WORKING GROUP FOR THE BAY OF BISCAY AND THE IBERIAN WATERS ECOREGION (WGBIE)

VOLUME 3 | ISSUE 48

ICES SCIENTIFIC REPORTS

RAPPORTS
SCIENTIFIQUES DU CIEM

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
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ISSN number: 2618-1371

ICES Scientific Reports

Volume 3 | Issue 48

WORKING GROUP FOR THE BAY OF BISCAY AND THE IBERIAN WATERS ECOREGION (WGBIE)

Recommended format for purpose of citation:

ICES. 2021. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. 3:48. 1101 pp. https://doi.org/10.17895/ices.pub.8212

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Lophius piscatorius – mon.27.8c9a (Cantabrian Sea, Atlantic Iberian waters)

Lophius budegassa – ank.27.8c9a (Cantabrian Sea, Atlantic Iberian waters)

Type of assessment in 2021

Update assessment for L. piscatorius and benchmark assessment for *L. budegassa*.

Software used

Stock Synthesis (SS) for L. piscatorius and SPiCT for *L. budegassa*.

Data revisions this year

No data revisions.

4.1 General

Two species of anglerfish, *Lophius piscatorius* and *L. budegassa*, are found in ICES divisions 8.c and 9.a. Both species are caught in mixed bottom-trawl fisheries and in artisanal fisheries using mainly fixed nets.

The two species are not usually landed separately for the majority of the commercial categories and they are recorded together in the ports' statistics. Therefore, estimates of each species in Spanish landings from divisions 8.c and 9.a and Portuguese landings of Division 9.a are derived from their relative proportions in market samples.

The total anglerfish landings are given in Table 4.1.1 by ICES division, country and fishing gear. Landings increased in the early eighties reaching a maximum level in 1986 (9433 t) and 1988 (10 021 t), and decreased after that to a minimum of 1801 t in 2001. In 2002–2005 period landings increased reaching 4757 t. This period was followed by another one where landings gradually declined and in 2011 landings were less than half of the 2005 amount (2179 t). From 2011 to 2014, landings slightly increased to 3030 t. Annual values then progressively decreased again in the next 6 years to 1515 t in 2020, the lowest value recorded of the stocks' historical time-series.

The species proportion in the landings has changed since 1986. At the beginning of the time-series (1980–1986), *L. piscatorius* represented more than 70% of the total anglerfish landings. After 1986, the proportion of *L. piscatorius* decreased in the annual landings but in 1999–2002 both species showed approximately the same weight. In 2003, the proportion of *L. piscatorius* started to increase again, with a mean proportion of 60% in total landings from 2010 to 2020.

ICES performs assessments for each species separately. The latest benchmark assessment for *L. piscatorius* in Division 8.c and 9.a was carried out in 2018 (ICES, 2018) when new settings and data were incorporated to the existing Stock Synthesis (SS) model (Methot Jr. and Wetzel, 2013). A benchmark assessment using SPiCT (Pedersen and Berg, 2017) for *L. budegassa* was conducted

during WKMSYSPiCT (ICES, 2021). The time-series of available cpue data were revised and several tests were conducted.

The ageing estimation problems detected during the previous benchmark (see WKFLAT report; ICES, 2012) continued unsolved for *L. piscatorius* (ICES, 2018) and no new studies were carried out for *L. budegassa*. The growth pattern inferred from mark-recapture and length composition data analyses (Landa *et al*., 2008) was used in the assessment of *L. piscatorius*.

4.1.1 References

ICES. 2012. Report of the Benchmark Workshop on the Flatfish Species and Anglerfish (WKFLAT), 1–8 March 2012, Bilbao, Spain. ICES CM 2012/ACOM:46.

ICES. 2018. Report of the Benchmark Workshop on Anglerfish stocks in the ICES area (WKANGLER), 12–16 February 2018, Copenhagen, Denmark. ICES CM 2018/ACOM: 31. 172 pp.

ICES. 2021. Benchmark Workshop on the development of MSY advice for category 3 stocks using Sur-plus Production Model in Continuous Time; SPiCT (WKMSYSPiCT). ICES Scientific Reports. 3:20. 316 pp. https://doi.org/10.17895/ices.pub.7919.

Landa, L., Duarte, R. and I. Quincoces. 2008. Growth of white anglerfish (*Lophius piscatorius*) tagged in the Northeast Atlantic, and a review of age studies on anglerfish. ICES Journal of Marine Science, 65: 72–80.

Methot Jr., R.D and Wetzel, C.C. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research, 142: 86–99.

Pedersen, M.W. and Berg, C.W., 2017. A stochastic surplus production model in continuous time. Fish and Fisheries 18: 226–243.

4.2 Summary of ICES advice for 2021 and management for 2020 and 2021

4.2.1 ICES advice for 2021

ICES gave a separate advice for each of these species in 2020 for 2021. For *L. piscatorius* ICES advises that when the EU multiannual plan (MAP) for Western waters and adjacent waters (EU, 2019) is applied, catches in 2021 that correspond to the F ranges are between 1295 t and 2472 t. Catches higher than those corresponding to F_{MSY} (1872 t) can only be taken under conditions specified in the MAP. For *L. budegassa,* ICES advises that when the precautionary approach is applied, catches in 2021 should be no more than 1800 t.

4.2.2 Management applicable for 2020 and 2021

The two species are managed under a common TAC that was set at 4023 t for 2020 and 3672 t for 2021. The reported landings in 2020 were 38% of the established TAC.

There is no minimum landing size for anglerfish. However, the Council Regulation laying down common marketing standards for certain fishery products (EU, 1996), fixes a minimum weight of 500 g for anglerfish. In Spain, this minimum weight was implemented in the year 2000.

4.2.3 Management considerations

Lophius piscatorius and *L. budegassa* are subject to a common TAC. Both species of anglerfish are reported together because of their similarity but they are assessed and their advice is provided separately.

It should be noted that both anglerfish are essentially caught in mixed fisheries. Hence, management measures applied to these species may have implications for other stocks and vice versa. Although these stocks are assessed separately, they are managed together. Due to the differences in the current status of the individual stocks the advice is given separately.

Table 4.1.1 ANGLERFISH (*L. piscatorius and L. budegassa*) - Divisions 8c and 9a.
Tonnes landed by the main fishing fleets for 1978-2020 as determined by the Working Group.

	Div. 8c						Div. 9a						Div. 8c+9a		Div. 8c+9a
	SPAIN			FRANCE			SPAIN			PORTUGAL					
Year	Trawl	Gillnet	Others	Trawl	Gillnet	TOTAL	Trawl	Gillnet	Others	Trawl	Artisanal	TOTAL	SUBTOTA	Unallocated/ Non-reported	TOTAL
1978	n/a	n/a				n/a	506			n/a	222	728	728		
1979	n/a	n/a				n/a	625			n/a	435	1 060	1 060		
1980	4 008	1 477				5 485	786			n/a	654	1 440	6 926		6926
1981	3 909	2 240				6 149	1 040			n/a	679	1 719	7 867		7867
1982	2 742	3 095				5 837	1 716			n/a	598	2 314	8 151		8151
1983	4 269	1 911				6 180	1 426			n/a	888	2 314	8 494		8494
1984	3 600	1 866				5 466	1 136			409	950	2 495	7 961		7961
1985	2 679	2 495				5 174	977			466	1 355	2 798	7 972		7972
1986	3 052	3 209				6 261	1 049			367	1 757	3 172	9 433		9433
1987	3 174	2 571				5 745	1 133			426	1 668	3 227	8 973		8973
1988	3 583	3 263				6 846	1 254			344	1 577	3 175	10 021		10021
1989	2 291	2 498				4 789	1 111			531	1 142	2 785	7 574		7574
1990	1 930	1 127				3 057	1 124			713	1 231	3 068	6 124		6124
1991	1 993	854				2 847	878			533	1 545	2 956	5 802		5802
1992	1 668	1 068				2 736	786			363	1 610	2 758	5 493		5493
1993	1 360	959				2 319	699			306	1 231	2 237	4 556		4556
1994	1 232	1 028				2 260	629			149	549	1 327	3 587		3587
1995	1 755	677				2 432	814			134	297	1 245	3 677		3677
1996	2 146	850				2 995	749			265	574	1 589	4 584		4584
1997	2 249	1 389				3 638	838			191	860	1 889	5 527		5527
1998	1 660	1 507				3 167	865			209	829	1 903	5 070		5070
1999	1 110	1 140				2 250	750			119	692	1 561	3 811		3811
2000	710	612				1 322	485			146	675	1 306	2 628		2628
2001	614	364				978	247			117	459	823	1 801		1801
2002	587	415		61	8	1 072	344			104	380	828	1 901		1901
2003	1 190	771		55	0	2 016	617			96	529	1 242	3 258		3258
2004	1 513	1 389		87	32	3 021	549			77	602	1 229	4 250		4250
2005	1 651	1 719		160	55	3 586	653			60	458	1 171	4 757		4757
2006	1 490	1 371		72	6	2 938	801			68	351	1 220	4 158		4158
2007	1 327	1 076		26	7	2 437	866			78	303	1 247	3 683		3683
2008	1 280	1 238		31	9	2 558	473			50	246	770	3 328		3328
2009	1 151	1 207		20	10	2 389	386			43	262	691	3 080		3080
2010	689	1 036		14	3	1 742	355			72	203	630	2 372		2372
2011	458	598	105	18	2	1 180	216	88	146	122	199	770	1 951	154	2105
2012	432	610	89	14	2	1 148	163	60	132	161	533	1 049	2 197	339	2536
2013	495	853	52	23	7	1 430	142	85	140	114	412	893	2 323	288	2612
2014	545	1 073	35	30	11	1 694	211	93	8	143	408	863	2 557	474	3030
2015	557	943	5	13	14	1 532	190	114	3	161	422	890	2 422	395	2818
2016	579	964	9	12	10	1 573	179	146	3	127	377	832	2 405	419	2824
2017	410	879	1	4	11	1 305	215	128	2	98	440	883	2 188	119	2307
2018	414	770	34	12	15	1 245	244	72	2	58	280	656	1 901	16	1916
2019	299	553	0	2	2	856	183	81	1	65	239	570	1 426	152	1577
2020	302	320	2	12	5	641	222	45	5	157	445	874	1 515	0	1515

n/a: not available

4.3 White anglerfish (*Lophius piscatorius*) in divisions 8.c and 9.a

4.3.1 General

4.3.1.1 Ecosystem aspects

The ecosystem aspects of the stock are common with *L. budegassa,* and are described in the Stock Annex.

4.3.1.2 Fishery description

L. piscatorius is mainly caught by Spanish and Portuguese bottom-trawlers and gillnet fisheries. For gillnet fishery, it is an important target species, while it is also a bycatch of the trawl fishery targeting hake or crustaceans (see Stock Annex). Since 2010, Spanish landings were on average 83% of total landings of the stock.

The length distribution of the landings is considerably different between both fisheries, with the gillnet landings showing higher mean lengths compared to those landed by trawls. From 2005 to 2020, the Spanish landings were on average 40% from the trawl fleet (in 2019, mean lengths of 63 cm and 73 cm in divisions 8.c and 9.a, respectively were observed) and 60% from the gillnet fishery (mean length of 85 cm in Division 8.c was observed in 2019). For the same period, Portuguese landings were on average 11% from bottom-trawlers (mean length of 54 cm in 2019) and 89% from the artisanal fleet (mean length of 70 cm in 2019).

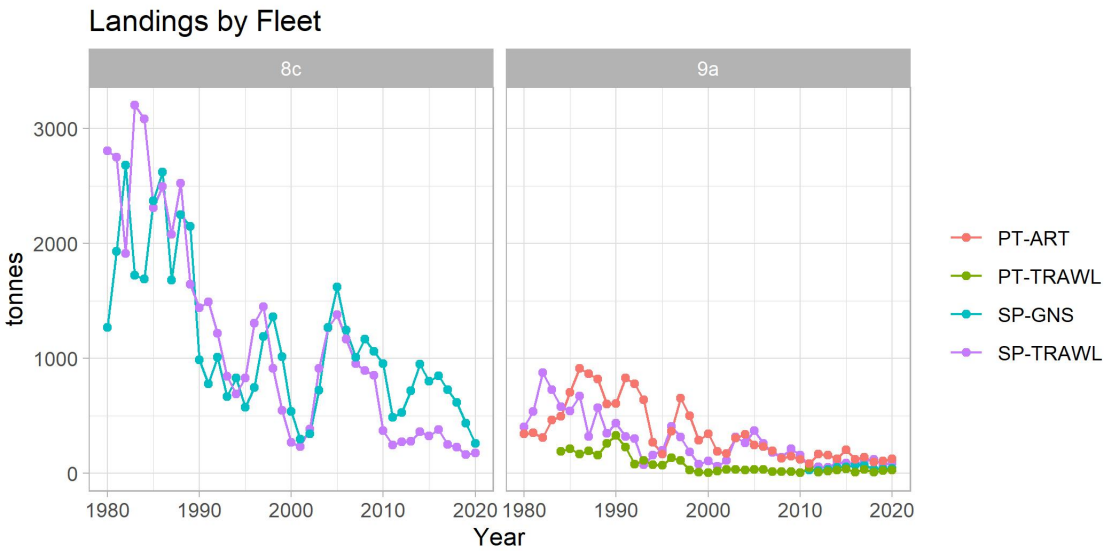
4.3.2 Feedback from Advice Drafting Group Bay of Biscay and Iberian Waters (ADGBBI) 2020

The ADG stock minutes for mon.27.8c9a raises some comments and questions about the assessment of the stock. The main issues are discussed below:

ADG: "Concern that the selectivity used is dome-shaped leaving out the large individuals, and the abundance index used comes largely from the survey that does not track the large individuals, so there's a need of information to support the increasing trend of the biomass index".

This concern is shared by the stock coordinator and the WGBIE. Unfortunately, there are no scientific surveys designed for this species, and the only information would come from commercial fishery. The need for a standardized abundance index from a commercial fleet for mon.27.8c9a was discussed many times. In February 2021, the IEO sent to the stock coordinator the logbooks records for a gillnet fleet targeting larger anglerfish (métier: GNS_DEF_>=100_0_0). There are still doubts about the possibility of using this information to build a standardized abundance index, as they do not include an appropriate unit of effort, the hauls are not identified, and the fishing operations are not geo-referenced. However, the objective is to standardize the index and use it as input data for the model in the next benchmark.

ADG: "Still important to have evidences or data that supports this increase in the abundance". The only information available is the time-series of landings from commercial fleets. No appropriate information from stakeholders neither scientific survey is available for the WGBIE. Since 2005, there is an overall decreasing trend in landings for the main fleets (SP-GNS, Spanish gillnets, and SP-TRAWL, Spanish trawlers) in Division 8.c (see figure below). Besides, the last 4 years, a sharp decline was observed on landings from fleet SP-GNS, which catches larger individuals (> 50 cm). In Division 9.a, landings have remained stable at low levels in recent years. No appropriate time-series of effort is available. Thus, there is no evidence of the increase in abundance, at least, in the areas/depths where fleets operate.



ADG: "The benchmark in 2018 recommended to use a dome-shaped curve for the artisanal fleet. If that was done to set the Reference points, was this settings used in the model this year?"

The Benchmark in 2018 (ICES, 2018) recommended modelling the selectivity of the four fleets included in the model as a double-normal function and to force at least one fleet to be asymptotic. The Portuguese artisanal fleet (PTART9a) was forced to be asymptotic, and it was accepted by the experts. The biological reference points were calculated as part of this Benchmark and using the settings described above (ICES, 2018). The settings used in the model for the assessments performed in WGBIE2020 were exactly the same: the selectivity of the 4 fleets is modelled as a double-normal function and the fleet PTART9A is forced to be asymptotic.

ADG: "These discussions make it clear that there is a need for the WG to look at these questions and the assumptions on large fish abundances and forecasts. The report for next year has to be clearer about the assumptions used in the model and forecasts"

All settings and assumptions used in the model and the forecast are included in the report this year.

ADG: "Look for a source of information on large specimens mainly driven by the decrease in catches and F."

With the information provided by IEO for gillnet fleet targeting anglerfish ("rasco"), attempts to build a standardized abundance index for the stock will be carried out in the next months.

4.3.2.1 ADG recommendations

ADG: "To look for information to confirm or review the increase on the abundance index for the stock despite the decrease of effort and the catches".

The information had been requested to the corresponding scientific laboratory many times in the last 3 years. Eventually, this information has been provided two months ago. It is still necessary a process of cleaning, analysis, and standardization of the data before reaching any conclusion about effort or abundance,

ADG: "Explore abundance indices for large specimens: data from gillnets?".

Work in progress. The abundance index from gillnet fleet ("rasco") will be used as input data of the model in a future benchmark.

4.3.3 Data

4.3.3.1 Commercial catches and discards

Total landings by country and gear for the period 1978–2020, as estimated by the WG, are given in Table 4.3.1. Unallocated and non-reported landings for this stock are available from 2011 to 2019. The unallocated and non-reported values are considered realistic and are taken into account for the assessment. Estimates of unallocated or non-reported landings were estimated based on the sampled vessels (Spanish concurrent sampling) and raised to the total effort of each métier and quarter.

Spanish discards estimates and landings below the minimum size of *L. piscatorius* in weight are shown in Table 4.3.2. No discards were reported in logbooks by any country. For the available time-series, anglerfish discards represent less than 16% of trawl catches. The maximum value observed from the time-series occurred in 2006 (99 t). Discards from the Spanish gillnet fleet are only available from 2013 to 2020 with quantities between 0 t and 144 t. The occasional high and zero values of discards reported for the gillnet fleet could be related to a very low sampling level. *L. piscatorius* discards in the Portuguese trawl fisheries are considered negligible (Fernandes and Prista, 2012; Prista *et al*., 2014). Based on the Spanish and Portuguese discards information, the WG concluded that discards could be considered negligible.

4.3.3.2 Biological sampling

The procedure for sampling this species is the same as for *L. budegassa* (see Stock Annex).

The sampling levels for Portugal in 2020 are shown in Table 1.4. Following the requirement of the EU Data Collection Framework, the métier sampling adopted in Spain and Portugal in 2009 can have an effect on the provided data. Spanish sampling levels are similar to previous years but a significant reduction of Portuguese samplings was observed in 2009–2011. Since 2012, Portugal has increased their sampling effort.

Length composition

The COVID-19 situation and Spanish administrative issues had a negative effect on the biological sampling. The sampling was reduced to minimum levels and for many Spanish métiers, there was no sampling in quarters 2 and 3.

Due to the low level of sampling and the gaps of information in many strata (métiers and quarters), it was not possible to estimate a length composition for total stock landings in 2020. Only for the Spanish gillnet fleet, a raised length composition of landings was available for quarters 1 and 4.

The annual length compositions for all combined fleets for the period 1986–2019 are presented in Figure 4.3.1.

Landings in number, the mean length and mean weight in the landings between 1986 and 2019 are shown in Table 4.3.3. The lowest total number in landings (year 2001) is 4% of the maximum value (year 1988). After 2001, increases were observed up to 2006, with decreases every year since then to year 2012. In the last 3 years, there is a strong downward trend in total landings number reaching 139 thousand in 2019 (value almost similar to the smallest number, 127 thousand in 2001, observed for the whole time-series). This decrease coincides with an increase in the mean length.

Mean lengths and mean weights in the landings increased sharply between 1995 and 2000. In 2002, low values of mean lengths and mean weights were observed, around the minimum of the time-series, due to the increase in smaller individuals. After that, increases in mean length were observed reaching 71 cm in 2010. In 2018, mean length and mean weight in landings increased

with respect to the previous year and that year values, 77 cm and 7163 g respectively, were the highest of the time-series.

Biological information

The growth pattern used in the assessment follows a von Bertalanffy model with fixed K = 0.11 and L_{inf} estimated by the model. Length-weight relationship, updated during the benchmark (ICES, 2018), maturity ogive and natural mortality used in the assessment are described in the Stock Annex.

4.3.3.3 Abundance indices from surveys

Spanish and Portuguese survey results for the period 1983–2020 are summarized in Table 4.3.4.

The abundance index from Spanish survey SP-NSGFS-Q4 (G2784) is shown in Figure 4.3.2. Since 2000, the highest abundance values were detected in 2001 and 2006, following this year a downward trend was observed. In 2015, 2016, 2017 and 2018, the abundance indices were the lowest of the series (Figure 4.3.2) and almost no individuals < 20 cm were recorded (Figure 4.3.3). In 2019 and 2020 slight increases in the abundance were observed.

Since 2013, the SP-NSGFS-Q4 (G2784) is conducted using a different vessel. The results of two inter-calibration experiments carried out between the two oceanographic vessels in 2012 and 2014 indicated that catches of white anglerfish have not been affected by the change of the vessel.

4.3.3.4 Commercial catch-effort data

Landings, effort and LPUE data are given in Table 4.3.5 and Figure 4.3.4. Values for Spanish trawlers (Division 8.c) from the ports of Santander and Avilés were collected since 1986, for A Coruña since 1982 and the Portuguese trawlers (Division 9.a) since 1989. A Coruña fleet series (landings, effort and LPUE) were updated to incorporate years at the beginning of the series (1982–1985). Three series are presented for A Coruña fleet: (1) A Coruña port for trips that are exclusively landed in the port, (2) A Coruña trucks for trips that are landed in other ports and (3) A Coruña fleet that takes into account all the trips of the fleet. For 2020, no information for A Coruña port was provided. Although abundance series from A Coruña port can be potentially used in the assessment, a previous analysis of the whole time-series must be done before taking it into account. The A Coruña fleet index, used in the assessment as abundance index from 1982–2012, is not available since 2013.

Until 2011, most logbooks of Portuguese fleets were filled out on paper but have been progressively replaced thereafter by electronic logbooks. In 2013, more than 90% of the logbooks were completed in the electronic version. The LPUEs series were revised from 2012 onwards. To revise the series backwards, further refinement of the algorithm is required.

For each fleet, the proportion of the landings in the stock is also given in Table 4.3.5. In 2007, a dataseries from the artisanal fleet from the port of Cedeira in Division 8.c was provided. This LPUE series is annually standardized to incorporate a new year of data and the latest available standardized series, from 1999–2011, is presented. Due to the reduction in the number of vessels of Cedeira fleet, this tuning series could not be considered as a representative abundance index of the stock and it is no longer recorded. A series of standardized effort for Portuguese trawl fleets (1989–2008) and their corresponding LPUEs are also given in Table 4.3.5, but not represented in Figure 4.3.4.

