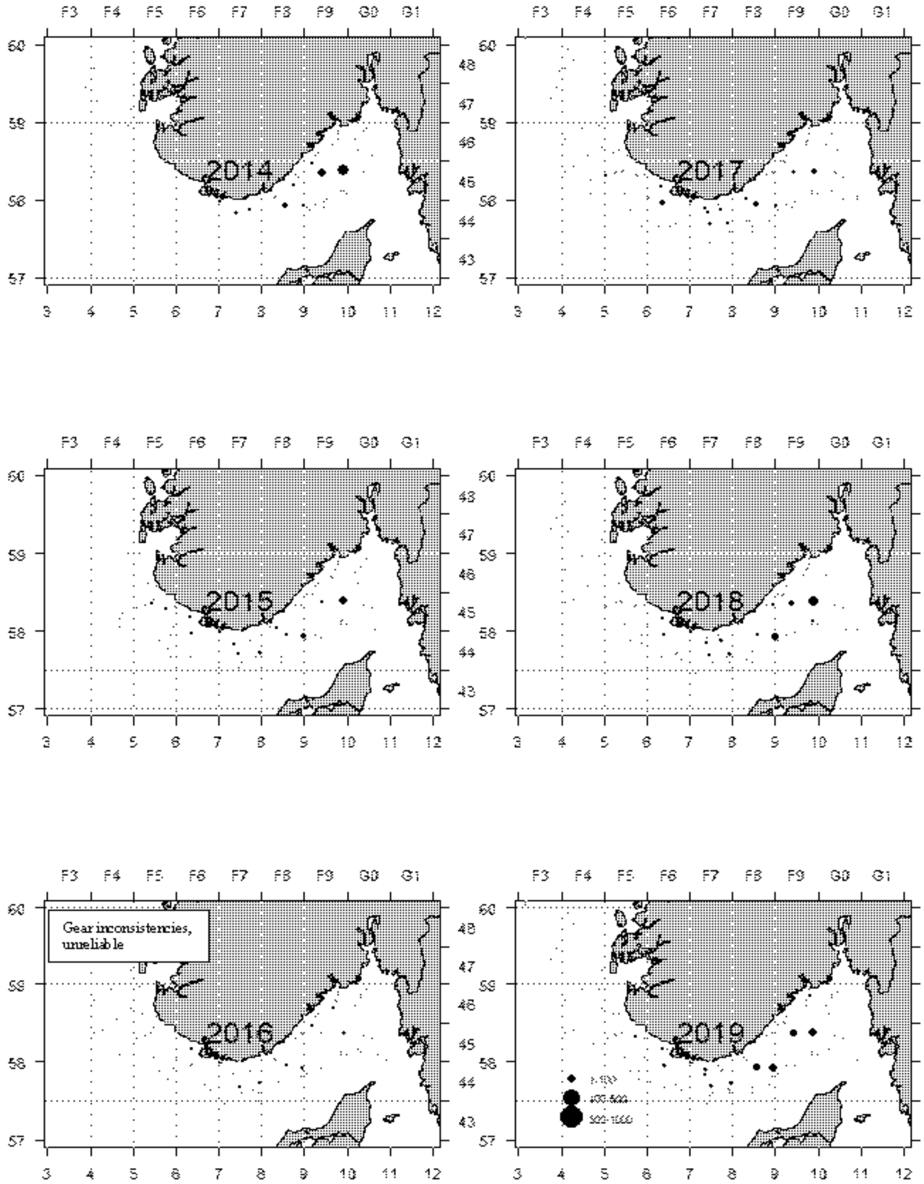

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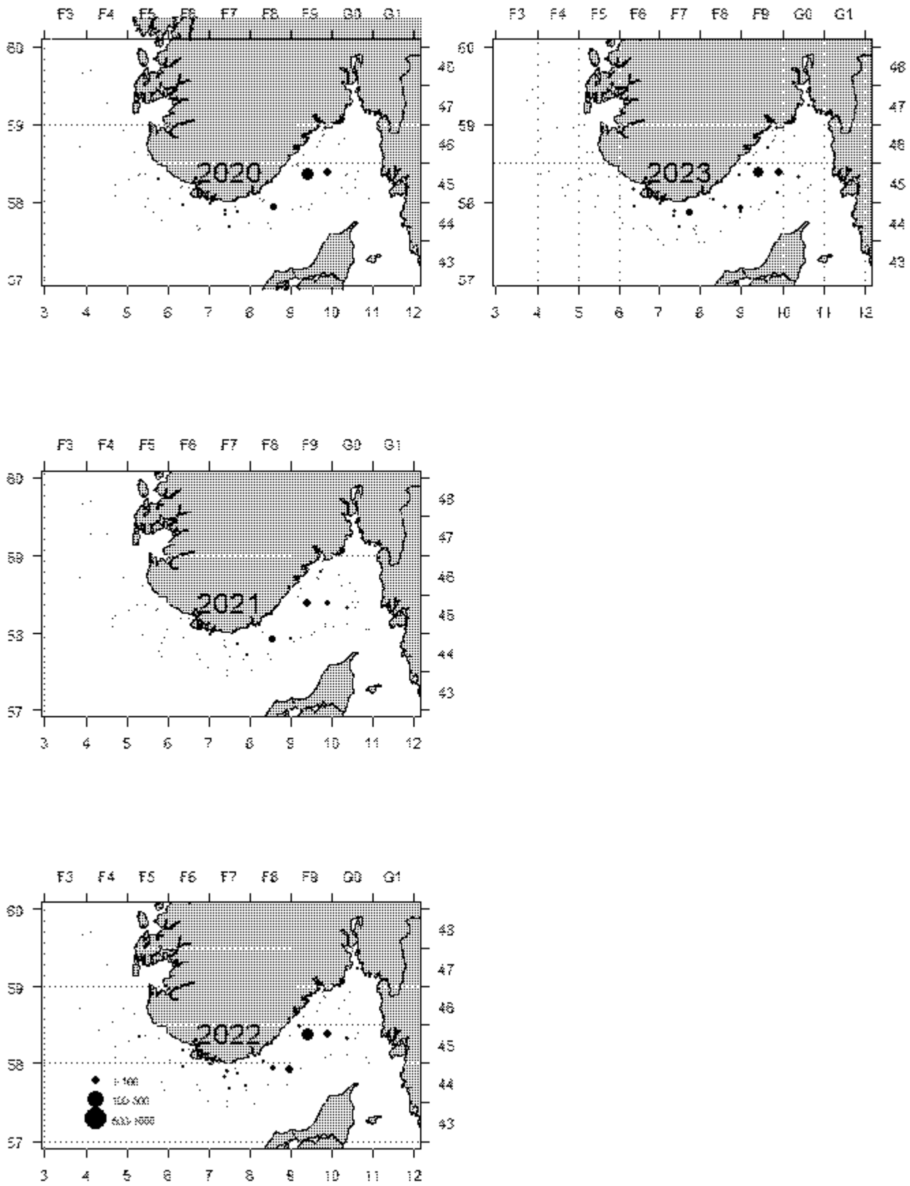

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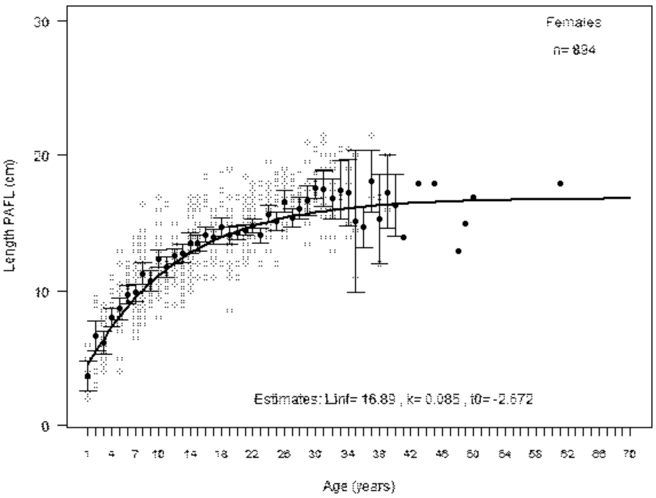

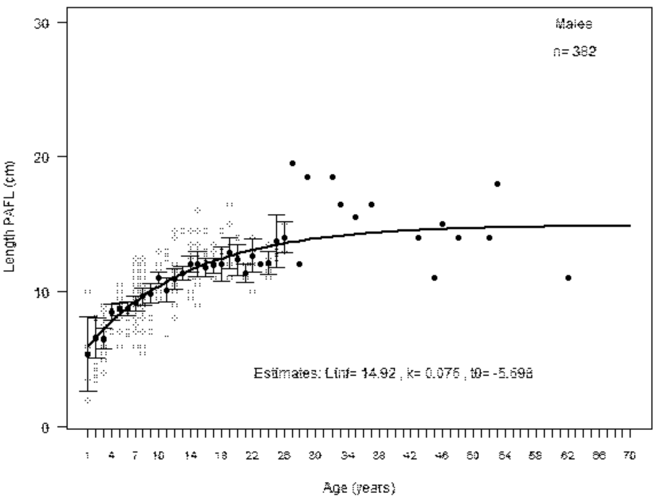

Figure 5. Length at age for female and male roundnose grenadier; data from Skagerrak 2008-2023. Mean values are estimated with ±2SE where there is more than one value. Estimated von Bertalanffy growth curves with parameters for females and males.

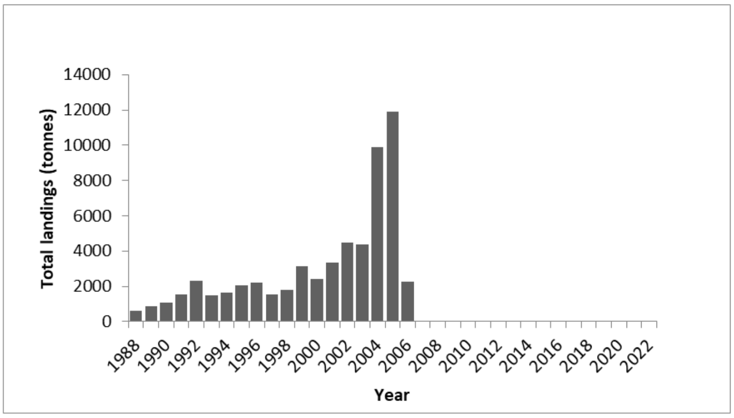

Figure 6. Total reported landings of roundnose grenadier in ICES Division 3a, 1988-2022. Landings from 2007 and later are very small and all less than 2 tons.

Working Document presented to the ICES Working Group on the
Biology and Assessment of Deep Sea Fisheries Resources

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The Blackspot seabream Spanish target fishery of the Strait of Gibraltar: updating the available information

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Abstract

This paper includes the available information of the Blackspot seabream (Pagellus bogaraveo) Spanish target fishery in the Strait of Gibraltar updating the documents presented in previous years with the information from 2022. So, data about landings, fishing effort, CPUEs and landings length frequencies are presented to its inclusion in the 2023 WGDEEP Report.

1. Introduction and fishery description

Since the earlies 1980´s a Spanish artisanal fishery targeting to Blackspot seabream (*Pagellus bogaraveo*, namely "*voraz*") have been developed in the Strait of Gibraltar area (ICES 9a South). This fishery has already been broadly described in previous Working Documents presented to the ICES WGDEEP (Gil *et al.*, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021 and 2022). Blackspot seabream Spanish fishery in the Strait of Gibraltar is almost a mono-specific fishery with a clear target species which represents the 74% from the total landed species which constitutes a fleet component by itself (Silva *et al.*, 2002).

In 2006, 2008, 2010, 2012 and 2016 different trials were attempted to assess this resource within the ICES WGDEEP (ICES, 2006, 2008, 2010, 2012, 2016 and 2018). Finally, 2018 scientific advice was based on abundance indexes (DLS category 3). All the available information from this target fishery (including the biomass index used as the basis for the assessment) were updated with the most recent (2022) data.

Thus, the main objective of this paper is to provide to the 2023 ICES WGDEEP a summary of the available information of this deep-water fishery located in a very narrow place of the ICES area 9.

2. Material and methods

Fishery information from the sale sheets was gathered for the period 1983-2021: monthly landings, monthly number of sales (as a proxy of fishing trip) and the number of days in which those sales were carried out. Moreover, landings length distributions was also estimated from the data collected by IEO monitoring programme (Gil *et al.*, 2000).

Geo-referenced information from SLSEPA devices (a sort of Vessel Monitoring System) on the "*voracera*" fleet operating at the Strait of Gibraltar were more recently available (from 2009 onwards): this monitoring system, locally called "green boxes" (to differentiate them from the EU VMS "blue boxes"), send every three minutes to a control centre several information about the fishing boat: time, positions, course and speed. Data were filtered and analyzed, according to the protocols proposed by Burgos *et al.* in 2013, to estimate fishing effort and catch rates of the Blackspot seabream Spanish target fishery.

3. Results and discussion

- Landings data: Figure 1 shows a continuous increase of Spanish landings from the beginning of the time series to reach a maximum in 1994. Since then landings´ trend decreased till 2002, despite the peaks in 1996 and 1997. Again, it shows an increasing trend from 2003 to 2009, decreasing afterwards except for a slight increase in 2014. Landings since 2018 show the lowest values of the series, with a 2020-2022 mean of about 7 tons (but less than 1 ton in the last year) landed by the Spanish "voracera" fleet.

Until now, discards can be assumed to be zero or negligible. However, the established minimum landing size of 33 centimeters for the species (both for NE Atlantic and Mediterranean Sea) and the landing obligation (EU Regulation 2013/1380) don´t might have an effect on the discards of this target fishery because its high survival exemption.

Hence landings are currently being used as a proxy of catches. However, it should be noted that not all the Spanish catches/landings come exclusively from ICES area 9 but they are considered from the same stock unit because the fishing area (Strait of Gibraltar) is placed between different Advice bodies/Regional Fisheries Organizations (ICES, GCFM and CECAF) boundaries. In fact, since 2015 Spanish Blackspot seabream landings available at InterCatch tool comprise different areas: 27.9.a (ICES), 34.1.11 (CECAF) and 37.1.1 (GFCM).

Data from Moroccan longliners fishing Blackspot seabream in the Strait of Gibraltar area are available since 2001. The information are available on FAO GFCM statistics (WGSAD-SAC and SRC-WW) so, when possible, it is included in the WGDEEP landings estimates because

Moroccan boats target the same population, sharing the main Strait of Gibraltar fishing grounds with Spain (ICES, 2016).

- <u>CPUEs</u>: Nominal biomass index shows ups and downs throughout the historical series (Figure 2). It is important to emphasize that the effort unit chosen (number of sales) may not be appropriate as does not consider the missing effort. So in the most recent years, when the resource is not quite abundant, the missing effort might increase substantially (fishing boats with no catches and no sale sheet records). Therefore, the LPUE trend since the first fishery´s decline (1997) should be interpreted with caution because it cannot be a real image of the resource abundance. Anyway, a severe and continuous decreasing trend is observed since 2016, with CPUEs lower than 40 kilos per fishing trip till about 20 kilos per fishing year in 2021 and less than 10 kilos in 2022.

Table 1 updates the available information from regional VMS (SLSEPA), following the data compilation and process described by Burgos *et al*. in 2013.

Table I. Estimates of fishing effort and CPUEs (2009-2022) from the "*voracera*" fleet targeting Blackspot seabream based on regional VMS (SLSEPA) and fishery statistics (sales sheets).

Data source		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
VMS	Landings (k)	459,010	274,882	190,786	79,163	37,799	94,261	137,444	73,508	24,716	4,402	4,825	1,579	2,614	313
	No. sales	7,200	5,863	4,711	2,946	2,086	2,989	3,079	1,873	1,017	309	248	62	89	36
	Fishing days (fishing trips)	8,373	7,238	6,160	3,686	2,695	4,191	4,234	2,724	1,740	1,046	607	125	266	235
	CPUE 1 (landings/no. sales)	64	47	40	27	18	32	45	39	24	14	19	25	29	9
	CPUE 2 (landings/fishing days)	55	38	31	21	14	22	32	27	14	4	8	13	10	1
	Missing effort (%)	14	19	24	20	23	29	27	31	42	70	59	50	67	80
TOTAL	Landings (k)	579,140	316,365	239,790	126,006	66,159	137,623	166,440	99,726	42,991	7,633	18,693	12,838	8,412	488
	No. sales	8,892	6,932	5,659	3,638	2,222	3,527	3,384	2,418	1,308	429	794	525	404	72
	CPUE 1 (landings/no. sales)	65	46	42	35	30	39	49	41	33	18	24	24	21	7

CPUE 2 (landings/fishing days), where the effort is estimated from the VMS device also declined with lower values than CPUE 1 because the fact of the missing effort. So, as expected, CPUEs estimates from VMS analysis shows the same trend but lower values than the nominal one, from sale sheets (Figure 2).

- <u>Length frequencies</u>: The mean length of landings seems to have decreased in two different periods: from 1995 to 1998 and from 2009 to 2013 (Figure 3). 2021 mean length estimate shows a significant increase (about 5 cm) but data should be revised because is not consistent with previous and following years.

4. Main conclusions

The general trend for the time series of both, landings and CPUEs, continues showing a decreasing pattern over recent years, exhibiting the lowest values of the whole series. This might be a consequence of an overexploitation status of the stock, which is addressing the fishery into a critical situation.

It should be noted that GFCM establish a management plan for the Blackspot seabream fishery of the Strait of Gibraltar in 2022 (GFCM/45/2022/3 on a multiannual management plan for the sustainable exploitation of blackspot seabream in the Alboran Sea, geographical subareas 1 to 3). The update of benchmark assessment (gadget model) for blackspot seabream in the Strait of Gibraltar was presented in the last GCFM WGSAD (December 2022). Results indicated that the stock is depleted with unsustainable exploitation and low fishing mortality. The recommendation was to proceed with immediate reduction of fishing mortality, implementing also a recovery plan (GFCM, 2022).

Acknowledgments

We would like to express our most sincere gratefulness to all those institutions and people for their collaboration in the execution of the monitoring of the Spanish "*voracera*" fishery: Spanish Institute of Oceanography (IEO, CSIC), Consejería de Agricultura y Pesca de la Junta de Andalucía and Tarifa´s Fishermen Brotherhood and 1st sale fishmarket.

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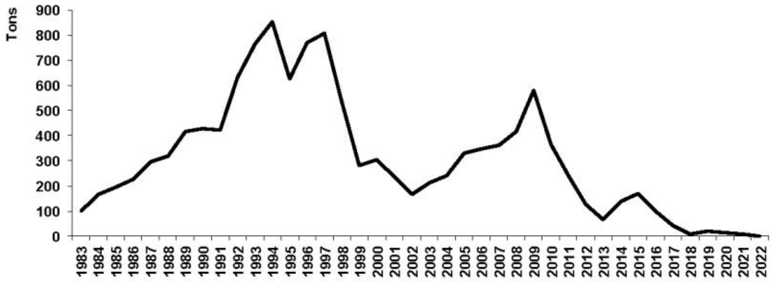

Figure 1. Blackspot seabream Spanish "*voracera*" fishery of the Strait of Gibraltar: total landings (1983-2022).

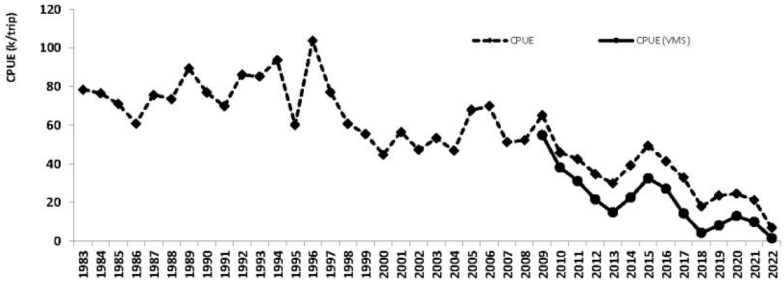

Figure 2. Blackspot seabream Spanish "*voracera*" fishery of the Strait of Gibraltar: nominal (sale sheets) CPUE (1983-2022) and (VMS) CPUE (2009-2022).

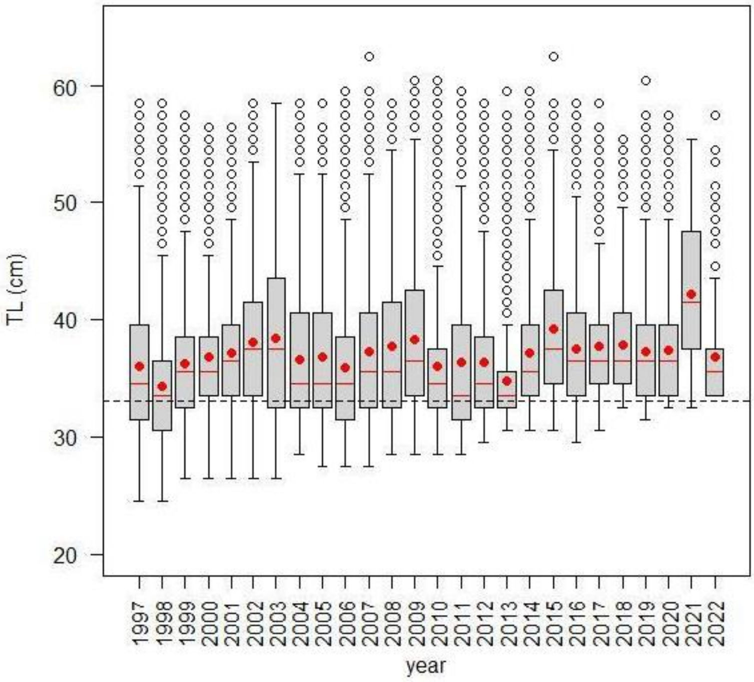

Figure 3. Blackspot seabream Spanish *"voracera"* fishery of the Strait of Gibraltar: landings length distribution descriptive statistics (red dot: mean value, red line: median value, box and whiskers: Interquartile Range plus Q_1-3IQR and Q_3+3IQR, circles: outliers).

Working Document for the ICES Working Group on Biology and Assessment of Deep-sea Fisheries Resources

3rd – 9th April 2023

Greater forkbeard *Phycis blennoides* in Portuguese waters (ICES Division 27.9.a)

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Abstract

This working document updates the information presented in previous WGDEEP meetings for the greater forkbeard *Phycis blennoides* in ICES Division 27.9.a (continental Portugal), particularly fishery dependent data and MSY length-based indicators (LBI). Length-based indicators LBI used to classify the stocks according to conservation/sustainability, yield optimization and MSY were estimated for the exploited population in continental Portugal based on length samples collected under the Portuguese DCF program.

1. General considerations

The greater forkbeard *Phycis blennoides* (Brünnich, 1768) is a demersal species from the family Gadidae. This species is widely distributed in the northeast Atlantic from Norway and Iceland to Cape Blanc in West Africa and in the Mediterranean Sea (Massutí et al., 1996), and occurs preferentially along the continental shelf and slope, at depths ranging between 60 and 1000 m deep (Massutí et al., 1996; Casas and Piñeiro 2000; García et al., 2000).

The greater forkbeard has a discrete recruitment period along the year and is available to fishing at the first years of life (Ragonese et al., 2002). The size of transition from the pelagic to the demersal habitat occurs at lengths around 6 cm in Atlantic waters (Casas and Piñeiro, 2000) and at a smaller size (4.5-5.0 cm total length) in the Mediterranean (Ragonese et al., 2002). In the Gulf of Tunis, age parameters were estimated as TL_{inf} = 57.17 cm, k = 0.193 year^{-1}, t_0 = –1.578 year for females, and TL_{inf} =44.74 cm, k = 0.313 year^{-1}, and t_0 =–1.210 year for males. Females grow faster than males, and the latter did not exceed 45 cm (Romdhani et al., 2016).

1.1. The greater forkbeard in Portuguese waters from ICES Division 27.9.a

In Portuguese continental waters, the length structure and the biology of greater forkbeard, namely reproduction, suggests that it completes the whole life cycle in the area (Lagarto et al., 2017). As in other geographic areas where the species occurs (e.g., in the Mediterranean), a depth effect on specimen's size is observed (Massutí et al., 1996) with larger specimens occurring at higher depths (>600 m deep) (Fig.1).

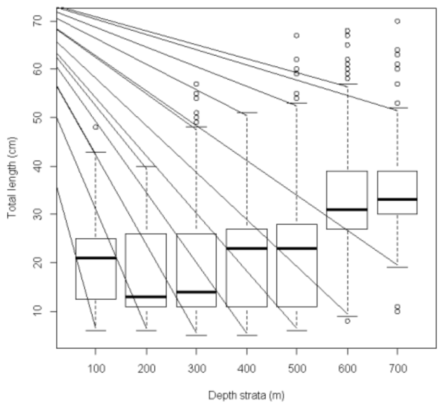

Figure 1. Inter-quartile total length range of *P. blennoides* by depth strata (m) caught during the Portuguese Crustacean Surveys/Nephrops TV Surveys (PT-CTS (UWTV (FU 28-29))) undertaken between 1997 and 2016 (no survey was conducted in 2012). (from Lagarto et al., 2017)

2. Fishery dependent data in Portuguese waters from ICES Division 27.9.a

In continental Portugal there are no fisheries targeting the greater forkbeard. This species is mainly caught as by-catch of other fisheries, particularly from the polyvalent fleet segment or multi-gear fleet, which is responsible for ~98% of the species total landings.

The Portuguese polyvalent segment includes vessels of different sizes usually licensed to operate with more than one fishing gear (e.g. gill and trammel nets, longlines, and traps). At each fishing trip, vessels belonging to this segment may deploy more than one fishing gear, depending on the targeted species and on the fishing grounds. The analysis of logbook data further indicates that, within the polyvalent segment, the greater forkbeard is mainly caught by demersal longlines (Moura and Figueiredo, 2020).

Most greater forkbeard landings are reported at Peniche landing port, in the Centre of Portugal. A marked seasonal pattern on Portuguese landings is observed with higher values between May and July (Lagarto et al., 2017). Although the reasons for this seasonality are unknown, it is considered that they might be related to the dynamics of the fleets and particularly to changes on their target species.

2.1. Commercial landings

Official Portuguese annual greater forkbeard landing estimates in ICES Division 27.9.a are presented in Table 1. It is worth mentioning that landings are likely to be biased due to species misidentification problems. It is admitted that greater forkbeard can be misidentified with its congener *Phycis phycis*. Moreover, the two *Phycis* species, and particularly at the beginning of time series, might be landed under the designation of *Phycis* spp. However, the fraction of *Phycis* spp. landings corresponding to *P. blennoides* is unknown and cannot be estimated as the level of DCF sampling coverage is insufficient.

Historically, the landings of greater forkbeard species are low, either because of its relatively low commercial value or to the low fishing effort at deeper fishing grounds.

Table 1. Official landings (ton) of *Phycis blennoides*, *Phycis phycis* and *Phycis* spp. by fleet from 2003 to 2022. *Phycis* spp. includes landings of *P. blennoides* and *P. phycis*. Source: DGRM (official landings).

	Phycis blennoides				*Phycis phycis*				*Phycis* spp.			
Year	TRAWL	PSEINERS	ARTISANAL	TOTAL	TRAWL	PSEINERS	ARTISANAL	TOTAL	TRAWL	PSEINERS	ARTISANAL	TOTAL
2003	0.08		10.87	10.95	0.75		5.69	6.44	7.87	0.50	314.14	322.51
2004	0.10	0.05	9.84	9.98	0.11		3.59	3.70	7.85	0.60	295.10	303.55
2005	0.17	0.03	14.00	14.20	1.06	0.02	83.49	84.57	5.68	0.13	183.03	188.84
2006	0.17		9.66	9.84	2.11	0.08	176.24	178.43	3.22	0.01	56.05	59.28
2007	0.10	0.02	13.40	13.52	2.69	0.28	215.65	218.62	4.01		25.20	29.21
2008	0.18	0.01	12.05	12.23	4.79	0.10	234.03	238.92	0.14		25.03	25.17
2009	0.10		14.64	14.74	11.20		452.92	464.13			18.61	18.61
2010	0.10		11.53	11.63	14.24		472.11	486.36			8.68	8.69
2011	0.04		13.43	13.48	7.08	0.01	450.68	457.76			5.91	5.91
2012	0.08		5.58	5.66	4.24	0.03	456.11	460.38			5.24	5.24
2013	0.11		7.67	7.78	4.22	0.92	274.22	279.35			3.78	3.78
2014	0.13		6.09	6.22	2.27	0.80	170.97	174.04			2.39	2.39
2015	0.04		7.39	7.43	5.32	0.73	154.72	160.77			1.58	1.58
2016	0.12		6.69	6.81	6.72	1.41	181.31	189.44			1.81	1.81
2017	0.20		8.85	9.05	4.13	1.69	172.38	178.21	0.00		1.27	1.28
2018	0.19		9.23	9.42	2.70	0.35	129.27	132.31			0.64	0.64
2019	0.02		7.12	7.14	2.03	0.313	133.35	135.69			1.34	1.34
2020	0.08		4.80	4.88	1.61	0.30	137.78	139.69			0.99	0.99
2021	0.09		11.16	11.25	1.66	0.53	331.83	334.01			0.66	0.66
2022	0.19		8.47	8.66	0.80	0.13	327.63	328.55			0.86	0.86

2.2. Length data

The greater forkbeard is sampled for length at several landing ports along the Portuguese continental coast under the national data collection program (PNAB/DCF). The total length of specimens sampled from 2014 to 2022 (under DCF market and onboard programs) ranged between 17 and 78 cm (Farias et al., 2021). The length frequency distributions slightly differed between the trawl and the polyvalent fleet segments (the length of specimens caught by trawlers are skewed to sizes smaller than those caught by polyvalent vessels) (Moura and Figueiredo, 2020). Given the very low landing values attributed to the trawl segment, the length frequency distribution of the greater forkbeard exploited population is mainly derived from the polyvalent fleet segment catches.

Length-based indicators (LBI) screening methods were applied to the length frequency distributions of the greater forkbeard landed in continental Portugal for the period 2019-2022. The procedure followed the ICES Technical guidance for providing reference points for stocks in categories 3 and 4 (Table 2) (ICES, 2017). The L_{mat} and L_{inf} estimates adopted were those made available by Spain for sexes combined: 53.89 cm and 91.46 cm, respectively (ICES WGDEEP datacall, 2018). The length-weight relationship parameters ($Wt = 0.016\ TL^{2.843}$) were defined by Mendes et al. (2004).

Table 2. Selected indicators for LBI screening plots. Indicator ratios in bold used for stock status assessment with traffic light system (from ICES, 2017).

