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

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i Executive summary

The ICES Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) assesses the status of 23 stocks distributed from ICES Divisions 3.a–4.a though to Subarea 9, mostly distributed in Subareas 7, 8 and 9. The group was tasked with conducting assessments of stock status for 23 stocks using analytical, forecast methods or trends indicators to provide catch forecasts and a first draft of the ICES advice for 2019. For two of the *Nephrops* stocks updates were provided on catch data with the advice release delayed until October after the completion of the surveys used for the assessment.

Analytical assessments using age-structured models were conducted for the northern stock of white anglerfish, the northern and southern stocks of megrim, four-spot megrim and sole in the Bay of Biscay. The two hake stocks and one southern stock of anglerfish were assessed using models that allow the use of length-structured data (no age data). A surplus-production model, without age or length structure, was used to assess the second southern stock of anglerfish and an age-length structure model was used for the European seabass in the Bay of Biscay. The state of stocks for which no analytical assessment could be performed was inferred from examination of catch, commercial LPUE or CPUE data and from survey information, where available.

The northern stock of hake was benchmarked this year to incorporate discards into the model that were previously omitted. New reference points with the accepted benchmark assessment were proposed by the group and new proxy biomass reference points where proposed for black anglerfish in Division's 7b-k, 8abd.

A recurrent issue significantly constrained the group's ability to fully address the terms of reference this year. Despite an ICES data call with a deadline of six weeks before the meeting, data for most stocks were submitted to ICES only two days before the start of the meeting and in one case 2 days after the meeting commenced. This delayed the process of having the data quality checked and the assessment completed before the start of the working group. This is an important matter of concerns for the working group members.

The structure of the report is set out with section 1 presenting a summary of each stock, discussing general issues and conclusions. Section 2 provides descriptions of the relevant fishing fleets and surveys used in the assessment of the stocks. Sections 3–18 contains the single stock assessments.

ii Expert group information

Expert group name	Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE)
Expert group cycle	Annual
Year cycle started	2019
Reporting year in cycle	1/1
Chair(s)	Lisa Readdy, UK
	Ching-Maria Villanueva, France
Meeting venue(s) and dates	2–9 May 2019, Lisbon, Portugal, 22 participants

1 Introduction

1.1 Summary by stock

The stocks assessed within WGBIE are distributed from ICES Division 3.a–9.a (Figure 1.1). Figure 1.2 shows the distribution areas of the *Nephrops* Functional Units (FUs) also assessed by the working group (WG). Brief summaries are given here and more detailed information can be found in the relevant stock sections.

Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Subarea 7 and Divisions 8.a, b, d

Both species are caught on the same grounds and by the same fleets and are usually not separated by species in the landings. Anglerfish is an important component of mixed fisheries taking hake, megrim, sole, cod, plaice and *Nephrops*. France contributes to most of the landings for the combined species in this area and has done so since 1990. The TAC for both species combined was set at 42 496 t for 2018 and 41 370 t for 2019. Since 2011 the landings of both species combined have been above the average of the timeseries.

Age determination problems and an increase in the uncertainty in the discard levels have prevented the performance of an analytical assessment since 2007. Since then, the assessments were based on examining commercial LPUEs and survey data (biomass, abundance indices and length distributions from surveys). Last year both stocks were benchmarked with *Lophius piscatorius* attaining an analytical assessment with reference points and forecast. *L. budegassa*, however, continues with assessing the status of the stock through examination of survey data.

For *L. piscatorius* the available data indicate that the biomass has been increasing as a consequence of the good recruitment observed in 2001, 2004, 2010 and 2014 and is above MSY $B_{trigger}$. Fishing mortality is estimated to be below F_{MSY} having been above for the entire timeseries. There is evidence of good recruitments in the more recent period with the last year of good recruitment in 2017. Recruitment in 2011, 2012 and 2013 although lower than in previous years is estimated to be above the Geometric mean of the series.

The assessment for *L. budegassa* excludes Division 7.a as they are only found in very small numbers at the very southern edge of this area. The assessment which uses the combined survey data gives an indication that the biomass has increased and is now at its highest level of the timeseries. The combined surveys show evidence of a large recruitment in 2013 dropping to similar levels seen historically, thereafter. This year proxy reference points were presented and as a consequence of the stock is assessed to be with in safe biological limits and fishing pressure is below $F_{MSYproxy}$.

Although the stocks are assessed separately they are managed together. More details on the anglerfish assessments can be found in Section 3.

Anglerfish (*L. piscatorius* and *L. budegassa*) in 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 usually landed together for the majority of commercial categories and they are recorded together in the ports' statistics. Landings of both species combined in 2018 were 1 916 t. The combined TAC was set at 4 166 t in 2019.

The two species were benchmarked in 2018 and are assessed separately, using a surplus-production model (software SPiCT), tuned with commercial LPUE series for *L. budegassa* and a length-based stock synthesis implementation for *L. piscatorius*.

Biomass of *L. piscatorius* decreased during the 1980s and early 1990s, but has progressively increased over the last two decades to an estimated 16 006 tonnes in 2019. The biomass has been estimated to be above the biomass reference point MSY $B_{trigger}$ since 2005. Fishing mortality peaked during the late 1980's but has since declined, now below F_{MSY} (0.24) from 2011. Recruitment has been relatively low in recent years and shows little evidence of strong year classes since 2001.

Trends in relative biomass of *L. budegassa* indicate a steady decrease since the beginning of the series until 2005. Since then an increase was observed and in 2016 was the highest estimated biomass of the time series. Fishing mortality remained at high levels between late eighties and late nineties, dropping after that. In 2016, fishing mortality is estimated to be the lowest value of the time-series.

Although the stocks are assessed separately, they are managed together.

More details are provided in Section 4.

Megrim *(Lepidorhombus whiffiagonis* and *L. boscii)* in Divisions 7.b-k and 8.a,b,d

Lepidorhombus spp. in Div. 7.b-k and 8.a, b, d are caught in a mixed demersal fishery catching anglerfish, hake and *Nephrops*, both as a targeted species and as valuable bycatch. The two species are landed and recorded together in ports' statistics. Information form landings was available for 2017 for *L. boscii* this provide a split for the two species. The 2018 and 2019 TAC were set at 13 528 t and 19 836 t, respectively. Landings in recent years were relatively stable around 15 000t. Discarding of smaller megrim is substantial and also includes individuals above the minimum landing size of 20 cm. The discards were variable, between 1 500 and 4 000 t.

The *L. whiffiagonis* is assessed with a Bayesian catch-at-age model considered as a full analytical assessment since 2016. Catch, landing and discard data have varied without trend over the time-series the most recent period, 2015-2017 show a slight increase. Recruitment has fluctuated without trend over the timeseries with 2016 and 2017 giving above average values. Biomass has steadily declined to its lowest level in 2006, increasing since then. The 2017 is estimated to be the highest of the time series.

The *L. boscii* was added to the terms of reference for assessment for the first-time last year. Data on catch, landings and discards for 2017, were available to the group and official landings are recorded under the combined species of *lepidhorombus* spp. Data available from surveys did not provide adequate information to assess the status of the stock, advice for this stock was not requested and therefore not provided.

Currently this stock is classified as a Data Limited Stock in category 5 as only data on catch for one year was available with very limited information from surveys.

Details of the assessment are presented in Section 5.

Megrims (*L. whiffiagonis* and *L. boscii*) in Divisions 8.c and 9.a

Southern megrims *L. whiffiagonis* and *L. boscii* are caught in mixed fisheries targeting demersal fish including hake, anglerfish and *Nephrops* and are not separated by species in the landings. The majority of the catches are taken by Spanish trawlers. Landings of both species combined in 2018 were 1 129 t (of which 28% correspond to *L. whiffiagonis*). The agreed combined TAC for megrim and four-spot megrim in ICES Divisions 8.c and 9.a was 1 387 t in 2018 and 1 872 t in 2019.

Both species are assessed separately, using XSA.

For *L. whiffiagonis* the assessment indicates that fishing mortality has increased since 2010 with a sharp decline from 2015. The SSB values in 2007-2010 were the lowest in the series but since 2011, SSB has increased and is now estimated to be above MSY $B_{trigger}$. After a very high recruitment (at age 1) in 2010 the recruitment has decreased to an average value. There are indications of high recruitment in 2015 and 2016.

For *L. boscii* the assessment indicates that SSB decreased gradually from 1989 to 2001, the lowest value in the series, and has since increased. In 2017 the SSB is estimated to be the highest of the series with 2018 being the second highest. Recruitment has fluctuated around 46 million fish during all the series. Very weak year classes are found in 1993, 1998 and 2008 and now in the most recent two years, with 2018 showing the lowest recruitment of the series but needs to be confirmed when more data are made available. Estimates of fishing mortality values show two different periods: an initial period with values around 0.5 from 1989 to 1996 followed by a decreasing trend with the lowest value in 2018 estimated to be below F_{MSY}.

Details of the assessments are presented in Section 6.

Sole in Divisions 8.a, b (Bay of Biscay)

Bay of Biscay sole is caught in ICES divisions 8.a and b. The fishery has two main components: one is a French gillnet fishery directed at sole (about two thirds of total catch) and the other one is a trawl fishery (French otter or twin trawlers and Belgian beam trawlers). The TAC was set at 3 420 t and 3 621 t for 2017 and 2018, respectively. Landings have been declining until 2017 (3 263 t) but has slightly increased this year to 3 468 t.

Discards are not included in the assessment as discards are considered to be low for the ages included in the assessment, which starts at age 2.

Since 1984, fishing mortality has gradually increased, peaking in 2002, decreased substantially the following two years. After 2005, F was stable at around 0.43 (= F_{pa}). In 2017 F is estimated to be at 0.3, below F_{MSY}. The SSB trend in earlier years increased from 1984 to a high value in 1993. Afterwards SSB shows a continuous decrease until 2003, the lowest value of the series. SSB has been increasing and was above B_{pa} from 2004–2013. In 2014, SSB dropped below MSY $B_{trigger}$ at 10 600t and the recruitment values are lower since 1992. Between 2004 and 2008 the recruitment series is stable at around 17 or 18 million with the 2009-year class providing the highest value since the early 1990s. The 2010 and 2011 values are close to the GM93-14 (21 million). However, the 2012 and 2013 values are the lowest of the series (13 million). Recruitment in 2017 (13 167 t) decreased but has been increasing since 2018.

Details on the assessment are in Section 7.

Sole in subdivisions 8.c and 9.a

Portugal and Spain are the main participants in these fisheries with *Solea solea* mainly caught with gillnets and trammel nets. In Portugal *Solea solea* is caught together with other similar species *Solea senegalensis* and *Pegusa lascaris* and it is only in recent years that official catches are reported separated by species. Total landings of *solea solea* was 595 t and 579 t for 2017 and 2018, respectively. The available information is insufficient to evaluate stock trends and exploitation status. Therefore, the state of the sole in Divisions 8.c and 9.a remains unknown.

Details on the assessment are in Section 8

Hake in Division 3.a, Subareas 4, 6 and 7 and divisions 8.a, b, d (Northern stock)

Hake is caught in nearly all fisheries in Subareas 7, 8. and in some fisheries in Subareas 4, 6. In recent years. Spain accounted for the main part of the landings, followed by France. Stock landings have been steadily increasing throughout the last decade, from 36 675 t in 2001 to 107 500 t in 2016, the highest value of the time-series. The 2017 landings saw a slight reduction down to

104 670 t with a corresponding drop in discarding. Since 2009, landings have been above the agreed TAC until 2015. Landings in the last two years are below the agreed TAC.

The stock was inter-benchmarked in 2019 (ICES, 2019) with one of the main objectives to assess the inclusion of hake eggs and larvae data collected during the triennial ICES Mackerel/Horse Mackerel Egg Survey (ICES, 2017) and to account for the whole discard data available in the assessment. The inter-benchmark concluded that the hake egg index needs to be further investigated. Due to considerable information provided by this index, it is now recommended for use as an external indicator for comparison with the assessment results (SSB trends). Data inclusion of discards in the assessment adequately matches the patterns observed in the data and was considered as a suitable basis for assessment of the northern hake stock. As the assessment now accounts for all the catch data available, there is no need to provide catch advice with two types of unwanted catch.

This year, the assessment was carried out according to the stock annex, and the group accepted the assessment as appropriate for providing advice. The retrospective pattern improved significantly in 2018 with the revision of the EVHOE survey and the update of the recruitment settings in the SS3 control file (ICES, 2018). The recruitment appears to fluctuate without substantial trend over the whole series with the 2008 estimated to be the highest of the time-series (756 million). In 2014, the recruitment decreased below mean level (355 million), with the exception of 2016. From high levels at the start of the series (104 046 t in 1980), the SSB decreased steadily to a low level at the end of the 90s (22 678 t in 1998). Since that year, SSB has increased to the highest value of the series in 2016 (351 334 t). The fishing mortality is calculated as the average annual F for sizes 15–80 cm. This measure of F is nearly identical with the average F for ages 1–5. Values of F increased from values around 0.5-0.6 in the late 70s and early 80s to values around 1.0 during the 90s. They declined sharply afterwards to 0.25 in 2014 and have remained stable since.

Details about the assessment of this stock are provided in Section 9.

Hake in Divisions 8.c and 9.a

Hake in Divisions 8.c and 9.a is caught in a mixed fishery by Spanish and Portuguese trawlers and artisanal fleets. Spain accounts for the main part of the landings. Total landings in 2017 and 2018 were 9 171 t and 10 183 t, respectively. Total discards in 2017 were 1 676 t and 1 942 t in 2018, increasing from very low levels.

The southern hake stock was benchmarked in 2014 to address the difficulties encountered by the GADGET model in its search for the set of parameters that maximize the likelihood function. The work confirmed that the model fitting procedure is finding a genuine optimum and can thus continue to be used as the assessment model.

The recruitment (age 0) is highly variable and presents two different periods: one from 1982–2004 with mean figures around 70 million, ranging from 40 to 120, and a recent period from 2005 to 2009 with mean values of 123 million and since 2010 to latest recruitment has been oscillating, ranging from 62 to 92 million. Fishing mortality increased from the beginning of the time-series (F=0.36 in 1982) peaking in 1995 at 1.19; declining to 0.79 in 1999 and remaining relatively stable until 2009 (F=0.98). F then progressively decreased to reach 0.60 in 2018. The SSB was very high at the beginning of the time-series with values around 40 000 t, then decreased to a minimum of 5 706t in 1998. Since then biomass has continuously increased, reaching 16 619 t in 2018, above the average of the series.

Details on the assessment of this stock are in Section 10.

Nephrops in ICES Division 8.a,b

There are two Functional Units in ICES Division 8.a,b: FU 23 (Bay of Biscay North) and FU 24 (Bay of Biscay South), see Figure 1.2. *Nephrops* in these FUs are exploited by French trawlers almost exclusively. Landings declined until 2000, from 5 875 t in 1988 to 3 069 t in 2000. After that year, they increased again to around 3 700 t, staying at that level for some time. Since 2006 landings have been around 3,300 t. In 2012 and 2013, a reduction in the landings occurred (2 520 t in 2012, 2 380 t in 2013) followed by an increase to 4 091 t in 2016. The agreed TAC for 2018 was 3 600 t.

A French regulation increased the minimum landing size in 2006 and several effort and gear selectivity regulations have also been put in place in recent years. The use of selective devices for trawlers targeting *Nephrops* became compulsory in 2008. All these measures are expected to be contributing in various ways to the changing patterns of landings and discards observed recently. In general, discards values after 2000 have been higher than in earlier years, although sampling only occurred on a regular basis from 2003, so information about discards is considerably weaker for the earlier period.

This stock was benchmark in 2016 and review the methods proposed using an underwater TV survey. The outcome of this process classified the stock as a category 1 stock and the methods developed were appropriate for assessing the stock for the provision of advice.

No quantitative analytical assessment was carried out during the working group as the survey used for the assessment had not been completed. An update of the assessment will be carried out after the working group and advice provided in October.

Details can be found in Section 11.

Nephrops in ICES Division 8.c

There are two Functional Units in Division 8.c (Figure 1.2): FU 25 (North Galicia) and FU 31 (Cantabrian Sea).

Nephrops are caught in the mixed bottom-trawl fishery in the North and Northwest Iberian Atlantic. Landings from both FUs have declined dramatically in recent years reaching less than 15 t in each FU in 2015, below the TAC in recent years, which has not been restrictive. The TACs were set at 0 t for the whole Division 8.c for 2017 to 2019. However, a scientific quota was established for *Nephrops* in FU 25 in order to undertake an observer programme to obtain data to continue to assess the status of the stock.

A recovery plan for southern hake and Iberian *Nephrops* stocks has been in force since 2006. The aim of the recovery plan is to rebuild the stocks within 10 years, with a reduction of 10% in F relatively to the previous year and the TAC set accordingly (Council Regulation (EC) No. 2166/2005).

According to the ICES data-limited approach, both stocks are considered as category 3.1.4. The two stocks are assessed by the analysis of the LPUE series trend. The perception of the stocks is the same as last year indicating an extremely low abundance level.

Additional details are provided in Section 12.

Nephrops in ICES Division 9.a

There are five Functional Units in Div. 9.a (Figure 1.2): FU 26 (West Galicia); FU 27 (North Portugal); FU 28 (Alentejo, Southwest Portugal); FU 29 (Algarve, South Portugal) and FU 30 (Gulf of Cádiz).

Landings in 2018 from the five FUs combined were 441 t. The TAC set for the whole of Subareas 9 and 10 and Union waters of CECAF 34.1.1 was 381 t and 401 t for 2018 and 2019.

A recovery plan for southern hake and Iberian *Nephrops* stocks has been in force since 2006. The aim of the recovery plan is to rebuild the stocks within 10 years, with a reduction of 10% in F relative to the previous year and the TAC set accordingly (Council Regulation (EC) No. 2166/2005).

FU 26+27 (West Galicia and North Portugal): The fishery shares the same characteristics of that in Division 8.c, described above.

Landings are reported by Spain and minor quantities by Portugal, from 2012 quantities have been similar and at very low levels. Spanish fleets fish in FU 26 and FU 27, whereas Portuguese artisanal fleets fish with traps in FU 27. Two periods can be distinguished in the time-series of landings available 1975-2016. During 1975-1989, the mean landing was 680 t, fluctuating between 575 and 800 t approximately. Since 1990 onwards there has been a marked downward trend in landings, being below 50 t from 2005 to 2011. In the last seven years, landings continued to decrease and are below 10 t. Discards rates are considered negligible.

According to the ICES data-limited approach, this stock is considered as category 3.1.4. The FU 26-27 are assessed by the analysis of the LPUE series trend, as was done in 2012. The perception of the stocks is the same as last year indicating an extremely low abundance level.

FU 28+29 (SW and S Portugal): *Nephrops* are taken by a multispecies and mixed bottom-trawl fishery. The trawl fleet comprises two components, one targeting fish operating along the entire coast, and another one targeting crustaceans, operating mainly in the southwest and south, in deep waters. There are two main target species in the crustacean fishery, Norway lobster and deep-water rose shrimp, with different but overlapping depth distributions. In years of high rose shrimp abundance, the fleet directs its effort to this species as a preference.

For the period 1984–1992, the recorded landings from FUs 28 and 29 have fluctuated between 420 and 530 t, with a long-term average of about 480 t, declining in the period 1990–1996, down to 132 t. From 1997 to 2005 landings increased to levels observed during the early 1990s, decreasing again in recent years. The landings in 2009-2011 was stable at around 150 t, increasing to 299 t over the years 2014-2018.

According to the ICES data-limited approach, this stock is classified in the category 3.2.0. and the advice is based on survey, fishery LPUEs and effort trends. Standardised effort shows a consistent declining trend until 2010, fluctuating at low levels since. The fleet standardised LPUE, used as an index of biomass, decreased in the period 2006-2011, increase since then. The proxy reference points where updated using the new LPUE time-series, length data and catches. The results indicate that the stock is exploited at levels below the F_{MSY} reference point.

FU 30 (Gulf of Cádiz): *Nephrops* in the Gulf of Cádiz is caught in a mixed fishery by the trawl fleet. Landings are markedly seasonal with high values from April to September. Landings were reported by Spain and minor quantities by Portugal. Landings increased from 100 t in the mid-90s to a higher level at the beginning of the 2000s. Landings decreased again until 2008 fluctuating at around 100 t from 2008 to 2012. From 2013, landings dropped to around 20 t, with the main reason that the quota in 2012 was exceeded and the European Commission applied a sanction so that the *Nephrops* fishery was closed with vessels only fishing for *Nephrops* for a few days during the summer and winter periods. From 2016 effort and landings have resumed back to levels seen prior to this period with the inclusion of the unreported landings.

According to the ICES data-limited approach, this stock is classified in the category 4.1.2. and the advice is based on an underwater TV survey. No quantitative analytical assessment was carried out during the working group as the survey used for the assessment and advice had not been completed. An update of the assessment will be carried out after the working group and advice provided in October.

The five *Nephrops* FUs (assessed as 3 separate stocks) are managed jointly, with a single TAC set for the whole of Subareas 9, 10 and CECAF 34.1.1. This may lead to unbalanced exploitation of the individual stocks. The northernmost stocks (FUs 26-27) are at extremely low levels, whereas the southern ones (FUs 28-29 and FU 30) are in better condition. To protect the stock in these Functional Units, management should be implemented at the Functional Unit level.

Additional details can be found in Section 13.

European seabass in Division 8.a,b

Seabass in the Bay of Biscay are targeted by France (more than 90% of international landings) by line fisheries which take place mainly from July to October, nets, pelagic trawlers, and in mixed bottom-trawl fisheries from November to April on pre-spawning and spawning grounds when seabass aggregate. Since the late 90s total landings were stable at around 2 500 t. Landing of netters have however increased since 2011 due to a decrease of sole quotas from 2011 and a redistribution of effort towards this species combined with good weather condition in 2014. Recreational fisheries are an important part of the total removals but these are not accurately quantified. Discards are known to take place but are not fully quantified. The available data suggests that discards can be considered negligible (<5%).

The seabass stock in the Bay of Biscay was benchmarked and included both recreational and commercial landings and is tuned by a commercial landings per unit of effort series. Since 2000, commercial landings have fluctuated without trend and the recreational catch gives similar fluctuations and trends given that the values are based on the assumption of constant F relating to recreation survey data collected around 2010.

The only available tuning index fluctuates without trend with the years 2012 to 2016 showing a decline, 2017 gives an increase. Estimated biomass has been declining in the recent period after an increase from its lowest level in 1999. Recruitment is variable and poorly estimated in the recent period with 2016 estimated to be above the geometric mean of the time-series. Fishing mortality, estimated as the average of ages 4-15, has fluctuated over without trend over the timeseries.

Additional details can be found in Section 14.

European seabass in Division 8.c, 9.a

Spanish and Portuguese vessels represent almost all of the total annual landings in divisions 8.c and 9.a. Commercial landings represent 716 t in 2018, a decline on the previous year, 952 t in 2017. A peak in landings is observed in 1989-90 and again in 2013, reaching more than 1 000 t, and lowest landings have been observed in 1980, 1981 and 1985 and more recently in 2003 (466 t). Discards from observer programmes show that discarding is negligible for this stock.

No stock assessment is carried out as the stock is considered as category 5.2.0. Information on abundance and exploitation is not yet available and the update of the landings data do not change the perception of the stock. Advice for this stock is based on the precautionary approach the precautionary buffer was not applied this year as it was last applied in 2017. Landings are more than the advised catch and it is uncertain whether the 2020 and 2021 advice will have any impact on the stock given that this is not limited by management as only a minimum landing size applies (EC regulation 850/98).

Additional details can be found in Section 15.

Plaice in Subarea 8. and Division 9.a

Plaice (*Pleuronectes platessa*) are caught as a bycatch by various fleets and gear types covering small-scale artisanal and trawl fisheries. Portugal and France are the main participants in this fishery with Spain playing a minor role. Present fishery statistics are considered to be preliminary as there are concerns about the reliability of data, missing French data in 1999 and the quality of the French data for 2008–09. Landings may also contain misidentified flounder (*Platichthys flesus*) as they are often confounded at sales auctions in Portugal. The quantity of discarding is uncertain. For these reasons, the landings are unlikely to be a good indicator of total removals and ICES considers that it is not possible to quantify the catches.

This stock is currently ranked as a Data Limited Stock in category 5.2.0 as only landings data are available. This year, the updated timeseries of landings and discards including 2018 data do not change the perception of the stock.

Additional details can be found in Section 16.

Pollack in Subarea 8. and Division 9.a

Pollack is mainly caught by France and Spain by several types of gears; nets, lines and trawls. Most of the landings are from gillnets fisheries. Since the early 2000s, the landings have been relatively stable between 1 500 t and 2 000 t.

Discards estimates in the Spanish fleet indicate that the discards may be low.

The stock is classified as a Data Limited Stock in category 5.2.0 as the only available information is on catches. This year, the updated timeseries of landings and discards including 2018 data do not change the perception of the stock.

Additional details can be found in Section 17.

Whiting in Subarea 8 and Division 9.a

Whiting (*Merlangius merlangus*) are caught in mixed demersal fisheries primarily by France and Spain. Present fishery statistics are considered to be preliminary. Total landings in recent years have fluctuated around 2 000 t, provisionally the 2016 landings is reported to be one of the highest of the time series, at around 2 525 tonnes, 2017 landings saw a decline down to 1 925 t with a further decline in 2018. Whiting has never been recorded in Spanish discards and is negligible in Portuguese discards. However, there are indications that discarding occurs in the French fleet, recent available information suggests this is highly variable between fleets and for some considerable.

This species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula. It is not clear whether this is a separate stock from a biological point of view.

The stock is classified as a Data Limited Stock in category 5.2.0 as the only available information is on catches. This year, the updated timeseries of landings and discards including 2018 data do not change the perception of the stock.

Additional details can be found in Section 18.

1.2 Available data

Catch (totals and/or age–length structured) and effort data according to species, country, area and métier were requested in the ICES standard data call for WGBIE. A deadline of the 21 March 2019 was set in order to prepare the datasets for the working group and progress on the use of InterCatch.

For most of the stocks assessed by WGBIE, InterCatch was used mainly to extract catch, landings and discards data. The data delivered to accessions via worksheet format was, for some stocks, used as the primary data source and compared to the data submitted on InterCatch.

The main data problems detected by the Working Group and for which action is required is the delay in the submission of data via InterCatch or accessions of catch and associated length and age samples and survey and commercial indices.

Spanish catch data for 2018 were presented well after the data call deadline without the needed time to complete the assessment before the group started. It was reported to the group that the reason for this was a fail in the Spanish Official Database that precluded the scientific estimation of landings and discards required for the assessment for most WGBIE stocks.