All fleets show a general decrease in landings during the eighties and early nineties. Slight increases in 1996 and 1997 landings can be observed in all fleets. From 2000 to 2005, Spanish fleets of A Coruña, Avilés and Cedeira showed an increase in landings while those landed by the Portuguese fleets remained at low levels. Since 2005–2009, landings from A Coruña and Cedeira fleets showed an overall decreasing trend. Proportion in total landings per fleet is higher for the

Cedeira and A Coruña. Landings for both Portuguese fleets increased in 2014 and 2015 then decreased in 2016 and 2018.

Effort trends show a general decline since the mid-nineties in all trawl fleets. In the last five years, low effort values were observed despite some slight fluctuations. Despite these variations along the time-series, the artisanal fleet of Cedeira shows an overall increasing trend until 2008. After this year the effort sharply declined to the minimum value of the series in 2011. From 2007–2011 the effort from A Coruña fleet was reduced by 47%, showing the lowest values of the series in 2011. The Portuguese Crustacean fleet shows high effort values in 2001 and 2002 that might be related to a change in the target species due to the very high abundance of rose shrimp during that period.

LPUEs from all available fleets show a general decline during the eighties and early nineties followed by some increase (Table 4.3.5). From 2002 to 2005, LPUEs increased for all fleets. This general LPUE trend is consistent between fleets including the artisanal fleet. In 2010 and 2011, an important increase of Cedeira LPUE was observed. Portuguese fleets showed a one-off increase in 2011 and, in 2017 Portuguese trawl fleet target crustaceans showed the highest LPUE of the time-series with 2 kg/hour.

4.3.4 Assessment

This is an update assessment using the model adopted in 2018 benchmark (ICES, 2018). Last year assessment (ICES, 2020a) was updated with 2020 data.

4.3.4.1 Input data

Input data used in the assessment are presented in the Stock Annex.

Due to the problems described in the previous section (see Commercial catch-effort data), the A Coruña-fleet and Cedeira-fleet abundance indices from 2013 to 2019 were not included in the assessment. Length composition of landings for the Spanish artisanal fleet in ICES Division 8.c (SPART8C) in 1st and 4th quarter are the only length compositions used as input data for the year 2020.

4.3.4.2 Model

The Stock Synthesis (SS) software was selected to be used in the assessment. The description of the model including the structure, settings, and parameters assumptions are presented below:

Model used: Stock Synthesis (SS) (Methot, 2000).
Software used: Stock Synthesis v3.30.10 (Methot *et al.*, 2018).

Stock Synthesis is an integrated assessment model. SS has been used for stock assessment all around the world. The area of highest use is the US Pacific Coast. SS is coded in C++ using Auto-Differentiation Model Builder (http://www.admb-project.org) and available at the NOAA Virtual Laboratory (https://vlab.ncep.noaa.gov/). SS has three main characteristics that differentiate it from classical assessment models:

- SS model structure allows for building of simple to complex models depending upon the data available. It is capable to build models with age and/or length structure and spatial structure.
- It is capable to use different sources of information.
- All parameters have a set of controls to allow prior constraints, time-varying flexibility, and linkages to environmental data.

The overall SS model is subdivided into 3 submodels. The first submodel simulates the population dynamics, where the basic abundance, mortality and growth functions create a synthetic representation of the true population. The second is the observation submodel. It contains the processes and filters designed to derive expected values for the various types of data. The last one is the statistical submodel, which quantifies the magnitude of the difference between observed and expected data and employs an algorithm to find the set of parameters that maximizes the goodness-of-fit.

The SS model developed for white anglerfish during the WKANGLER 2018 has been designed for a particular set of data and specifications. White anglerfish is harvested by four fleets, and two commercial LPUE series and one fishery-independent survey provide information about relative abundance. No discard information is considered. Length composition data are available from both the fisheries and surveys. No age information is available for this stock.

Input data

- Years: 1980–2020.

Model structure:

- Temporal unit: quarterly based data (landings, LPUE and length–frequency) were used in SS calculations.
- Spatial structure: One area.
- Sex: Both sexes combined.

Fleet definition:

Four *fleets* were defined considering the gear type and country:

- Spanish trawlers in ICES divisions8.c–9.a (SPTR8C9A)
- Spanish artisanal in ICES Division 8.c (SPART8C)
- Portuguese trawlers in ICES Division 9.a (PTTR9A)
- Portuguese artisanal in ICES Division 9.a (PTART9A)

Landed catches:

Quarterly landings entered the model as biomass (in weight) for the four fleets. Landings data for January 1980 to December 2020 were used to conduct the stock assessment of white anglerfish.

From 1980 to 1988 quarterly landings were estimated using the average proportion for the following five years (1989–1993) by fleet. In the case of SPART8C quarterly landings were estimated from 1980 to 1993 using the average proportion for the next five years (1994–1998).

Abundance indices:

- A Coruña trawlers (SPCORTR8C): Quarterly LPUE in weight from 1982 to 2012, as four separate indices, i.e. one index per quarter.
- Cedeira gillnetters (SPCEDGN8C): Quarterly LPUE in weight from 1999 to 2011, as four separate indices, i.e. one index per quarter.
- Spanish Groundfish Survey (SPGFS): Abundance index in numbers from 1983 to 2020, except for 1987.

Length composition of data:

The length bin was set by 2 cm, from 4 to 100 cm, by 10 cm from 100 to 160 cm and by 40 cm from 160 to 200 cm. Length composition for the four fishing fleets and the three abundance indices were used. The available length data and their disaggregated level differ among fleets:

Length composition of Fleets:

- SPTR8C9A: 1986–2019, quarterly basis. From 1986 to 1988 quarterly length proportions were estimated from an annual proportion using the Data Super-Period approach available in SS.
- SPART8C: 1986–2020, quarterly basis. From 1986 to 1994 quarterly length proportions were estimated from an annual proportion using the Data Super-Period approach available in SS. For year 2020 only length proportions for 1st and 4th quarters were included.
- PTTR9A: 1986–2009, quarterly basis. From 1986 to 1988 quarterly length proportions were estimated from an annual proportion using the Data Super-Period approach presented in SS.
- PTART9A: 1986–2009, quarterly basis. From 1986 to 1988 quarterly length proportions were estimated from an annual proportion using the Data Super-Period approach present in SS.

Length composition of Abundance Indices:

- SPCORTR8C: 1982–2012, quarterly basis, with gaps in years 1982, 1984, 1985 and 1986.
- SPCEDGN8C: 1999–2011, quarterly basis.
- SPGFS: length composition for fourth quarter, from 1983–2020. 1987 length composition is missing.

Model assumptions and parameters

- Natural mortality: M = 0.2 for all ages and years.
- Growth: von Bertalanffy function: K = 0.11 fixed, L_{max} and mean length-at-age 0.75 are estimated.
- Maturity ogive: length-based logistic, L_{50} = 61.84 and slope = −0.1001, constant over time.
- Weight-at-length: a = 2.5×10^{-5}, b = 2.853, not estimated.
- Recruitment allocation in Quarter 3.
- Stock–recruitment relationship: Beverton–Holt model: steepness h = 0.999, sigmaR = 0.4, R0 estimated.
- Selectivity: For all fleets selectivity was only length-based and was modelled as a double normal function. Selectivity for fishery PTART9A was set to be flat-top (asymptotic). Selectivity varies among fleets, but is assumed to be time-invariant.

4.3.4.3 Assessment results

The model diagnosis is carried out by means of the analysis of residuals of abundance indices. Residual plots of the fits to the abundance indices are shown in Figure 4.3.5. Although some minor trends have been detected, as it happened for A Coruña indices from 1995 to 2000, it can be considered that the model follows trends of the abundance indices used in the model (A Coruña, Cedeira and the Spanish survey). For the Spanish survey (G2784), in the last 7 years, the model overestimates the index. It seems that the model does not follow the very low values of the index in the years 2014–2020. Pearson residual plots are presented for the model fits to the length-composition data of the abundance indices (Figure 4.3.6). No specific pattern was detected in any of the abundance indices. However, some high positive residuals are evident for G2784 index. Nevertheless, the model fits reasonably well.

The model estimates size-based selectivity functions for commercial fleets (Figure 4.3.7) and for abundance indices (Figure 4.3.8). All the selection patterns were assumed constant over the time. The selection pattern for the Spanish trawl fleet is efficient for a wide range of lengths, from smaller to very large individuals. The Spanish artisanal fleet is most efficient at a narrow length range of large-sized fish, mainly from 75 to 90 cm. The Portuguese trawl fleet selection pattern indicates that this fishery is most efficient for individuals ranging between 30 and 60 cm. This selection pattern shows strange selection over larger fish, possibly the effect of an insufficient length sampling. The Portuguese artisanal fleet selection pattern was modelled to be asymptotic, retaining all fish above 60 cm.

The selection patterns are equal for all quarters in A Coruña and Cedeira indices. For A Coruña index, the selection pattern has a wide length range while Cedeira index shows selectivity directed to larger individuals. The Spanish survey (G2784) index shows a well-defined selectivity to smaller individuals.

The variance-covariance matrix (Hessian calculation) was calculated to represent uncertainty in the spawning biomass and recruitment. The annual F summary reported in the standard SS output files (with both point estimate and standard deviation) do not correspond to the F summary used here (the average of over lengths 30 to 130 cm). The uncertainty of F could not be calculated from the variance-covariance matrix.

4.3.4.4 Historic trends in biomass, fishing mortality and recruitment

Table 4.3.6 and Figure 4.3.9 provide the summary of results from the assessment model and observed landings. Maximum values of recruitment are recorded at the beginning of the time-series (1982, 1986, 1987 and 1989) with values over 3 million. Along the time-series, other high recruitment values were detected in 1994 and 2001. Since 2006, the recruitment has been below 1 million except in 2010, 2011 and 2014. The abundance of age-0 in years 2015, 2016 and 2017 was very low, being at the minimum values throughout the time-series. A recruitment value above 1 million was estimated in 2019. Landings steadily decreased from 3.8 kt in 2005 to 1.1 kt in 2011, coinciding with the decrease in F, from 0.385 in 2005 to 0.133 in 2011. Compared to 2019, landings and F decreased in 2020 by 21% and 10%, respectively. Since 2005, SSB was above 6 kt and it steadily increased to the highest value of the times-series (11.9 kt) estimated at the beginning of 2019.

The very low recruitment values estimated by the model for years 2015 to 2018 have not been reflected in the SSB. In fact, the SSB has increased from 2015 to 2019 between 1% and 4% per year. Taking into account that white anglerfish reaches its maturity at 62 cm which corresponds approximately to 4 years, the potential impact of low recruitments on SSB will only be detected after 4 or 5 years. In 2020 and 2021, the SSB values decreased slightly related to the previous year estimates. However, the progressive decline in landings detected from 2017 to 2020, may reflect the low abundance of ages 2, 3 and 4 exploited by the fishery.

4.3.4.5 Retrospective pattern for SSB, fishing mortality, yield and recruitment

In order to assess the consistency of the assessment from year-to-year, a retrospective analysis was carried out. It was conducted by removing one year (2020), two years (2020 and 2019), three years (2020–2018), four years (2020–2017) and five years (2020–2016) of data while using the same model configuration (Figure 4.3.10). All the retrospective analysis runs were similar in the recruitment estimates. Although there are some uncertainties in recent recruitment estimates, no consistent bias was observed. Retrospective analysis showed an underestimation of the SSB in the final years and an overestimation of F. Nevertheless, there was no strong retrospective pattern and the assessment was accepted for projections. Mohn's Rho index (Mohn, 1999) for the last 5 years were estimated for recruitment (−0.50), F (0.13) and SSB (0.13).

4.3.5 Catch options and prognosis

4.3.5.1 Short-term projections

This year projections were performed on the basis of the present assessment.

For fishing mortality, the F *status quo* (F_{sq}) equals to 0.093, estimated as the average of $F_{2018\text{-}2020}$ over lengths 30–130 cm, was used for the intermediate year (2021). Although there is a decreasing trend in F, it was decided not to scale F_{sq} to the final year because of the uncertainty on SSB estimates. Unscaled F_{sq} was considered more precautionary as a higher value of F is closer to F_{MSY}.

The recruitment used for projections in this WG is the geometric mean calculated from 2003 to the final assessment year (2020), following the option indicated in the Stock Annex when a trend in the time-series was detected. Recruitment short-term projection assumption value is given in Table 4.3.7. Projected landings in 2022 and SSB at the beginning of 2023 for different management options in 2022 are presented in Table 4.3.7. Under F *status quo* scenario in 2022, a small increase in the 2022 landings, as well as an increase in the 2023 SSB, are expected with respect to 2021 landings and 2022 SSB, respectively.

4.3.5.2 Yield and biomass per recruit analysis

The summary table of Yield and SSB per recruit analysis is given in the table below:

	SPR level	Fmult	F(30-130cm)	YPR(land)	SSB/R
Fmax	0.14	3.18	0.263	1.99	6.51
F0.1	0.26	2.03	0.168	1.88	12.09
F40%	0.40	1.31	0.108	1.61	18.85
F35%	0.35	1.52	0.126	1.72	16.49
F30%	0.30	1.77	0.146	1.81	14.13

The F that maximizes the yield-per-recruit, F_{max}, is estimated at 0.263 which is well above F_{sq} (0.093) and which corresponds to a SPR level of 14%. The $F_{0.1}$, rate of fishing mortality at which the slope of the YPR curve falls to 10% of its value at the origin, is equal to 0.168 and it is corresponding to a SPR level of 26%. Fishing mortality of $F_{30\%}$, $_{35\%}$ and $_{40\%}$ were estimated at 0.146, 0.126 and 0.108, respectively. The *status quo* F is below F_{max}, $F_{0.1}$, and $F_{30\%}$, $F_{35\%}$ and $F_{40\%}$.

4.3.6 Biological reference points of stock biomass and yield

Biological reference points for southern white anglerfish stock were calculated in the Benchmark WKANGLER (ICES, 2018). In this year Working Group, and following the ACOM guidelines (ICES, 2020b), the value of F_{pa} was revised according to the new definition "$F_{p0.5}$: the F that leads to SSB ≥ B_{lim} with 95% probability" (calculated with $B_{trigger}$). Besides, as the new F_{pa} value was higher than the F_{lim}, previous Fl_{im} value was discarded and has not been defined yet. The reference points in use for the stock are presented in the following table:

Framework	Reference points	Value	Rational
Precautionary approach	B_{lim}	1993 t	B_{loss}
	B_{pa}	2769 t	B_{lim}*exp (1.645*0.2)
	F_{lim}	not defined	
	F_{pa}	0.87	$F_{p0.5}$; the F that leads to SSB ≥ Blim with 95% probability, calculated using Btrigger.

MSY Approach	F_{MSY}	0.24	Stochastic simulation, F maximizes median equilibrium yield
	$F_{MSY\text{-}lower}$	0.164	Stochastic simulations, 5% reduction in long-term yield compared with MSY.
	$F_{MSY\text{-}upper}$	0.33	
	MSY $B_{trigger}$	6283 t	5th percentile of SSB when fishing at F_{MSY}

4.3.7 Comments on the assessment

The spawning-stock biomass has increased from 2007 to 2019. SSB in 2021 is estimated at 11.6 kt which is well above of B_{pa} (2769 t) and MSY $B_{trigger}$ (6283 t). Fishing mortality in 2020 has decreased by 10% relative to 2019. F in 2020 is estimated to be at a value of 0.083, below F_{pa} (0.87) and F_{MSY} (0.24). An increase in landings occurred from 1.1 kt in 2011 to 2.0 kt in 2014 but declined to 0.7 kt in 2020. For the period 2015–2018, recruitments were extremely low, being the main concern about the status of the stock. In 2019, the recruitment estimated indicates a moderate increase in the abundance of age-0, decreasing again in 2020.

4.3.8 Quality considerations

The available unallocated and non-reported landings for the years 2011–2019 are included in the stock assessment since the estimates were considered realistic. However, the importance of the unallocated/non-reported landings is difficult to assess and the results of the assessment might have been affected by the inclusion of these data.

Uncertainty of the assessment model may have increased due to the missing data for commercial abundance indices since 2012. For the last 10 years, the model lacks an abundance indicator for larger individuals which might impact the calculation of F for larger individuals and on the SSB estimates.

4.3.9 Management considerations

Management considerations are describing for both anglerfish stocks in section 4.2.

4.3.10 Recommendations for next benchmark

During the WKTaDSa (ICES, 2021), a number of issues to improve the current assessment model of mon.27.8c9a were identified. The following tasks are proposed for the next benchmark:

- Simplify the current model by changing the structure from quarter time-step to an annual time-step.
- Reduce the number of fishing fleets included in the model. The four fleets defined in the current model could be reduced to 2 fleets: Gillnet Fleet and Trawler Fleet.
- Explore the selectivity pattern of the fleets. The Stock Synthesis experts expressed that there are reasons against and for selecting a specific selectivity pattern, but they don't agree with general rules (like "at least one fleet-selectivity must be asymptotic"). A specific residual analysis should be carried out to identify the potential impact of different selectivity patterns on F and SSB estimates.
- Use an age-variant natural mortality. Also, it must be explored if the differential sex growth (females reach larger sizes than males) should be taken into account to define natural mortality for older ages.
- Inclusion of a standardized abundance index for larger individuals. It is proposed to use the commercial abundance index from Spanish gillnet fleet targeting anglerfish.

- The model-based estimates of effective sample size should be updated every year using the Dirichlet-Multinomial method (Mosimann, 1962).
- Create a protocol of modern model diagnostics for model development and selection using the functions included in the R library *ss3diags*.

4.3.11 References

EU. 1996. Regulation (EC) No 2406/96 of 26 November 1996 laying down common marketing standards for certain fishery products.

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj.

Fernandes, A.C. and Prista, N. 2012. Portuguese discard data on anglerfish Lophius piscatorius and black bellied angler Lophius budegassa (2004–2010). Working document-07 presented at WKFLAT2012. ICES CM: ACOM: 46.

ICES. 2018. Report of the Benchmark Workshop on Anglerfish stocks in the ICES area (WKANGLER), 12−16 February 2018, Copenhagen, Denmark. ICES CM 2018/ACOM: 31. 172 pp.

ICES. 2020a. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. 2:49. 845 pp. http://doi.org/10.17895/ices.pub.6033.

ICES. 2020b. Minutes of the meeting of the ICES Advisory Committee (ACOM), Copenhagen, Denmark, 10–12 March 2020. 58 pp. http://doi.org/10.17895/ices.pub.7452.

ICES. 2021. Workshop on Tools and Development of Stock Assessment Models using a4a and Stock Synthesis (WKTADSA). ICES Scientific Reports. 3:33. 197 pp. https://doi.org/10.17895/ices.pub.8004

Methot, R.D. 2000. Technical Description of the Stock Synthesis Assessment Program. National Marine Fisheries Service, Seattle, WA. NOAA Tech Memo. NMFS-NWFSC-43: 46 pp.

Methot, R.D., Wetzel, C. and I. Taylor. 2018. User Manual for Stock Synthesis: Model Version 3.30.10. NOAA Fisheries Service, Seattle. 191 pp.

Mohn, R. 1999. The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. ICES Journal of Marine Science 56: 473–488.

Mosimann,J.E. 1962. On the compound multinomial distribution, the multivariate-distribution, and correlations among proportions.Biometrika.,49,65–82.

Prista, N., Fernandes, A., Pereira, J, Silva, C., Alpoim, R. and Borges, F. 2014. Discards of WGBIE species by the Portuguese bottom otter trawl operating in the ICES division 9.a (2004−2013). Working Document presented at WGBIE2014.

4.3.12 Tables and figures

Table 4.3.1 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a.
Tonnes landed by the main fishing fleets for 1978-2020 as determined by the Working Group.

	Div. 8c						Div. 9a						Div. 8c+9a		Div. 8c+9a
	SPAIN			FRANCE			SPAIN			PORTUGAL					
Year	Trawl	Gillnet	Others	Trawl	Gillnet	TOTAL	Trawl	Gillnet	Others	Trawl	Artisanal	TOTAL	SUBTOTAL	Unallocated / Non-reported	TOTAL
1978	n/a	n/a				n/a	258				115	373			
1979	n/a	n/a				n/a	319				225	544			
1980	2 806	1 270				4 076	401				339	740	4 816	0	4 816
1981	2 750	1 931				4 681	535				352	887	5 568	0	5 568
1982	1 915	2 682				4 597	875				310	1 185	5 782	0	5 782
1983	3 205	1 723				4 928	726				460	1 186	6 114	0	6 114
1984	3 086	1 690				4 776	578			186	492	1 256	6 032	0	6 032
1985	2 313	2 372				4 685	540			212	702	1 454	6 139	0	6 139
1986	2 499	2 624				5 123	670			167	910	1 747	6 870	0	6 870
1987	2 080	1 683				3 763	320			194	864	1 378	5 141	0	5 141
1988	2 525	2 253				4 778	570			157	817	1 543	6 321	0	6 321
1989	1 643	2 147				3 790	347			259	600	1 206	4 996	0	4 996
1990	1 439	985				2 424	435			326	606	1 366	3 790	0	3 790
1991	1 490	778				2 268	319			224	829	1 372	3 640	0	3 640
1992	1 217	1 011				2 228	301			76	778	1 154	3 382	0	3 382
1993	844	666				1 510	72			111	636	819	2 329	0	2 329
1994	690	827				1 517	154			70	266	490	2 007	0	2 007
1995	830	572				1 403	199			66	166	431	1 834	0	1 834
1996	1 306	745				2 050	407			133	365	905	2 955	0	2 955
1997	1 449	1 191				2 640	315			110	650	1 075	3 714	0	3 714
1998	912	1 359				2 271	184			28	497	710	2 981	0	2 981
1999	545	1 013				1 558	79			9	285	374	1 932	0	1 932
2000	269	538				808	107			4	340	451	1 259	0	1 259
2001	231	294				525	57			16	190	263	788	0	788
2002	385	341		51	7	784	110			29	168	307	1 090	0	1 090
2003	911	722		46	0	1 679	312			29	305	645	2 324	0	2 324
2004	1 262	1 269		73	27	2 631	264			27	335	626	3 257	0	3 257
2005	1 378	1 622		134	46	3 180	371			29	244	643	3 824	0	3 824
2006	1 166	1 247		60	5	2 478	260			29	230	519	2 997	0	2 997
2007	955	1 009		22	6	1 992	181			13	192	386	2 378	0	2 378
2008	894	1 168		26	8	2 096	138			11	127	275	2 371	0	2 371
2009	850	1 058		17	9	1 935	213			10	148	371	2 306	0	2 306
2010	370	955		12	2	1 339	158			2	119	279	1 618	0	1 618
2011	243	483	73	15	2	816	59	28	48	46	80	260	1 077	80	1 157
2012	271	527	67	12	2	880	54	20	42	6	163	285	1 165	230	1 395
2013	274	718	38	19	6	1 054	47	30	50	15	154	296	1 350	190	1 541
2014	358	947	28	25	9	1 368	91	47	4	27	122	291	1 659	374	2 032
2015	324	802	4	11	12	1 152	86	53	2	34	200	375	1 527	244	1 771
2016	376	846	3	10	8	1 243	76	67	1	8	120	273	1 516	294	1 809
2017	248	726	1	3	8	986	106	66	1	30	138	341	1 327	119	1 446
2018	227	614	34	5	6	886	117	35	1	6	94	253	1 139	4	1 144
2019	161	435	0	0	0	597	74	33	1	22	104	233	830	78	909
2020	175	256	1	8	3	443	84	40	2	28	125	279	722	0	722

n/a: not available

Table 4.3.2 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a.
Weight and percentage of unwanted catches for Spanish fleets.