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above L_{opt} + 10%	0.3–0.4	Pmega	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	> 1	Conservation (immatures)
L_c	Length at first catch (length at 50% of mode)	L_{mat}	L_c/L_{mat}	> 1	
L_{mean}	Mean length of individuals > L_c	$L_{opt} = {}^2/_3\ L_{inf}$	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{max_y}	Length class with maximum biomass in catch	Lopt = ${}^2/_3\ L_{inf}$	L_{maxy} / L_{opt}	≈1	
L_{mean}	Mean length of individuals > L_c	$L_{F=M}$ = ($0.75L_c$+0.25 L_{inf})	L_{mean} / $L_{F=M}$	≥ 1	MSY

Results from the LBI screening method are shown in Tables 3a and 3b and Figure 2.

Table 3a. Results from LBI screening: indicator values.

Year	L_{75}	L_{25}	L_{med}	L_{90}	L_{95}	L_{mean}	L_c	$L_{F=M}$	L_{maxy}	L_{mat}	L_{opt}	L_{inf}	$L_{max5\%}$
2019	51.5	45.5	49.5	58.5	63.5	52.57	46	57.365	51.5	53.89	60.97	91.46	66.47
2020	44.5	42.5	44.5	53.5	53.5	46.03	42	54.365	44.5	53.89	60.97	91.46	53.50
2021	46.5	40.5	43.5	48.5	53.5	46.54	42	54.365	48.5	53.89	60.97	91.46	59.55
2022	62.5	56.5	58.5	64.5	65.5	59.21	46	57.365	58.5	53.89	60.97	91.46	65.50

All LBI estimates increased between 2021 and 2022 (Table 3a).

Table 3b. Results from LBI screening: indicator ratios. Ref., Reference expected values from ICES (2017).

		Conservation					Optimizing Yield	MSY
		L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{95\%}/L_{inf}$	L_{maxy}/L_{opt}	$L_{max5\%}/L_{inf}$	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
Year	Ref.	> 1	> 1	> 0.8	≈ 1	> 0.8	≈ 1 (>0.9)	≥ 1
2019		0.85	0.84	0.69	0.84	0.73	0.86	0.92
2020		0.78	0.79	0.58	0.73	0.58	0.75	0.85
2021		0.78	0.75	0.58	0.80	0.65	0.76	0.86
2022		0.85	1.05	0.72	0.96	0.72	0.97	1.03

Most of the ratios between indicators estimates (Table 3b) are below the proposed expected values (see Table 3). These results are related to the poor representation, on landings, of all the size ranges of the population. Discards are known to occur but are unquantifiable. It is acknowledged that the largest specimens are discarded from the deep-water longline fisheries but numbers are relatively low (Lagarto et al., 2017). In addition, onboard data for this fleet is derived from a small area of the total stock distribution in the Portuguese continental waters. Thus, the fishing effort affecting the largest individuals is relatively low.

Conservation ratio estimates increased in 2022 in relation to previous years and $L_{25\%}/L_{mat}$ and L_{maxy}/L_{opt} were above the reference values in 2022 (Table 3b and Figure 2). The Optimizing Yield indicator ratio increased between 2021 and 2022 to values above the reference, which indicates that the stock is being fished above optimum yield. The indicator for MSY increased from 2020 to 2022 and is now consistent with an adequate exploitation.

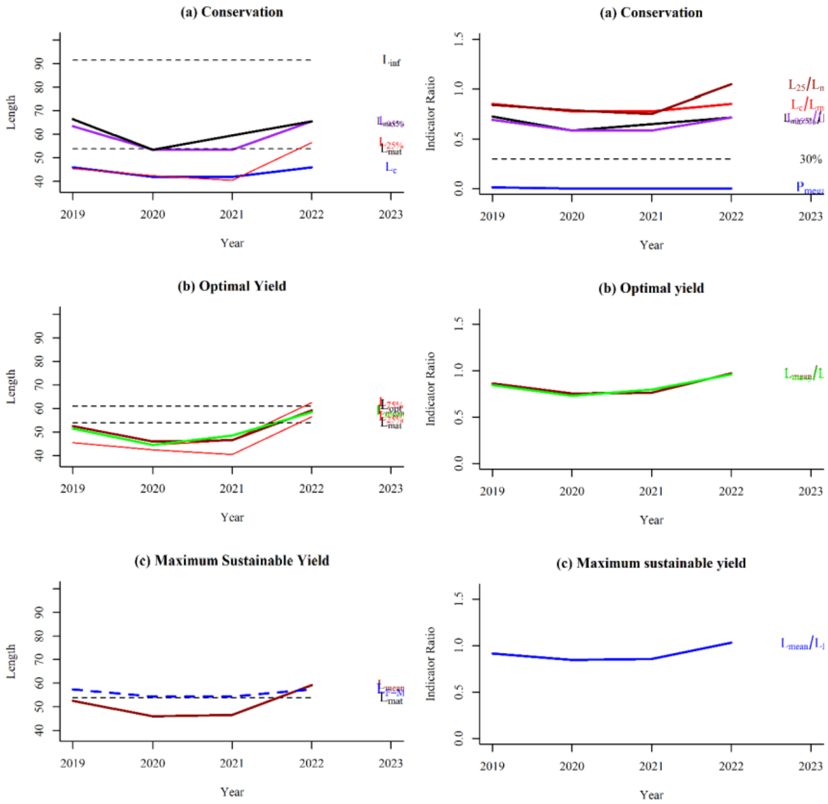

Figure 2. Results from LBI screening.

3. Fishery independent data in Portuguese waters from ICES division 27.9.a

Fishery independent data available from the Portuguese Crustacean Surveys/ Nephrops TV Surveys (PT-CTS (UWTV (FU 28-29))) has been used to estimate a standardized relative biomass index between 1997 and 2018 (Farias et al., 2021). In 2019 and 2020, the PT-CTS (UWTV (FU 28-29)) survey was not performed. In 2021, the R/V Mário Ruivo started to operate, but the survey's spatial coverage was smaller and fishing stations in the area where the species is traditionally more abundant were missing (Moura et al., 2022). The standardized biomass index has not been updated since 2021 (Farias et al., 2021).

4. Conclusions

Two standardized CPUE series based on commercial data suggested that the status of the greater forkbeard population inhabiting the Portuguese continental waters in recent years has been stable (Farias et al., 2021).

The standardized survey biomass estimates, which represents a relatively long time series, were well above the overall mean and showed an increasing trend in the last years of the time series (Farias et al., 2021). For the period between 1997 and 2016, an increasing trend was also observed for the juvenile component of the population, indicating that the fishing pressure over the Portuguese population had not seriously impaired the recruitment (Lagarto et al., 2017).

In general, LBI screening results, particularly the indicator of MSY, are above the reference values, suggesting that the stock is in a fair status.

Given the fact that this species is not targeted by any fishery, the results obtained suggest that the Portuguese fisheries are not impairing the population of greater forkbeard, whose information for the Portuguese waters further indicates that the species is able to complete the whole life cycle in the area.

Worth to mention that the relative low fishing impact of the Portuguese fisheries in deeper grounds reduces the impact over the fraction of larger specimens of the population, as the species tends to be larger at greater depths.

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Comparison between Greater silver smelt in ICES Subarea 5.a and Division 14 assessed using Gadget2 versus Gadget3 implementations

Will Butler, Pamela J. Woods, and Magnús Thorlacius

2023-05-03

Contents

Recently, a new implementation of Gadget has been designed and tested, and is being used for assessment of Greenland halibut (*Reinhardtius hippoglossoides*) and beaked redfish (*Sebastes mentella*) (ICES, 2023). The operational model is essentially the same as in previous implementations with some additional options (Lentin *et al.*, 2022). However, as it is based on the TMB package (Uffe *et al.*, 2017) in R statistical software (R Core Team, 2023), it can use different optimization routines. The Gadget3 model shown here was optimized using the BFGS algorithm, rather than the three-step routine used under Gadget2 implementation, which included simulated annealing, followed by Hooke and Jeeves, and finally BFGS optimizations. The largest benefit of using the Gadget3 implementation rather than the Gadget2 implementation is access to auto-differentiation libraries that greatly speeds the optimization time, which in the past has been a limitation to being able to produce confidence intervals based on a spatial bootstrap method (Elvarsson *et al.*, 2018). Another benefit is that in the future, it is more likely that Gadget3 will be maintained. We propose here to switch the implementation platform of the assessment model for Greater silver smelt in ICES Subarea 14 and Division 5.a (East Greenland and Iceland grounds) to Gadget3 from the Gadget2, as it would alleviate time constraints while producing results that correspond well with results from Gadget2. Fits to survey indices are very similar (Figure 1), as are fits to autumn survey length and age-length distribution data (Figures 2 and 4) and the commercial length and age-length distribution data (Figures 3 and 5) . Model results are also very similar (Figure), and the analytical retrospective analyses, both of which show very low Mohn's rho values, can essentially not be distinguished (Figures 6 vs.).

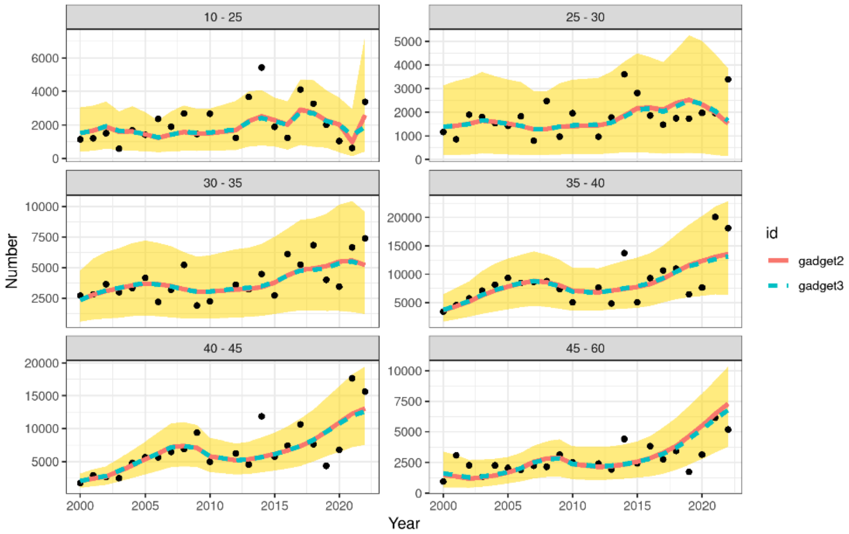


Figure 1: Greater silver smelt in 5a and 14. Comparison of fits to the survey index data implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Red lines indicate Gadget2, blue dashed lines indicate Gadget3.

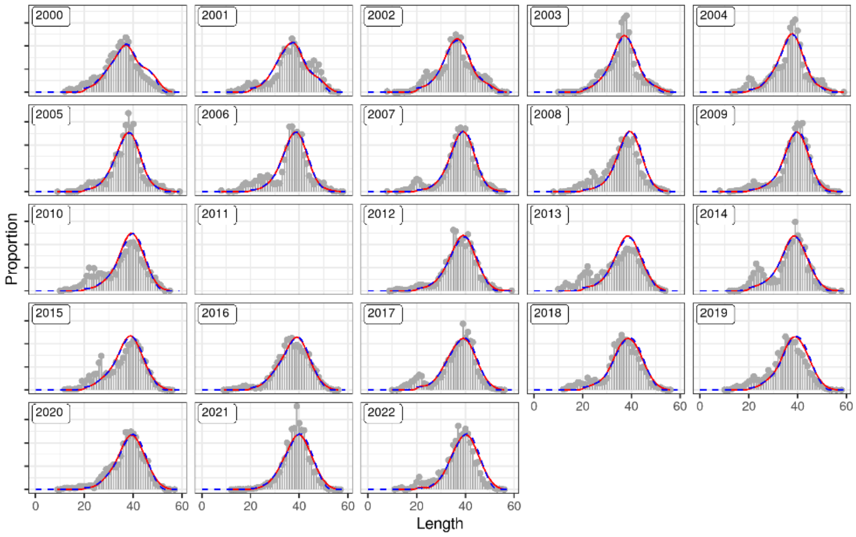


Figure 2: Greater silver smelt in 5a and 14. Comparison of fits to the autumn survey length distribution data implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Red lines indicate Gadget2, blue dashed lines indicate Gadget3.

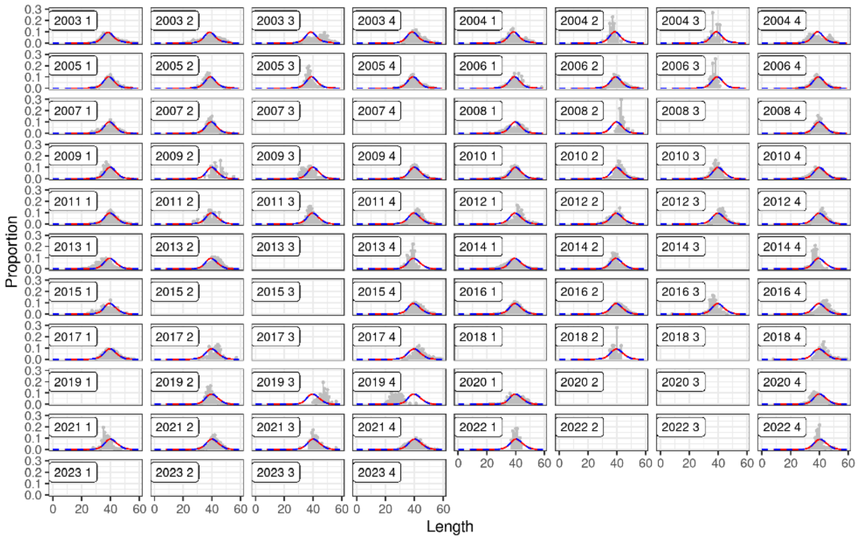


Figure 3: Greater silver smelt in 5a and 14. Comparison of fits to the commercial length distribution data implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Red lines indicate Gadget2, blue dashed lines indicate Gadget3.

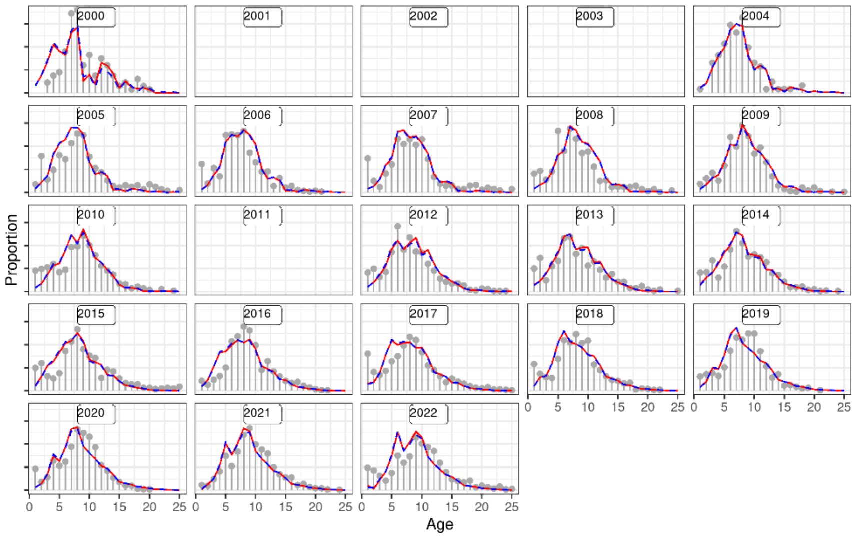


Figure 4: Greater silver smelt in 5a and 14. Comparison of fits to the autumn survey age-length distribution data implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Red lines indicate Gadget2, blue dashed lines indicate Gadget3.

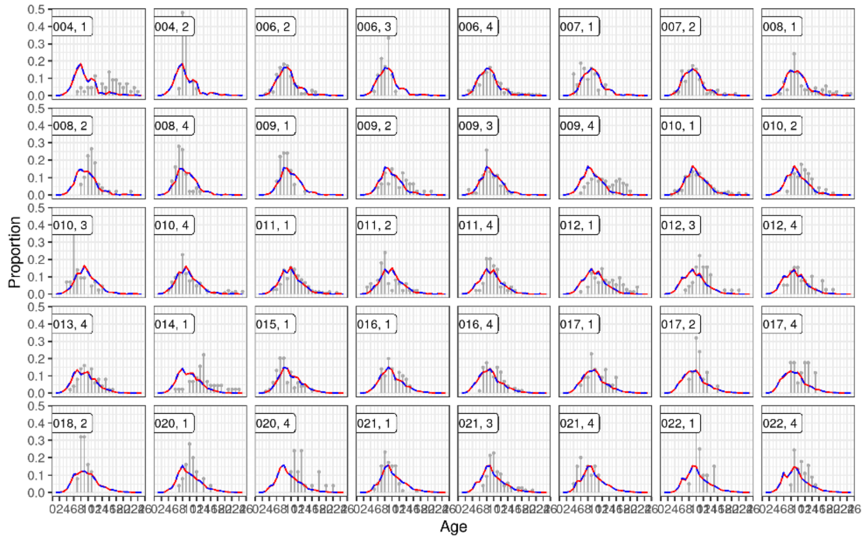
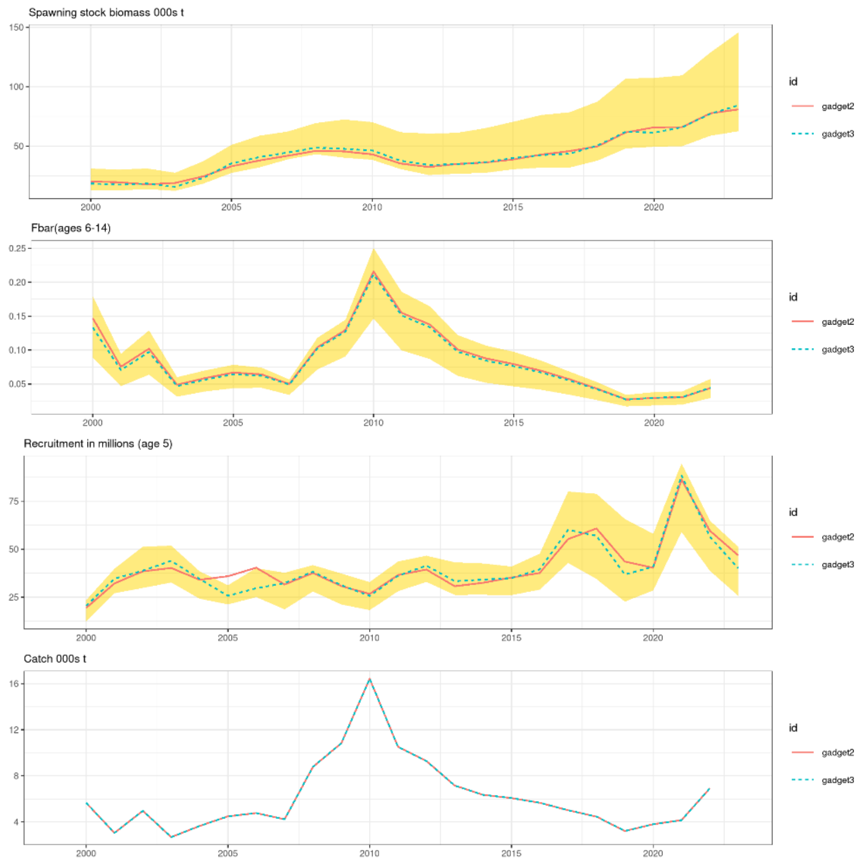


Figure 5: Greater silver smelt in 5a and 14. Comparison of fits to the commercial age-length distribution data implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Red lines indicate Gadget2, blue dashed lines indicate Gadget3.



\begin{figure}
\caption{Greater silver smelt in 5a and 14. Comparison of assesssment results when implemented using Gadget3, as done in this year's assessment, versus Gadget2 (implementation platform from previous years). Yellow bands indicate 90% confidence intervals based on a spatial bootstrap generated from the Gadget3 model.} \end{figure}

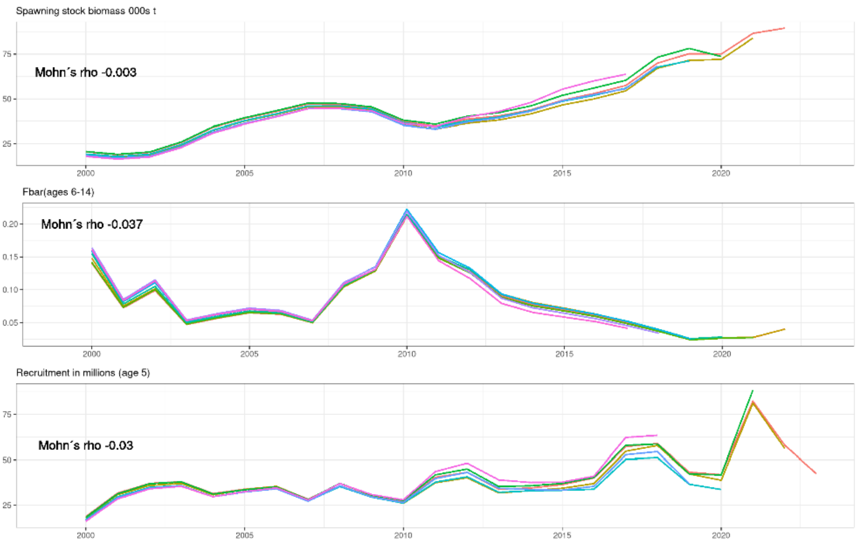
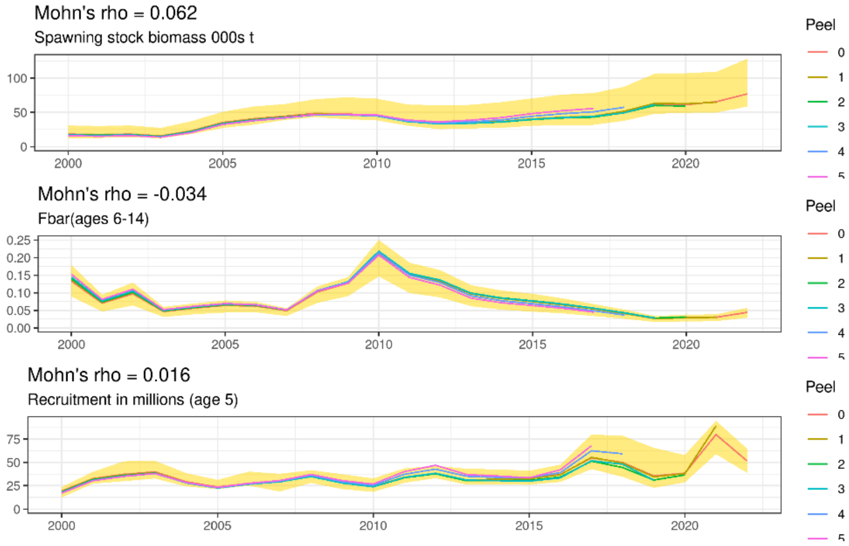


Figure 6: Greater silver smelt in 5a and 14. Analytical retrospective pattern resulting when implemented using Gadget2, implementation platform from previous years.



\begin{figure}
\caption{Greater silver smelt in 5a and 14. Analytical retrospective pattern resulting when implemented using Gadget3, as done in this year's assessment. Yellow bands indicate 90% confidence intervals based on a spatial bootstrap generated from the Gadget3 model.} \end{figure}

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Pagellus bogaraveo in Portuguese continental waters (ICES Division 27.9.a)

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1. Introduction

Pagellus bogaraveo (Brünnich, 1768), the blackspot seabream, distributes between southern Norway and Cape Blanc, in the Mediterranean Sea, and in the Azores, Madeira, and Canary Archipelagos (Desbrosses, 1932; Pinho and Menezes, 2005).

Spawning occurs in shallow waters, where juveniles of age groups 0 and 1 are reported to remain at depths lower than 170 m, close to the coast, in the Azores (Menezes et al., 2001), the Bay of Biscay (Lorance, 2011), and the Mediterranean Sea (Biagi et al., 1998; Félix-Hackradt et al., 2013). When juveniles reach 150–180 mm total length (TL), they migrate along the slope to depths deeper than 200 m, following an ontogenetic migration towards deeper waters (Olivier, 1928; Desbrosses, 1932; Morato et al., 2001; Spedicato et al., 2002). Nevertheless, fish with sizes larger than 40 cm have been occasionally caught in coastal waters (Priol, 1932).

The blackspot seabream is a protandric hermaphrodite – individuals are first functional males and then develop into functional females (Buxton and Garratt, 1990; Krug, 1990; Gil, 2006). In the Azores, the age of first maturity is about 8 years old for females (Krug, 1990). In Cadiz waters, the main spawning period occurs during the 1st quarter (Gil, 2010), whereas in the Azores spawning is from March to April (Martins *et al.*, 2007).

In the Northeast Atlantic, *P. bogaraveo*'s stock structure is still unknown. Genetic studies showed a restricted gene flow among the populations located in the Azores (ICES Division 27.10.a.2) and those on the Portuguese continental slope (ICES Division 27.9.a) and Madeira (CECAF FAO Division 34.1.2) (Stockley *et al.*, 2005; Pinera et al., 2013). Mitochondrial control region showed similar genetic diversity among sampling sites in the NE Atlantic and the Mediterranean, and no differentiation between the Azores and the remaining locations (Robalo et al., 2021). More recently, a genomic study using biological samples from different geographic areas supported the existence of three well-differentiated clusters in the Atlantic: (i) the Azores; (ii) Cadiz; and (iii) the continental Atlantic coast (Cunha et al., submitted). Those results confirmed that the Azorean population is isolated from the other populations and support the separation of the population occurring off Cadiz from the remaining Iberian area.

Despite the poor knowledge on the species stock structure, ICES adopts three management components for management purposes: (a) Subareas 27.6, 27.7, and 27.8; (b) Subarea 27.9; and (c) Subarea 27.10 (Azores) (ICES, 2007). These components were established to better record the available information and do not have implicit the existence of three different stocks of *P. bogaraveo*. There is no evidence of movements between the northernmost component and the southern part of Subarea 27.9 where a targeted fishery takes place in the Strait of Gibraltar (ICES, 2019).

The Spanish longline fishery operating in the Strait of Gibraltar has been managed as a regulated open-access fishery since its initial exploitation, in 1983 (Gil et al., 2019). In 2001, Moroccan longliners started a target fishery in the same area. Therefore, two directed fisheries are presently taking place in the Spanish and Moroccan Exclusive Economic Zone (EEZ) (ICES, 2017).

Total Allowable Catch (TAC), Portuguese quota, and official landings are presented for continental Portugal (ICES Division 27.9.a) for the period between 2014 and 2022 (Table 1).

Table 1. *Pagellus bogaraveo* Total Allowable Catch (TAC) and Portuguese quota and official landings in ICES Subarea 27.9, between 2014 and 2022.

Year	TAC EU ICES Subarea 27.9	Portugal quota ICES Subarea 27.9	Official Portuguese landings ICES Division 27.9.a
2014	780	166	59
2015	374	80	66
2016	183	39	70
2017	174	37	69
2018	165	35	58
2019	149	32	36
2020	149	32	43
2021	119	25	29
2022	119	25	32
2023	114	24	
2024	114	24	

1.1. Fishery in Portugal continental

In continental Portugal, *P. bogaraveo* is mainly caught as by-catch of fisheries targeting other species, although some vessels are licensed to target the species.

Fishery data and information collected through enquiries made to Peniche (Portuguese central western coast) skippers with experience on *P. bogaraveo* fishing has shown that: (i) the species tends to gather at specific fishing grounds with particular seamount-like topographic features, being mainly caught at depths around 250 m; (ii) the fishing grounds substrates are mainly composed by muddy sand, rock, and sand; (iii) the species length range is not different between the different fishing grounds. Some skippers additionally referred that, during winter, the species migrates, driven by environmental factors or biological conditions, such as reproduction (Araújo et al., 2016).

Information on blackspot seabream collected from 1990 to 2018 in the Portuguese Nephrops TV Surveys (PT-CTS (UWTV (FU 28-29))) and the Portuguese Autumn Groundfish Surveys (PT-GFS) conducted by the Portuguese Institute for the Sea and Atmosphere (IPMA) supports the hypothesis of a patchy distribution, as the species is more frequently caught at specific grounds (Farias and Figueiredo, 2019). It is important to note that the PT-CTS (UWTV (FU 28-29)) survey design is considered inadequate to estimate the species abundance or biomass, as the species distributes preferentially at non-trawlable areas.

2. Methodology

1.1. Fishery dependent data

1.1.1. Landings and mean price in continental Portugal

Portuguese landings in ICES Division 27.9.a were characterized. Fishery dependent data were collected from commercial landings for the period between 2009 and 2022.

Pagellus bogaraveo total landings in weight (ton) and value (euro) were analysed by year, fishing segment and NUTS (Nomenclature of Territorial Units for Statistics). The EU NUTS classification system (https://ec.europa.eu/eurostat/web/regions/background) is a regional system that divides each EU Member State's territorial area into units, providing a harmonised hierarchy between regions. Following the criteria adopted under this system, continental Portugal is divided into 5 different NUTS II (level 2), namely: North; Centre; Lisbon Metropolitan Area; Alentejo; and Algarve.

1.1.2. Landings and mean price by fleet and selected NUTS II

Pagellus bogaraveo total landings in weight (ton) and value (euro) were analysed throughout the year, between 2009 and 2022, by fishing segment (polyvalent and trawl), considering the NUTS II with the most representative landings of the species: North, Centre, and Algarve.

1.1.3. Landings in the most important Portuguese continental ports

Pagellus bogaraveo total landings in weight (ton) were analysed throughout the year, between 2009 and 2022, by fishing segment (polyvalent and trawl) for NUTS II landing ports with the highest landings of the species: Matosinhos port belongs to NUTS II North; Aveiro, Nazaré, and Peniche ports belong to NUTS II Centre; and Sagres belongs to NUTS II Algarve.

1.2. LPUE

1.2.1. Reference fleet

Reference fleets for the polyvalent and for the trawl fishing segments were defined for the most important landing port considering total landings and value of the species, Peniche. The criteria adopted for the selection of fishing vessels were defined according to the number of fishing trips with positive landings of the species and the number of months of the year with positive landings of the species, during the period between 2015 and 2022.

For the polyvalent fishing segment, the criteria adopted for the selection of fishing vessel were: more than 9 fishing trips per year and more than 6 months with positive landings of the species.

For the trawl fishing segment, the criteria adopted for the selection of fishing vessel where: more than 9 fishing trips per year and more than 5 months with positive landings of the species.

In 2023, vessels with low or null fishing trips with landings of the species in the period between 2019 and 2022 were excluded.