The consequences of this delay is the lack of time for a suitable quality control that can affect the quality of the advice. Specific details for the impact on each stock are provided in the corresponding stock section. This delay has also impacted on the completion of the ToRs of the group.

Several stocks assessed by the Group are managed by means of TACs that apply to areas different from those corresponding to individual stocks, notably in Subarea 7, as well as for the *Nephrops* FUs in 8.c and 9.a, or to a combination of species in the cases of anglerfish and megrim.

Biological sampling levels by country and stock are summarized in Table 1.4a and b

1.3 Stock data problems relevant to data collection

WGBIE were not made aware of an issue with problems relevant to data collection this year.

1.4 Use of InterCatch by WGBIE

Progress has been made by the group with regards to the use of InterCatch. Several stocks are partly using InterCatch in this process but as a place to hold all the raw data with the files being processed and raised externally.

This year, northern hake files were exclusively processed with in InterCatch, because of the complexity of the data, with the number of countries and métiers, raising the data were again very time consuming, cumbersome and difficult with no one year being repeatable. This year was made more difficult with member states re-uploading data after the data call deadline and during the WGBIE meeting.

1.5 Assessment and forecast auditing process

WGBIE carried out the standard audits of individual assessments and forecasts where available for all stocks assessed. Following a template provided by ICES secretariat, the choice of assessment model, the model configuration and the data used in the assessments have been checked against the corresponding settings described in the Stock Annex. Not all audits could be completed by the end of the meeting and the remaining stocks were audited after the meeting. Only minor corrections were raised by the auditors and these were corrected accordingly.

1.6 Stock annexes

All stocks assessed by this WG have a stock annex.

1.7 Benchmark of single species assessments

Stocks with full analytical assessment, of which there are nine, have completed an issues list in preparation for benchmarking and to review future research needs. A further 3 stocks ranging from category 3 to category 5 have also prepared an issue list this year.

1.7.1 Proposals for future benchmarks

Although hake in Subarea 4, 6 and 7 and Divisions 3.a, 8.abd went through an inter-benchmark process in 2019 it remains on the benchmark list driven by the issues which relate to both hake stocks.

Name	Assessment status	Latest Benchmark	Benchmark next year	Planning Year +2	Comments
Hake in Subareas 4, 6, and 7 and Divisions 3.a, 8.a,b,d (Northern stock)	Update	WKSouth 2014, IBPHake 2019		Yes	Revision of biological data.
Hake in Divisions 8.c and 9.a (Southern stock)	Update	WKSouth 2014		Yes	Strong retrospective pattern, the cause of which is unclear. Revision of biological data.

The WG reviewed the stocks to be benchmarked using the benchmark prioritization scoring sheet. There are five categories each with a score of 1 to 5, 5 being high priority, the scores from the five categories are then combined using a weighting. The final selection of which stock to benchmark is via a ranked system with all stock assessed by ICES..

The updated tables and relevant comments regarding the issues lists and benchmark prioritization are at Annex 5.

1.8 Mohn's rho

As standard practice the Mohn's rho for each of the stocks assessed using a full analytical assessment within a category 1 and 2 classification of stock assessment was calculated (Figure 1.3) using between a 5– and 7–year peel. WGBIE assesses nine stocks which fall into this category of assessment using a combination of age and/or length structured models. With the exception of megrim in 7.b-k8.abd and hake in 3.a46-8.abd all stocks are within the 20% threshold for SSB and F. However, recruitment shows much more retrospective bias suggesting that recruitment is not easily estimated by the models for four of the nine stocks as these were evaluated as being outside the threshold of ±20%.

1.9 Evaluation of *nephrops* functional units 29 and 30

The WG reviewed the progress made toward the evaluation of *nephrops* functional units 29 and 30 as being one stock. Information presented included bathymetry and substrate, *nephrops* biological parameters for each of the units, fishery dependant data; landings and vessel monitoring system satellite data. The results of which were inconclusive as to whether the two units are one stock. The WG recommended that further investigation is needed, and available data are standardised across the two units to facilitate comparisons.

1.10 Special request: Whiting in Subarea 8 and Division 9.a.

This year WGBIE received a special request to update catch advice for 2019 taking into consideration all relevant available data.

"The last ICES catch advice for whiting in ICES divisions 8 and 9a was issued 30 June 2017 for 2018 and 2019. 2016 fisheries dependent data was used in this assessment. ICES is requested to take into account all relevant data available since 2016 and consider, if appropriate, updating the catch advice for 2019. If possible, ICES is asked to include the best available estimates of discards in previous years and an advice with a clear division of total catch, wanted catch and unwanted catch for 2019."

The data made available to ICES was limited particularly for the discard component of the catch. The level and quality of sample data available to the group was considered too low to adequately raise the discards to total catch as the discard level between fleets, countries, areas, gears, seasons and year was highly variable, observed rates between 0 and 80% of catches. Therefore, ICES was not able to fully complete the special request and update the 2019 advice accordingly. It is unclear whether there is additional information that could be made available in future years.

1.11 Fisheries overviews

Some progress was made last year on the development of a mixed-fishery analysis. Due to delays in the data submissions this impacted on the completion of the ToR to further develop the fisheries overviews. A subgroup have agreed to continue work on this inter-sessionally.

1.12 Ecosystem overviews

During, 2015, Iñigo Martínez (ICES) requested a review of the draft report "Ecosystem Overview", section Bay of Biscay and Iberian waters, and to include considerations from WGBIE. During the last three years WGBIE meetings 2016–2018 the group reviewed the document providing feedback comments and edits for consideration. The working group agreed that until the feedback and comments are reviewed and incorporated that it would not review this document during this year's working group.

1.13 Research needs of relevance for the expert group

The group assess a number of data limited stocks classified as category 5, of which there are 5. In order to assess these stocks and their status in relation to biological reference points they would require landings and discards data with associated length and age, survey or commercial indices of abundance or biomass. If newly developed indices are appropriate the EWG would be in a position to provide a more robust assessment of stock status and advice.

Many of the stocks have recruitment indices available with limited indices for the adult population, therefore, it would be advantageous to develop and use adult biomass indices to help reduce the uncertainty in the spawning stock biomass estimates. Further research and appropriate evaluation is recommended in the development of such indices for stocks where standard surveys are not appropriate due to catchability issues.

For the stocks of hake, megrim, four spot megrim, anglerfish, seabass and some of the *nephrop* functional units further studies are required to better understand the mixing between areas and the biology over time such as growth, maturity, length-weight, sex-ratio and natural mortality. To fully make use of new research on these stocks it would be beneficial to focus on developing appropriate assessment methods and reviewing the performance of such models through comprehensive sensitivity analyses.

1.14 References

ICES. 2012a. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM), 10-16 May 2012, ICES Headquarters, Copenhagen. ICES CM 2012/ACOM:11. 599 pp.

ICES. 2012b. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2012c Report of the Inter Benchmark Protocol on *Nephrops* (IBPNephrops 2012), March 2012, By correspondence. ICES CM 2012/ACOM:42. 5 pp.

ICES. 2010a. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM), 5 - 11 May 2010, Bilbao, Spain. ICES CM 2010/ACOM:11. 571 pp.

ICES. 2010b ICES Workshop on Iberian mixed fisheries management plan evaluation of Southern hake, *Nephrops* and anglerfish, 22 - 26 November 2010, Lisbon, Portugal. ICES CM 2010/ ACOM:63. 96 pp.

ICES. 2016. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 183 pp.

ICES. 2017. Final Report of the Working Group on Mackerel and Horse Mackerel Egg Surveys. WGMEGS Report 2017, 24–28 April 2017. Vigo, Spain. ICES CM 2017/SSGIEOM:18. 134 pp.

ICES. 2018. 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 CM 2018/ACOM:12. 642pp.

ICES. 2019. Inter-benchmark of Hake (*Merluccius merluccius*) in subareas 4, 6, and 7 and divisions 3.a, 8.a–b, and 8.d, Northern stock (Greater North Sea, Celtic Seas, and the northern Bay of Biscay) (IBP-hake). ICES Scientific Reports. 1:4. 28 pp. http://doi.org/10.17895/ices.pub.4707

1.15 Tables and Figures

Table 1.4a Biological sampling levels by stock and country. Number of individuals measured and aged from landings in 2018.

		Angler (L.pisc.)		Angler (L.bude.)		Megrim (L.whiff.)		Megrim (L. boscii)	Sole (S. solea)	
		7.b–k &8.a,b,d	8.c &9.a	7.b–k &8.a,b,d	8.c &9.a	7.b–k &8.a,b,d	8c &9a	8.c &9.a	8.a,b	8.c &9.a
Belgium	No. lengths	4495				5714				
	No. ages					538				
	No. samples**	20				20				
E & W (UK)	No. lengths	20878				30026				
	No. ages					1385				
	No. samples*	195				218				
France	No. lengths	9908				5598				
	No. ages					-				
	No. samples*	648				264				
Portugal	No. lengths		151		522		78	4153		
	No. ages***									
	No. samples*		47		55		3	57		
Republic of	No. lengths					47150				

		Angler (L.pisc.)		Angler (L.bude.)		Megrim (L.whiff.)		Megrim (L. boscii)	Sole (S. solea)	
Ireland	No. ages					-				
	No. samples**					263				
Spain	No. lengths	15996	5252		4512	69701	11003	32092		1917
	No. ages					-	779	942		
	No. samples	131	318		296	144	188	216		113
Denmark	No. lengths									
	No. ages									
	No. samples									
Total	No. lengths					158189				
	No. ages					3846				
Total nb. in international landings ('000)			161			46322				
Nb. measured as % of annual nb. caught			7%			3.4%				

*** Vessels, ** Categories**

***** Ages, surveys, **** Boxes/hauls (for sampling on board)**

******* Otoliths collected and prepared but not read**

Table 1.4a (continued)

		Hake		*Nephrops*			Seabass		Pollack	Whiting	Plaice
		3.a, 4, 6, 7&8.a,b	8.c &9.a	8.ab FU 23-24	8.c FU 25-31	9.a FU 26-30	8.ab	8.c &9.a	8&9.a	8&9.a	8&9.a
Scotland (UK)	No. lengths	2385									
	No. ages										
	No. samples*	79									
E & W (UK)	No. lengths	22226									
	No. ages										
	No. samples*	285									
France	No. lengths	25961		19031			5163		94		154
	No. Ages*****						984				
	No. samples****	1043		434					12		
Portugal	No. lengths		17709			6304		2725			1326
	No. ages***										
	No. samples*		331			41					
Republic of	No. lengths	21718									
Ireland	No. ages*****										
	No. samples*	555									
Spain	No. lengths	67210	76716		8524	8243		1854	677		
	No. ages				na						

		Hake	*Nephrops*			Seabass	Pollack	Whiting	Plaice
	No. samples*	180	1344	77 (a)	20		72		
Denmark	No. lengths	9375							
	No. ages								
	No. samples*	24							
Total	No. lengths	149603			14547				
	No. ages								
Total No. in international landings ('000)		44677	47510	32	11388		na		
Nb. meas. as % of annual nb. caught		0.30%	0.20%	26%	0.13%		na		

*** Vessels, ** Categories**

***** Ages, surveys, **** Boxes/hauls (for sampling on board), (a) hauls**

******* Otoliths collected and prepared but not read**

Table 1.4b Biological sampling levels by stock and country. Number of individuals measured and aged from discards in 2018.

		Angler (L.pisc.)		Angler (L.bude.)		Megrim (L.whiff.)		Megrim (L. boscii)	Sole (S. solea)	
		7.b–k &8.a,b,d	8.c &9.a	7.b–k &8.a,b,d	8.c &9.a	7.b–k &8.a,b,d	8.c &9.a	8.c &9.a	8.a,b	8.c &9.a
Belgium	No. lengths	3417				2642				
	No. ages					207				
	No. samples	20				20				
E & W (UK)	No. lengths	2300				5588				
	No. ages					239				
	No. samples	665				398				
France	No. lengths	126				1327				
	No. ages					-				
	No. samples	25				148				
Portugal	No. lengths		2		1		3	73		
	No. ages									
	No. samples (a)		32		32		32	32		
Republic of	No. lengths					13243				
Ireland	No. ages									
	No. samples					303				
Spain	No. lengths	102	13		13	6103	512	1989		
	No. ages					-				

		Angler (L.pisc.)		Angler (L.bude.)		Megrim (L.whiff.)		Megrim (L. boscii)	Sole (S. solea)
	No. samples	300	344		204	415	213	232	
Denmark	No. lengths								
	No. ages								
	No. samples								
Total	No. lengths								
	No. ages								
Total no. in international discards ('000)									
Nb. meas. as % of annual nb. Discarded									

(a) Trips

Table 1.4b (continued).

		Hake		*Nephrops*			Seabass		Pollack	Whiting	Plaice
		3.a, 4, 6, 7&8.a,b	8.c &9.a	8.ab FU 2324	8.c FU 2531	9.a FU 26-30	8.ab	8.c &9.a	8.&9.a	8&9.a	8&9.a
Scotland (UK)	No. lengths	6071									
	No. ages										
	No. samples	153									
E & W (UK)	No. lengths	1854									
	No. ages										
	No. samples	463									
France	No. lengths	5112		2681			191		87		
	No. Ages										
	No. samples	416		75					10		
Portugal	No. lengths		478			1			0	0	0
	No. ages										
	No. samples (a)		32			11			32	32	32
Republic of	No. lengths	71923									
Ireland	No. ages										
	No. samples	1494									
Spain	No. lengths	6814			na				1		
	No. ages				na						

		Hake	*Nephrops*			Seabass	Pollack	Whiting	Plaice
	No. samples	607		na			1		
Denmark	No. lengths	2001							
	No. ages								
	No. samples	170							
Total	No. lengths	37107			0				
	No. ages								
Total no. in international discards ('000)		0.27%		0	0		na		
Nb. meas. as % of annual nb. Discarded				na	na		na		

(a) Trips

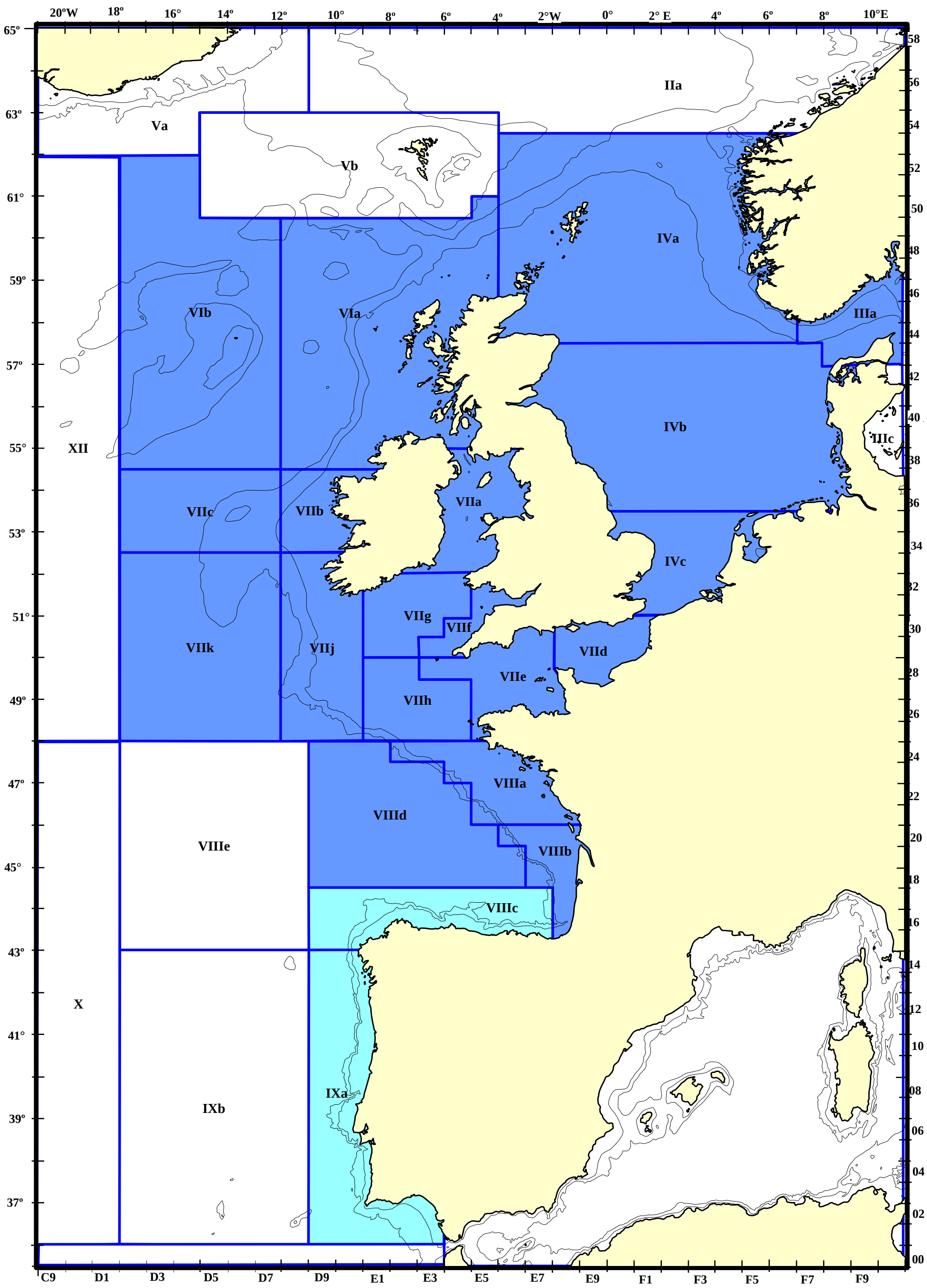


Figure 1.1. Map of ICES Divisions. Northern (3.a, 4, 6, 7. and 8.abd) and Southern (8.c and 9.a) Divisions with different shading.

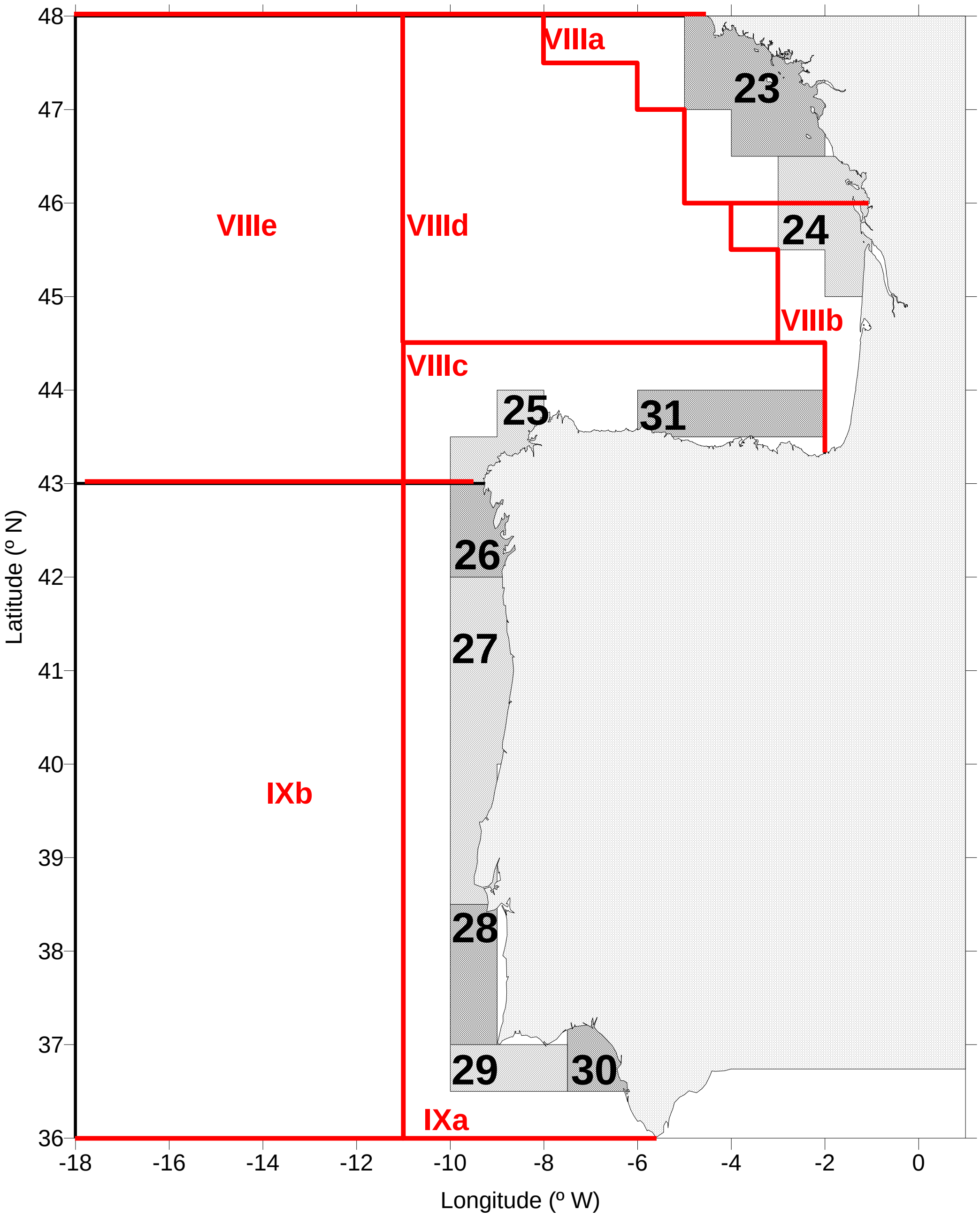


Figure 1.2. ICES Division 8, 9.a. *Nephrops* Functional Units. Division 8.ab (Management Area N): FUs 23-24. Division 8.c (Management Area O): FUs 25 and 31. Division 9.a (Management Area Q): FUs 26-30.

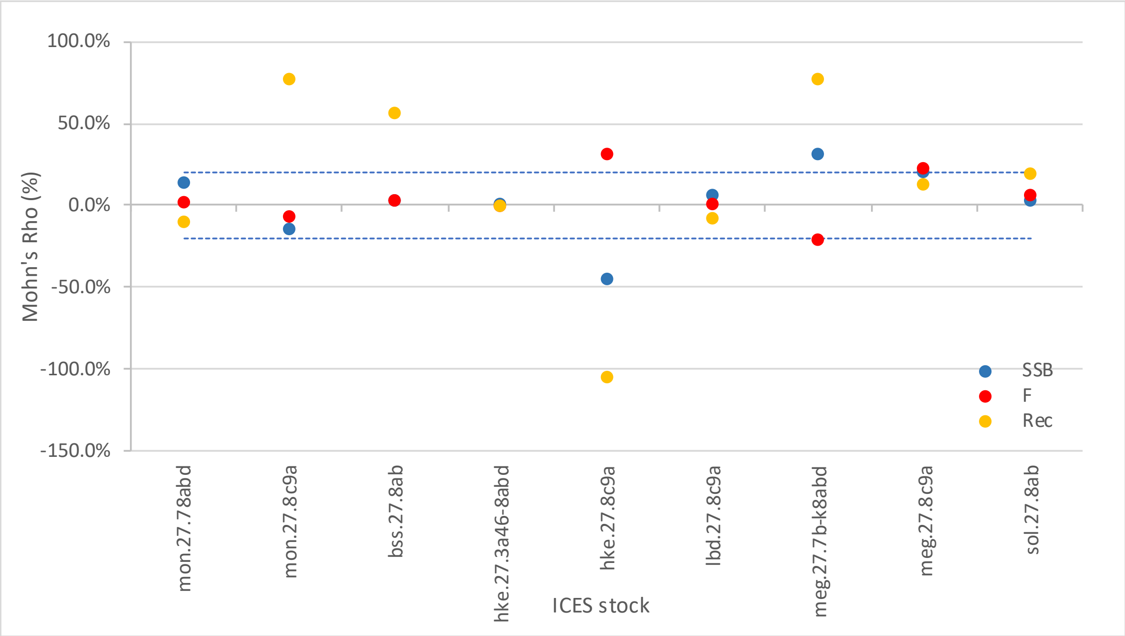


Figure 1.3. Mohn's rho for each of the stocks that used a category 1 full analytical assessment of stock status, horizontal dotted lines represent the ±20% threshold.

2 Description of Commercial Fisheries and Research Surveys.

2.1 Fisheries description

This Section describes the fishery units relevant to the stocks assessed in this WG. Additionally, to facilitate the use of InterCatch, it presents the “fleets” that the WG proposes to use for data submission in InterCatch.

2.1.1 Celtic–Biscay Shelf (Subarea 7 and Divisions 8.a,b,d).

The fleets operating in the ICES Subarea 7 and Divisions 8.a,b,d are used in this WG following the Fishery Units (FU) defined by the “ICES Working Group on Fisheries Units in subareas 7 and 8” (ICES, 1991):

Under the implementation of the mixed fisheries approach in the ICES WG’s new information updating some national fleet segmentations was presented in WGHMM reports, from general overviews (ICES, 2004; ICES, 2005) to detailed national descriptions: French fleets (ICES, 2006), Irish fleets (ICES, 2007), and Spanish fleets (ICES, 2008). This information in relation to the métiers definition did not change the Fishery Units used in the single-stock assessments. However, the hierarchical disaggregation of FU into métiers is essential not only for carrying out mixed-fisheries assessments, but also for a deeper understanding of the fisheries behaviour.

Fishery Unit	Description	Sub-area
FU1	Longline in medium to deep water	7
FU2	Longline in shallow water	7
FU3	Gillnets	7
FU4	Non-*Nephrops* trawling in medium to deep water	7
FU5	Non-Nephrops trawling in shallow water	7
FU6	Beam trawling in shallow water	7
FU8	Nephrops trawling in medium to deep water	7
FU9	Nephrops trawling in shallow to medium water	8
FU10	Trawling in shallow to medium water	8
FU12	Longline in medium to deep water	8
FU13	Gillnets in shallow to medium water	8
FU14	Trawling in medium to deep water	8
FU15	Miscellaneous	7 & 8
FU16	Outsiders	3.a, 4, 5 & 6

Fishery Unit	Description	Sub-area
FU00	French unknown	

The EU Data Collection Framework (DCF; Council Regulation (EC) 199/2008; EC Regulation 665/2008; Decision 2008/949/EC) establishes a framework for the collection of economic, biological and transversal data by Member States. One of the most relevant changes of this more recent period with respect to the previous Data Collection Regulation (DCR; Reg. (EC) No 1639/2001) has been the inclusion of the ecosystem approach by means of moving from stock-based sampling to métier-based sampling. The DCF defines the métier as “a group of fishing operations targeting the same species or a similar assemblage of species, using similar gear, during the same period of the year and/or within the same area, and which are characterized by a similar exploitation pattern”. Due to the sampling design, established since 2009, which can affect the fishery data supplied to this WG, it has been agreed to detail the métiers related with the stocks assessed by this WG, trying to find the correspondence with the Fishing Units.