Discards Recorded in Logbooks		Gillnet
Year	Weight (t)	Weight (t)
2019	0	0
2020	0	0

Landings BelowMinimumSize		Gillnet
Year	Weight (t)	Weight (t)
2018	0.027	0.111
2019	0	0
2020*	0.001	0

Discards Estimates: Trawl

Year	Weight (t)	CV	% Trawl Catches	% Total Catches
1994	20.9	34.05	2.2	1.0
1995	n/a	n/a	n/a	n/a
1996	n/a	"	n/a	n/a
1997	5.4	68.13	0.3	0.1
1998	n/a	n/a	n/a	n/a
1999	0.7	"	0.1	0.0
2000	6.2	"	1.6	0.5
2001	n/a	"	n/a	n/a
2002	n/a	"	n/a	n/a
2003	26.2	"	2.0	1.1
2004	64.9	"	3.8	2.0
2005	56.2	"	2.9	1.4
2006	99.3	"	6.2	3.2
2007	17.2	"	1.4	0.7
2008	5.1	"	0.5	0.2
2009	24.5	"	2.2	1.1
2010	12.5	"	2.3	0.8
2011	30.1	"	7.7	2.5
2012	66.7	"	16.3	4.6
2013	65.8	"	15.7	3.8
2014	24.4	"	4.6	1.2
2015	20.8	"	4.4	1.2
2016	0.03	"	0.0	0.0
2017	13.3	"	3.3	0.9
2018	4.1	"	1.2	0.4
2019	1.9	"	0.7	0.2
2020*	2.2	"	0.7	0.3

Discards Estimates: Gillnet

Year	Weight (t)	% Gillnet Catches	% Total Catches
2013	143.8	13.7	8.2
2014	0.0	0.0	0.0
2015	7.6	0.7	0.4
2016	24.2	2.3	1.3
2017	17.0	1.8	1.2
2018	1.8	0.2	0.2
2019	16.7	2.8	1.8
2020*	3.8	0.9	0.5

n/a: not available

CV: coefficient of variation

* only for 3rd and 4th quarter

Table 4.3.3 ANGLERFISH (*L. piscatorius*). Divisions 8c and 9a.
Numbers, mean weight and mean length of landings between 1986 and 2019.

Year	Total (thousands)	Mean Weight (g)	Mean Length (cm)
1986	1 872	3 670	61
1987	2 806	1 832	44
1988	2 853	2 216	50
1989	1 821	2 744	54
1990	1 677	2 261	49
1991	1 657	2 197	50
1992	1 256	2 692	54
1993	857	2 719	54
1994	704	2 850	54
1995	876	2 093	48
1996	1 153	2 564	52
1997	1 043	3 560	60
1998	583	5 113	68
1999	290	6 674	71
2000	190	6 885	72
2001	127	6 189	64
2002	381	2 766	50
2003	784	2 907	54
2004	809	3 456	61
2005	856	4 259	63
2006	923	3 211	58
2007	553	4 251	62
2008	540	4 327	63
2009	492	4 630	64
2010	288	5 569	71
2011	249	4 252	62
2012	244	4 711	65
2013	269	4 929	66
2014	289	5 630	70
2015	307	4 902	66
2016	327	5 485	69
2017	233	6 205	73
2018	161	7 163	77
2019	139	6 519	73

na: not available

Table 4.3.4 ANGLERFISH (*L. piscatorius*). Divisions 8c and 9a. Abundance indices from Spanish and Portuguese surveys.

	SP-NSGFS-Q4 (G2784)					PtGFS-WIBTS-Q4 (G8899)		
	September-October (total area Miño-Bidasoa)					October		
Year	Hauls	kg/30 min		nº/30 min		Hauls	kg/60 min	nº/60 min
		Yst	se	Yst	se			
1983	145	2.03	0.29	3.50	0.46	117	n/a	n/a
1984	111	2.60	0.47	2.90	0.55	na	n/a	n/a
1985	97	1.33	0.36	1.90	0.26	150	n/a	n/a
1986	92	4.28	0.80	10.70	1.40	117	n/a	n/a
1987	ns	ns	ns	ns	ns	81	n/a	n/a
1988	101	3.33	0.70	1.50	0.25	98	n/a	n/a
1989	91	0.44	0.08	2.40	0.30	138	0.09	0.07
1990	120	1.19	0.22	1.20	0.22	123	0.46	0.05
1991	107	0.71	0.22	0.50	0.09	99	+	+
1992	116	0.76	0.15	1.18	0.16	59	0.09	0.01
1993	109	0.88	0.16	1.20	0.14	65	0.08	0.01
1994	118	1.66	0.62	3.70	0.49	94	+	0.02
1995	116	2.19	0.32	5.70	0.69	88	0.05	0.03
1996*	114	1.54	0.26	1.40	0.16	71	0.27	0.18
1997	116	1.69	0.39	0.67	0.11	58	0.49	0.03
1998	114	1.40	0.37	0.39	0.08	96	+	+
1999*	116	0.75	0.23	0.36	0.06	79	+	+
2000	113	0.57	0.19	0.88	0.18	78	+	+
2001	113	1.09	0.24	2.88	0.28	58	+	+
2002	110	1.34	0.21	2.76	0.29	67	0.06	0.04
2003*	112	1.67	0.40	1.41	0.16	80	0.29	0.15
2004*	114	2.09	0.32	2.71	0.32	79	0.16	0.12
2005	116	3.05	0.54	2.04	0.19	87	0.12	0.04
2006	115	1.88	0.40	2.86	0.30	88	+	+
2007	117	1.65	0.25	2.56	0.25	96	+	+
2008	115	1.85	0.37	1.96	0.35	87	+	+
2009	117	1.07	0.17	1.91	0.17	93	+	+
2010	114	1.29	0.25	1.95	0.28	87	+	+
2011	114	0.77	0.16	1.09	0.18	86	+	+
2012	115	1.11	0.27	1.06	0.14	ns	ns	ns
2013**	114	2.09	0.64	2.30	0.30	93	0.34	0.02
2014**	116	1.56	0.36	1.24	0.17	81	0.00	0.00
2015**	114	1.14	0.25	0.58	0.10	90	0.00	0.00
2016**	114	0.76	0.28	0.30	0.06	85	0.00	0.00
2017**	112	0.53	0.30	0.18	0.07	89	0.00	0.00
2018**	113	0.64	0.25	0.13	0.03	53	0.00	0.00
2019**	113	0.53	0.21	0.31	0.07	n/a	n/a	n/a
2020**	109	0.73	0.22	0.37	0.07	n/a	n/a	n/a

Yst = stratified mean

se = standard error

ns = no survey

n/a = not available

+ = less than 0.01

* For Portuguese Surveys - R/V Capricornio, other years R/V Noruega

** For Spanish Surveys - R/V Miguel Oliver, other years R/V Coornide de Saavedra

Table 4.3.5 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a.
Landings, fishing effort and landings per unit effort for trawl and gillnet fleets.
For landings the percentage relative to total annual stock landings is given.

	SP-AVITR8C				SP-SANTR8C				STAND-SP-CEDGNS8C			
Year	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (soaking days)	LPUE (kg/soaking day)
1986	500	7	10 845	46.1	516	8	18 153	28.4				
1987	500	10	8 309	60.2	529	10	14 995	35.3				
1988	401	6	9 047	44.3	387	6	16 660	23.3				
1989	214	4	8 063	26.5	305	6	17 607	17.3				
1990	260	7	8 497	30.6	278	7	20 469	13.6				
1991	245	7	7 681	31.9	281	8	22 391	12.6				
1992	198	6	--	--	222	7	22 833	9.7				
1993	76	3	7 635	9.9	186	8	21 370	8.7				
1994	116	6	9 620	12.0	188	9	22 772	8.2				
1995	192	10	6 146	31.2	186	10	14 046	13.2				
1996	322	11	4 525	71.1	270	9	12 071	22.4				
1997	345	9	5 061	68.1	381	10	11 776	32.3				
1998	286	10	5 929	48.3	316	11	10 646	29.7				
1999	108	6	6 829	15.8	182	9	10 349	17.6	342	18	4 582	74.5
2000	28	2	4 453	6.3	75	6	8 779	8.6	140	11	2 981	46.8
2001	23	3	1 838	12.5	54	7	3 053	17.6	87	11	1 932	44.8
2002	75	7	2 748	27.5	57	6	3 975	14.3	130	13	2 398	54.3
2003	111	5	2 526	44.0	85	4	3 837	22.1	159	7	2 703	59.0
2004	216	7	--	--	106	3	3 776	28.1	382	12	4 677	81.6
2005	278	8	--	--	59	2	1 404	41.9	434	12	3 325	130.4
2006	148	5	--	--	89	3	2 718	32.7	415	14	3 911	106.2
2007	101	4	--	--	103	4	4 334	23.8	233	10	3 976	58.6
2008	99	4	--	--	--	--	--	--	228	10	5 133	44.3
2009	69	3	--	--	35	2	1 125	31.3	183	8	2 300	79.5
2010	--	--	--	--	44	3	1 628	27.1	231	15	1 880	122.7
2011	--	--	--	--	44	4	--	--	60	6	522	115.9
2012	--	--	--	--	22	2	--	--	63	5	--	--

	SP-CORTR8C-PORT				SP-CORTR8C-TRUCKS				SP-CORTR8C-FLEET			
Year	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)
1982	1618	28	63 313	26					1618	28	63 313	25.6
1983	1490	24	51 008	29					1490	24	51 008	29.2
1984	1560	26	48 665	32					1560	26	48 665	32.1
1985	1134	18	45 157	25					1134	18	45 157	25.1
1986	825	12	40 420	20					825	12	40 420	20.4
1987	618	12	34 651	18					618	12	34 651	17.8
1988	656	10	41 481	16					656	10	41 481	15.8
1989	508	10	44 410	11					508	10	44 410	11.4
1990	550	15	44 403	12					550	15	44 403	12.4
1991	491	13	40 429	12					491	13	40 429	12.1
1992	432	13	38 899	11					432	13	38 899	11.1
1993	385	17	44 478	9					385	17	44 478	8.7
1994	245	12	39 602	6	63	3	12 795	5	309	15	52 397	5.9
1995	260	14	41 476	6	57	3	10 232	6	316	17	51 708	6.1
1996	413	14	35 709	12	83	3	8 791	9	496	17	44 501	11.2
1997	411	11	35 494	12	59	2	9 108	6	470	13	44 602	10.5
1998	138	5	29 508	5	30	1	--	--	168	6	--	--
1999	168	9	30 131	6	--	--	--	--	--	--	--	--
2000	85	7	30 079	3	2	0	--	--	88	7	--	--
2001	84	11	29 935	3	--	--	--	--	--	--	--	--
2002	130	12	21 948	6	61	6	6 747	9	191	18	28 695	6.7
2003	228	10	18 519	12	115	5	7 608	15	342	15	26 127	13.1
2004	277	9	19 198	14	162	5	10 342	16	439	13	29 540	14.9
2005	391	10	20 663	19	248	6	10 302	24	639	17	30 965	20.6
2006	242	8	19 264	13	273	9	12 866	21	515	17	32 130	16.0
2007	222	9	21 651	10	233	10	13 187	18	455	19	34 838	13.1
2008	274	12	20 212	14	153	6	9 812	16	428	18	30 024	14.2
2009	165	7	16 152	10	152	7	12 930	12	317	14	29 092	10.9
2010	129	8	16 680	8	70	4	9 003	8	165	10	22 746	7.3
2011	92	8	12 835	7	--	--	--	--	146	13	18 617	7.9
2012	132	9	14 446	9	--	--	--	--	142	10	21 110	6.7
2013	122	8	14 736	8	--	--	--	--	--	--	--	--
2014	114	6	18 060	6	--	--	--	--	--	--	--	--
2015	88	5	13 309	7	--	--	--	--	--	--	--	--
2016	138	8	13 718	10	--	--	--	--	--	--	--	--
2017	76	5	12 449	6	--	--	--	--	--	--	--	--
2018	95	8	13 247	7	--	--	--	--	--	--	--	--
2019	42	5	12 824	3	--	--	--	--	--	--	--	--
2020	--	--	--	--	--	--	--	--	--	--	--	--

	PT-CRUST						PT-FISH					
Year	LANDINGS	%	EFFORT (1000 hours)	EFFORT (1000 hauls)	LPUE (kg/hour)	LPUE (kg/haul)	LANDINGS	%	EFFORT (1000 hours)	EFFORT (1000 hauls)	LPUE (kg/hour)	LPUE (kg/haul)
1989	85	2	76	23	1.1	3.7	175	3	52	18	3.3	9.9
1990	106	3	90	20	1.2	5.2	219	6	61	17	3.6	12.8
1991	73	2	83	17	0.9	4.4	151	4	57	15	2.6	9.8
1992	25	1	71	15	0.3	1.6	51	2	49	14	1.0	3.7
1993	36	2	75	13	0.5	2.7	75	3	56	13	1.3	5.7
1994	23	1	41	8	0.6	3.0	47	2	36	10	1.3	4.9
1995	22	1	38	8	0.6	2.8	45	2	41	9	1.1	4.9
1996	45	2	64	14	0.7	3.1	88	3	54	12	1.6	7.1
1997	51	1	43	11	1.2	4.5	59	2	27	9	2.2	6.7
1998	11	<1	48	11	0.2	1.0	17	1	35	10	0.5	1.8
1999	3	<1	24	8	0.1	0.4	6	<1	18	6	0.3	1.0
2000	2	<1	42	10	0.0	0.2	2	<1	19	6	0.1	0.4
2001	9	1	85	18	0.1	0.5	7	1	19	5	0.4	1.4
2002	18	2	62	10	0.3	1.9	11	1	14	4	0.8	2.4
2003	13	1	42	10	0.3	1.3	16	1	17	6	0.9	2.8
2004	12	<1	21	7	0.6	1.9	14	<1	14	4	1.0	3.3
2005	12	<1	20	5	0.6	2.2	17	<1	13	4	1.3	4.7
2006	13	<1	22	5	0.6	2.4	16	1	12	4	1.3	4.2
2007	7	<1	22	6	0.3	1.1	6	<1	8	3	0.8	2.1
2008	6	<1	14	4	0.4	1.5	5	<1	5	2	1.0	2.9
2009	5	<1	15	--	0.3	--	5	<1	6	--	0.8	--
2010	1	<1	21	--	0.0	--	1	<1	14	--	0.1	--
2011	24	2	18	--	1.3	--	22	2	9	--	2.4	--
2012	3	<1	36	--	0.1	--	3	<1	16	--	0.2	--
2013	8	<1	27	--	0.3	--	7	<1	12	--	0.6	--
2014	16	1	32	--	0.5	--	13	1	16	--	0.8	--
2015	18	1	17	--	1.1	--	16	1	14	--	1.2	--
2016	4	<1	12	--	0.3	--	4	<1	11	--	0.3	--
2017	16	1	8	--	2.0	--	15	1	11	--	1.3	--
2018	3	<1	5	--	0.6	--	3	<1	6	--	0.4	--
2019	12	1	6	--	1.9	--	11	1	5	--	2.0	--
2020	15	2	13	--	0.6	--	14	2	7	--	0.9	--

Table 4.3.6 ANGLERFISH (*L. piscatorius*) - Division 8c and 9a. Summary of the assessment results.

	Recruit Age0 (thousands)	Total Biomass (t)	Total SSB (t)	Landings (t)	Yield/SSB	F (30-130 cm)
1980	678	15 512	9 817	4 817	0.49	0.30
1981	1 933	16 536	11 387	5 566	0.49	0.33
1982	7 350	15 585	11 913	5 782	0.49	0.38
1983	1 946	14 368	10 647	6 113	0.57	0.49
1984	774	14 051	8 821	6 031	0.68	0.51
1985	1 829	13 024	8 418	6 139	0.73	0.53
1986	6 525	10 773	7 766	6 870	0.89	0.80
1987	3 708	7 407	4 799	5 139	1.07	0.92
1988	1 078	7 306	3 146	6 321	2.01	1.39
1989	3 332	5 959	2 483	4 995	2.01	1.09
1990	2 233	4 939	2 411	3 790	1.57	0.81
1991	1 064	4 806	2 213	3 640	1.65	0.83
1992	1 321	4 510	2 114	3 382	1.60	0.87
1993	1 699	3 788	1 973	2 329	1.18	0.63
1994	3 127	3 830	2 065	2 007	0.97	0.50
1995	1 821	4 638	2 333	1 835	0.79	0.33
1996	335	6 588	3 295	2 956	0.90	0.39
1997	282	7 540	4 362	3 715	0.85	0.45
1998	224	6 819	4 749	2 981	0.63	0.38
1999	742	5 789	4 588	1 933	0.42	0.30
2000	646	5 096	4 248	1 256	0.30	0.24
2001	3 714	4 938	3 988	788	0.198	0.16
2002	1 619	5 817	4 187	1 093	0.26	0.189
2003	348	7 959	4 808	2 326	0.48	0.29
2004	2 167	9 366	5 878	3 258	0.55	0.33
2005	1 370	9 577	6 813	3 827	0.56	0.39
2006	1 284	9 010	6 525	2 998	0.46	0.34
2007	713	8 806	6 304	2 377	0.38	0.28
2008	777	9 081	6 657	2 372	0.36	0.26
2009	879	9 130	7 028	2 307	0.33	0.25
2010	1 513	8 922	7 122	1 620	0.23	0.183
2011	1 177	9 334	7 442	1 156	0.155	0.133
2012	530	10 526	8 204	1 396	0.170	0.139
2013	818	11 676	9 142	1 540	0.168	0.136
2014	1 559	12 550	10 217	2 033	0.199	0.169
2015	247	12 814	10 679	1 771	0.166	0.148
2016	214	13 327	11 051	1 809	0.164	0.156
2017	202	13 336	11 351	1 447	0.127	0.125
2018	403	13 254	11 784	1 144	0.097	0.104
2019	1 053	13 032	11 958	908	0.076	0.092
2020	539	12 842	11 802	720	0.061	0.083
2021	706	12 983	11 625			

*geometric.mean(2003-2020)

Table 4.3.7 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Catch option table.

SSB(2021)	Rec proj	F(30-130cm)	Land(2021)	SSB(2022)
11 625	706	0.093	760	11 557

Fmult	Fland (30-130cm)	Landings (2022)	SSB (2023)
0	0	0	12 608
0.1	0.0093	82	12 518
0.2	0.0186	163	12 428
0.3	0.028	244	12 340
0.4	0.037	324	12 252
0.5	0.047	403	12 165
0.6	0.056	481	12 078
0.7	0.065	559	11 992
0.8	0.074	636	11 907
0.9	0.084	713	11 823
1	0.093	788	11 739
1.1	0.102	863	11 656
1.2	0.112	938	11 574
1.3	0.121	1011	11 493
1.4	0.130	1084	11 412
1.5	0.140	1157	11 332
1.6	0.149	1228	11 252
1.7	0.158	1300	11 173
1.8	0.167	1370	11 095
1.9	0.177	1440	11 018
2	0.186	1509	10 941
2.1	0.195	1578	10 864
2.2	0.20	1646	10 789
2.3	0.21	1713	10 714
2.4	0.22	1780	10 639
2.5	0.23	1846	10 566
2.6	0.24	1912	10 492
2.7	0.25	1977	10 420
2.8	0.26	2041	10 348
2.9	0.27	2105	10 276
3	0.28	2169	10206

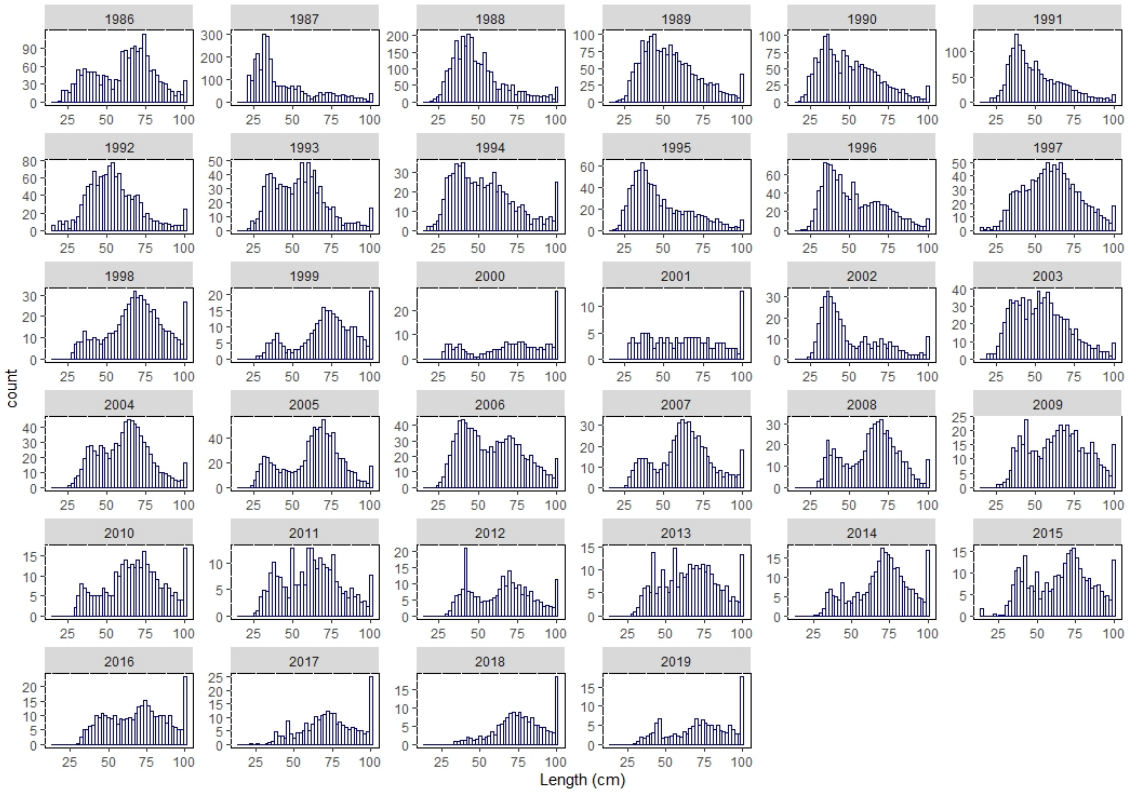


Figure 4.3.1. ANGLERFISH (*L. piscatorius*) - divisions 8.c and 9.a. Length distributions of landings (thousands, from 1986 to 2019).

