9 Black scabbardfish (*Aphanopus carbo*) in the North-east 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 those 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, 2019 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 27.5.b and Subareas 27.6, 27.7, and 27.12 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 2016, there was a slight decrease.

Since 2010, Icelandic landings in ICES Division 27.5.a have increased, remaining stable around 300 t between 2012 and 2017, and decreasing in more recent years (Figure 9.4.1).

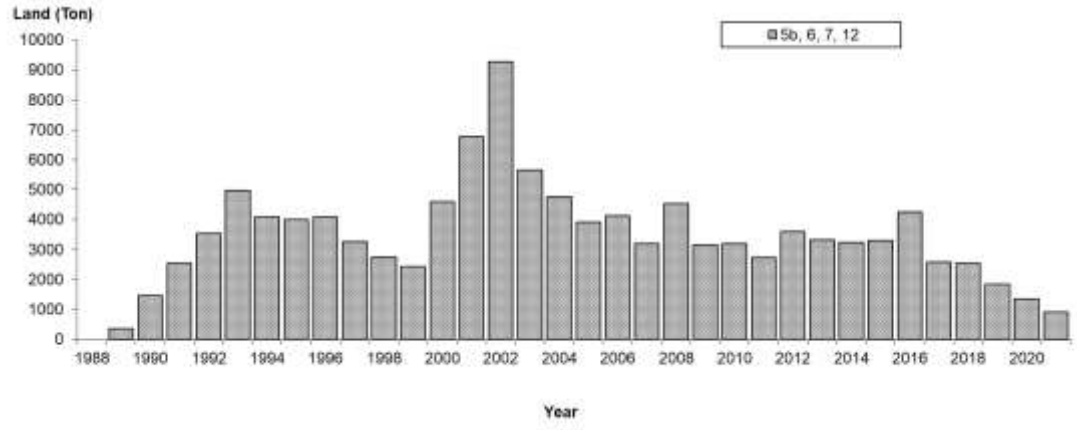


Figure 9.2.1. bsf.27.nea Northern component annual landings time-series for ICES subareas 27.5.b, 27.6, 27.7, and 27.12.

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, augmented from 2009 to 2012, showed a decreasing trend until 2020, increasing in 2021. From 2013 to 2018, the relative importance of Spanish landings of black scabbardfish showed a slight increased, decreasing between 2019 and 2021, whereas Faroese landings increased from 2017 to 2020, but their relative importance decreased in 2021 (Figure 9.2.2).

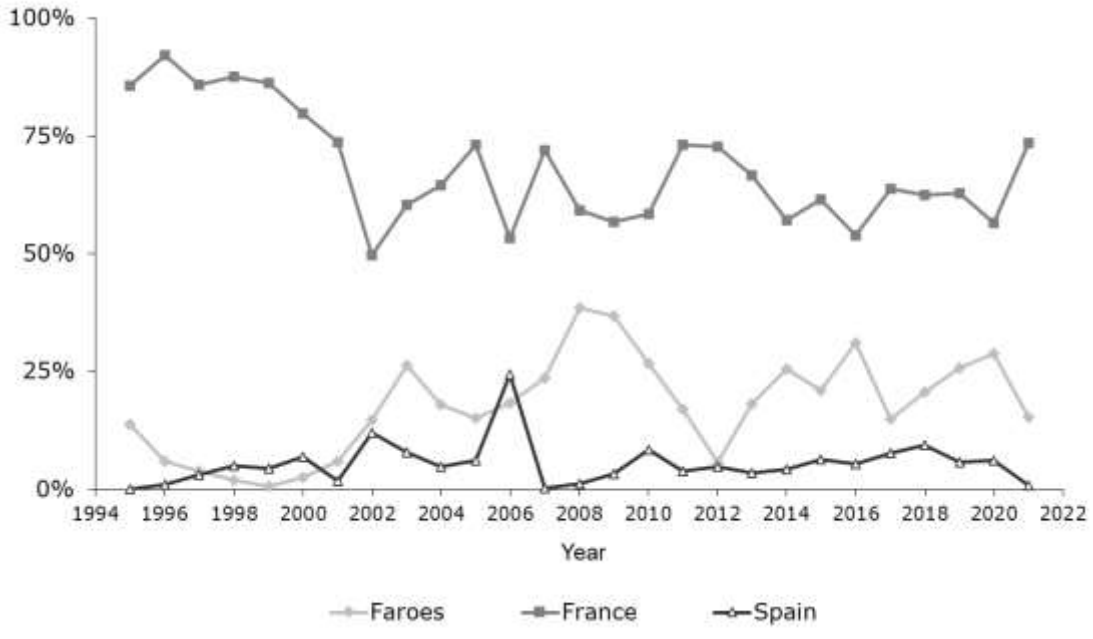


Figure 9.2.2 bsf.27.nea Northern component French, Spanish and Faroese relative contribution to the annual landings for the Northern component.

9.2.3 ICES Advice

The latest ICES advice, in 2020, was: "*ICES advises that when the precautionary approach is applied, catches should be no more than 4506 tonnes in each of the years 2021 and 2022.*

Distributed by area, this corresponds to annual catches of no more than 2143 tonnes in subareas 6 and 7 and divisions 5.b and 12.b, annual catches of no more than 2084 tonnes in Subarea 8 and Division 9.a, and annual catches of no more than 280 tonnes in subareas 1, 2, 4, and 10 and divisions 3.a and 5.a."

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 2021, 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.b, 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.b, 27.6, 27.7 and 27.12
2006	3042	4127
2007	3042	3192
2008	3042	4532
2009	2738	3160
2010	2547	3202
2011	2356	2733
2012	2179	3600
2013	3051	3332
2014	3966	3240
2015	3649	3312
2016	3357	4260
2017	2954	2595
2018	2600	2545
2019	2470	1839
2020	2470	1350
2021	583*	907

*** From 2021 onwards, the EU TAC does not include the UK quota.**

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.

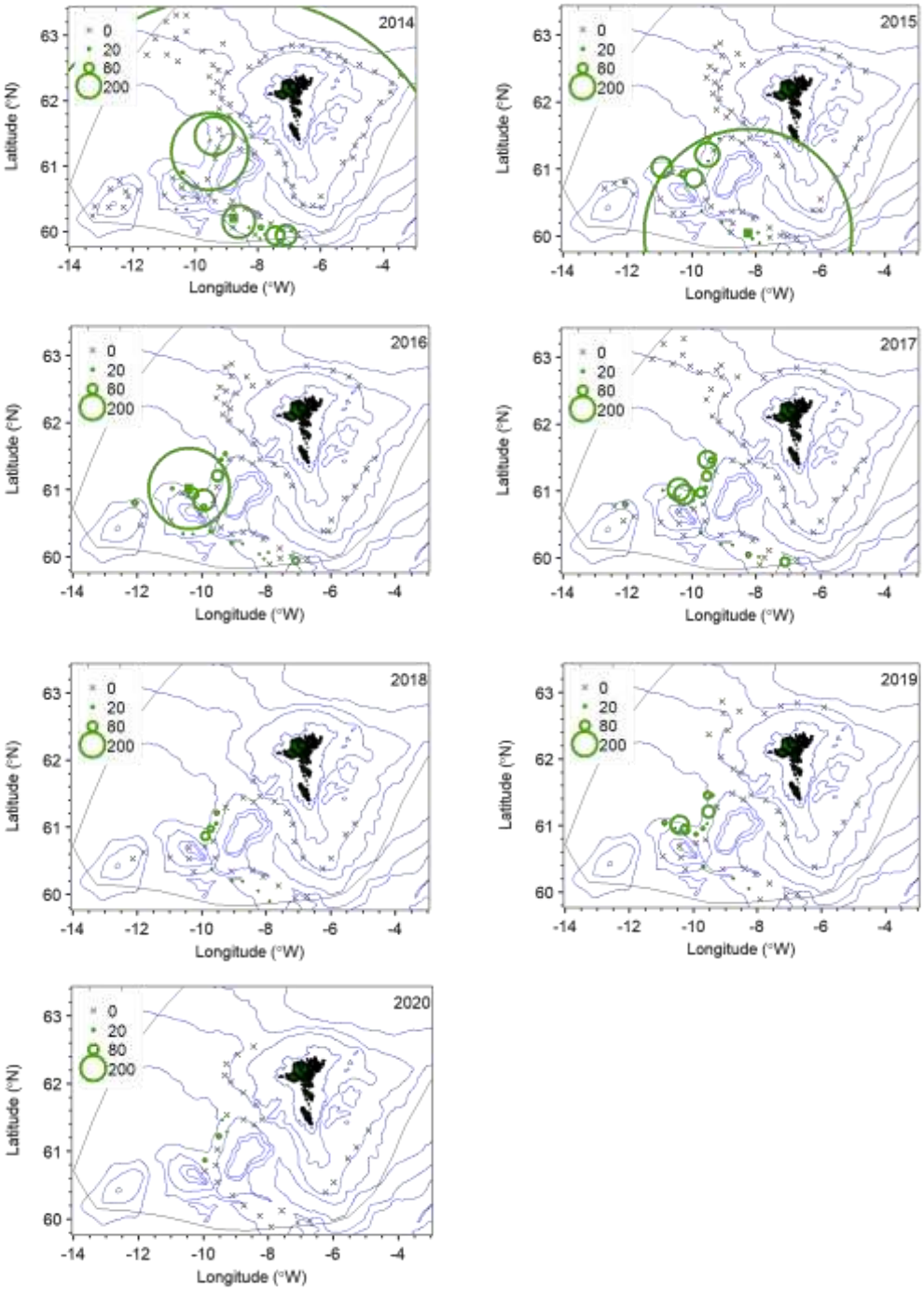


Figure 9.2.3. bsf.27.nea Northern component. Spatial distribution of CPUE (kg/h) from the deep-water surveys in 2014-2020. The green squares show the position of the largest catch. (Source: Ofstad, 2019, WD; Ofstad, L., 2020, 2021, pers. comm.).

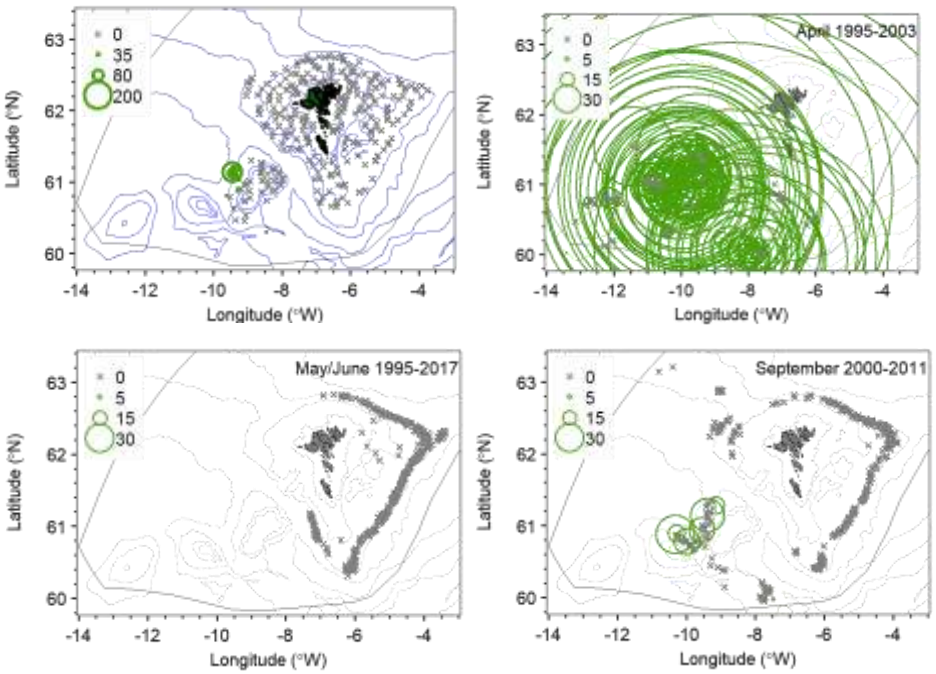


Figure 9.2.4. bsf.27.nea Northern component. Spatial distribution, CPUE (kg/h), from different surveys. Annual groundfish surveys, August 1996-2017 (upper left), Blue ling surveys, April 1995-2003 (upper right), Greenland halibut surveys, May/June 1995–2017 (lower left) and Redfish surveys, September 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).

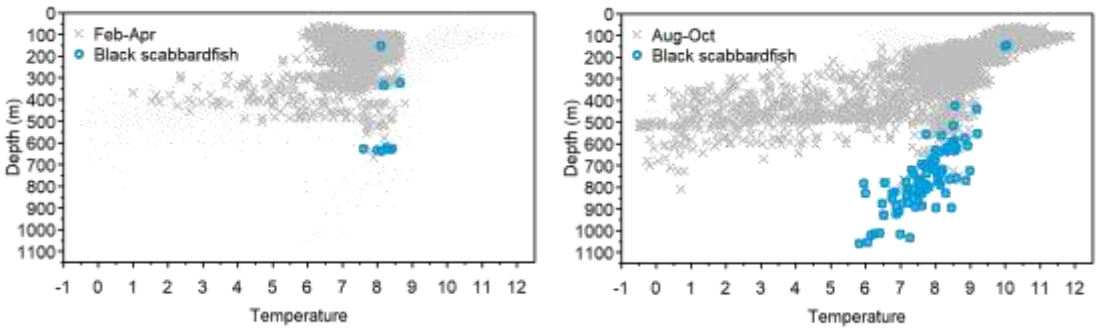


Figure 9.2.5. bsf.27.nea Northern component. Temperature and depth distribution of black scabbardfish (blue dots) and catch with no black scabbardfish (grey crosses) in February-April (left) and August-October (right). (Source: Ofstad, 2019, WD)

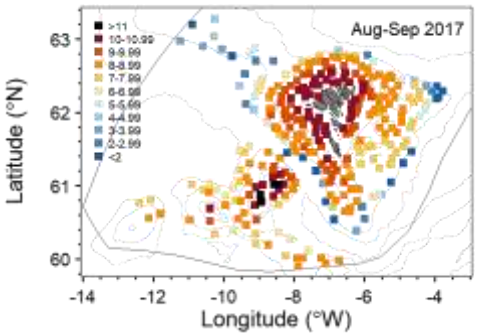


Figure 9.2.6. Temperature and depth distribution in Faroese waters August-September 2017. (Source: Ofstad, 2019, WD)

9.2.5.3 Length compositions

The annual length frequency distributions, based on French on-board observer data, for the period 2004-2020 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.

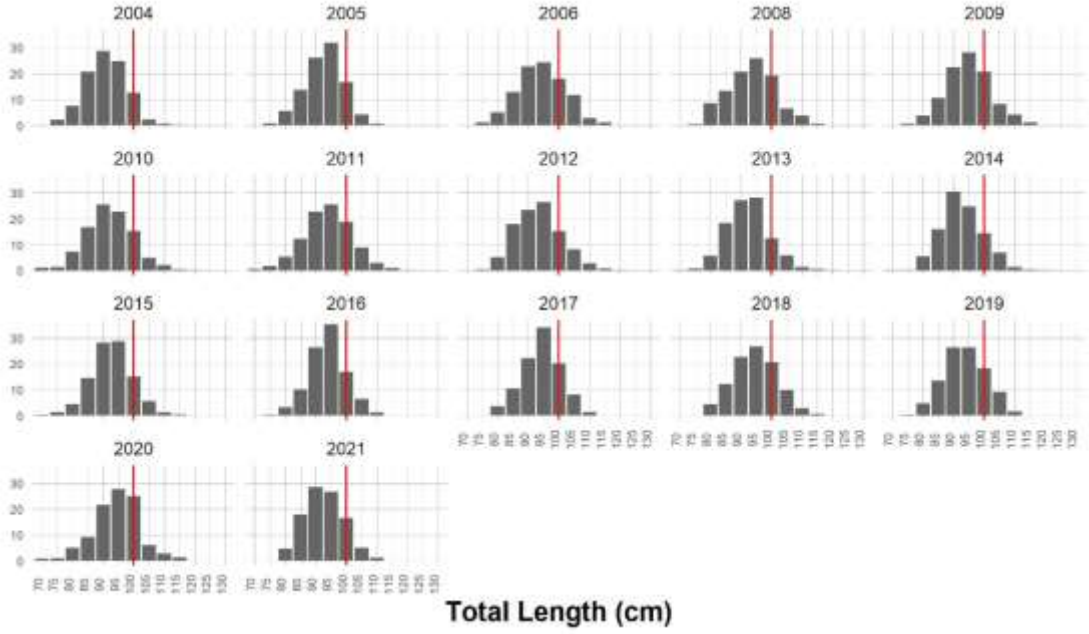


Figure 9.2.7. bsf.27.nea Northern component. Annual frequency length distribution of black scabbardfish based on French observer data collected on-board commercial vessels (2004–2021). The red vertical line indicates the length of 1st maturity of the species.