Data for stock assessment are typically provided to stock coordinators either still according to the old FUs and the traditional tuning fleets or to the DCF métiers. In the case of discards and/or biological data, although sampling may be done at the DCF métier Level 6, estimates are often re-aggregated to Level 5 due to low sampling levels reached by countries. Thus, this WG agreed to use DCF Level 5 (without mesh size) as the “fleet” level to introduce data in InterCatch. The table below shows the “fleets” to be used for InterCatch and their correspondence with the old Fishery Units and the DCF métiers at Level 6.

FU	Fleet for InterCatch	DCF MÉTIER (Level 6)	DESCRIPTION	FR	IR	SP	UK
FU1	LLS_DEF	LLS_DEF_0_0_0	Set longline directed to demersal fish			X	X
FU2							
FU3	GNS_DEF	GNS_DEF_100-219_0_0	Set gillnet directed to demersal fish (100-219 mm)	X	X	X	
FU4	OTB_DEF	OTB_DEF_70-99_0_0	Bottom otter trawl directed to demersal fish (70-99 mm)		X	X	X
		OTB_DEF_100-119_0_0	Bottom otter trawl directed to demersal fish (100-119 mm)		X	X	X
FU5	OTB_DEF		Otter trawl directed to demersal Fish shallow water				X
FU6	TBB_DEF		Beam trawl		X		X
FU8	OTB_CRU						
FU9	OTB_CRU	OTB_CRU_70-99_0_0	Bottom otter trawl directed to crustaceans (70-99 mm)	X	X		X
FU10	OTB_DEF						
FU12	LLS_DEF	LLS_DEF_0_0_0	Set longline directed to demersal fish	X		X	
	GNS_DEF	GNS_DEF_45-59_0_0	Set gillnet directed to demersal fish (45-59 mm)	X			

FU	Fleet for InterCatch	DCF MÉTIER (Level 6)	DESCRIPTION	FR	IR	SP	UK
FU13		GNS_DEF_>=100_0_0	Set gillnet directed to demersal fish (at least 100 mm)	X	X	X	
FU14	OTB_DEF	OTB_DEF_>=70_0_0	Bottom otter trawl directed to demersal fish (at least 70 mm)	X	X	X	
	OTB_MCF	OTB_MCF _>=70_0_0	Bottom otter trawl directed to mixed cephalo-pods and demersal fish (at least 70 mm)			X	
	OTT_DEF	OTT_DEF _>=70_0_0	Multi-rig otter trawl directed to demersal fish (at least 70 mm)	X	X		
	OTB_CRU	OTB_CRU _>=70_0_0	Bottom otter trawl directed to crustaceans (at least 70 mm)	X	X		
	OTT_CRU	OTT_CRU _>=70_0_0	Multi-rig otter trawl directed to crustaceans (at least 70 mm)	X	X		
	OTB_MPD	OTB_MPD _>=70_0_0	Bottom otter trawl directed to mixed pelagic and demersal fish (at least 70 mm)			X	
	PTB_DEF	PTB_DEF _>=70_0_0	Bottom pair trawl directed to demersal fish (at least 70 mm)			X	
FU15	SSC_DEF		Fly shooting seine directed to demersal fish		X		
FU16	OTB_DEF	OTB_DEF _100-119_0_0	Bottom otter trawl directed to demersal fish (100-119 mm)	X	X	X	X
	LLS_DEF	LLS_DEF _0_0_0	Set longline directed to demersal fish			X	
	SSC_DEF		Fly shooting seine directed to demersal fish		X		
FU00	PTM_DEF		Midwater pair trawl directed to demersal fish				

For the Bay of Biscay sole stock, the correspondence with DCF métiers is somewhat complicated because the fleets used are:

Inshore-gillnets (French gillnetters with length < 12 m) (GNx or GTx)

Offshore-gillnets (French gillnetters with length > 12 m) (GNx or GTx)

Inshore-trawlers (French trawlers with length < 12 m) (OTx, TBx, PTx)

Offshore-trawlers (French trawlers with length > 12 m)

In other words, the fleets used correspond to netters and trawlers fishing for sole in the Bay of Biscay, grouped according to vessel length.

2.1.2 Atlantic Iberian Peninsula Shelf (Divisions 8.c and 9.a).

The Fishery Units operating in the Atlantic Iberian Peninsula waters were described originally in the report of the "Southern hake task force" meeting (STECF, 1994), and have been used in this WG as follows:

Country	Fishery Unit	Description
Spain	Small Gillnet	Gillnet fleet using "beta" gear (60 mm mesh size) for targeting hake in Divisions 8c and 9.a North
	Gillnet	Gillnet fleet using "volanta" gear (90 mm mesh size) for targeting hake in Division 8c
		Gillnet fleet using "rasco"gear (280 mm mesh size) for targeting anglerfish in Division 8c
	Longline	Longline fleet targeting a variety of species (hake, great fork beard, conger) in Division 8c
	Northern Artisanal	Miscellaneous fleet exploiting a variety of species in Divisions 8c and 9.a North
	Southern Artisanal	Miscellaneous fleet exploiting a variety of species in Division 9.a South (Gulf of Cádiz)
	Northern Trawl	Miscellaneous fleet operating in Divisions 8c and 9.a North composed of bottom pairtrawlers targeting blue whiting and hake (55 mm mesh size, and 25 m of vertical opening); and two types of bottom otter trawlers (70 mm mesh size): trawlers using the "baca" gear (1.5 of vertical opening) targeting hake, anglerfish, megrim and Nephrops, and trawlers using "jurelera" (often referred to as "HVO", high vertical opening, in the present report) gear (>5m of vertical opening) targeting mackerel and horse mackerel.
	Southern Trawl	Bottom otter trawlers operating in Division 9.a South (Gulf of Cádiz) exploiting a variety of species (sparids, cephalopods, sole, hake, horse mackerel, blue whiting, shrimp, Norway lobster).
Portugal	Artisanal	Miscellaneous fleet with two components (inshore and offshore) operating in Portuguese waters of Division 9.a involving gillnet (80 mm mesh size), trammel (>100 mm mesh size), longline and other gears. Species caught: hake, octopus, pout, horse mackerel and others
	Trawl	Trawl fleet operating in Portuguese waters of Division 9.a compounded by bottom otter trawlers targeting crustaceans (55 mesh size), and bottom otter trawlers targeting different species of fish (65 mm mesh size).

The Spanish and Portuguese fleets operating in the Atlantic Iberian Peninsula shelf were segmented into métiers under the EU project IBERMIX (DG FISH/2004/03-33), and the results were described in Section 2 of the 2007 WGHMM report (ICES, 2007).

The correspondence between Fishing Units and DCF métiers has also been compiled for the southern stock fleets and is presented in the following table. As for the Celtic-Biscay shelf, sampling inconsistencies among biological and commercial data make the use of the DCF Level 5 preferable for the uploading of Iberian data in to InterCatch. This re-aggregation affects the Spanish gillnet operating in the Northern Spanish waters, because the set gillnet ("*beta*") directed to hake (GNS_DEF_60-79_0_0) and the set gillnet ("volanta") also targeting hake (GNS_DEF_80-99_0_0) must be sampled together. It must take into account that the set gillnet using more than

280 mm mesh size (GNS_DEF_280_0_0) targeting mostly anglerfish be distinguished at Level 5 (the level proposed for the InterCatch fleets) from the two gillnet métiers previously mentioned (which are directly mainly to hake). So a revision of the current InterCatch fleet proposal is required in this case.

COUNTRY	FU	Fleet for InterCatch	MÉTIERS (Level 6)	DESCRIPTION (mesh size in brackets)	SP	PT
	Gillnet		GNS_DEF_80-99_0_0	Set gillnet directed to demersal species (80-99 mm)	X	
		GNS_DEF	GNS_DEF_280_0_0	Set gillnet directed to demersal species (at least 280 mm)	X	
	Northern Artisanal		GNS_DEF_60-79_0_0	Set gillnet directed to demersal fish (60-79 mm)	X	
	Longline	LLS_DEF	LLS_DEF_0_0_0	Set longline directed to demersal fish	X	
Spain	Southern artisanal	LLS_DWS	LLS_DWS_0_0_0	Set longline directed to deep-water species	X	
		PTB_DEF	PTB_DEF _> = 55_0_0	Pair bottom trawl directed to demersal fish (at least 55 mm)	X	
	Northern Trawl	OTB_DEF	OTB_DEF_>=55_0_0	Otter bottom trawl directed to demersal fish (at least 55 mm)	X	
		OTB_MPD	OTB_MPD_>=55_0_0	Otter bottom trawl directed to mixed pelagic and demersal fish (at least 55 mm)	X	
	Southern trawl	OTB_DEM	OTB_DEM_>=55_0_0	Otter bottom trawl directed to demersal species (at least 55 mm)	X	
		GTR_DEF	GTR_DEF_>=100_0_0	Trammelnet directed to demersal fish (at least 100 mm)		X
	Artisanal	GNS_DEF	GNS_DEF_80-99_0_0	Set gillnet directed to demersal fish (80-99 mm)		X
Portugal		LLS_DEF	LLS_DEF_0_0_0	Set longline directed to demersal fish		X
		LLS_DWS	LLS_DWS_0_0_0	Set longline directed to deep-water species		X
	Trawl	OTB_CRU	OTB_CRU_>=55_0_0	Otter bottom trawl directed to crustaceans (at least 55 mm)		X
		OTB_DEF	OTB_DEF_60-69_0_0	Otter bottom trawl directed to demersal fish (60-69 mm)		X

2.2 Description of surveys

This section gives a brief description of the surveys referred to in this WG report. The surveys are listed in the following table, including the acronym used by WGBIE and previous to that the WGHMM in 2010. The DCF acronym and the new ICES survey acronym which will be used throughout this WG report and Stock Annexes are presented below. The new survey acronyms used this year were provided by ICES Secretariat, aiming for consistency across all ICES Expert Groups. When ICES Secretariat has not included a survey in the list for which it has provided acronyms, the WGHMM 2010 acronym will remain in use.

Survey	WGHMM 2010 acronym	DCF acronym	ICES survey acronym as of 2011
Spanish groundfish survey – quarter 4	SP-GFS	IBTS-EA-4Q	SpGFS-WIBTS-Q4
Spanish Porcupine groundfish survey	SP-PGFS	IBTS-EA	SpPGFS-WIBTS-Q4
Spanish Cadiz groundfish survey – Autumn	SP-GFS-caut		SPGFS-caut-WIBTS-Q4
Spanish Cadiz groundfish survey – Spring	SP-GFS-cspr		SPGFS-cspr-WIBTS-Q1
Portuguese groundfish survey – October	P-GFS-oct	IBTS-EA-4Q	PtGFS-WIBTS-Q4
Portuguese groundfish survey – July (terminated)	P-GFS-jul		----
Portuguese crustacean trawl survey / Nephrops TV survey offshore Portugal	P-CTS	UWFT (FU 28-29)	PT-CTS (UWTV (FU 28-29))
Portuguese winter groundfish survey/Western IBTS 1st quarter	PESCADA-BD		PtGFS-WIBTS-Q1
French EVHOE groundfish survey	EVHOE	IBTS-EA-4Q	EVHOE-WIBTS-Q4
French RESSGASC groundfish survey (ended in 2002)	RESSGASC		----
French Bay of Biscay sole beam trawl survey	ORHAGO		ORHAGO
French Nephrops survey in Bay of Biscay	LANGOLF		LANGOLF
UK west coast groundfish survey (ended in 2004)	UK-WCGFS		-----
UK Western English Channel Beam Trawl Survey			UK-WECBTS
UK Bottom-trawl Survey			EN-Cefas-A, B
English fisheries science partnership survey	EW-FSP		FSP-Eng-Monk
Irish groundfish survey	IGFS	IBTS-EA-4Q	IGFS-WIBTS-Q4
Combined IGFS/EVHOE WIBTS survey	-	-	FR_IE_IBTS
Irish Monkfish survey		SIAMISS / IAMS	IE_Monksurvey

A brief description of each survey follows. A general map identifying survey areas can be found in ICES IBTS WG reports.

2.2.1 Spanish groundfish survey (SPGFS-WIBTS-Q4)

The SpGFS-WIBTS-Q4 covers the northern Spanish shelf comprised in ICES Division 8c and the northern part of 9.a, including the Cantabrian Sea and off Galicia waters. It is a bottom-trawl survey that aims to collect data on the distribution, relative abundance and biology of commercial fish species such as hake, monkfish and white anglerfish, megrim, four-spot megrim, blue whiting and horse mackerel. Abundance indices are estimated by length and in some cases by age, with indices also estimated for *Nephrops*, and data collected for other demersal fish and invertebrates. The survey is ca. 120 hauls and is from 30–800 m depths, usually starts at the end of the 3rd quarter (September) and finishes in the 4th quarter.

2.2.2 Spanish Porcupine groundfish survey (SPGFS-WIBTS-Q4)

The SpPGFS-WIBTS-Q4 occurs at the end of the 3rd quarter (September) and start of the 4th quarter. It is a bottom-trawl survey that aims to collect data on the distribution, relative abundance and biology of commercial fish in ICES Division 7.b-k, which corresponds to the Porcupine Bank and the adjacent area in western Irish waters between 180–800m. The survey area covers 45 880 Km^2 and approximately 80 hauls per year are carried out.

2.2.3 Cadiz groundfish surveys-Spring (SPGFS-cspr-WIBTS-Q1) and autumn (SPGFS-caut-WIBTS-Q4)

The bottom-trawl surveys SPGFS-cspr-WIBTS-Q1 and SPGFS-caut-WIBTS-Q4 occur in the southern part of ICES Division 9.a, the Gulf of Cádiz, and collect data on the distribution, relative abundance, and biology of commercial fish species. The area covered is 7 224 Km^2 and extends from 15–800m. The primary species of interest are hake, horse mackerel, wedge sole, sea breams, mackerel and Spanish mackerel. Data and abundance indices are also collected and estimated for other demersal fish species and invertebrates such as rose and red shrimps, *Nephrops* and cephalopod molluscs.

2.2.4 Portuguese groundfish survey October (PTGFS-WIBTS-Q4)

PtGFS-WIBTS-Q4 extends from latitude 41°20' N to 36°30' N (ICES Div. 9.a) and from 20–500m depth. The survey takes place in autumn. The main objectives of the survey is to estimate the abundance and study the distribution of the most important commercial species in the Portuguese trawl fishery (hake, horse mackerel, blue whiting, sea bream and *Nephrops*), mainly to monitor the abundance and distribution of hake and horse mackerel recruitment. The surveys aim to carry out ca. 90 stations per year.

2.2.5 Portuguese crustacean trawl survey/*Nephrops* TV survey offshore Portugal (PT-CTS (UWTV (FU 28-29))

The PT-CTS (UWTV (FU 28-29)) survey is carried out in May-July and covers the southwest coast (Alentejo or FU 28) and the south coast (Algarve or FU 29). The main objectives are to estimate the abundance, to study the distribution and the biological characteristics of the main crustacean species, namely *Nephrops norvegicus* (Norway lobster), *Parapenaeus longirostris* (rose shrimp) and *Aristeus antennatus* (red shrimp). The average number of stations in the period 1997–2004 was 60. Sediment samples have been collected since 2005 with the aim to study the characteristics of the *Nephrops* fishing grounds. In 2008 and 2009, the crustacean trawl survey conducted in Functional Units 28 and 29, was combined with an experimental video sampling.

2.2.6 Portuguese winter groundfish survey/Western IBTS 1st quarter (PTGFS-WIBTS-Q1)

The PtGFS-WIBTS-Q1survey has been carried out along the Portuguese continental waters from latitude 41°20' N to 36°30' N (ICES Div. 9.a) and from 20–500m depth. The winter groundfish survey plan comprises 75 fishing stations, 66 at fixed positions and 9 at random. The main aim of the survey is to estimate spawning biomass of hake.

2.2.7 French EVHOE groundfish survey (EVHOE-WIBTS-Q4)

The EVHOE-WIBTS-Q4 survey covers the Celtic Sea with ICES Divisions 7.f,g,h,j, and the French part of the Bay of Biscay in divisions 8ab. The survey is conducted from 15 to 600 m depths, usually in the fourth quarter, starting at the end of the October. The primary species of interest are hake, monkfish, anglerfish, megrim, cod, haddock and whiting, with data also collected for all other demersal and pelagic fish. The sampling strategy is stratified random allocation, the number of set per stratum based on the 4 most important commercial species (hake, monkfish and megrim) leaving at least two stations per stratum and 140 valid tows are planned every year although this number depends on available sea time.

2.2.8 French RESSGASC groundfish survey (RESSGASC)

The RESSGASC survey was conducted in the Bay of Biscay from 1978–2002. Over the years 1978–1997 the survey was conducted with quarterly periodicity. It was conducted twice a year after that (in Spring and Autumn). Survey data prior to 1987 are normally excluded from the time-series, since there was a change of vessel at that time.

2.2.9 French Bay of Biscay sole beam trawl survey (ORHAGO)

The ORHAGO survey was launched in 2007, with the aim of producing an abundance index and biological parameters such as length distribution for the Bay of Biscay sole. It is usually carried out in November, with approximately 23 days of duration and sampling 70–80 stations. It uses beam trawl gear and is coordinated by the ICES WGBEAM.

2.2.10 French *Nephrops* survey in the Bay of Biscay (LANGOLF)

This survey commenced in 2006 specifically for providing abundance indices of *Nephrops* in the Bay of Biscay. It is carried out on the area of the Central Mud Bank of the Bay of Biscay (ca.11680 km^2), in the second quarter (May apart from the 1st year when the survey occurred in April), using twin trawl, with hours of trawling around dawn and dusk. The whole mud bank is divided to five sedimentary strata and the sampling allocation combines the surface by stratum and the fishing effort concentration. 70-80 experimental hauls are carried out by year. Since the IBP *Nephrops* 2012, this survey is included as tuning series in the stock assessment.

2.2.11 UK west coast groundfish survey (UK-WCGFS)

This survey, which ended in 2004, was conducted in March in the Celtic sea with ca. 62 hauls. It does not include the 0-age group with one of the primary aims to investigate the 1 and 2 age groups. Numbers-at-age for this abundance index are estimated from length compositions using a mixed distribution by statistical method.

2.2.12 English fisheries science partnership survey (FSP-Eng-Monk)

The FSP-Eng-Monk survey, part of the English fisheries science partnership programme, was been carried out on an annual basis since 2003 with 208 valid hauls in 2010, the survey discontinued in 2012. The aims of the survey were to investigate abundance and size composition of anglerfish on the main UK anglerfish fishing grounds off the southwest coast of England within ICES Subdivisions 7.e–h.

2.2.13 English Western English Channel Beam Trawl Survey

Since 1989 the survey has remained relatively unchanged, apart from small adjustments to the position of individual hauls to provide an improved spacing. In 1995, two inshore tows in shallow water (8-15m) were introduced. The survey now consists of 58 tows of 30 minutes duration, with a towing speed or 4 knots in an area within 35 miles radius of Start Point. The objective is to provide indices of abundance, which are independent of commercial fisheries, of all age groups of sole and plaice on the western Channel grounds, and an index of recruitment of young (1–3 year-old) sole prior to full recruitment to the fishery.

2.2.14 English Bottom-trawl Survey

This bottom-trawl survey covered the Irish, Celtic Sea and Western English Channel but it was discontinued in 2004.

2.2.15 Irish groundfish survey (IGFS-WIBTS-Q4)

The IGFS-WIBTS-Q4 is carried out in 4th quarter in divisions 6.a, 7.b,c,g,j, though only part of 6.a and the border of Division 7.c, in depths of 30–600m. The annual target is 170 valid tows of 30 minute duration which are carried out in daylight hours at a fishing speed of 4 knots. Data are collected on the distribution, relative abundance and biological parameters of a large range of commercial fish such as haddock, whiting, plaice and sole with survey data provided also for cod, white and black anglerfish, megrim, lemon sole, hake, saithe, ling, blue whiting and a number of elasmobranchs as well as several pelagics (herring, horse mackerel and mackerel).

2.2.16 Combined EVHOE IGFS survey (FR_IE_IBTS)

The Irish IBTS Q4 groundfish survey (IGFS-WIBTS-Q4) covers areas 27.7bgjk. The French EVHOE-WIBTS-Q4 survey covers areas 27.7j8ab. Both surveys are coordinated and largely standardised under WGIBTS and both use a GOV trawl. Together the two surveys cover the majority of the ank.27.78abd and mon.27.78abd stock areas up to depths of 200–300 m. This is where most of the young fish occur. Older fish migrate to deeper waters and are not fully available to these surveys.

Data for Irish and French IBTS Q4 groundfish surveys (IGFS and EVHOE) were obtained from DATRAS, quality checked and cleaned. The two surveys were combined into a single index (with the survey code FR_IE_IBTS) by weighting their average catches by the area covered by each survey series (IGFS gets a weight of approximately 45% and EVHOE 55%). Because the main recruitment area appears to change over time and sometimes occurs in the Irish survey area, sometimes in the French area and sometimes in both; the combined survey gives a more coherent recruitment signal than the two separate surveys.

An index of catch numbers-at-length per hour fished was calculated for the years 2003 onwards.

2.2.17 Irish monkfish survey (IE_Monksurvey)

Irish anglerfish survey data in area 27.7 are available for the years 2007, 2008 (under the acronym SIAMISS), 2016 onwards (IAMS). These surveys were designed to estimate the biomass of anglerfish and they cover a significant part of the stock in all depths up to 1000 m.

The survey index consists of catch numbers-at-length per swept-area.

The midpoint of the survey period is in January or February. However, because the survey data are available for the current year at the time of the assessment working group, it is beneficial to include the current year's survey in the assessment. The only way to do that in the current assessment framework is to offset the survey by a small amount so the survey is nominally taking place on the 31st of December of the previous year.

3 Anglerfish (*Lophius piscatorius and Lophius budegassa*) in Subarea 7 and Divisions and 8.a,b,d

3.1 General

Stock description and management units

The stock assessment area (27.78.abd) is the same for both species of anglerfish (*Lophius piscatorius* and *Lophius budegassa*). The two stocks are managed through TACs for the two species combined. There is a separate TAC for Subarea 27.7 and for Divisions 27.8.abde. Catches in 27.8.e are negligible.

ICES advice applicable to 2019

For *L. budegassa*: *ICES advises that when the precautionary approach is applied, catches in 2019 should be no more than 10 799 tonnes.*

For *L. piscatorius*: *ICES advises that when the MSY approach is applied, catches in 2019 should be no more than 31 042 tonnes.*

Management applicable to 2019

Species: Anglerfish *Lophiidae*	**Zone: 7 (ANF/07.)[1],**	**Zone: 8a, 8b, 8d and 8e** **(ANF/8ABDE.)**
Belgium	3 049	-
Germany	340	-
Spain	1 212	1 275
France	19 568	7 096
Ireland	2 501	-
The Netherlands	395	-
United Kingdom	5 934	-
Union	32 999	8 371
TAC	32 999 Precautionary TAC	8 371 Precautionary TAC

The combined TAC for 27.7 and 27.8abde was 41 370 tonnes, this was 1.1% below the combined advice for the two species of 41 841. There are no *de-minimis* or high-survivability exceptions included in the multi annual plan for the North-Western Waters and adjacent waters (Commission Delegated Regulation (EU) 2019/472) for anglerfish.

[1] Special condition: of which up to 10 % may be fished in 8a, 8b, 8d and 8e

The fishery

Both species of anglerfish (*L. piscatorius* and *L. budegassa*) are taken in a mixed fishery, mainly with hake, megrim and *Nephrops*.

The fishery for anglerfish developed in the late 1960s and landings quickly reached around 25 000 tonnes (for both *Lophius* species combined). Since then, landings have fluctuated between 20 and 40 thousand tonnes per year (Figure 3.1.1).

France takes the vast majority of the landings; followed by Spain, the UK and Ireland. Minor landings have been recorded for Belgium, Germany and Portugal (Figure 3.1.1. and Table 3.1.1).

Around 2/3 of the catches are taken by otter trawlers targeting demersal fish; gillnets take 10-20% and the remainder is taken by beam trawlers and otter trawlers targeting *Nephrops.*

Around 80% of the catch is taken in Subarea 27.7.

Information from stakeholders

WGBIE did not receive information from stakeholders regarding these stocks.

3.1.1 Data

Data revisions

No revised catch data prior to 2018 were submitted.

Landings and Discards

Figure 3.1.1 shows the time-series of the official landings of the combined species. Table 3.1.1 gives the ICES estimates of landings and discards by species as well as the official landings.

The combined-species landings are split into species specific landings at the national level, using the species composition in the sampling data from the onshore and offshore sampling programmes. Figure 3.1.2 shows the proportions of the two species over time by country. The proportions vary by country but the trends are similar between countries. The overall proportion of *L piscatorius* in the combined *Lophius* landings varied between 62% and 83% with a mean of 74%. The FR_IE_IBTS survey shows very similar trends in species proportion to the overall international landings proportion. The survey proportion appears to be offset by about a year, presumably because the survey includes more young fish.

Effort

Figure 3.1.3 shows that the fishing effort in the main fleets catching anglerfish has declined substantially since the early 1990s. Figure 3.1.4 shows that the LPUE of *L. piscatorius* has increased around threefold since the 1990s. The LPUE of *L. budegassa*, however, (Figure 3.1.5) does not show a clear trend, but the IRE-OTB shows a big increase.