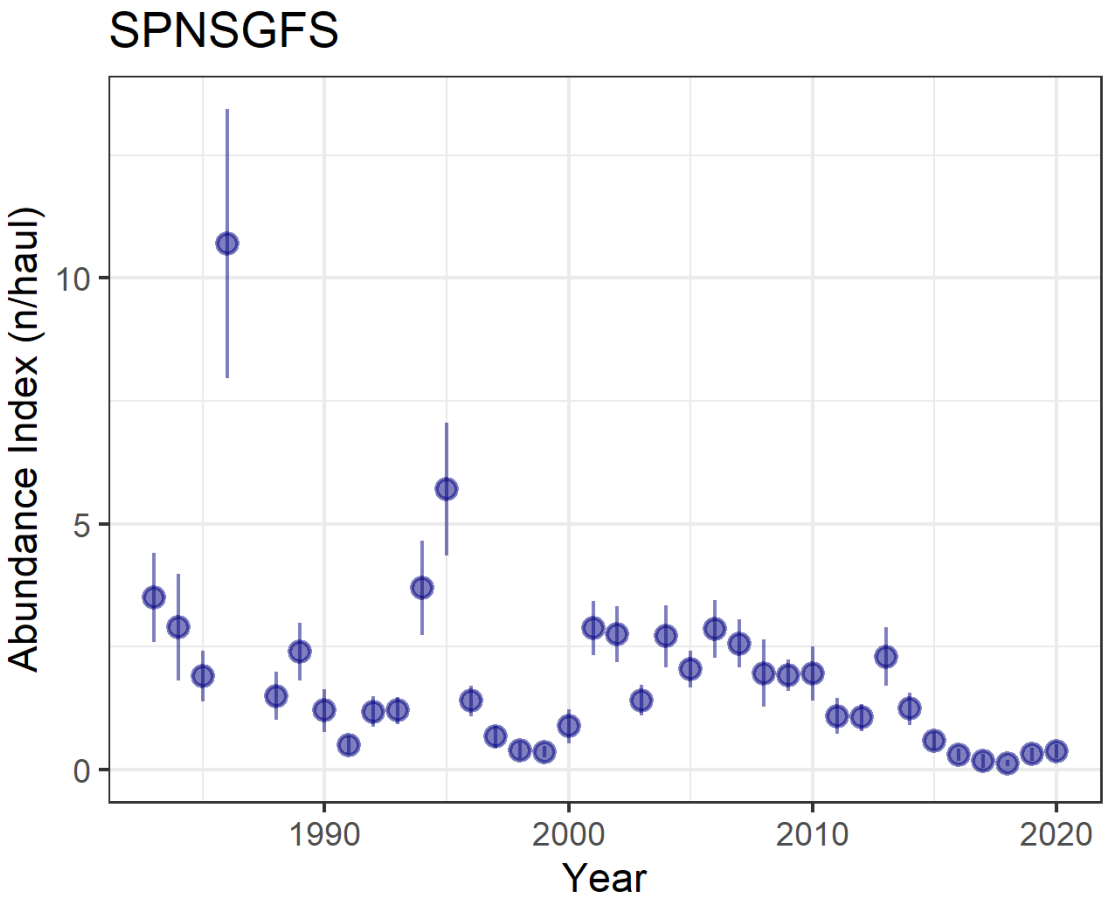


Figure 4.3.2. ANGLERFISH (*L. piscatorius*) - divisions 8.c and 9.a. Abundance index (in numbers/haul) from survey SP-NSGFS-Q4 (G2784). Bars represent 95% confidence intervals.

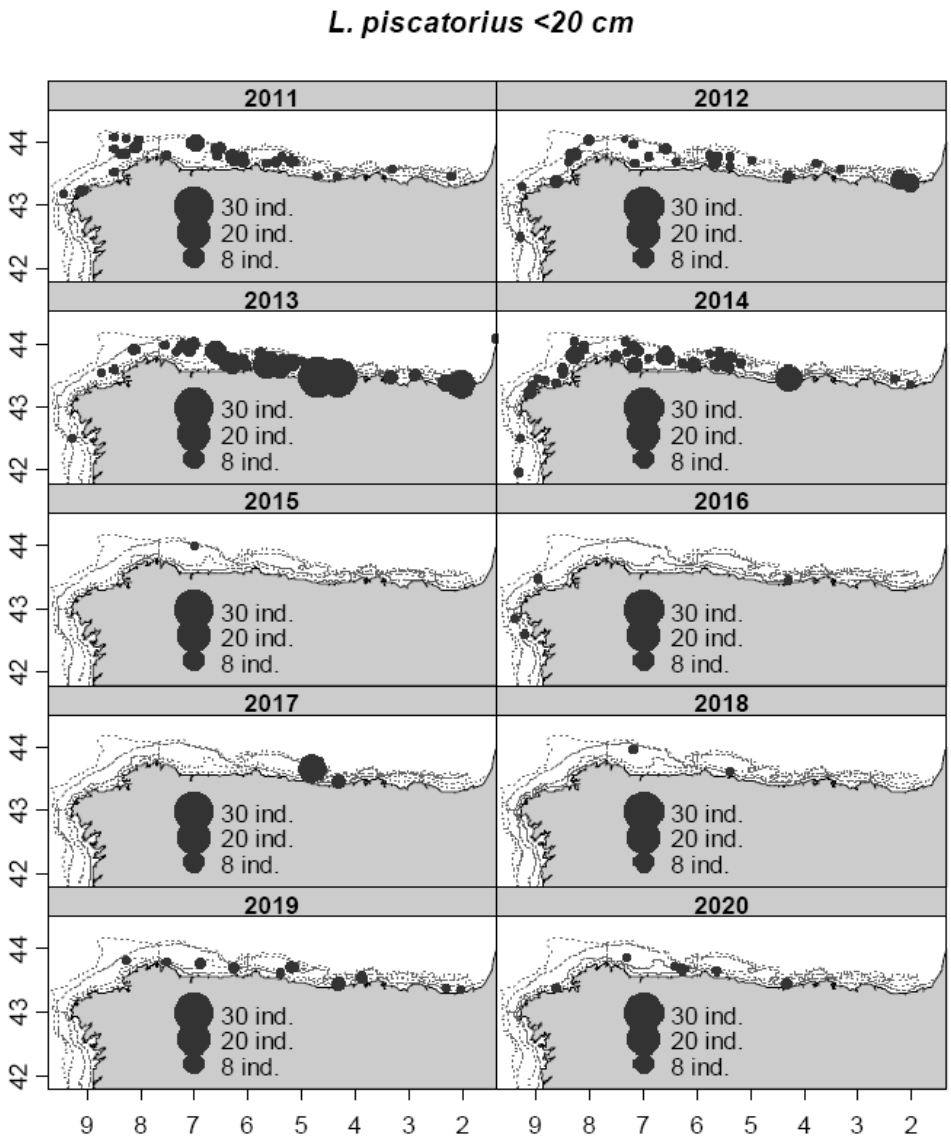


Figure 4.3.3. ANGLERFISH (*L. piscatorius*) - divisions 8.c and 9.a. Spatial distribution of juveniles (length 0–20 cm) in North Spanish Coast demersal survey (SP-NSGFS-Q4 (G2784)) between 2011 and 2020.

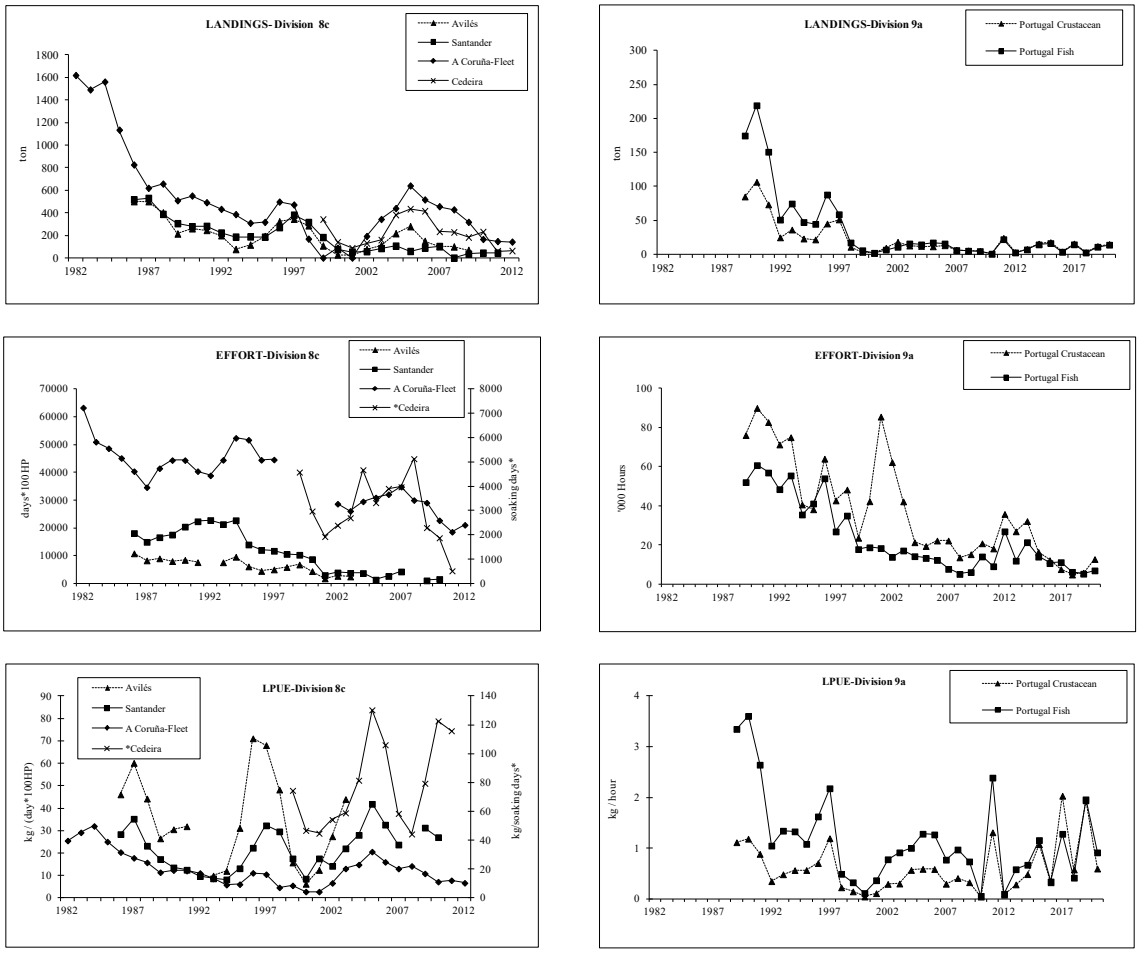


Figure 4.3.4. ANGLERFISH (*L. piscatorius*) - divisions 8.c and 9.a. Trawl and gillnet landings, effort and LPUE data between 1982–2020.

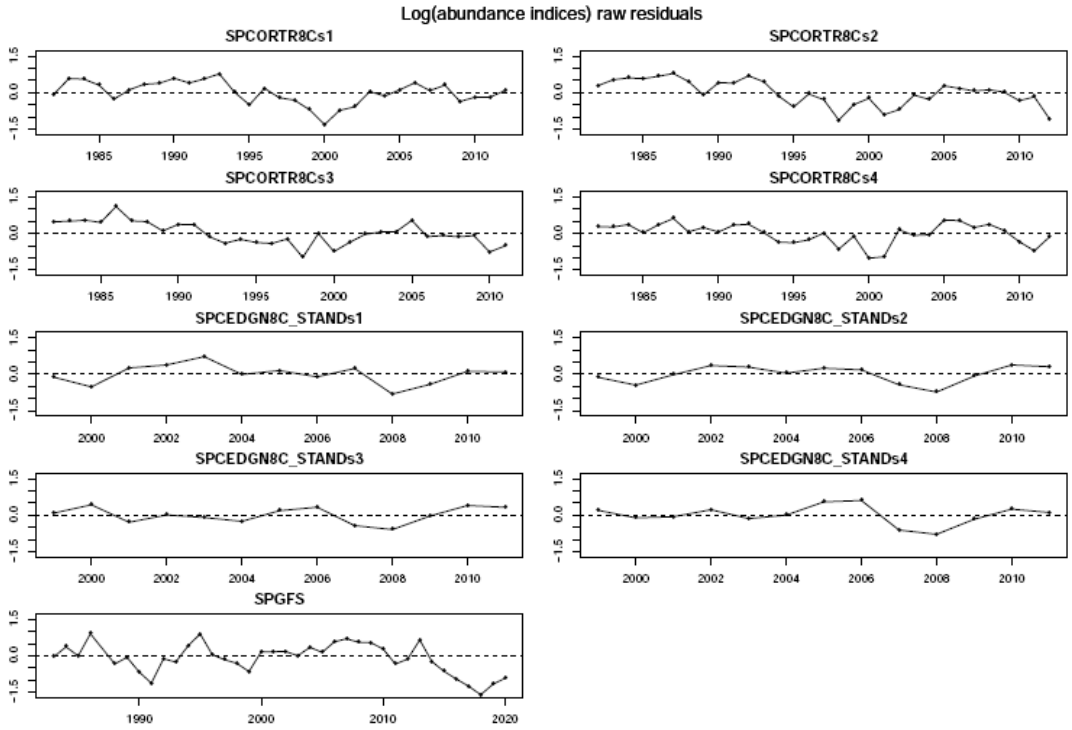


Figure 4.3.5 ANGLERFISH (*L. piscatorius*) - divisions 8.c and 9.a. Residuals of the fits to the surveys in log(abundance indices). A Coruña and Cedeira are by quarters.

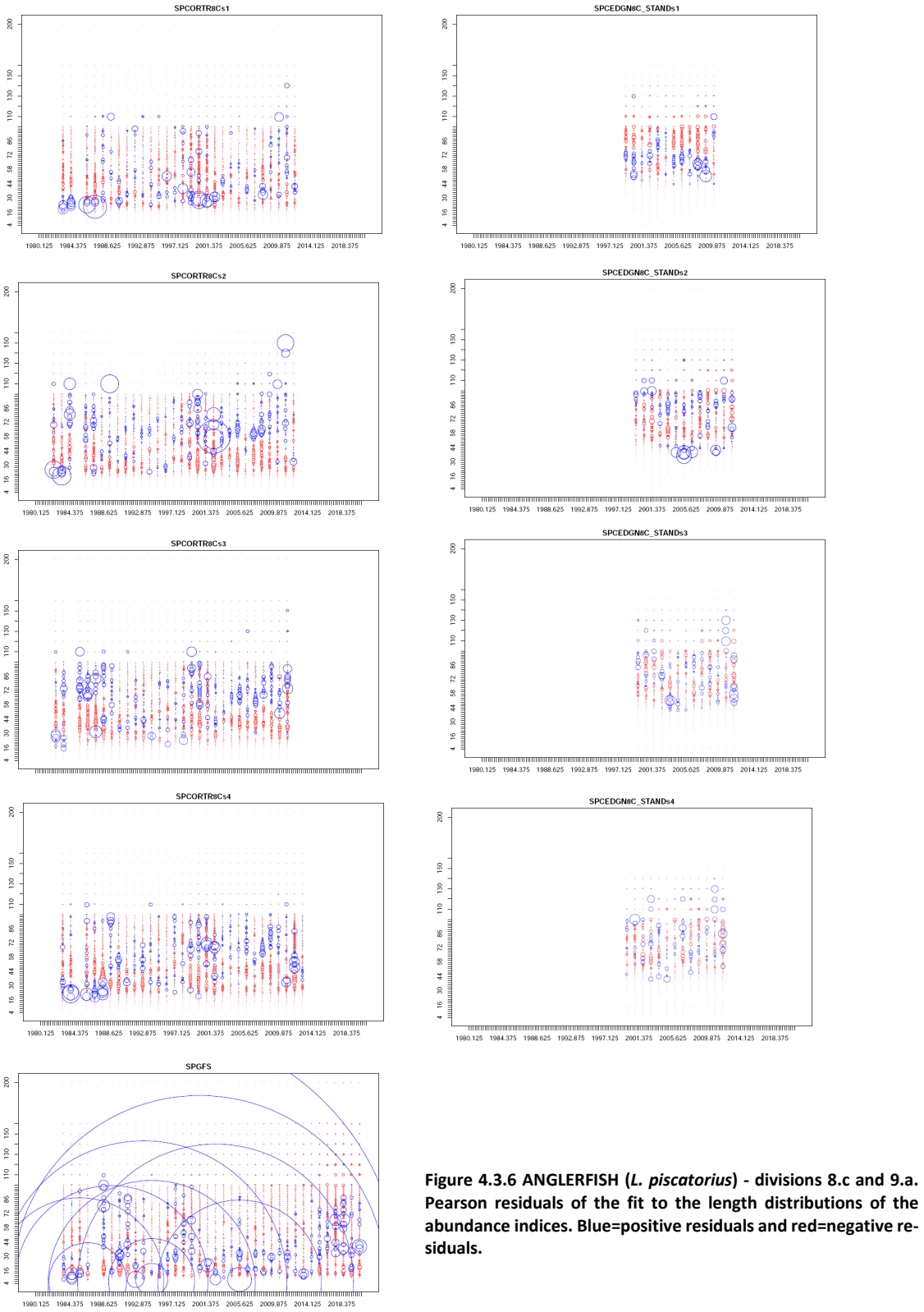


Figure 4.3.6 ANGLERFISH (*L. piscatorius*) - divisions 8.c and 9.a. Pearson residuals of the fit to the length distributions of the abundance indices. Blue=positive residuals and red=negative residuals.

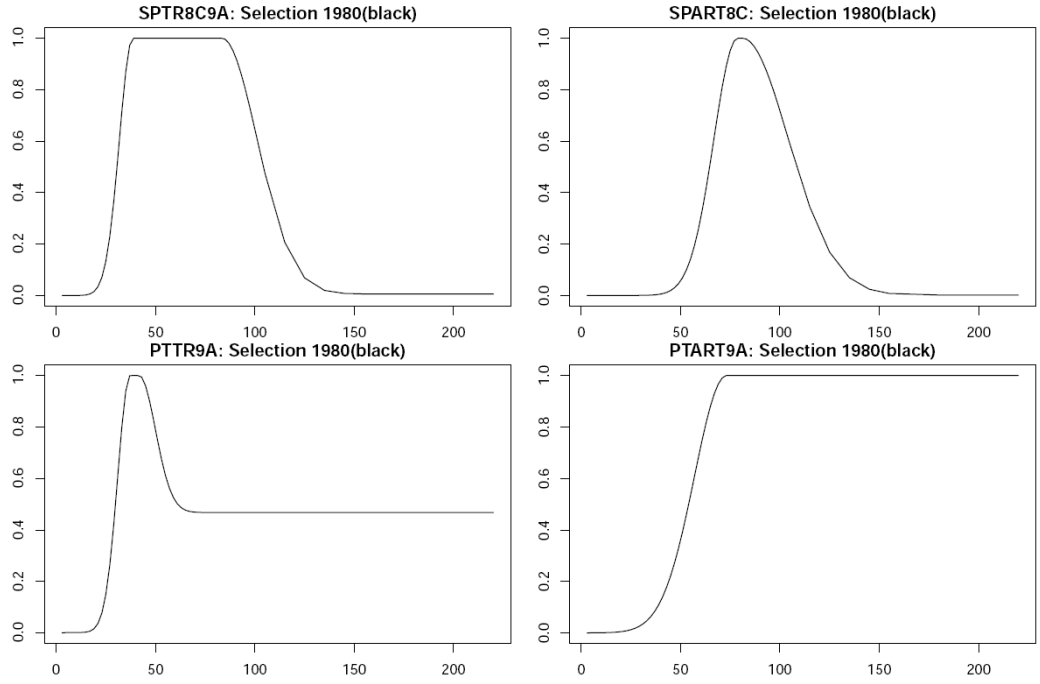


Figure 4.3.7 ANGLERFISH (*L. piscatorius*) - divisions 8.c and 9.a. Relative selection patterns at length by fishery estimated by Stock Synthesis.