1.2.2. CPUE adjustment

For each selected vessel, data available at fishing trip level was further analysed. The landed weight of the species (in kg) per fishing trip corresponds to the total weight landed by the vessel after each trip. A trip is defined from the moment the vessel leaves the dock to when it returns to the dock.

The landed weight per fishing trip was considered as an indicator of biomass index, further referred as CPUE. Important to note that discards of the species are negligible in Portuguese continental fisheries.

CPUE data were standardized through the adjustment of generalized linear models (GLM). The model with the best adjustment was selected based on the AIC criterion and on the analysis of residuals.

1.3. Length distribution

Pagellus bogaraveo length sampling data available from the national Data Collection Framework (DCF) for the polyvalent and the trawl segments for continental Portugal were analysed by year in the period between 2014 and 2022. Numbers-at-length were raised to the total landings of the species.

1.4. LBI

Length-based indicators (LBI) screening methods were applied to *P. bogaraveo* length data for continental Portugal. The procedure followed the ICES Technical guidance for providing reference points for stocks in categories 3 and 4 (ICES, 2017b). The L_{mat} and L_{inf} estimates were adopted from Gil et al. (2009) and CopeMed II (2019), respectively. The length-weight relationship parameters ($W = 1.17542e\text{-}05 \times L^{3.0366}$) were estimated based on biological sampling data collected in 2020 and following the procedure in fishR Vignette (Ogle, 2013). Selected indicators, reference points, indicator ratios and their expected values are presented in Table 2 (ICES, 2017b).

Table 2. Selected indicators for LBI screening plots (ICES, 2017b).

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above L_{opt} + 10%	0.3–0.4	Pmega	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	> 1	Conservation (immatures)
L_c	Length at first catch (length at 50% of mode)	L_{mat}	L_c/L_{mat}	> 1	
L_{mean}	Mean length of individuals > L_c	$L_{opt} = {}^2/_3\ L_{inf}$	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{max_y}	Length class with maximum biomass in catch	$Lopt = {}^2/_3\ L_{inf}$	L_{maxy} / L_{opt}	≈1	

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
L_{mean}	Mean length of individuals > L_c	$L_{F=M}$ = $(0.75L_c+0.25L_{inf})$	$L_{mean} / L_{F=M}$	≥ 1	MSY

2. Results and discussion

2.1. Fishery dependent data

2.1.1. Landings and mean price in continental Portugal

In the period between 2009 and 2022, the species was landed in all five NUTS II of the Portuguese continental coast (Figure 1). Landing ports in central Portugal (NUTS II "Centro") showed the highest landings in weight followed by the Algarve (South Portugal), that was around four times lower, and the North (NUTS II "Norte") that was up to 8 times lower. Similar proportions were found between the NUTS in terms of value of the species (Figure 2).

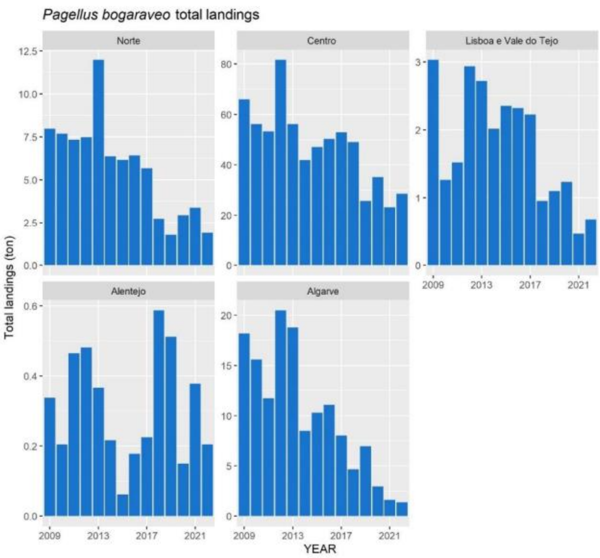

Figure 1. *Pagellus bogaraveo* total landings in tonnes in each NUTS II in continental Portugal between 2009 and 2022.

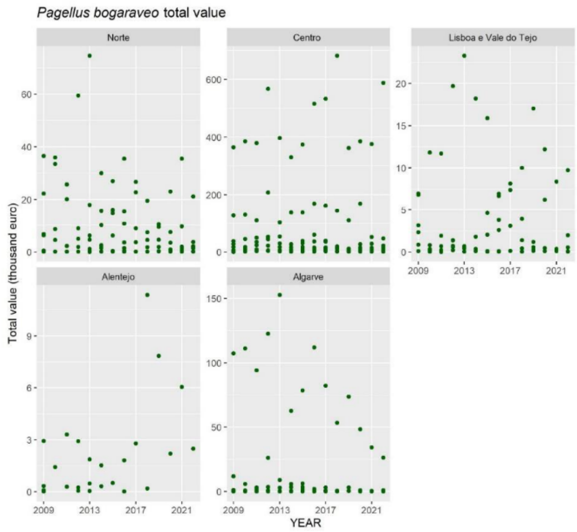

Figure 2. *Pagellus bogaraveo* total value in thousands of euros in each NUTS II in continental Portugal between 2009 and 2022.

In all NUTS II, the polyvalent fishing segment presented the highest landing values, followed by the trawl segment, with purse seine showing nearly negligible landings (Figure 3). These differences were more evident in central Portugal (NUTS II "Centro"), where the polyvalent represented around 60% of the species landings, the trawl segment represented nearly 40%, and the purse-seine fishery less than 1%.

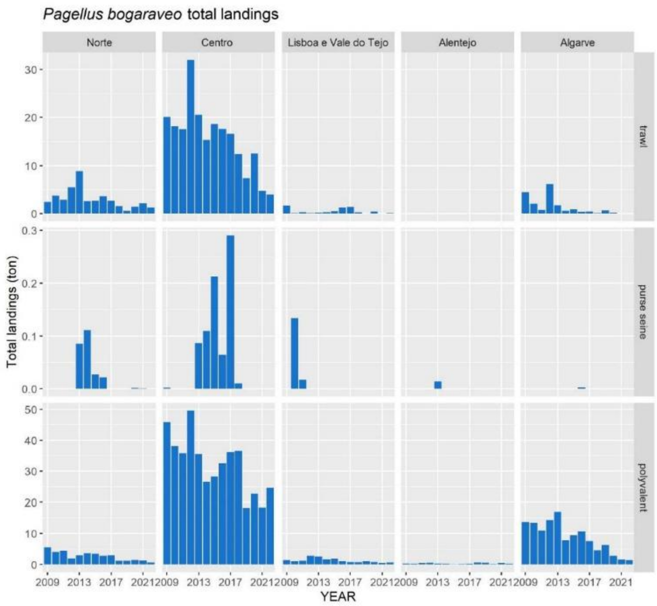

Figure 3. *Pagellus bogaraveo* total landings in tonnes by fishing segment (trawl, purse seine, and polyvalent) in each NUTS II in continental Portugal between 2009 and 2022.

The number of vessels landing *P. bogaraveo* was higher for the polyvalent fishing segment than for the trawl segment in all NUTS II (Figure 4). For the period between 2009 and 2022, a decreasing trend in the number of vessels landing the species was observed in the Centre, Lisbon area, and Algarve (NUTS II "Norte", "Lisboa e Vale do Tejo", and "Centro", respectively), which is probably associated with the continuous EU TAC reduction in Subarea 27.9 since 2004 (ICES, 2017a). However, the number of polyvalent and trawl vessels landing *P. bogaraveo* increased between 2019 and 2020, followed by a decrease in the subsequent years in the North (NUTS II "Norte") and Centre (NUTS II "Centro).

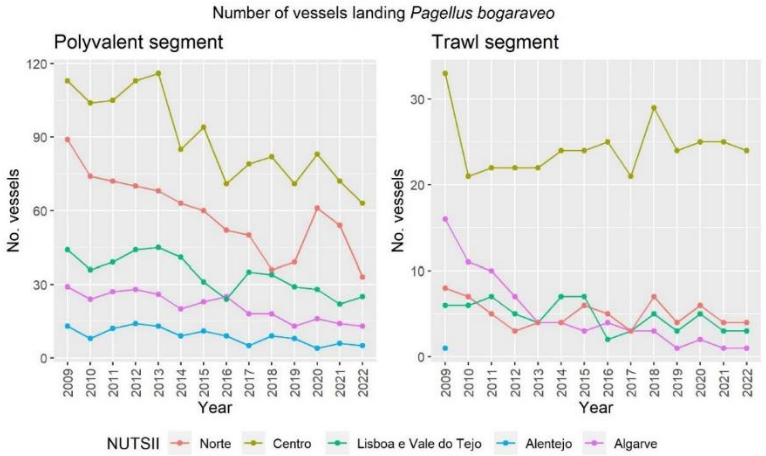

Figure 4. Number of vessels landing *Pagellus bogaraveo* in each NUTS II in continental Portugal, by year and by fishing segment (polyvalent and trawl), from 2009 to 2022.

2.1.2. Landings and mean price by fleet and selected NUTS II

Polyvalent fishing segment landings were higher in the winter months (late and early months of the year), more accentuated in the Centre region (NUTS II "Centro") (Figure 5). In the North (NUTS II "Norte") and Algarve, some years showed a peak in summer months but with little effect in terms of total landings when considering all the regions. From 2009 to 2022, there was a decreasing trend in the species landings in the three considered NUTS II, with the exception of the Centre region were the monthly landings increased between 2021 and 2022.

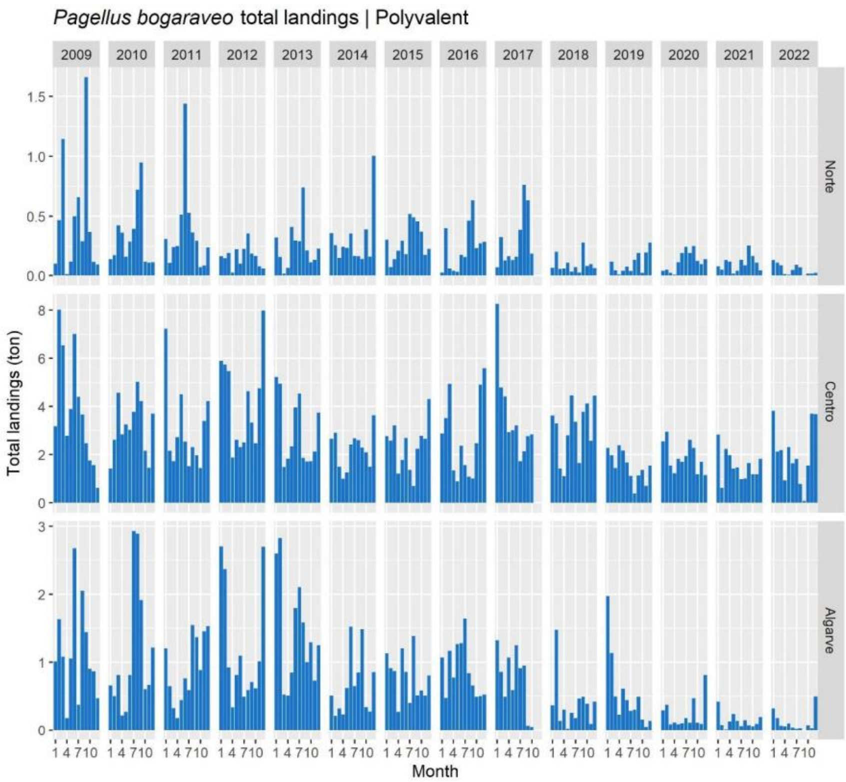

Figure 5. *Pagellus bogaraveo* landings (tons) from the polyvalent fleet by month and year at the three most important NUTS II in continental Portugal, from 2009 to 2022.

The trawl fishing segment shows a sharp decrease in total landings by month from 2012-2013 to 2022 (Figure 6). In the North (NUTS II "Norte") and in the Centre (NUTS II "Centro"), landings were higher at the beginning of the year. In the South (NUTS II "Algarve"), landings occurred mainly in the summer months, being nearly negligible between 2020 and 2022.

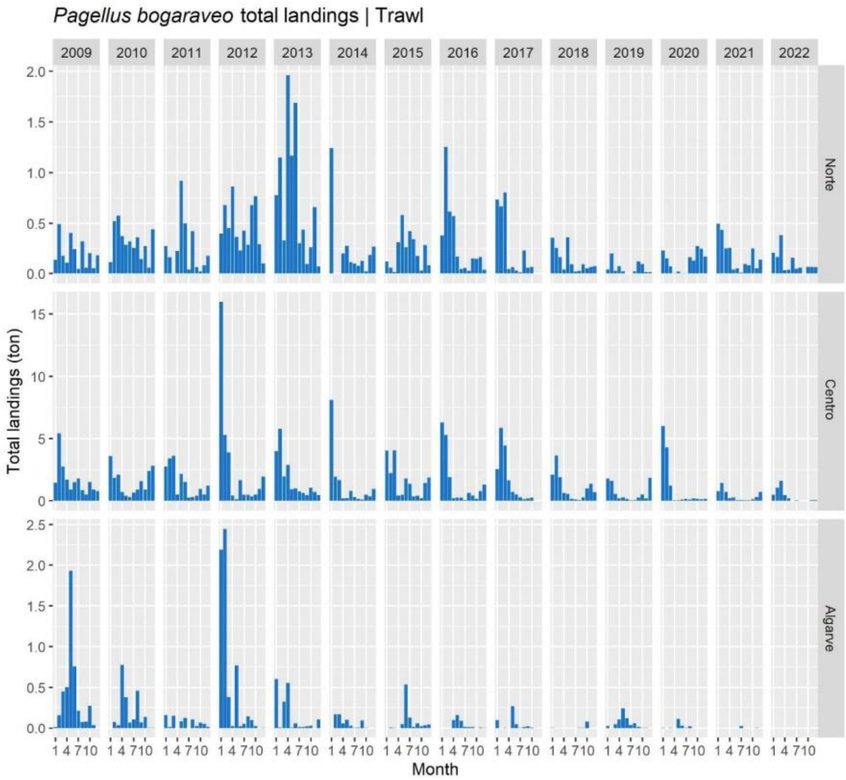

Figure 6. *Pagellus bogaraveo* landings (tons) from the trawl fleet by month and year at the three most important NUTS II in continental Portugal, from 2009 to 2021.

For the three main NUTS II, the mean price per Kg showed variations along the months of the year for the polyvalent fleet (Figure 7) and the trawl fleet (Figure 8), being those variations more noticeable in the polyvalent segment and in the last months of the year, since 2016.

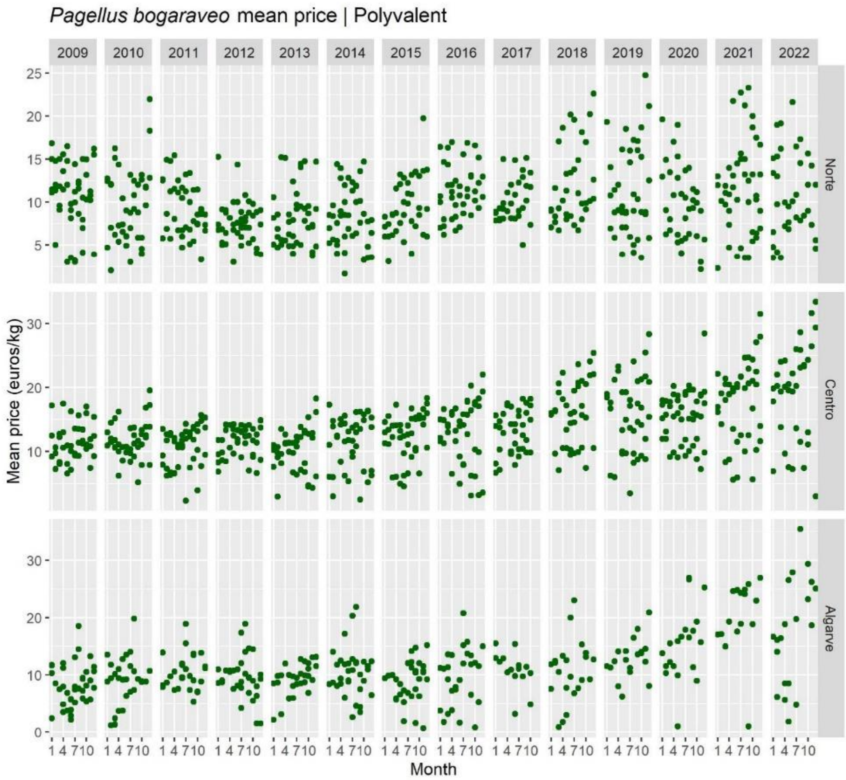

Figure 7. Mean price (in euro per Kg) of *Pagellus bogaraveo* landed by the polyvalent fishing segment by month and year for the three main NUTS II in continental Portugal between 2009 and 2022.

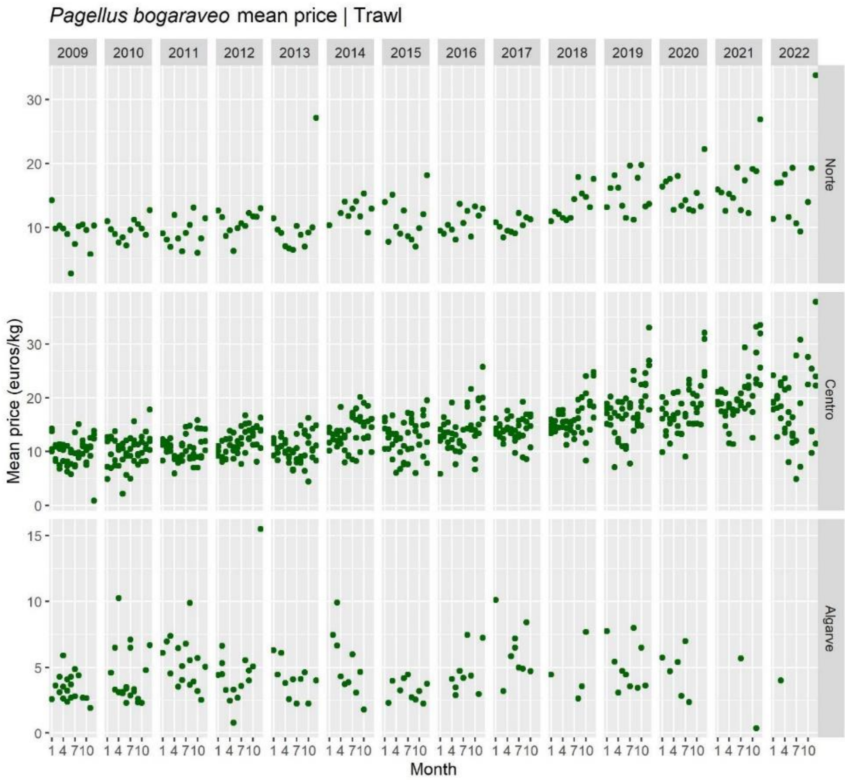

Figure 8. Mean price (in euro per Kg) of *Pagellus bogaraveo* landed by the trawl fishing segment by month and year for the three main NUTS II in continental Portugal between 2009 and 2022.

2.1.3. Landings in the most important Portuguese continental ports

P. bogaraveo landed weight by trip is presented in Figure 9 for the polyvalent segment and in Figure 10 for the trawl segment. Peniche port (Portuguese central western coast) was the most important landing port (landings between 2015 and 2022 represented nearly 50% of the Portuguese landings of the species in ICES Division 27.9.a) for both fishing segments. Extreme values were excluded from the plots for better visualization of data. In the later years, the highest landing values are registered between December and March for the polyvalent segment in Peniche.

P. bogaraveo total landings by most important ports and by fleet segment are summarised in Annex 1.

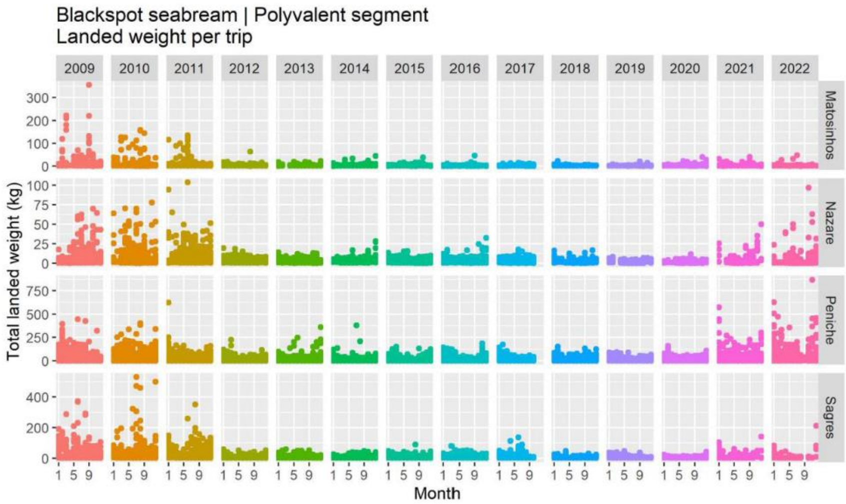

Figure 9. *Pagellus bogaraveo* total landed weight (kg) from the polyvalent fishing segment by month and year at the most important ports in Portugal continental, from 2009 to 2022.

Figure 10. *Pagellus bogaraveo* total landed weight (kg) from the trawl fishing segment by month and year at the most important ports in continental Portugal, from 2009 to 2022.

2.2. LPUE

2.2.1. Reference fleet

A total of 36 fishing vessels were selected for the polyvalent fleet landing in Peniche port and a total of 10 fishing vessels were selected for the trawl fleet landing in Peniche port.

2.2.2. CPUE adjustment

GLM was adjusted to annual log-CPUE estimations for Peniche's polyvalent reference fleet considering a normal distribution and the identity link function. The GLM estimates of the annual CPUE for Peniche's polyvalent reference fleet for the selected model are presented in Figure 11 and Table 3. CPUE for the polyvalent reference fleet has been stable throughout the considered time period, showing a slight decrease from 2018 to 2019 and an increasing trend from 2019 to 2022.

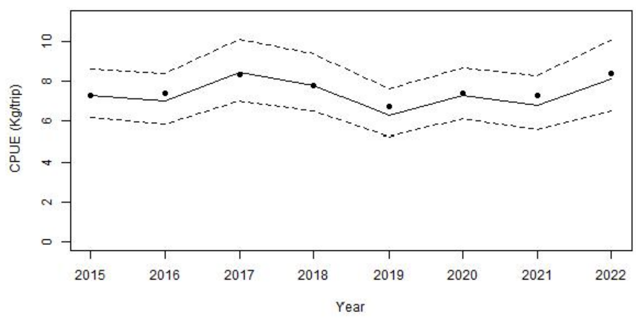

Figure 11. *Pagellus bogaraveo* standardized annual estimates of CPUE for Peniche polyvalent fishing segment reference fleet from 2015 to 2022.

Table 3. *Pagellus bogaraveo* CPUE series estimates for Peniche polyvalent reference fleet. 95% confidence interval.

Year	CPUE obs	CPUE pred.lower	CPUE pred	CPUE pred.upper
2015	7.31	6.18	7.31	8.65
2016	7.40	5.88	7.03	8.40
2017	8.34	7.03	8.44	10.12
2018	7.81	6.51	7.82	9.39
2019	6.71	5.23	6.33	7.65
2020	7.42	6.13	7.28	8.65
2021	7.28	5.61	6.82	8.29
2022	8.38	6.51	8.10	10.08

The analysis of the residuals of the fitted model is presented in Figure 12.

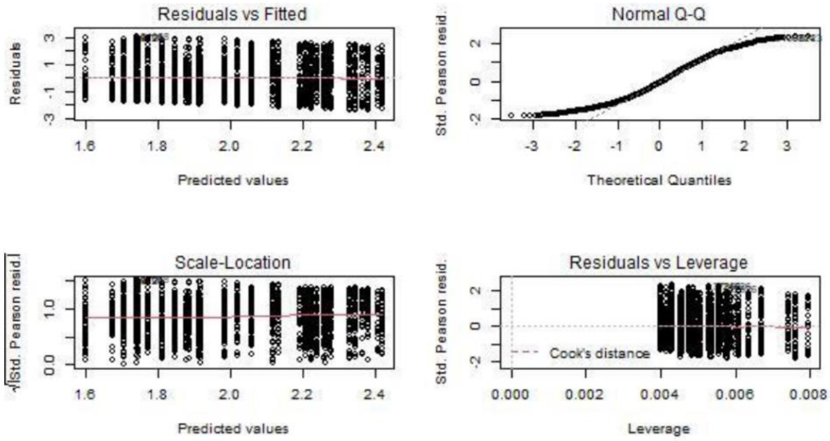

Figure 12. *Pagellus bogaraveo* analysis of the residuals of standardized annual estimates of CPUE for Peniche polyvalent fishing segment reference fleet from 2015 to 2022.

GLM was adjusted to annual log-CPUE estimations for Peniche's trawl reference fleet considering a normal distribution and the identity link function. The model was selected based on AIC and analysis of the residuals. The GLM estimates of the annual CPUE for Peniche's trawl reference fleet for the selected model are presented in Figure 13 and Table 4. CPUE for the trawl reference fleet showed a decreasing trend until 2019, followed by an increasing in that year, and has been stable since 2021.

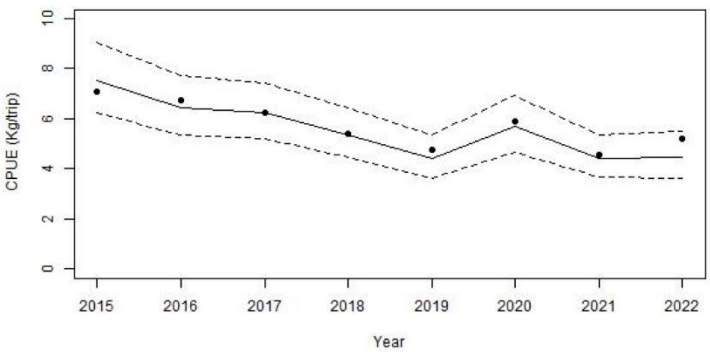

Figure 13. *Pagellus bogaraveo* standardized annual estimates of CPUE for Peniche trawl fishing segment reference fleet from 2015 to 2022.

Table 4. *Pagellus bogaraveo* CPUE series estimates for Peniche trawl reference fleet. 95% confidence interval.

Year	CPUE obs	CPUE pred. lower	CPUE pred	CPUE pred. upper
2015	7.06	6.22	7.51	9.06
2016	6.70	5.32	6.41	7.73
2017	6.21	5.19	6.21	7.43
2018	5.40	4.43	5.35	6.45
2019	4.74	3.59	4.38	5.35
2020	5.87	4.63	5.66	6.92
2021	4.57	3.64	4.40	5.33
2022	5.21	3.63	4.45	5.47

The analysis of the residuals of the fitted model is presented in Figure 14.

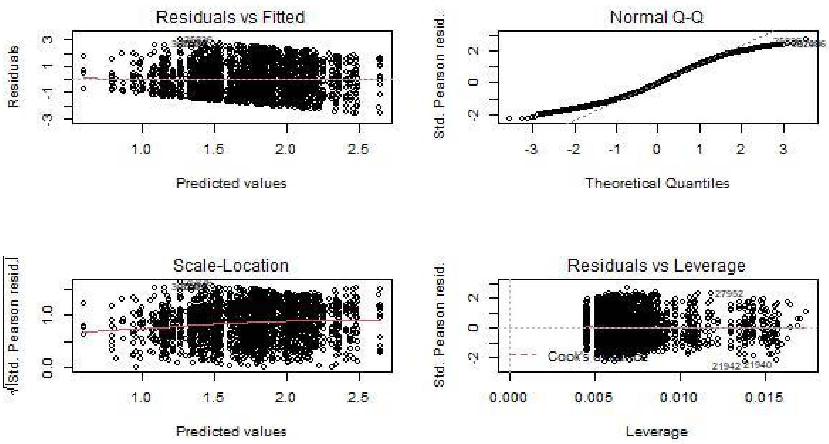

Figure 14. *Pagellus bogaraveo* analysis of the residuals of standardized annual estimates of CPUE for Peniche trawl fishing segment reference fleet from 2015 to 2022.

2.3. Length distribution

P. bogaraveo length distributions were extrapolated from DCF length sampling data available for the polyvalent (Figure 15) and the trawl (Figure 16) fishery segments for Portugal continental by year in the period between 2014 and 2022. The smaller sizes are poorly represented probably because the minimum landing size of *P. bogaraveo* is 33 cm and the discards of specimens bellow that size are negligible given that the species shows a very high survival rate (Serra-Pereira et al., 2019). In 2020, only 4 samples were measured from the polyvalent segment, which corresponded to 72 specimens, and only 4 samples from the trawl segment, which included 52 specimens (Farias and Figueiredo, 2021).

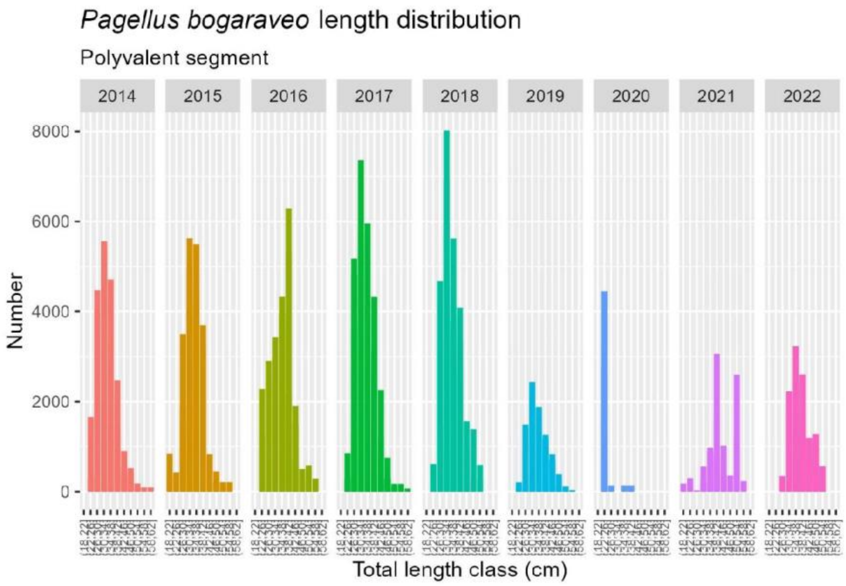

Figure 15. *Pagellus bogaraveo* extrapolated length frequency distributions for the polyvalent fishing segment for the years between 2014 and 2022. (4 cm total length classes)

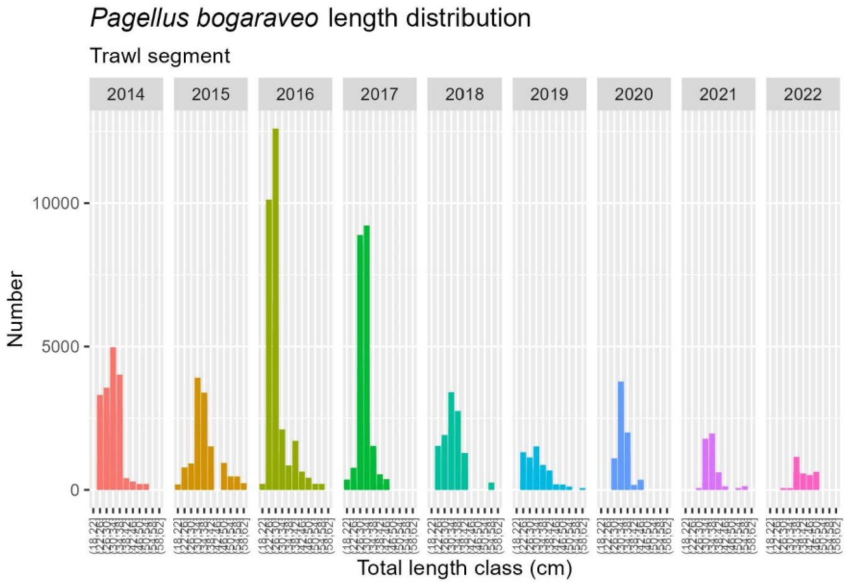

Figure 16. *Pagellus bogaraveo* extrapolated length frequency distributions for the trawl fishing segment for the years between 2014 and 2022. (4 cm total length classes)

Differences in length distribution between the polyvalent segment and the trawl segment result from the fact that polyvalent vessels operate in areas farther from the coast and at higher depths, where larger fish are more common (Farias et al., 2018).