For the period 2004–2021, 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 lowest mean length values were registered in 2010 and 2020, which may be associated with a high recruitment signal.

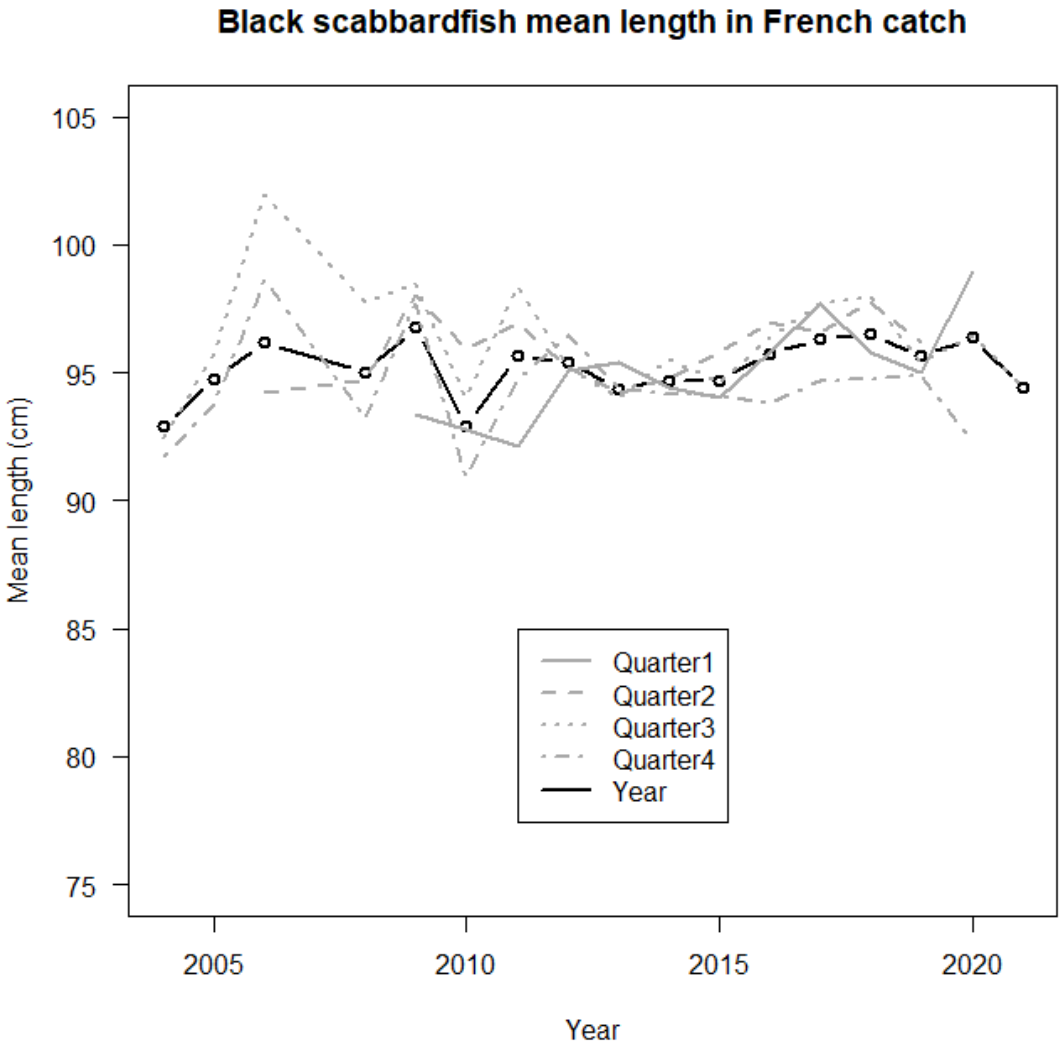


Figure 9.2.8. bsf.27.nea Northern component. Mean length estimates of black scabbardfish by quarter for the period 2004-2019. Data were collected under the French on-board observer program.

For the period 2014–2021, 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 survey 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. In 2021, there is no length data from the Faroese survey.

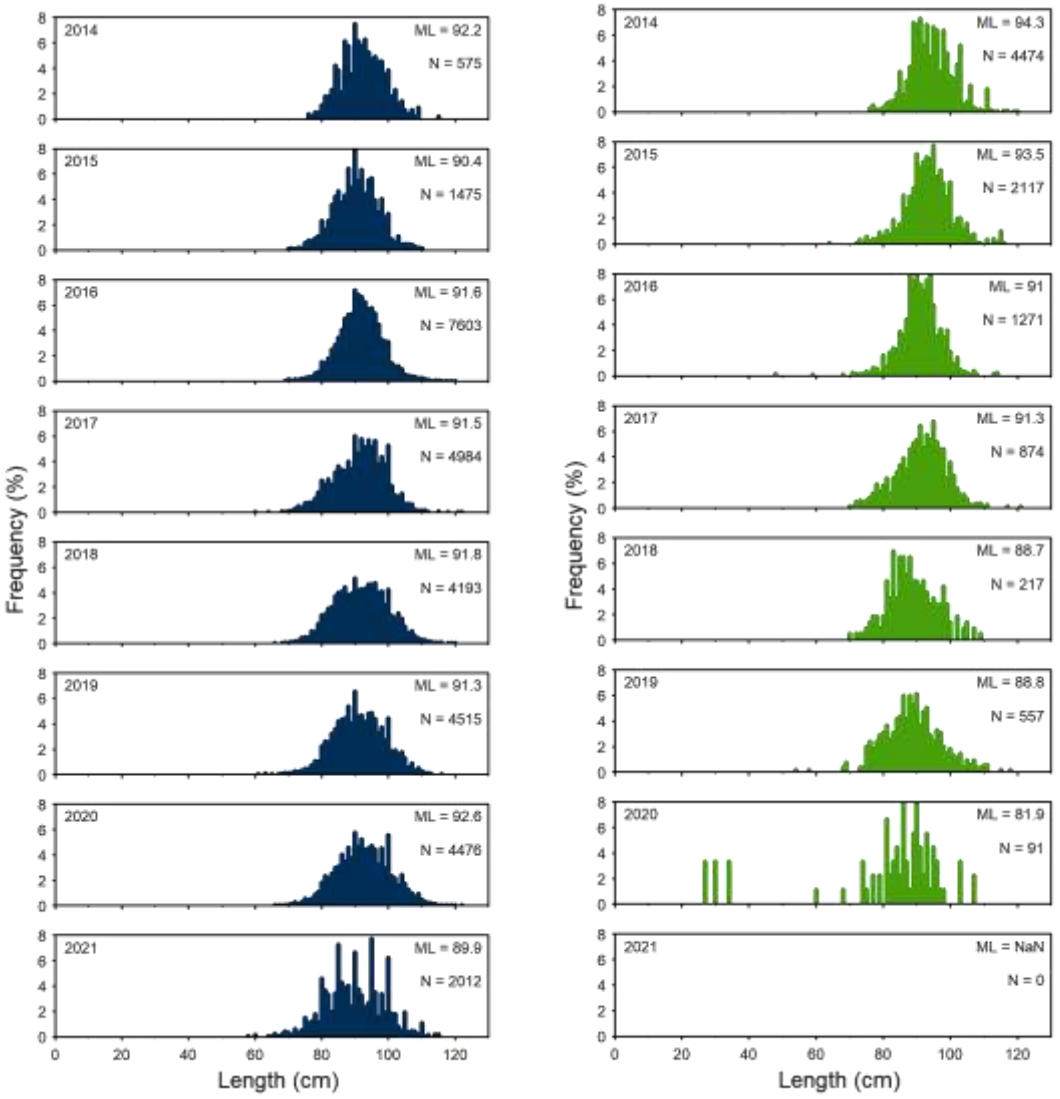


Figure 9.2.9. bsf.27.nea Northern component. Length-frequency distribution from the landings (left) and the deep-water survey (right) in 2014-2021. (Source: Ofstad, L., 2022, pers. comm.)

In 2021, 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).

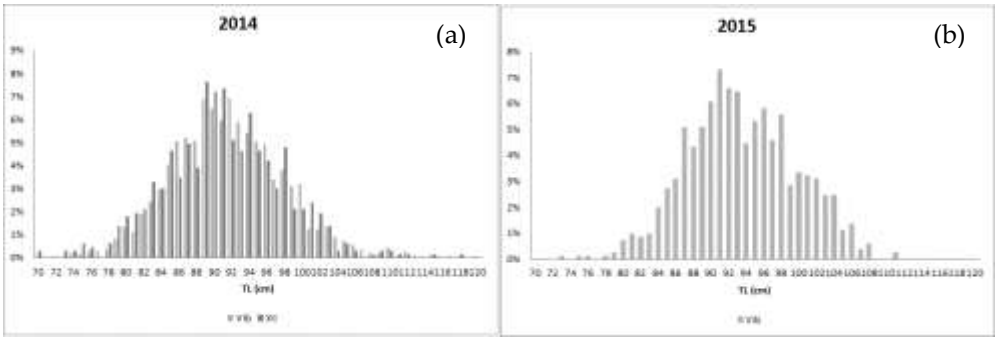


Figure 9.2.10. bsf.27.nea Northern component. Length frequency distribution based on Spanish on-board observations in 2014 (a) and in 2015 (b) in Division 6.b and Subarea 12.

Length frequency distributions for ICES Division 27.5.a based on the Icelandic Autumn surveys for the period 2000–2020 are presented in Figure 9.2.11.

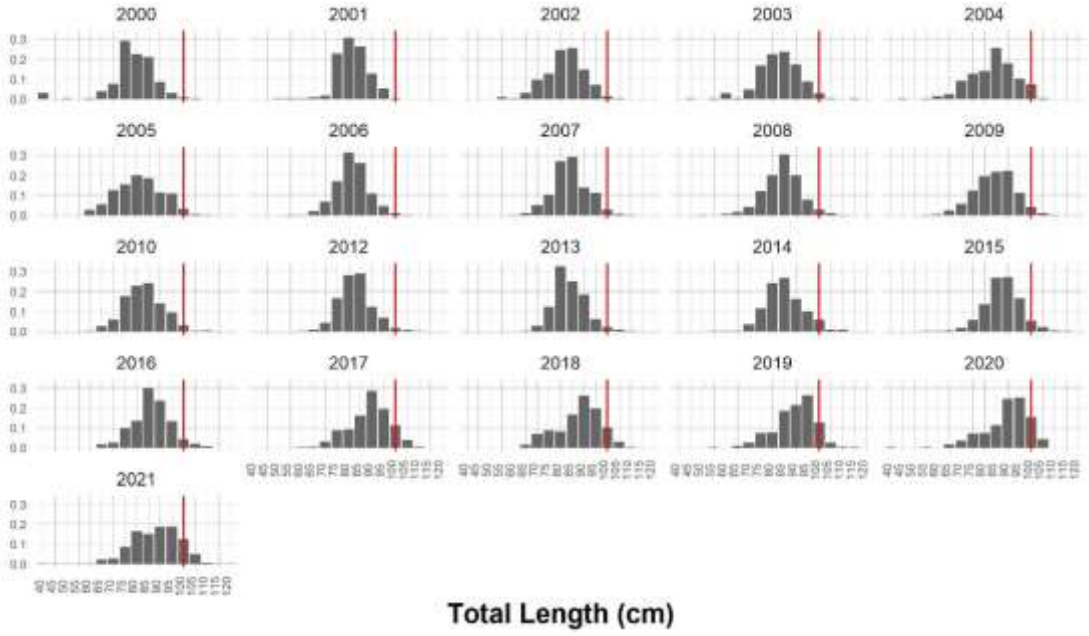


Figure 9.2.11. bsf.27.nea Northern component. Black scabbardfish in Division 27.5.a: length distribution from the Icelandic Autumn survey, from 2000 to 2019. The red vertical line indicates the length of 1st maturity of the species.

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 (length at first maturity) predominate.

The longest length data time series is from France, therefore 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 2020 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 tonnes) and number caught in length class C2 and C3 by semester. SEM1 corresponds to months 3-8 of the year and SEM 2 corresponds to months 9-12 of the year plus months 1 and 2 of the following year.

	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

No data on age composition are available. The assessment approach for the stock is a stage-based model, with stages corresponding to the broad length classes: C1: individuals < 70 cm TL, C2 individuals ≥ 70 cm and <103 cm, C3 individuals ≥ 103 cm TL.

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 juvenile 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. The model includes vessel, ICES rectangle, depth and semester as explanatory variable. The estimated CPUE is a model prediction for one vessel in one ICES rectangle and one fishing depth. 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.

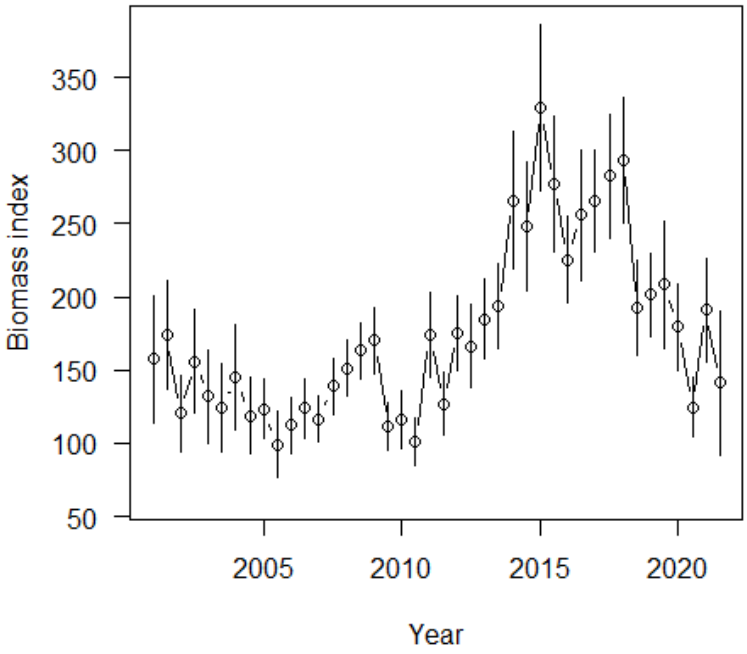


Figure 9.2.12. bsf.27.nea Northern component. CPUE by new semesters, i.e., SEM1= months 3-8 of the year and SEM2=month 9-12 of the year, plus months 1 and 2 of the next year.

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.

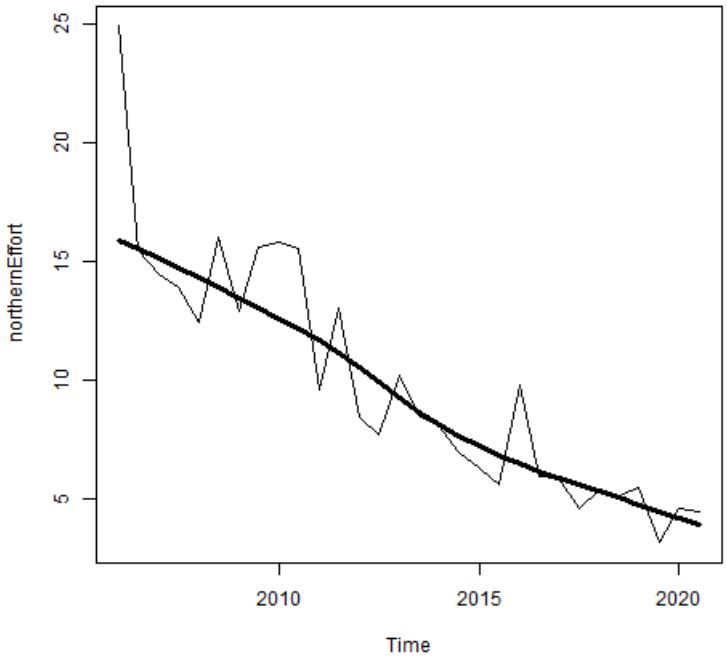


Figure 9.2.13. bsf.27.nea Northern component. Standardised effort by new semesters, i.e., SEM1= months 3-8 of the year and SEM2=month 9-12 of the year, plus months 1 and 2 of the next year.