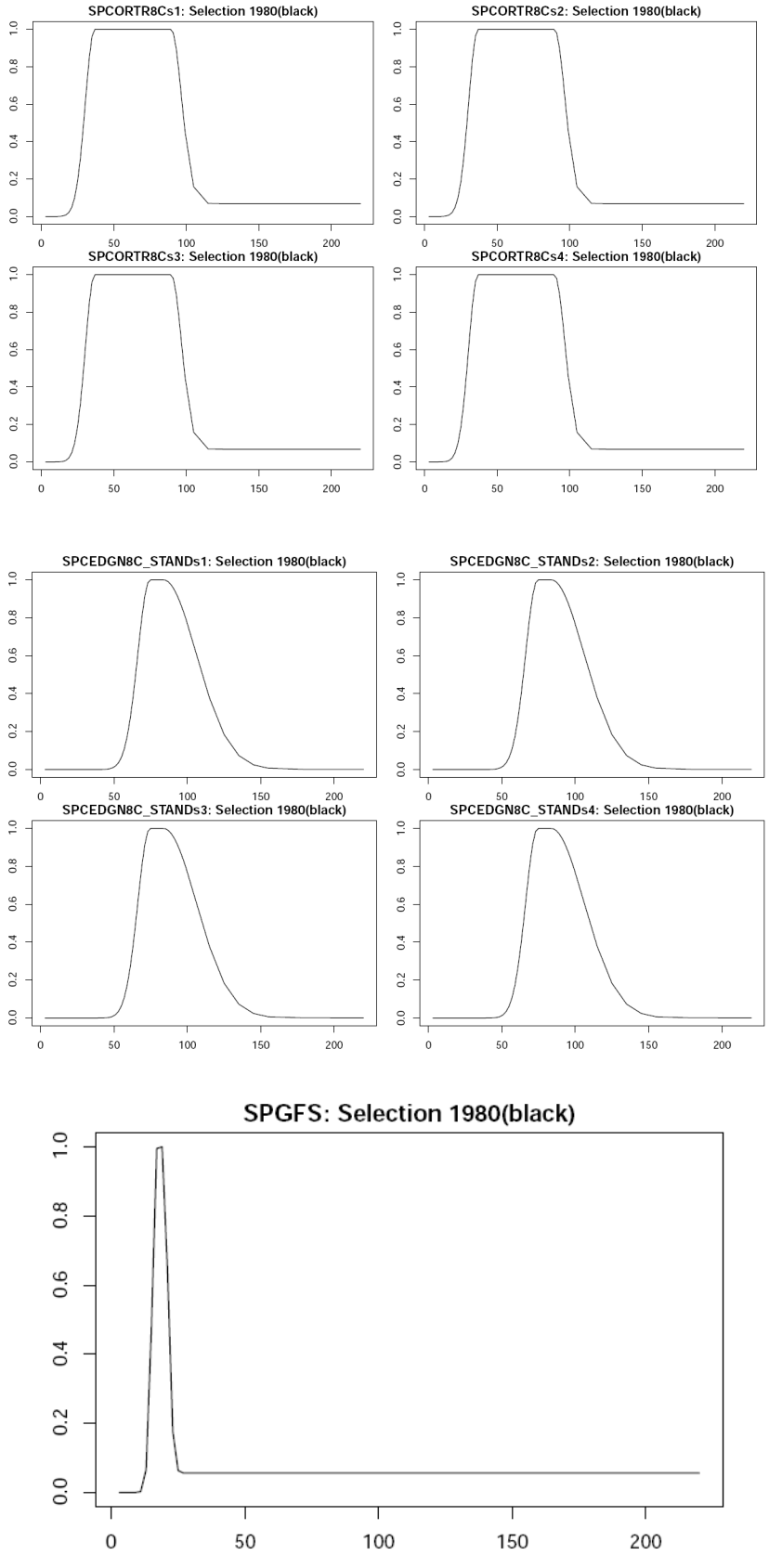


Figure 4.3.8 ANGLERFISH (*L. piscatorius*) - divisions 8.c and 9.a. Relative selection patterns at length by abundance index estimated by Stock Synthesis. A Coruña and Cedeira indices are by quarter.

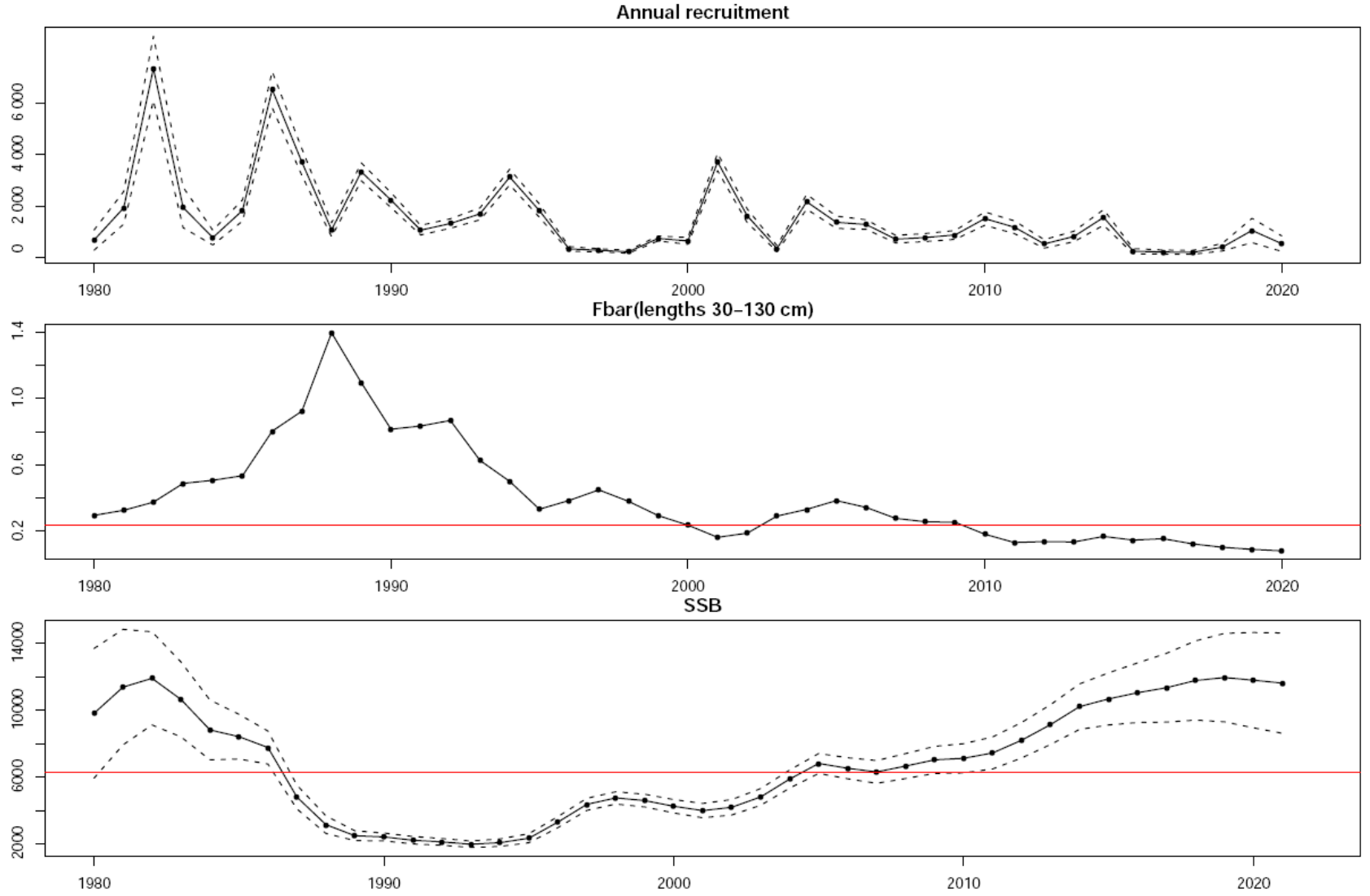


Figure 4.3.9 ANGLERFISH (*L. piscatorius*) - divisions 8.c and 9.a. Summary plots of stock trends (with 95% intervals for recruitment and SSB).

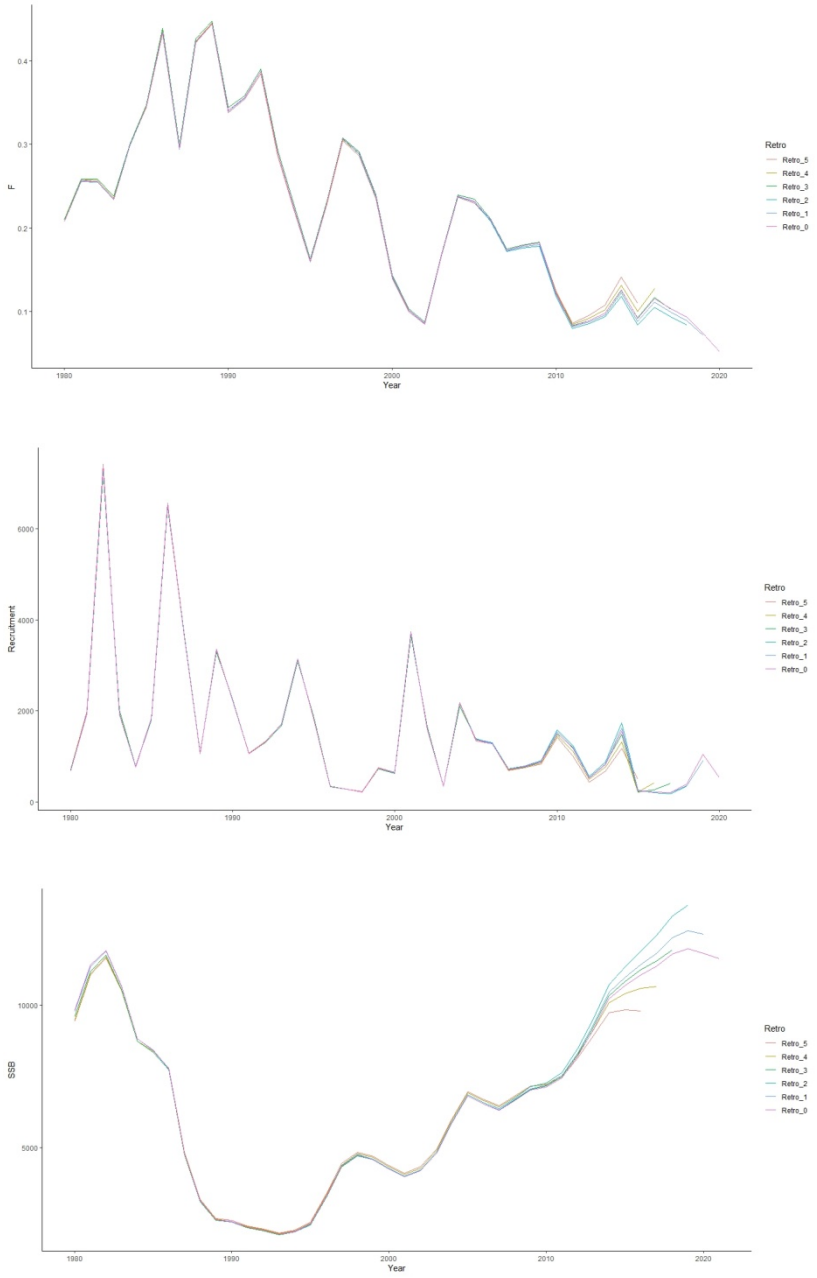


Figure 4.3.10 ANGLERFISH (*L. piscatorius*) - divisions 8.c and 9.a. Retrospective plots from SS model.

4.4 Black-bellied anglerfish (*Lophius budegassa*) in divisions 8.c and 9.a

4.4.1 General

4.4.1.1 Ecosystem aspects

Biological/ecosystem aspects are common with *L. piscatorius* and are described in the Stock Annex.

4.4.1.2 Fishery description

L. budegassa is mainly caught by Spanish and Portuguese bottom-trawlers and net fisheries (gillnet and trammelnets). As with *L. piscatorius*, *L. budegassa* is an important target species for the artisanal fleets and a bycatch for the trawl fleets targeting fish or crustaceans (see Stock Annex). French trawl, gillnet and trammelnet fisheries also catch *L. budegassa*, but reported values represent < 1% (on average) of the total landings of the stock.

The length distribution of the landings varies among fisheries, with gillnet and artisanal landings showing higher mean lengths compared to the trawl landings, except in 2017, when the mean lengths of the trawl and artisanal fisheries were similar. Since 2008, the Spanish landings were mostly allocated to the trawl fleet (66% in 2020; mean lengths in 2019 of 45.7 cm in divisions 8.c and 9.a), followed by the gillnet fishery (29% in 2020; mean length in 2019 of 59.7 cm in Division 8.c) and other fleets (5%). Portuguese landings, for the same period were mainly from the artisanal fleet (71%; mean length of 56.9 cm in 2020), followed by the trawl fleet (29%; mean length of 49.4 cm in 2020). French landings since 2008 correspond, on average, to 64% from the trawl fleet, 35% from the gillnet fleet and < 1% from others fleets.

4.4.2 Data

4.4.2.1 Commercial catches and discards

Total landings of *L. budegassa* by country and gear for the period 1978–2020, as estimated by the Working Group, are given in Table 4.4.1. Portuguese and Spanish landing data and discards were revised for WKANGLER 2018 benchmark (ICES, 2018a). French landings data were available to WGBIE since 2002. Historical landings analysis is presented in the Stock Annex. Unallocated/non reported landings for this stock were available from 2011 to 2016 and again in 2018−2019. Estimates of unallocated or non-reported landings were based on the sampled vessels (Spanish concurrent sampling) and raised to the total effort for each métier and quarter. The unallocated/non reported values were considered realistic and are included in the assessment.

From 2002 to 2007, landings increased to 1306 t, decreasing afterwards to levels between 754-774 t in 2009–2010. From 2011 to 2016, catches fluctuated between 948 and 1141 t but decreased since then, reaching 669 t in 2019. In 2020 landings increased to 793 t.

Spanish trawl and gillnet discard estimates of *L. budegassa* in weight and associated coefficient of variation (CV) are shown in Table 4.4.2. The estimated Spanish trawl discards observed from 1994–2019, show two peaks, in 2006 (114 t) and in 2010 (64 t), being relatively low since then. The estimated Spanish gillnet discards are available since 2011 and varied between 0 and 14.3 t.

Sampling effort and frequency of occurrence of *L. budegassa* discards in the trawl Portuguese fisheries were presented for the 2004–2013 period (Prista *et al*. 2014, WD03 in ICES, 2014). The maximum frequency of occurrence in discards in the trawl fleet targeting fish was 2% (sampling effort varies between 50 and 194 hauls per year). The maximum occurrence of discards in the trawl fleet targeting crustaceans was 8% (sampling effort varies between 28 and 111 hauls per

year). Due to the low frequency of occurrence of anglerfish in the discards, it is not possible to apply the algorithm used for hake (presented in Prista *et al*. 2014 – WD3 in ICES, 2014). For this reason, discard estimates were not calculated since 2014.

Partial information on the Spanish and Portuguese discards was available and the WG concluded that discards could be considered negligible.

4.4.2.2 Biological sampling

The procedure for sampling this species is the same as for *L. piscatorius* (see both *L. piscatorius* and *L. budegassa* Stock Annexes).

The sampling levels for 2020 are shown in Table 1.4. The number of samples decreased due to the COVID-19 pandemic both in Portugal and Spain and also due to administrative issues in Spain.

The métier sampling adopted in Spain and Portugal in 2009, following the requirement of EU Data Collection Framework, can have an effect on the data provided. Excluding 2020, Spanish sampling levels are similar to previous years but a notable reduction of Portuguese sampling levels was observed in 2009–2011. Since 2012, Portugal increased the sampling effort.

Length composition

Table 4.4.3 gives the annual length compositions by ICES division, country and gear and the adjusted length composition for total stock landings for 2020). The new data should be interpreted with caution given the low levels of sampling for some fleets. Length composition is not used in the assessment of *L. budegassa* but provides ancillary information.

The annual length compositions for the years between 2002 and 2020 are presented in Figure 4.4.1. The total annual landings in numbers, the annual mean length and the mean weight are presented in Table 4.4.4. In 2020, individuals < 25 cm were frequent in catches, in values close to those observed in 2013 and 2014. This is the first peak in those classes since 2015, when a small number of individuals was also recorded. The estimated mean length (42 cm) is the lowest since 2007. The decrease in the number of samples can lead to some bias in these estimates.

The estimated total number of landed individuals shows a remarkable decrease in the year 2000, when compared to previous years. In 2005, the value was 9% of the maximum value (observed in 1987). In 2006 and 2007, the number of landed fish more than doubled the 2005 number. The estimated number of landed fish decreased to a minimum in 2009 and varied between 230 and 531 thousand since then, showing the lowest values in the time-series. The estimated mean weight is relatively high since 2012 (> 2 kg).

4.4.2.3 Abundance indices from surveys

Spanish and Portuguese survey results for the period 1983–2020 are summarized in Table 4.4.5. The Portuguese survey was not performed in 2012, 2019 and 2020. Considering the very small number of anglerfish caught in the SpGFS-WIBTS-Q4 (code: G2784) and PtGFS-WIBTS-Q4 (code: G8899) surveys, these indices were considered unsuitable to evaluate the change in abundance of this species. However, they can provide some information about recruitment. On the contrary, data from SPGFS-caut-WIBTS-Q4 (Gulf of Cádiz, code: G4309) are regular and its usefulness has been considered promising (ICES, 2018a, 2021a) but more studies on species distribution are needed to better interpret results from this survey. The biomass index from this survey increased since the beginning of the time-series, reaching a maximum value in 2015. The biomass values in 2019 and 2020 are lower than the value estimated for 2018 but are still among the highest values of the time-series.

The small number of specimens < 20 cm in the Spanish bottom-trawl surveys on the Northern Spanish Shelf suggest a lack of recruitment in the surveyed area during the period 2017–2019 (Figure 4.4.2). The peak of individuals < 20 cm observed in 2020 is the first signal of recruitment since 2016. A similar distribution is observable in the length distribution from the SPGFS-caut-WIBTS-Q4 (Gulf of Cádiz; code: G4309) in 2020 (Figure 4.4.3).

4.4.2.4 Commercial catch-effort data

Landings, effort and LPUE data are given in Table 4.4.6 and Figure 4.4.4 for Spanish trawlers from ports of Santander, Avilés and A Coruña (all in Division 8.c) since 1986, and for Portuguese trawlers (Division 9.a) since 1989. Data are also available for the standardized Cedeira gillnet fleet from 1999 to 2012. For each fleet, the proportion in relation to the total landings is given. Landed values for each of the Portuguese trawl fleets were updated from 2012 onwards.

Since 2013, Spain only provides information for A Coruña port series. Effort data for this tuning fleet in 2013 were calculated using the information from electronic logbooks and following different criteria than those established for previous years. In order to check the consistency of the Spanish time-series, a backward revision of the time-series is needed to compare the different estimation methods and sources of information used. The standardization of the series should be also conducted. This series was not updated with information for the year 2020.

Three LPUE series were presented in the past for the A Coruña trawler fleet: (a) "A Coruña port" for trips that are exclusively landed in the port; (b) "A Coruña trucks" for trips that are landed in other ports; (c) and "A Coruña fleet" that takes into account all the trips of the A Coruña trawler fleet. The LPUE series previously used in the assessment (A Coruña fleet) was not updated since 2012.

Until 2011, for the Portuguese fleets, most logbooks were filled in paper but have thereafter been progressively replaced by electronic logbooks. Since 2013, > 90% of the logbooks were reported in the electronic version. Generalized linear mixed models (GLMMs) were used to standardize both LPUE data, considering as independent variables Year, Quarter, Area and as the random variable Vessel. Details can be found in the Benchmark Workshop on the development of MSY advice for category 3 stocks using Surplus Production Model in Continuous Time report (WKMSYSPiCT – ICES, 2021a).

Logbook data from the Portuguese artisanal fleet, particularly from vessels targeting *Lophius* spp. are also available since 2008 (electronic and paper). A LPUE series for the fleet targeting anglerfish with trammelnets was presented to WKMSYSPiCT (ICES, 2021a). However, more work is needed particularly to accommodate targeting effects using more adequate methodologies (e.g. clustering methods) as well as higher spatial resolution (ICES, 2021a).

Excluding the Avilés and Santander fleets, the overall trend in landings for all fleets was decreasing from the late eighties to mid-nineties (Figure 4.4.4). A slight increase was observed from 1995 to 1998. The A Coruña fleet showed the most important drop in landings and in relative proportion of total landings in 2002. LPUEs of Spanish Avilés and Santander fleets show high values during the second half of the 90s. Despite the variability observed, a decreasing trend was observed for all fleets from 2000 to 2005 which was then followed by a slightly increasing trend. The LPUE time-series from the Portuguese trawl fleet targeting crustaceans shows an increasing trend reaching a maximum value in 2018. The value in 2020 is among the highest of the time-series. The LPUE time-series from the Portuguese trawl fleet targeting fish is variable but also shows an increasing trend from 2001 to 2012. Similarly to the crustacean fleet, the value in 2020 is among the highest of the time-series.

Effort trend analysis was presented in section 4.3.4.4.

4.4.3 Assessment

4.4.3.1 History of the assessment

In WKANGLER 2018 (ICES, 2018a), a new model, SPiCT (Pedersen and Berg, 2017), was proposed for the assessment of *L. budegassa*, a stochastic production model in continuous time. This model was considered more reliable than the previous model used, ASPIC (Prager, 1992, 1994).The benchmarked approach gave comparable trends, but the estimates of stock biomass were notably higher, and fishing mortality lower compared with the previous assessment method. A stepwise approach was proposed by WGBIE 2018 but was rejected by ACOM. Given the uncertainties regarding the absolute levels of biomass and fishing pressure, the assessment was considered as indicative of trends only and it was decided to present the advice as a category 3.2 stock with proxy reference points, based on SPiCT results (ICES, 2018b).

A new benchmark was proposed for this stock in 2021 using SPiCT. cpue data available for the stock were revised and several tests were conducted. Results and discussion of the results are available at WKMSYSPiCT report (ICES, 2021a).

4.4.3.2 Exploratory assessment with Stock Synthesis

Tests with stock synthesis model (SS3; Methot and Wetzel, 2013) were conducted during the Workshop on Tools and Development of Stock Assessment Models Using a4a and Stock Synthesis (WKTaDSA). A length-based model was developed assuming one area, one season, catch data from nets fleets (gillnets and trammelnets) and from trawl fleets (data from Portugal and Spain combined), two commercial LPUE indices and one biomass series from SpGFS-WIBTS-Q4 (code: G2784) to inform about recruitment. Several model configurations were tested but more work is required to reach a base model. The workshop was conducted prior to WKMSYPiCT and conclusions from this benchmark should be considered in future. However, results from SS model were promising and are available at WKTaDSA report (ICES, 2021b). Some comments are also available at WKMSYSPiCT report (see reviewers' comments).