2.4. LBI

Results from the LBI screening method are shown in Tables 5 and 6 and Figures 17 and 18.

Table 5. *Pagellus bogaraveo* in ICES Division 27.9.a. Results from LBI screening.

Year	L_{75}	L_{25}	L_{med}	L_{90}	L_{95}	L_{mean}	L_c	$L_{F=M}$	L_{maxy}	L_{mat}	L_{opt}	L_{inf}	$L_{max5\%}$
2014	36	29	33	39	42	33.39	26	35.00	34	35.1	41.33	62	46.88
2015	38	32	35	41	45	36.50	30	38.00	36	35.1	41.33	62	52.09
2016	38	27	31	42	45	33.52	26	35.00	40	35.1	41.33	62	49.58
2017	36	30	32	40	43	34.95	30	38.00	31	35.1	41.33	62	46.15
2018	38	31	34	41	44	35.78	30	38.00	37	35.1	41.33	62	47.60
2019	39	31	34	43	46	35.28	26	35.00	38	35.1	41.33	62	49.03
2020	34	25	32	37	38	33.35	26	35.00	34	35.1	41.33	62	41.42
2021	43	36	39	52	54	40.29	22	32.00	52	35.1	41.33	62	54.53
2022	43	35	38	47	49	40.60	34	41.00	38	35.1	41.33	62	50.01

All LBI estimates increased between 2020 and 2021, except L_c and $L_{F=M}$, which increased between 2021 and 2022 (Table 5).

Table 6. *Pagellus bogaraveo* in ICES Division 27.9.a. LBI screening ratios.

		Conservation						Optimizing Yield	MSY
		L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{95\%}/L_{inf}$	L_{maxy}/L_{opt}	$L_{max5\%}/L_{inf}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
Year	Ref.	> 1	> 1	> 0.8	≈ 1	> 0.8	>30%	≈ 1 (>0.9)	≥ 1
2014		0.74	0.83	0.68	0.82	0.76	3%	0.81	0.95
2015		0.85	0.91	0.73	0.87	0.84	5%	0.88	1.04
2016		0.74	0.77	0.73	0.97	0.80	5%	0.81	0.96
2017		0.85	0.85	0.69	0.75	0.74	2%	0.85	1.00
2018		0.85	0.88	0.71	0.90	0.77	4%	0.87	1.02
2019		0.74	0.88	0.74	0.92	0.79	6%	0.85	1.01
2020		0.74	0.71	0.61	0.82	0.67	0%	0.81	0.95
2021		0.63	1.03	0.87	1.26	0.88	20%	0.97	1.15
2022		0.97	1.00	0.79	0.92	0.81	16%	0.98	1.16

Most ratio estimates of conservation increased in 2021 in relation to previous years and remained close to the reference values in 2022, including the L_c/L_{mat} which increased had been at lower levels (Table 6). The Optimizing Yield indicator ratio increased between 2020 and 2021 and remained at the same level in 2022, which indicates that the stock is being fished at levels close to optimum yield. The indicator for MSY ($L_{mean}/L_{F=M}$) was above the reference value in most of the years of the series, including 2020 and 2021, being consistent with an adequate exploitation.

The values estimated for the conservation ratios results might reflect some of EU size measures, such as the adopted minimum landing size (MLS). L_c/L_{mat} and $L_{25\%}/L_{mat}$ low estimates might be related with the fact that the L_{mat} of females, which is above the MLS, was assumed in the screening since *P. bogaraveo* is a protandric hermaphrodite.

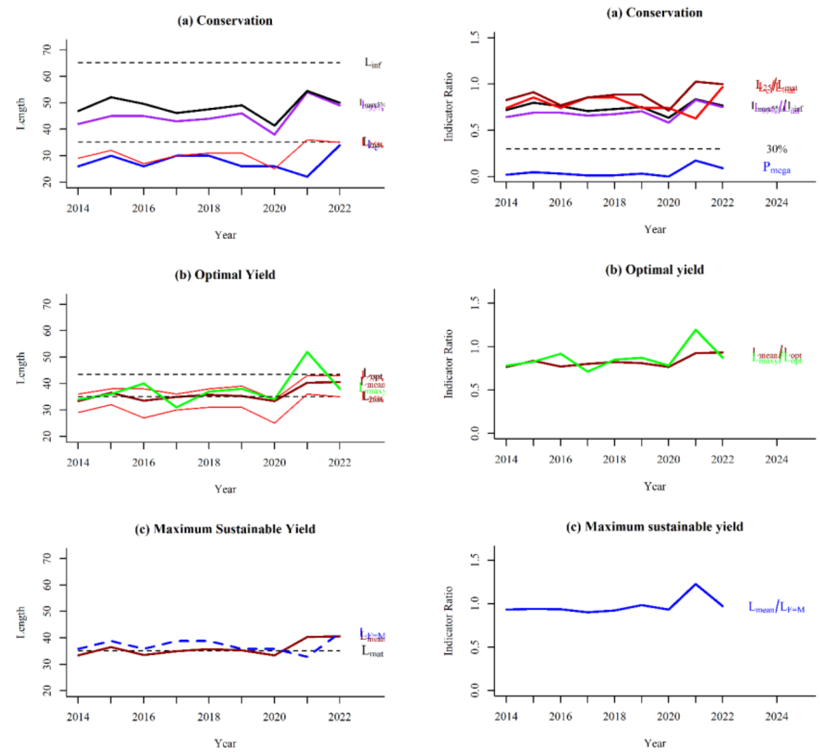

Figure 17. *Pagellus bogaraveo* in ICES Division 27.9.a. Results from LBI screening (left) and LBI screening ratios (left).

Time-series plots show that most of the indicators had low variability between 2014 and 2022.

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ANNEX I

Table 7. *Pagellus bogaraveo* total landed weight (ton) by fleet segment in the six most important landing ports for the species. Ports are organized by NUTS II between 2009 and 2022.

		North			Centre				Lisbon Metrop. Area	Algarve	
Year	Gear	Matosinhos	Povoa do Varzim	Viana do Castelo	Aveiro	Figueira da Foz	Nazare	Peniche	Sesimbra	Sagres	Portimao
2009	Polyvalent	4.24	0.66	0.5734	0.06	0.43	3.42	41.98	0.59	13.47	0.05
	Trawl	2.43	-	-	1.43	0.64	2.69	15.32	1.55	-	4.32
2010	Polyvalent	2.64	0.45	0.8427	0.09	0.50	3.83	33.65	0.91	13.33	0.05
	Trawl	3.73	-	-	1.12	1.05	1.47	14.50	0.05	0.00	1.90
2011	Polyvalent	2.27	0.34	1.8148	0.52	0.20	3.92	31.09	0.97	10.63	0.20
	Trawl	2.90	-	-	3.03	0.79	2.32	11.43	0.32	-	0.74
2012	Polyvalent	1.03	0.29	0.5313	0.53	0.24	3.99	44.85	2.18	13.88	0.05
	Trawl	5.56	-	-	3.63	1.80	5.33	21.29	0.09	-	6.14
2013	Polyvalent	1.55	0.52	0.6831	0.74	0.10	2.60	32.05	2.21	16.70	0.03
	Trawl	8.91	-	-	4.79	1.51	3.34	10.89	0.18	-	1.73
2014	Polyvalent	1.05	0.35	1.9169	0.36	0.02	1.80	24.36	1.55	6.89	0.41
	Trawl	2.62	-	-	1.09	0.48	1.11	12.61	0.31	-	0.62
2015	Polyvalent	1.32	0.80	1.3293	0.55	0.06	2.82	24.88	1.46	8.65	0.07
	Trawl	2.70	-	-	1.99	0.93	1.38	14.30	0.51	-	0.90
2016	Polyvalent	0.86	0.35	1.3854	0.34	0.09	2.28	29.87	0.49	10.45	0.02
	Trawl	3.62	-	-	3.68	0.70	0.95	12.26	1.26	-	0.40
2017	Polyvalent	1.73	0.43	0.775	0.55	0.09	2.43	33.04	0.58	7.35	-
	Trawl	2.71	-	-	2.78	1.12	0.57	12.09	1.41	-	0.46
2018	Polyvalent	0.54	0.19	0.4024	0.20	0.02	1.02	35.40	0.52	4.50	0.00
	Trawl	1.58	-	-	1.07	1.10	0.60	9.66	0.28	-	0.09
2019	Polyvalent	0.49	0.23	0.3601	0.31	0.03	0.49	17.35	0.95	6.25	-
	Trawl	0.63	-	-	0.58	0.44	0.35	6.08	0.02	-	0.66
2020	Polyvalent	0.90	0.14	0.3199	1.37	0.04	0.53	20.72	0.73	2.60	0.10
	Trawl	1.46	-	-	1.51	0.40	0.12	10.54	0.46	-	0.17
2021	Polyvalent	0.62	0.15	0.11	0.48	0.03	0.56	17.33	0.42	1.57	-
	Trawl	2.15	-	-	0.68	1.21	0.61	2.28	0.02	-	0.02
2022	Polyvalent	0.28	0.18	0.10	0.44	0.01	1.02	23.15	0.55	1.18	0.00
	Trawl	1.29	-	-	0.67	0.73	0.59	1.99	0.09	-	0.00

Working Document for the ICES Working Group on Biology and Assessment of Deep-Sea Fisheries Resources

Lisbon, 03rd - 09th May 2023

Scabbard fish in the Madeira archipelago (CECAF 34.1.2)

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Abstract

This working document updates the information existing from the previous WGDEEP meeting of 2022 for the *Aphanopus* spp. in CECAF fishing area 34. Mainly an update on the time-series of annual Portuguese landings (by vessel segment), length distributions and unstandardized CPUE at CECAF area. A standardized biomass index series based on daily landings of commercial horizontal mid-water drifting longline fishery in Madeira was also updated with data from 2022.

1. INTRODUCTION

The fishery for deep-water species carried out in the Madeira EEZ and international adjacent waters (CECAF 34.1.2. area), dates back to the 17th century (Merrett and Haedrich, 1997) and for several decades this was the only fishery targeting scabbard fish in the Northeast Atlantic (Bordalo-Machado and Figueiredo, 2009). This fishery as an important and irreplaceable economic and social value in the Madeira fisheries sector. In Madeira, exploited deep-water fish stocks are overwhelmingly dominated by two scabbard fish species: *Aphanopus carbo* Lowe 1839 and *Aphanopus intermedius* Parin, 1983, which represent about half of the overall landings throughout the year (Delgado et al., 2013, 2018; Hermida and Delgado, 2016). This deep-sea fishery targeting the black and intermediate scabbard fish, off the Madeira archipelago, is recognized as an artisanal and selective activity targeting predominantly adult individuals and presenting a low rate of bycatch (Severino et al., 2009).

Both scabbard fish species occur at a wide depth range, from 200 m in the northern part of the NE Atlantic (Nakamura and Parin, 1993) to 2300 m off the Canary Islands (Pajuelo et al., 2008) for *A. carbo*, although more frequent at 800-1300 m in Madeira (Morales-Nin and Sena-Carvalho, 1996) and to 1350 m for *A. intermedius* (Delgado et al., 2013). *Aphanopus carbo* and *A. intermedius* seem to be adapted to a strong activity of migrating upwards at night to feed on crustaceans, cephalopods, and fishes (Tuset et al., 2010). Furthermore, these two sympatric species move to reproduction areas off Macaronesian archipelagos (i.e., Madeira and the Canary

Islands) and the northwest coast of Africa (Figueiredo et al., 2003; Pajuelo et al., 2008; Perera 2008; Farias et al., 2013). The spawning season of both *Aphanopus* species has been reported to take place from October to December (Figueiredo et al., 2003; Delgado et al., 2013).

The black and intermediate scabbard fish fishery represents one of the most profitable commercial activities on small-scale fisheries in Madeira archipelago. In 2022, the commercial landings in weight of *Aphanopus* spp. reached annual catches of up to 2259 tonnes yielding a total first sale value of approximately 7.5 M€.

WGDEEP does not assess fisheries in Madeira (Eastern Central Atlantic area, CECAF) or in other areas outside the ICES area. Nonetheless, it is admitted that the incorporation of reliable CECAF data could provide a wider perception of the stock dynamics of these migratory species in the northeast Atlantic.

1.1. Fishery in Madeira

In compliance with the Multiannual Union Programme for Data Collection (EU-MAP), the Madeira fishing fleet targeting the deep-water species, *A. carbo* and *A. intermedius*, uses a specialized fishing gear with longlines (LLD_DWF_0_0_0). The fishing gear is a mid-water horizontal drifting longline, set in the water column usually at depths of between 800 and 1300 m (Figure 1).

The fishing gear used to catch the scabbardfishes is a drifting longline always set at least more than 100 m above the bottom of the sea. This is an important aspect of the fishery as, in normal circumstances, the gear does not contact the sea floor thus is not a menace to hypothetical Vulnerable Marine Ecosystems (VME).

This fishery is known by its highly selective nature, concerning the bycatches of non-target species and the length structure of the catches of the targeted species – constituted almost exclusively by adult specimens over 90 cm total length. The catches of sub adult individuals scarcely achieve around 0.5% of the total number of individuals captured.

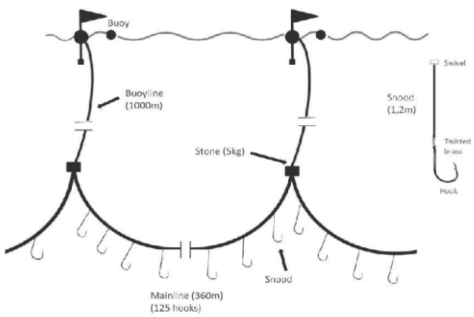

Figure 1 – Mid-water horizontal drifting longline used by the Madeira fishing fleet.

There is a combination of prevailing factors that result in a fishery with such unique features. Such factors are the geographical area of the fishery, where, according to the migratory model proposed by Farias et al. (2013), only adult specimens are available to this type of fishery and the highly selective nature of the fishing methodology itself, namely the fact that the passive fishing gear is operated strictly within a depth layer of the water column, between 800 and 1300 meters deep, without being anchored, and always well above the seafloor. The gear aims to catch the black scabbard fish in its daily vertical migration to feed, thus minimizing the probability of capture of benthic bycatch species.

This fishery, carried out by the fishing vessels targeting the black and intermediate scabbard fish registered in Madeira, which was traditionally performed mostly around the islands of Madeira and Porto Santo and the seamounts inside the Madeira EEZ, has undergone considerable geographic expansion in recent decades in the Northeast Atlantic, mostly from 2005 onwards, and initiated a process of expansion looking for new fishing areas (Figure 2). Progressively, new fishing grounds located in international waters SE of the Azores, off the Canaries and the "rediscovery" of the seamounts within the Madeira EEZ became indispensable for this fishery and bilateral agreements with the Azores and the Canaries were made to allow the fleet access to those areas.

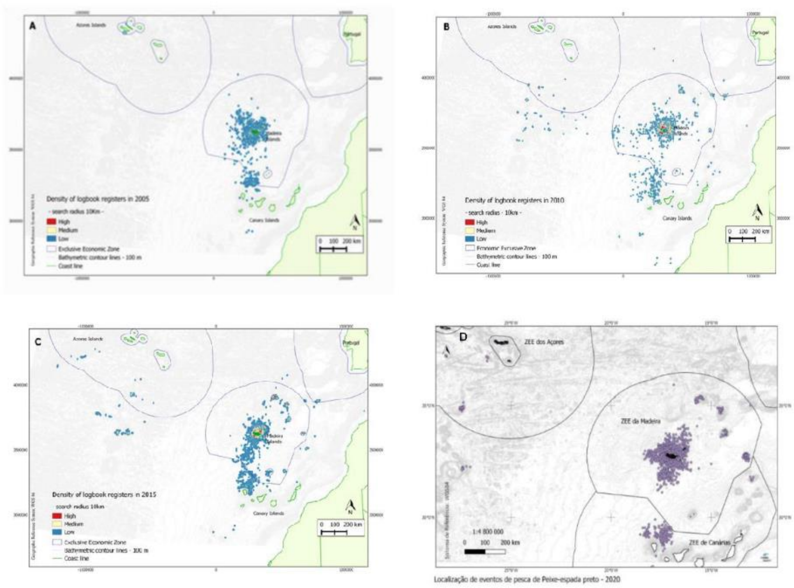

Figure 2 - Density plots illustrating the geographical distribution of the fishing sets with catches in 2005 (A), 2010 (B), 2015 (C) and 2020 (D): density maps estimated with the software Quantum GIS 2.2, module "heatmap" covering a search radius of 10 Km (Regional Directorate of the Sea - Madeira).

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 and intermediate scabbard fish have moved to new fishing grounds, some of them located outside the EEZ of Madeira (SE of the Azores and off the NW of the Canaries) (Figure 2).

From 2019 to the present, most of fishery targeting the black and intermediate scabbard fish have been carried out within the Madeira EEZ. However, the fishing grounds off the Northwest of Canaries continues to be a relevant fishing area for the Madeira fishing fleet, due to the availability of black and intermediate scabbard fish and the lack of interest in these species by the Canary fishing fleet, which makes profitability the capture of them by the fishing fleet from Madeira. The capture of *Aphanopus* spp. in the Azores fishing grounds by the fishing fleet from Madeira has been decreasing since 2015. According to the fishermen fishing in Azores is not profitable due to the distance between Madeira and Azores.

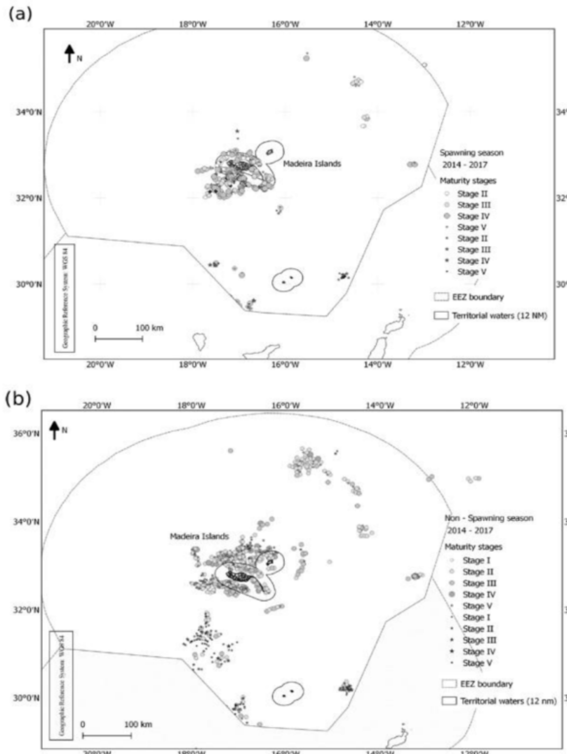

Figure 3 - Map showing both *Aphanopus* species distribution, *A. carbo* (grey circles) and *A. intermedius* (grey stars), during spawning (a) and non-spawning (b) seasons according to the distance from the coast (<12 and >12 nautical miles; 1 n.m. = 1.852 km) (Vasconcelos et al., 2020).

The enlargement of the maritime area covered by the fishing operations was prompted by the decrease of the abundance of the resource in the traditional fishing grounds, near the islands of Madeira and Porto Santo. And also due to the improvement of the fishing fleet of Madeira verified in the last years. This search for new fishing grounds was driven by the need to stabilise catches that suffered a severe decline from 2000 onwards. A relative stabilisation of the fishery was achieved in the last years but the enormous increase in the costs led several vessels to leave the activity.

Though, most of the *Aphanopus* spp. fishery still remains concentrated off the islands of Madeira and Porto Santo, especially during the spawning season from October to December, mainly the fishery operated by the small vessels (< 12 m). Migrations to areas less than 12 n.m. from the coast, were observed for *A. carbo* throughout the spawning season (Figure 3) (interannual database from 2014-2017; Vasconcelos et al., 2020). The mature stages IV and V were the ones that overwhelmingly dominated this migration pattern to shallower areas. This migration of mature adults towards areas near the coast, especially during spawning, occurs simultaneously with a noticeable increase of the proportion of fishing events inside the EEZ (<12 n.m.), making them more susceptible to mid-water drifting longline fishery (Vasconcelos et al., 2020).

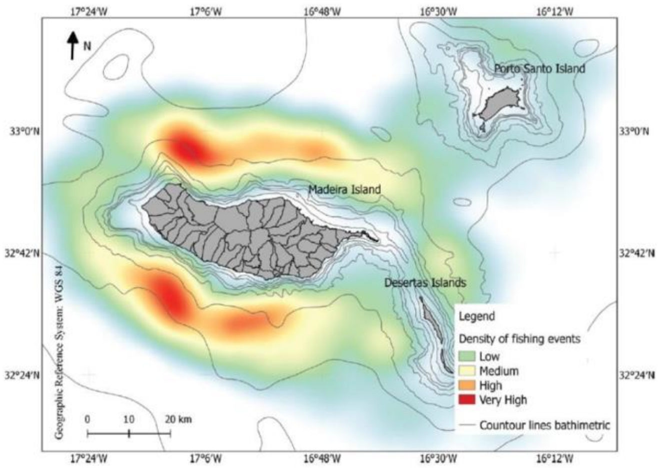

Figure 4 - Kernel density estimation plot showing the mean density values of the fishing events during the spawning season per compartment of 10 km × 10 km generated for the study area and for the period 2014–2017. Low: 1–10; Medium: 11–20; High: 21–30; and Very High: >31 fishing events (Vasconcelos et al., 2020).

There are three main aggregation areas identified off Madeira (Figure 4), where fishing events occurs during spawning, mainly the fishing grounds from Câmara de Lobos and Ribeira Brava at the south coast of Madeira and Porto do Moniz-Seixal at the north coast (Vasconcelos et al., 2020). The fishing grounds are located at an average distance of 2 to 4 n.m. offshore, although the same depths are found over a wider range of 3 to 6 n.m. offshore (Vasconcelos et al., 2020). Most likely, these areas correspond to areas with environmental and sea bottom topography that favour reproduction, as these areas generally correspond to canyons where there are prominent folds in the bathymetry towards the coast and its nearby steep slopes. These represent very closed geological formations with the dimension of extensive canyons, probably protected from strong currents and where high densities of spawning individuals aggregate, facilitating high probability of successful external fertilization (Vasconcelos et al., 2020).

2. METHODS

2.1. Fishery dependent data

2.1.1. Landings and mean price in Madeira archipelago

Portuguese total landings of *Aphanopus* spp. in CECAF area 34 (in weight, ton, and value, euro) were analysed by year. Fishery dependent data were collected from commercial landings for the period between 1990 and 2022.

2.1.2. Landings and mean price in Madeira archipelago by vessel length category

Portuguese landings of *Aphanopus* spp. in CECAF area 34 (in weight, tonnes, and value, euro) were analysed by year and by fishing vessel segment (vessel length category). Fishery dependent data were collected from commercial landings for the period between 2008 and 2022. The active fishing fleet at CECAF area is grouped into the following categories: VL0010 (vessel size less than 10 m), VL1012 (vessel size between 10 and 11.99 m), VL1218 (vessel size between 12 and 17.99 m) and VL1824 (vessel size between 18 and 23.99 m).

2.2. Length distribution

Aphanopus spp. length sampling data available for Madeira were analysed considering both species combined by year for the period between 2009 and 2022. Numbers-at-length were raised to the total landings.

2.3. CPUE

All landings from the commercial mid-water drifting longline fishery at all the fishing ports of Madeira (mainly port of Funchal), in the Northeast Atlantic (32°00′–33°30′N, 15°30′–18°00′W) were considered for this analysis, during the period between 2008 and 2022. From each fishing trip data on total weight landed of the species (in kg), vessel name and corresponding length category, engine power (KW), number of days at sea, number of fishing days and fishing operations, and the total number of hooks were examined. A trip was defined from the moment the vessel leaves the dock to when it gets back to the dock.

The standardized CPUE model based on daily landings of commercial mid-water horizontal drifting longline fishery in Madeira was updated with data from 2022.

3. RESULTS AND DISCUSSION

3.1. Fishery dependent data

3.1.1. Landings and mean price in Madeira archipelago

The annual landings of black and intermediate scabbard fish derived from Madeiran mid-water longliners for the period between 1990 and 2022 are presented in Figure 5.

Catches in CECAF 34 area were updated with fishery data from Madeiran mid-water longliners landings from 1990 to 2022. These catches are recorded by the Regional Fisheries Department of Madeira (Figure 5). CECAF catches have been decreasing after the 1998 peak, but an increase was observed from 2012 onwards. Between 2020 and 2021 a decrease was observed mainly due to the reduction in fishing days caused by the COVID-19 pandemic. In 2022, an increase of 386 tonnes was observed when comparing with 2021.

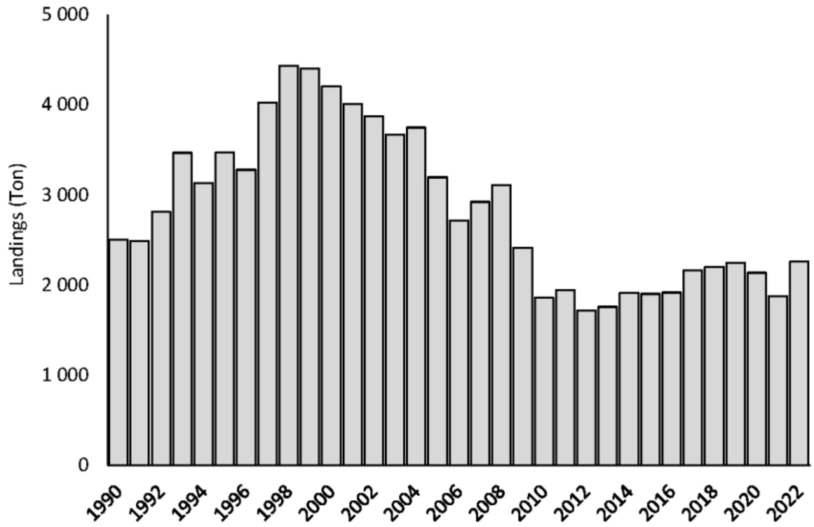

Figure 5 - Time-series of annual Portuguese landings of *Aphanopus* spp. at CECAF area (1990-2022).

The EU TAC and total catches for CECAF 34 area from 2005 to 2022 are presented in Table 1. It was observed a relevant decrease in the EU TAC for the *Aphanopus* spp. fishery in CECAF 34.1.2, from 4285 tons in 2005 to 2259 tons in 2022.

Table 1 - Black scabbard fish TACs and total landings in CECAF area 34, between 2010 and 2022, for both species (*Aphanopus carbo* and *Aphanopus intermedius*).

Year	EU TAC CECAF 34.1.2 area	Landings CECAF 34.1.2. Area
2005	4 285	3 195
2006	4 285	2 717
2007	4 285	2 922
2008	4 285	3 109
2009	4 285	2 413
2010	4 285	1 860
2011	4 071	1 941
2012	3 867	1 716
2013	3 674	1 758
2014	3 490	1 913
2015	3 141	1 902
2016	2 827	1 917
2017	2 488	2 163
2018	2 189	2 199
2019	2 189	2 246
2020	2 189	2 136
2021	2 189	1873
2022	2 189	2259

Following the methodology adopted at WGDEEP 2016 (ICES, 2016), standardised annual catch estimates for the period from 1990 to 2022 of the nineteen fishing 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 DSEIMar/DRM database (Figure 6).

The results do not support that given the diversity of species, which includes different taxonomic groups, lifestyles and both short- and long-lived organisms, the declining trends are reflecting changes on resources abundance which may imply that Madeiran waters are subject to severe over-exploitation. Further studies and a careful interpretation of trend variations of some resources are still required. It may happen that in some cases landing trends are not only related to the resources' abundance in Madeiran waters, but subject to other factors like variations on the market regulation (e.g. small pelagic fishery), environmental, application of TAC's and quotas, among others.

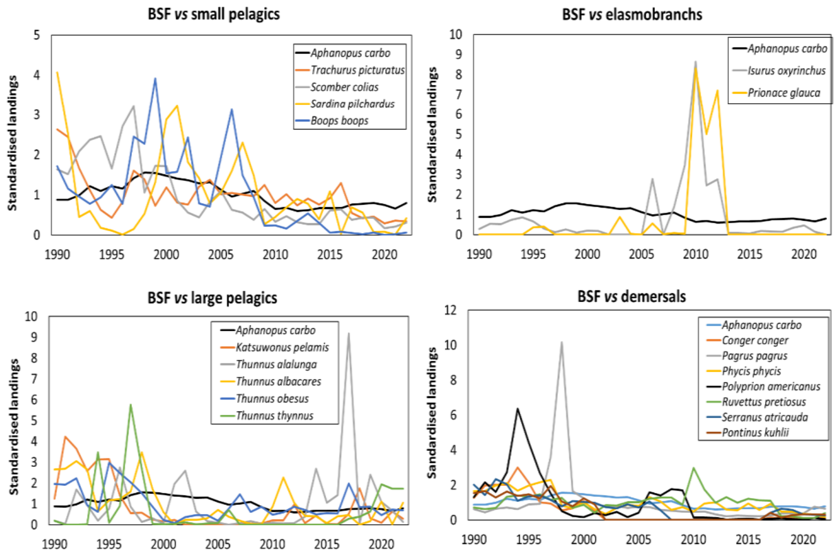

Figure 6 - Trends in standardised landings of scabbard fishes and the 19 other top ranked species in Madeiran landings.