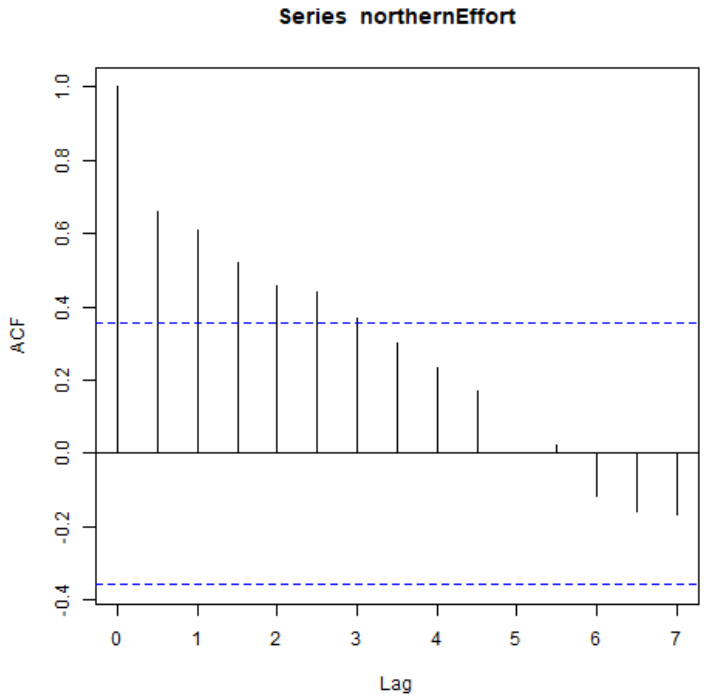


Figure 9.2.14. bsf.27.nea Northern component. Standardised fishing effort time series autocorrelation.

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.

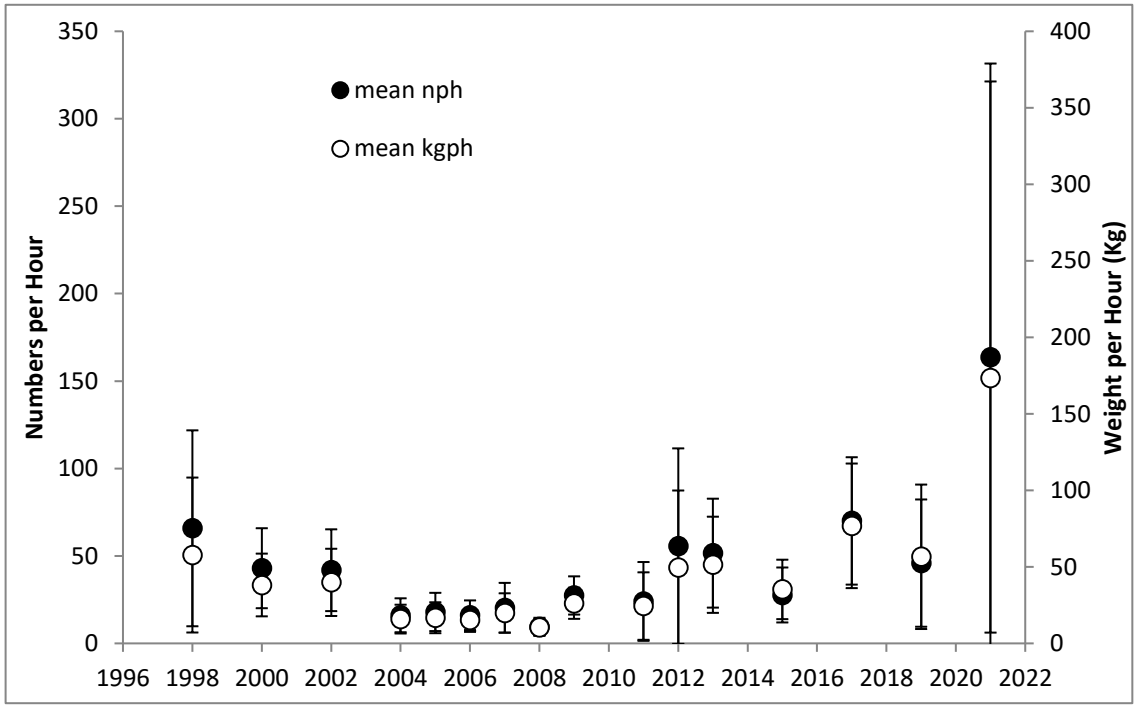


Figure 9.2.15. bsf.27.nea Northern component. Annual biomass and abundance indices of black scabbardfish estimated for depths deeper than 500 m and shallower than 1600 m, from 1998 to 2021. Seamounts/Rockall not included. (Source: Campbell, N., 2022, pers. comm.)

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 2021 (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).

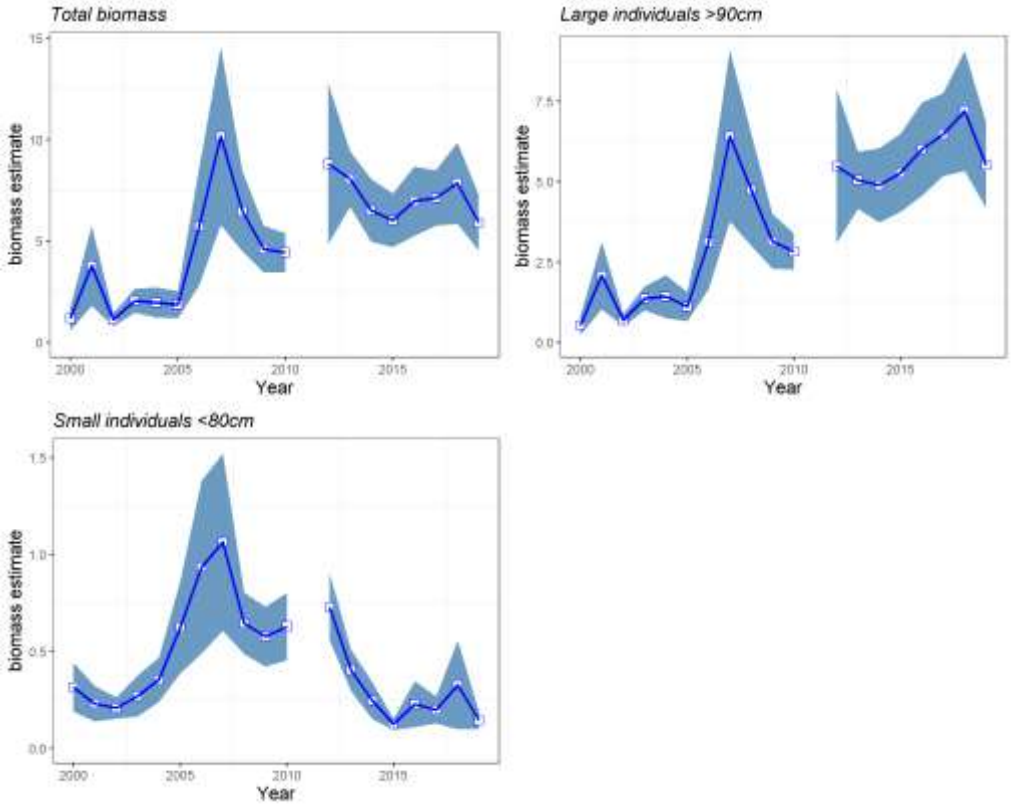


Figure 9.2.16. bsf.27.nea Northern component. Black scabbardfish biomass index with 95% confidence interval from the Icelandic Autumn survey from 2000 to 2019 for all sizes (Total biomass, upper left); specimens larger than 90 cm (Large individuals >90 cm, upper right); specimens smaller than 80 cm (Small individuals <80 cm, lower left). (Source: Woods, P., 2020, pers. comm.)

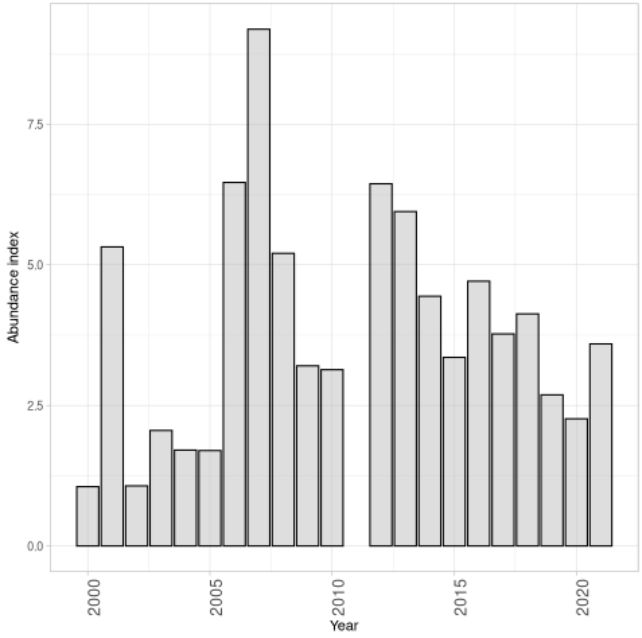


Figure 9.2.17. bsf.27.nea Northern component. Abundance of black scabbardfish from Icelandic Autumn survey from 2000 to 2021. (Source: Woods, P., 2022, pers. comm.)

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. 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 2021, 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. The temporal evolution of commercial CPUEs from Faroese trawlers in 5.b (only one trawler continued fishing the black scabbardfish in the later years, Ofstad pers. comm.) and French trawlers (mostly) in 6.a are similar with stable or decreasing CPUE until the early 2010s followed by an increase until 2015 then a decrease.

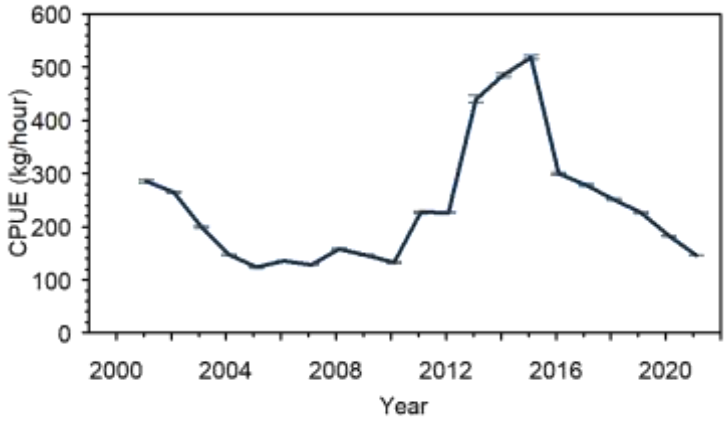


Figure 9.2.18. bsf.27.nea Northern component. Standardised CPUE (kg/hour) from Faroese commercial trawlers (> 1000 HK). Criteria: black scabbardfish >30% of total catch and effort > 2 hours per haul. (Source: Ofstad, L., 2022, pers. comm.).

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 individuals 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.

Stock assessment and model settings

Abundances of black scabbardfish at the Northern and Southern components are estimates based on two Bayesian state-space models. Under each model two separated processes run simultaneously but not independently since the migration from Northern to the Southern component is taken into account when fitting the model for the Southern component.

Model outputs provide posterior distributions of the stochastic state processes parameters associated with the species life cycle and with the migration processes. The prior distributions of those parameters are defined in a way that each of them incorporates the information available both on the biology and the fishery. More details on the definition of the prior distributions and on the model are described in the Stock Annex.

In each model an observational process is included. The observation processes consist of the Catch in number by semester.

Model adequacy

The quality of the model fitting is evaluated for each model separately. For the Northern component, the **C2** and **C3** length groups catch estimates in semester ***s*** (that are equal to the median of the posterior distributions of those state process vector components in the **s** semester) are compared with the corresponding observational catch values. For the Southern model, the catch estimates in semester **s** are obtained in the same way as for the Northern component and these are compared with the corresponding observational catch values.

The evaluation of the model's adequacy based on the expected deviance estimates (Northern component 1679.868 and Southern component 1525.611) together and the credible intervals (intervals in the domain of the posterior probability distributions) indicate a good fitting (Figure 9.2.19).

The catch estimates (posterior medians) of C2 and C3 length classes combined and the corresponding observed catch in Northern and Southern components show a good adjustment. For both components, the range of the 95% credible intervals are relatively narrow, particularly for the semesters at the end of the studied period (Figure 9.2.19).

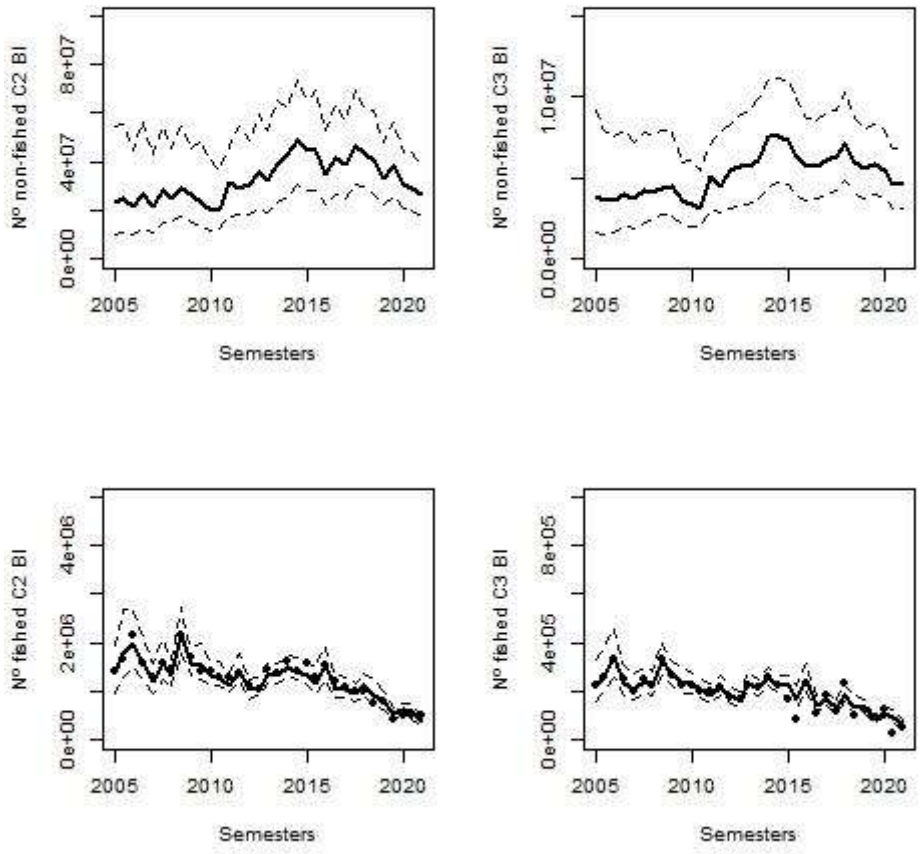


Figure 9.2.19. bsf.27.nea. Estimated catches (solid line) and 95% credible intervals (dashed lines), for Northern component C2 length group (upper left), C3 length group (upper right) and Southern component C2 length group (lower left) and C3 length group (lower right). Observed catches are represented by black dots.

The time-series of the estimates of the total abundance in the Northern component for the C2 and C3 length groups show that, in recent years, the abundance is consistently at higher levels when compared to the beginning of the series (Figure 9.2.20).

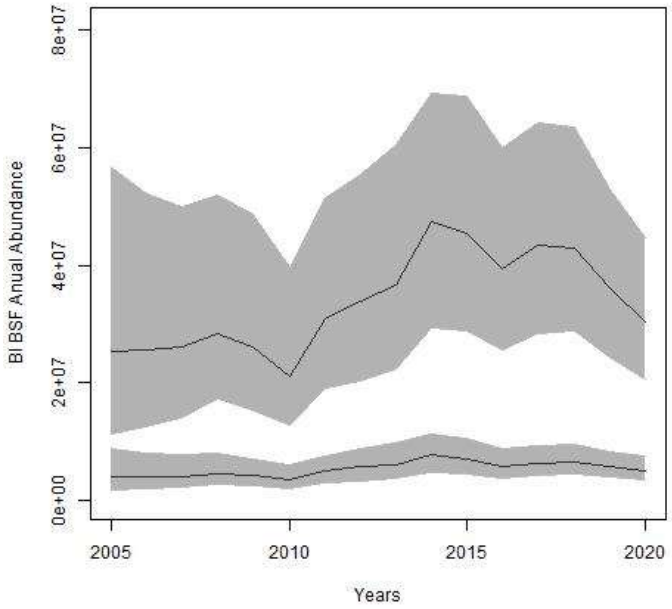


Figure 9.2.20. bsf.27.nea Northern component. Estimated black scabbardfish annual abundances for C2 (upper) and C3 (lower) length groups with the 95% credible intervals.

The temporal evolution of the total abundance in the Southern component for the C2 and C3 length group is presented in Figure 9.2.21.