4.4.3.3 SPiCT Model

The SPiCT model was revised at WKMSYSPiCT (ICES, 2021a). The new model assumes the Schaefer population growth model (fixed parameter) and the default biomass and catches observed/process error ratios (alpha and beta, respectively).

The SPiCT input data:

- Total landings from 1980–2020 (discards are considered negligible).
- Portuguese trawl fleet targeting fish (1989–2020) (Index 1)

The input data are presented in Tables 4.4.1 (Landings) and 4.4.6. (cpue index for the Portuguese trawl fleet targeting fish) and Figure 4.4.5.

SPiCT settings:

- Euler time-step (years): 1/16 (default)
- cpue at the middle of the year
- Production curve shape: assume Schaefer (n = 2).
- B/K: assume initial depletion rate of 0.5 (logbkratio = c(log(0.5),0.5,1))
- Other parameters: default (estimated by the model).

From the LPUE tuning indices previously used, only the PT-TRF9a, now standardized, was maintained. The other two indices were not considered due to uncertainty around the trends in the last years of the series in the case of PT-TRC9 and autocorrelation issues with the SP-CORTR8c (fleet series; not updated since 2012). PT-TRC9 was driving the stock to a very optimistic status which is not in agreement with the historical landings trajectory and with the low

landings obtained in 2019. In this model, a prior for B/K of 0.5 was assumed, as exploitation was likely to occur before the beginning of the available time-series. Despite target fisheries development in the late 1970s, previously, the species was likely to be caught and discarded in other fisheries.

4.4.3.4 Assessment diagnostics

No significant bias or autocorrelation were found and both QQ-plot and the Shapiro test shows normality in the residuals (Figure 4.4.6.). Confidence intervals for F/F_{MSY} and B/B_{MSY} do not extend more than 1 order of magnitude, as proposed by Mildenberger *et al*. (2021).

Some retrospective pattern is observed, suggesting some past overestimation of fishing mortality and underestimation of biomass. However, each peel of the retro is within the 95% confidence intervals of the assessment (Figure 4.4.7.). The Mohn's rho statistics (Mohn, 1999) were estimated as - 0.033 and 0.01 for B/B_{MSY} and F/F_{MSY}, respectively, indicating no strong retrospective pattern.

4.4.3.5 Assessment results

SPiCT results are presented in Tables 4.4.7. and 4.4.8 and in Figure 4.4.8. The stock biomass (B) increased from 2002 to 2013 and was then stable until 2018. An increase was registered in the last two years of the series. B/B_{MSY} is estimated to be above MSY $B_{trigger}$ proxy over the whole time-series. Fishing mortality (F) has decreased since 1998 and is estimated to have been below F_{MSY} proxy since 2004 (with exception of 2007).

The perception of the status of stock did not change with the new model. Trends in F/F_{MSY} are similar to those obtained in the 2020 assessment, but less optimistic. Regarding $B/B_{MSY,}$ trends are also similar to those previously presented but no increase in biomass is visible around the 2000s.

4.4.4 Short-term projections

Short-term projections consider the fishing mortality in the intermediate year as the estimated F at the time-step of the last observation and the estimated seasonal F process. Results for each scenario discussed in WKMSYPiCT are presented in Table 4.4.9. All the scenarios considered for fishing mortality are expected to keep the stock above B_{MSY} in 2022. Although the stock is included in the multiannual plan for stocks fished in the Western Waters and adjacent waters (EU, 2019), F_{MSY} ranges were not yet defined.

4.4.5 Biological reference points

WKANGLER (ICES, 2018a) reiterated the basis for MSY reference points previously assumed by ICES. Those reference points were later considered as proxies (ICES, 2018b). See section 4.4.4. for further details.

Framework	Reference point	Relative value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	0.5*	Relative value (B/BMSY) from the SPiCT assessment model. BMSY is estimated directly from the SPiCT model and changes when the assessment is updated.	ICES (2021a)
	F_{MSY}	1*	Relative value (F/FMSY) from the SPiCT assessment model. FMSY is estimated directly from the SPiCT model and changes when the assessment is updated.	ICES (2021a)
Precautionary approach	$B_{lim\ proxy}$	$0.3 \times B_{MSY}$ *	Relative value (equilibrium yield at this biomass is 50% of the MSY proxy).	ICES (2021a)

	B_{pa}	Not defined		
	$F_{lim\ proxy}$	$1.7 \times F_{MSY}$ *	Relative value (the F that drives the stock to the proxy of B_{lim}).	ICES (2021a)
	F_{pa}	Not defined		
Management plan	SSB_{mgt}	Not applicable		
	F_{mgt}	Not applicable		

***No reference points are defined for this stock in terms of absolute values. The SPiCT-estimated values of the ratios F/FMSY and B/BMSY are used to estimate stock status relative to the MSY reference points.**

4.4.6 Comments on the assessment

This stock was benchmarked in 2021 and advice is now given under MSY approach (WKMSYSPiCT, 2021a). Therefore, the present assessment is not fully comparable with previous years assessment (see section 4.4.4. Assessment).

The stock is included in the multiannual plan for stocks fished in the Western Waters and adjacent waters (EU, 2019) but reference points for F_{MSY} ranges are still not defined for this stock under the new assessment model.

The collection of data from the commercial fishery and research surveys during 2020 has been impacted by COVID-19 restrictions to a varying degree across member states. For this stock, the diagnostics for the assessment were deemed acceptable and the impact on the perception of the stock status and advice is considered minimal.

4.4.7 Quality considerations

Until 2011, for the Portuguese fleets, most logbooks were filled in paper but have thereafter been progressively replaced by e-logbooks. Since 2013 more than 90% of the logbooks are being completed in the electronic version. The LPUE series were standardized using the data previously used in the assessment. Revision of the data and improvement in the standardization methods should also be considered to accommodate targeting effects using more adequate methodologies (e.g. clustering methods) as well as higher spatial resolution. Standardized LPUEs are also required from fleets operating in other areas where the stock distributes. In addition, more accurate information on stock biology, ecology and distribution as well as on the behaviour of the fisheries is desirable to understand and validate some biomass indicators available for the stock (ICES, 2021a).

4.4.8 Management considerations

Management considerations are in section 4.2.

4.4.9 References

ICES. 2018a. Report of the Benchmark Workshop on Anglerfish Stocks in the ICES Area (WKANGLER), 12–16 February 2018, Copenhagen, Denmark. ICES CM 2018/ACOM: 31. 177 pp.

ICES. 2018b. Report of the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE), 3–10 May 2018, ICES HQ, Copenhagen, Denmark. ICES CM2018/ACOM: 12. 642 pp.

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L 83. 17 pp. http://data.europa.eu/eli/reg/2019/472/oj.

ICES. 2021a. Benchmark Workshop on the development of MSY advice for category 3 stocks using Surplus Production Model in Continuous Time; SPiCT (WKMSYSPiCT). ICES Scientific Reports. 3:20. 316 pp. https://doi.org/10.17895/ices.pub.7919

ICES. 2021b. Workshop on Tools and Development of Stock Assessment Models using a4a and Stock Synthesis (WKTADSA). ICES Scientific Reports. 3:33. 197 pp. https://doi.org/10.17895/ices.pub.8004

Methot Jr, R. D., Wetzel, C. R. 2013. Stock synthesis: a biological and statistical framework for fish stock assessment and fishery management. Fisheries Research, 142, 86–99.

Mildenberger, T.K., Kokkalis, A., Berg, C.W. 2020. Guidelines for the stochastic production model in continuous time (SPiCT). https://raw.githubusercontent.com/DTUAqua/spict/master/spict/inst/doc/spict_guidelines.pdf

Mohn, R. 1999. The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. ICES Journal of Marine Science, 56: 473–488.

Pedersen, M.W. and Berg, C.W. 2017. A stochastic surplus production model in continuous time. Fish and Fisheries, 18: 226–243.

Prager, M.H. 1992. ASPIC – A surplus-production model incorporating covariates. Col. Vol. Sci. Pap. ICCAT, 38: 218–229.

Prager, M.H. 1994. A suite of extensions to a non-equilibrium surplus-production model. Fishery Bulletin 92: 374–389.

Prista, N., Fernandes, A., Pereira, J, Silva, C., Alpoim, R. and Borges, F. 2014. Discards of WGBIE species by the Portuguese bottom otter trawl operating in the ICES division 9.a (2004–2013). In Report of the Working Group for the Bay of Biscay and the Iberian waters Ecoregion (WGBIE), 7–13 May 2014, Lisbon, Portugal. ICES CM 2014/ACOM: 11, pp 474–475

Ruiz-Pico, Blanco, M., Fernández-Zapico, Punzón, A., Preciado, I., and Velasco, F. 2021. Results of most relevant commercial species on the Northern Spanish Shelf groundfish survey. Working Document presented to the Working Group the Bay of Biscay and the Iberian Waters Ecoregion ICES WGBIE, May 2021. 37 pp.

4.4.10 Tables and figures

Table 4.4.1. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. Tonnes landed by the main fishing fleets for 1978–2020 as determined by the Working Group. n/a: not available

	Div. 8c							Div. 9a							Div. 8c+9a	
	SPAIN			FRANCE				SPAIN			PORTUGAL				Unallocated/	
Year	Trawl	Gillnet	Others	Trawl	Gillnet	Others	TOTAL	Trawl	Gillnet	Others	Trawl	Artisanal	TOTAL	SUBTOTAL	Non reported	TOTAL
1978	n/a	n/a					n/a	248			n/a	107	355	355		355
1979	n/a	n/a					n/a	306			n/a	210	516	516		516
1980	1203	207					1409	385			n/a	315	700	2110		2110
1981	1159	309					1468	505			n/a	327	832	2300		2300
1982	827	413					1240	841			n/a	288	1129	2369		2369
1983	1064	188					1252	699			n/a	428	1127	2379		2379
1984	514	176					690	558			223	458	1239	1929		1929
1985	366	123					489	437			254	653	1344	1833		1833
1986	553	585					1138	379			200	847	1425	2563		2563
1987	1094	888					1982	813			232	804	1849	3832		3832
1988	1058	1010					2068	684			188	760	1632	3700		3700
1989	648	351					999	764			272	542	1579	2578		2578
1990	491	142					633	689			387	625	1701	2334		2334
1991	503	76					579	559			309	716	1584	2162		2162
1992	451	57					508	485			287	832	1603	2111		2111
1993	516	292					809	627			196	596	1418	2227		2227
1994	542	201					743	475			79	283	837	1580		1580
1995	924	104					1029	615			68	131	814	1843		1843
1996	840	105					945	342			133	210	684	1629		1629
1997	800	198					998	524			81	210	815	1813		1813
1998	748	148					896	681			181	332	1194	2089		2089
1999	565	127					692	671			110	406	1187	1879		1879
2000	441	73					514	377			142	336	855	1369		1369
2001	383	69					452	190			101	269	560	1013		1013
2002	202	74		10	1	0	288	234	0	0	75	213	522	810		810
2003	279	49		9	0	0	338	305	0	0	68	224	597	934		934
2004	251	120		14	5	0	391	285	0	0	50	267	603	993		993
2005	273	97		26	9	0	405	283	0	0	31	214	527	933		933
2006	323	124		12	1	0	460	541	0	0	39	121	701	1161		1161
2007	372	68		4	1	0	444	684	0	0	66	111	861	1306		1306
2008	386	70		5	1	0	462	336	0	0	40	119	495	957		957
2009	301	148		3	1	0	454	172	0	0	34	114	320	774		774
2010	319	81		2	1	0	403	197	0	0	70	84	351	754		754
2011	214	115	32	3	0	0	364	157	60	98	75	119	510	874	74	948
2012	161	83	22	2	0	0	268	109	40	90	156	370	765	1033	109	1141
2013	221	135	14	4	1	0	375	95	55	90	100	258	598	973	98	1071
2014	187	126	7	5	2	0	326	120	47	4	116	286	572	898	100	998
2015	233	141	1	2	2	0	380	103	62	2	126	222	515	895	152	1047
2016	203	118	5	2	2	0	330	103	79	2	120	257	560	889	125	1014
2017	163	153	0	1	3	0	319	109	62	1	68	302	542	861		861
2018	186	156	1	7	9	0	359	126	37	1	52	185	402	761	11	773
2019	137	117	0	1	2	0	259	109	49	1	43	135	337	595	73	669
2020	126	65	0	4	2	0	198	138	5	3	128	321	596	793		793

Table 4.4.2. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. Weight and percentage of discards for Spanish trawl and gillnet fleets.

TRAWL				
Year	**Weight (t)**	**CV**	**% Trawl Catches**	**% Total Catches**
1994	6.1	24.4	0.6	0.4
1995	n/a	n/a	n/a	n/a
1996	n/a	n/a	n/a	n/a
1997	21.3	35.2	1.6	1.2
1998	n/a	n/a	n/a	n/a
1999	19.7	43.7	1.6	1.0
2000	8.7	35.1	1.1	0.6
2001	n/a	n/a	n/a	n/a
2002	n/a	n/a	n/a	n/a
2003	1.4	n/a	0.2	0.1
2004	10.9	n/a	2.0	1.1
2005	9.3	n/a	1.7	1.0
2006	114.0	n/a	11.7	9.8
2007	4.2	n/a	0.4	0.3
2008	4.9	n/a	0.7	0.5
2009	23.3	n/a	4.7	3.0
2010	63.5	n/a	11.0	8.4
2011	19.7	n/a	5.0	2.1
2012	5.9	n/a	2.1	0.5
2013	22.3	n/a	6.6	2.1
2014	27.8	n/a	8.3	2.8
2015	0.5	n/a	0.2	0.0
2016	0.4	n/a	0.1	0.0
2017	3.7	n/a	1.3	0.4
2018	1.1	n/a	0.3	0.1
2019	2.2	n/a	0.9	0.3
2020	2.2	n/a	0.8	0.3

TRAWL				
Year	Weight (t)	CV	% Trawl Catches	% Total Catches
GILLNETS				
2011	10.6	n/a		
2012	14.3	n/a		
2013	0	n/a		
2014	0.1	n/a	0.03	0.01
2015	0.4	n/a	0.18	0.04
2016	5.0	n/a	2.47	0.49
2017	10.9	n/a	4.82	1.26
2018	2.6	n/a	1.33	0.34
2019	13.3	n/a	7.40	1.98
2020	0.9	n/a	1.33	0.12

n/a: not available

CV: coefficient of variation

Table 4.4.3. ANGLERFISH (*L. budegassa*) - divisions 8.c and 9.a. Length composition by fleet for landings (thousands) in 2020. Unreported catches excluded. Adjusted Total: adjusted to landings from fleets without length composition. n/a: not available.

	Div.8c			Div.9a				Div. 8c+9a	
	SPAIN			SPAIN	PORTUGAL				Adjusted
Length (cm)	Trawl	Gillnet	TOTAL	Trawl	Trawl	Artisanal	TOTAL	TOTAL	TOTAL
14				3,617			3,617	3,617	3,711
15									
16				7,233			7,233	7,233	7,421
17				7,233			7,233	7,233	7,421
18				7,233			7,233	7,233	7,421
19				10,850			10,850	10,850	11,133
20				18,083			18,083	18,083	18,554
21				3,617			3,617	3,617	3,711
22				21,700			21,700	21,700	22,265
23				18,083			18,083	18,083	18,554
24				7,233			7,233	7,233	7,421
25				18,083			18,083	18,083	18,554
26									
27									
28									
29									
30				3,617			3,617	3,617	3,711
31	0,125		0,125					0,125	0,133
32	0,008		0,008		0,232		0,232	0,240	0,240
33	0,006		0,006		0,465		0,465	0,470	0,471
34	0,137		0,137		0,465		0,465	0,601	0,609
35	0,006		0,006		0,529		0,529	0,535	0,535
36	0,039	0,006	0,045		1,142		1,142	1,187	1,190
37	0,110		0,110	0,781	2,235		3,016	3,126	3,152
38	0,064		0,064	0,523	1,953		2,476	2,540	2,557
39	0,106	0,021	0,128	0,781	1,107		1,888	2,016	2,044
40	0,060	0,011	0,072		1,177	1,448	2,626	2,698	2,702
41	0,309	0,039	0,347	1,078	3,307	2,686	7,071	7,419	7,467
42	0,743	0,025	0,769	0,607	2,951	2,868	6,426	7,195	7,255
43	2,498	0,006	2,503	0,229	1,915	2,330	4,473	6,977	7,127
44	0,359	0,011	0,371		1,090	4,505	5,595	5,965	5,987
45	0,752	0,065	0,817		1,756	0,895	2,652	3,469	3,516
46	0,367	0,074	0,441	0,378	3,479	4,491	8,348	8,789	8,825
47	0,439	0,011	0,450		2,993	2,330	5,323	5,773	5,799
48	0,261	0,046	0,307	1,256	1,372	0,895	3,524	3,830	3,881
49	0,364	0,000	0,364		1,438	4,085	5,522	5,886	5,907
50	0,075	0,044	0,119		2,869	1,819	4,688	4,806	4,813
51	0,490	0,116	0,606		3,429	10,471	13,900	14,506	14,541
52	0,973	0,248	1,221	0,634	2,399	20,951	23,985	25,206	25,293
53	0,266	0,206	0,472		2,051	0,895	2,946	3,418	3,446
54	0,925	0,260	1,185	0,781	4,366	5,890	11,037	12,222	12,311
55	0,231	0,278	0,508		2,972	0,895	3,867	4,375	4,405
56	0,202	0,125	0,328		1,811		1,811	2,138	2,157
57	0,031	0,239	0,270		2,473		2,473	2,744	2,759
58	0,781	0,513	1,294		1,555		1,555	2,850	2,925
59	0,960	0,209	1,169	0,781	1,346	0,895	3,022	4,192	4,280
60	0,006	0,246	0,252		0,762		0,762	1,014	1,029
61	0,294	0,392	0,686	0,634	0,046		0,680	1,366	1,423
62	0,631	0,529	1,160		0,207	0,895	1,102	2,262	2,330
63	0,659	0,198	0,858	0,781	0,999	1,434	3,215	4,072	4,143
64	1,515	0,335	1,851	0,987	0,478		1,465	3,316	3,449
65	0,478	0,337	0,815	0,674	0,212		0,886	1,700	1,765
66	0,184	0,244	0,429	1,046	0,074		1,120	1,549	1,601
67	1,079	0,391	1,470		0,161		0,161	1,631	1,717
68	1,040	0,496	1,536	0,523	0,028	8,616	9,167	10,703	10,806
69	0,847	0,481	1,327	0,210	0,125		0,335	1,663	1,745
70	0,035	0,287	0,321	0,443	0,207		0,650	0,971	1,002
71	0,284	0,123	0,406	0,515	0,107		0,622	1,029	1,066
72	0,461	0,657	1,118	0,903			0,903	2,021	2,110
73	0,020	0,316	0,337		0,046		0,046	0,383	0,403
74	0,894	0,189	1,083	0,210	0,093	1,791	2,094	3,177	3,245
75	0,085	0,265	0,350		0,065		0,065	0,415	0,435
76	0,009	0,253	0,262	1,568	0,079		1,647	1,909	1,965
77	0,099	0,091	0,190	0,523	0,152	0,909	1,584	1,774	1,799
78				0,519			0,519	0,519	0,533
79		0,028	0,028			1,434	1,434	1,463	1,464
80	0,006	0,066	0,072			0,909	0,909	0,982	0,986
81	0,015	0,035	0,050		0,087	0,895	0,982	1,032	1,035
82	0,044	0,149	0,193		0,087		0,087	0,280	0,291
83	0,000	0,083	0,083		0,087	0,539	0,626	0,709	0,714
84	0,177		0,177					0,177	0,187
85	0,432		0,432					0,432	0,457
86					0,357		0,357	0,357	0,357
87									
88		0,028	0,028		0,174	0,895	1,069	1,098	1,100
89		0,028	0,028		0,299		0,299	0,326	0,328
90						1,448	1,448	1,448	1,448
91						0,895	0,895	0,895	0,895
92				0,210		1,434	1,644	1,644	1,650
93		0,081	0,081			1,791	1,791	1,871	1,876
94						1,434	1,434	1,434	1,434
95									
96									
97		0,141	0,141					0,141	0,150
98									
99		0,088	0,088					0,088	0,093
100+		0,344	0,344		0,087		0,087	0,431	0,451
TOTAL	21	9	30	144	60	94	298	328	334
Landings (t)	126	65	191	138	128	321	587	778	793
Mean Weight (g)	6029	6822	6275	959	2144	3424	1973	2372	2377
Mean Length (cm)	57,2	63,3	59,0	25,9	49,4	56,9	40,4	42,1	42,0
Measured weight (t)	n/a	n/a	n/a	n/a	1171,3	738,8	1910,1	n/a	n/a

Table 4.4.4. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. Number, mean weight and mean length of landings between 1986 and 2020.

Year	Total (thousands)	Mean Weight (g)	Mean Length (cm)
1986	1704	1504	43
1987	4673	820	34
1988	2653	1395	43
1989	1815	1420	44
1990	1590	1468	44
1991	1672	1294	42
1992	1497	1410	45
1993	1238	1799	48
1994	1063	1486	44
1995	1583	1157	40
1996	1146	1422	44
1997	1452	1248	41
1998	1554	1380	42
1999	1268	1487	42
2000	680	2010	47
2001	435	2329	49
2002	514	1497	41
2003	507	1826	46
2004	468	1974	47
2005	408	2198	49
2006	1030	1115	37
2007	1036	1255	39
2008	503	1889	48
2009	298	2585	51
2010	387	1940	45
2011	531	1641	43
2012	435	2366	49
2013	361	2678	50

Year	Total (thousands)	Mean Weight (g)	Mean Length (cm)
2014	442	2011	43
2015	406	2195	49
2016	340	2602	52
2017	324	2662	50
2018	295	2015	51
2019	230	2591	50
2020	334	2377	42

Table 4.4.5. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. Abundance indices from Spanish (SpGFS-WIBTS-Q4, G2784: stratified mean; SPGFS-caut-WIBTS-Q4, G4309: stratified mean) and Portuguese research surveys (PtGFS-WIBTS-Q4, G8899; simple mean).