3.1.2 References

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

3.1.3 Figures and Tables

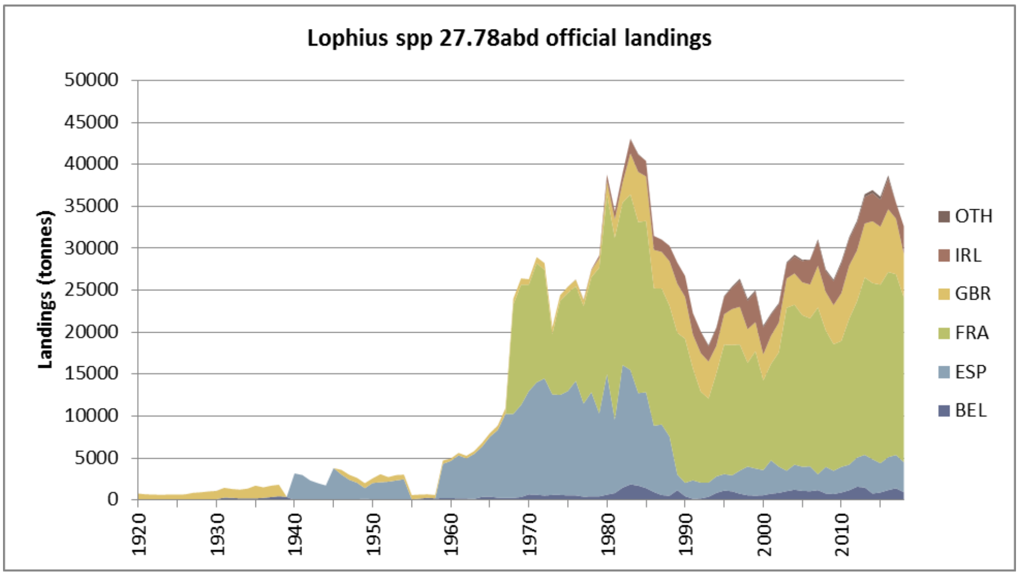


Figure 3.1.1. *Lophius* spp in 27.78abd. Time-series of the official landings.

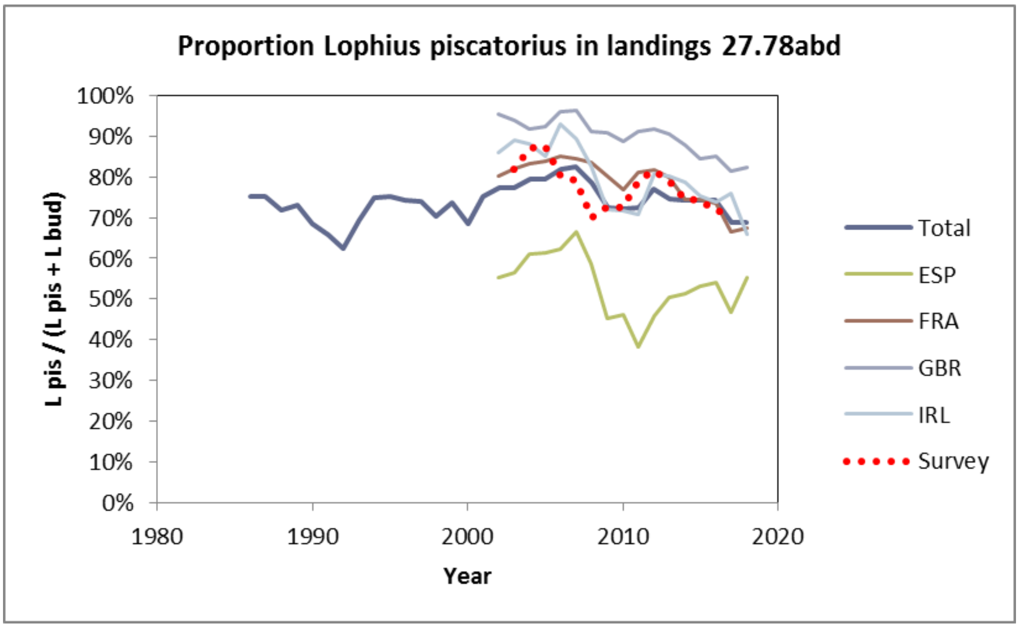


Figure 3.1.2. *Lophius* spp in 27.78abd. Species composition by country. The species proportion in the combined FR_IE_IBTS survey is also shown (but not used to split the catches).

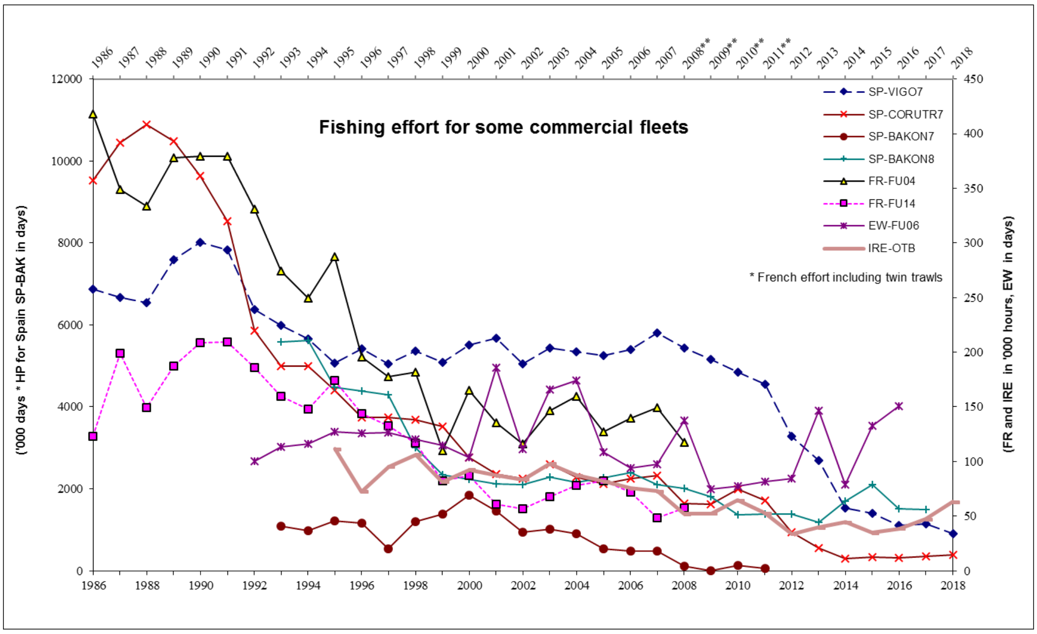


Figure 3.1.3. ***Lophius*** **spp in 27.78abd. Effort by the main fleets.**

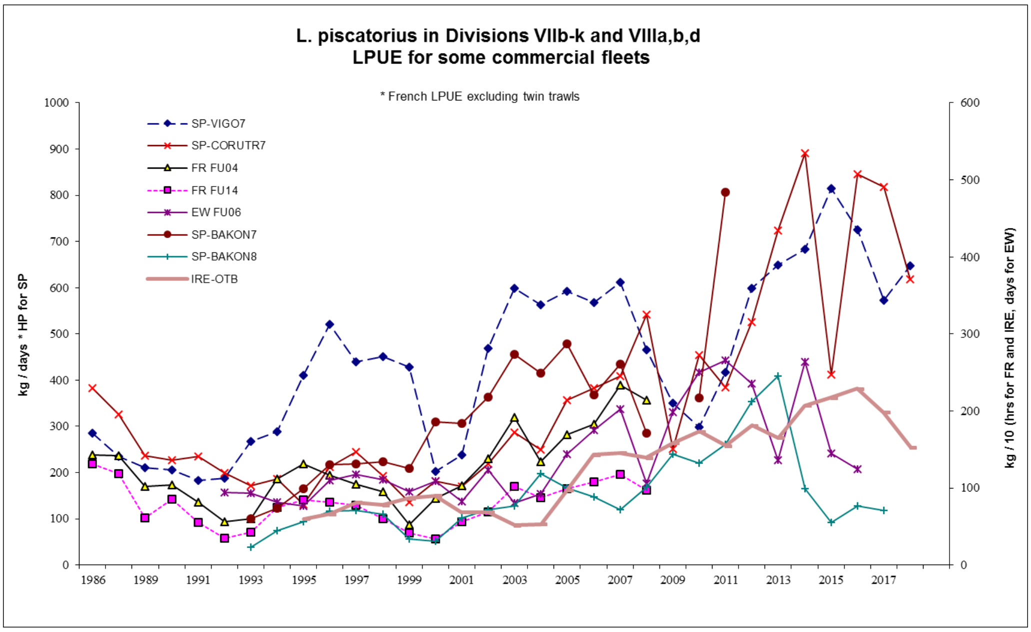


Figure 3.1.4. ***Lophius piscatorius*** **in 27.78abd. LPUE of** ***L. piscatorius*** **by the main fleets.**

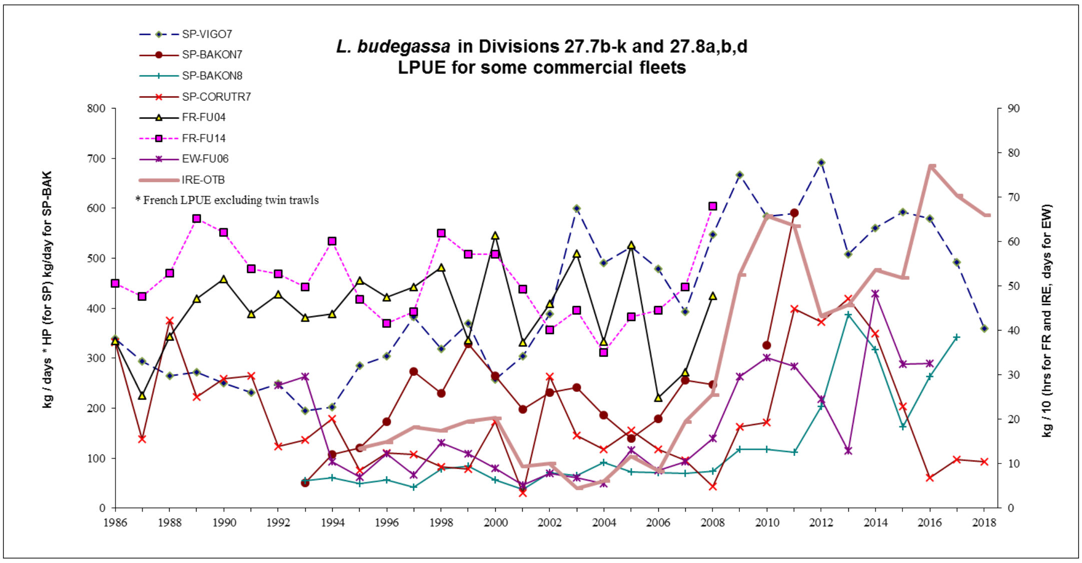


Figure 3.1.5. *Lophius budegassa* in 27.78abd. LPUE of *L. budegassa* by the main fleets.

Table 3.1.1. *Lophius* spp in 27.78abd. Time-series of the ICES estimates of the landings and discards and official landings.

Year	*Lophius piscatorius*					*Lophius budegassa*				*L. piscatorius + budegassa*	
	Landings				Disc	Landings			Disc	ICES Lan	Disc
	7a	7bk	8abd	total	78abd	7bk	8abd	total	78abd	78abd	78abd
1986	1315	19545	4123	24983		6443	1774	8217		33200	
1987	1182	17181	4729	23092		5115	2503	7618		30710	
1988	1219	16148	3948	21315		6346	2035	8381		29696	
1989	2885	18240	2889	24014		6434	2387	8821		32835	
1990	1229	16374	3379	20982		7060	2571	9631		30613	
1991	603	14002	2159	16764		6254	2525	8779		25543	
1992	851	11404	1362	13617		6008	2168	8176		21793	
1993	1437	11870	1588	14895		4648	1919	6567		21462	
1994	1081	14075	2045	17201		3949	1796	5745		22946	
1995	1303	16618	3112	21033		5204	1750	6954		27987	
1996	1171	18174	3987	23332		5979	2114	8093		31425	
1997	1323	17742	3918	22983		6187	1929	8116		31099	
1998	902	16787	2787	20476		6509	2089	8598		29074	
1999	542	16776	1473	18791		5068	1670	6738		25529	
2000	505	12909	1031	14445		5219	1425	6644		21089	
2001	611	15056	1624	17291		4478	1250	5728		23019	
2002	672	17874	3537	22083		4734	1771	6505		28588	
2003	639	21980	5315	27933	2511	6256	1916	8171	179	36105	2690
2004	604	22479	5945	29028	2411	5358	2178	7537	676	36565	3087
2005	489	21882	5498	27869	2110	5214	1974	7187	727	35056	2837
2006	418	21947	5287	27652	892	4675	1456	6131	704	33783	1596
2007	428	25424	5361	31213	816	4857	1751	6608	413	37821	1229
2008	290	21097	5666	27053	993	6039	1360	7399	1585	34452	2579
2009	218	17145	4472	21835	2078	6478	1809	8287	2113	30122	4191
2010	177	17555	4483	22215	2672	6812	1815	8626	1436	30841	4107
2011	235	19309	5114	24657	1832	7416	1933	9348	971	34006	2802
2012	295	23007	4887	28188	2330	5959	2471	8429	1459	36618	3789

Year	*Lophius piscatorius*					*Lophius budegassa*				*L. piscatorius + budegassa*	
	Landings				Disc	Landings			Disc	ICES Lan	Disc
	7a	7bk	8abd	total	78abd	7bk	8abd	total	78abd	78abd	78abd
2013	269	25782	4560	30611	1684	7274	3200	10475	2285	41086	3970
2014	253	23276	4945	28474	1859	6114	3718	9832	2570	38306	4428
2015	234	23103	4521	27859	2324	6284	3365	9649	1460	37508	3784
2016	656	24836	3919	29411	3585	6127	4093	10220	2441	39630	6026
2017	312	22169	3154	25635	2175	7518	4172	11690	1770	37325	3945
2018	313	18865	3506	22685	1396	6863	3312	10174	1109	32859	2505

3.2 Anglerfish *(L. piscatorius)* in Divisions 7 and 8.a,b,d

Type of assessment

Update Category 1 assessment.

Feedback from ADG

No issues identified.

Feedback from EG audit 2017

No issues identified.

3.2.1 Data

WGBIE were made aware of an issue with the sampling level in Q1 and Q2 of 2017 from France (ICES, 2018). Because of the lack of market sampling for length (biological and onboard sampling was unaffected), efforts were made to try and fill the deficiency in the number of samples by use of simulation techniques. Both simulated data and actual data were uploaded to InterCatch combined making it impossible to distinguish true samples from simulated ones. Therefore, it is not possible to assess the impact of such simulated data on the assessment and the group recommended that sensitivities with and without the simulated data are carried out when this is made available.

The stock annex describes the methods for filling-in unsampled landings and discards. Figure 3.2.1 shows that only about half of the landings had length data associated with them. More than half of the discards were unsampled and had to be estimated from the discard rate of the sampled catches. However, discard rates are relatively low so this affects only a small proportion of the total catch weight.

Figure 3.2.2 shows the quarterly length frequency distribution of the catch data.

The length data are converted to pseudo-ages by first estimating the mean lengths at age in each quarter from a Von Bertalanffy growth function (VBGF) with the parameters L_{inf} = 171 cm; K=0.1075; t0=0. Then, for each quarter and year, a mixture distribution is estimated for the length distribution of the catches with the mean values predicted by the VBGF and standard deviations that increase linearly from 3 cm at age 0 to 10cm at age 9. This mixture distribution is then used as an age-length key which is then applied to the catch, landings and discard numbers-at-length. The resulting numbers and weights-at-age are used as inputs for the assessment model. Table 3.2.1 gives an overview of the model inputs.

Figure 3.2.3a and 3.2.3b shows the age distribution of the catches in terms of abundance and biomass. Catch numbers are generally highest at ages 1 or 2. The highest biomass in the catches is at ages 3–5. Note that this stock is assumed to mature at age 5

Figure 3.2.4 shows the cohort tracking of the catch numbers-at-age. Cohort tracking is reasonably consistent up to age 7.

Figure 3.2.5 shows the proportion of discards-at-age. Nearly all 0-group anglerfish are discarded; around 80% of 1-year-olds are discarded and in recent years an increasing proportion of 2–year-olds have been discarded.

Surveys

The surveys are described in detail in the stock annex and in section 2 of the report.

The survey data are converted to pseudo-ages in the same way as the catch data (see above and stock annex for more details).

The combined IGFS-WIBTS-Q4 and EVHOE-WIBTS-Q4 surveys (FR_IR_IBTS for short) very consistent cohort tracking for the younger ages (Figure 3.2.6a). Note that no index was available in 2017 because the French survey did not take place in that year due to mechanical issues.

The IE_Monksurvey only consists of three recent years of data but appears to track the 2014 and 2010 cohorts (Figure 3.2.6b).

The SP_Porcupine survey tracks cohorts very consistently up to at least age 7 (Figure 3.2.6c).

Figure 3.2.7a and b show the internal and external consistency of the surveys. The FR_IR_IBTS is very consistent for young ages; the IE_Monksurvey is too short to clearly show internal consistency and the SP_Porcupine survey is somewhat noisy at ages 1 and 6 but otherwise quite consistent (Figure 3.2.7a). The FR_IBTS and SP_Porcupine have very similar signals for the 1-year olds but less so for the 2 and 3-year-olds. Figure 3.2.7c shows the overall abundance indices of the surveys.

Biological

The stock annex describes the background to the estimates of the biological parameters.

- Maturity is assumed to be 0% for ages 0-4 and 100% for ages 5-7+
- Natural mortality is assumed to be 0.25 for all ages and years

3.2.2 Historical stock development

Model used: a4a (+length-split based on VBGF to estimate age comp)

Software used: R package Fla4a (version 1.6.4) in R (version 3.5.2)

An overview of the available input data by year and age is shown in Figure 3.2.8.

Model specification (see stock annex for details):

```
fmodel: ~factor(replace(age, age > 6, 6)) + factor(year)
srmodel: ~factor(year)
n1model: ~factor(age)
qmodel:
  FR_IE_IBTS:   ~1
  IE_MONKSURVEY: ~I(1/(1 + exp(-age)))
  SP-PORC:      ~factor(replace(age, age > 5, 5))
vmodel:
  catch:        ~s(age, k = 3)
  FR_IE_IBTS:   ~1
  IE_MONKSURVEY: ~1
  SP-PORC:      ~1
```

The F-bar range was set to ages 3–6

Data screening and exploratory model runs

The data were thoroughly explored using the functionality of FLR and other packages. The sensitivity of the model to inclusion of the tuning fleets was explored and the final WKAnglerfish assessment outputs were compared to the first retrospective run of the current model. The details of the data exploration can be found in the presentations folder on the WGBIE SharePoint.

Final update assessment

Figure 3.2.9 shows the patterns in F-at-age and catchability estimated by the model. F is estimated to be quite low for age 0; then gradually increases over ages 1 to 5 and decreases again for age 6 and 7+ (F is forced to be the same for ages 6 and 7+). This may indicate reduced availability of older fish to the fishery as they move to deeper water. Alternatively it could indicate higher natural mortality. The catchability (Q) of the FR_IE_IBTS survey is set to be the same for all ages; for the IE_Monkfish survey, Q increases along a logistic function. This survey uses commercial fishing gear and the catchability follows a similar pattern to the estimated F-at-age. For the SP_Porcupine survey, Q is freely estimated for ages 2, 3, and 4; ages 5 and 6 are bound with a reduced availability of older fish.

Figure 3.2.10 shows the residuals. These do not show any pattern except for the 2-year-olds of the FR_IE_IBTS survey for which most of the residuals are positive.

Figure 3.2.11 shows the summary plot as well as the retrospective analysis. The recruits are estimated with quite high precision but in some years, the retrospective estimates are outside the confidence limits; indicating that the precision of the recruitment estimate might be lower than estimated. The 2017 estimate of recruitment is highly uncertain because there was no recruitment index available for 2017.

Fishing mortality shows a decreasing trend since 2004 (Figure 3.2.11) and is now below F_{MSY}.

SSB shows a steady increasing trend in SSB since 2005 and continues to rise. There is a retrospective adjustment of both SSB and F at the start of the time series (in the period where no survey data is available). This is because in a separable assessment the F-pattern of the entire time series is adjusted with each new year of data. However, in both cases the retrospective pattern is inside of the confidence intervals and the Mohn's rho values were lower than 0.2 (for recruitment -0.106, for SSB 0.136 and for f 0.0106). A sensitivity analysis was done during the benchmark, introducing different F-patterns before discards data were available and after. The results suggest that that this could improve the retrospective pattern, but further analysis is required.

Mohn's rho was calculated using the default 5 peels of the mohn() function in the package icesAdvice 2.0.0

Parameter	Mohn's Rho
Recruitment	-0.106
Fbar	0.0106
SSB	0.136

Comparison with previous assessments

Since the WGBIE 2018, a change was made in the method for estimating age distributions from length frequency distributions: a different optimisation was used. This resulted in very small differences in the catch numbers-at-age (likely due to rounding). WGBIE compared the results of the two methods and the impact on the assessment results was almost indistinguishable.

State of the stock

Fishing mortality is now below F_{MSY} and has been below $F_{MSYupper}$ for the last 5 years. SSB has been above MSY $B_{trigger}$ and is now at the highest value in the time-series.

3.2.3 Biological reference points

Biological reference points were established by WKAngler (2018).

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	22 278 t	B_{pa}
Approach	F_{MSY}	0.28	Median Eqsim estimate for landings (F_{MSY} catch = 0.30)
	F_{MSY} range	0.181-0.39	
	B_{lim}	16 032 t	B_{loss}
Precautionary	B_{pa}	22 278 t	B_{lim} + assessment error
Approach	F_{lim}	0.53	F with 5% probability of SSB <B_{lim}
	F_{pa}	0.36	F_{lim} + assessment error

Because the assessment has some retrospective bias in the start as well as the end of the time series, the working group investigated if the biological reference points are still appropriate. The analysis showed that the F_{MSY} estimate is still sensitive to the addition of an extra year of data. It was estimated to be 0.23 using the 2019 assessment but the last year's assessment would result in an estimate of 0.36. WGBIE (like WKANGLER 2018) considers that F_{MSY} = 0.28 is a conservative and pragmatic reference point (F has always been above F_{MSY} and yet the stock has seen a sharp increase in SSB). Therefore WGBIE does not propose to update the reference points this year.

3.2.4 Short-term projections

Short-term projections were carried out as described in the stock annex:

- Because F shows a trend, F_{2019} was scaled to the last year. Because this is a separable assessment, this means that F_{2019}=F_{2018}.
- No catch constraint was applied in the intermediate year as the TAC does not appear to be restrictive.

Table 3.2.3 gives the catch options. Figure 3.2.12 shows the contributions of the cohorts to the 2019 and 2020 forecasted landings and 2020 and 2021 SSB. The 2018 recruitment contributes 40% to the forecasted landings. Both the French-Irish IBTS index and the Irish Monkfish survey registered this cohort as particularly strong, so the working group decided to follow the stock annex, rather than replace the 2018 cohort with a geometric mean.

3.2.5 Uncertainties in the assessment and forecast

2018 was the first time since 2006 that ICES has provided advice based on an analytical assessment of this stock. Previously, the advice was based on a category 3 assessment.

WKANGLER (2018) has shown that the estimated stock trends are robust to various assumptions on growth, natural mortality, the selection of tuning fleets and model specification.

The estimate of the F_{MSY} Reference point appears to be sensitive to the exact shape of the stock-recruit curve. The current F_{MSY} of 0.28 is considered to be conservative because the stock has increased considerably during the last 15 years even though fishing effort was well above 0.28 during that period.

3.2.6 Management considerations

Management of the two anglerfish species under a combined TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species.

3.2.7 Recommendations for the next benchmark

- Further explore SS3 as an assessment model for this stock
- Explore alternative methods like delay-difference production
- Refine a4a model settings and age-split
- Update growth parameters with any new tagging data etc.
- Further investigate stock structure

3.2.8 Figures and tables

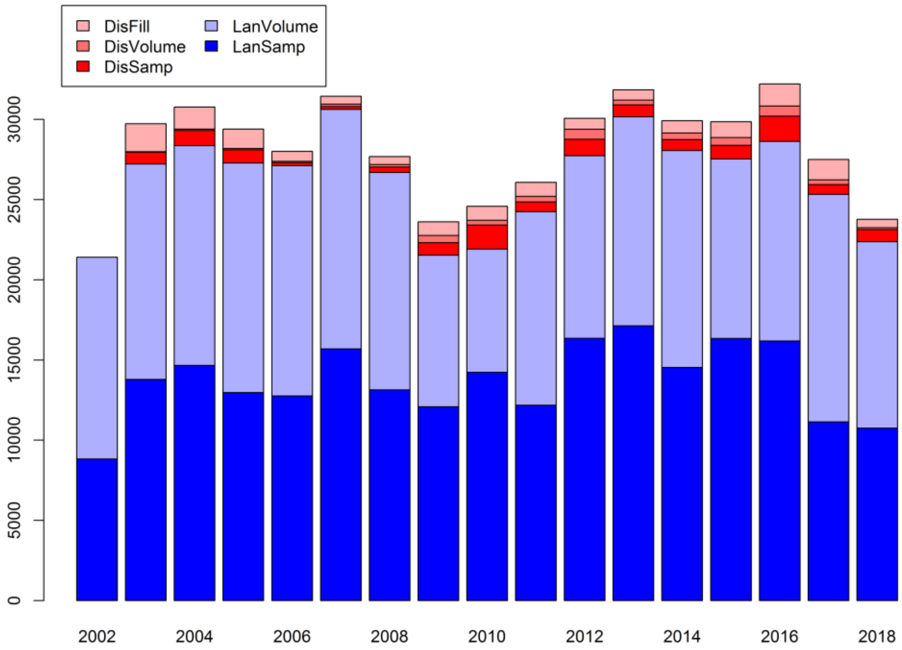


Figure 3.2.1. *Lophius piscatorius* in 27.78abd. Allocations of unsampled landings and discards by year. Dark blue represents the sampled landings; light blue represents landings for which only the tonnage was available but no sampling data; Red represents the sampled discards; medium pink represents discards for which an estimate of the tonnage was available but no sampling data and light pink represents discards for which no information was available.