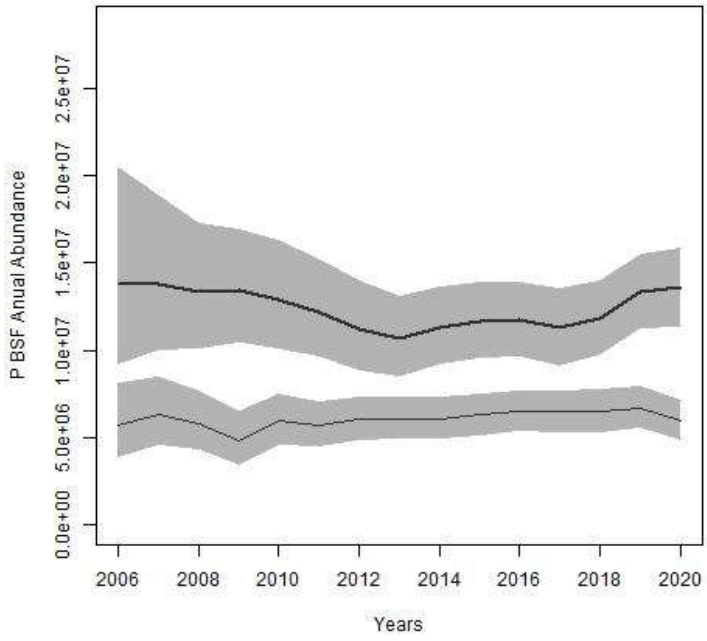


Figure 9.2.21. bsf.27.nea Southern component. Estimated black scabbardfish abundances for C2 (lower) and C3 (upper) length groups with 95% credible intervals.

For the two stock components and for both C2 and C3 length groups the credible intervals are wider at the beginning of the time series narrowing by the end of the time series, more markedly in C3 group in the Southern component (Figures 9.2.20 and 9.2.21).

The temporal evolution of the estimates of the total abundance of black scabbardfish suggests a downward trend in the Northern component, although at higher levels than at the beginning of the series, and an upward trend in the Southern component (Figure 9.2.22).

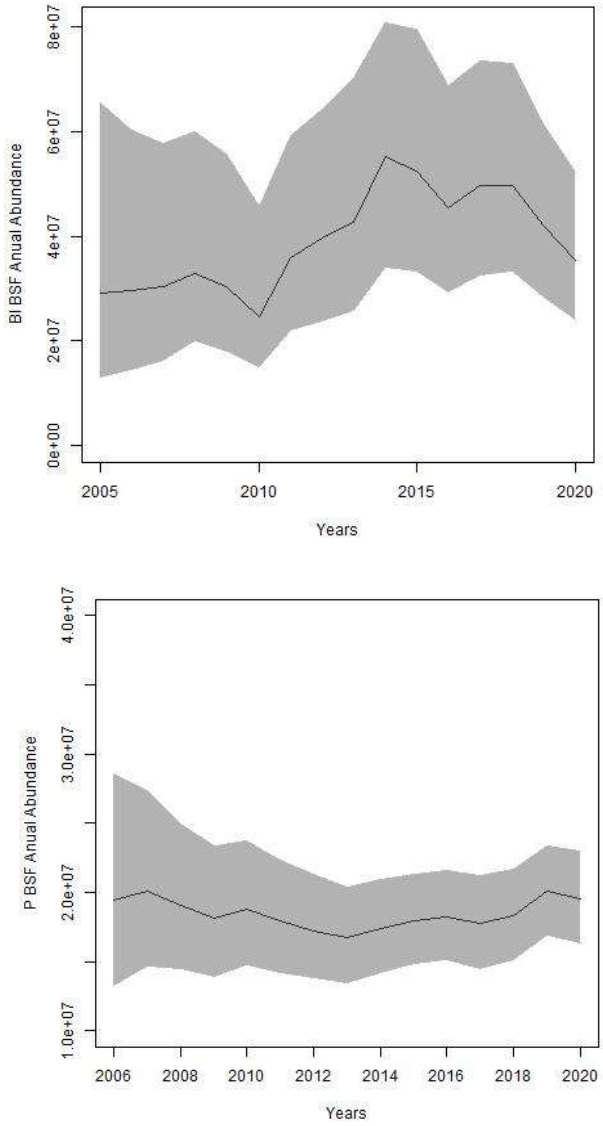


Figure 9.2.22. bsf.27.nea Northern (upper) and Southern (lower) components. Estimated black scabbardfish annual abundances with 95% credible intervals.

The posterior distributions for all the parameters of the Northern and Southern components are presented in Figures 9.2.23 and 9.2.24, respectively.

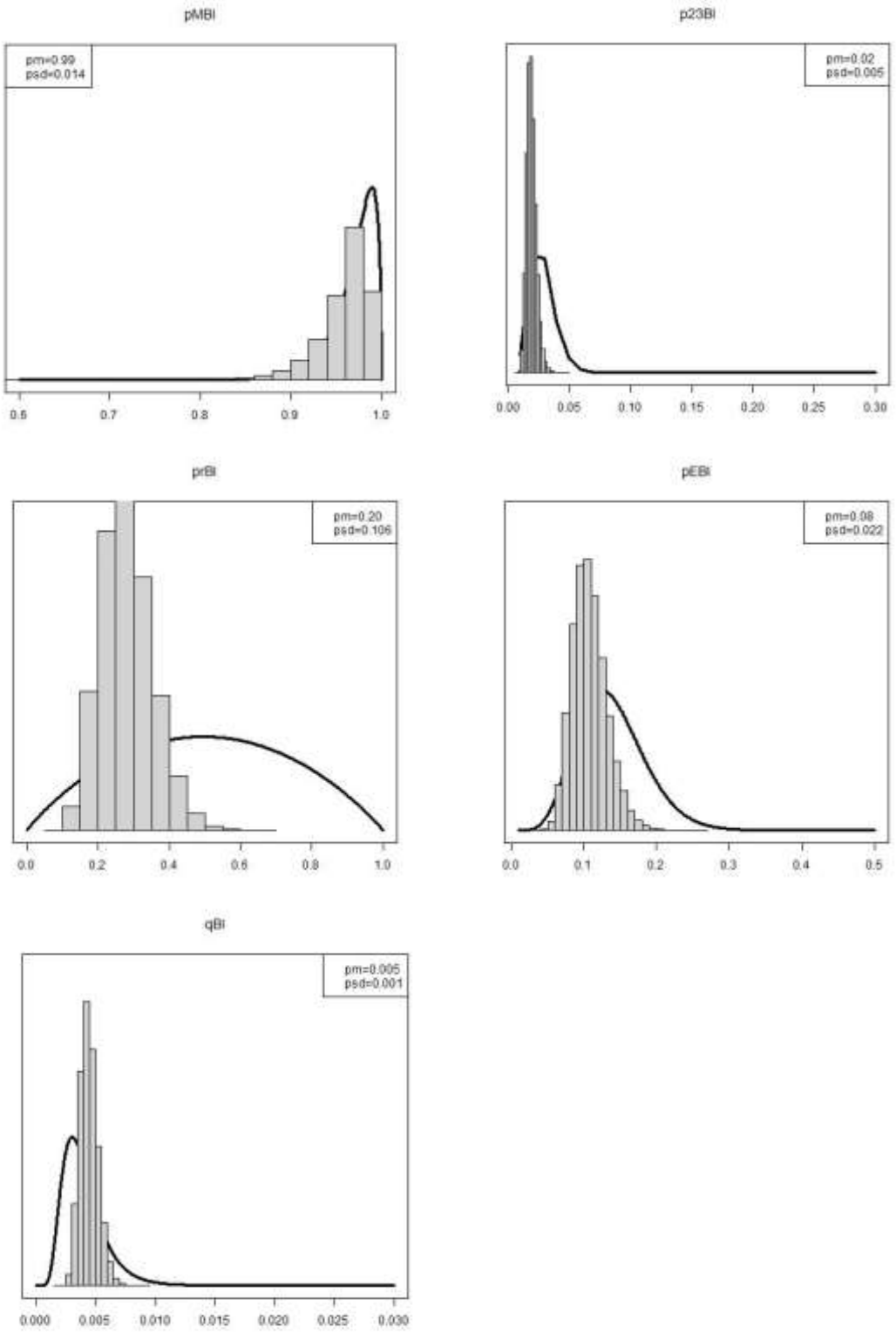


Figure 9.2.23. bsf.27.nea Northern component. Prior (thick line) and posterior distributions (histogram) for parameters of the Northern component. pMBI is the probability of surviving to natural mortality; p23BI is the probability of a specimen from the Northern component transiting from C2 to C3 during one semester. prBI is the probability of a specimen entering the length group C2 in the Northern component during the second semester; pEBI is the probability of a specimen belonging to length group C2 or C3 leaving the Northern component in the first semester; qBI is the probability of catchability in the Northern component.

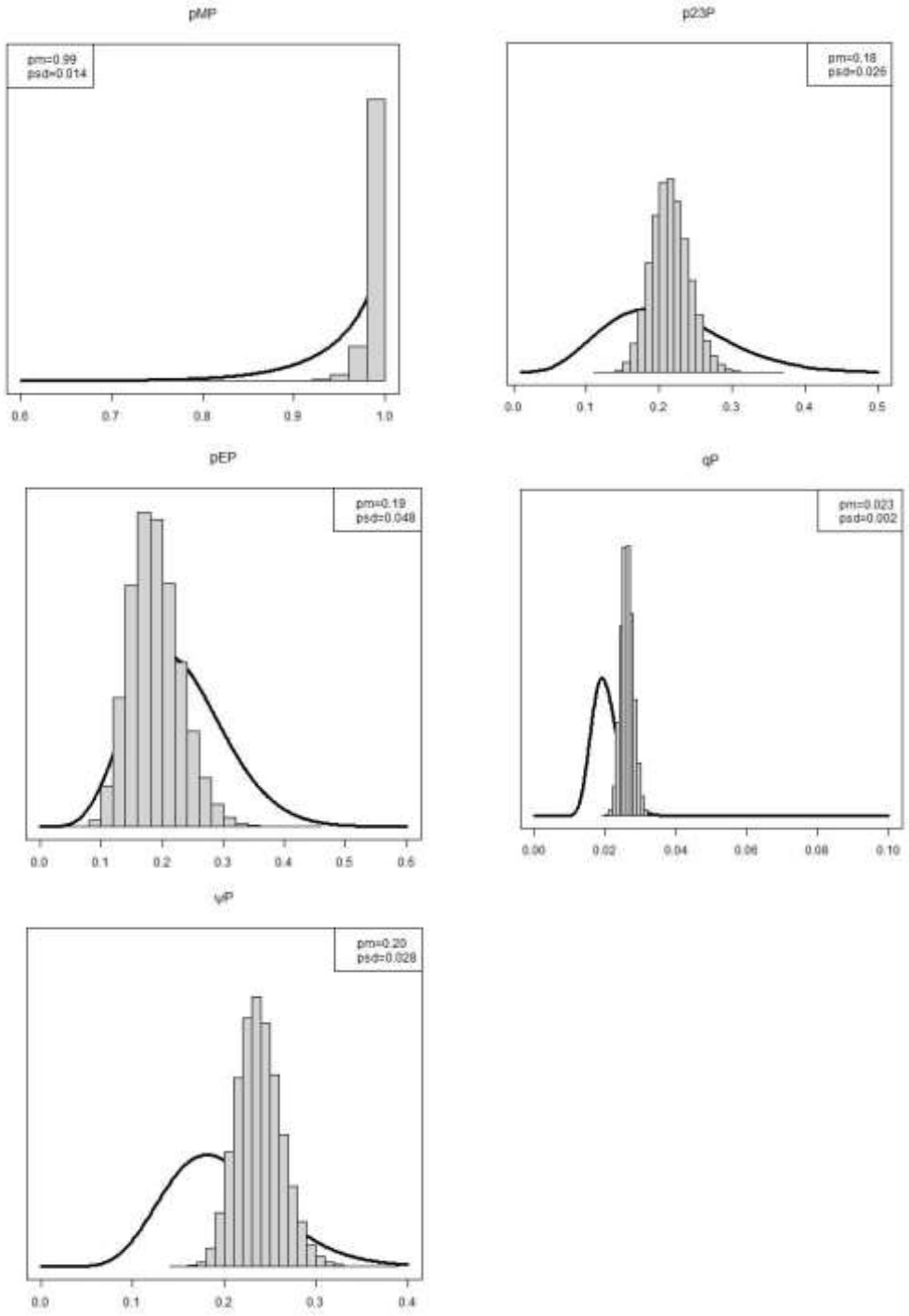


Figure 9.2.24. bsf.27.nea Southern component. Prior (thick line) and posterior distributions (histogram) for parameters of the Southern component. pMP is the probability of surviving to natural mortality; p23P is the probability of a specimen from the Southern component transiting from C2 to C3 during one semester; pEP is the probability of a specimen belonging to length group C3 leaving the Southern component in the first semester; qP is the probability of catchability in the Southern component.

All the priori distributions adopted for the parameters had a quite large coefficient of variation. These high values were included as precautionary measures to guarantee the introduction of uncertainty on their values. For most of the parameters' posterior distributions (Figures 9.2.23 and 9.2.24) it is evident that the observational data provided information to update the priori distributions. The posterior distributions have a narrow range.

HCR from WKDEEP 2014

At the WKDEEP 2014 and in view of the admitted linkage between the Northern and Southern components, it was agreed that the status of the stock as a whole in the NE Atlantic should be considered when giving management advice for either fishery component. However, it has also been agreed that given the presumed sequential nature of the exploitation pattern, management should also take into consideration trends occurring in the separate areas.

A harvest control rule was adopted in WKDEEP 2014 so that the catches in the two components are updated based on each component total abundance trends for the most recent five years. The harvest control rule simply specifies that catch advice should only increase when the abundance trends for the two components are increasing. If either is stable or decreasing, the advised catch for each of the two components should be adjusted according to the rate of change in the one showing the decrease.

The HCR adopted at 2014 Benchmark involves the estimation the trend of stock abundance by area and the selection of the one with the lowest value. The trend of abundance time series refers to the five most recent years. For each area, the trend corresponds to the slope that results from the adjustment of a linear regression to abundance estimates at a given year (Y) versus abundance estimate at the previous year (Y-1). Finally, the catch advice for the following two years corresponds to the product of the selected trend value and the total catch of the latest year.

The 2018 AGDEEP analysed the HCR under different trend scenarios and concluded that in some unlikely scenarios there is a potential flaw in the HCR. To account to this potential flaw of the HCR, in WGDEEP 2020, the trend of the stock is based on the slope of the linear regression adjusted to the abundance estimates of the five most recent years, scaled by dividing annual estimates by the mean abundance of those five years.

The trend estimates for each component are presented in Table 9.2.3. Following the HCR adopted, with selection of the minimum slope, the catches in the two components should be reduced by 6.48%.

Table 9.2.3. bsf.27.nea. Slope estimates of the regressions for the Northern and Southern components.

	Northern component	Southern component
Annual	-0.0648	0.0267

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 2021. 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 2021 (Table 9.2.4).

Table 9.2.4. bsf.27.nea Northern and Southern components. LBI screening method ratios between 2014 and 2021.

	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}	$L_{mean}/L_{F=M}$
Ref.	**> 1**	**> 1**	**> 0.8**	**≈ 1**	**> 0.8**	**>30%**	**≈ 1 (>0.9)**	**≥ 1**
2014	0.68	0.90	0.73	1.00	0.75	4%	0.94	1.08
2015	0.87	0.92	0.73	0.93	0.75	4%	0.97	0.96
2016	0.91	0.93	0.73	0.97	0.75	3%	0.98	0.94
2017	0.91	0.93	0.71	0.97	0.74	2%	0.98	0.94
2018	0.87	0.92	0.72	1.02	0.74	3%	0.97	0.96
2019	0.91	0.95	0.73	1.01	0.75	4%	1.00	0.96
2020	0.99	1.00	0.74	1.03	0.76	6%	1.03	0.94
2021	1.03	1.02	0.75	1.05	0.76	8%	1.05	0.94

The length at first catch was smaller than the length at first maturity in all years except 2021.

The MSY indicator ($L_{mean}/L_{F=M}$) was close to 1 in all years, and the optimizing yield indicator (L_{mean}/L_{opt}) was above 0.9 in all analysed years.

Analysis of results

LBI results show that the stock is at an adequate status as the exploitation levels are close to the length-based indicator of MSY.

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 is 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.

9.2.7 Management considerations

New rule for ICES category 3 data-limited stocks

In ICES areas, the bsf.27.nea stock is assessed using the abundance estimates derived from a state-space model, which was benchmarked by ICES and that accounts for the spatial dynamics of the species (including the migration from the Northern to the Southern component) and its life cycle parameters, which presents differences between the two components: Northern and Southern.

Model SPiCT

If following the WKLIFE X recommendations for category 3 stocks, the production model SPiCT could be envisaged, although some constrains related with species aspects need to be considered. A dedicated work is thus required with input from SPiCT developers as the black scabbardfish stock assessed in ICES area comprehends two components spatially separated and with different

length structure. Spawning occurs in areas outside ICES and spawning grounds are not yet fully identified. In effect, only a spawning area close to the shore in Madeira archipelago is known. A recent study using otolith microchemical demonstrated the existence of two potential spawning areas. As a consequence, a benchmark focusing on the potential application of SPiCT to this stock could be envisaged but the species vital processes and its spatial dynamics are required to be considered. The inclusion of the latter, i.e., well documented migrations between areas, is particularly challenging given the underlying assumptions of the production models. To explore the adequacy of SPiCT to the stock strong adjustments on the code and extensive sensitivity analyses, particularly concerning on the choice of priori distributions, are expected.