	SpGFS-WIBTS-Q4					PtGFS-WIBTS-Q4			SPGFS-caut-WIBTS-Q4				
	September-October (total area Miño-Bidasoa)					October			Gulf of Cádiz				
Year	Hauls	kg/30 min		n/30 min		Hauls	n/h	kg/h	Hauls	g/h	se (biom.)	n/h	se (abund.)
		Yst	Sst	Yst	Sst								
1983	145	0,68	0,17	0,50	0,09	117	n/a	n/a					
1984	111	0,60	0,17	0,60	0,11	na	n/a	n/a					
1985	97	0,46	0,11	0,50	0,07	150	n/a	n/a					
1986	92	1,42	0,32	2,50	0,33	117	n/a	n/a					
1987	ns	ns	ns	ns	ns	81	n/a	n/a					
1988	101	2,27	0,38	1,50	0,21	98	n/a	n/a					
1989	91	0,45	0,10	0,90	0,21	138	0,23	0,19					
1990	120	1,52	0,47	1,50	0,22	123	0,11	0,17					
1991	107	0,83	0,14	0,60	0,10	99	+	0,02					
1992	116	1,16	0,19	0,80	0,11	59	+	+					
1993	109	0,90	0,20	0,90	0,13	65	0,02	0,04	29	215	20.95	0.22	0.02
1994	118	0,75	0,17	1,00	0,12	94	0,06	0,09	ns	ns	ns	ns	ns
1995	116	0,72	0,12	1,00	0,11	88	0,02	0,08	ns	ns	ns	ns	ns
1996*	114	0,95	0,17	1,30	0,18	71	0,27	0,50	ns	ns	ns	ns	ns
1997	116	1,16	0,20	0,97	0,11	58	0,03	0,01	27	267	28.94	0.24	0.02
1998	114	0,88	0,18	0,57	0,09	96	0,02	0,12	34	139	10.18	0.17	0.01
1999*	116	0,43	0,12	0,26	0,06	79	0,08	0,07	38	89	8.21	0.27	0.02
2000	113	0,66	0,18	0,40	0,08	78	0,13	0,13	30	514	29.84	0.92	0.04
2001	113	0,19	0,06	0,52	0,10	58	+	+	39	298	24.36	0.41	0.04
2002	110	0,26	0,09	0,33	0,07	67	0	0	39	224	22.58	0.33	0.02
2003*	112	0,36	0,11	0,35	0,10	80	0,22	0,21	41	370	30.2	0.3	0.02
2004*	114	0,76	0,23	0,44	0,12	79	0,14	0,21	40	509	37.94	0.26	0.02
2005	116	0,64	0,20	1,62	0,30	87	0,01	+	42	990	43.43	2.6	0.08
2006	115	1,08	0,22	1,16	0,19	88	0,02	0,46	41	465	37.91	0.22	0.01
2007	117	0,59	0,12	0,48	0,08	96	0,02	0,03	37	703	54.25	0.4	0.03
2008	115	0,35	0,09	0,29	0,05	87	0,07	0,36	41	449	25.49	0.24	0.01
2009	117	0,30	0,08	0,35	0,08	93	0,02	+	43	561	35.11	0.43	0.02
2010	127	0,35	0,09	0,53	0,09	87	0,09	0,18	44	726	60.01	0.73	0.04
2011	111	0,63	0,15	0,52	0,08	86	0,02	0,06	40	806	43.58	0.57	0.03
2012	115	0,61	0,10	0,74	0,11	ns	ns	ns	37	723	53.73	0.77	0.03
2013**	114	1,27	0,36	1,40	0,35	93	0,02	0,03	43	1572	69.91	1.29	0.07
2014**	116	1,11	0,27	0,87	0,15	81	0,00	0,00	45	531	28.31	0.38	0.02
2015**	114	0,55	0,13	0,36	0,08	90	0,00	0,00	43	2058	96.93	1.45	0.05
2016**	114	0,51	0,10	0,40	0,06	85	0,02	0,30	45	1196	51.7	1.16	0.05
2017**	112	0,55	0,15	0,35	0,08	89	0,09	0,05	44	1085	49.24	0.76	0.03
2018**	113	0,76	0,23	0,29	0,07	53	0,08	0,10	45	1645	82.01	1.85	0.05
2019**	113	0,41	0,15	0,17	0,04	ns	ns	ns	43	1252	50.62	0.68	0.02
2020**	109	0,29	0,12	0,27	0,07	ns	ns	ns	44,00	1296	65.29	1.23	0.03

Yst = stratified mean
Sst = Standard error of the mean
ns = no survey
n/a = not available
+ = less than 0.01
*** For Portuguese Surveys - R/V Capricornio, other years R/V Noruega**
**** For both Spanish Surveys - R/V Miguel Oliver, other years R/V Cornide Saavedra**

Table 4.4.6. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. Landings, fishing effort, standardized fishing effort, landings per unit effort and standardized landings per unit effort for trawl (all but STAND-SP-CEDGNS8C) and gill-net fleets (STAND-SP-CEDGNS8C). For landings, the percentage relative to the total annual stock landings is given.

	Avilés, SP-AVITR8C				Santander, SP-SANTR8C				Standardized Cedeira, STAND-SP-CEDGNS8C			
Year	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (soaking days)	LPUE (kg/soaking day)
1986	64	3	10845	5,9	21	1	18153	1,1	--	--	--	--
1987	85	2	8309	10,3	16	0	14995	1,1	--	--	--	--
1988	125	3	9047	13,9	30	1	16660	1,8	--	--	--	--
1989	119	5	8063	14,7	32	1	17607	1,8	--	--	--	--
1990	58	2	8497	6,8	40	2	20469	1,9	--	--	--	--
1991	52	2	7681	6,7	62	3	22391	2,8	--	--	--	--
1992	33	2	--	--	107	5	22833,0	4,7	--	--	--	--
1993	53	2	7635	7,0	143	6	21370	6,7	--	--	--	--
1994	65	4	9620	6,7	196	12	22772	8,6	--	--	--	--
1995	141	8	6146	23,0	126	7	14046	9,0	--	--	--	--
1996	162	10	4525	35,8	89	5	12071	7,4	--	--	--	--
1997	143	8	5061	28,3	122	7	11776	10,4	--	--	--	--
1998	91	4	5929	15,3	114	5	10646	10,7	--	--	--	--
1999	41	2	6829	5,9	67	4	10349	6,5	14	1	4 582	3,0
2000	23	2	4453	5,1	44	3	8779	5,0	4	<1	2 981	1,3
2001	12	1	1838	6,7	28	3	3053	9,3	6	1	1 932	3,0
2002	11	1	2748	4,1	16	2	3975	4,1	7	1	2 398	3,0
2003	9	1	2526	3,6	15	2	3837	4,0	3	<1	2 703	0,9
2004	32	3	--	--	23	2	3776,0	6,0	5	1	4 677	1,1
2005	54	6	--	--	7	1	1404,0	4,9	2	<1	3 325	0,7
2006	16	1	--	--	18	2	2717,5	6,8	4	<1	3 911	1,0
2007	11	1	--	--	19	1	4333,7	4,5	2	<1	3 976	0,6
2008	10	1	--	--	--	--	--	--	0	<1	5 133	0,1
2009	5	1	--	--	8	1	1124,8	6,8	4	1	2 300	1,7
2010	--	--	--	--	19,4	3	1627,8	11,9	4	1	1 880	2,1
2011	--	--	--	--	36,4	4	--	--	1	<1	522	1,3
2012	--	--	--	--	21,8	2	--	--	4	<1	--	--

	A Coruña-Port, SP-CORTR8C-PORT				A Coruña-Trucks, SP-CORTR8C-TRUCKS				A Coruña-Fleet, SP-CORTR8C-FLEET			
Year	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)
1982	655	28	63 313	10,3	--	--	--	--	655	28	63 313	10,3
1983	765	32	51 008	15,0	--	--	--	--	765	32	51 008	15,0
1984	574	30	48 665	11,8	--	--	--	--	574	30	48 665	11,8
1985	253	14	45 157	5,6	--	--	--	--	253	14	45 157	5,6
1986	352	14	40 420	8,7	--	--	--	--	352	14	40 420	8,7
1987	673	18	34 651	19,4	--	--	--	--	673	18	34 651	19,4
1988	570	15	41 481	13,7	--	--	--	--	570	15	41 481	13,7
1989	344	13	44 410	7,7	--	--	--	--	344	13	44 410	7,7
1990	288	12	44 403	6,5	--	--	--	--	288	12	44 403	6,5
1991	225	10	40 429	5,6	--	--	--	--	225	10	40 429	5,6
1992	211	10	38 899	5,4	--	--	--	--	211	10	38 899	5,4
1993	199	9	44 478	4,5	--	--	--	--	199	9	44 478	4,5
1994	166	11	39 602	4,2	37	2	12 795	2,9	204	13	52 397	3,9
1995	353	19	41 476	8,5	75	4	10 232	7,3	428	23	51 708	8,3
1996	334	21	35 709	9,4	68	4	8 791	7,8	403	25	44 501	9,0
1997	298	16	35 494	8,4	43	2	9 108	4,8	341	19	44 602	7,7
1998	323	15	29 508	10,9	72	3	--	--	394	19	--	--
1999	374	20	30 131	12,4	--	--	--	--	--	--	--	--
2000	287	21	30 079	9,6	6	0	--	--	293	21	--	--
2001	281	28	29 935	9,4	--	--	--	--	--	--	--	--
2002	76	9	21 948	3,5	31	4	6 747	4,6	107	13	28 695	3,7
2003	85	9	18 519	4,6	43	5	7 608	5,6	128	14	26 127	4,9
2004	68	7	19 198	3,5	40	4	10 342	3,8	107	11	29 540	3,6
2005	54	6	20 663	2,6	32	3	10 302	3,1	86	9	30 965	2,8
2006	70	6	19 264	3,6	81	7	12 866	6,3	151	13	32 130	4,7
2007	109	8	21 651	5,1	113	9	13 187	8,6	223	17	34 838	6,4
2008	163	17	20 212	8,1	98	10	9 812	10,0	261	27	30 024	8,7
2009	80	10	16 152	5,0	67	9	12 930	5,2	147	19	29 092	5,1
2010	74	10	16 680	4,4	87	12	9 003	9,7	199	26	22 746	8,7
2011	64	7	12 835	5,0	--	--	--	--	144	15	18 617	7,7
2012	102	9	14 446	7,0	--	--	--	--	172	15	21 110	8,2
2013	88	8	14 736	6,0	--	--	--	--	--	--	--	--
2014	79	8	18 060	4,4	--	--	--	--	--	--	--	--
2015	67	6	13 309	5,0	--	--	--	--	--	--	--	--
2016	89	9	13 718	6,5	--	--	--	--	--	--	--	--
2017	64	7	12 449	5,2	--	--	--	--	--	--	--	--
2018	79	10	13 247	6,0	--	--	--	--	--	--	--	--
2019	75	11	12 824	5,9	--	--	--	--	--	--	--	--
2020	--	--	--	--	--	--	--	--	--	--	--	--

	Portugal Crustacean, PT-TRC9A						Portugal Fish, PT-TRF9A					
Year	LANDINGS	%	EFFORT (1000 hours)	EFFORT (1000 hauls)	LPUE (kg/hour)	LPUE (kg/haul)	LANDINGS	%	EFFORT (1000 hours)	EFFORT (1000 hauls)	LPUE (kg/hour)	LPUE (kg/haul)
1989	89	3	76	23	--	3,92	183	7	52	18	3	10,4
1990	127	5	90	20	0,8	6,2	261	11	61	17	5	15,2
1991	101	5	83	17	--	6,1	208	10	57	15	3,6	13,5
1992	94	4	71	15	1,0	6,2	193	9	49	14	2,4	14,1
1993	64	3	75	13	0,9	4,8	132	6	56	13	2,3	10,1
1994	26	2	41	8	0,6	3,4	53	3	36	10	1,2	5,5
1995	22	1	38	8	0,7	2,8	46	2	41	9	1,5	5,0
1996	45	3	64	14	0,7	3,1	88	5	54	12	2,2	7,1
1997	38	2	43	11	0,9	3,3	43	2	27	9	1,3	4,9
1998	70	3	48	11	1,3	6,3	111	5	35	10	1,2	11,5
1999	41	2	24	8	0,9	5,0	69	4	18	6	1,6	12,2
2000	66	5	42	10	2,6	6,5	76	6	19	6	2,0	12,6
2001	59	6	85	18	0,8	3,2	42	4	19	5	1,0	8,5
2002	47	6	62	10	--	4,8	28	3	14	4	2,9	6,2
2003	30	3	42	10	0,7	3,1	38	4	17	6	2,4	6,7
2004	23	2	21	7	0,9	3,5	27	3	14	4	1,9	6,2
2005	12	1	20	5	0,6	2,4	19	2	13	4	1,2	5,0
2006	18	2	22	5	0,9	3,3	22	2	12	4	1,4	5,6
2007	34	3	22	6	1,3	5,6	31	2	8	3	2,7	10,5
2008	21	2	14	4	1,2	5,4	19	2	5	2	2,1	10,6
2009	18	2	15	--	1,0	--	16	2	6	--	1,8	--
2010	37	5	21	--	1,6	--	34	4	14	--	2,8	--
2011	39	4	18	--	2,3	--	36	4	9	--	2,7	--
2012	66	6	36	--	2,7	--	90	8	16	--	5,0	--
2013	37	3	27	--	2,5	--	62	6	12	--	3,8	--
2014	50	5	17	--	2,8	--	66	7	16	--	3,1	--
2015	48	5	17	--	3,3	--	78	7	14	--	2,7	--
2016	52	5	12	--	4,4	--	67	7	11	--	3,8	--
2017	42	5	9	--	3,8	--	26	3	11	--	2,5	--
2018	36	5	5	--	4,8	--	16	2	6	--	2,9	--
2019	27	4	6	--	3,5		16	2	5	--	2,7	--
2020	52	7	--	--	4,2		76	10	--	--	4,2	--

Table 4.4.7. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. SPiCT summary results.

Model parameter estimates w 95% CI					
	estimate	**cilow**	**ciupp**	**log.est**	
alpha	2.715	0.656	11.247	0.999	
beta	0.138	0.024	0.804	-1.983	
r	0.247	0.104	0.590	-1.397	
rc	0.247	0.104	0.590	-1.397	
rold	0.247	0.104	0.590	-1.397	
m	1767	1262	2474	7.477	
K	28584	12495	65387	10.261	
q	0.000	0.000	0.000	-8.486	
sdb	0.108	0.031	0.379	-2.225	
sdf	0.193	0.129	0.290	-1.643	
sdi	0.293	0.213	0.403	-1.226	
sdc	0.027	0.005	0.146	-3.626	
DETERMINISTIC REFERENCE POINTS (DRP)					
	estimate	**cilow**	**ciupp**	**log.est**	
B_{MSYD}	14292	6248	32694	9.567	
F_{MSYD}	0.124	0.052	0.295	-2.090	
MSYd	1767	1262	2474	7.477	
STOCHASTIC REFERENCE POINTS (SRP)					
	estimate	**cilow**	**ciupp**	**log.est**	**rel.diff.Drp**
B_{MSYS}	13909	6054	31955	9.540	-0.028
F_{MSYS}	0.121	0.051	0.286	-2.114	-0.024
MSYs	1678	1241	2269	7.425	-0.053
STATES W 95% CI (INP$MSYTYPE: S)					
	estimate	**cilow**	**ciupp**	**log.est**	
B_2020.94	17620	8098	38338	9.777	

Model parameter estimates w 95% CI				
	estimate	**cilow**	**ciupp**	**log.est**
F_2020.94	0.048	0.021	0.107	-3.044
B_2020.94/B_{MSY}	1.267	0.683	2.349	0.237
F_2020.94/F_{MSY}	0.394	0.195	0.798	-0.930

PREDICTIONS W 95% CI (INP$MSYTYPE: S)				
	prediction	**cilow**	**ciupp**	**log.est**
B_2022.00	18352	8539	39445	9.818
F_2022.00	0.048	0.019	0.117	-3.044
B_2022.00/B_{MSY}	1.320	0.723	2.408	0.277
F_2022.00/F_{MSY}	0.394	0.176	0.883	-0.930
Catch_2021.00	857	610	1204	6.753
E(B_inf)	21564	NA	NA	9.979

Table 4.4.8. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. SPiCT estimates for B/B_{MSY} and F/F_{MSY}. CI, 95% confidence intervals.

Year	B/B_{MSY}			F/F_{MSY}		
	Estimate	CI high	CI Low	Estimate	CI high	CI Low
1980	1.36	2.81	0.66	0.96	1.78	0.52
1981	1.36	2.65	0.7	1.03	1.86	0.57
1982	1.35	2.54	0.72	1.08	1.93	0.61
1983	1.34	2.45	0.73	1.02	1.79	0.58
1984	1.27	2.28	0.71	0.88	1.52	0.51
1985	1.21	2.14	0.69	0.97	1.65	0.57
1986	1.26	2.17	0.73	1.39	2.6	0.73
1987	1.36	2.55	0.73	1.82	4.0	0.82
1988	1.33	2.85	0.62	1.60	3.5	0.74
1989	1.14	2.37	0.55	1.35	2.8	0.64
1990	1.05	2.12	0.52	1.36	2.9	0.64
1991	0.98	2.01	0.48	1.39	2.8	0.69
1992	0.89	1.73	0.45	1.63	3.3	0.81
1993	0.82	1.6	0.42	1.58	3.0	0.84
1994	0.69	1.28	0.38	1.51	2.8	0.83
1995	0.65	1.18	0.36	1.66	3.1	0.89
1996	0.63	1.16	0.35	1.60	2.9	0.87
1997	0.61	1.11	0.34	1.91	3.6	1.01
1998	0.62	1.15	0.33	2.1	4.2	1.01
1999	0.6	1.19	0.3	1.73	3.6	0.82
2000	0.56	1.15	0.27	1.31	2.7	0.63
2001	0.54	1.08	0.26	0.97	1.98	0.48
2002	0.54	1.07	0.27	0.86	1.77	0.42
2003	0.59	1.18	0.29	0.94	1.99	0.44
2004	0.63	1.29	0.31	0.90	1.84	0.44
2005	0.63	1.25	0.32	0.90	1.84	0.44
2006	0.66	1.32	0.33	1.04	2.3	0.48

Year	B/B_{MSY}			F/F_{MSY}		
	Estimate	CI high	CI Low	Estimate	CI high	CI Low
2007	0.75	1.59	0.35	0.91	2.0	0.41
2008	0.76	1.62	0.36	0.66	1.39	0.32
2009	0.76	1.54	0.37	0.55	1.13	0.26
2010	0.81	1.62	0.4	0.54	1.14	0.25
2011	0.91	1.87	0.45	0.61	1.40	0.26
2012	1.05	2.32	0.48	0.61	1.45	0.26
2013	1.11	2.49	0.49	0.55	1.24	0.25
2014	1.1	2.33	0.52	0.55	1.19	0.25
2015	1.11	2.29	0.53	0.56	1.21	0.26
2016	1.13	2.33	0.55	0.50	1.06	0.24
2017	1.11	2.2	0.56	0.44	0.90	0.22
2018	1.1	2.11	0.57	0.38	0.75	0.195
2019	1.1	2.06	0.59	0.36	0.70	0.186
2020	1.17	2.16	0.63	0.39	0.80	0.195
2021	1.27	2.35	0.69			
Average	**0.95**	**1.87**	**0.48**	**1.05**	**2.1**	**0.53**

Table 4.4.9. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. Estimates of catch, B/B_{msy} and F/F_{msy} for the scenarios proposed.

Scenario	Catch (t)	B/BMSY	F/FMSY
F = 0	0	1.42	0.00
F = Fsq	888	1.36	0.39
F = Fmsy	2179	1.27	1.00
F = Fmsy_c_fractile	1969	1.29	0.90

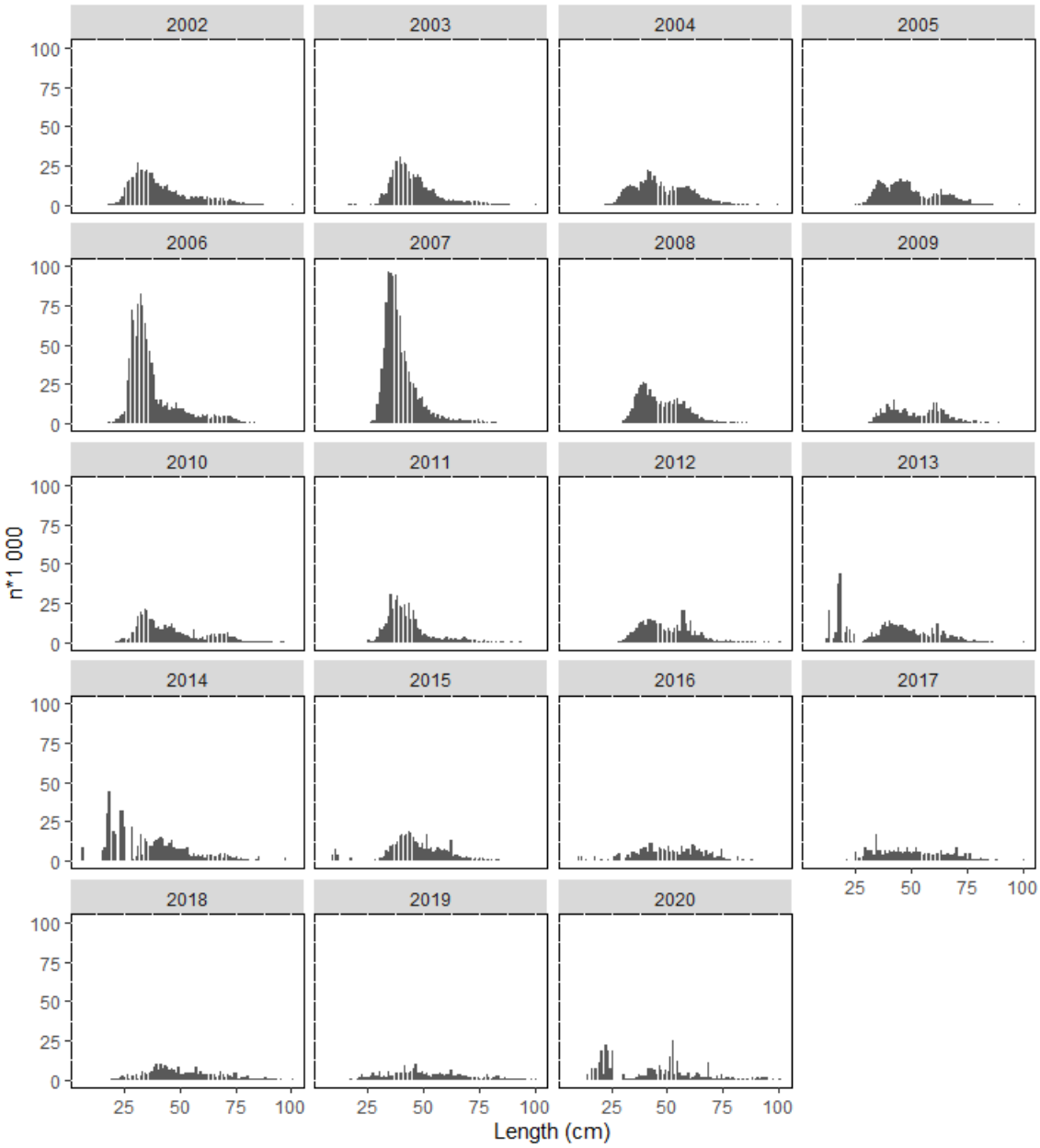


Figure 4.4.1. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. Length distributions of landings (thousands for 2002–2020).