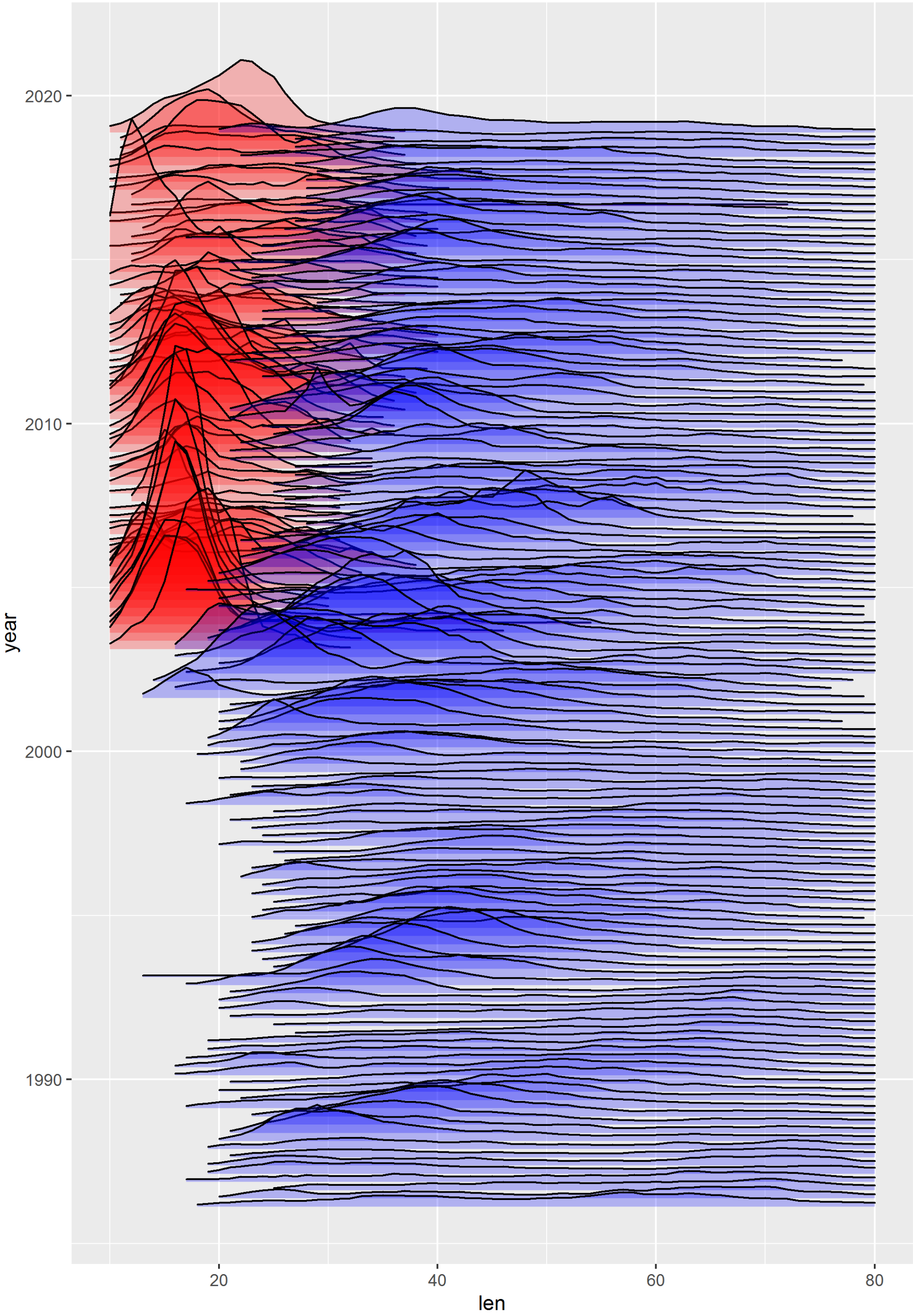


Figure 3.2.2. ***Lophius piscatorius*** **in 27.78abd. Quarterly length frequency distributions of the landings (blue) and discards (red). No discard data were available prior to 2003.**

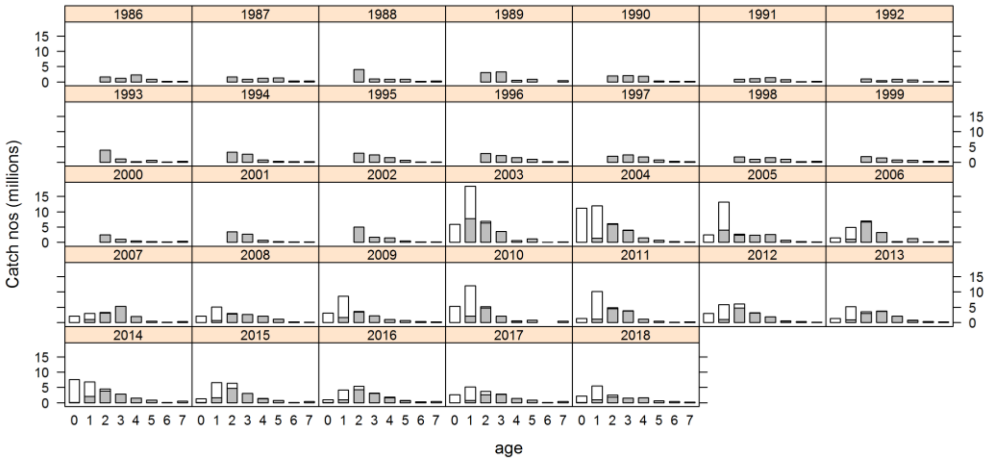


Figure 3.2.3a. ***Lophius piscatorius*** **in 27.78abd. Age distributions of the catches by year in terms of abundance.**

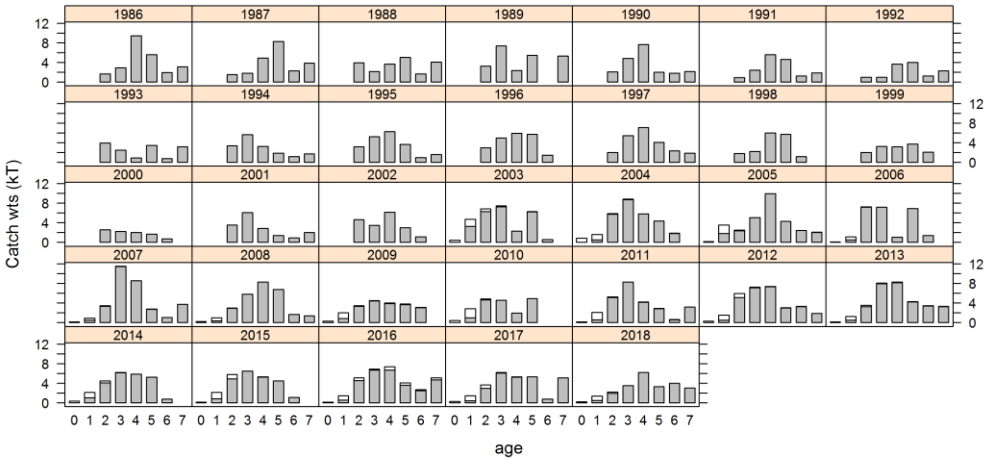


Figure 3.2.3b. ***Lophius piscatorius*** **in 27.78abd. Age distribution of the catches by year in terms of biomass.**

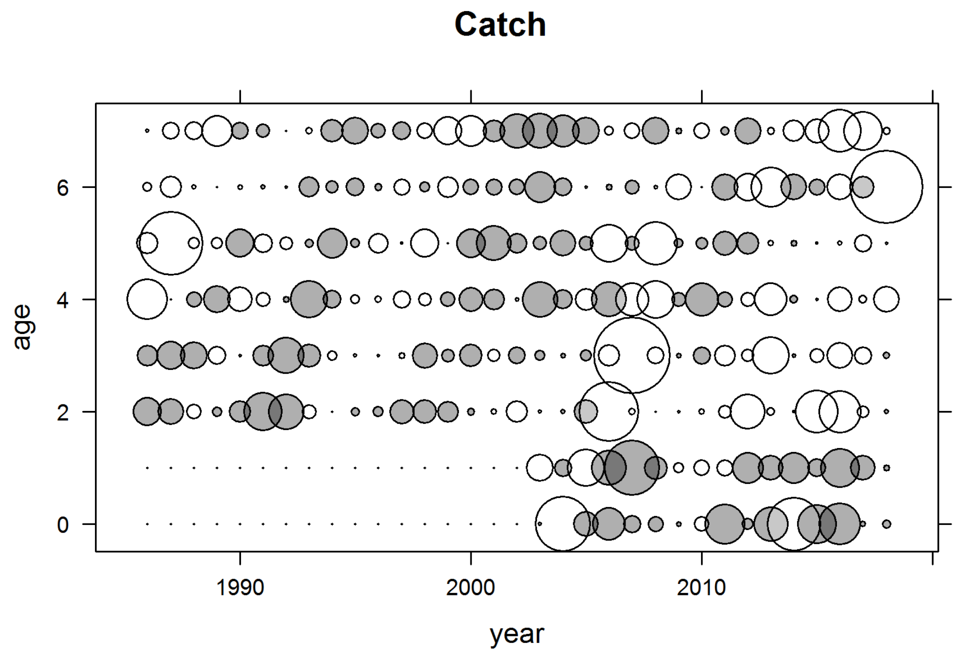


Figure 3.2.4 ***Lophius piscatorius*** **in 27.78abd. Standardised proportion at age per year of the catch numbers. Cohorts can be tracked consistently up to age 7.**

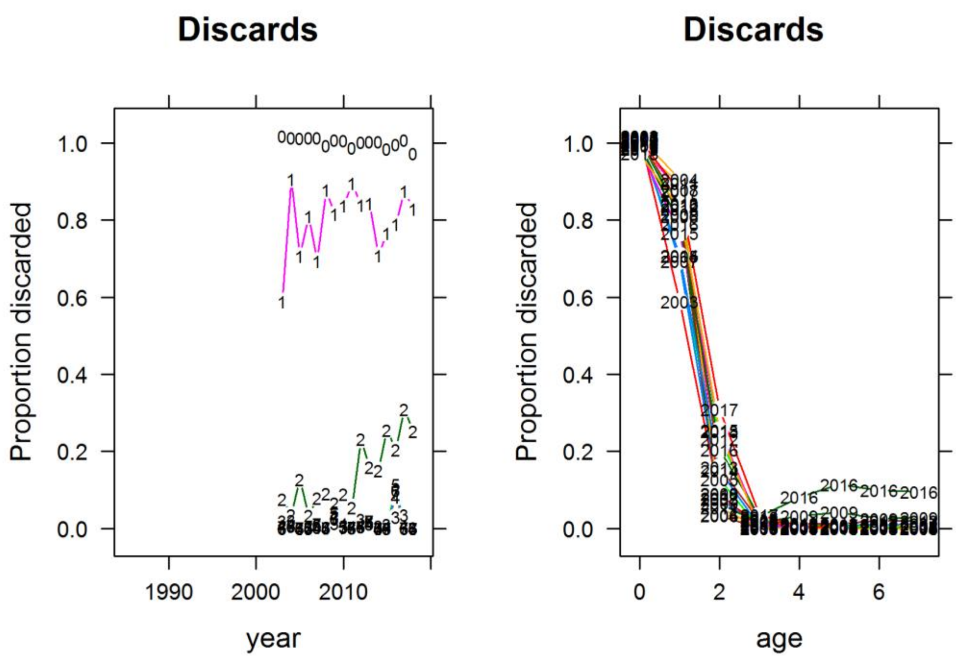


Figure 3.2.5. ***Lophius piscatorius*** **in 27.78abd. Proportions of discards-at-age over time (left) and by age (right).**

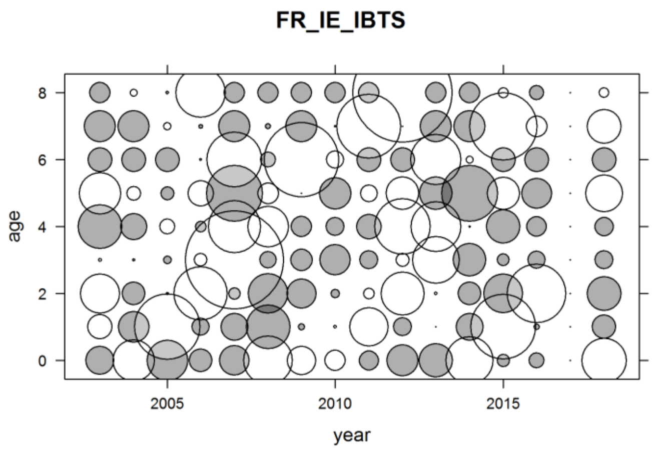


Figure 3.2.6a. ***Lophius piscatorius*** **in 27.78abd. Standardised proportion-at-age per year of the FR_IE_IBTS index.**

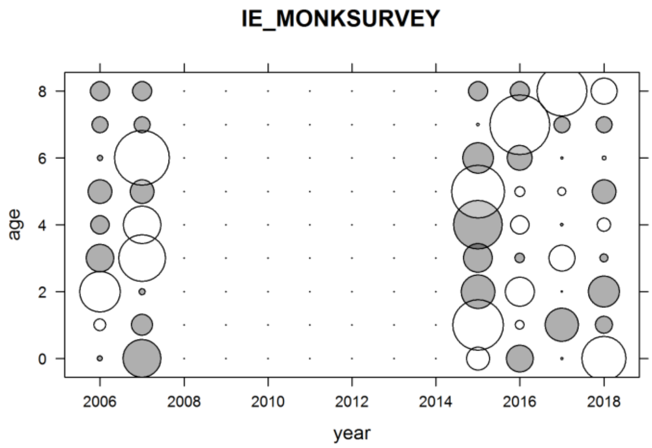


Figure 3.2.6b. ***Lophius piscatorius*** **in 27.78abd. Standardised proportion-at-age per year of the IE_Monksurvey index.**

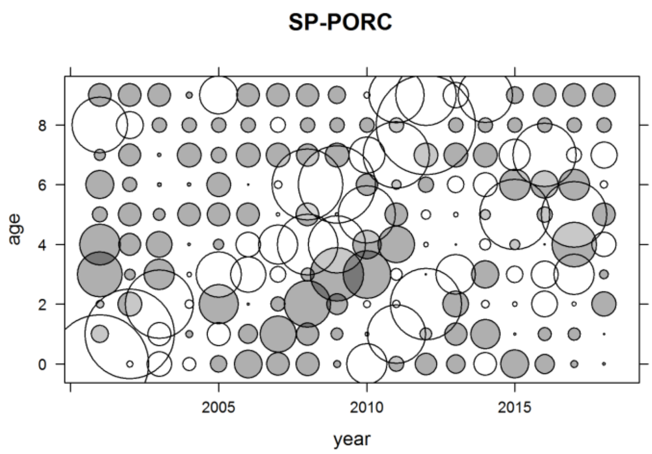


Figure 3.2.6c. ***Lophius piscatorius*** **in 27.78abd. Standardised proportion at age per year of the SP_Porcupine index. Cohorts can be tracked consistently up to age 6.**

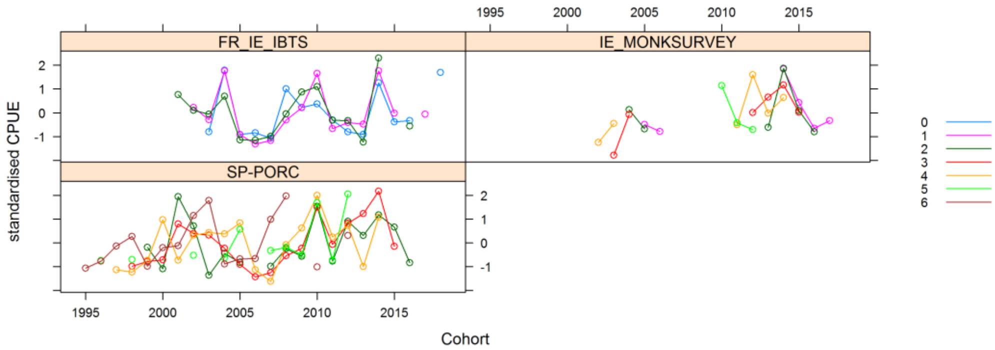


Figure 3.2.7a. ***Lophius piscatorius*** **in 27.78abd. Internal consistency of the survey indices.**

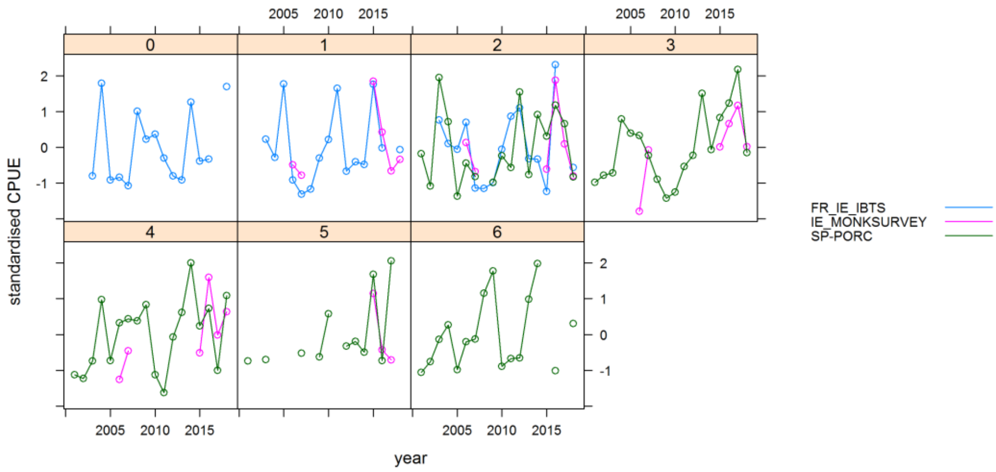


Figure 3.2.7b. ***Lophius piscatorius*** **in 27.78abd. External consistency of the survey indices.**

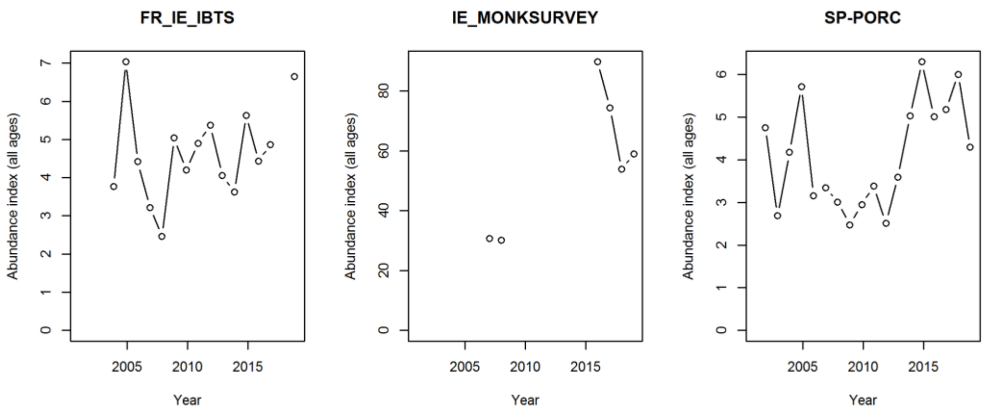


Figure 3.2.7c. ***Lophius piscatorius*** **in 27.78abd. Overall survey abundance trends (all ages combined).**

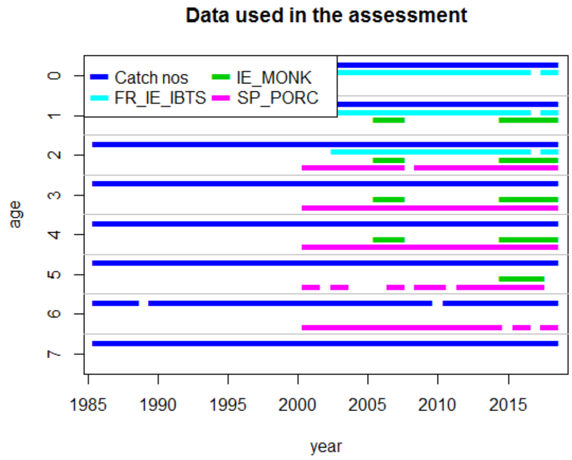


Figure 3.2.8. *Lophius piscatorius* in 27.78abd. Overview of the available catch and survey data. Age 7 is a plus group.

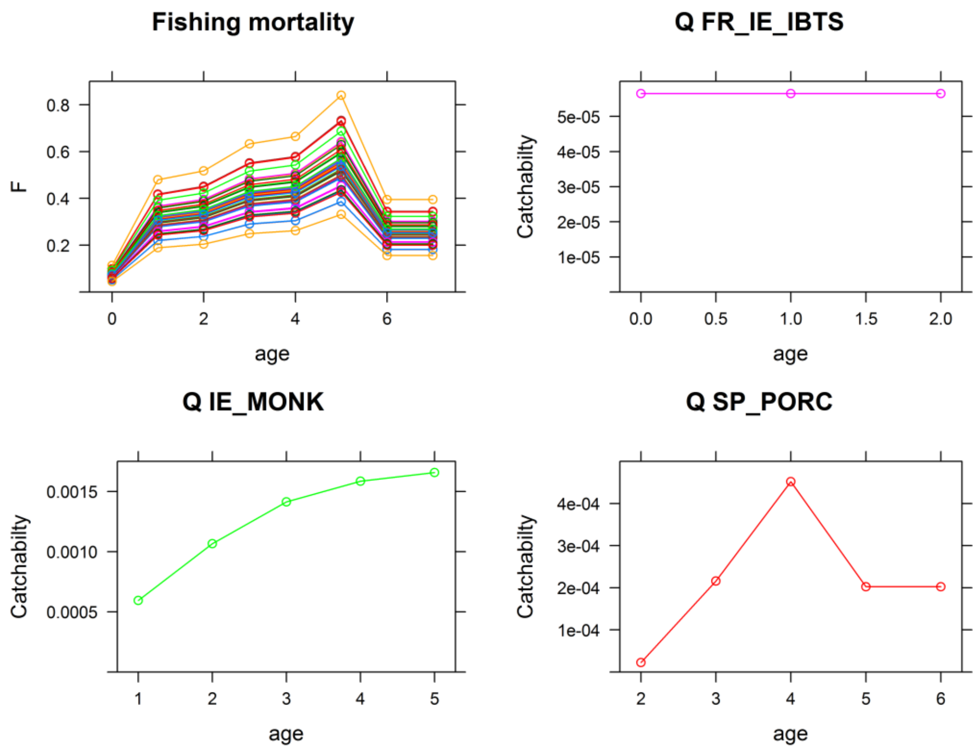


Figure 3.2.9. *Lophius piscatorius* in 27.78abd. Pattern in F-at-age (colours indicate years) and catchability-at-age of the surveys.

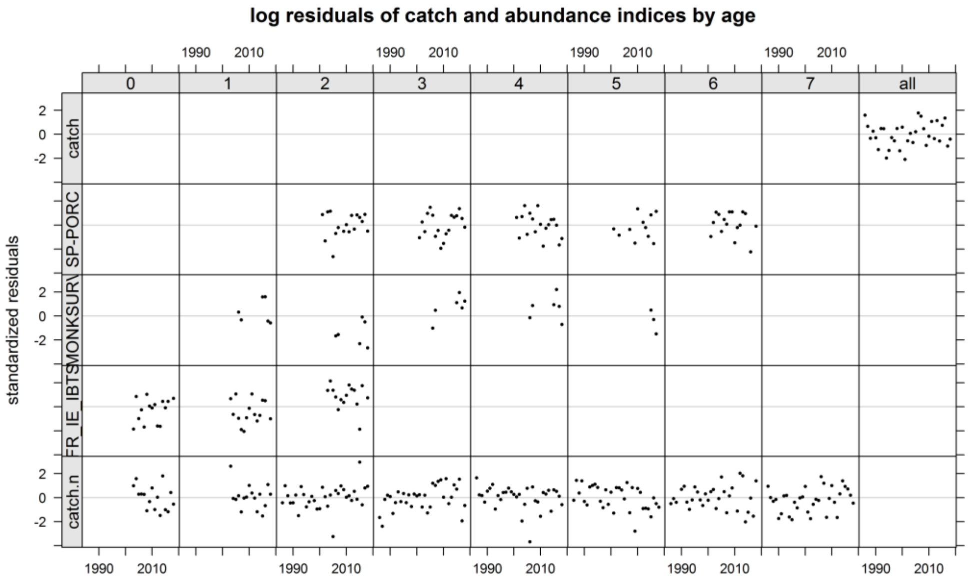


Figure 3.2.10. ***Lophius piscatorius*** **in 27.78abd. Standardised residuals of the catch and the surveys.**

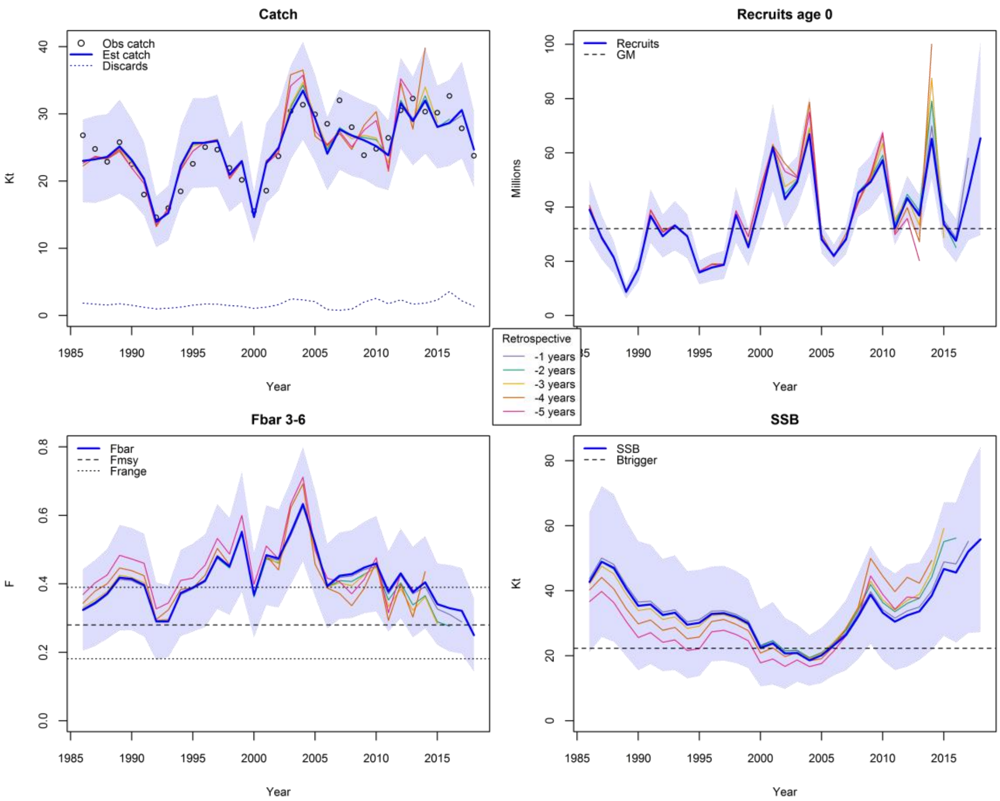


Figure 3.2.11. ***Lophius piscatorius*** **in 27.78abd. Summary plot of the assessment outputs. Light blue areas are the 95% confidence intervals. The coloured lines are the retrospective runs.**