Comment: Given the above, SPiCT is not considered appropriate for the black scabbardfish, particularly given its spatial dynamics. The application of a production model will require that it deals with the following: i) existence of two spatial population components, ii) the time lag of migration from the Northern to the Southern component of the stock and iii) the vital parameters of each component.

rfb rule

Following the guidance on the parameter determination for the rfb rule, possible estimates of the input values are presented in the next table. Note that these estimates require a discussion with rfb developers, **as their determination cannot strictly follow the standard rfb guidance**.

Variable	Estimate	Input data	Comment
r: Stock biomass trend	0.932	Northern and Southern component biomass estimates. The estimates were scaled by the respective long-term mean.	Biomass estimates are derived from ICES benchmark space-state model.
b: Biomass safeguard $= \mathbf{min}(\mathbf{1}, \boldsymbol{I_{y-1}} / \boldsymbol{I_{\mathbf{trigger}}})$ $I_{\mathrm{trigger}} = I_{\mathrm{loss}}\, \omega$ Considering $\omega = 1.4$	0.92 (no guidelines for stocks like bsf.27.nea)	Northern and Southern component estimates time series (2001-2021) (I_trigger minimum estimate) This was done by not considering the evolution of population of each component and the linkage between the two. This could represent a high risk of getting a biased estimate	The species has a large distribution area data are exclusively derived from fishing which covers a smaller part. The threshold proposed is considered unrealistic as this is a regulated fishery since the beginning. Thus biomass indicator is unlike to present enough variability that justify such level. Worth to remark that the long-term exploitation rate has been extremely low for this stock further suggesting that its distribution is much more extended (covering unexploited areas) than that from where data are obtained.
m linked to von Bertalanffy k	0.95	k estimated from the Von Bertalanffy model adopted for the species which is also considered in the assessment model adopted for the species	Species is considered to have a quite fast growth rate, which is further consistent with its life strategy
f: Fishing proxy	1,119 (no guidelines for population with a clear spatial separation exists)	Raised length data collected under the sampling program of the Northern and Southern component	Length structure of the whole stock in ICES area differ between the two components. Given the spatial structure of the population and its migratory pattern, the F proxy needs to be revaluated and more simulations of OM, under a benchmark workshop, are recommended.

Further considerations on the rfb application:

The proposed rfb rule was defined based on simulated population with different life strategies and considering several assumptions mainly regarding species life cycle and fishing selectivity. Regarding bsf.27.nea stock some relevant considerations are next presented:

1. The OM adopted in rfb considers that the essayed stocks were heavily exploited at the initial status. For the bsf.27.nea stock the long-term harvest rates indicated relatively low initial levels that have been decreasing in recent years. The standardized fishing effort time series is next presented (the negative trend is statistically significant) (Figures 9.2.13 and 9.3.4).

   Northern component
   MannKendall (northernEffort)
   tau = -0.784; 2-sided p-value =1.3118e^{-09}

   Southern component
   MannKendall (southernEffort)
   tau = -0.402; 2-sided p-value =0.001907

Comment: Given the low exploitation rates in the two components it is highly unlikely that the stock was severely depleted at the beginning of the exploitation, as it is hypothesized in the OM adopted for rfb rule.

2. The OM adopted does not include the management measures eventually adopted throughout the analyzed time-series and that could have had an impact on the evolution of population.

   In the case of deep-water species EU management rules set (TAC and quotas) have been adopted since 2003. The implementation of these EU rules led to some of European fleets drastically reduced or stopped their fishing activity, as was the case of Ireland.

   In the case of black scabbardfish the TAC adopted have been continuously reduced and were considered catch constrained.

   Furthermore, the recent EU trawl ban regulation for areas deeper than 800m has constrain the fishing activity in areas/depth were black scabbardfish concentrate (Figure 9.2.25) and mean catch rates are higher (Figure 9.2.26).

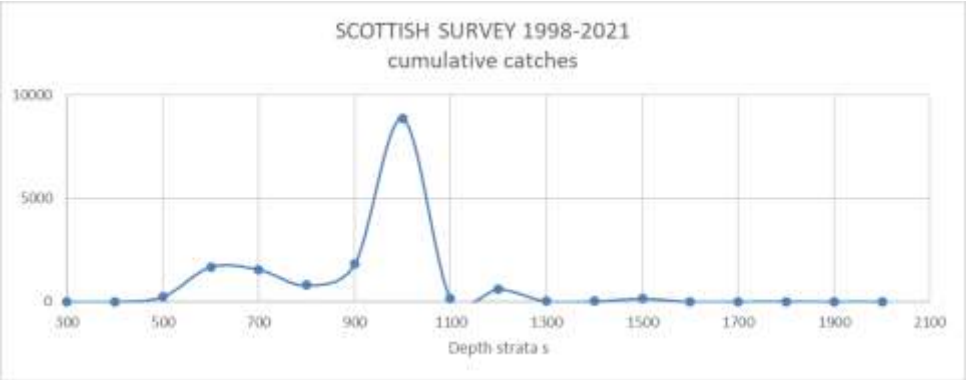


Figure 9.2.25. bsf.27.nea Cumulative catches of black scabbardfish by depth strata based on the Scottish surveys held from 1998 to 2021.

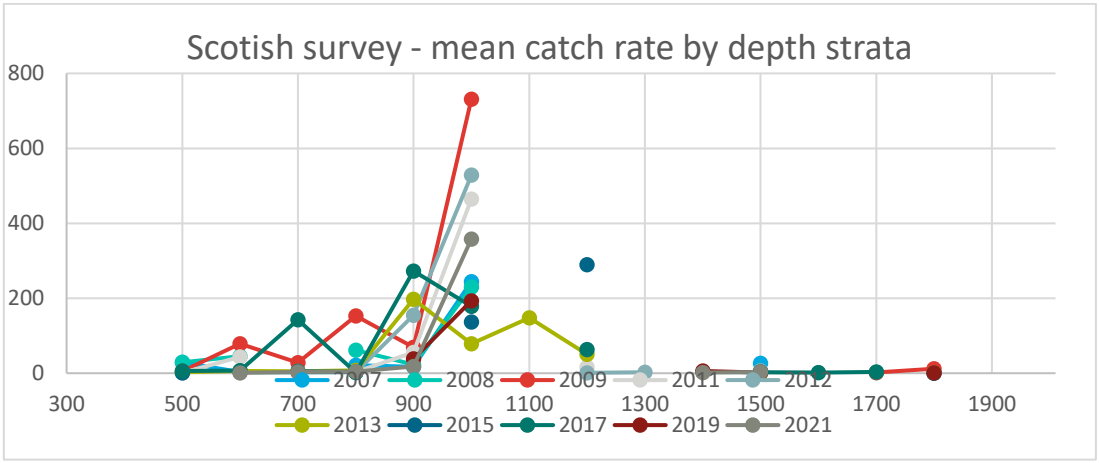


Figure 9.2.26. bsf.27.nea Mean catch rate of black scabbardfish by depth strata based on the Scottish surveys held from 2013 to 2021.

3. OM variable input

Ratio: average of last two years' values, divided by average of three preceding years' values. There are available simulation results for some different combinations. No uncertainty around the value were considered in the simulation process.

Biomass safeguard: reduce catch advice when index falls below trigger. In the absence of better knowledge: $\boldsymbol{\omega = 1.4}$ follows same logic as category 1: **MSY** $\boldsymbol{B_{trigger} = 1.4\, B_{\lim}}$; $\boldsymbol{B_{\lim} = B_{loss}}$ $\boldsymbol{I_{trigger}}$ might have to be adapted if stock has been exploited only heavily/lightly in the past, ideally, $\boldsymbol{I_{trigger}}$ should correspond to ~**MSY** $\boldsymbol{B_{trigger}}$
Comment: The black scabbardfish stock is considered not to be lightly exploited. The harvest rate estimates clearly show this. However, the simulations carried on using OM constructed for the rfb rule did not consider this situation, as the starting point adopted was overexploited populations.

Simulation results are not available for cases where the initial level of the depletion render the evolution of population abundance stable. For these cases, simulation and sensitivity analyses are required in order to find a appropriated value to be adopted. Otherwise, the adoption of 1.4 for a stable situation may lead to under exploitation situation of the stock. There is no indication from simulation work on the most appropriated value although authors refer "might have to be adapted if stock has been exploited only heavily/lightly in the past".

f

Data input mean catch length; length of first capture; von Bertalanffy
Fishing proxy: mean length relative to MSY proxy length $L_{F=M} = 0.75L_c + 0.25L_\infty$
Comment: Under OM the mean length is a populational parameter, which in the case of black scabbardfish is not available as no surveys are carrying out covering its distribution area.

Results and sensitivity impact of different gears, areas and fishing areas are not considered, which in the case of black scabbardfish are relevant aspects; trawl is the main fishing gear used in the northern component and longliners in the southern component.

$\boldsymbol{m}$ linked to von Bertalanffy k

$$\boldsymbol{m} = \begin{cases} \boldsymbol{k} < 0.2\mathbf{yr}^{-1}; \boldsymbol{m} = \mathbf{0.95} \\ \mathbf{0.2} \leq \boldsymbol{k} < 0.32\mathbf{yr}^{-1}; \boldsymbol{m} = \mathbf{0.9} \end{cases}$$

Comment: In OM m parameter, could be changed being species specific and tailored accordingly, instead to be applied to a wide range of k values.

Conclusion

Previously to the adoption of the rfb rule to be applied on bsf.27.nea advice, a benchmark workshop to tailor the simulation process to the knowledge available for the species, as well as the observational data is strongly recommended.

Fishing effort

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 9.2.27, in relation to total fishing effort) indicates changes on the fishing depth by the French trawlers. 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). This change is likely to have an impact on catchability of the fish by the French trawler. A deeper scrutiny on the effect of the French fishing grounds depth in this variable by year is required. This may imply an update of the prior distribution in the benchmarked assessment model.

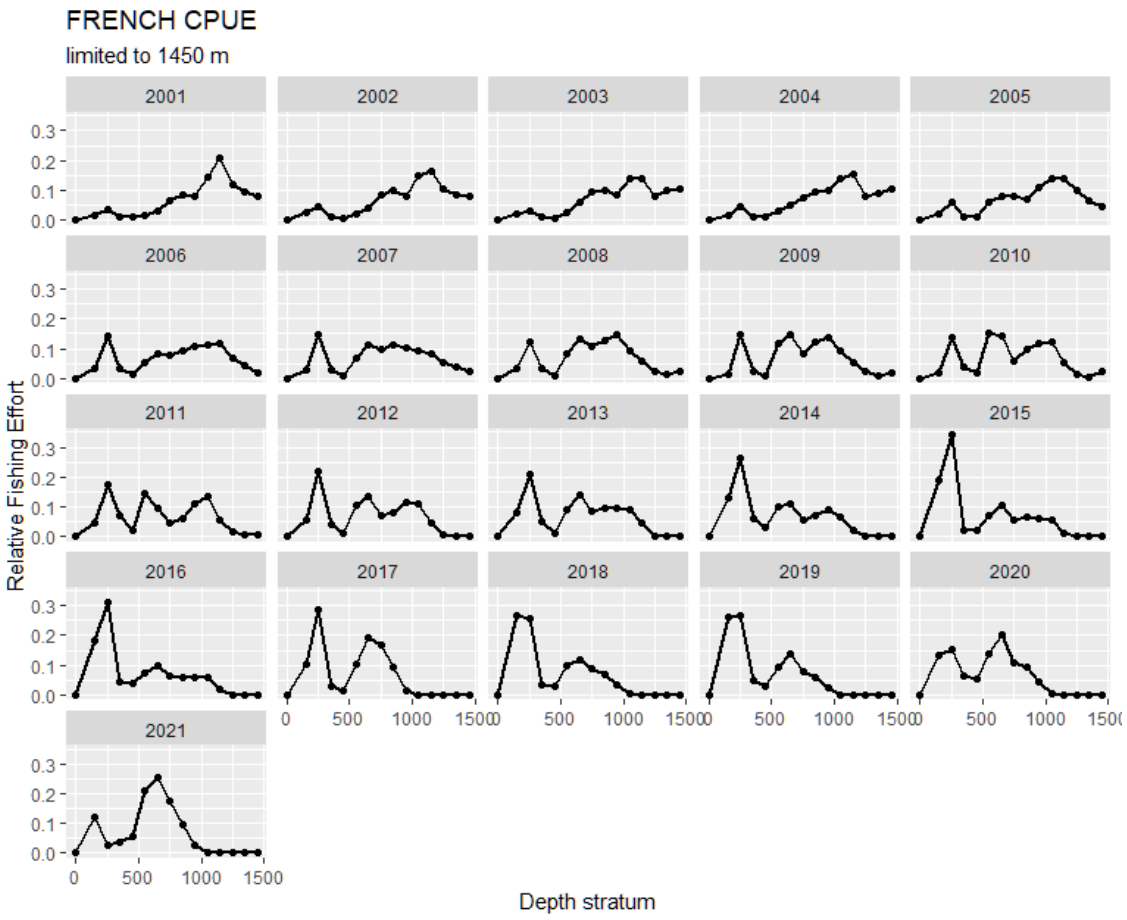


Figure 9.2.27. bsf.27.nea Northern component. French fleet annual relative fishing effort by depth strata, in relation to total fishing effort).

9.2.8 Tables

Table 9.2.5a. 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	232	541	143	0	0	0	0	0	1	**916**
2015	115	530	0	211			1			**857**
2016	142	509	712	52						**1416**
2017	285	143		112			0			**541**
2018	324	229		41			-			**594**
2019	395	93		52						**540**
2020	317	102		21			0			**440**
2021	41	101		17						**159**

*** Updated in 2022 - STATLAND data 2014-2017.**
****STATLAND data from 1988 to 2011.**

****STATLAND data.**

Table 9.2.5b. Landings of black scabbardfish from Division 27.12. Working Group estimates. E&W&NI is England, Wales and Northern Ireland (this table does not include all fishing countries, see below for other countries).

Year	Faroes	France	Scotland	Spain	Germany*	E&W&NI	Ireland
1988					.		
1989		0			.		
1990		0			.		
1991		2			-		
1992		7			-		
1993	1051	24			93		
1994	779	9			45		
1995	301	8					
1996	187	7		41			
1997	102	1		98			
1998	20	324		134			
1999		1	0	109			
2000	1	5		237			
2001		3		115			
2002		0	1	1117		0	
2003		7		444			1

Year	Faroes	France	Scotland	Spain	Germany*	E&W&NI	Ireland
2004	95	10	1	230			
2005	127	14		239			0
2006	8	0		1009			
2007	0		0	9			0
2008	1		0	53			0
2009	156			103		0	0
2010	27	1		180		0	0
2011	24	1		113			
2012				47			
2013	1			50			
2014				149			
2015				51			
2016				82			
2017	0			68			
2018				125			
2019	0			46			
2020				25			
2021				0			

***STATLAND data from 1988 to 2011.**

Table 9.2.5b. Continued. The column total includes countries from the previous table and countries in this table.

Year	Iceland*	Poland*	Russia**	Lithuania*	Estonia	Unallocated	Total
1988		-	.	.	.		**0**
1989		-	.	.	.		**0**
1990		-	.	.	.		**0**
1991		-	.	.	-		**2**
1992		-	.	-	-		**7**
1993		-	.	-	-		**1168**
1994		-	.	-	-		**833**
1995		-	.	-			**309**
1996	0	-	.				**235**

Year	Iceland*	Poland*	Russia**	Lithuania*	Estonia	Unallocated	Total
1997							**201**
1998							**478**
1999							**109**
2000							**243**
2001							**118**
2002							**1119**
2003		1		1			**454**
2004				1			**338**
2005					1		**381**
2006					2		**1019**
2007					7		**16**
2008			4				**58**
2009							**259**
2010							**208**
2011							**138**
2012						907	**954**
2013						289	**340**
2014							**149**
2015							**51**
2016							**82**
2017							**68**
2018							**125**
2019							**46**
2020							**25**
2021							**0**

***STATLAND data from 1988 to 2011.**

****STATLAND data.**

Table 9.2.5c. Landings of black scabbardfish from Subarea 27.6. Working group estimates (this table does not include all fishing countries, see below for other countries).