The first sale value of *Aphanopus* spp., in millions of euros, for the period between 2008 and 2022 is presented in Figure 7. This value followed the same trend observed in the annual landings in terms of weight. The reduction in the economic value observed in 2020 and 2021 is related to the decrease in effort due to COVID 19 Pandemic. In 2022, the total first sale value achieved 7.5M€, increasing 1.7M€ in relation to 2021.

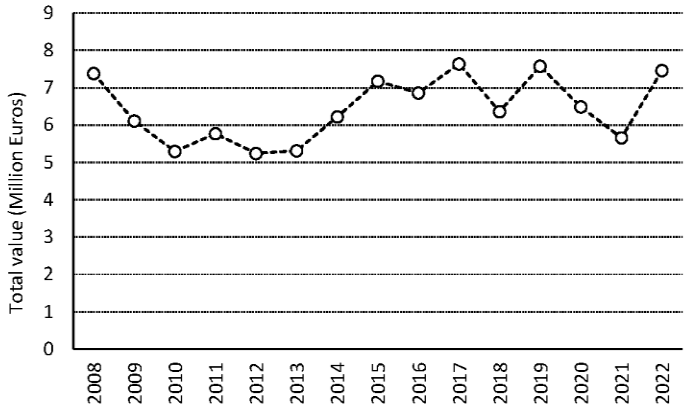

Figure 7 – Economic value of the catches of *Aphanopus* spp., in millions of euros, for CECAF 34.1.2., between 2008 and 2022.

3.1.2. Landings and mean price in Madeira archipelago by vessel length category

The number of vessels in activity in Madeiran longline fleet has steadily decreased during the last two decades (Figure 8).

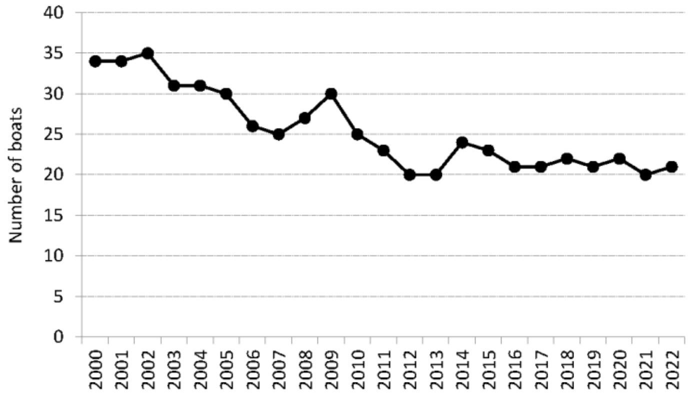

Figure 8 - Number of vessels active in the fishery of *Aphanopus* spp. at CECAF 34.1.2 area between 2000 and 2022.

Though, in the last years, the fishery as achieved a certain stability in the number of active vessels, as the small number of vessels remaining in the fishery are small artisanal vessels (Figure 9). In 2022, 52% of the active vessels were grouped between 12 and 18 m of overall length, thus hardly having operational conditions to make any significant increase in the present total number of hooks used in each fishing set.

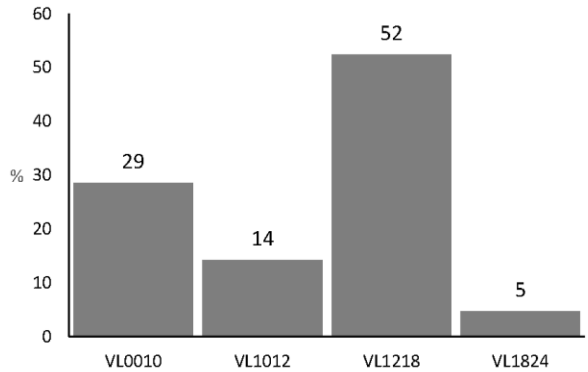

Figure 9 - Composition of the active fleet in the fishery of *Aphanopus* spp. at CECAF 34.1.2 area in 2022 per vessel length category (n=21 vessels).

A time-series of annual Portuguese landings at CECAF 34.1.2 area per vessel length is represented in Figure 10. The majority of the annual landings in Madeira are made by vessels of the length segments VL1218 and VL1824, wherein *ca.* 79% of the total landings in 2022 were captured by VL1218.

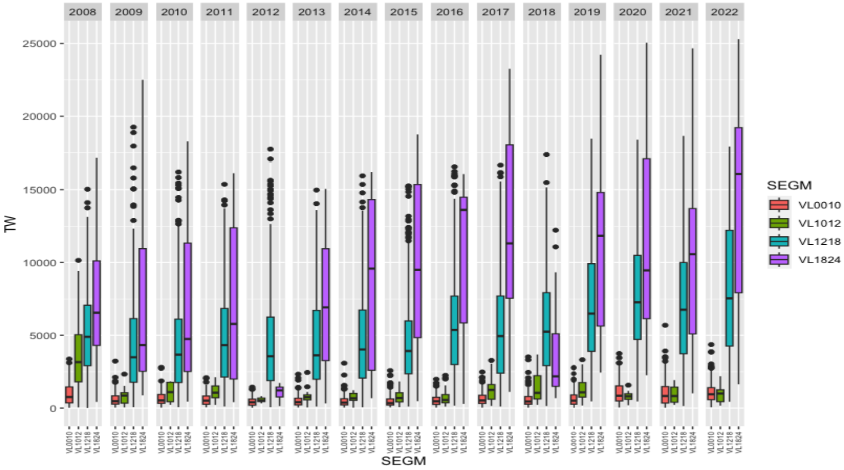

Figure 10 - Time-series of annual Portuguese landings of *Aphanopus* spp. at CECAF 34.1.2 area per vessel length category (SEGM), from 2008 to 2022.

The vessel length category VL1218 presented the highest landing and first sale values, followed by the vessel segment VL1824 (Figure 11). Though the number of vessels in the segment VL1824 represents only 5% of the total active fleet in Madeira, their contribution is higher (*ca.* 12.6%) than both vessel segments VL0010 and VL1012 together (*ca.* 8.5%). In 2022, it was observed an increase in the landings and economic values for all segments being more pronounced in the segment VL1824.

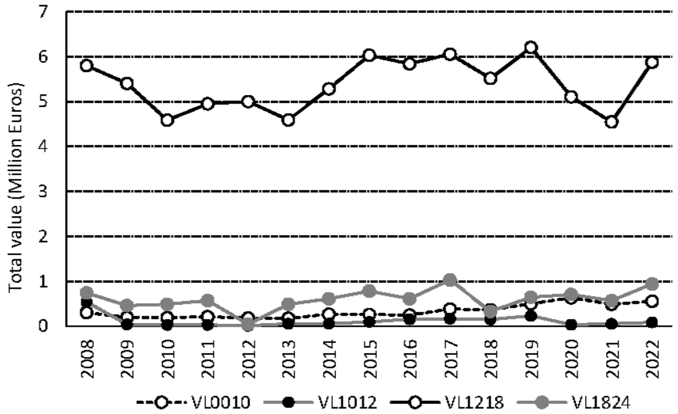

Figure 11 – Economic value of the catches of *Aphanopus* spp., in millions of euros per vessel category between 2008 and 2022.

3.2. Length distribution

The analysis of data indicates neither great changes on the length range between years nor on the mean length (around 114-118 cm total length, TL). From 2010 to 2018 the mean length was between 117 and 118 cm TL, occurring a slight decrease in 2019-2022 (115-116 cm TL).

Annual total length–frequency distributions of the exploited population caught by the Madeiran longline fleet in CECAF 34.1.2 area for the period 2010-2022 are presented in Figure 12. The range of scabbardfish total length varied between 87 cm and 155 cm.

Overall, between 2010 and 2022 there was verified a stability in the composition of lengths and average lengths for scabbardfish species caught by the Madeiran fleet.

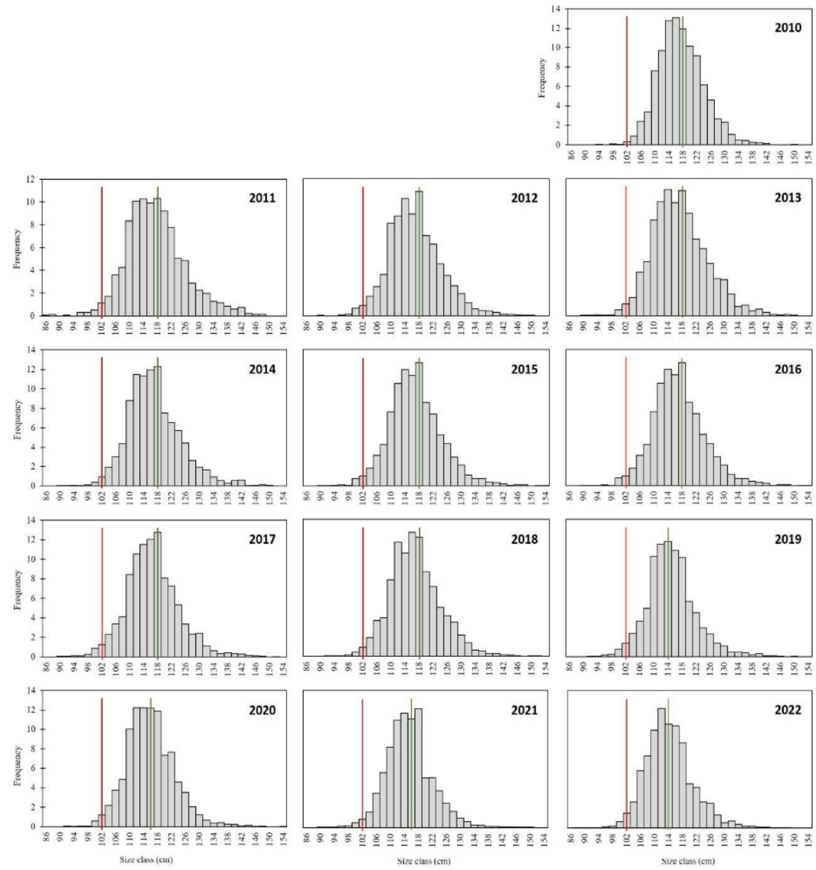

Figure 12 - Annual length–frequency distribution of specimens of *Aphanopus* spp. landed by the Portuguese middle-water longliners operating along CECAF area 34.1.2, from 2010 to 2022. Red line represents the length at first maturity according to Figueiredo et al. (2003) and green line represents the annual mean total length.

3.3. CPUE

Fishing effort in total number of hooks accumulated per year is represented in Figure 13. There was an overall decrease in the available period, reflecting the decline of the number of vessels. The year of 2004 stands for the highest total number of hooks (*ca.* 22.3 M) in the period available, since then effort has declined, and it is rather constant in the last years around 14-11 M hooks per year. In 2022, the total number of hooks was approximately 11.8 M.

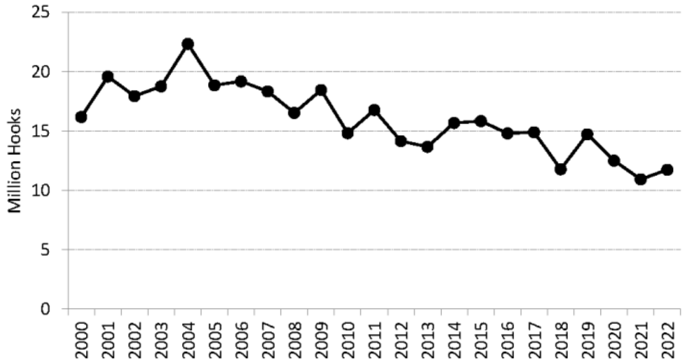

Figure 13 - Time-series of the total annual effort estimated for the CECAF 34.1.2 area (million hooks) for the *Aphanopus* spp. fishery, between 2000 and 2022.

The unstandardized CPUE had an overall decline along the analysed period (Figure 14). The variation observed in the years 2000-2006 was about -45% in CPUE, corresponding to an increase of 16% in the fishing effort. From 2006 to 2008 there was a slight recovery of the landings and of the unstandardized CPUE. The decreasing trend of landings restarted in 2008, but all indicators analysed reached a certain level of stability between 2010 and 2016, and even a recovery was observed since 2020, with an increase of 21 kg/1000 hooks from 2021 to 2022.

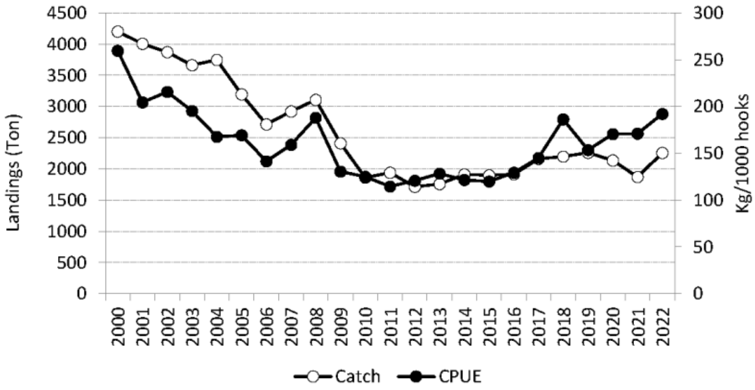

Figure 14 - Time-series of Landings per unit effort, CPUE unstandardized (kg / thousand hooks) of *Aphanopus* spp. in CECAF 34.1.2 area, between 2000 and 2022.

A standardized CPUE model based on daily landings of commercial drifting longline fishery in CECAF 34.1.2 area is being developed for the period of 2008-2022. An exploratory data analysis showed a high correlation between the number of hooks and the number of hauls (Figure 15), but no other variable showed highly correlation with the number hooks per haul.

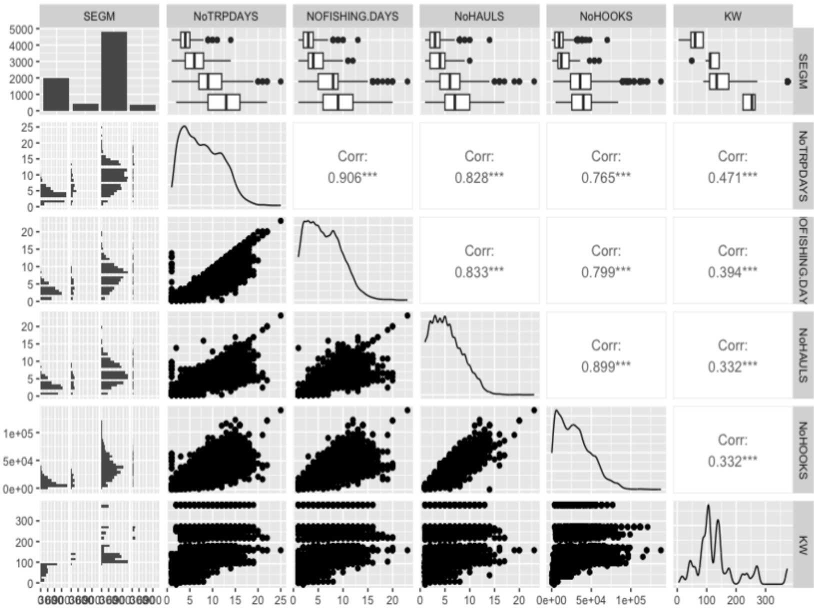

Figure 15 - Exploratory data analysis showing the correlation between the potential variables for the CPUE standardised model of *Aphanopus* spp.

For the period from 2008 to 2022, a standardised CPUE was obtained by adjusting a GLM model based on daily landings of commercial mid-water horizontal drifting longline fishery in CECAF 34.1.2 (Figure 16). The response variable (CPUE) was black and intermediate scabbard fish catches in weight per hook.

The exploratory standardised CPUE data analysis per year and by vessel segment (Figure 16B) showed a recovery in the last five years, especially in the vessel segments smaller than 18 meters, which represents 95% of the Madeira mid-water drifting longline fleet. However, these are just preliminary results and further analysis will be performed.

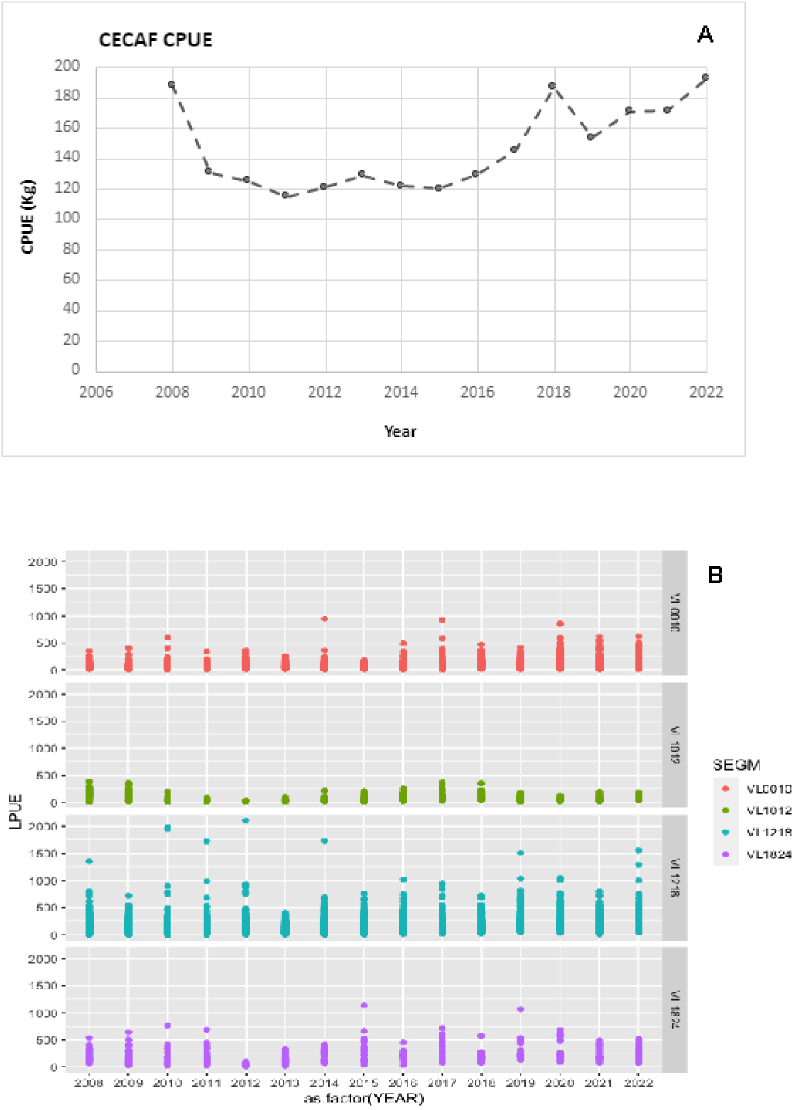

Figure 16 - Time-series of the CPUE (kg/hooks) of *Aphanopus* spp. for all segments combined (A), and standardised CPUE per vessel segment (B).

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Exploratory surplus production models assessment of *Pagellus bogaraveo* **in Subarea 10 (Azores grounds)**

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1. Introduction

Blackspot seabream *Pagellus bograveo* is a sparid fish distributed in the Northeast Atlantic, from south of Norway to Cape Blanc in Mauritania, including Azores, Madeira, and Canary Archipelagos, and the Mediterranean Sea (Froese & Pauly, 2019). This species presents complex life-history and biological dynamics in the face of slow growth, sequential hermaphrodism, and discontinuous essential habitat including coastal areas of the islands and seamounts (Krug, 1990; ICES, 2012). It is considered a deep-water species and, since the stock structure is unknown, three management units have been adopted for assessment purposes in the Northeast Atlantic: (a) Subareas 27.6, 27.7, and 27.8; (b) Subarea 27.9; and (c) Subarea 27.10 (Azores) (ICES, 2007).

The availability and market demand for blackspot seabream to drive the dynamics of the multi-specific demersal, mixed hook, and line fishery in the Azores. Blackspot seabream is the main target species owing to its high selling price (Pinho, 2003; Santos et al., 2019), and ranks first in terms of total landed value in the region (Santos et al., 2020). The status of the stock is uncertain, although recent studies using length-based data-limited assessment suggest being exploited at or above the Maximum Sustainable Yield (MSY) levels (Medeiros-Leal et al., 2023). Consequently, of this historical exploitation, several management measures to limit catch, fishing effort and minimum landing size have implemented along the years (ICES, 2022).

Blackspot seabream stocks can easily be overexploited, as shown by the Bay of Biscay stock collapse in the 1980s (Lorance, 2011). This case was a wake-up call for scientists and fisheries managers to the vulnerability of the species related with the life history traits (protandrous hermaphroditism and late maturity). Surplus production models (SPM) are the only data-limited method that allows for a full assessment of fish stocks. These models provide exploitation and stock status assessment based on MSY reference points and catch forecasts based on alternative scenarios. For this study, were employed two SPMs to assess the stock of blackspot seabream in Azorean waters (ICES 27.10.a.2): 1) Just Another Bayesian Biomass Assessment (JABBA); 2) Stochastic Surplus Production Model (SPiCT).

2. Methodology

2.1. Fishery dependent data

2.1.1. Landings and abundance indeces in Azorean waters.

The data used in this study came from the database of the Department of Oceanography and Fisheries, University of the Azores (DOP/UAz) and were obtained from the Azores Auction Services and collected through fishing inquiries under the DCF. Official landings were recorded from 1985 to 2017 for each fishing trip (*n* = 3,679,979) and included vessel size, *métier* (*i.e.*, a group of fishing operations targeting a specific assemblage of species, using a specific gear, during a precise period of the year and/or within the specific area; EC, 2008) and catch in kg by species. Between 1990 and 2017, 31,616 fishing inquiries were conducted to harbor-present vessel captains at the moment of landing. These inquiries were undertaken to complete the information for fishing effort and covered all fleet segments, with a focus on those that are not obliged to maintain a logbook (*i.e.*, vessels <10 m in length). Each inquiry included the size of the vessel, the number of days it spent at sea and information about the fishing operation, such as the type of gear used, the average depth at which fishing took place and the catch in kg by species.

LPUE (Kg per landings^{-1} vessel^{-1}) and CPUE (Kg days at sea^{-1} vessel^{-1}) were estimated for blackspot seabream. To reduce the influence of potential drivers (*e.g.*, targeted species, vessel size, fishing gear) on these catch rates, generalized linear models (GLMs) were utilized to calculate standardized abundance indices (Santos et al., 2022; Santos et al., 2023). Details on the procedure for selecting the interactions and explanatory factors that explained most of the variability in the data, model validation and catch standardization can be found in Santos et al. (2022).

2.2. Fishery independent data

2.2.1. Survey derived abundance index.

Survey-derived abundance indices (RPN; individuals per 1000 hooks) were calculated for the period 1996-2019 and came from the Azorean spring bottom longline survey (Pinho et al., 2020). Surveys followed a stratified random design and covered the main islands and major seamounts. To estimate de annual index used in further analysis, were only considered the exploited biomass (LT > 33cm).

2.3. Population parameters

Surplus production models, such as JABBA and SPiCT, are age and size aggregated models that approximate changes in biomass as a function of the biomass of the preceding year, the surplus production biomass, and the removal by the fishery in the form of catch. Somatic growth, reproduction, natural mortality and associated density-dependent process are inseparably captured in the estimated surplus production function that is governed by three parameters: 1) the intrinsic rate of population increase (r); 2) the shape parameter and 3) the unfished equilibrium biomass. However, there is a direct link between age-structured stock parameters and the expected surplus production function, so that stock parameters describing, length-at-age, weight-at-age, maturity-at-age, and selectivity-at-age, natural mortality, and the steepness parameter of the assumed Beverton and Hold SSR can be used to approximate the surplus production (Winker et al., 2020). To estimate the three parameters used as priors in surplus production models were used the R package SPMprior available on github.com/henning-winker/SPMpriors. The life-history parameters used to estimate the priors are presented at Table 1.

Table 1. Input constant parameters used in the age-structured model for blackspot seabream *Pagellus bogaraveo* of the Azores (ICES area 10).

PARAMETERS	VALUE	DEFINITION	OBS.
L_{oo} (cm)	55.12	Asymptotic average maximum length	Medeiros-Leal et al. (2023)
K (year-1)	0.12	Growth coefficient of the von Bertalanffy growth model	Medeiros-Leal et al. (2023)
T_0 (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_{mat} (L_F, cm)	29	Length at size first maturity	Santos et al. (2020)
M	0.3	Natural mortality	Silva et al. (2021)
M/k	1.67	Ratio natural mortality over growth coefficient	Medeiros-Leal et al. (2023)

2.4. Surplus production models

2.4.1. Just Another Bayesian Biomass Assessment (JABBA)

JABBA is a Bayesian state-space surplus production model with a Bayesian framework that reduces uncertainty in the model with reasonable prior information and state-space modelling that estimates both process and observation errors (REF). To reduce the uncertainty of the reference points estimates, sensitivity analysis was performed using priors derived from different steepness (h=0.5 and h=0.6), for five scenarios. Detailed information about each specific scenarios are presented at Table 2.

2.4.2. Stochastic Surplus Production model in Continuous Time (SPiCT)

SPiCT, a stochastic surplus production model in continuous time, incorporates dynamics in both biomass and fisheries, and observation error of both catches and biomass indices (REF). To reduce the uncertainty of the reference points estimates, sensitivity analysis was performed using priors derived from different steepness (h=0.5 and h=0.6), for five scenarios. Detailed information about each specific scenarios are presented at Table 2.

Table 2. Definition of each five scenarios used for the sensitivity analysis (ICES area 10).

SCENARIO	DEFINITION
1	r + Bmsy/K + All time series
2	r + Bmsy/K + Edit Survey
3	r + Bmsy/K + Edit Survey/CPUE/LPUE
4	r + Bmsy/K + All time series + Uncertainty Catches
5	r + Bmsy/K + Edit Survey/CPUE/LPUE + Uncertainty Catches

3. Results and discussion

3.1.1. Landings and abundance indices (fishery dependent and independent)

Official landings are reported by Azores since 1985. The discard rates are considered negligible because was estimated at 6%, and with a high survivorship that corresponding mortality is likely smaller than 5%. The Azorean landings were TAC constrained from 2013 to 2022 and a decrease of the landings were registered since them (Figure 1).

Pronounced differences in the LPUE after 2000s could indicate that the stock has declined or that productivity of the stocks changed (Figure 1). However, these statements could not be fully accepted, because the LPUE trends indicate a fast and high decline of the productivity after 2000s, meanwhile the CPUE and Survey indices did not follow the same pattern (Figure 1). The most plausible justification for these differences between the three abundance indices is related with changes in the data collection program sample design. Since 2000s the data collection program became the responsibility of the EU Data Collection Framework (DCF), before holding by the Department of Oceanography and Fisheries of University of the Azores. For this reason, was decided to work in further stock assessment analysis with two time-blocs for LPUE indices, the first between 1985-2006 and the second 2007-2017.

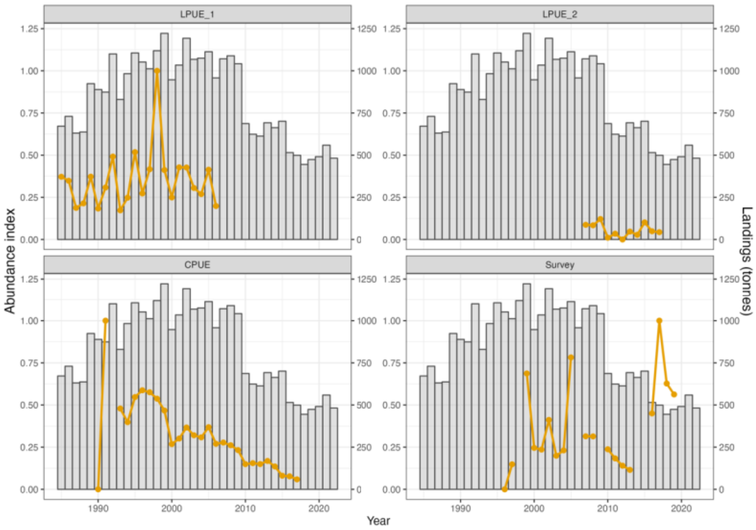

Figure 1. Standardized and scaled to mean LPUE (Kg landings^{-1} vessel^{-1}), CPUE (Kg days at sea^{-1} vessel^{-1}) from the Azorean bottom longline fishery (1985-2017), and exploited biomass (>33 cm) of Annual abundance in number (Relative Population Number) from the bottom longline survey (1996-2019) for blackspot seabream *Pagellus bogaraveo* from the Azorean bottom longline fishery.

3.2. Population parameters

We applied the age-structured stock parameters approach to transform a total of 8 parameters, describing the age-structured and demographics of blackspot seabream, into the surplus production function parameters r and m, which we approximated as function of either exploited biomass (EB_{MSY}) or spawning biomass (SB_{MSY}) (Figure 2). Our results confirmed that the functional of the parameter age-structured yield curve can be closely approximated by the derived parametrization equivalent surplus production curves (Figure 2). The effect of h on r can be inferred from the notable change in central r values for three alternative steepness assumptions (Figure 2).

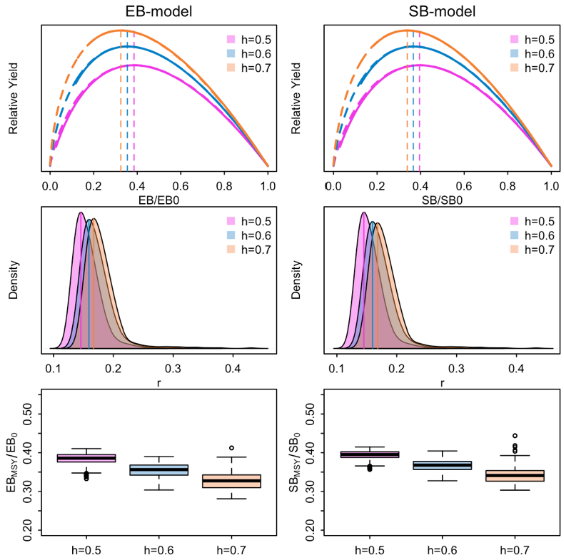

Figure 2. (Top Panel) Showing the functional from of the yield curves produced from the Age-Structured Equilibrium Model (ASME; solid line) and the formulation of the Surplus Production function (solid) as a function of EB/EB0 and SB/SB0 for a range of fixed steepness values of the spawning recruitment relationship(h = 0.5, h = 0.6, h = 0.7) (top panel); (Middle Panel) density distributions of simulated r values from Monte-Carlo simulations based on the EB-model and SB-model; and (Lower Panel) boxplot generated inflection points of EB_{MSY}/EB_0 and SB_{MSY}/SB_0 for each of the fixed steepness h input values.