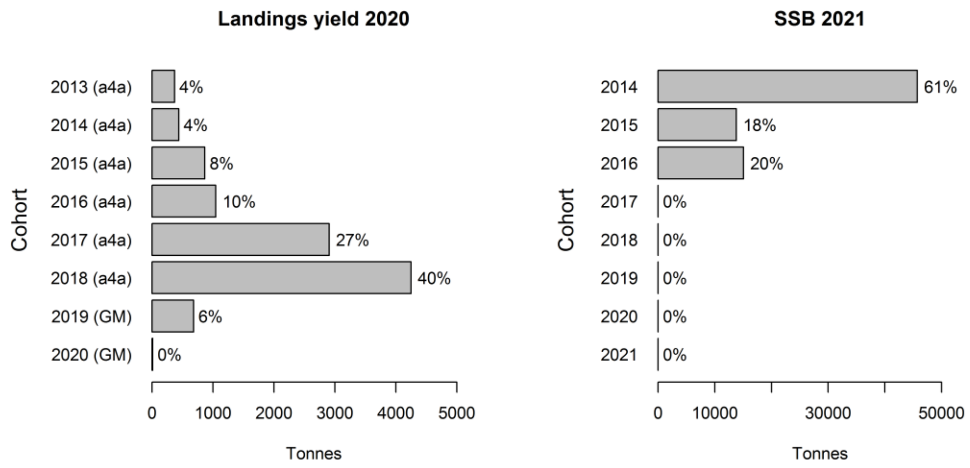


Figure 3.2.12. ***Lophius piscatorius*** **in 27.78abd. Cohort contributions to the forecast landings in 2020 and SSB in 2021.**

Table 3.2.1. *Lophius piscatorius* in 27.78abd. Stock assessment model input data: catch.n is the catch numbers-at-age (thousands); p.dis is the proportion of the catch numbers that are discarded; catch.wt and stock wt are the catch and stock weights-at-age (kg). FR_IE_IBTS (n/hr); IE_MONK (n/km^2) and SP_PORC (n/30mis) are the tuning indices.

catch.n	0	1	2	3	4	5	6	7	8	9
1986			1606	1207	2303	911	213	154	46	38
1987			1625	810	1142	1357	258	163	68	60
1988			4048	945	861	816	205	239	41	38
1989			3039	3279	561	897		321	83	22
1990			2007	2057	1884	326	200	15	135	4
1991			887	1047	1361	757	135	105	28	17
1992			962	411	884	660	139	167	16	7
1993			3865	1100	198	568	85	204	18	32
1994			3233	2556	761	313	125	70	48	13
1995			2876	2328	1498	600	97	38	39	35
1996			2808	2160	1437	942	158	148		29
1997			1897	2388	1712	670	267	123	12	11
1998			1747	931	1436	931	124	259	22	
1999			1856	1430	766	609	249	252	76	
2000			2460	980	499	280	92	182	144	
2001			3448	2668	675	247	103	8	49	74
2002			5035	1624	1506	507	125		3	79
2003	5866	18354	6829	3567	529	1077	63	68	67	3
2004	11123	11880	6104	3961	1455	728	200	113	43	7
2005	2491	13188	2629	2295	2510	704	261	45	91	10
2006	1498	4852	6916	3221	277	1184	162	261	23	
2007	2034	2955	3285	5320	2010	479	108	151	126	8
2008	2085	5035	2968	2645	2102	1112	180	29	46	23
2009	3055	8544	3640	2189	959	645	333	232		6
2010	5320	12046	5135	2061	488	804		455		
2011	1356	10107	4826	3797	1041	485	62	141	103	5
2012	2925	5824	6111	3171	1888	487	377	5	91	28
2013	1311	5202	3502	3738	2067	709	368	174	48	33

catch.n	0	1	2	3	4	5	6	7	8	9
2014	7533	6838	4513	2808	1454	854	77	451	13	
2015	1274	6586	6338	3079	1338	746	117	307	81	5
2016	959	4147	5314	3148	1807	683	282	374	36	14
2017	2650	5179	3706	2810	1372	852	71	319	63	25
p.dis	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2003	0.995	0.576	0.075	0.018	0.006	0.001	0.000	0.000	0.009	0.000
2004	0.994	0.888	0.034	0.020	0.009	0.006	0.006	0.006	0.005	0.000
2005	0.994	0.694	0.125	0.001	0.001	0.002	0.000	0.003	0.001	0.000
2006	0.998	0.799	0.033	0.000	0.002	0.002	0.004	0.000	0.000	
2007	1.000	0.684	0.078	0.003	0.002	0.008	0.010	0.016	0.006	0.009
2008	0.983	0.869	0.090	0.001	0.001	0.001	0.003	0.003	0.001	0.001
2009	0.998	0.808	0.065	0.014	0.032	0.041	0.025	0.029		0.003
2010	0.999	0.831	0.089	0.003	0.012	0.006		0.001		
2011	0.978	0.887	0.054	0.002	0.005	0.001	0.002	0.003	0.002	0.000
2012	0.992	0.831	0.229	0.023	0.007	0.005	0.004	0.002	0.004	0.003
2013	0.995	0.836	0.158	0.019	0.013	0.013	0.019	0.028	0.001	0.010
2014	0.995	0.702	0.149	0.006	0.000	0.000	0.000	0.000	0.000	
2015	0.977	0.761	0.253	0.011	0.003	0.001	0.000	0.000	0.000	0.000
2016	0.985	0.781	0.202	0.029	0.081	0.113	0.098	0.101	0.043	0.040
2017	0.996	0.865	0.306	0.034	0.007	0.001	0.000	0.000	0.002	0.013
catch.wt	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1986	0.124	0.385	1.015	2.367	4.114	6.131	9.079	11.449	14.196	18.266
1987	0.141	0.385	0.941	2.226	4.263	6.116	8.619	11.733	13.371	17.131
1988	0.125	0.466	0.964	2.276	4.225	6.177	8.383	11.809	13.617	17.818
1989	0.120	0.384	1.067	2.239	4.196	6.069	9.071	11.474	14.863	16.974
1990	0.118	0.352	1.027	2.331	4.077	6.112	8.891	10.518	14.141	16.787
1991	0.127	0.391	1.016	2.302	4.092	6.108	8.930	11.254	14.758	17.149
catch.wt	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1992	0.120	0.451	1.003	2.252	4.133	6.016	9.010	11.453	14.457	18.111

1993	0.080	0.500	1.017	2.217	4.378	6.000	9.166	11.244	15.376	17.544
1994	0.140	0.549	1.027	2.208	4.202	5.799	9.367	10.963	14.261	16.719
1995	0.099	0.496	1.093	2.231	4.172	6.042	9.329	11.180	13.821	17.566
1996	0.099	0.414	1.040	2.278	4.120	6.073	9.127	11.341	14.325	18.212
1997	0.126	0.455	1.035	2.266	4.145	5.961	9.029	10.992	15.191	18.915
1998	0.127	0.412	1.019	2.371	4.138	6.117	9.077	11.449	13.597	18.052
1999	0.123	0.462	1.071	2.260	4.094	6.038	8.271	11.808	13.310	18.052
2000	0.110	0.452	1.034	2.298	4.077	5.979	7.909	11.724	13.768	18.052
2001	0.098	0.363	1.021	2.293	4.207	5.769	9.034	10.442	13.941	16.996
2002	0.117	0.362	0.921	2.132	4.095	5.833	8.959	11.511	13.224	18.322
2003	0.071	0.255	0.999	2.088	4.390	5.811	9.704	12.753	13.856	18.781
2004	0.077	0.136	0.965	2.231	4.015	5.970	9.607	11.389	14.338	22.171
2005	0.061	0.267	0.954	2.206	3.961	6.054	9.354	11.196	14.864	17.539
2006	0.070	0.232	1.053	2.243	3.707	5.874	8.694	11.780	13.866	18.052
2007	0.071	0.297	1.047	2.161	4.252	5.731	9.494	12.075	14.027	18.772
2008	0.087	0.195	1.002	2.194	3.951	6.064	9.367	11.389	13.485	17.013
2009	0.085	0.233	0.943	2.063	4.202	5.921	9.148	11.490	14.325	17.499
2010	0.078	0.235	0.941	2.202	3.970	6.104	9.071	11.717	14.325	18.052
2011	0.086	0.201	1.080	2.178	3.995	5.972	8.651	12.008	13.741	17.730
2012	0.084	0.259	0.972	2.289	3.914	6.182	8.826	12.180	14.318	16.832
2013	0.091	0.244	1.008	2.164	3.993	6.016	9.386	11.446	14.614	19.050
2014	0.040	0.311	0.983	2.192	4.015	6.096	9.570	11.772	17.234	18.052
2015	0.096	0.320	0.907	2.108	3.936	6.005	9.258	11.516	15.451	19.068
2016	0.083	0.338	0.963	2.189	4.059	5.954	9.264	11.616	15.321	19.863
2017	0.086	0.278	0.981	2.201	3.839	6.197	9.628	11.694	14.409	18.534

stock.wt	0	1	2	3	4	5	6	7	8	9
1986	0.014	0.197	0.702	1.784	3.394	5.451	7.844	10.637	14.196	17.411
1987	0.014	0.222	0.643	1.788	3.397	5.459	7.780	10.637	13.189	15.344
1988	0.014	0.248	0.589	1.788	3.413	5.451	7.857	10.526	13.617	17.407
1989	0.014	0.186	0.748	1.719	3.436	5.360	7.867	10.491	13.329	16.974
1990	0.014	0.203	0.661	1.801	3.400	5.451	7.842	10.518	13.194	17.411
1991	0.014	0.189	0.701	1.736	3.428	5.448	7.841	10.530	13.278	16.036
1992	0.014	0.227	0.647	1.751	3.444	5.441	7.845	10.567	13.329	18.256
1993	0.014	0.122	0.679	1.736	3.448	5.380	7.867	10.460	13.329	17.140
1994	0.014	0.253	0.711	1.736	3.424	5.381	7.867	10.461	13.279	16.082
1995	0.014	0.221	0.769	1.725	3.455	5.362	7.867	10.637	13.189	17.411
1996	0.014	0.260	0.618	1.777	3.430	5.448	7.813	10.538	13.329	15.810
1997	0.014	0.199	0.752	1.732	3.425	5.443	7.851	10.570	13.329	18.612
1998	0.014	0.187	0.730	1.739	3.433	5.449	7.849	10.503	13.597	17.411
1999	0.014	0.199	0.694	1.800	3.364	5.480	7.849	10.637	12.837	17.411
2000	0.014	0.217	0.691	1.736	3.423	5.455	7.831	10.518	12.896	17.411
2001	0.014	0.219	0.708	1.733	3.438	5.368	7.867	10.442	13.271	16.148
2002	0.014	0.200	0.609	1.718	3.438	5.265	7.867	10.637	13.224	15.528
2003	0.014	0.133	0.738	1.648	3.498	5.184	7.867	10.637	13.936	17.411
2004	0.022	0.094	0.720	1.727	3.410	5.403	7.867	10.577	13.329	19.087
2005	0.014	0.129	0.608	1.768	3.411	5.441	7.867	10.763	12.955	17.411
2006	0.007	0.135	0.713	1.646	3.495	5.290	7.867	10.545	13.187	17.411
2007	0.013	0.144	0.690	1.744	3.443	5.338	7.867	10.710	13.019	17.411
2008	0.010	0.128	0.677	1.692	3.387	5.406	7.867	10.637	12.641	17.411
2009	0.014	0.117	0.695	1.667	3.444	5.378	7.998	10.823	13.329	17.411
2010	0.010	0.135	0.698	1.650	3.476	5.291	7.867	10.659	13.329	17.411
2011	0.014	0.113	0.787	1.693	3.430	5.336	7.867	10.765	13.079	17.411
2012	0.014	0.138	0.662	1.797	3.369	5.506	7.948	10.637	13.570	16.359
2013	0.015	0.136	0.649	1.731	3.392	5.457	7.867	10.842	13.329	20.000
2014	0.019	0.134	0.717	1.694	3.405	5.483	7.867	11.026	13.329	17.411

stock.wt	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2015	0.014	0.162	0.655	1.680	3.418	5.448	7.867	10.842	13.329	18.975
2016	0.014	0.159	0.684	1.713	3.416	5.460	7.997	10.759	13.329	19.273
2017	0.014	0.149	0.690	1.708	3.419	5.493	7.867	10.848	14.435	18.963
FR_IE_IBTS	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2003	0.882	1.155	1.078	0.543		0.102				0.010
2004	4.066	0.883	0.827	0.955	0.145	0.136			0.015	0.008
2005	0.732	1.860	0.729	0.605	0.345	0.041		0.041		
2006	0.826	0.530	1.023	0.546	0.139	0.072	0.029	0.010	0.013	
2007	0.554	0.338	0.362	0.835	0.270		0.078			0.025
2008	2.092	0.421	0.357	0.533	0.491	0.108	0.018	0.018		
2009	2.151	0.875	0.418	0.399	0.115	0.066	0.167			0.010
2010	2.322	1.148	0.770	0.378	0.147	0.034	0.080	0.021		
2011	1.504	1.910	1.117	0.551	0.120	0.110		0.069		
2012	0.888	0.679	1.204	0.667	0.465	0.100		0.017	0.026	0.007
2013	0.752	0.819	0.669	0.851	0.390	0.024	0.109			0.012
2014	3.420	0.778	0.664	0.408	0.276		0.068			0.019
2015	1.397	1.969	0.327	0.513	0.053	0.109		0.059	0.006	
2016	1.465	1.026	1.660	0.509	0.139	0.034		0.034		0.002
IE_MONK	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2006	6.696	7.951	8.249	4.318	2.669		0.811			
2007	2.713	4.614	3.947	11.915	4.630		2.253			
2015	28.720	34.967	4.314	12.263	4.496	4.076	0.521	0.369		
2016	9.883	18.559	17.502	15.178	9.694	1.466	0.779	1.308		
2017	13.037	6.052	8.110	17.451	5.717	0.992	1.736		0.873	

SP_PORC	0	1	2	3	4	5	6	7	8	9
2001	2.934	0.227	0.254	0.564	0.609	0.067	0.012	0.061	0.003	0.023
2002	0.451	0.819	0.086	0.704	0.556		0.058	0.004	0.012	
2003	1.075	0.597	0.654	0.752	0.801	0.077	0.149	0.070		
2004	1.150	0.421	0.423	1.833	1.648		0.202			0.038
2005	0.196	0.452	0.031	1.542	0.804		0.030	0.019		0.079
2006	0.027	0.150	0.204	1.503	1.325		0.136			
2007	0.099	0.008	0.137	1.103	1.379	0.133	0.146		0.009	
2008	0.076	0.091		0.624	1.356		0.327	0.001		0.002
2009	0.323	0.181	0.106	0.251	1.577	0.100	0.412			0.007
2010	1.134	0.328	0.246	0.370	0.610	0.461	0.038	0.162		0.037
2011	0.178	0.576	0.185	0.883	0.367		0.068	0.184		0.078
2012	0.141	0.220	0.579	1.104	1.125	0.191	0.072		0.045	0.119
2013	0.267	0.184	0.147	2.338	1.474	0.226	0.303			0.096
2014	1.570	0.124	0.460	1.219	2.151	0.139	0.439			0.196
2015	0.036	0.466	0.346	1.853	1.286	0.799		0.208		0.019
2016	0.255	0.303	0.509	2.146	1.523	0.065	0.025	0.360		
2017	0.657	0.363	0.412	2.816	0.669	0.910		0.184		

Table 3.2.2. *Lophius piscatorius* in 27.78abd. Summary of the assessment. Landings, discards, catch, estimated catch, total stock biomass in kilotonnes, recruitment in millions. CV is the relative standard error.

Year	Lan	Dis*	Cat	CatEst	Tsb	Ssb	SsbCv	Recr	RecrCv	Fbar	FbarCv
1986	24.981	1.8325123	26.8135123	23.0196858	81.089	42.716	0.26044105	39.0633719	0.14015979	0.324	0.1882716
1987	23.091	1.693869	24.784869	23.2514958	82.427	48.955	0.24538862	28.8722891	0.14317953	0.344	0.18604651
1988	21.314	1.56351496	22.877515	23.6308927	78.936	47.044	0.25051016	21.4199996	0.14489064	0.371	0.18328841
1989	24.015	1.76165017	25.7766502	25.1577659	76.711	40.73	0.26412963	8.73420578	0.14735135	0.418	0.18660287
1990	20.982	1.53916068	22.5211607	23.1514782	72.356	35.407	0.291609	17.1226213	0.14395426	0.414	0.18357488
1991	16.763	1.2296707	17.9926707	20.336648	61.72	35.811	0.26525369	36.7399247	0.13754811	0.397	0.19143577
1992	13.617	0.99889196	14.615892	13.9497532	55.961	32.562	0.27412321	29.3141794	0.13810278	0.291	0.19931271
1993	14.895	1.09264123	15.9876412	15.2783433	59.222	33.258	0.2748211	33.1861731	0.13912659	0.291	0.18900344
1994	17.201	1.26180073	18.4628007	22.3110222	72.179	29.573	0.28759341	29.281168	0.14209266	0.373	0.17158177
1995	21.033	1.54290185	22.5759019	25.6766627	78.394	30.118	0.27830533	15.9048651	0.1416275	0.389	0.16709512
1996	23.333	1.71162121	25.0446212	25.7012204	72.253	32.872	0.22654539	17.7022524	0.14510471	0.41	0.16585366
1997	22.983	1.68594653	24.6689465	26.0007434	67.18	33.097	0.22434057	18.6750288	0.14176263	0.48	0.16458333
1998	20.474	1.50189571	21.9758957	20.972968	57.326	31.941	0.2257913	37.107684	0.14112295	0.451	0.16186253
1999	18.792	1.37851051	20.1705105	23.0030032	53.131	29.924	0.23322417	25.1762601	0.14072439	0.552	0.16304348
2000	14.451	1.06007106	15.5110711	14.6508853	48.326	22.476	0.26775227	42.6058301	0.13770943	0.367	0.16893733
2001	17.294	1.26862286	18.5626229	22.6862946	59.176	23.853	0.27116086	62.0444662	0.13269482	0.484	0.15495868
2002	22.0830098	1.61992662	23.7029364	24.9569912	62.706	20.754	0.26746651	42.9344003	0.13288274	0.474	0.15400844

Year	Lan	Dis*	Cat	CatEst	Tsb	Ssb	SsbCv	Recr	RecrCv	Fbar	FbarCv
2003	27.9334631	2.48209481	30.4155579	30.2028347	67.156	20.853	0.21488515	49.2213466	0.0984263	0.548	0.13868613
2004	29.0280013	2.33774489	31.3657461	33.470724	68.249	18.59	0.2140936	66.9091203	0.10518915	0.633	0.13586098
2005	27.8693594	2.06160727	29.9309667	29.3310776	66.592	20.171	0.2140697	28.1356123	0.09580242	0.517	0.15280464
2006	27.6524933	0.88082556	28.5333188	24.0744247	69.462	23.219	0.201516	22.0591864	0.09778076	0.394	0.15989848
2007	31.2130469	0.80072754	32.0137744	27.6870057	76.586	26.406	0.20790729	28.1542415	0.09895614	0.424	0.1509434
2008	27.0529267	0.97112526	28.024052	26.802043	75.944	32.129	0.20728936	45.2434653	0.09919689	0.429	0.15617716
2009	21.8350887	2.0266151	23.8617038	26.0771882	70.457	38.79	0.19631348	49.2629488	0.10027382	0.448	0.15401786
2010	22.2148459	2.58384202	24.7986879	25.2029656	69.971	33.235	0.22286746	57.232418	0.10123087	0.459	0.15686275
2011	24.6572995	1.77659689	26.4338964	23.8522785	77.633	30.476	0.24593122	32.1701536	0.09972335	0.378	0.15873016
2012	28.1883008	2.33373655	30.5220374	31.5939029	89.434	32.414	0.24449312	43.3702095	0.09599125	0.431	0.15545244
2013	30.6108475	1.68190775	32.2927552	28.9433624	88.762	33.666	0.22334106	36.8987079	0.10604292	0.376	0.18085106
2014	28.4744762	1.85420886	30.3286851	31.9854523	92.607	38.479	0.21757322	65.2258253	0.1138524	0.405	0.17037037
2015	27.8587795	2.31424611	30.1730256	28.0646803	95.415	46.718	0.22089987	33.6998778	0.12725657	0.341	0.17888563
2016	29.0825818	3.58051095	32.6630927	28.6779988	104.194	45.627	0.2368992	27.6213284	0.14712912	0.329	0.2006079
2017	25.6335773	2.2016405	27.8352178	30.5726489	112.257	52.119	0.24060323	45.5175956	0.19952618	0.321	0.19937695
2018	22.3713322	1.39622398	23.7675562	24.6993186	115.872	55.785	0.25578561	65.3805544	0.27847989	0.25	0.22

Discards before 2003 were estimated from the proportion of the catch that was discarded over the period 2003–26

Table 3.2.3. ***Lophius piscatorius*** **in 27.78abd. Catch options: Catch, landings and discards in 2019 in tonnes; F of the catch, landings and discards in 2019; SSB in 2020 in kilotonnes; dSSB, dLand and dCatch are the change in SSB, landings and catch with the previous year (%).**

Basis20	Catch20	Land20	Dis	FCatch20	FLand20	FDis20	SSB21	dSSB	dLand	dCatch
F_{MSY}	31798	29510	2288	0.28000	0.27129	0.00871	74595	-0.44	26.20	3.03
F_{MSY}lower	21428	19894	1534	0.18100	0.17537	0.00563	81095	8.24	-14.92	-30.56
F_{MSY}upper	42331	39268	3063	0.39000	0.37786	0.01214	68045	-9.18	67.93	37.16
F = Fsq	28773	26706	2067	0.25023	0.24245	0.00779	76486	2.09	14.21	-6.77
F = 0	0	0	0	0.00000	NaN	NaN	94679	26.37	-100.00	-100.00
F = 0.181	21428	19894	1534	0.18100	0.17537	0.00563	81095	8.24	-14.92	-30.56
F = 0.18	21319	19793	1526	0.18000	0.17440	0.00560	81164	8.33	-15.35	-30.92
F = 0.19	22408	20803	1605	0.19000	0.18409	0.00591	80479	7.42	-11.03	-27.39
F = 0.2	23488	21805	1683	0.20000	0.19378	0.00622	79800	6.51	-6.75	-23.89
F = 0.21	24558	22798	1761	0.21000	0.20346	0.00654	79128	5.61	-2.50	-20.42
F = 0.22	25620	23782	1838	0.22000	0.21315	0.00685	78462	4.72	1.71	-16.98
F = 0.23	26672	24757	1914	0.23000	0.22284	0.00716	77802	3.84	5.88	-13.58
F = 0.24	27715	25725	1990	0.24000	0.23253	0.00747	77148	2.97	10.02	-10.20
F = 0.25	28749	26683	2066	0.25000	0.24222	0.00778	76501	2.11	14.11	-6.85
F = 0.26	29774	27634	2140	0.26000	0.25191	0.00809	75859	1.25	18.18	-3.52
F = 0.27	30791	28576	2215	0.27000	0.26160	0.00840	75224	0.40	22.21	-0.23
F = 0.28	31798	29510	2288	0.28000	0.27129	0.00871	74595	-0.44	26.20	3.03

Basis20	Catch20	Land20	Dis	FCatch20	FLand20	FDis20	SSB21	dSSB	dLand	dCatch
F = 0.29	32797	30436	2361	0.29000	0.28098	0.00902	73971	-1.27	30.16	6.27
F = 0.3	33788	31354	2434	0.30000	0.29066	0.00934	73353	-2.10	34.09	9.48
F = 0.31	34770	32264	2506	0.31000	0.30035	0.00965	72741	-2.91	37.98	12.66
F = 0.32	35744	33166	2577	0.32000	0.31004	0.00996	72135	-3.72	41.84	15.82
F = 0.33	36709	34061	2648	0.33000	0.31973	0.01027	71534	-4.52	45.67	18.94
F = 0.34	37666	34948	2719	0.34000	0.32942	0.01058	70939	-5.32	49.46	22.04
F = 0.35	38615	35827	2788	0.35000	0.33911	0.01089	70349	-6.10	53.22	25.12
F = 0.36	39556	36698	2858	0.36000	0.34880	0.01120	69765	-6.88	56.94	28.17
F = 0.37	40489	37562	2927	0.37000	0.35849	0.01151	69186	-7.66	60.64	31.19
F = 0.38	41414	38419	2995	0.38000	0.36817	0.01183	68613	-8.42	64.30	34.19
F = 0.39	42331	39268	3063	0.39000	0.37786	0.01214	68045	-9.18	67.93	37.16
F = 0.53	54386	50426	3961	0.53000	0.51351	0.01649	60618	-19.09	115.65	76.20

3.3 *Anglerfish (L. budegassa)* in Divisions and 8.a,b,d

Type of assessment

Category 3 assessment using survey trends.

Feedback from ADG

ADG discussed whether to apply the PA buffer as the assessment lies on the threshold. The buffer was applied, following the ICES guidelines under which it would be applied:

- The stock size is unknown
- It is not a by-catch species
- F has been declining, though is only below F_{MSY} for the first time.
- While biomass has increased, it has not significantly increased.
- Agreement that the stock is re-assessed in 2019 and provide annual advice.

Feedback from EG audit 2017

The uncertainty around the combined abundance survey index is relatively large since the catch rates are quite low in these surveys; however they cover a large part of the stock distribution. There is also some additional information that suggests that the stock size has increased in recent years.

3.3.1 Data

Catch numbers at length

The stock annex describes the methods for filling-in unsampled landings and discards. Figure 3.3.1 shows that about 1/3 of the landings had length data associated with them. About half of the discards were unsampled and had to be estimated from the discard rate of the sampled catches. However, discard rate are relatively low so this affects only a small proportion of the total catch weight.

Figures 3.3.2a and b shows the annual age and length frequency distribution of the catch data both before and after allocating length data to unsampled catches.

Figure 3.3.3 shows the length distribution of the catches in terms of abundance and biomass. Catch numbers are generally highest at size classes 10-20cm. The highest biomass in the catches is around 50-60cm. Note that the females mature around 65cm.

Surveys

The surveys are described in detail in the stock annex and in section 2 of the report.

The combined IGFS-WIBTS-Q4 and EVHOE-WIBTS-Q4 surveys biomass index used as the basis of the advice. In 2017 the French survey vessel Thalassa suffered major mechanical issues and the majority of the EVHOE-WIBTS-Q4 bottom trawl survey could not be completed.

The VAST (Vector Autoregressive Spatio-Temporal) model (www.github.com/james-thorson/VAST) was used to estimate the missing 2017 data. VAST is a spatially explicit model that predicts population density for all locations within a spatial domain, and then predicts derived quantities (e.g. biomass, abundance) by aggregating population density across the spatial domain while weighting density estimates by the area associated with each estimate. VAST imputes biomass or abundance in unsampled areas using spatially correlated random effects.

The VAST model provided nearly identical biomass trends to the original survey index. The model was to be able to accurately predict the index when the missing data were simulated for other years. Full details of the analysis can be found in working document WD01.