Year	France			Faroes		Ireland	Scotland		Spain
	27.6	27.6.a	27.6.b	27.6.a	27	27.6.a	27.6.a	27.6.b	27.6.a
1988									
1989		138	0	46			-	-	
1990		971	53				-	-	
1991		2244	62				-	-	
1992		2998	113	3			-	-	
1993		2857	87		62		-	-	
1994		2331	55				2	-	
1995		2598	15				14	4	
1996		2980	1				36	<0.5	
1997		2278	16		3		147	88	
1998		1553	7				142	6	
1999		1610	8				133	58	
2000		2971	27				333	41	
2001		3791	29		3		486	145	
2002		3833	156	2			603	300	
2003		2934	67	45			78	9	
2004		2637	99	59			100	24	
2005	3	2533	59	38			18	62	
2006	-	1713	36	59		1	63	0	
2007	-	1991	4	44	37	0	53	0	
2008	-	2348	0	37	0	0	26	0	
2009	15	1609	1	39	0	0	80	0	
2010	-	1778	1	72		0	73	0	
2011	5	1791	3	31			1	0	
2012	-	1509	0	3			34	0	
2013		1799	9	6			57		
2014	0	1902	0	4	2		110		
2015		1870		1			124		10

Year	France			Faroes		Ireland	Scotland		Spain
	27.6	27.6.a	27.6.b	27.6.a	27	27.6.a	27.6.a	27.6.b	27.6.a
2016		2336					96		9
2017		1714		64			101		3
2018		1601		-	-		65	0	0
2019		1124					45		1
2020	0	769	0	0	0	0	20	0	0
2021	0	651	0	1	0	0	34	0	0

Table 9.2.5c. Continued. The column total includes countries from the previous table and countries in this table.

Year	Germany*		Netherlands **			Lithua-nia**	Estonia**	Poland**	Rus-sia**	E& W& NI****	Unallo-cated	Total
	27.6.a	27.6.b	27.6.a	27.6.b	27.6	27.6.a	27.6.b	27.6.b	27.6.b	6.a		
1988	.	.	-	-		.	.		.			**0**
1989	.	.	-	-		.	.	-	.			**184**
1990	.	.	-	-		.	.	-	.			**1023**
1991	-	-	-	-		.	-	-	-			**2307**
1992	-	-	-	-		-	-	-	-			**3113**
1993	48	-	-	-		-	-	-	-			**3054**
1994	30	15	-	-		-	-	-	-			**2433**
1995	-	3	-	-		-	-	-	-			**2634**
1996	-	2	-	-		-	-	-	-			**3019**
1997			-	-		-	-	-	-			**2533**
1998			-	-		-	-	-	-			**1708**
1999			11	-		-	-	-	-			**1820**
2000			7	-		-	-	-	-			**3378**
2001			-	-		3	225	-	226			**4908**
2002			21	2		9		2				**4928**
2003				2		12	7	2	7			**3162**
2004						85	5		5			**3014**

Year	Germany*		Netherlands **			Lithua-nia**	Estonia**	Poland**	Rus-sia**	E& W& NI****	Unallo-cated	Total
	27.6.a	27.6.b	27.6.a	27.6.b	27.6	27.6.a	27.6.b	27.6.b	27.6.b	6.a		
2005						5	11		11			**2741**
2006						1	3		3			**1879**
2007												**2129**
2008			14						1			**2427**
2009												**1744**
2010												**1923**
2011												**1830**
2012											690	**2236**
2013											189	**2060**
2014	0		3	0		0	0	0	0		0	**2021**
2015					5							**2181**
2016					1							**2606**
2017					0							**2035**
2018												**1791**
2019												**1222**
2020												**846**
2021										34		**720**

***STATLAND data from 1988 to 2011.**

****STATLAND data.**

Table 9.2.5d. 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**

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	
1993		0	24	149	16		170	109				-				**468**
1994		0	32	165	8		120	336				-				**662**
1995		0	52	121	9		74	385				-				**641**
1996		0	104	130	2		60	360				-				**658**
1997		0	24	200	1		33	202				-			1	**462**
1998		0	15	104	6		52	211				-			2	**390**
1999	-	-	7	97	0	2	70	177				-			0	**355**
2000	-	-	25	173	1	4	100	253				3			0	**559**
2001	-	-	40	237	0	3	180	267				41			0	**768**
2002	-	0	33	105	2	7	138	49				53				**386**
2003	-	-	15	29	1	3	159	36				1				**245**
2004	-	-	31	28	8	9	115	63				0				**253**
2005	0	5	6	11	1	17	105	23				-				**169**
2006	-	-	3	10	1	24	315	20	1	32	37	0	2			**445**
2007	-	-	2	7	0	4	168	7	0	52	17	-	-			**257**
2008	-	-	2	19	0	6	148	4	-	-	-	0	-			**179**
2009	-	-	-	29	1	2	53	4	-	-	-	-	-			**90**
2010	-	-	2	40	0	2	36	-	-	-	-	-	-			**81**
2011	-	-	0	81	0	2	129	-	-	-	-	-	-			**212**
2012	-	-	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					5	**37**
2021			0	0		3	18	0						0	7	**28**

Table 9.2.5e. Landings of black scabbardfish from Divisions 27.6 and 27.7. Working Group estimates. E&W&NI is England, Wales and Northern Ireland (breakdown per Subarea not available).

Year	Ireland	E&W&NI	Total
1988			
1989			**0**
1990			**0**
1991			**0**
1992			**0**
1993	8		**8**
1994	3		**3**
1995			**0**
1996		1	**1**
1997	0	2	**2**
1998	0	1	**1**
1999	1	1	**2**
2000	59	40	**99**
2001	68	37	**105**
2002	1050	43	**1093**
2003	159	5	**164**
2004	293	2	**295**
2005	79	-	**79**
2006	-	-	**0**
2007	-	-	**0**
2008	-	-	**0**
2009	-	-	**0**
2010	-	-	**0**
2011	-	-	**0**
2012	-	-	**0**
2013	-	-	**0**
2014	-	-	**0**
2015	-	-	**0**
2016	-	-	**0**

Year	Ireland	E&W&NI	Total
2017	-	-	**0**
2018		0	**0**
2019			**0**
2020	0	0	**0**
2021	0		**0**

Table 9.2.5f. 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**
2007	1		**1**
2008	0		**0**
2009	15		**15**

Year	Iceland	Faroes	Total
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	103		**103**
2021	31		**31**

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).

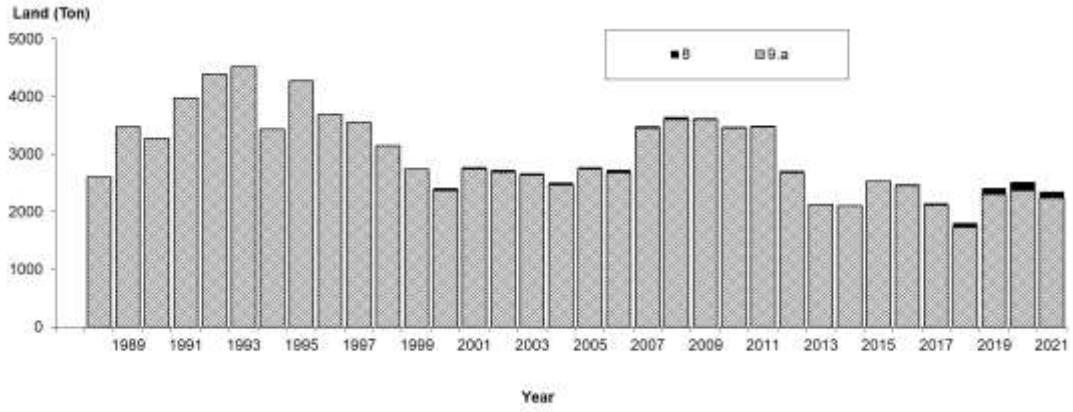


Figure 9.3.1. bsf.27.nea Southern component. Annual landings for ICES Subarea 27.8 and Division 27.9.a.

9.3.3 ICES Advice

The latest ICES advice, in 2020, was: "*ICES advises that when the precautionary approach is applied, catches should be no more than 4506 tonnes in each of the years 2021 and 2022.*

Distributed by area, this corresponds to annual catches of no more than 2143 tonnes in subareas 6 and 7 and divisions 5.b and 12.b, annual catches of no more than 2084 tonnes in Subarea 8 and Division 9.a, and annual catches of no more than 280 tonnes in subareas 1, 2, 4, and 10 and divisions 3.a and 5.a."

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 2021.

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	0
2020	2832	2509	0
2021	2266	2348	0

*** 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

No new information on the discards of deep-water species produced by the Portuguese on-board sampling programme (EU DCR/NP) was presented to WGDEEP in 2022.

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 2021 are presented in Figure 9.3.2.

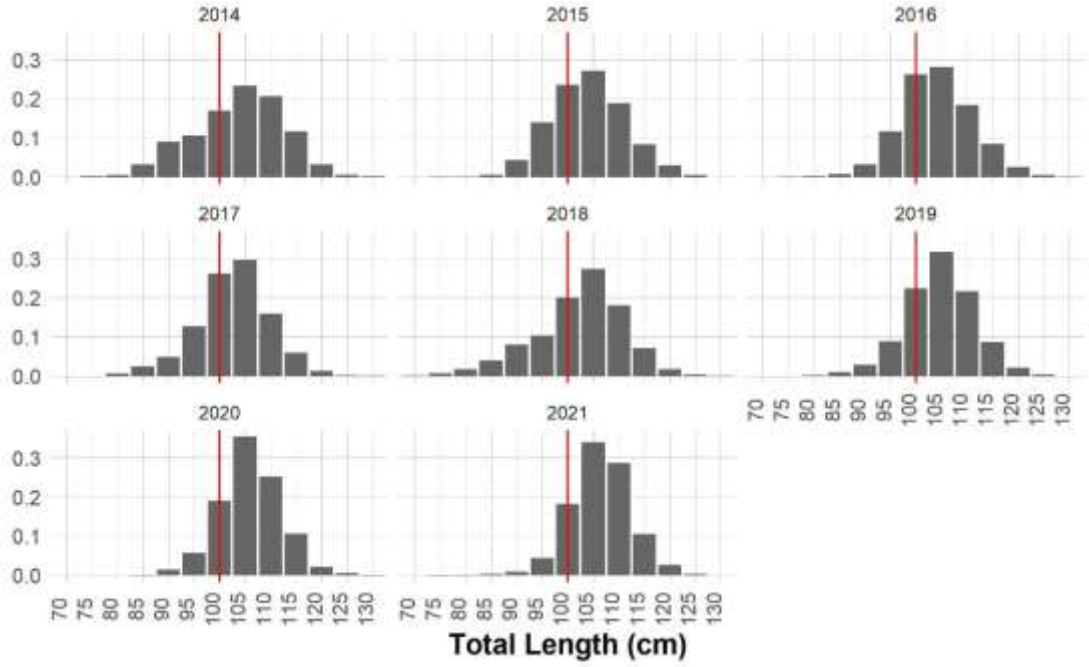


Figure 9.3.2. bsf.27.nea Southern component. Length–frequency distribution of black scabbardfish exploited by the deep-water longline fishery for ICES Division 27.9.a, from 2014 to 2021. The red vertical line indicates the length of 1st maturity of the species.

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. 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 1995-2021 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 $\geq$ 1000 Kg and more than one year of landings were considered.

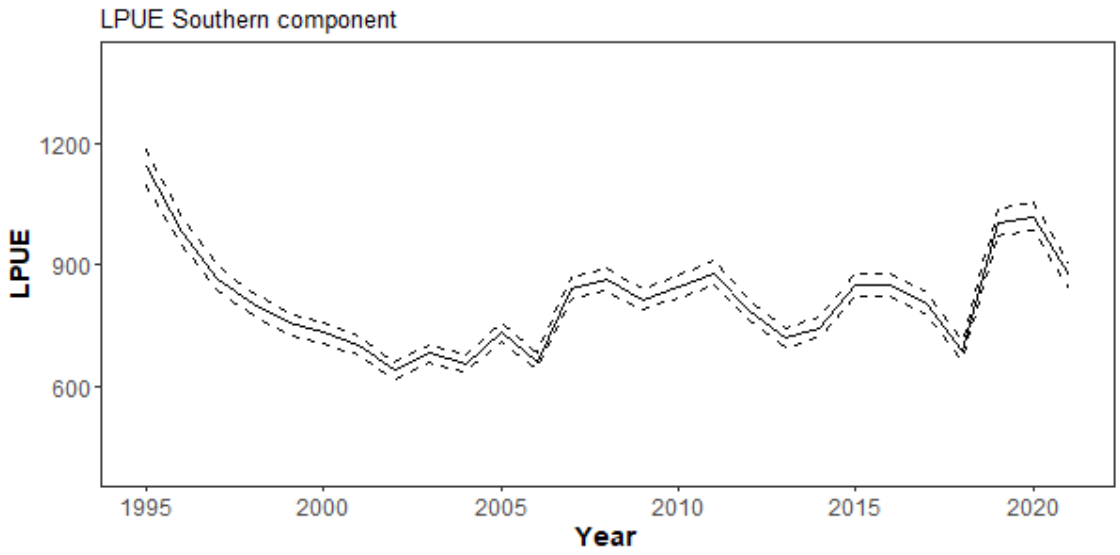


Figure 9.3.3. bsf.27.nea Southern component. Standardised Portuguese CPUE.

For the period between 2006 and 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 = -0.402; 2-sided p-value = 0.001907) confirms the downward trend in fishing effort for the Southern component.

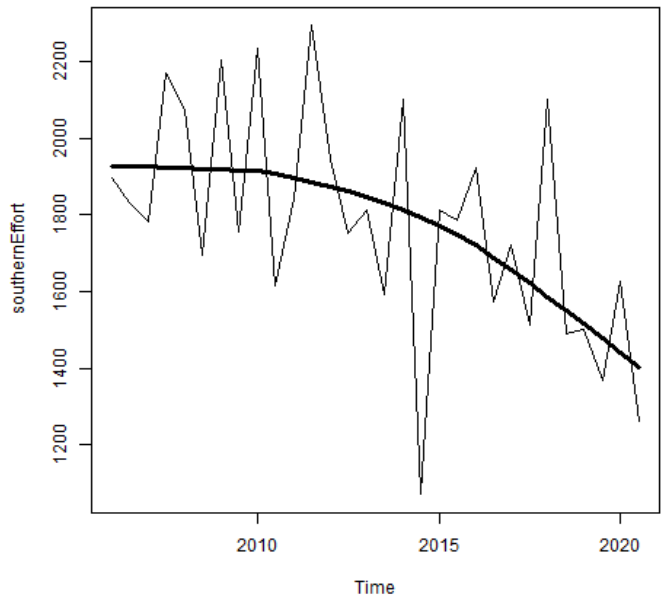


Figure 9.3.4. bsf.27.nea Southern component. Standardised effort by new semesters, i.e., SEM1= months 3-8 of the year and SEM2=month 9-12 of the year, plus months 1 and 2 of the next year.

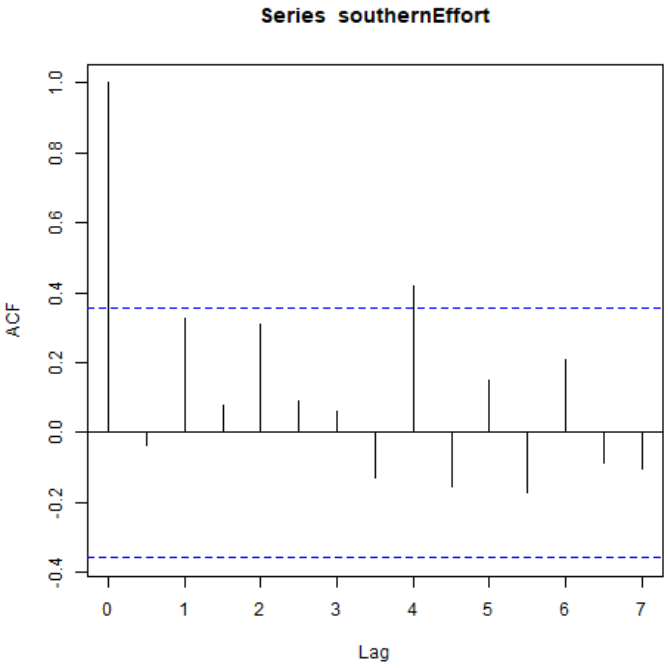


Figure 9.3.5. bsf.27.nea Southern component. Standardised fishing effort time series autocorrelation.

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**

Year	Portugal	France	Spain	Total
2009	3601			**3601**
2010	3453		0	**3453**
2011	3476			**3476**
2012	2668		12	**2680**
2013	2130			**2130**
2014	2109			**2109**
2015	2527		0	**2527**
2016	2456		0	**2456**
2017	2117		0	**2117**
2018	1727		0	**1727**
2019	2302			**2302**
2020	2369	0	0	**2369**
2021	2245		0	**2245**

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**

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	
2001		16	0		12	0					1	**29**
2002		17	2		16						1	**36**
2003		25			8						1	**34**
2004	0	25	0		14						1	**40**
2005		19	0		6						1	**26**
2006		30	2	0	19						0	**52**
2007		14	1		13						1	**29**
2008		10	0		35						1	**45**
2009		15	1	0	3						1	**19**
2010	0	13	1	0	3							**17**
2011		4	0	0	14							**18**
2012		10	0		3						18	**32**
2013		5	0	0	2						3	**10**
2014		7	0	0	3							**9**
2015		5	0								0	**5**
2016		2	0		1						16	**19**
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	0	55	23	1	20	0	**139**
2021		13	12	0	5		36	19	2	17	0	**103**

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 in for the period 2012-2016 landings increased, decreasing to less than 100 kg in 2020. 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 2020, was: "*ICES advises that when the precautionary approach is applied, catches should be no more than 4506 tonnes in each of the years 2021 and 2022.*

Distributed by area, this corresponds to annual catches of no more than 2143 tonnes in subareas 6 and 7 and divisions 5.b and 12.b, annual catches of no more than 2084 tonnes in Subarea 8 and Division 9.a, and annual catches of no more than 280 tonnes in subareas 1, 2, 4, and 10 and divisions 3.a and 5.a."