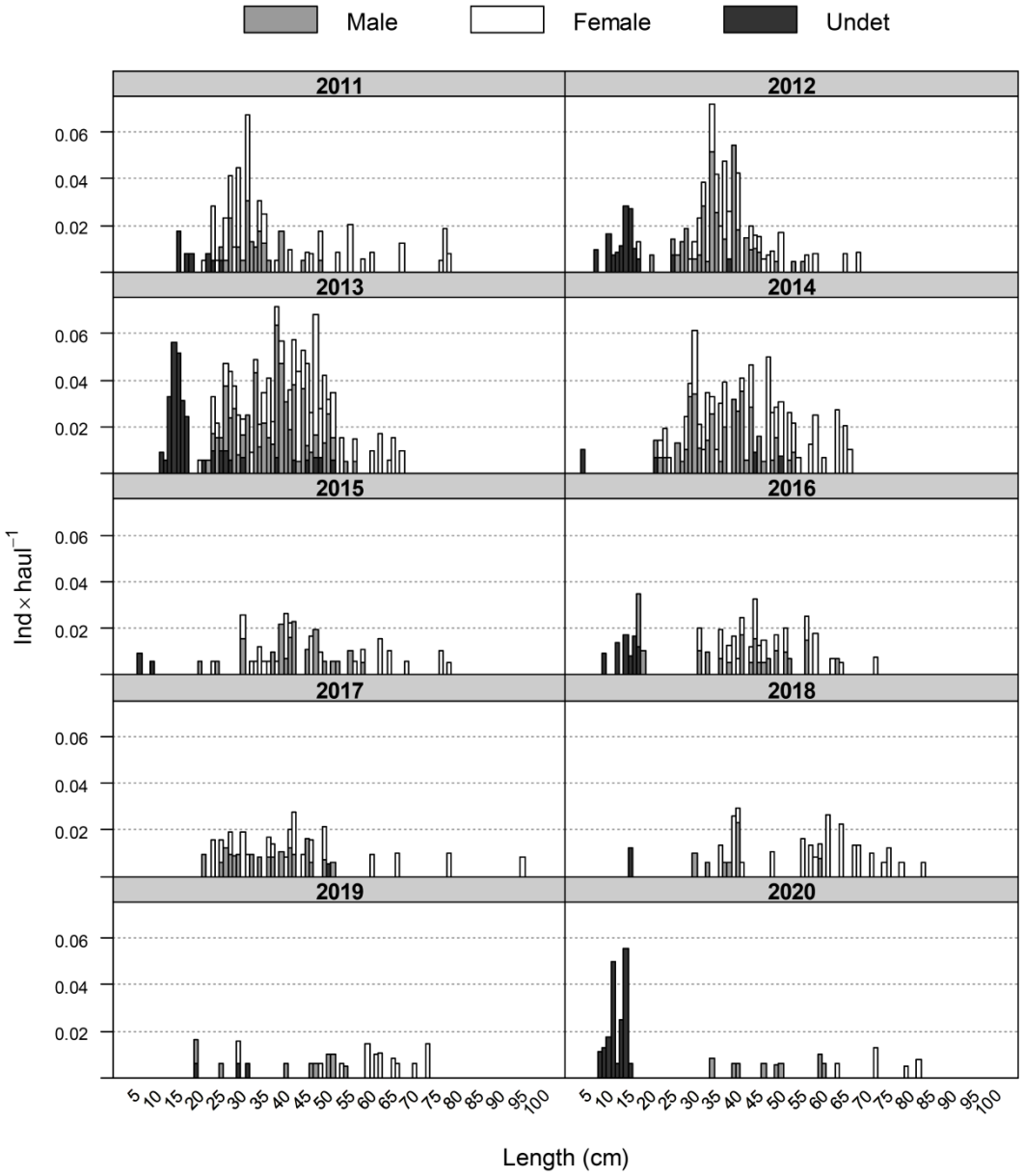


Figure 4.4.2. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. Mean stratified length distributions of *Lophius budegassa* in the Northern Spanish Shelf Groundfish Survey (SpGFS-WIBTS-Q4; code: G2784) in the period 2011–2020 (from Ruiz-Pico *et al.*, 2021).

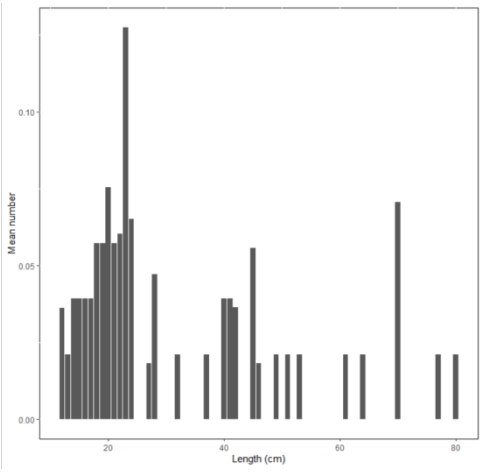


Figure 4.4.3. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. Mean stratified length distributions of *Lophius budegassa* in the SPGFS-caut-WIBTS-Q4 (Gulf of Cádiz; code: G4309) in 2020.

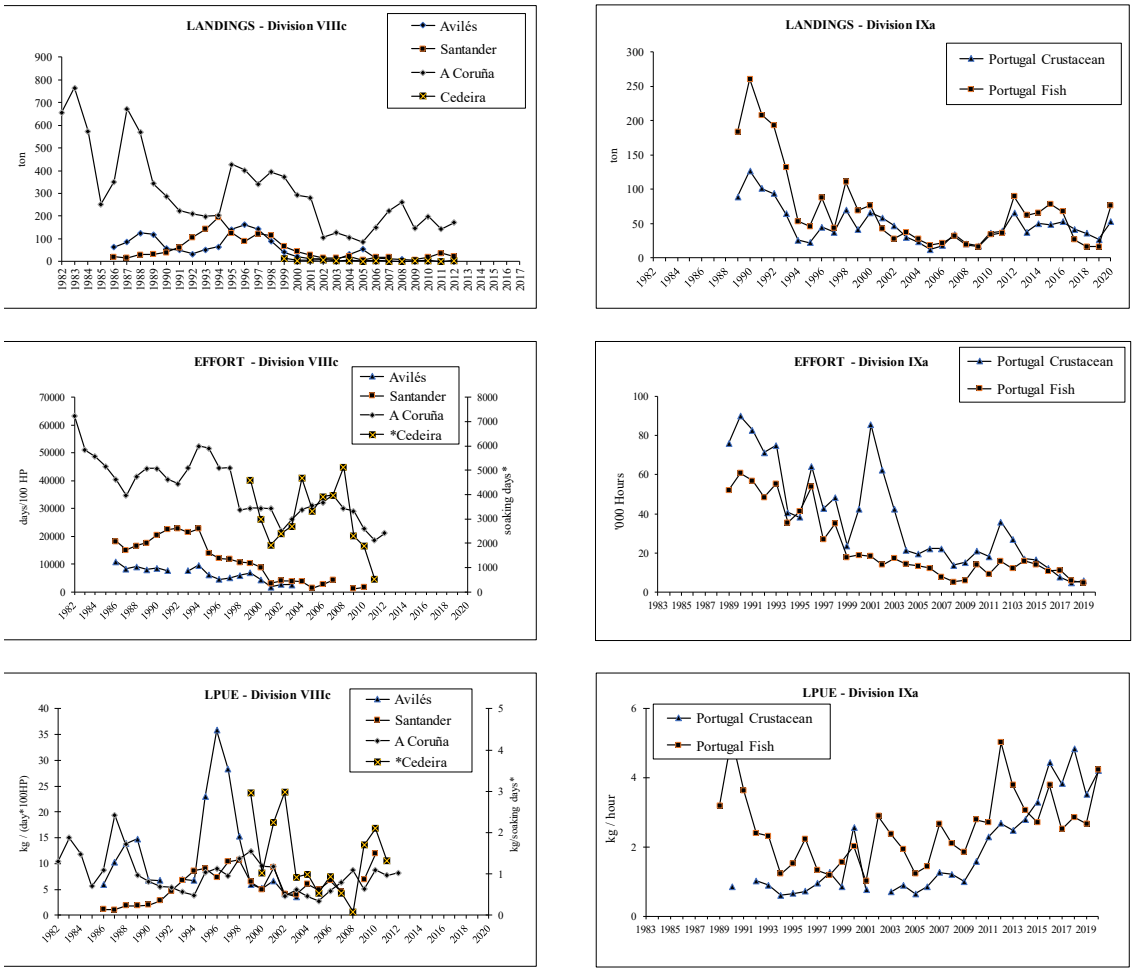


Figure 4.4.4. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. Trawl and gillnet landings, effort and LPUE data between 1986 and 2020.

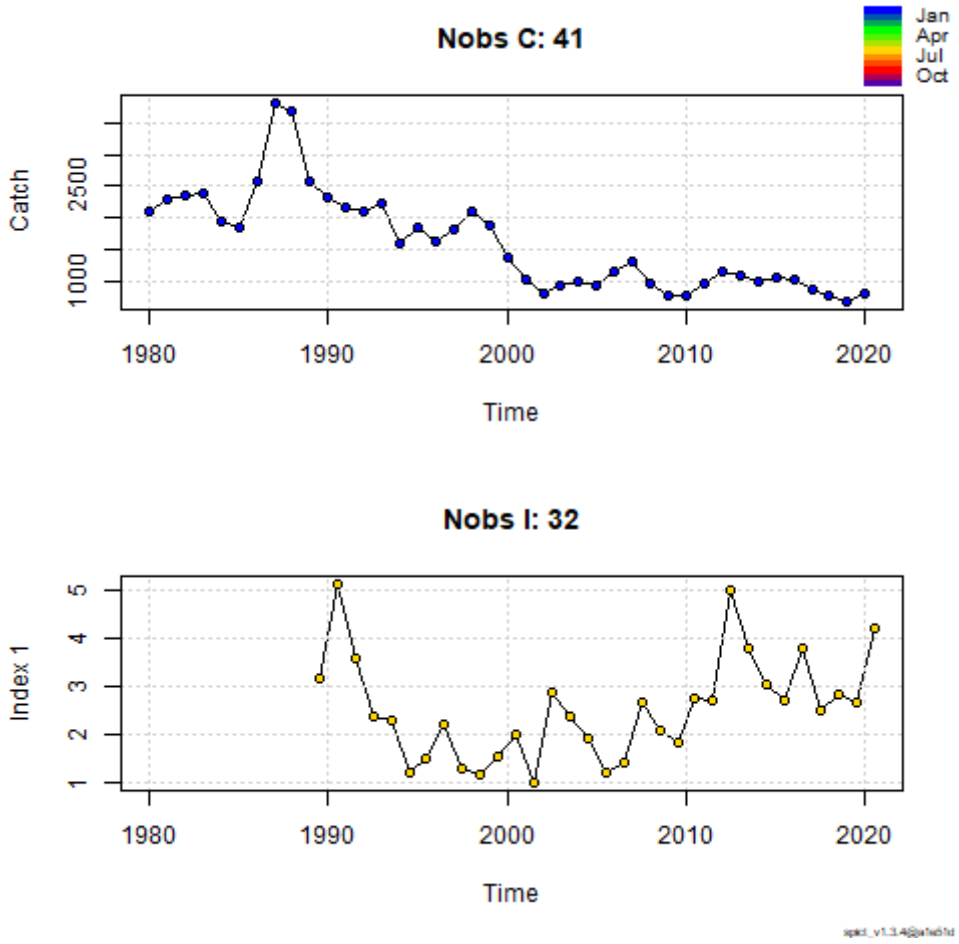


Figure 4.4.5. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. SPiCT input data. Upper panel, Catch data. Lower panel, PT-TRF9a LPUE index (Portuguese trawl fleet targeting fish, 1989 - 2020).

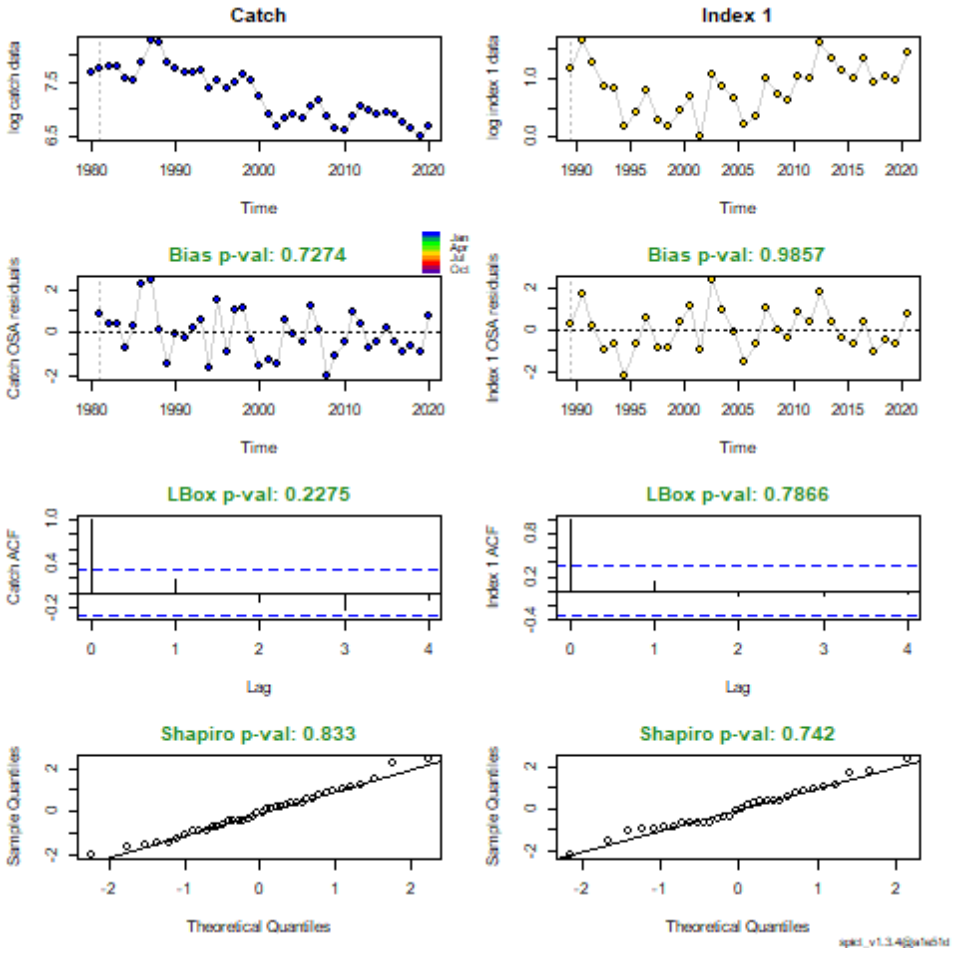


Figure 4.4.6. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. SPiCT diagnostics. Row1, Log of the input dataseries. Row 2, OSA residuals with the p-value of a test for bias. Row 3, Empirical autocorrelation of the residuals with tests for significant autocorrelation. Row 4, Tests for normality of the residuals, QQ-plot and Shapiro test.

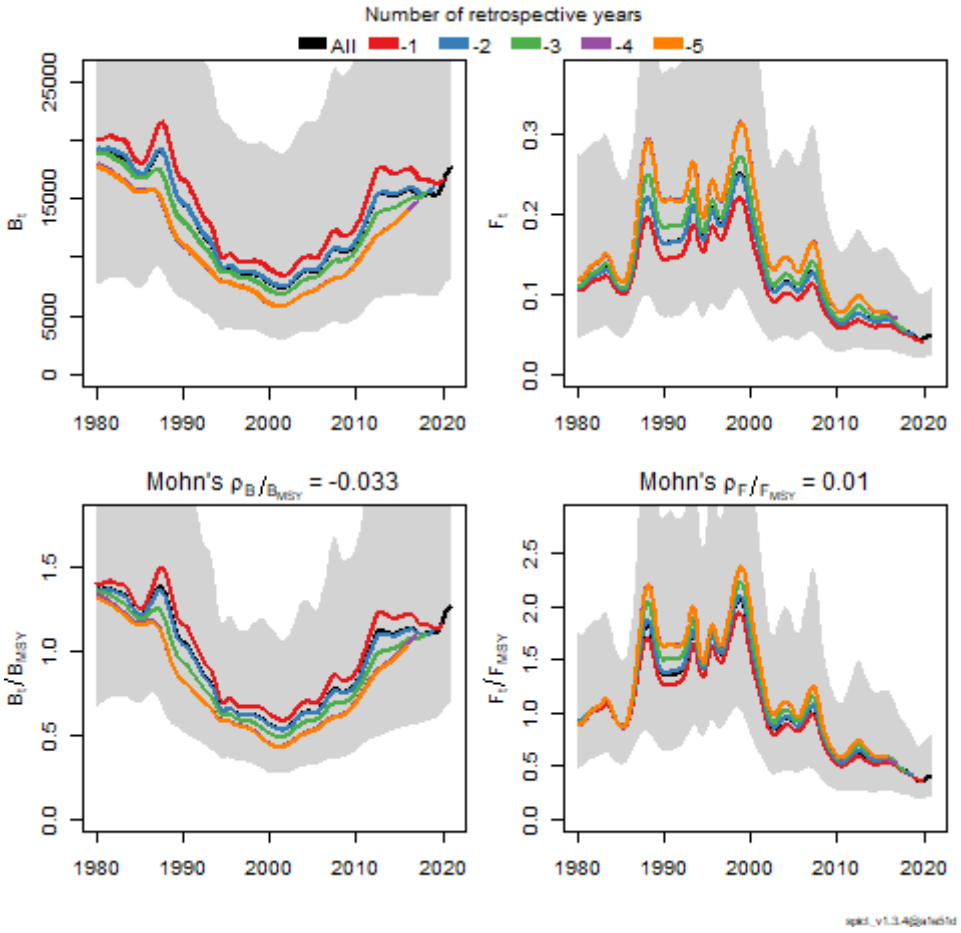


Figure 4.4.7. Anglerfish (*L. budegassa*) - divisions 8.c and 9.a. 5 years retrospective analysis. Upper panel, absolute biomass and fishing mortality. Lower panel, relative biomass and fishing mortality. Grey regions represent 95% CIs.

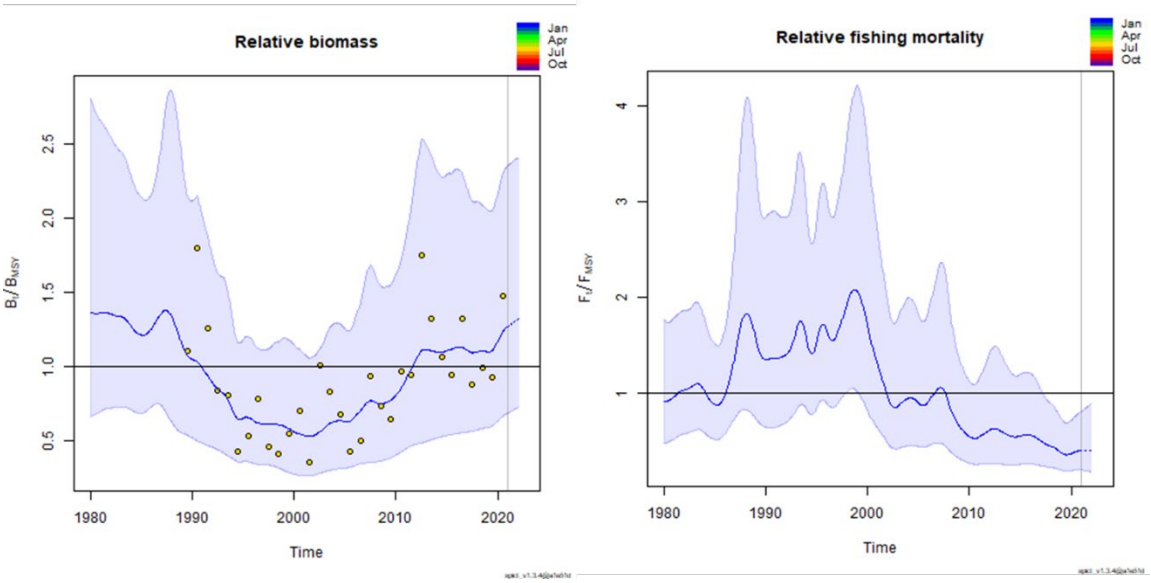


Figure 4.4.8. Black-bellied anglerfish (*L. budegassa*) - divisions 8.c and 9.a. SPiCT results: Left panel, relative biomass; right panel, relative fishing mortality. Solid blue lines are estimated values; vertical grey lines indicate the time of the last observation beyond which dotted lines indicate forecasts; shaded blue regions are 95% CIs for relative estimates; solid circles correspond to the index PT-TRF9a (Portuguese fish fleet).