Initial results provided similar trends to the original survey index but higher absolute values. When the model was run again without estimating (and correcting for) differences in catchability, the absolute values were very close to the original index for both recruitment and biomass. The working group agreed that the second option was more appropriate as the main purpose of the modelling exercise was not to provide a more scientifically robust index, but to deal with missing data in 2017. For that purpose it was considered better for the model to replicate the original index as closely as possible for this year's advice.

ACOM leadership expressed some concerns about the use of a modelled survey index. The concerns are listed below, with responses from WGBIE 2019:

- <u>Concern:</u> Survey design-based calculation is the default for survey indices for most stocks and model-based estimates are generally not used. This provides transparency as to how the indices are derived and allows for easy verification of results using DATRAS for example.

  → *Response:*

    1. To a certain extent the VAST model ignores the survey design (i.e. the spatial stratification). However, because the model is spatially explicit, it achieves almost the same outcome. Additionally, the station density in either survey does not actually vary much between stations, so the design effect is minimal.
    2. While design-based calculations may be preferable for single survey, the combined survey index is simply a weighted average of the single survey indices, this ignores the area of overlap and is therefore potentially biased. The VAST model provides a convenient and statistically robust method of combining the two surveys.
    3. The working group will continue to monitor the outcomes of the VAST model against the original index as well as the raw data from DATRAS. This approach allows continued verification of the data and estimates.

- <u>Concern</u>: Using a model will result in differences for past values of indices. While differences are likely to be small, we may end up having requests to provide revised advice for the current year using the updated model as it may imply small changes in the ratio.

  → *Response:*

    1. Category 1 models all suffer from some sort of retrospective pattern, yet it is very unusual to provide revised advice in the current year for these stocks, based on small retrospective revisions.
    2. Historic survey data are regularly revised as mistakes are discovered or improved estimation methods are proposed. Therefore it is incorrect to suggest that the historic index values do not change.
    3. There are a number of category 3 stocks for which the biomass trend is not a survey index but an assessment model (e.g. an XSA that is accepted for trends only). These models will be likely to have much larger retrospective patterns than the VAST model, which will only use data from other years to estimate areas without survey coverage.

Figure 3.3.4a shows the observed and modelled distribution of the catches of recruits on the two IBTS surveys. Recruitment generally occurs in the western Celtic Sea and in some years in Biscay.

Figure 3.3.4b shows the observed and modelled distribution of the catch weights on the two IBTS surveys. During some years, the catches are highest in the area covered by the IGFS survey, in other years the EVHOE survey has higher catches. It is unclear whether this is due to movement of the stock or whether it is due to factors affecting the catchability on the surveys (e.g. weather, gear performance).

Figure 3.3.5 shows the biomass and recruitment indices of the two surveys as well as the combined index. The combined survey biomass index is more stable than the single-survey indices but the uncertainty around the index is still considerable. Both surveys recorded their highest biomass index of their time series in 2018.

Both surveys agree on a very strong 2013 recruitment, however this cohort was not obvious in the length distributions of the following years in the surveys or catches.

Table 3.3.1 provides the index values.

3.3.2 Biological reference points

Working document "WD 07 Reference points for black anglerfish in 27abd" describes the estimation of an MSY proxy reference point for this stock.

Length-based indicators were explored for this stock but due to the highly variable recruitment of this stock, these indicators are not considered suitable for determining reference points and are used for screening purposes only (Figure 3.3.6). Some of the indicators show a moderate increasing trend in recent years (e.g. the mean length of the largest 5%; the 95%ile; the mean length above L_c).

The mean-length Z method was applied to the catch data for the period 2003–2017 with the following life-history parameters:

Parameter	Value
Linf	175
K	0.078
T0	0
M	0.3
a	0.0195
b	2.93
maxage	10
Lc	36

F01 = 0.23 was estimated in an equilibrium yield-per-recruit analysis, using the catch length frequency distribution of all years combined, together with the parameters listed above (Figure 3.3.7).

The mean-length Z analysis was then performed using the mlen_effort() function in the code from https://github.com/ices-tools-dev/ICES_MSY. A proxy of fishing effort was obtained from the *L. piscatorius* assessment in 27.78abd by dividing the TSB estimate by the catches (under the assumption that the two stocks are exposed to similar fishing effort). Figure 3.3.7 shows the outputs. F is estimated to be below the proxy reference point of F01 in the most recent year. A number of sensitivity runs were performed with higher and slower growth, estimated (rather than fixed) M and Lc = 16 and Lc = 25. Each of these runs resulted in F<F0.1 in the last year.

The precise value of the biomass reference points depend on whether the VAST model is applied to the full time series or only to 2017:

Reference point	VAST 2003–18	VAST 2017	Technical basis
MSY $B_{trigger_{proxy}}$	1.29	1.25	B_{pa}
$F_{MSY_{proxy}}$	1	1	Relative value (F/F_{MSY}) from YPR and mean length-based Z.
B_{lim}	0.92	0.89	B_{loss}
B_{pa}	1.29	1.25	$B_{lim * 1.4}$

3.3.3 Quality of the assessment

Some of the catch data was submitted well after the deadline. As catch data are not used in the assessment, this is not expected to have negatively impacted on the quality of the assessment.
One of the survey indices was not available until 3 days before the start of the assessment working group; additionally there was a mistake in the raw data uploaded to DATRAS. This put additional pressure on working group members and reduced the amount of time that could be spent on ensuring the quality of the data.
The FR-EVHOE-WIBTS-Q4 survey was not completed in 2017 due to a vessel breakdown; the working group applied a spatial model (VAST) to estimate the full timeseries of the index (including 2017). The VAST model provided nearly identical biomass trends to the original survey index. The model was to be able to accurately predict the index when the missing data were simulated for other years.
The combined IE-IGFS-WIBTS-Q4 and FR-EVHOE-WIBTS-Q4 surveys cover a large part of the stock distribution and most of the depth range of the stock (< 500 m). However, the catch rates are low, leading to some uncertainty around the index. The IE-IGFS-WIBTS-Q4 and FR-EVHOE-WIBTS-Q4 surveys sometimes display conflicting signals and the combined index is expected to provide a more robust basis for the advice than the individual indices. In 2018 both surveys registered the highest biomass of their time series.

3.3.4 Management considerations

Management of the two anglerfish species under a combined TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species. However, currently the stock size of both species is increasing and neither species appears to be at risk of over-exploitation.

3.3.5 Recommendations for the next benchmark

- Further explore SS3 as an assessment model for this stock
- Explore alternative methods like delay-difference production
- Update growth parameters with any new tagging data etc.
- Further investigate stock structure

3.3.6 Figures and tables

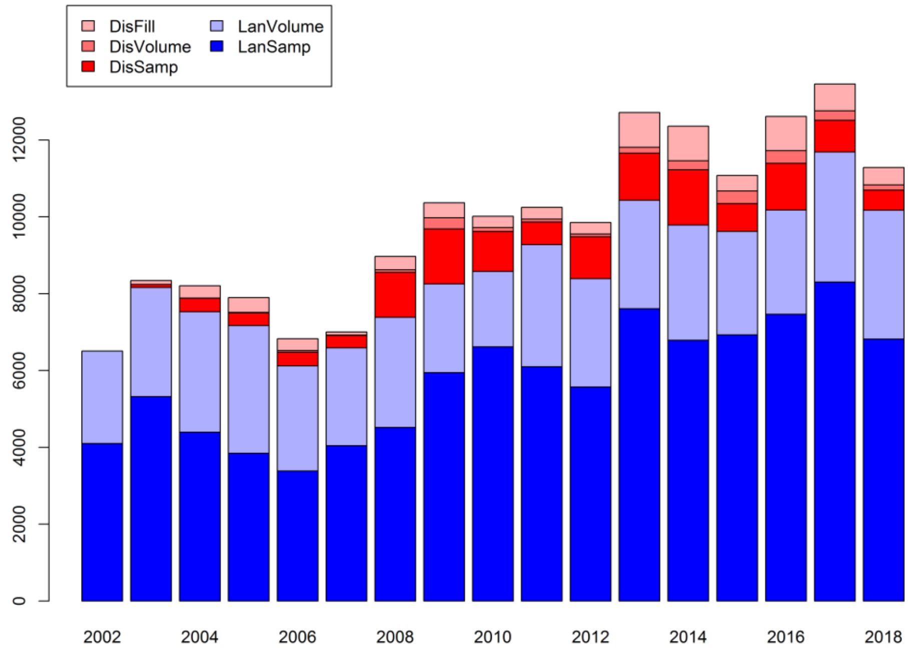


Figure 3.3.1. ***Lophius budegassa*** **in 27.78abd. Allocations of unsampled landings and discards by year. Dark blue represents the sampled landings; light blue represents landings for which only the tonnage was available but no sampling data; Red represents the sampled discards; medium pink represents discards for which an estimate of the tonnage was available but no sampling data and light pink represents discards for which no information was available.**

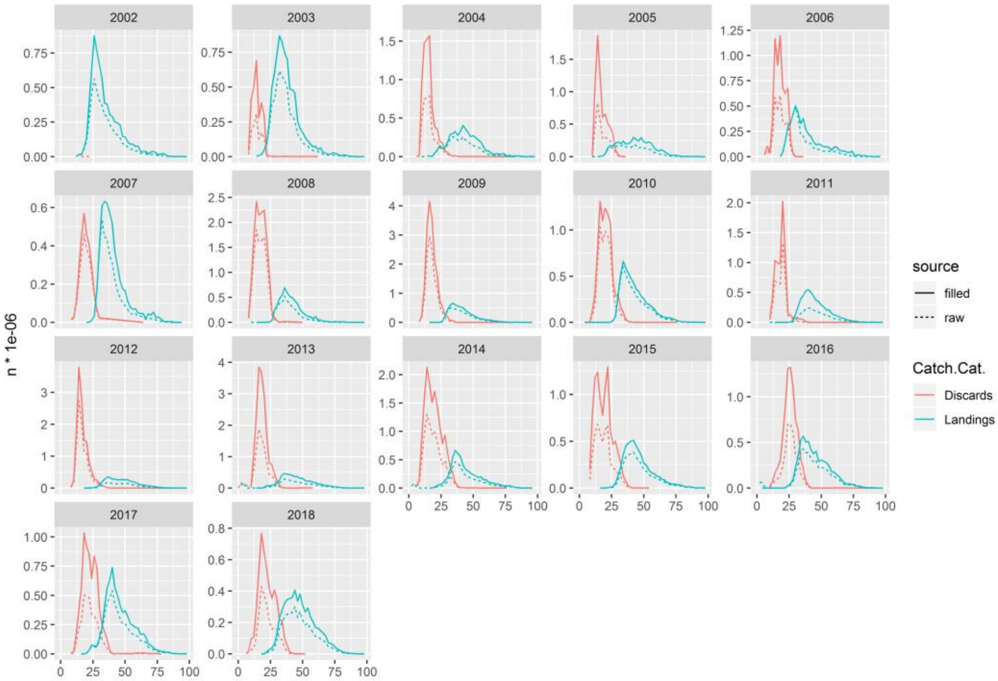


Figure 3.3.2a. ***Lophius budegassa*** **in 27.78abd. Annual length frequency distributions of the landings (blue) and discards (red). The dotted lines show the sampled strata submitted to InterCatch; the solid lines are the estimates after allocations of unsampled catches. No discard data were available prior to 2003.**

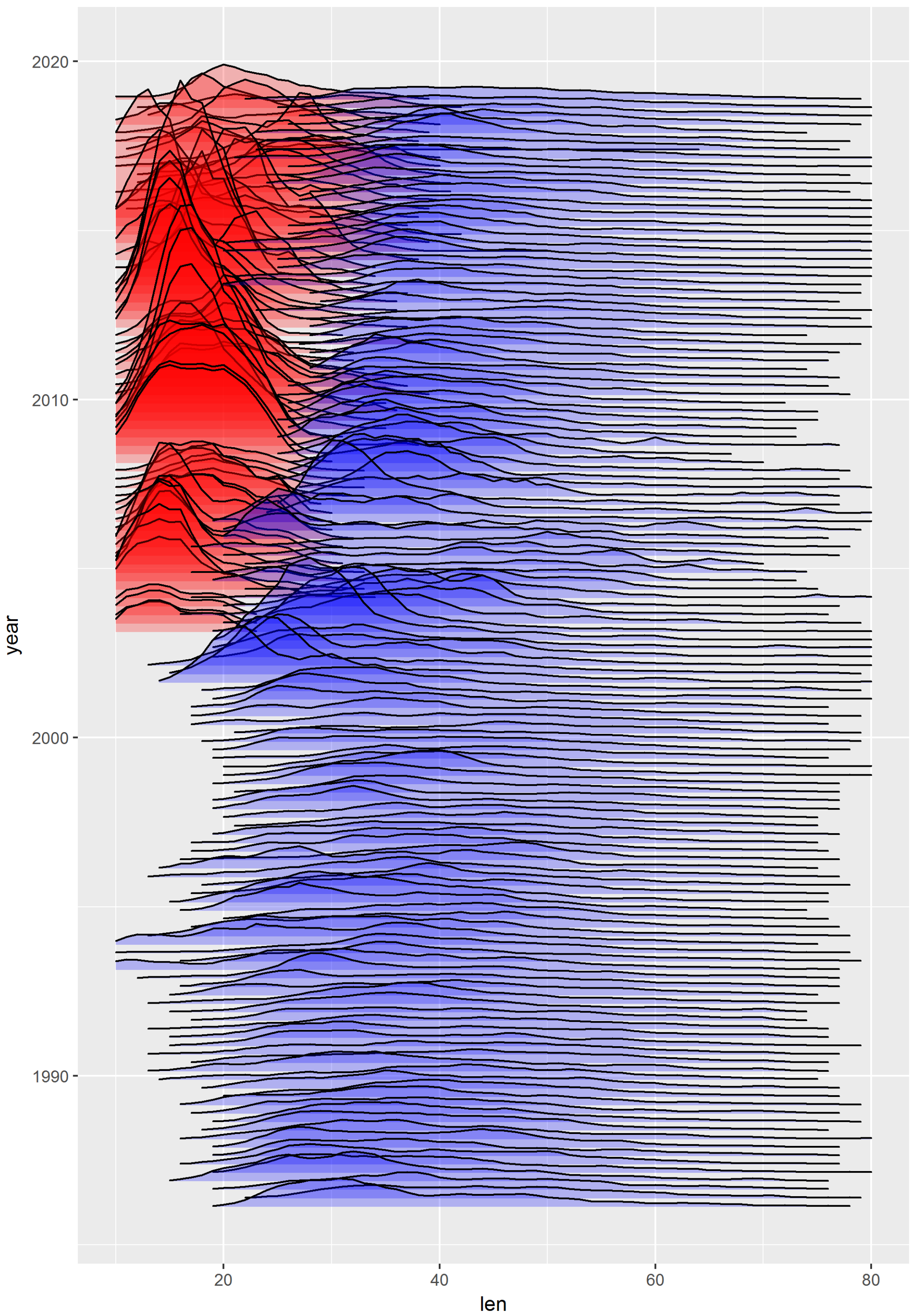


Figure 3.3.2b. ***Lophius budegassa*** **in 27.78abd. quarterly raised length frequency distributions of the landings (blue) and discards (red). No discard data were available prior to 2003.**

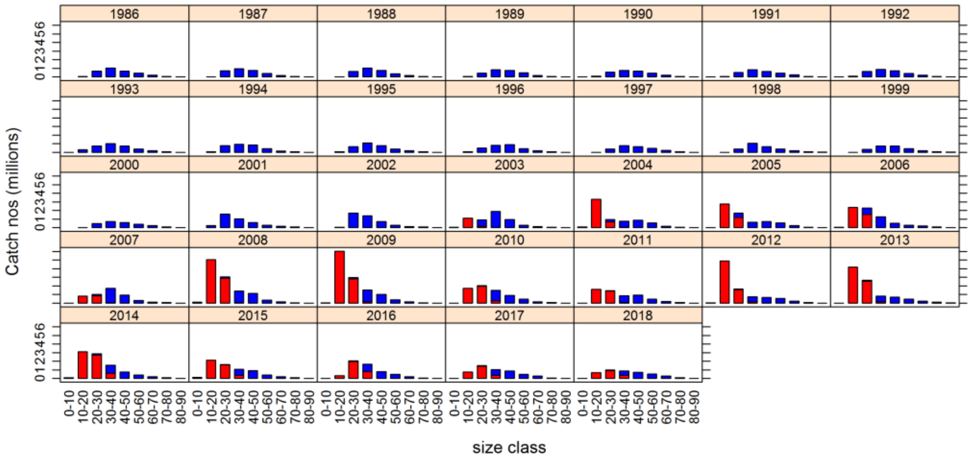


Figure 3.3.3a. ***Lophius budegassa*** **in 27.78abd. Length distributions of the catches by year in terms of abundance.**

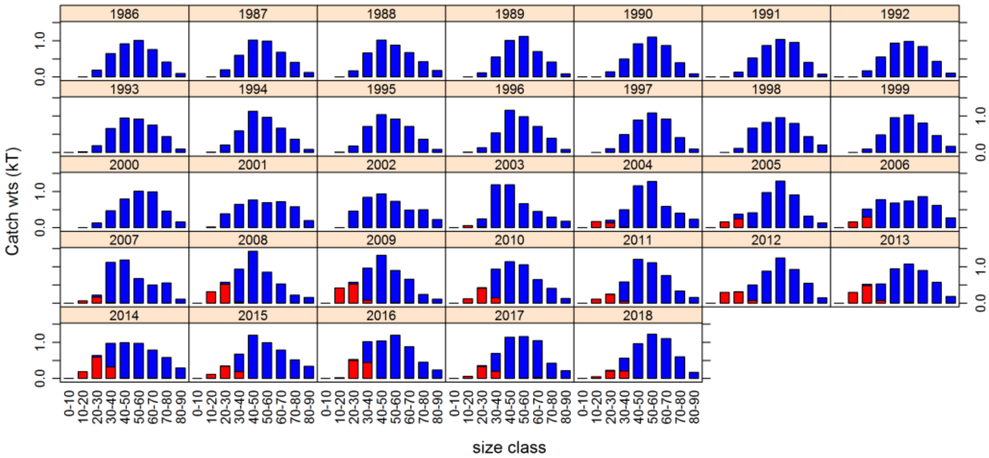
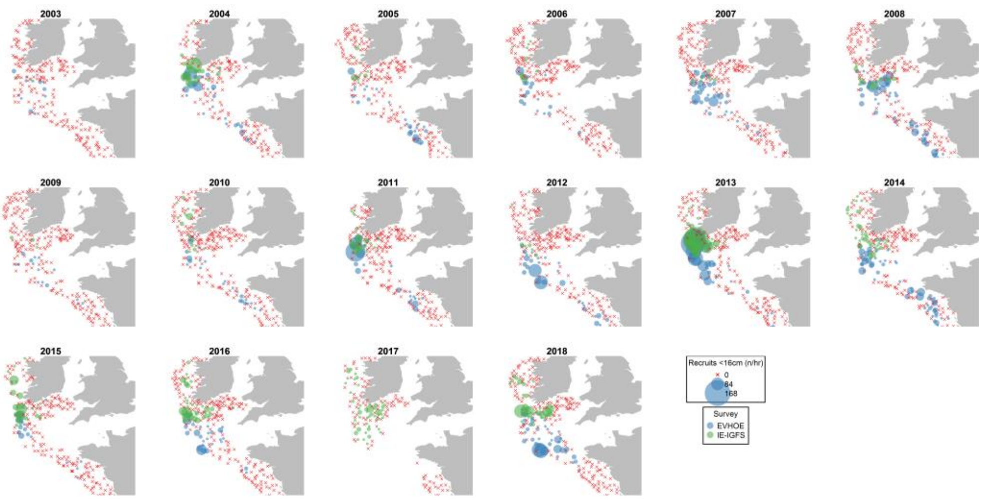


Figure 3.3.3b. ***Lophius budegassa*** **in 27.78abd. Length distributions of the catches by year in terms of biomass.**



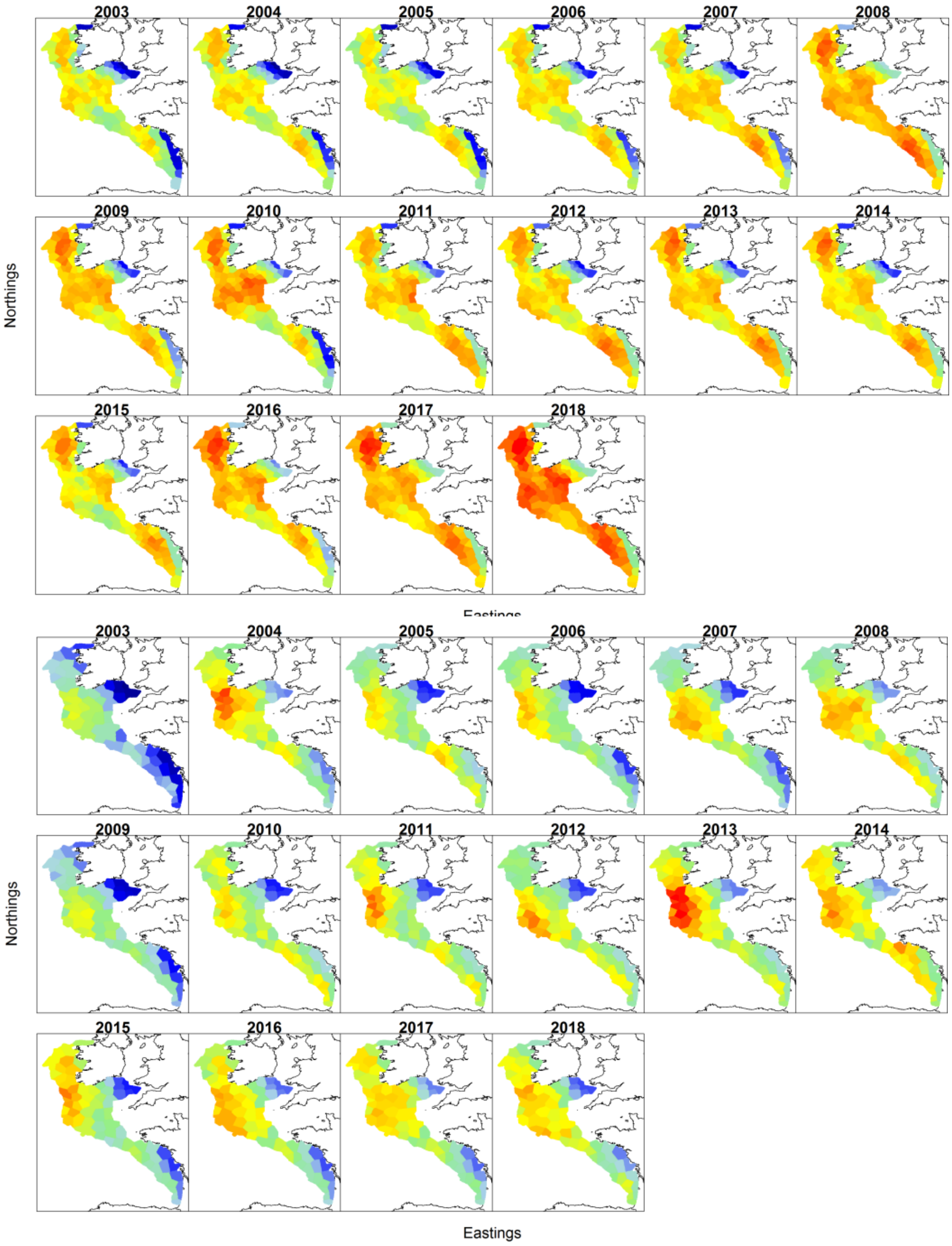


Figure 3.3.4a. ***Lophius budegassa*** **in 27.78abd. Observed (top) and modelled (bottom) abundance of recruits on the IGFS-WIBTS-Q4 and EVHOE-WIBTS-Q4 surveys.**

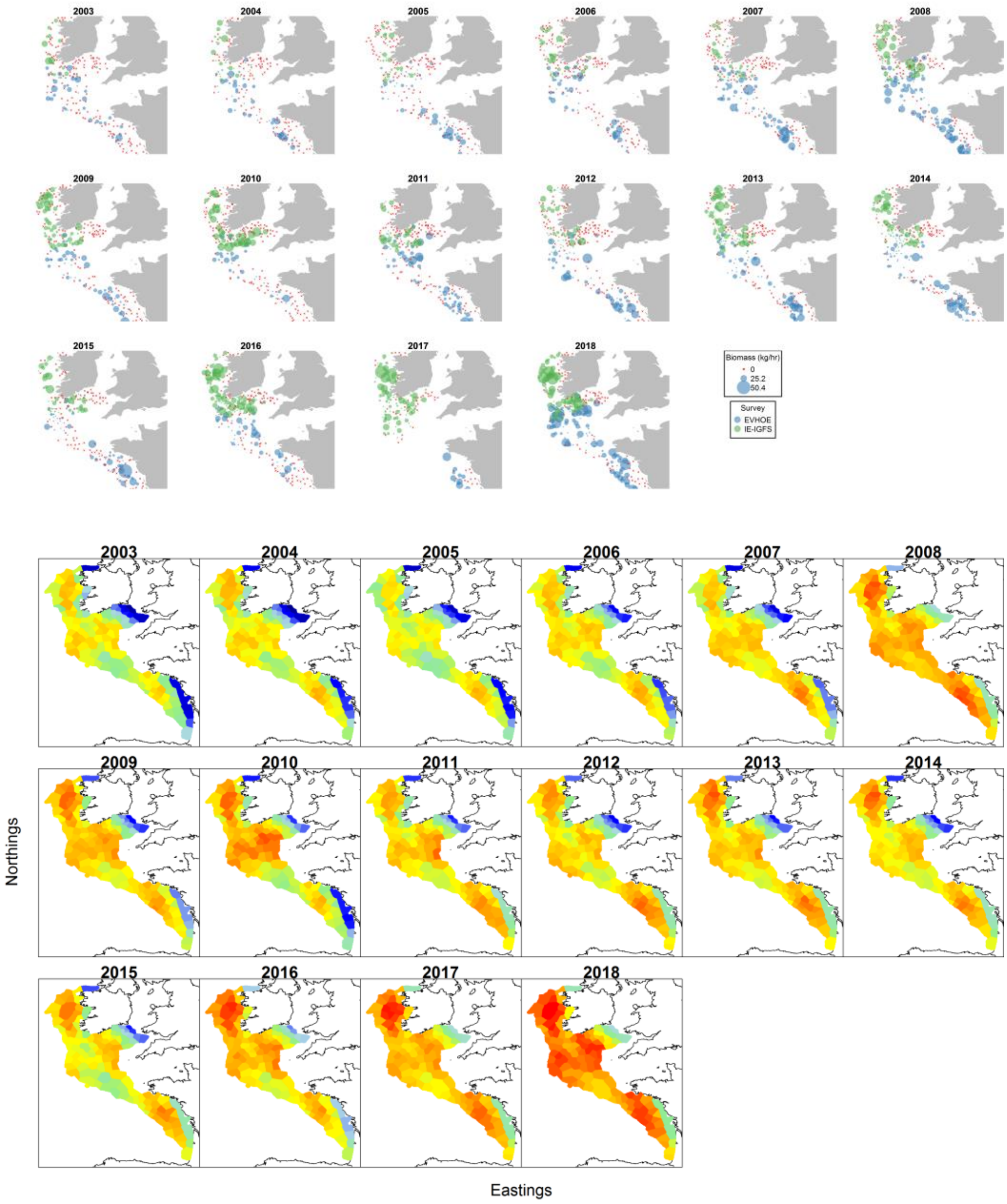


Figure 3.3.4b. *Lophius budegassa* in 27.78abd. Observed (top) and modelled (bottom) catch weights on the IGFS-WIBTS-Q4 and EVHOE-WIBTS-Q4 surveys.