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 2021 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 2021.

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	75
2009	12	182
2010	12	338
2011	12	338
2012	9	916
2013	9	622
2014	9	401
2015	9	508
2016	9	441
2017	9	364
2018	9	170
2019	-	86
2020	-	107
2021	-	33

*** 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.

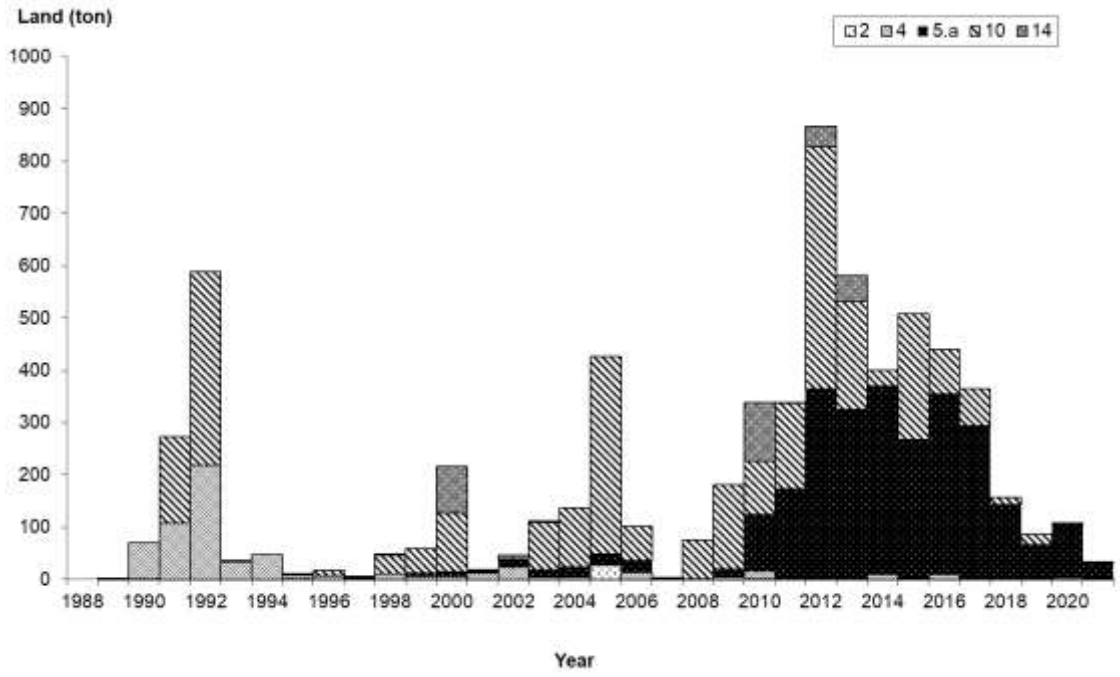


Figure 9.4.1. Annual landings for black scabbardfish in ICES subareas 27.2, 27.4, 27.5.a, 27.10, and 27.14, between 1988 and 2021.

Greenland catches of black scabbardfish have been null in years between 1998 and 2021 except 2010 and 2011 (Nielsen, 2022 WD). For these two later years, 100 and 300 kg were reported from trawl bycatch, both in September (Figure 9.4.2).

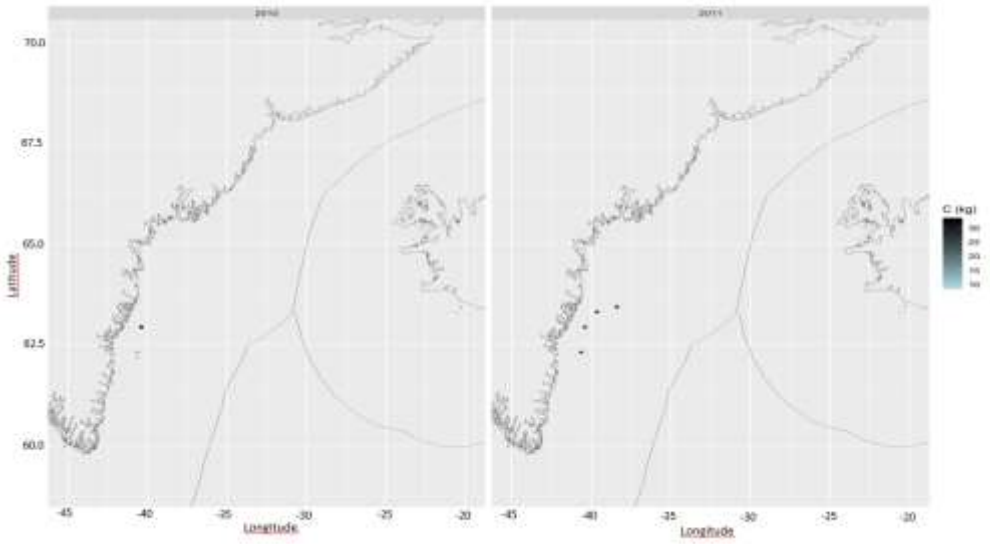


Figure 9.4.2. bsf.27.nea Black scabbardfish in 14. Distribution of commercial catches of black scabbard fish (in Kg) in East Greenland from 2010 and 2011. (Source: Nielsen *et al.*, 2019b WD)

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, 2022 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).

Black scabbardfish was rarely caught in the survey; the species did not occur in 1998, 1999, 2000, 2002, 2003, 2006, and 2016 surveys. In 2013 and 2015, the species was caught in one station out of an average number of 78 stations, 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, the species was only registered in Q5 at depths between 801-1200 m, where most of the biomass has also been observed in previous years (Figure 9.4.3)

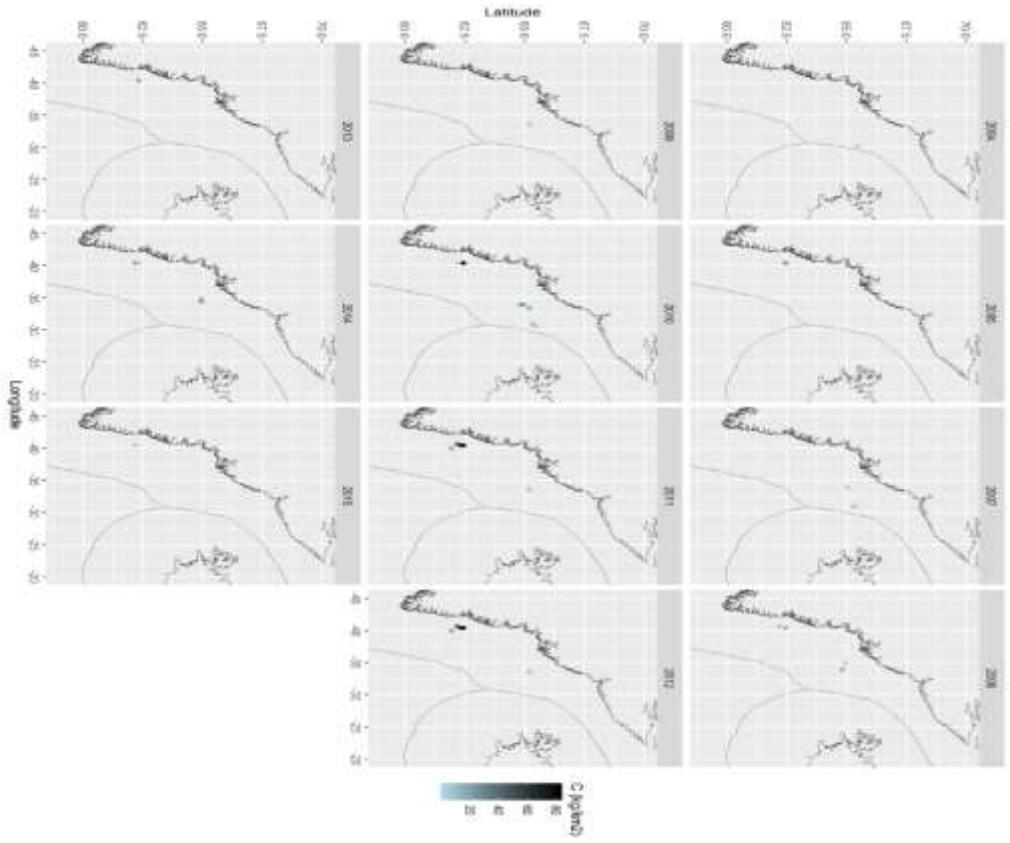


Figure 9.4.3. bsf.27.nea Black scabbardfish in Subarea 27.14. Distribution of survey catches of black scabbard fish at East Greenland (ICES Division 27.14.b) in 1998-2016. No survey in 2001, 2017, and 2018. (Source: Nielsen *et al.*, 2019a WD)

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 fishing gear (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).

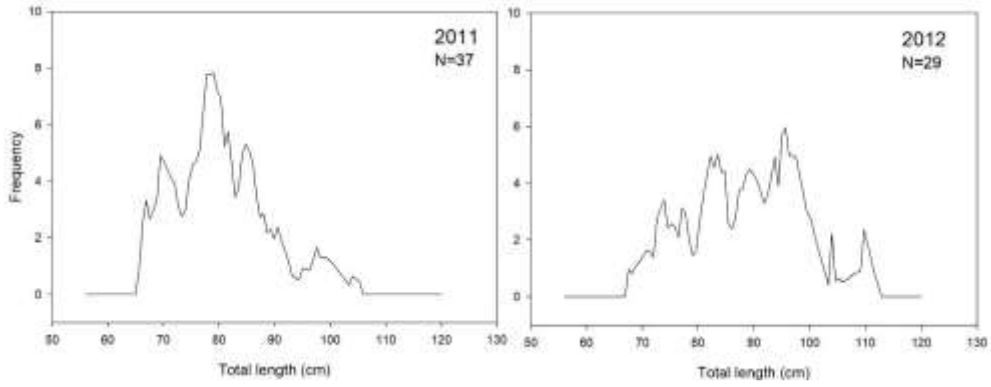


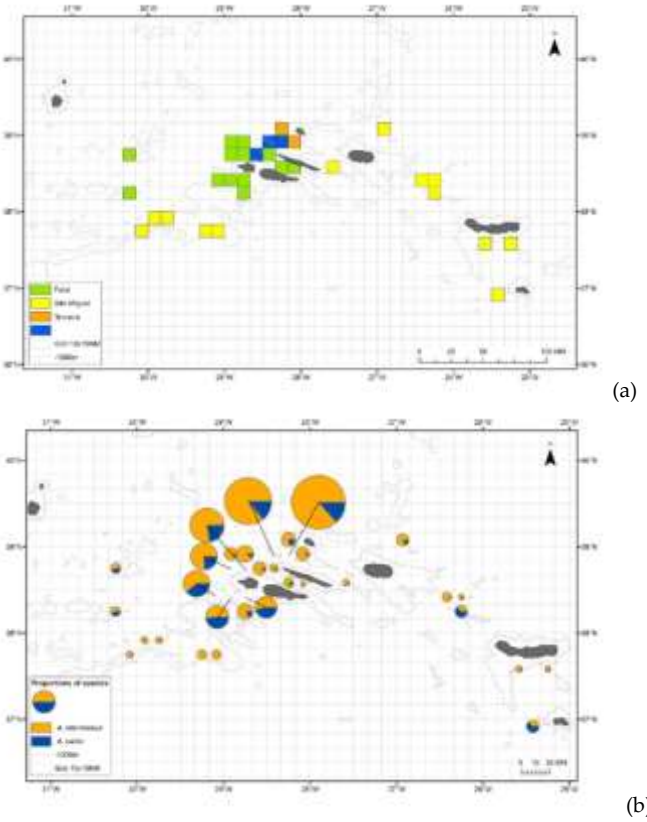
Figure 9.4.4 bsf.27.nea Black scabbardfish in Subarea 27.14. Length distribution of black scabbardfish at East Greenland (ICES Division 27.14.b) for 2011 and 2012. Survey years with n<20 are not shown. No survey in 2001, 2017 and 2018. (Source: Nielsen *et al.*, 2019a WD)

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.

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 could be 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	Iceland*	France	Total
		27.2.a	27.2.a.2	27.3.a	
1988					**0**
1989	0				**0**
1990	1				**1**
1991	0				**0**
1992	0				**0**
1993	0				**0**
1994	0				**0**
1995	1				**1**
1996	0				**0**
1997	0				**0**
1998	0				**0**
1999	-				**0**
2000	-				**0**
2001	-				**0**
2002	-				**0**
2003	-				**0**
2004	-				**0**
2005	0	27			**27**
2006	-	-			**0**
2007	-	0			**0**
2008	-	-			**0**
2009	-	-			**0**

Year	France	Faroes	Iceland*	France	Total
		27.2.a	27.2.a.2	27.3.a	
2010	0	-			**0**
2011	-	-			**0**
2012					**0**
2013	-	-			**0**
2014	-	-			**0**
2015	-	-			**0**
2016	-	-		0	**0**
2017	-	-		-	**0**
2018	-	.	13	-	**13**
2019					**0**
2020	0				**0**
2021					**0**

*** Preliminary catch statistics**

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	
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**

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.c	27.4	27.4.a	
2004		4	1			0			-			**5**
2005		1	1			0			-			**2**
2006		13				0	0	0	-			**13**
2007		1	0			-			-			**1**
2008		0				0			-			**0**
2009		5	0			-	-	-	-	-		**5**
2010		13	2			-	-	-	-	-		**15**
2011		-	1			-	-	-	-	-		**1**
2012		0				-	-	-	-	-		**0**
2013		1	0	0		-	-	-				**1**
2014		10	0	0		0	0	0	0	0		**10**
2015		2	0	0		0	0	0	0	0		**2**
2016		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							**2**

***STATLAND data**

****Preliminary catch statistics.**

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		<0.5	0	0	**0**
2021		<0.5			**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**
2007	0		0		**0**

Year	Faroes	Spain	Greenland	Unallocated	Total
	27.14		**27.14.b**		
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**

9.5 Black scabbardfish 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.*, 2022 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).

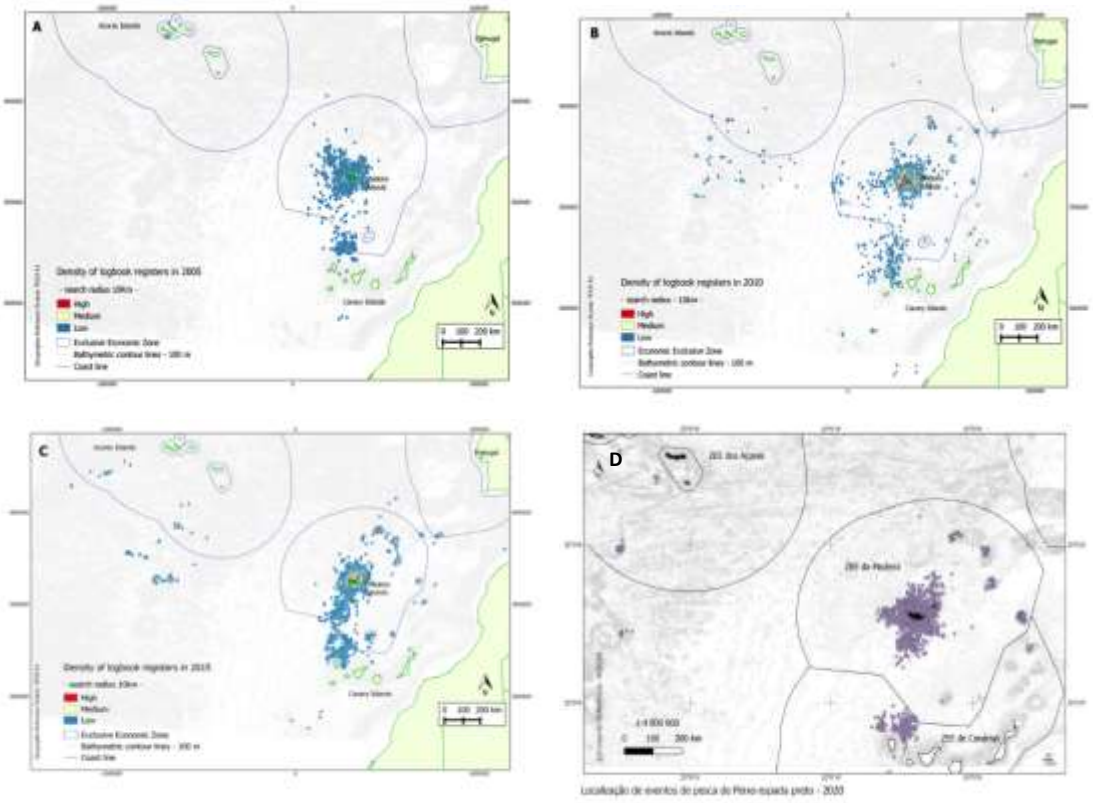


Figure 9.5.1. bsf CECAF area. Density plots illustrating the geographical distribution of the fishing sets with catches in 2005 (A), 2010 (B), 2015 (C) (Delgado *et al*., 2018) and (D) 2020 (Sousa et al., 2021 WD).