3.3.3. Surplus production models

3.3.3.1. Just Another Bayesian Biomass Assessment (JABBA)

The sensitivity analysis showed that the reference points results F/F_{MSY}, B/B_{MSY} and MSY were more reliable when the h=0.5 steepness was used. The steepness h= 0.5 also provide an improvement of the residual's diagnostics and retrospectivity analysis (Table 3). Besides that, the scenario 3 model using the h=0.5 presented the best fit of the 10 scenarios and was defined as the base case model, and the next results for the stock assessment purposes are based on this model (Table 3). Results of JABBA model suggests a carrying capacity (K) of 14853 t, a B_{MSY} of 5644 t, F_{MSY} = 0.14 year^{-1} and MSY=811 t for blackspot seabream in Azores. The stock biomass at the end of 2019 was 20% of the B_{MSY} and the fishing mortality was 29% of the F_{MSY}. Biomass presented a continuous decreased period from 1995 to 2010, with a stable period between 2011 to 2015, and a very slight increase since thereafter (Figure 3), while the fishing mortality was above F_{MSY} between 1998 to 2015. The relative biomass (B_{2019}/B_{MSY}) and exploitation level (F_{2019}/F_{MSY}) in 2019 were 0.81 and 0.72 respectively, indicating that the blackspot seabream fishery in the Azores was in a recovering status. The default JABBA plots are shown in Figures

12.4.10. JABBA model presented a good fit of the residual's diagnostics and retrospectivity analysis, and the convergence was achieved (Figure 4).

Table 3. Results of the steepness sensitivity analysis using JABBA model for blackspot seabream *Pagellus bogaraveo* of the Azores (ICES area 10).

		Reference points				Residuals Diagnostics				Retrospective analysis	
Scenarios	Stepness	B/BMSY	F/FMSY	FMSY	MSY	Posteriores	Process dev	Residuals	Runs test	Retro	Hindcast
1	h=0.6	0.88	0.62	0.17	861	Yes	Yes	55.20%	No	Yes	2.47
2	h=0.6	0.87	0.62	0.17	870	Yes	Yes	48.60%	No	Yes	1.88
3	h=0.6	0.80	0.70	0.17	839	Yes	Yes	45.80%	No	Yes	3.88
4	h=0.6	0.92	0.58	0.17	963	Yes	Yes	48.80%	No	Yes	2.48
5	h=0.6	0.76	0.73	0.17	930	Yes	Yes	45.80%	No	Yes	3.85
1	h=0.5	1.14	0.49	0.15	848	Yes	Yes	45.80%	No	Yes	2.5
2	h=0.5	0.84	0.7	0.14	811	Yes	Yes	36.80%	No	Yes	5.06
3	h=0.5	0.84	0.7	0.16	778	Yes	Yes	34.80%	Yes	Yes	5.72
4	h=0.5	0.89	0.65	0.14	814	Yes	Yes	38.60%	No	Yes	2.53
5	h=0.5	0.83	0.7	0.14	890	Yes	Yes	36.90%	Yes	Yes	5.67

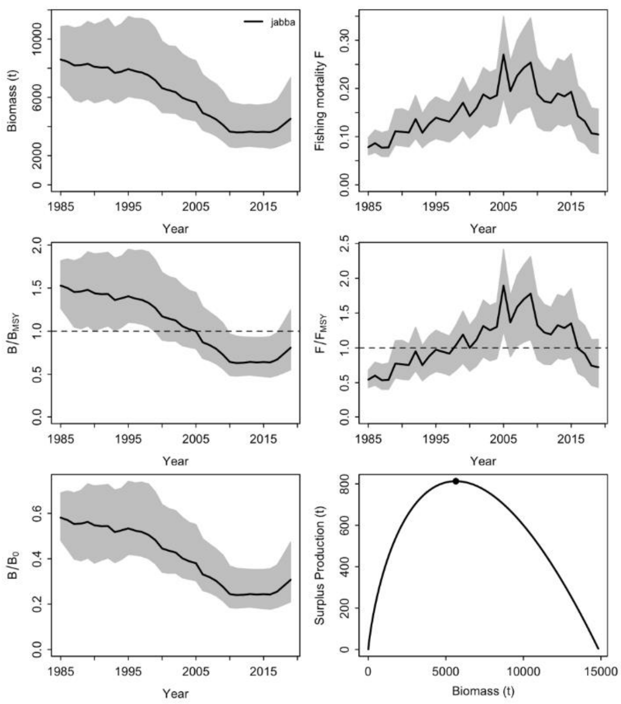

Figure 3. Basic results of JABBA model for the blackspot seabream *Pagellus bogaraveo* from the Azores using standardized CPUE, LPUE and Survey data (ICES, 10.a.2).

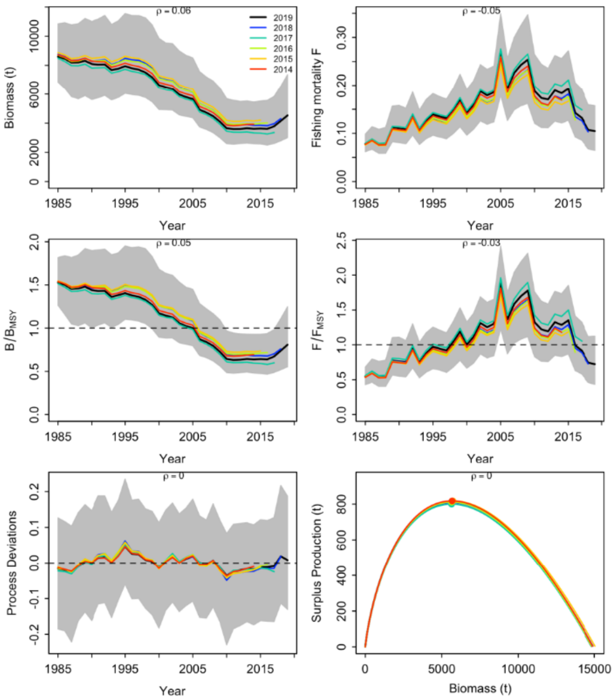

Figure 4. Retrospectivity analysis from JABBA model applied to the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

3.3.3.2. Stochastic Surplus Production model in Continuous Time (SPiCT)

The sensitivity analysis showed that the reference points results F/F_{MSY}, B/B_{MSY} and MSY were more reliable when the h=0.5 steepness was used. The steepness h= 0.5 also provide an improvement of the residual's diagnostics and retrospectivity analysis (Table 4). Besides that, the scenario 3 model using the h=0.5 presented the best fit of the 10 scenarios and was defined as the base case model, and the next results for the stock assessment purposes are based on this model (Table 4). Results of SPiCT model suggests a carrying capacity (K) of 13061 t, a B_{MSY} of 4378 t, F_{MSY} = 0.17 year^{-1} and MSY=753 t for blackspot seabream in Azores. The stock biomass at the end of 2019 was 22 % of the B_{MSY} and the fishing mortality was 12% of the F_{MSY}. Biomass presented a continuous decreased period from 1999 to 2010, with a stable period between 2011 to 2015, and a very slight increase since thereafter (Figure 5), while the fishing mortality was above F_{MSY} until 2015. The relative biomass (B_{2019}/B_{MSY}) and exploitation level (F_{2019}/F_{MSY}) in 2019 were 0.78 and 0.85 respectively, indicating that the blackspot seabream fishery in the Azores was in a recovering status. The default SPiCT plots are shown in Figures 12.4.12. SPiCT model presented a good fit of the residual's diagnostics and retrospectivity analysis, and the convergence was achieved (Figures 6 and 7).

Table 3. Results of the steepness sensitivity analysis using JABBA model for blackspot seabream *Pagellus bogaraveo* of the Azores (ICES area 10).

		Reference points				Residuals Diagnostics				Retrospective analysis	
Scenarios	Stepness	B/BMSY	F/FMSY	FMSY	MSY	Posteriores	Process dev	Residuals	Runs test	Retro	Hindcast
1	h=0.6	1.5	0.07	0.22	1033	Yes			No	No	2.5
2	h=0.6	1.41	0.35	0.23	992	Yes			No	No	5.06
3	h=0.6	0.88	0.73	0.21	783	Yes			Yes	Yes	5.72
4	h=0.6	1.4	0.33	0.23	1136	Yes			No	No	2.53
5	h=0.6	0.88	0.73	0.21	861	Yes			Yes	Yes	5.67
1	h=0.5	1.14	0.49	0.15	848	Yes			No	Yes	2.5
2	h=0.5	1.07	0.52	0.15	849	Yes			No	Yes	5.06
3	h=0.5	0.72	0.91	0.16	752	Yes			Yes	Yes	5.72
4	h=0.5	1.03	0.55	0.15	923	Yes			No	Yes	2.53
5	h=0.5	0.83	0.7	0.14	890	Yes			Yes	Yes	5.67

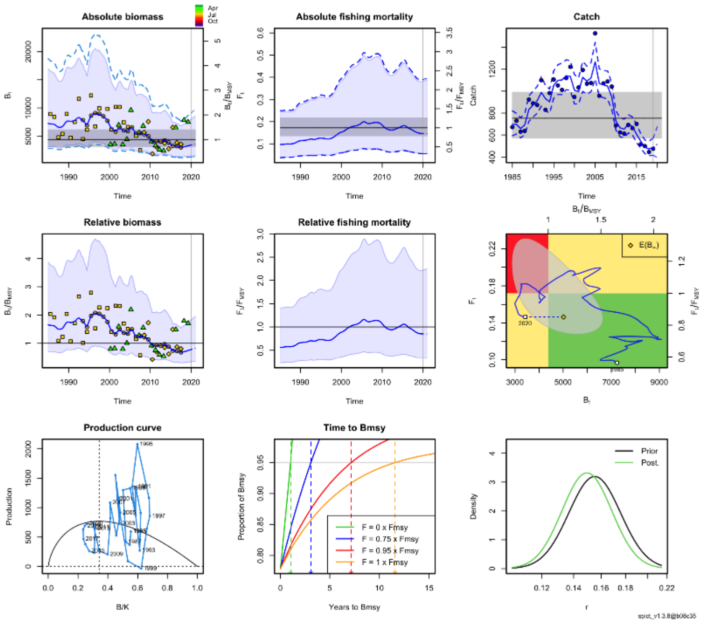

Figure 5. Basic results of SPICT model for the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

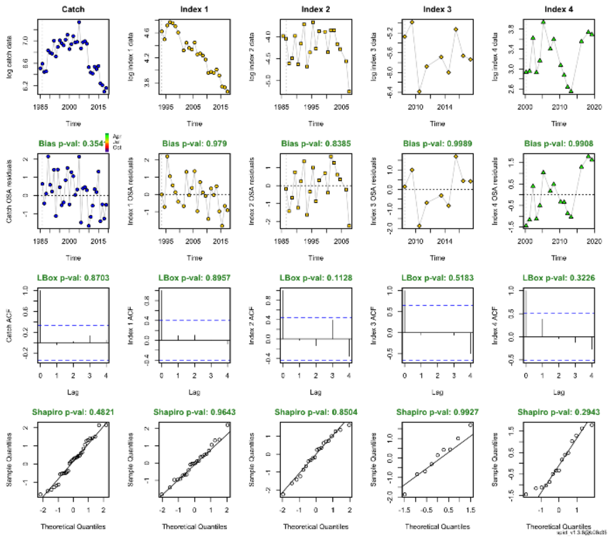

Figure 6. Residual results from SPICT model applied to the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

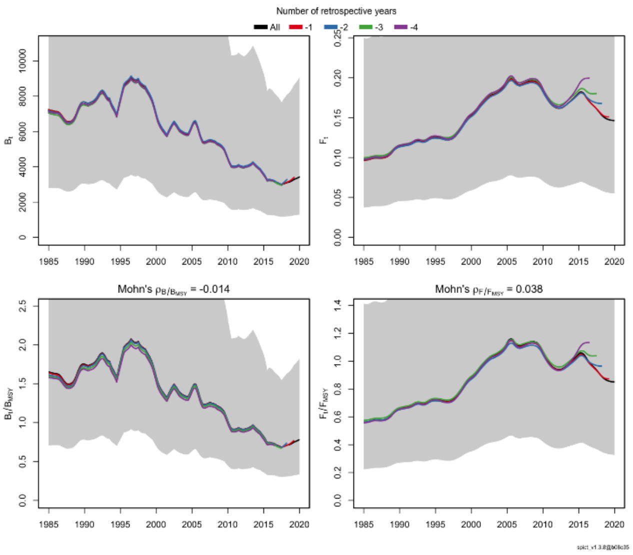

Figure 7. Retrospectivity analysis results from SPICT model applied to the blackspot seabream *Pagellus bogaraveo* from the Azores using CPUE, LPUE and Survey data (ICES, 10.a.2).

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The development of the Norwegian longline fleet's fishery for ling, tusk and blue ling during the period 2000-2022

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Introduction

Ling, tusk and blue ling were fished by Norway for centuries, and the amount landed has been recorded since 1896 (Figure 1). The major catches of these species are taken by longliners, and the catches are to a large degree bycatches. The fishery for these species is influenced by the size of various quotas for other species, especially the quota for Arcto Norwegian cod. Therefore, total catch may not be a good indicator of the condition of these stocks (Figure 2).

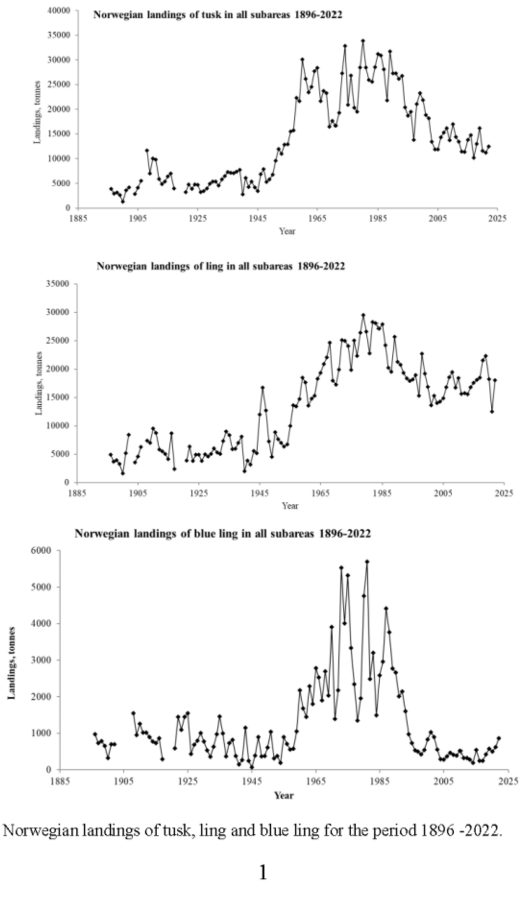


Figure 1. Reported Norwegian landings of tusk, ling and blue ling for the period 1896 -2022.

Scientific surveys do not cover the main habitats of ling, blue ling and tusk. Therefore, these stocks need to be monitored based on commercial data. One possible way to track their abundance, based only on commercial data, would be to develop a catch per unit of effort series for the fishery. But again, the major challenge for any cpue series: It is easy to generate a cpue series, and it is difficult to determine if the series track abundance.

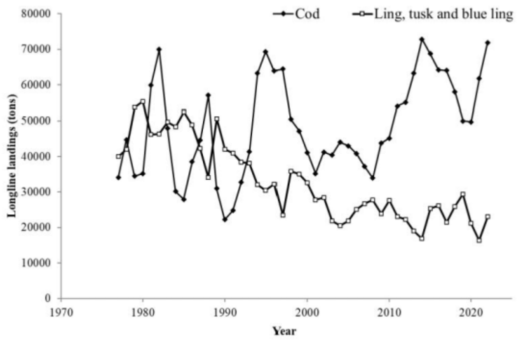


Figure 2. Total landings by longliners of cod (diamonds) and the combined total landings of ling, tusk and blue ling (open squares) for the period 1977- 2022.

Development of the Norwegian fleet of longliners, 1977- 2022

In addition to data on total landings*, the Norwegian Directorate of Fisheries (NDF) provides data on number of fishing vessels participated in the fishery, the gear employed, areas fished and changes in vessel ownership. In Table 1 are the number of long liners during the period 1977 to 2022, the total landed catch by the fleet, and the average annual catch per vessel. The number of vessels increased from 36 in 1977 to a peak of 72 in 2000, and after that the number decreased to 25 in 2014-2017, the last few years the number of vessels has stabilized at 26 vessels fishing more than 8 tons ling, tusk and blue ling.

The number of vessels declined mainly because of changes in the law concerning the quotas for cod. The decrease in the number of vessels was accompanied by a decrease in total catches until 2004; afterwards, the landings have been varying but stable (Figure 3a). The catch-per-vessel was stable from 1980 until 2003. In the period 2003- 2019 there was a steady increase in catch-per-vessel with a sharp decrease in 2021 followed by an increase in 2022 (Figure 3b).

* The data provided by the NDF are; the total landed catch, the logbook data, and the catch along with its location.

In 2012 new regulations were initiated and the number of cod quotas for each vessel increased from 3 to 5. This caused a further reduction in the number of long liners; from 36 in 2012, to 25 in 2015 to 2018. In 2022 there were 26 vessels.

a) b)

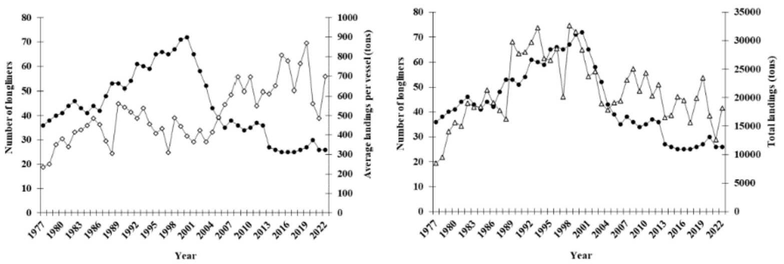


Figure 3. a) The number of long liners (filled circles) and the average landings per vessel of ling and tusk (open diamonds) in the period 1977-2022 and, b) the number of longliners and the total landings of ling and tusk (open triangles).

Logbooks

All available logbooks for the years 2000-2022 are now in the database, and the data have undergone extensive quality control procedures. The data for 2010 is incomplete because of problems getting some of the logbook data, both for the paper logbooks and for the electronic logbooks. In 2010, electronic logbooks were implemented for the longline fleet. The Norwegian Directorate of Fisheries has received the data, but because of lack of quality control, the 2010 data will not be released. Some fishers did not send paper logbooks because they had delivered the data electronically. Because of this, logbooks from only 11 of 35 vessels are available for 2010. The quality of the logbooks varies considerably, and a serious problem is that some lack information on the number of hooks used per day. The data from 2011 are almost complete with data from 35 of 37 vessels. In 2012 to 2022 all logbooks are available, though some days have been deleted due to punching errors.

Days in the fishery

The Norwegian longline logbooks provide information on the geographical distribution of the fleet. In Table 2 are the average number of days a vessel spent fishing for tusk, ling and blue ling, jointly or separately, for all ICES Subareas and Divisions. After 2000, when new quota regulations for cod were introduced, the number of days each vessel fished for three-deep-water species increased, and by 2005 the number of days in the fishery was twice that was in 2000. The data for 2006 show that the number of days in the fishery has decreased by more than 20 percent compared with 2005 and 2007. The data was checked for errors, but none were discovered. The number of fishing days has trended downward since 2007, most likely because of the record large stock of Arcto Norwegian cod. This trend changed dramatically in 2019 when the number of fishing days per vessel increased from 134 days in 2018 to 192 days in the tusk fishery and in the ling fishery it changed from 94 in 2018 to 125 in 2019. However, in 2020 the total number of fishing days had declined to 147.

Division 2a has been the main fishing grounds since 2000, followed by 4a and 5b (Table 2).

Average number of hooks per day

Table 3 are estimates of the average number of hooks used per day in each ICES area and in the total fishery for the 2000-2022. For all areas combined, there was a steady increase in the number of hooks used from 2000 through 2009. This is also the general trend for subareas (Figure 4). The combined time series for 1972-1994 (Bergstad and Hareide, 1996) and the series based on data from 2000-2012 show that the average number of hooks has increased from 10 000 hooks per day in 1972 to around 39 000 in 2022 (Figure 6).

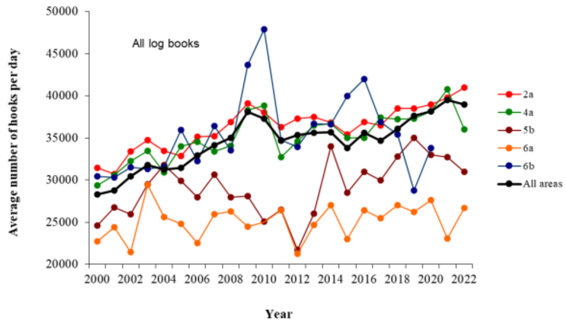


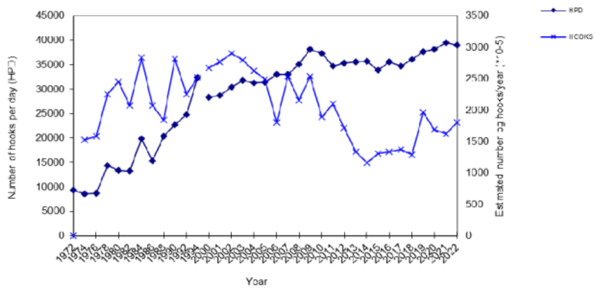
Figure 4. Average number of hooks the Norwegian longliner fleet used per day in each of the ICES subareas and in the total fishery for the years 2000-2022 for the fishery for tusk, ling and blue ling.

Total number of hooks per year

Based on the number of vessels, the number of hooks per day, and the number of days each vessel participated in the fishery, estimates of the total number of hooks used per year were generated (Tables 1, 2 and 3). Table 4 and Figure 5 show the estimated number of hooks (in thousands) set in each of the ICES subareas and in the total for all areas for the years 2000-2022 During the period 1974 to 2013 the total number of hooks per year has varied considerably, after this the number of hooks per year have been stable but with an increase from 2019 and 2021 (Figure 6).

The total number of hooks per year considers; the number of vessels, the number of hooks per day, and the number of days each vessel participated in the fishery, may be a suitable measure of tracked applied effort. Based on this measure of effort, it appears that the average effort for the years 2011-2021 is 40% less than the average effort during the years 2000-2003.

a.



b.

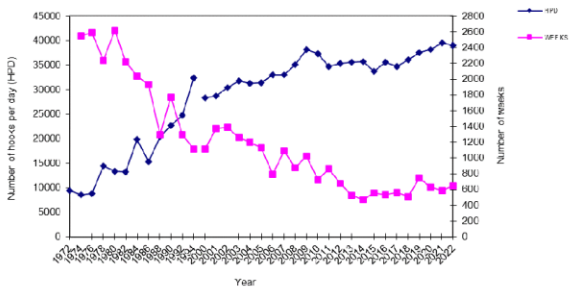


Figure 5. The combined time series for 1972-1994 (Bergstad and Hareide, 1996) and the series based on data from 2000-2022: a) The numbers of hooks used per day, and the total number of hooks used per year; b) The numbers of hooks used per day, and the total number of weeks the long liners participated in the fishery for ling and tusk.

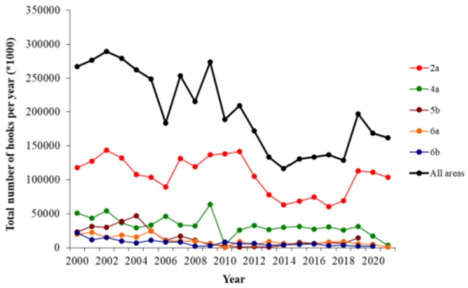


Figure 6. Estimated total number of hooks (in thousands) the Norwegian longliner fleet used in the ICES subareas with highest catches and in the total fishery for the years 2000-2022 for the fishery for tusk, ling and blue ling.

The size of the vessels

There was a steady increase in the average size of the vessels from 34 m in 1977 to 46.6 m in 2022. Figure 7 show the average size of the vessels and the smallest and the largest vessel in the fleet for the period 1977 to 2022.

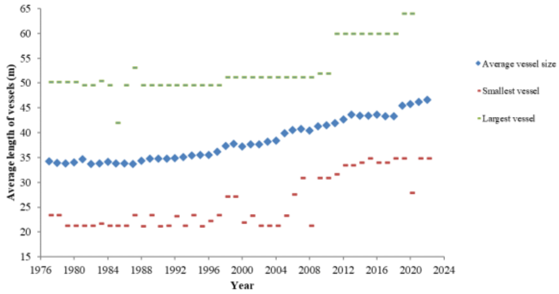


Figure 7. Average size of longliners >21 m for the period 1977-2022.

Fishing area

Approximately 65-70% of the commercial catches of ling are taken by vessels using demersal longlines, either target species or bycatch (Helle and Pennington, 2015), and the remains are taken mainly by gillnets but also some by trawlers. Although the tusk fishery takes place from Rockall to the southern Barents Sea (Helle and Pennington, 2004), between 70 to 80 percent of the catches by Norwegian vessels are from the Norwegian Economic Zone.

Figure 8 shows all the catches of ling registered in the electronic logbooks by longliners in 2013-2020 in areas 1 and 2.

Tusk are mainly caught by longliners (approximately 90 percent of the total catch). Figure 9 shows all catches of tusk registered in the electronic logbooks by longliners in Areas 1 and 2 during the period 2013 to 2022.

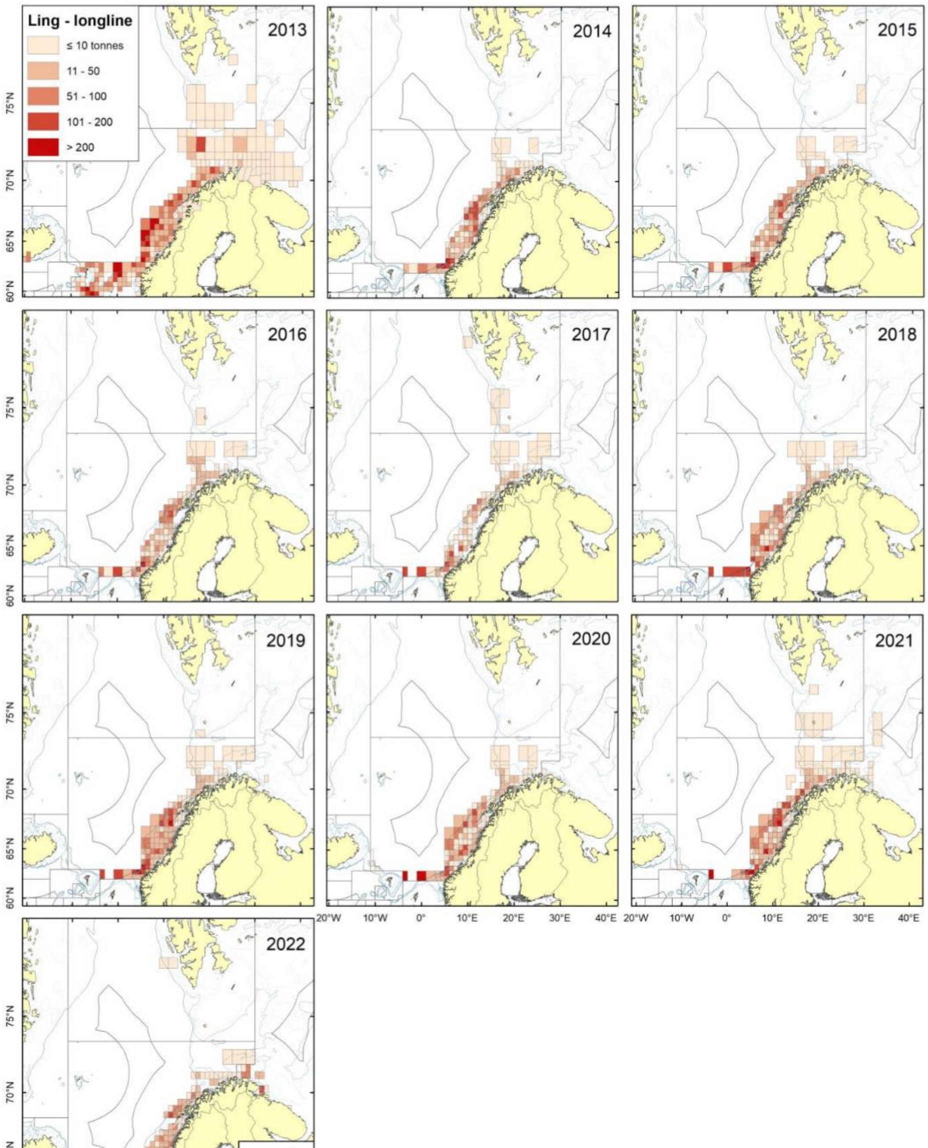


Figure 8. Distribution of the catches using longlines by the Norwegian fishery for ling in 2013 to 2022 in areas 1 and 2.