Catches in CECAF 34 area were updated with fishery data from Madeiran longliners landings from 1990 to 2021 (Figure 9.5.1). 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 (Figure 9.5.2 and Table 9.5.1).

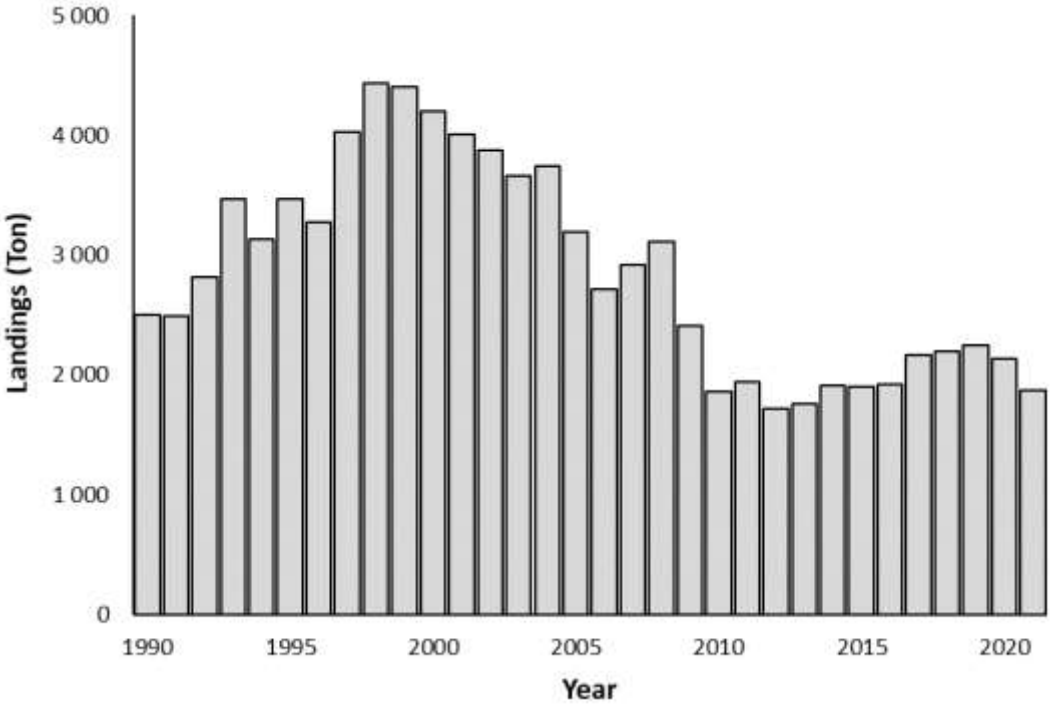


Figure 9.5.2. bsf CECAF 34. Time-series of annual Portuguese landings at CECAF area (Sousa et al., 2022 WD).

The EU TAC and total catches for CECAF 34 area from 2005 to 2021 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 2021 (all landings are from Portugal).

Year	EU TAC CECAF 34.1.2 area	Landings CECAF 34.1.2. Area
2005	4285	3195
2006	4285	2717
2007	4285	2922
2008	4285	3109
2009	4285	2413
2010	4285	1860
2011	4071	1941
2012	3867	1716
2013	3674	1758
2014	3490	1913
2015	3141	1902
2016	2827	1917
2017	2488	2163
2018	2189	2199

Year	EU TAC CECAF 34.1.2 area	Landings CECAF 34.1.2. Area
2019	2189	2246
2020	2189	2136
2021*	2189	1873

*** provisional estimates**

Following the methodology adopted at WGDEEP 2016 (ICES, 2016), standardised annual catch estimates for the period from 1990 to 2021 of the nineteen resources (ordered in terms of total weight catch) and grouped into four groups (1, large pelagics; 2, elasmobranchs; 3, small pelagics; and 4, demersals) were determined based on data extracted from DSI/DRM database (Figure 9.5.3).

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.

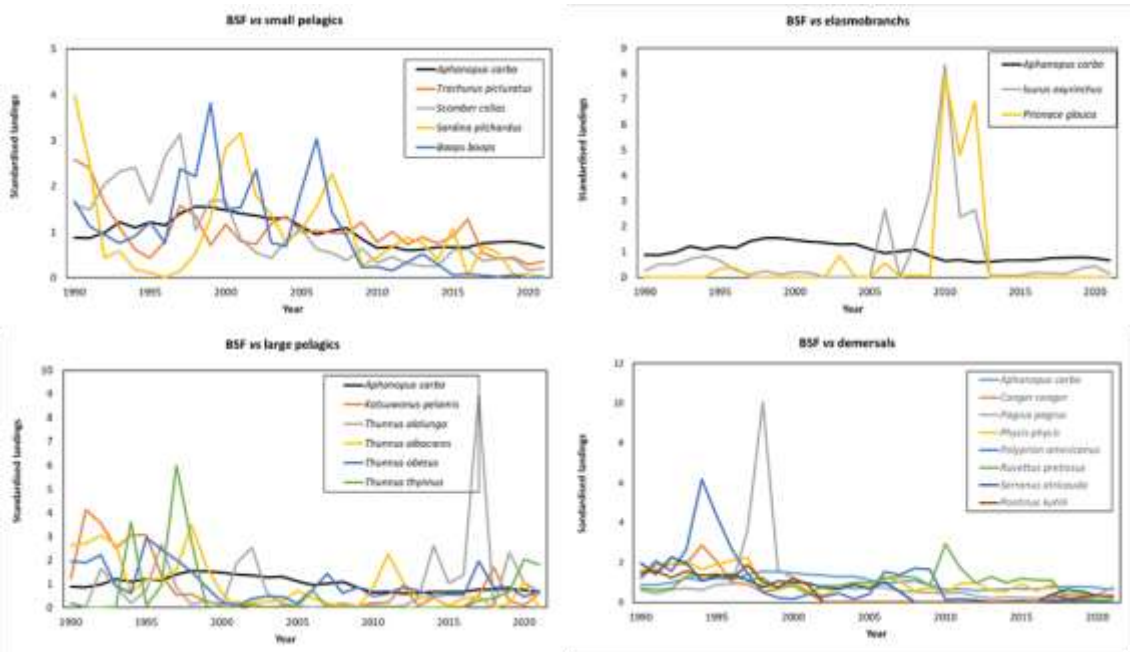


Figure 9.5.3. bsf CECAF area. Trends in standardised landings of black scabbardfish and the 19 other top ranked species in Madeiran landings (Sousa et al., 2022 WD).

For the period 2009–2021, the total length frequency distributions of the exploited population caught by the Madeiran longline fleet shows slight changes on the mean length throughout time (Figure 9.5.4). From 2011 to 2017 the mean length was constant at 118 cm TL, occurring a slight decrease in 2019 and 2020 (114 cm TL). In 2021, a slight increase in the mean length was observed (118 cm TL).

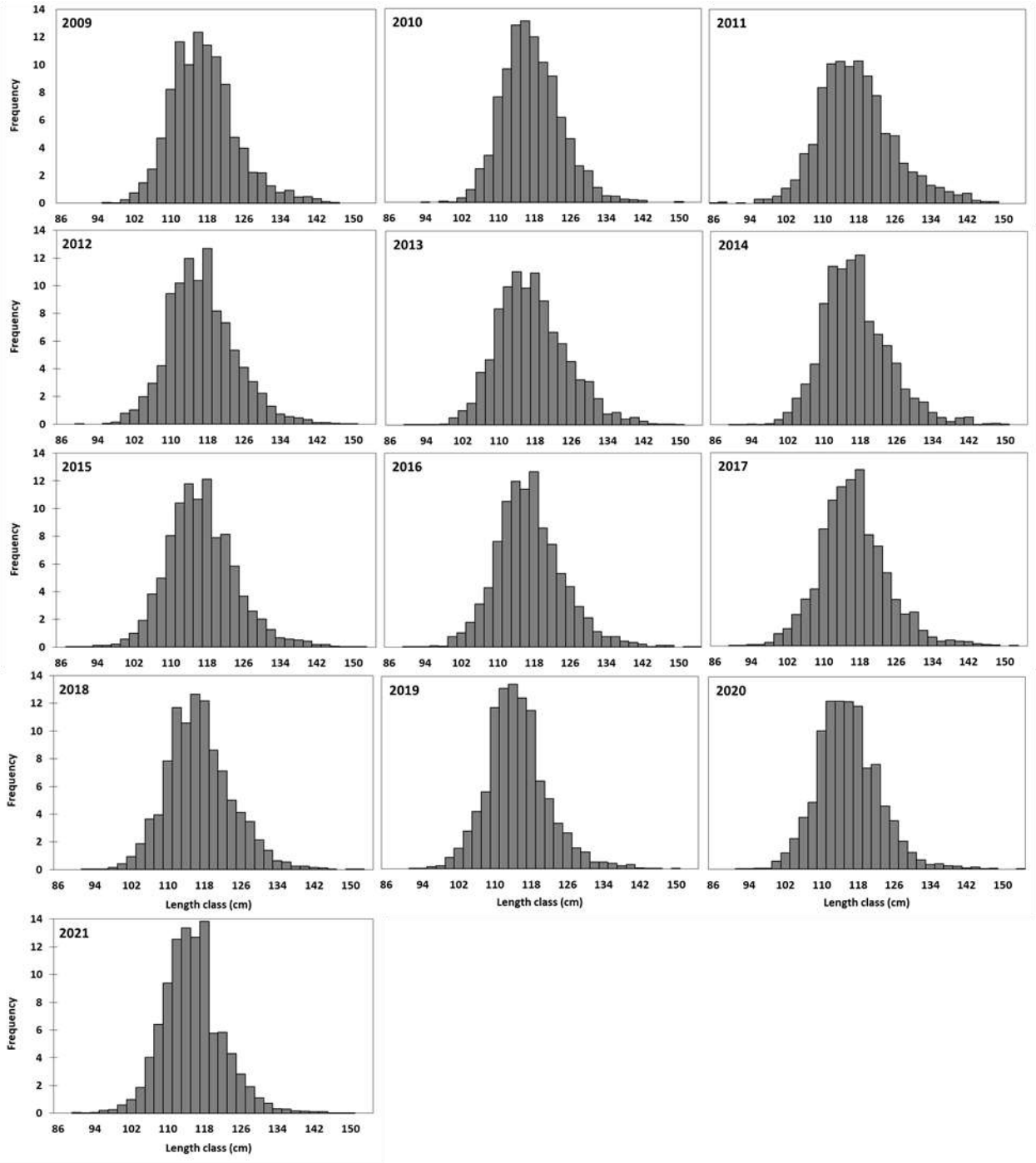


Figure 9.5.4. bsf CECAF. Annual length–frequency distribution of specimens landed by the Portuguese longliners operating along CECAF area (Sousa et al., 2022 WD).

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. Such decreasing trend is in line with the reduction in the number of active vessels (Figure 9.5.5).

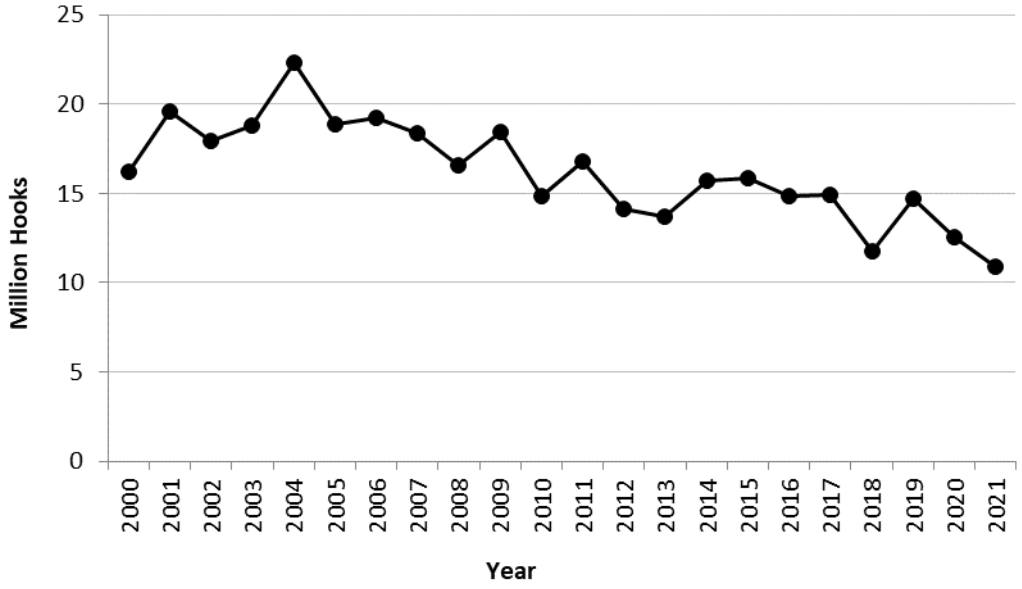


Figure 9.5.5. bsf CECAF 34 area. Time-series of the total annual effort estimated for the CECAF 34.1.2 area (million hooks) for the *Aphanopus* spp. fishery between 2000 and 2021 (Sousa et al., 2022 WD).

The unstandardized CPUE, calculated as total landings divided by the overall number of hooked deployed by year. The time series of the total number of hooks shows an overall decline throughout the whole period (Figure 9.5.5). The variation of unstandardized CPUE in the years 2000-2006 was about -45% in CPUE relatively to the initial years. From 2006 to 2008 there was a slight increase in the unstandardized CPUE, followed by a decrease and showed a slight increase since 2020. Although the CPUE as landings divided by total number of hooks may be realistic a more advance modelling to estimate a standardized CPUE would be a great interest to the assessment of the stock. Such a standardized CPUE could include variables from season (quarter, month or other as suitable) and fishing area for which data might be available from the EU-DCmap data collection framework.

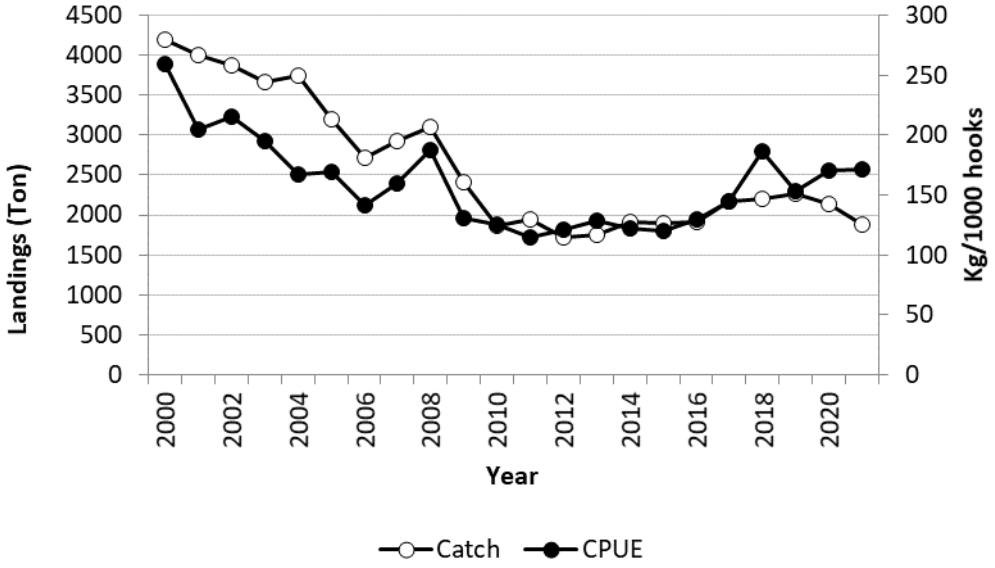


Figure 9.5.6. bsf CECAF 34 area. Time-series of landings per unit effort and unstandardized CPUE (kg/thousand hooks) in CECAF area between 2000 and 2021 (Sousa et al., 2022 WD).

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