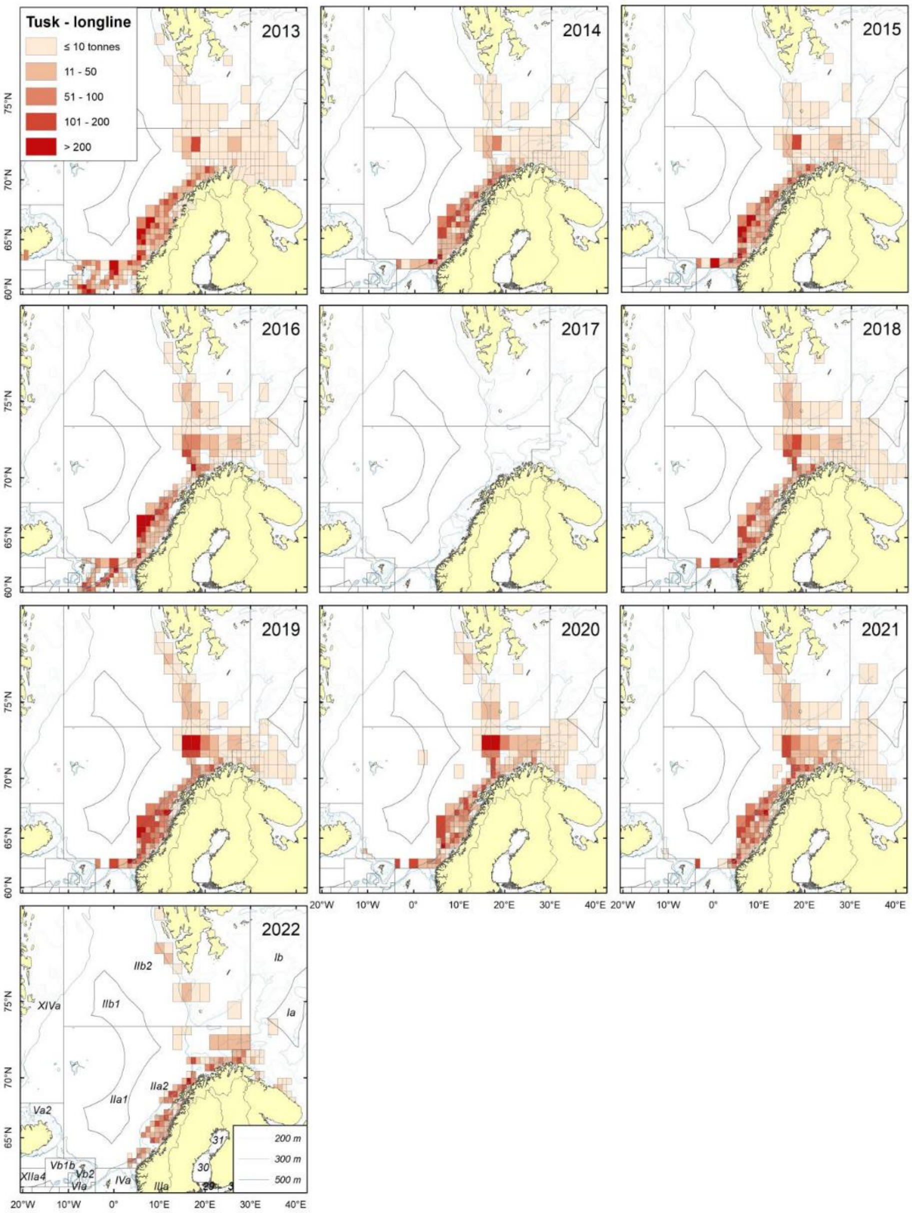


Figure 9. Distribution of the catches using longlines by the Norwegian fishery for tusk in 2013 to 2022 in areas 1 and 2.

CPUE

Based on methods described in Helle *et al*., 2015 to derive a cpue series were for ling and tusk calculated two ways; using all data available and catches for which ling and tusk were targeted (>30 percent of the daily total catch).

In Figures 11 and 13 are plots of the estimated cpue series for the most important ICES subareas for ling and tusk: based on all the available data, and a cpue series based on only those catches that ling or tusk appear to be targeted; included plots of estimated 95% confidence intervals.

Ling:

Both cpue series for ling in 2a have been relatively stable since 2011, but with a declining trend the last four years for the targeted fishery.

In Areas 4a there was a steady increase in cpue from 2002 until 2016 and were down in 2017 and 2018 but with a slight increase in 2019 and 2020. In 2021 there were little or no fishing in the traditional areas due to no agreement about the TAC in the area. The estimate is therefore based on very limited data and does not present a correct picture of the stock situation. In 2022 the index was at the same level as in 2020.

In 6a and 6b there was also a positive trend from 2002 to 2016 with a varying but stable index. The Norwegian fleet had limited access to the areas in 2021 and there was very little fishery in 2022. There was no fishing in area 6b the two last years.

When all ling data for Areas 3.a, 4, 6, are combined for a cpue series, and ling was targeted a cpue series, both indicate a steady increase since 2003 to 2017 and then a decline in 2018. In 2020 there were an increase. The estimates for 2021 do not represent the normal fishery in the areas and should not be considered valid. In 2022 the index was at the same level as in 2020.

Tusk:
Both cpue series in Area 2a have been relatively stable since 2011.

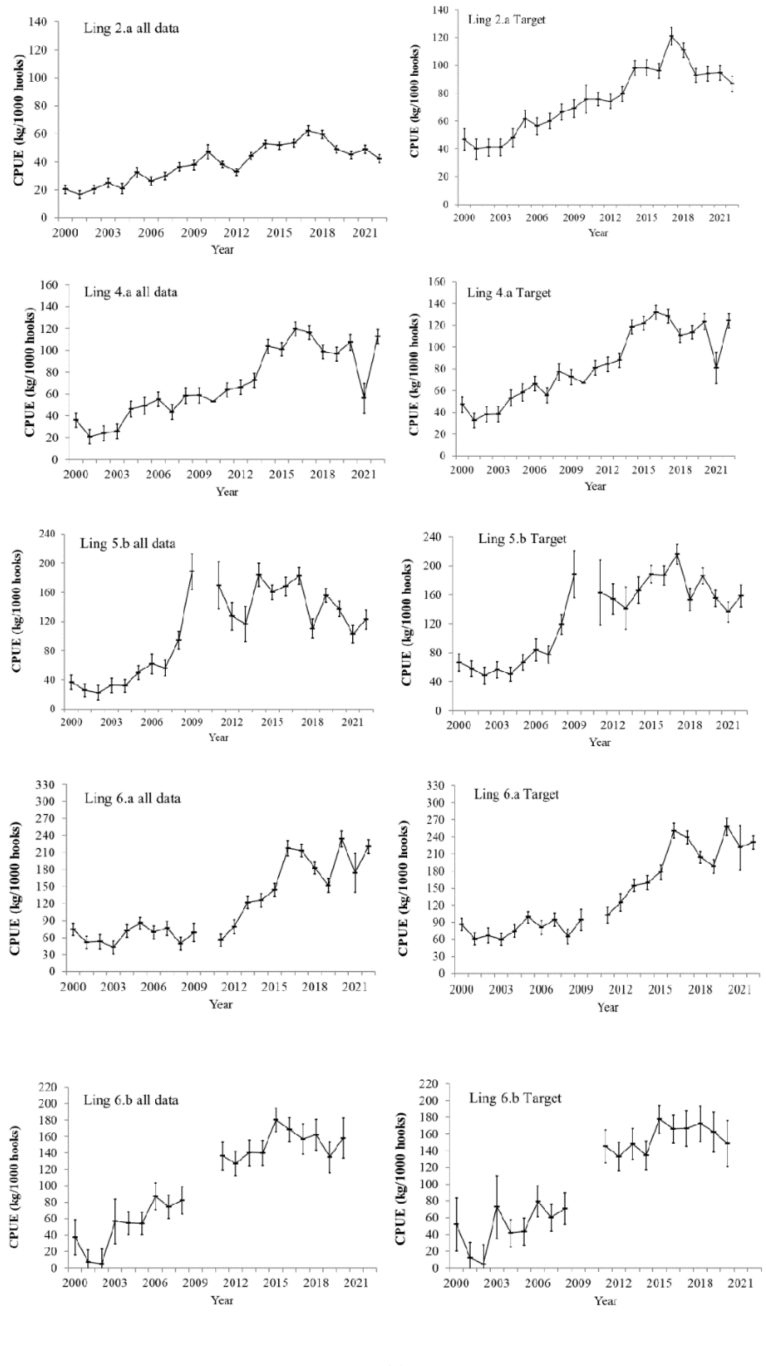
The series in Area 4a based on all the catches indicates at first a stable series and then a slightly decreasing trend for the last six years, while the series based on the targeted fishery shows a clear and positive upward trend from 2002 until 2013, after this there was a declining trend, and this trend is especially clear for the targeted fishery.

The series in Area 5b shows a stable trend from 2000 to 2008, afterwards it increased until 2012, then decreased until 2017 and a relatively large increase in 2018 and a decreasing trend after 2018.

In area 6a a cpue series based on the Norwegian longline data shows an increase in cpue from 2004 to 2008, afterwards it has remained at a high and slightly increasing level when all data are used, and a sharp increase from 2018 to 2019 for the targeted fishery followed by a decrease in 2020 (Figure 13). In 2022 the index was at the same level as during the period 2011-2016.

The combined cpue series for areas 4a, 5b and 6a. shows an increasing trend from 2000 to 2010, after 2010 cpue was at a high and stable level, declined in 2017.. After 2017 the index has been varying but in 2022 the index was at the same level as during the period 2011-2016.

The cpue series for Area 6b when all data were used, a catch from longliners show a decrease from 2000 to 2006. After 2006, the cpue was low but at a stable level. There was no direct fishery for tusk in the last years.


Ling 2.a all data
Ling 2.a Target
Ling 4.a all data
Ling 4.a Target
Ling 5.b all data
Ling 5.b Target
Ling 6.a all data
Ling 6.a Target
Ling 6.b all data
Ling 6.b Target
CPUE (kg/1000 hooks)
Year

11

Figure 11. Estimated cpue (kg/1000 hooks) of ling in Subareas 2a, 4a, 5b, 6a and 6b based on skipper's logbooks during the period 2000-2022. The bars denote the 95% confidence intervals.

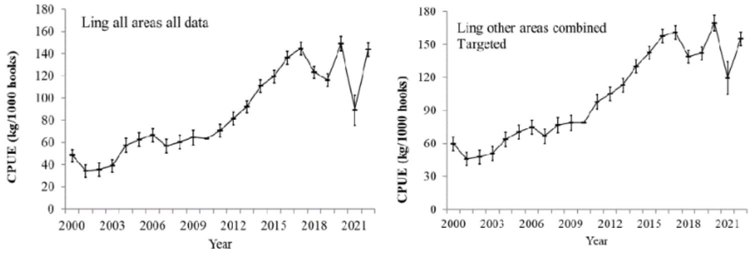


Figure 12. Ling areas combined (3, 4, 6) based on skipper's logbooks during the period 2000-2022. The bars denote the 95% confidence intervals.

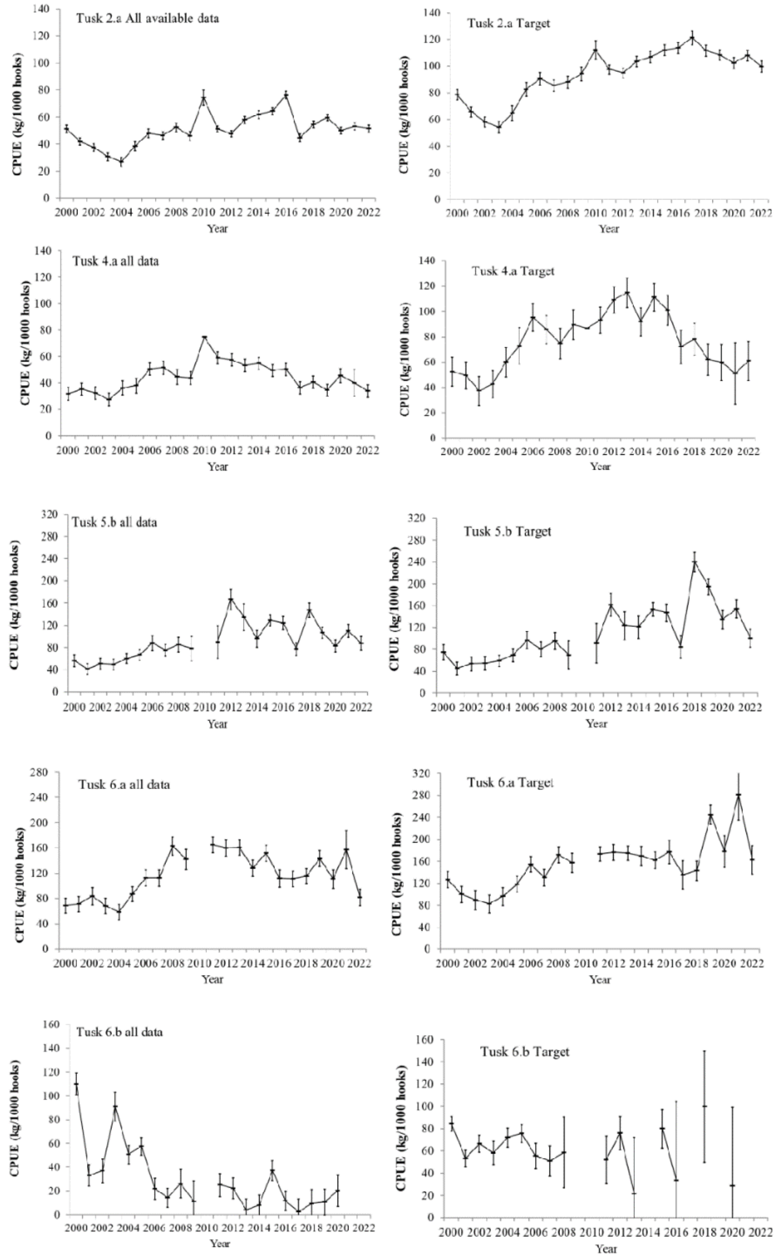


Figure 13. Estimated cpue (kg/1000 hooks) of tusk in Subareas 2a, 4a, 5b, 6a and 6b based on skipper's logbooks during the period 2000-2022. The bars denote the 95% confidence intervals.

13

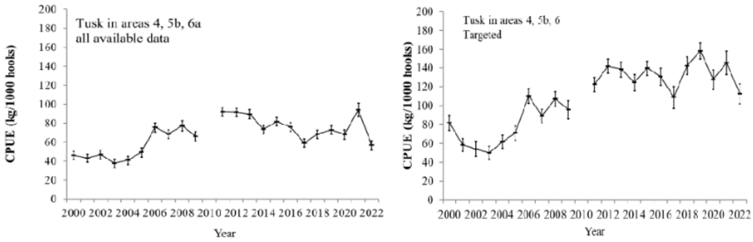


Figure 14. Tusk in other areas combined (4, 5b, 6a) based on skipper's logbooks during the period 2000-2021. The bars denote the 95% confidence intervals.

Blue ling

The cpue series for blue ling based on longline data shows a low and stable level for the Areas 1, 2, 3a and 4. Although there was no direct fishery in these areas, the stock doesn't seem to show any recovery.

A low and steady population for blue ling were in subareas 5a and 14 and in Areas 5b, 6 and 7. When only data from 6a, there was a positive trend from 2004 to 2015, after this the trend has been at a lower level.

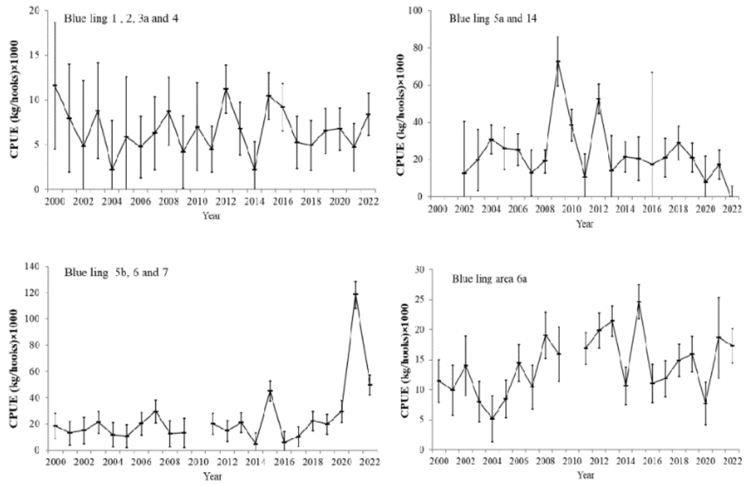


Figure 15. Estimated cpue (kg/1000 hooks) of blue ling in Subareas: 1, 2, 3.a; 4, 5.a; 14, 5.b, 6; 7; and in Subarea 6.a. All data from skipper's logbooks during the period 2000-2022. The bars denote the 95% confidence intervals.

Conclusions and discussion.

Legislation enacted since 2000 for regulating the cod fishery caused a continuous reduction in the number of longliners in the fishery for tusk, ling and blue ling, and by 2009, there were only 34 vessels above 21m in the fishery. Due to recent regulations, the number of vessels was 26 in 2021. Because of this decrease the number of vessels were 58 % fewer since 2000, the total number of hooks employed reduced, the total number of weeks fished, and until 2021, there were a significant reduction in effort. Compared with 2000, a decrease in total effort has occurred even though there was an increase in the number of hooks set per vessel/day until 2021. The large increase in effort in 2019 is probably due to a reduction in cod quotas. This fishery should be monitored and reported to prevent overfishing (Figures 5 and 6).

During the period 1998 through 2003, the total landings declined from 32 675 to 19 000 tons, while the catch-per-vessel remained relatively constant. The total catches were stable during the years 2004 through 2006, but after that, there was a sharp increase in 2007 and 2008. The average catch-per-vessel increased considerably during 2003- 2008, afterwards the catch has been relatively stable.

It should be noted that using the total landings as a measure of stock development can be very misleading. For example, there is a negative correlation between the landings of cod and the total landings of ling, blue ling and tusk (Figure 2), which is due to cod being the most valued species. Therefore, the decrease in total landings does not indicate a reduced stock size, but only an increase in cod quotas.

If a stock is not covered by a scientific survey, then a commercial cpue index is often used to track temporal trends in abundance. It is widely recognised that caution must be used when interpreting a cpue series based on commercial catch data. But by considering: the application and distribution of fishing effort; species specific knowledge, such as when a species is targeted or if it is a preferred species; patterns in the total catch by fleet and by vessel; etc., then based on all these factors, a reliable assessment of a stock’s condition.

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Table 1. Summary statistics for the Norwegian longliner fleet during the period 1995-2022 (vessels exceeding 21m).

Year	Number of longliners	Total landed catch by fleet	Catch per vessel (Tons)
1977	36	8471	235
1978	38	9563	252
1979	40	14038	351
1980	41	15651	382
1981	44	15002	341
1982	46	19079	415
1983	43	18338	426
1984	41	18398	449
1985	44	21364	486
1986	42	19080	454
1987	48	17788	371
1988	53	16253	307
1989	53	29816	563
1990	51	27726	544
1991	54	27979	518
1992	61	29718	487
1993	60	32290	538
1994	59	26908	456
1995	65	26571	409
1996	66	28645	434
1997	65	20173	310
1998	67	32675	488
1999	71	31528	444
2000	72	28391	394
2001	65	23681	364
2002	58	24619	424
2003	52	18969	365
2004	43	17815	414
2005	39	19106	490
2006	35	19475	556
2007	38	23060	607
2008	36	25069	696
2009	34	21158	622
2010	35	24360	696
2011	37	20344	550
2012	36	22302	620
2013	27	16522	612
2014	26	16907	650
2015	25	20189	808
2016	25	19478	779
2017	25	15663	627
2018	26	19895	765
2019	27	23498	870
2020	30	16827	561
2021	26	12621	485
2022	26	18134	698

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

All species	1	2a	2b	3a	4a	4b	5a	5b	6a	6b	7c	12	14b	All areas
2000	9	54	2	+	24	2		13	12	10	2	+	6	131
2001	5	64	9		22		1	18	14	6	1	5	3	148
2002	10	74	2		29			20	12	8		1	8	164
2003	12	73	3	1	21	1	3	25	12	6		3	9	169
2004	20	75	11		22		2	34	14	5	1	1	9	195
2005	23	81	14		25		2	21	25	8	0,4		5	203
2006	11	73	3		38		3	11	13	7				159
2007	15	101	21		27	3	2	15	10	6	1			201
2008	7	90	18	1	26		4	11	10	2			2	171
2009	19	103	20	1	49	1	2	4	7	2			3	211
2010	8	104	13		3		1	3		5			5	145
2011	12	103	4		21	3	2	1	9	4				159
2012	9	78	4		26	1	2	2	5	5	1		2	135
2013	6	63	2		22	2	2	1	11	4			1	114
2014	5	66	2		31	1	2	4	9	4			2	126
2015	8	77	4		36	1	2	11	9	5			2	155
2016	4	81	7		31	1	2	8	8	5			3	150
2017	12	66	15		33		2	10	13	3			4	158
2018	4	69	6		27	1	2	7	13	4			4	137
2019	5	109	14		31	1	2	15	8	3			6	194
2020	6	95	7		15		2	11	6	2			3	147
2021	16	100	20		3		2	10	1	0			6	158
2022	9	95	18		34		2	8	7				5	178

Tusk	1	2a	2b	4a	4b	5a	5b	6a	6b	7c	12	14b	All areas
2000	3	34	1	18	1		11	12	4	2	1	2	88
2001	1	57		22		1	18	14	6	1	3	1	124
2002	5	66	2	28			20	12	8			2	141
2003	5	58		19	2	3	25	12	5			1	130
2004	6	60	1	21		2	34	14	5	1		3	148
2005	5	69	2	25		2	21	23	8	0		3	158
2006	1	67	1	37		3	11	13	7				140
2007	5	89	3	26		2	15	10	6	0			157
2008	4	92	4	30		4	14	15	5				169
2009	6	87	2	56	2	2	4	7	2			1	159
2010	4	93	2	2		3			4			2	112
2011	12	103	4	21		2	1	9	4				155
2012	9	78	4	25		2	2	5	4	1		2	132
2013	6	63	2	22		2	1	11	3			1	111
2014	5	66	2	31		2	4	9	3			2	125
2015	8	77	4	36	1	2	11	9	5			2	154
2016	4	81	7	30		2	8	8	5			3	148
2017	12	66	15	31		2	10	13	2			3	154
2018	4	69	6	26		2	7	13	3			4	134
2019	5	109	14	30	1	2	15	8	2			6	192
2020	6	95	7	15		2	11	6	2			3	146
2021	16	99	20	3		2	10	1				6	157
2022	9	91	18	34		2	8	7				5	174

Ling	2a	3a	4a	4b	5a	5b	6a	6b	7c	14b	All areas
2000	23	+	19	1		12	13	4	3		76
2001	40		22	+	1	17	13	5	1		100
2002	50		29			18	11	7			114
2003	40	1	20	1	3	24	12	4			104
2004	37		22		2	34	14	5	1		115
2005	51		25		2	21	23	8	+		126
2006	54		38		3	11	13	7			126
2007	65		27	3	2	15	10	6	1		128
2008	52	1	25		4	11	9	2			104
2009	65	1	49		2	4	7	2			130
2010	70		3		3			7			83
2011	73		21	3	4	2	8	4			113
2012	59		26	1	2	2	5	5	1		98
2013	44		22	1	2	1	11	4			85
2014	53		31	1	2	4	9	4		1	106
2015	54		37	1	2	11	9	5		1	122
2016	55		31	1	2	7	8	5		1	111
2017	27		33		2	10	13	3			88
2018	41		27	1	2	6	13	4			94
2019	66		31	1	2	14	8	3			125
2020	47		15		2	10	6	2			83
2021	53		3		1	9	1				67
2022	53		34		1	7	7				102

Blue ling	2a	4a	5a	5b	6a	6b	12	14b	All areas
2000	1	1		4	9	1	2	+	18
2001	1	+	1	3	6	1	5		15
2002	1	1		4	4	2		+	11
2003	1		1	5	8	2	2	+	14
2004	+	1	2	5	6	+		+	14
2005	+	1	1	1	10			+	14
2006	1	2	2	4	8	+			18
2007	1	2	1	5	6	1			16
2008	2	4	3	4	10			1	25
2009	1	4	2	3	6			1	17
2010	2	1	2					2	7
2011	2	2		1	7				12
2012	1	2		2	5			1	12
2013	1	2		1	8				13
2014	1	3	1	2	5	1		1	12
2015	3	4	1	5	7				20
2016	1	4		3	6				15
2017	1	3		5	7			1	17
2018	1	3		4	8			1	17
2019	4	3		6	6			2	21
2020	6	4		3	4				17
2021	6		1	4	1			1	13
2022	5	9	1	4	6			1	26

Table 3. Average number of hooks that the Norwegian longliner fleet used per day in each of the ICES subareas/divisions and in the total fishery for the years 2000-2022 in the fishery for tusk, ling and blue ling. n is the total number of days with hook information contained in the logbooks.

All		1	2a	2b	3a	4a	4b	5a	5b	6a	6b	7c	12	14b	All areas
2000	Average	31688	31439	35409	30250	29378	30263		24594	22763	30471	29600	18136	2815	28325
	n	353	1916	71	4	685	38		411	435	227	80	22	191	4429
2001	Average	33325	30703	34638		30553	33500		26760	24419	30340	33108	17548	2465	28743
	n	163	2196	315		727	10		613	447	140	37	175	135	4958
2002	Average	35432	33431	34756		32291	33867		25939	21484	31557			9458	30432
	n	263	2031	45		667	15		475	186	149			251	4083
2003	Average	35045	34766	34776	33037	33484	32559	22605	29513	29421	31325		13063	11515	31794
	n	376	1839	67	27	510	34	38	515	302	97		48	228	4081
2004	Average	32431	33475	31859		30934		25815	31804	25636	31559	25250		12474	31285
	n	433	1389	217		439		54	693	308	111	28		105	3777
2005	Average	32671	32861	35082		34039		23100	29885	24807	35949	33429		18960	31438
	n	316	1248	207		331		30	374	369	137	7		91	3110
2006	Average	33182	35140	39298		34561		21526	27943	22504	32273				32959
	n	187	1252	57		673		57	159	248	139				2711
2007	Average	34380	35207	37881	35000	33414	38086	25414	30681	25958	36400	31071			34110
	n	318	2103	328	8	587	58	58	355	249	145	14			4223
2008	Average	36833	36890	39650	36467	34056	31500	32704	27968	26319	33514			9464	35042
	n	96	1500	297	15	395	10	71	188	138	35			45	2790
2009	Average	39184	39142	43744	34636	38299	30167	26106	28123	24455	43645			7034	38127
	n	267	1419	281	11	680	6	33	57	99	31			38	2922
2010	Average	40519	38057	41607		38838		20182	25067		47904			7672	37296
	n	19	1089	135		37		11	30		52			58	1491
2011	Average	37205	36260	35280	35275	32737	37343	28062	26492	26424	34727			25750	34668
	n	411	3622	126	8	740	104	63	24	310	137			4	5549
2012	Average	36434	37298	38357		34639		33647	21702	21249	33934	39064		9091	35381
	n	307	2817	157		933		68	63	196	176	22		59	4765
2013	Average	39500	37500	42000		36500	43000	30900	26000	24700	36700	31000		27500	35600
	n	211	2073	81		710	34	69	34	351	132	10		36	3678
2014	Average	37699	36782	39660		36715	44614	35015	34000	26979	36551			22374	35676
	n	112	1501	44		707	22	46	101	214	97			65	2909
2015	Average	36100	35400	43500		35000	40800	31600	32400	30700	29000			29800	33800
	n	209	1902	91		908	33	54	276	222	130			53	3878

20

2016	Average	40000	36900	42000		35000	35000	37000	31000	26400	42000			31400	35600
	n	100	2025	175		775	25	50	200	200	125			75	3750
2017	Average	41700	36500	43000		37400	40300	33700	30000	25500	36900			25400	34700
	n	302	1660	374		815	11	54	260	320	78			89	3963
2018	Average	42800	38500	42000		37200	44500	42600	32800	27000	35400			35400	36100
	n	99	1776	142		692	34	51	148	295	96			105	3738
2019	Average	43000	38500	44300		37300	43800	38400	35000	26200	28800			26800	37600
	n	123	2956	381		842	31	63	393	218	79			172	5258
2020	Average	44600	39000	45900		38200		41400	33000	27600	33800			23300	38200
	n	168	2853	221		464		59	315	181	56			88	4405
2021	Average	43700	39800	46400		40800	47800	30000	32700	23100				34300	39500
	n	408	2600	524		80	6	42	250	17				150	4077
2022	Average	46900	41000	48600		36000		35000	31000	26700				31100	39000
	n	233	2353	459		900		45	200	191				120	4500

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Table 4. Estimated total number of hooks (in thousands) that the Norwegian longliner fishery for tusk, ling and blue ling used in each of the ICES subareas/divisions and in the total area for the years 2000-2022.

All	1	2a	2b	3a	4a	4b	5a	5b	6a	6b	7c	12	14b	All areas
2000	20534	117708	5099	218	50765	4358		23020	19667	21939	4262	1306	1216	267161
2001	10831	127724	20263		43691			31309	22221	11833	2152	5703	481	276508
2002	20551	143486	4032		54313			30089	14953	14642			4389	289469
2003	21868	131972	5425	1718	36565	1693	3526	38367	18359	9773		2038	5389	279406
2004	27891	107957	15069		29264		2220	46497	15433	6785	1086		4827	262325
2005	29306	103808	19155		33188		1802	24476	24187	11216	521		3697	248895
2006	12775	89783	4126		45966		2260	10758	10239	7907				183567
2007	19081	131569	29434		33381	4228	1881	17028	9604	8081	1150			253676
2008	9282	119524	25693	1313	31876		4709	11075	9475	2413			681	215719
2009	25313	137075	29746	1178	63806	1026	1775	3825	5820	2968			717	273523
2010	11345	138527	18931		4078		706	2632		8383			1343	189277
2011	16965	141922	5363		26124	4257	2133	1007	9037	5279				209464
2012	11805	104733	5523		32422	1230	2423	1566	3825	6108			655	171952
2013	7821	77963	2772		26500	1419	2039	858	8966	3633			1815	133752
2014	4901	63118	2062		29592	1160	1821	3536	6313	3801			1163	116875
2015	7220	68145	4350	0	31500	1020	1580	8910	6907,5	3625	0	0	1490	130975
2016	4000	74722	7350	0	27125	875	1850	6200	5280	5250	0	0	2355	133500
2017	12510	60225	16125	0	30855		1685	7500	8288	2768	0	0	2540	137065
2018	4451	69069	6552	0	26114	1157	2215	5970	9126	3682	0	0	3682	128588
2019	5805	113306	16745	0	31220	1183	2074	14175	5659	2333	0	0	4342	196949
2020	8028	111150	9639	0	17190	0	2484	10890	4968	2028	0	0	2097	168462
2021	18179	103480	24128	0	3182		1560	8502	601	0	0	0	5351	162266
2022	10975	101270	22745	0	31824		1820	6448	4859	0	0	0	4043	180492

Annex 4: Audit reports

Review of ICES Scientific Report, Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP) 2022, 3rd - 09th May 2023

Reviewers: Ricardo Sousa

Expert group Chair: Elvar Hallfredsson (NOR) & Juan Gil Herrera (ES)

Secretariat representative: David Miller

Audience to write for: advice drafting group, ACOM, and next year's expert group

General
Assessment was performed according to the stock annex.

For single-stock summary sheet advice

Stock Tusk (*Brosme brosme*) in Subarea 14 and Division 5.a (East Greenland and Iceland grounds) - **usk.27.5a14**

Short description of the assessment as follows:

1) **Assessment type:** Analytical age-based assessment (SAM model).
2) **Assessment:** Update.
3) **Forecast:** Presented.
4) **Assessment model:** Precautionary approach and conforms to ICES MSY framework.
5) **Consistency:** Advice is consistent with reported data.
6) **Stock status:** Fishing pressure on the stock is below FMSY, and spawning-stock size is above MSY Btrigger, Bpa, and Blim.
7) **Management plan:** Yes. Management plan for the stock component in Division 5.a. (Icelandic tusk), which has been evaluated by ICES.

General comments

The advice sheet was easy to follow and interpret.

Data have been updated with available information.

Last benchmarked in 2022.

Technical comments
No additional comments.

Conclusions

The assessment has been performed correctly.

Review of ICES Scientific Report. Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 2023, 3 - 9 May

Reviewers: Bruno Almón

Expert group Chair: Elvar Hallfredsson and Juan Gil

Secretariat representative: David Miller

General

Assessment was made according to the benchmark conclusions and updated with the new information.

For single-stock summary sheet advice

Stock

Atlantic wolffish (*Anarhichas lupus*) in Division 5.a (Iceland grounds)

Short description of the assessment as follows (examples in grey text):

1) Assessment type: Update
2) Assessment: Analytical age-based assessment
3) Forecast: accepted
4) Assessment model: SAM model
5) Consistency: The Icelandic Ministry of Industries and Innovation's fisheries management plan for Icelandic Atlantic wolffish has been evaluated by ICES in 2022. It was considered to be precautionary and conforms to ICES MSY approach, and a SAM model was agreed upon for use in the assessment
6) Stock status: SSB has been rather stable over the time period, while fishing mortality has gradually decreased, and recruitment has slightly decreased after 2001 but remained stable.
7) Management plan: Icelandic management plan, benchmarked in 2022 (ICES, 2022a).

General comments
In the evaluation of the management plan, the basis for the assessment was revised and the adopted harvest control rule (HCR) was considered in accordance with the precautionary approach and consistent with the ICES MSY framework.

Technical comments
The catch scenario is provided for the fishery year from 1 September 2022 to 31 August 2023.

Conclusions
The assessment has been performed correctly.

<u>Format for audits</u> (to be drawn up by expert groups and not review groups)

Review of ICES Scientific Report, WGDEEP, 2023, 3. - 9. May

Reviewer: **Lise Helen Ofstad**

Expert group Chairs: **Elvar Hallfredsson and Juan Gil Herrera**

Secretariat representative: **David Miller**

General
Assessment was made according to the rbf rule.

Stock **Ling 27.1-2**,

1) Assessment type: "update"
2) Assessment: accepted
3) Forecast: not presented
4) Assessment model: rbf rule instead of 3/2 rule. Standardized CPUE index from Norwegian longline target fishery (where ling >30% of catch), data since 2000. LBI, data since 2001.
5) Consistency: the rbf rule was applied for the first time this year
6) Stock status: The estimated biomass index has decreased by 9% (A/B=0.91). The abundance index has decreased in resent years, but is well above the mean value. The exploitation status from LBI has been below the $F_{MSY\ proxy}$ for the whole period (data since 2000). The fishing pressure proxy relative to MSY proxy was 0.95.
7) Management plan: None

General comments
The rbf rule, from the ICES framework for category 3 stocks, was used for the first time this year. The assessment appears to have been carried out according to the agreed use of the rbf rule. The report and stock annex will be fully updated with information about the rbf rule and the numbers used in it.

This stock has never been benchmarked. It seems that there exist enough data to do an exploratory age-based assessment on this stock. There have been routinely collected lengths, weights and ages from the landings (since 2002), and the cpue from the reference fleet could be used as tuning series (data since 2000).

Technical comments
None

Conclusions
The assessment has been completed correctly

Format for audits (to be drawn up by expert groups and not review groups)

Audit of Ling in Division 5.a (Iceland grounds) (WGDEEP 2023)

Reviewers: Erik Berg

Expert group Chair: Elvar Hallfredsson

Secretariat representative: David Miller

Audience to write for: advice drafting group, ACOM, and next year's expert group

General
Lin.27.5a assessment and draft advice have been approved by the Working Group (WGDEEP).

For single-stock summary sheet advice

Stock: Ling (*Molva molva*) in Division 5.a (Iceland grounds); lin.27.5a

Short description of the assessment as follows (examples in grey text):

1) Assessment type: update
2) Assessment: accepted
3) Forecast: not presented in the report. Some results presented in the advice sheet.
4) Assessment model: SAM
5) Consistency: Seems to overestimate stock in assessment year
6) Stock status: B > B_{lim}, B_{pa}, $B_{trigger}$; F_{lim} < F = F_{pa}; R uncertain, seems to be lower than in the period 2000-2010.
7) Management plan: agreed in 2022: The plan is evaluated and considered to be precautionary and conforms to ICES MSY approach.

General comments
This was a well-documented and ordered section. It was easy to follow and interpret. The stock was benchmarked in 2022 and a new model is used (now SAM, earlier Gadget). The stock annex is not updated since 2017 and it's therefore not possible to audit the assessment according to the stock annex.

The forecast (short time prediction) should be included in the report. It's impossible to audit the forecast without knowing model used in forecast in addition to the numbers going in and the numbers coming out of the forecast.

Technical comments
No technical comments.

Conclusions
The assessment has "probably" been performed correctly and gives a valid basis for advice. Stock annex should be updated.

Review of **Ling 27.5b**, WGDEEP 2023, 03 th May to 09th May

Reviewers: **Wendell Medeiros-Leal**

Expert group Chair: **Elvar Hallfredsson and Juan Gil Herrera**

Secretariat representative: **David Miller**

Stock: Ling (*Molva Molva*) in Division 5.b

Short description of the assessment as follows:

1) **Assessment type:** Category 1. Benchmarked in 2021
2) **Assessment:** Accepted
3) **Forecast**: Accepted
4) **Assessment model:** Age-based analytical assessment (SAM) that uses catches in the model and in the forecast. Tunning series; Faroese spring and summer groundfish surveys.
5) **Consistency:** The assessment of ling in division 5.b was upgraded from category 3 to category 1 in 2021. A revision of the stock size and SSB trend showed large decrease in recruitment in recent years.
6) **Stock status**: F_{pa} and F_{lim} < Fishing mortality > $F_{MSY;}$ SBB > MSY $B_{trigger}$ and between B_{pa} and $Bl_{im;}$ R and SSB have decreasing in the last 5 years; F shows an increasing trend in recent years.
7) **Management plan:** Adjust effort corresponding to catch advice was adopted in 2020 and applied in 2021. For 2022 ICES is not aware of any agreed precautionary management plan for ling in this area.

General comments

The text it is according to the standards sentences and tables for the advice sheets. Stock development over time, quality and basis of the assessment, reference points and history of the catch and landings are well described. The advice was updated in the stock annex.

Technical comments

The stock annex was fully updated. A description of the fishery dependent and independent data, the traits of life-history, biology of ling in division 5.b, and detailed information about the age-based analytical assessment (SAM) are provided. Minor comments suggested in the report section.

Conclusions

The assessment has been performed correctly and according to the stock annex.

<u>Format for audits</u> (to be drawn up by expert groups and not review groups)

Review of ICES Scientific Report, Working Group on Biology and Assessment of Deep-sea fisheries resources (WGDEEP) , 2023, 2nd-9th May

Reviewers: Inês Farias

Expert group Chair: Elvar Halfredsson, Juan Gil

Secretariat representative: David Miller

Audience to write for: advice drafting group, ACOM, and next year's expert group

General
Recommendations, general remarks for expert groups, etc. (use bullet points and subheadings if needed)
Since 2015, greater silver smelt is now divided into four management units by ICES areas;

- aru.27.123a4 in ICES areas 1, 2, 3a and 4;
- aru.27.5a14 in ICES areas 5a and 14;
- aru.27.5b6a in ICES areas 5b and 6a;
- aru.27.6b7–1012 in ICES areas 6b, 7-10 and 12.

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.
Additionally, 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. Catches in this area increased substantially after 2012 with peak in 2018. While the years 2019-2021 show a declining trend, the catches from this area has increased again in 2022.

For single-stock summary sheet advice

Stock **aru.27.123a4**

Short description of the assessment as follows (examples in grey text):

1) Assessment type: MSY approach
2) Assessment: accepted
3) Forecast: accepted
4) Assessment model: rfb rule applied for a trend-based advice. The relative biomass index from SPiCT was used for the stock development.
5) Consistency: Last assessment was in 2021 (after benchmark in 2020) and was accepted; this year's accepted. Both accepted the 2 over 3 rule.
6) Stock status: Relative biomass is above MSY Btrigger proxy (Itrigger) and the fishing pressure is below FMSY proxy
7) Management plan: ICES is not aware of any agreed precautionary management plan for greater silver smelt in these areas.

General comments
Due to covid19 complications, the 2020 Norwegian slope survey in subareas 1 and 2 did not cover the northernmost survey area (stratum 3). The biomass estimates for this stratum has been minor compared to stratum 1A and 2A (Figure 6.2.11). Thus, the SPiCT analysis was run with summed biomass estimates for stratum 1A and 2A, leaving out stratum 3. The SPiCT analysis for 2022 are run with the acoustic index from the Norwegian slope survey conducted in 2022.

Existing abundance, length and age data series for this stock are rather short compared to potential life span of the species (approx. 30 years). However, if the time-series are maintained they may support more analytical assessment in a near future.

It is foreseeably a labour-intensive task to get the logbooks prior to 2011 digitalized, and a cost-benefit consideration is needed based on further analysis of the electronic logbook data and experience with CPUE series from other areas. It is currently unknown if the CPUE reliably will reflect the dynamics in the population.

Technical comments

The assessment is in accordance to the WKGSS 2020 benchmark workshop and the recommendations from WKLIFE X, regarding applying ICES-rfb rule.

Conclusions

The assessment is in accordance with the WKGSS 2020 benchmark workshop.

The advice is in accordance with the SA.

Review of ICES Scientific Report, Working group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 2023, 3rd – 9th of May.

Reviewers: Magnús Thorlacius

Expert group Chair: Elvar Hallfreðsson and Juan Gil Herrera

Secretariat representative: David Miller

General
The assessment was made according to the benchmark conclusions and updated with the new information.

For single-stock summary sheet advice

Stock
Greater silver smelt (Argentina silus) in Divisions 5.b and 6.a (Faroese grounds)

Short description of the assessment as follows (examples in grey text):

1) Assessment type: update
2) Assessment: Analytical age-based assessment
3) Forecast: accepted
4) Assessment model: SAM model
5) Consistency: The management plan has been evaluated by ICES in 2021. Despite a discrepancy in calculated catch (InterCatch) and SAM estimates, the model is considered to be precautionary and conforms with ICES MSY approach. The SAM model was agreed upon for use in the assessment.
6) Stock status: The stock SSB is in decline but fishing mortality is below FMSY, recruitment is increasing and an upward retrospective SSB change occurred from 2022 to 2023, limiting the change in advice since last year.
7) Management plan: the current management plan was benchmarked in 2021 (ICES, 2021)

General comments

In the evaluation of the management plan, the basis for the assessment was revised and the adopted harvest control rule (HCR) was considered in accordance with the precautionary approach and consistent with the ICES MSY framework.

Technical comments

Conclusions
The assessment has been performed correctly.

References

ICES. 2021a. Benchmark Workshop of Greater silver smelt (WKGSS; Outputs from 2020 meeting). ICES Scientific Reports, 3:5. 485 pp. https://doi.org/10.17895/ices.pub.5986

Review of ICES Scientific Report. Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 3 - 9 May 2023

Reviewers: Hannipoula Olsen

Expert group Chair: Elvar Hallfredsson and Juan Gil

Secretariat representative: David Miller

General

The assessment for aru27.6b7-1012 is a category 3 assessment giving advice every other year and last assessment was based on the 2 over 3 rule. This year the ICES-rfb rule was implemented for a trend-based advice.

For single-stock summary sheet advice

Stock **ARU.27.6b7-1012**

Short description of the assessment as follows:

1) Assessment type: update
2) Assessment: accepted
3) Forecast: not presented
4) Assessment model: Survey trends-based assessment using the ICES rfb rule for the first time with index from Spanish Porcupine Bank Bottom Trawl survey (SP-PORC [G5768]). VBGF L_∞ used is 48 cm. VBGF k used is 0.225.
5) Consistency: new approach using rfb rule applied to previous 2 over 3 rule
6) Stock status: $B>B_{trigger\ proxy}$ ($L_{trigger}$); $F>F_{msy\ proxy}$; R uncertain
7) Management plan: EU introduced TAC management in 2003. For 2023 and 2024, EU TAC is 7670 t and UK TAC is 454t in subareas 5, 6 and 7 which includes directed and mixed fishery in another stock unit. Bycatch of greater silver smelt may be unavoidable in blue withing fishery.

General comments:

The Stock Annex report is updated and well documented making it easy to interpret. With the new and implemented ICES framework for category 3 stocks – the rfb rule, reference points have been defined allowing for MSY approach to be applied.

Technical comments

Are landings and discard tables in Stock annex needed? These are already listed in report.

Conclusions

Assessment is made correctly, and in accordance to the stock annex; advice is given upon ICES standards.

Review of ICES Scientific Report Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 3 - 9 May 2023

Reviewers: Guzman Diez

Expert group Chair: Elvar Hallfredsson and Juan Gil

Secretariat representative: David Miller

General

Assessment was made according to the stock annex

For single-stock summary sheet advice

Stock **bli.27.5a14**

Short description of the assessment as follows (examples in grey text):

1) Assessment type: ICES cat 3, based on Survey trends-based assessment (ICES, 2022a) with the Icelandic autumn survey (IS-SMH [G4493])
2) Assessment: accepted
3) Forecast: not presented, no forecast for cat 3
4) Assessment model: based on the rfb rule
5) Consistency: the rfb rule was applied in 2022 for the first time
6) Stock status: unknown, recent index values are low. Recruitment in the five last years is is lower than in 2008-2009, and similar to the period 1999-2007. The average of the biomass index (2 over 3 years) shows a decrease.
7) Management plan: no management plan for blue ling in this area.

General comments

Time series for the stock suggest pulses of catches and recruitment. Because of it being formed of several cohorts, the SSB (represented by the survey index of adult fish) displays a smoother time-series. For this stock the productivity aspect would deserve investigations such as exploring the difference between years with high and low catches (may be also impacted by fisheries activity) and recruitment.

Technical comments

It is a roll-over advice so the advice is the same of the previous year.
Auditors in 2022 commented that ~~T~~two survey indices (Spring and Autumn surveys) are presented in the report but only Autumn ~~one~~ is used for the advice. Although this is argued in the stock annex, it would be good to provide the arguments also in the WG report. Has the recommendation from the stock annex to explore the use of the spring survey for young fish been explored?

The stock annex has not been updated with the use of the rfb rule.

Conclusions

Assessment was made according to the stock annex. Report produced according to ICES standards, with useful and good quality figures

<u>Format for audits</u> (to be drawn up by expert groups and not review groups)

Review of ICES Scientific Report, WGDEEP 2023 3 to 9 May 2023

Reviewers: Ivone Figueiredothe

Expert group Chair: Elvar H. Hallfredsson, UK (elvar.hallfredsson@hi.no) and Juan Gil Herrera, Spain (juan.gil@ieo.csic.es)

Secretariat representative: David Miller (david.miller@ices.dk)

Audience to write for: advice drafting group, ACOM, and next year's expert group

General

Recommendations

The stock structure of blackspot seabream in ICES area is unknown but for stock assessment and scientific advice on management purposes ICES considers three different components. One of these component is Subarea 10 (Azores region). This component is assessed using a survey trend analysis. (category 3). In recent years and due to several constrains some Azorean surveys were not conducted.

In 2021, the survey did not perform all the planned fishing stations. As a consequence, the annual abundance estimate was restricted to areas I and II.

In WGDEEP 2023, length data from the fishery were only made available at the beginning of the meeting. Despite the delay the group decided to accept the data and the stock was assessed using the rfb ICES advice .

For advice other than single-stock summary fisheries advice

For single-stock summary sheet advice

Stock

Short description of the assessment as follows (examples in grey text):

1) Assessment type: MSY approach (data-limited assessment)
2) Assessment: accepted
3) Forecast:N.A.
4) Assessment model: empirical rfb rul
5) Consistency: last year's assessment adopted the 2 over 3 rule.
6) Stock status: Stock size is above MSY Btrigger proxy (Itrigger), and the fishing pressure is above FMSYproxy
7) Management plan: ICES is not aware of any agreed precautionary management plan for blackspot seabream in this area.

General comments

In 2023 the "rfb" rule was applied to the stock. Due to the interruption of COVID-19 and a strike of the crew members of the research vessel, the annual Azorean spring bottom longline survey was not carried in 2020 and in 2022. As conseuquence, the WGDEEP 2023 decided to present two alternative bases for advice:

> Scenario A: Last year´s ICES fishing opportunity advice Ay. The numerator abundance index A was calculated using 2021. The denominator abundance index B was based on an interpolated value for 2020 and 2018, 2019, 2020 indices were averaged. The r - stock abundance trend correspond to index ratio A/B. The fishing pressure proxy (f) was calculated using the length-composition from the fishery for the period 2019-2022..

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Scenario B: Average of the catches from latest three years Cy (average 2020-2022). The numerator abundance index A was calculated using 2021. The denominator abundance index B was based on an interpolated value for 2020 and 2018, 2019, 2020 indices were averaged. The r - stock abundance trend correspond to index ratio A/B. The fishing pressure proxy (f) was calculated using the length-composition from the fishery for the period 2019-2022.

For the last five years (2016-2021), survey data show an important increase in the relative abundance index relatively to the previous period.

Technical comments

Conclusions

The increase of abundance observed in the survey in recent years appears i to be consistent through all statistical survey areas. This increase may be a consequence of the restrictive management measures adopted by the Regional Azorean Government.

Format for audits (to be drawn up by expert groups and not review groups)

Review of ICES Scientific Report, (*expert group/workshop title*) (*year*) (*dates*)

Reviewers: Adriana Nogueira-Gassent

Expert group Chair: Elvar Hallfredsson and Juan Gil

Secretariat representative: David Miller

Audience to write for: advice drafting group, ACOM, and next year's expert group

General

- Lack of scientific information for that stock
- Stock is considered depleted
- No assessment for that stock
- The precautionary approach is applied

For single-stock summary sheet advice

Stock **bli27.nea (ICES 1,2,3a,4 and 12)**

Short description of the assessment as follows (examples in grey text):

1) Assessment type: update
2) Assessment: no assessment
3) Forecast: not presented
4) Assessment model: no model. Advice is based on precautionary approach (stock category 5).
5) Consistency: last assessment in 2019 was catch trends-based assessment, the precautionary approach was also applied and same advice was given (zero catches for the 3 years advice period). Consistent.
6) Stock status: the stock is considered depleted, and no sign of stock rebuilding. No reference points for this stock.
7) Management plan: ICES is not aware of any agreed precautionary management plan for blue ling in these areas

General comments

There are no more directed fisheries for that stock, it is taken only as bycatch in those areas. Since 2010, M.dypteria has been adscribe as M. macrophthalma in Subareas 8 and 9, so landings reported in the advice sheet are not from these Subareas.

Landing have been decreasing from high levels in the 1988-1993 to a 19% of that level. The stock is considered depleted.

The report was well documented. Summary advice sheet was consistent with the report. Some numbers in a table of the report had to be updated to be consistent with the advice summary sheet and it has been done.

Technical comments

None

Conclusions

Advice sheet is consistent with the information provided by the report.

Format for audits

Review of ICES Scientific Report, (*Working Group on the Biology and Assessment of Deep-sea Fisheries Resources/WGDEEP / 3. -9. May 2023*)

Reviewers: Anika Sonjudóttir

Expert group Chairs: Elvar H. Hallfredsson and Juan Gil Herrera

Secretariat representative: David Miller

Audience to write for: advice drafting group, ACOM, and next year's expert group

General
Recommendations, general remarks for expert groups, etc. (use bullet points and subheadings if needed)
1)

For single-stock summary sheet advice

Stock**: Ling in subareas 3,4, 6–9, 12, and 14 (Northeast Atlantic and Arctic Ocean)**

Short description of the assessment as follows (examples in grey text):

1) **Assessment type:** ICES framework for category 3 stocks was applied (rfb rule, method 2.1).
2) **Assessment**: accepted
3) **Forecast**: not presented
4) **Assessment model**: a standardized CPUE series from the Norwegian longline fleet
5) **Data issues:** advice is based on indices from fleet operating in subareas 4 and 6 but the advice applies for all areas.
6) **Consistency**: new approach (rfb) applied**.**
7) **Stock status**: Fishing pressure is above FMSY. No reference points for stock size have been defined.
8) **Management Plan:** ICES is not aware of any agreed precautionary management plan for ling in these areas.

General comments
The report was well documented with updated data. The advice was drafted consistently with the correspondent chapter in the report.

Conclusions
The assessment has been performed correctly

Review of ICES Scientific Report, (*WGDEEP*) *(2023)* (*May 3th – May 9th*)

Reviewers: Lise Heggebakken

Expert group Chair: Elvar Hallfredsson and Juan Gil

Secretariat representative: David Miller

General
The assessment for rng.27.1245a8914ab is a category 6 stock assessment and was previous based on average landings data from 2014-2018. Greenland provided new catch data in 2023, however there is still uncertainty over the reliability of historical landings in Subarea 13, consequently the basis for the advice given in 2023 was revised based on previous landings advice. The fishery is a bycatch fishery and trend in landings may reflect changes in activity in other fisheries rather than in stock abundance. Therefore, ICES consider that a precautionary reduction of catches should be implemented, hence the precautionary buffer was applied. It is a precautionary approach and there is no management plan.

For single-stock summary sheet advice

Stock: rng.27.1235a8914ab (Roundnose grenadier (*Coryphaenoides rupestris*) in subareas 1,2,4,8, and 9, Division 14a, and in subdivisions 14.b.2 and 5.a.2 (Northeast Atlantic and Arctic Ocean).

Short description of the assessment as follows:

1) Assessment type: no assessment
2) Assessment: accepted
3) Forecast: not presented
4) Assessment model: no model to this assessment
5) Consistency: last assessment accepted – this year's accepted with previous landings advice as basis
6) Stock status: unknown
7) Management plan: no management plan

General comments

Landings data may be overreported due to species misidentification (potential confusion in logbooks between roughhead and roundnose grenadier in divisions 2.a and 14.b). Work is underway to revise historical landings.

Technical comments
The report is well documented and easy to interpret; the documentation for the advice is fully described in the report. The advice is written according to the framework for the catch scenarios. For the basis for the advice, the previous landings advice was used instead of the average landings from four latest year, due to uncertainty in the reported landings.

Conclusions
The assessment has been performed correctly.

<u>Format for audits</u> (to be drawn up by expert groups and not review groups)

Review of ICES Scientific Report, (*WGDEEP*) *(2023*) (*May 3th – May 9th*)

Reviewers: Hege Øverbø Hansen

Expert group Chair: Elvar Hallfredsson and Juan Gil

Secretariat representative: David Miller

Audience to write for: advice drafting group, ACOM, and next year's expert group

General

The assessment for rng.27.5a10b12ac14b is a category 5 stock assessment and was based on landings data; discards were poorly known and effort data was highly uncertain. It is a precautionary approach and there is no management plan.

For single-stock summary sheet advice

Stock rng.27.5a10b12ac14b

Short description of the assessment as follows:

1) Assessment type: update
2) Assessment: accepted
3) Forecast: not presented
4) Assessment model: no model to this assessment
5) Consistency: last year assessment accepted – this year's accepted
6) Stock status: unknown
7) Management plan: no management plan

General comments

Substantial landings were recorded in the 1970s and 1980s. Since then, landings have been variable and have decreased to 0 in 2022. There is no data on abundance trends but in the absence of fishing, the stock is expected to rebuild from the past depletion state caused by exploitation before the 2000s.

Technical comments

The report is well documented and easy to interpret; the documentation for the advice is fully described in the report. The advice is written according to the framework for the catch scenarios, basis of the advice and assessment.

Conclusions

The assessment has been performed correctly.

Audit usk.27.1-2

Review of ICES Scientific Report. Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 3. -9. May 2023, Lisbon (hybrid meeting)

Reviewers: Pascal Lorance

Expert group Chair: : Elvar H. Hallfredsson and Juan Gil Herrera

Secretariat representative: David Miller

General

For single-stock summary sheet advice

Stock **usk.27.1-2 Tusk (*Brosme brosme*) in subareas 1 and 2 (Northeast Arctic)**

Short description of the assessment as follows (examples in grey text):

1) Assessment type: MSY approach using the rfb rule (ICES framework for ICES Category 3 stocks)Assessment: accepted
2) Forecast: not presented
3) Assessment model: rfb rule, with *r* estimated from the CPUE of the Norwegian longline fleet targeting ling in the stock area, *f* estimated from the length distribution of the catch and b, estimted to be 1 as the CPUE trend show a clear increase since a low level in 2003. The availability of more data for several stocks of ling and tusk
4) Consistency: The previous (2021) assessment was based upon the 2 over 3 rule and was accepted. The 2023 assessment was based on the rfb rule, so not directly comparable to the previous. The *r* of the rfb rule is based on the same time-series (updated) as the biomass index from the previous assessment. It is a CPUE of Norwegian longline fleet targeting ling in the stock area. This fleet makes up the bulk of the catch. As discards are forbidden in the stock area, the assessment and advice are based on catches (=landings). The biomass biomass is decreasing since 2017 after a sustained increase in 2003-2017.
5) Stock status:exploited near MSY levels
6) Management plan: None.

General comments Current levels of the biomass index (*r* of the rfb rule) are well above the early 2000s level so the *b* factor of the rfb rule is 1. The more advanced rfb rule, compared to the 2 over 3 rule, includes the *f* multiplier which is a length-based proxy for fishing pressure relative to F_{MSY}. Here *f* suggest the stock is exploited below F_{MSY} . Other stocks where Norwegian longliner are one of the main fleet showed different stock status (e.g. lin.27.346-91214 was assessed as exploited above MSY, $f<1$). Lastly the rule was applied with the multiplier m=0.95, clealry appropriate for tusk, as relatively long-lived species so $k<0.2$). The time series of the LBI used for the evaluation of the exploitation status (inverse of the *f* of rhe rfb rule), suggests the stock has been exploited below F_{MSY} in the past 20 years, which is in line with the general increase of the CPUE.

Technical comments The availability of more data for several stocks of ling and tusk including some with survey data available was discussed at the EG, which considered the CPUE data was reliable.

Conclusions
Assessment and adive are correct, suitable detail are provided in the report

Audit 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)

Review of ICES Scientific Report. Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 3. -9. May 2023, Lisbon (hybrid meeting)

Reviewers: Pascal Lorance

Expert group Chair: : Elvar H. Hallfredsson and Juan Gil Herrera

Secretariat representative: David Miller

General
None

For single-stock summary sheet advice

Stock **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**

Short description of the assessment :

1) Assessment type: MSY approach using the rfb rule (ICES framework for ICES Category 3 stocks)
2) Assessment: accepted
3) Forecast: not presented
4) Assessment model: rfb rule, with *r* estimated from the CPUE of the Norwegian longline fleet targeting ling in the stock area, *f* estimated from the length distribution of the catch and b, estimted to be 1 as the CPUE trend show a clear increase since a low level in 2003.
5) Consistency: The previous (2021) assessment was based upon the 2 over 3 rule and was accepted. The 2023 assessment was based on the rfb rule, so not directly comparable to the previous. The *r* of the rfb rule is based on the same time-series (updated) as the biomass index from the previous assessment. It is a CPUE of Norwegian longline fleet targeting ling in the stock area, the main fishing fleet for the stock. Discards are minor but are considered in the assessement. The biomass index shows strong year-to-year variations, which are unlikely to be related to actual year-to-year changes in stock biomass. These may rather come from fishing strategy (e.g. target species or accurate spatial or depth distribution of the fishing) is decreasing since 2017 after a sustained increase in 2003-2017.
6) Stock status:exploited near MSY levels
7) Management plan: None.

General comments Current levels of the biomass index (*r* of the rfb rule) are well above the early 2000s level, so the *b* factor of the rfb rule is 1. The more advanced rfb rule, compared to the 2 over 3 rule, includes the *f* multiplier which is a length-based proxy for fishing pressure relative to F_{MSY}. Here *f* suggest the stock is exploited below F_{MSY} but the combination with the low *r* lead to an advised catch smaller than the previous advice. The rule was applied with the multiplier m=0.95, clealry appropriate for tusk, as relatively long-lived species so k<0.2). The time series of the LBI used for the evaluation of the exploitation status (inverse of the *f* of rhe rfb rule), suggests that the stock has been exploited at F_{MSY} at the beginning of the time-series (2003-2008) and below F_{MSY} afterwards (Figure 2 in the advice). This is in aggrement with the general increase of the CPUE from 2006-07 to 2018-2020. In recent years the biomass indicator seems to level off, with the actual *r* multiplier (2 over 3 rule) decreasing.

Technical comments None

Conclusions
The assessment and adive are correct.

Annex 5: Stock annex edits

ICES. 2023. Stock Annex: Greater silver smelt (*Argentina silus*) in divisions 5.b and 6.a (Faroes grounds and west of Scotland). ICES Stock Annexes. Report. https://doi.org/10.17895/ices.pub.23599581

ICES2023. Stock annex: Greater silver smelt (*Argentina silus*) in subareas 7–10 and 12, and Division 6.b (other areas). ICES Stock Annexes. Report. https://doi.org/10.17895/ices.pub.23599617

ICES. 2023. Stock annex: Greater forkbeard (*Phycis blennoides*) in subareas 1–10, 12 and 14 (the Northeast Atlantic and adjacent waters). ICES Stock Annexes. Report. https://doi.org/10.17895/ices.pub.23599638

ICES. 2023. Stock annex: Ling (*Molva molva*) in Division 5.a (Iceland grounds). ICES Stock Annexes. Report. https://doi.org/10.17895/ices.pub.23599644

ICES. 2023. Stock annex: Ling (*Molva molva*) in Division 5.b (Faroes grounds). ICES Stock Annexes. Report. https://doi.org/10.17895/ices.pub.23599662

ICES. 2023. Stock annex: Tusk (*Brosme brosme*) in Subarea 14 and Division 5.a (East Greenland, and Iceland grounds). ICES Stock Annexes. Report. https://doi.org/10.17895/ices.pub.23599668