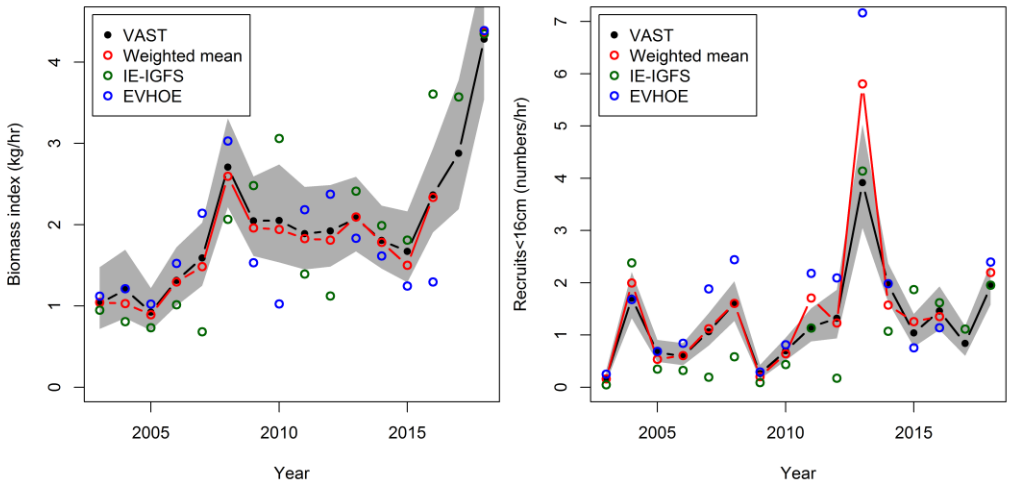


Figure 3.3.5. ***Lophius budegassa*** **in 27.78abd. Survey trends in terms of biomass (left) and recruits (<16cm; right). Black dots: VAST index; grey areas indicate the 95% confidence intervals. Red dots: weighted mean of the EVHOE and IGFS indices (the previously used combined index). Green and blue dots: the individual IGFS and EVHOE indices.**

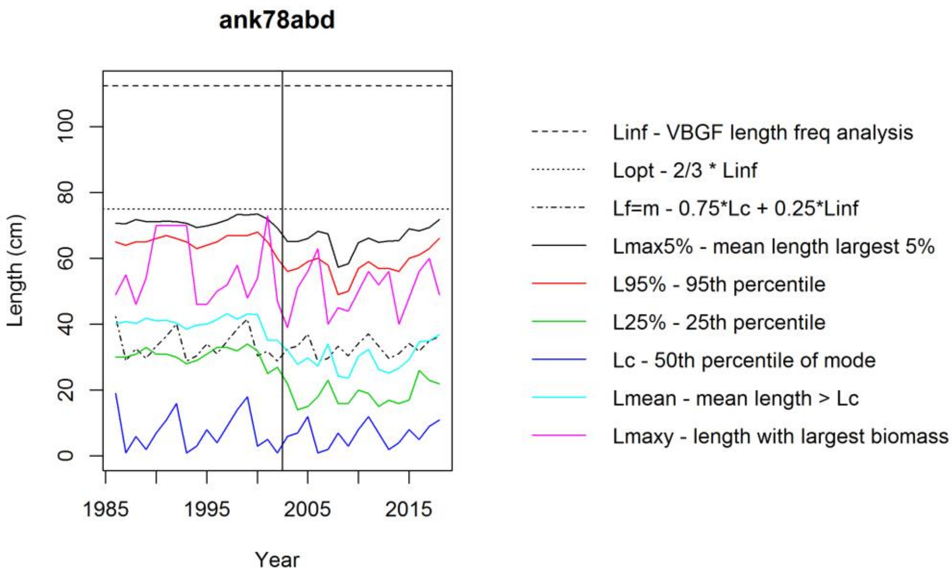


Figure 3.3.6. ***Lophius budegassa*** **in 27.78abd. YPR curve. Length-based indicators. Data prior to 2003 do not include discards (vertical black line). Length-based indicators are presented for information only as WGBIE does not consider them appropriate for determining reference points.**

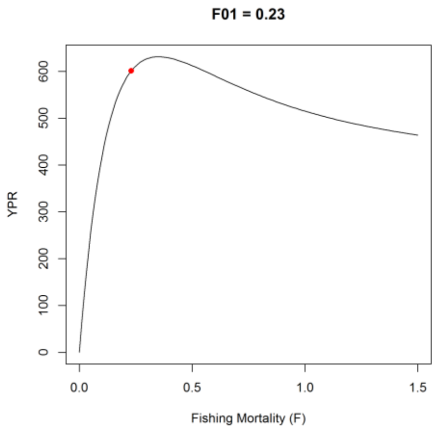


Figure 3.3.7. *Lophius budegassa* in 27.78abd. YPR curve. F01

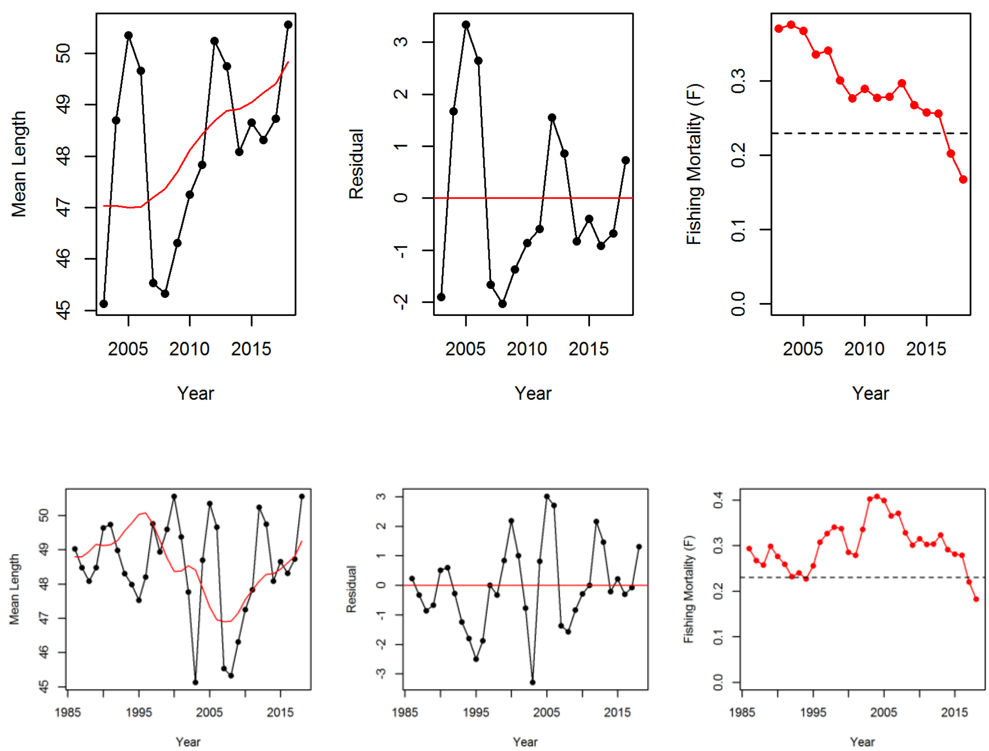


Figure 3.3.67. *Lophius budegassa* in 27.78abd. Length-based Z (with effort) estimate of fishing mortality (right), the dashed line is F01.

Table 3.3.1. *Lophius budegassa* in 27.78abd. Biomass and recruitment index for the individual surveys (EVHOE and IGFS) and combined. Estimated values (Est) and 95% confidence limits (CiLo and CiHi). The average of the last 2 years and the preceding 3 years and its ratio are given at the bottom of the table. This is the basis for the catch advice.

Year	Recruitment (nos < 16cm / hr)			Biomass (kg / hr)			F/F_{MSY}
	Est	CiLo	CiHi	Est	CiLo	CiHi	
2003	0.18	0.33	0.10	1.03	1.48	0.72	1.61
2004	1.71	2.21	1.32	1.2	1.69	0.85	1.64
2005	0.66	0.91	0.49	0.92	1.22	0.70	1.60
2006	0.60	0.84	0.42	1.31	1.72	1.00	1.46
2007	1.06	1.42	0.80	1.59	2.02	1.25	1.48
2008	1.61	2.03	1.27	2.71	3.31	2.22	1.31
2009	0.26	0.43	0.16	2.05	2.59	1.62	1.20
2010	0.70	0.95	0.51	2.05	2.74	1.54	1.26
2011	1.15	1.51	0.88	1.89	2.46	1.45	1.21
2012	1.32	1.87	0.94	1.92	2.49	1.48	1.21
2013	3.92	5.03	3.05	2.08	2.59	1.67	1.29
2014	1.97	2.37	1.63	1.81	2.23	1.46	1.16
2015	1.04	1.40	0.77	1.67	2.16	1.29	1.12
2016	1.46	1.93	1.10	2.37	2.94	1.91	1.11
2017	0.84	1.17	0.60	2.88	3.78	2.19	0.88
2018	1.94	2.36	1.59	4.28	5.17	3.55	0.73
2017–18	**Average A**			3.58			
2014–16	**Average B**			1.95			
	Ratio A/B			1.84			

4 'Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Divisions 8c and 9a

L. piscatorius and L. budegassa

Type of assessment in 2019: Update (the assessment models and settings were approved in the benchmark WKANGLER-2018).

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

Data revisions this year: No revisions have been carried out this year.

4.1 General

Two species of anglerfish, *Lophius piscatorius* and *L. budegassa*, are found in ICES Divisions 8c and 9a. 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 8c and 9a and Portuguese landings of Division 9a 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 increasing in the early eighties and reaching maximum in 1986 (9433 t) and 1988 (10021 t), and decreasing after that to the minimum in 2001 (1801 t). 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 3130 t, to decrease the next 4 years to 1916 t in 2018.

The species proportion in the landings has changed since 1986. In 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 and in 1999–2002 both species had approximately the same weight in the annual landings. Since then the *L. piscatorius* proportion increased. The mean proportion of *L. piscatorius* in the landings from 2009 to 2018 is 61%.

ICES performs assessments for each species separately. The latest benchmark assessment of anglerfish in Division 8c and 9a was carried out in 2018 (ICES, 2018), a new assessment using SPiCT for *L. budegassa* was approved and new settings and data were incorporated to the Stock Synthesis (SS) model for *L. piscatorius.*

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

4.2 Summary of ICES advice for 2019 and management for 2018 and 2019

ICES advice for 2019:

ICES gave a separate advice for each of these species in 2019. ICES advises that when the MSY approach is applied, catches in 2019 should be no more than 2153 tonnes for *Lophius piscatorius* and no more than 2212 tonnes for *L. budegassa*. All catches are assumed to be landed.

Management applicable for 2018 and 2019:

The two species are managed under a common TAC that was set at 3955 t for 2018 and 4166 t for 2019. The reported landings in 2018 were 48% of the established TAC.

There is no minimal landing size for anglerfish but an EU Council Regulation (2406/96) laying down common marketing standards for certain fishery products fixes a minimum weight of 500 g for anglerfish. In Spain this minimum weight was put into effect in 2000.

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. It is necessary to take into account that a recovery plan for hake and *Nephrops* is taking place in the same area.

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 1978-2018 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	506	0	0	n/a	222	728			
1979	n/a	n/a				n/a	625	0	0	n/a	435	1 060			
1980	4 008	1 477	0	0	0	5 485	786	0	0	n/a	654	1 440	6 926	0	6 926
1981	3 909	2 240	0	0	0	6 149	1 040	0	0	n/a	679	1 719	7 867	0	7 867
1982	2 742	3 095	0	0	0	5 837	1 716	0	0	n/a	598	2 314	8 151	0	8 151
1983	4 269	1 911	0	0	0	6 180	1 426	0	0	n/a	888	2 314	8 494	0	8 494
1984	3 600	1 866	0	0	0	5 466	1 136	0	0	409	950	2 495	7 961	0	7 961
1985	2 679	2 495	0	0	0	5 174	977	0	0	466	1 355	2 798	7 972	0	7 972
1986	3 052	3 209	0	0	0	6 261	1 049	0	0	367	1 757	3 172	9 433	0	9 433
1987	3 174	2 571	0	0	0	5 745	1 133	0	0	426	1 668	3 227	8 973	0	8 973
1988	3 583	3 263	0	0	0	6 846	1 254	0	0	344	1 577	3 175	10 021	0	10 021
1989	2 291	2 498	0	0	0	4 789	1 111	0	0	531	1 142	2 785	7 574	0	7 574
1990	1 930	1 127	0	0	0	3 057	1 124	0	0	713	1 231	3 068	6 124	0	6 124
1991	1 993	854	0	0	0	2 847	878	0	0	533	1 545	2 956	5 802	0	5 802
1992	1 668	1 068	0	0	0	2 736	786	0	0	363	1 610	2 758	5 493	0	5 493
1993	1 360	959	0	0	0	2 319	699	0	0	306	1 231	2 237	4 556	0	4 556
1994	1 232	1 028	0	0	0	2 260	629	0	0	149	549	1 327	3 587	0	3 587
1995	1 755	677	0	0	0	2 432	814	0	0	134	297	1 245	3 677	0	3 677
1996	2 146	850	0	0	0	2 995	749	0	0	265	574	1 589	4 584	0	4 584
1997	2 249	1 389	0	0	0	3 638	838	0	0	191	860	1 889	5 527	0	5 527
1998	1 660	1 507	0	0	0	3 167	865	0	0	209	829	1 903	5 070	0	5 070
1999	1 110	1 140	0	0	0	2 250	750	0	0	119	692	1 561	3 811	0	3 811
2000	710	612	0	0	0	1 322	485	0	0	146	675	1 306	2 628	0	2 628
2001	614	364	0	0	0	978	247	0	0	117	459	823	1 801	0	1 801
2002	587	415	0	61	8	1 072	344	0	0	104	380	828	1 900	0	1 900
2003	1 190	771	0	55	0	2 016	617	0	0	96	529	1 242	3 258	0	3 258
2004	1 513	1 389	0	87	32	3 021	549	0	0	77	602	1 229	4 250	0	4 250
2005	1 651	1 719	0	160	55	3 586	653	0	0	60	458	1 171	4 757	0	4 757
2006	1 490	1 371	0	72	6	2 938	801	0	0	68	351	1 220	4 158	0	4 158
2007	1 327	1 076	0	26	7	2 437	866	0	0	78	303	1 247	3 683	0	3 683
2008	1 280	1 238	0	31	9	2 558	473	0	0	50	246	770	3 328	0	3 328
2009	1 151	1 207	0	20	10	2 389	386	0	0	43	262	691	3 080	0	3 080
2010	689	1 036	0	14	3	1 742	355	0	0	72	203	630	2 372	0	2 372
2011	504	598	105	18	2	1 227	244	88	146	122	199	798	2 025	154	2 179
2012	504	616	89	14	2	1 226	194	60	132	161	533	1 080	2 306	339	2 645
2013	555	860	52	23	7	1 497	173	85	140	114	412	925	2 421	288	2 710
2014	644	1 073	35	30	11	1 793	212	93	8	143	408	864	2 657	474	3 130
2015	653	983	5	13	14	1 668	206	114	3	161	422	906	2 574	395	2 969
2016	656	988	9	12	10	1 674	202	146	3	127	377	856	2 530	419	2 948
2017	410	879	1	6	11	1 307	215	128	2	98	440	883	2 190	119	2 309
2018	414	770	34	12	15	1 245	244	72	2	58	280	656	1 901	16	1 916

n/a: not available

4.3 Anglerfish (*L. piscatorius*) in Divisions 8c and 9a

4.3.1 General

Ecosystem aspects

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

4.3.2 Fishery description

L. piscatorius is mainly caught by Spanish and Portuguese bottom trawlers and gillnet fisheries. For some gillnet fishery, it is an important target species, while it is also a by catch of the trawl fishery targeting hake or crustaceans (see Stock Annex). Since 2009 Spanish landings were on average 87% 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 the trawl landings. From 2004 to 2018, the Spanish landings were on average 41% from the trawl fleet (mean lengths in 2018 of 70 cm and 73 cm in Divisions 8c and 9a, respectively) and 59% from the gillnet fishery (mean length of 83 cm in Division 8c in 2018). For the same period, Portuguese landings were on average 11% from bottom trawlers (mean length of 45 cm in 2018) and 89% from the artisanal fleet (mean length of 85 cm in 2018).

4.3.3 Data

4.3.3.1 Commercial catches and discards

Total landings by country and gear for the period 1978–2018, as estimated by the WG, are given in Table 4.3.1. Unallocated and non-reported landings for this stock are available for the years from 2011 to 2018. 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) raised to the total effort for each métier and quarter.

Spanish discards estimates and landings below minimum size of *L. piscatorius* in weight are shown in the Table 4.3.2. For the available time-series anglerfish discards represent less than 18% of Spanish trawl catches. The maximum value of the time-series occurred in 2006 with 99 t. The Spanish gillnet fleet discards value are only available from 2013 to 2018 with quantities between 0 t and 144 t. The occasional high and the zero value of discards reported for the gillnet fleet could be related with a very low sampling level. *L. piscatorius* discards in the Portuguese trawl fisheries are considered negligible (Fernández & Prista, 2012; Prista *et al.*, 2014). Based on the partial information on the Spanish and Portuguese discards the WG concluded that discards could be considered negligible.

4.3.3.2 Biological sampling

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

The sampling levels for Portugal in 2018 are shown in Table 1.4. The métier sampling adopted in Spain and Portugal in 2009, following the requirement of the EU Data Collection Framework, can have an effect in the provided data. Spanish sampling levels are similar to previous years but an important reduction of Portuguese sampling levels was observed in 2009-2011, since 2012 Portugal increased the sampling effort.

Length composition

Table 4.3.3 gives the available annual length compositions by ICES division, country and gear and adjusted length composition for total stock landings for 2018. The annual length compositions for all fleets combined for the period 1986–2018 are presented in Figure 4.3.1.

Landings in number, the mean length and mean weight in the landings between 1986 and 2018 are showed in Table 4.3.4. 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 2011. 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 were observed reaching 71 cm in 2010. In 2018 mean weight and mean length of landings increased with respect to the previous year and the mean length of 77 cm and mean weight of 7 163 g are the highest values 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 relation, 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 1983–2018 are summarized in Table 4.3.5.

The abundance index from Spanish survey SP-NSGFS-Q4 is shown in Figure 4.3.2. Since 2000 the highest abundance values were detected in 2001 and 2006, since 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).

Since 2013 the SP-NSGFS-Q4 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 has 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 4.3.6 and Figure 4.3.4 for Spanish trawlers (Division 8c) from the ports of Santander and Avilés since 1986, for A Coruña since 1982 and for the Portuguese trawlers (Division 9a) 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: A Coruña port for trips that are exclusively landed in the port, A Coruña trucks for trips that are landed in other ports and A Coruña fleet that takes into account all the trips of the fleet. For 2018 only information for A Coruña port was provided. Although A Coruña port is a potential abundance series to be 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.

For the Portuguese fleets, until 2011 most logbooks were filled in paper but have thereafter been progressively replaced by e-logbooks. In 2013 more than 90% of the logbooks are being 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 the table. In 2007 a data series from the artisanal fleet from the port of Cedeira in Division 8c was provided. This LPUE series is annually standardized to incorporate a new year data, 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. Standardized effort provided for Portuguese trawl fleets (1989–2008) and their corresponding LPUEs are also given in Table 4.3.6, but not represented in Figure 4.3.4.

All fleets show a general decrease in landings during the eighties and early nineties. A slight landings increase in 1996 and 1997 can be observed in all fleets. From 2000 to 2005 Spanish fleets of A Coruña, Avilés and Cedeira show an increase in landings while the Portuguese fleets are stabilized at low levels. Since 2005–2009 landings from A Coruña and Cedeira fleets showed an overall decreasing trend. Proportion in total landings is higher for the Cedeira and A Coruña fleets. Landings for both Portuguese fleets increased in 2014 and 2015 and decrease in 2016 and 2018.

Effort trends show a general decline since the mid-nineties in all trawl fleets. In last five years they kept low effort values with some slight fluctuations. The artisanal fleet of Cedeira despite fluctuations along the time-series 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 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. From 2002 to 2005 LPUEs increased for all fleets. This general LPUE trend is consistent between fleets including the artisanal fleet. In 2009 and 2010 an important increase of Cedeira LPUE was observed. Portuguese fleets shown a one-off increase in 2011, and in 2017 Portuguese trawl fleet target crustaceans showed the highest LPUE of the time series with 2 k/hour.

4.3.4 Assessment

A new model assessment was adopted in 2018 benchmark (WKANGLER). The assessment approved in the WKANGLER (ICES, 2018) was updated with 2018 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 previous section (see Commercial catch-effort data), the A Coruña-fleet and Cedeira-fleet abundance indices from 2013 to 2018 were not included in the assessment.

4.3.4.2 Model

The Stock Synthesis (SS) software was selected to be used in the assessment (Methot, 2000). The description of the model including the structure, settings, and parameters assumptions are provided in the Stock Annex.

4.3.4.3 Assessment results

The model diagnosis is carried out means 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 happens 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 Spanish survey the last 4 years, model is overestimating the index. Pearson residual plots are presented for the model fits to the length-composition data of the abundance indices (Figure 4.3.6). There were not detected specific patterns in any of the abundance indices. However, some high positive residual are evident for SP-NSGFS 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, since the smaller fish until very large individuals. The Spanish artisanal fleet is most efficient at a narrow length range and for large fish, mainly from 75 to 90 cm. The Portuguese trawl fleet selection pattern indicates that this fishery is most efficient at the length range between 30 and 60 cm. This selection pattern shows strange selection over larger fish that could be an effect of an insufficient length sampling. The Portuguese artisanal fleet has an asymptotic selection pattern, 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 the selectivity is directed to larger individuals. The Spanish survey index shows well defined selectivity to the smaller individuals.

A 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) does not correspond to the F summary used here (the average of over lengths 30 to 130). 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 4.3.7 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 and 1987) with values over the 3 million. Along the time-series other high recruitment values were detected in 1989, 1994 and 2001. Since 2006 the recruitment has been below 1 million except in 2010, 2011 and 2014. The abundance of age0 in 2017, estimated at 185 thousands, was the lowest value throughout the time-series. Landings steadily decreased from 3.8 Kt in 2005 to 1.1Kt in 2011, coinciding with the decrease in F, from 0.38 in 2005 to 0.128 in 2011. Respect to 2017, landings and F decreased in 2018 by 20% and 16% respectively. Since 2005 SSB was above 6 kt and it steady increased to the highest value of the times series estimated at the beginning of 2019 with 13.5 kt.

The very low recruitment values estimated by the model for the last 4 years have not been reflected in the SSB. In fact, the SSB has increased from 2015 to 2019, between 3% and 5% a year. For a better understanding of this issue, a visual analysis of the length composition of the population was carried out. The normalized population length compositions by year are presented in Figure 4.3.10. From 2015 to 2019, the proportion of larger fish in the population was increased. The reduction of smaller – medium size individuals in the population would be the consequence of the latest bad recruitments. The important decrease of F during these years would have allowed fish to growth to sizes above L_{50} (= 61.8 cm) and above 100 cm.

A sensitivity analysis was done to evaluate the impact of a change in the selection pattern and of an increase of the weight of the survey abundance index in the model.

Three different runs were compared:

- RUN Flat-PT-ART, the approved model for the stock, with next settings: the selection pattern for the fishery PT-ART-9a is flat-top modelled and the weight for the survey index is λ=1.
- RUN Flat-PT-ART_1.5Lambda: the selection pattern for the fishery PT-ART-9a is flat-top modelled and the weight for the survey index is λ=1.5.

- RUN Flat-SP-ART: the selection pattern for the main fishery (SP-ART-8C) was modelled as a flat-top curve and the weight for the survey index was λ=1.

The comparison of the stock trends for the 3 different runs is shown in Figure 4.3.11. The increase in the weight of the survey index did not have an impact on the stock trends and the results from RUN Flat-PT-ART and RUN Flat-PT-ART_1.5Lambda were totally overlapped. A flat-top selection pattern for the fishery SP-ART-8c resulted in slightly higher values of the recruitment throughout the whole time series. From 1980 to 1996, the SSB estimates were similar between run Flat-PT-ART and run Flat-SP-ART. Since 1997 the trends in SSB were equal for both runs and the unexpected increase in SSB for the latest 4 years was also recorded by both runs. However, the run Flat-SP-ART involved higher values of SSB with respect to Flat-PT-ART from 1997 to 2019.

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 (2018), two years (2018 and 2017), three years (2018-2016), four years (2018–2015) and five years of data (2018–2014) of data while using the same model configuration (Figure 4.3.12). All the retrospective analysis runs were similar in the estimates of recruitment. Although there is some uncertainty in recent recruitment estimates no consistent bias was observed. Retrospective analysis showed an underestimation of the SSB in the final years an overestimation of F. Nevertheless, there was no strong retrospective pattern and the assessment was accepted for projections. . Monhn's Rho index for the last 5 years were estimated for recruitment (0.74), F (-0.07) and SSB (0.15).

4.3.5 Catch options and prognosis

4.3.5.1 Short-term projections

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

For fishing mortality, the F *status quo* equal to 0.093, estimated as the F_{2018} over lengths 30–130 cm, was used for 2019. In the case of recruitment, the geometric mean of a recent period (2003–2018) was used following the option indicated in the Stock Annex when a trend in the time series was detected.

Projected landings in 2020 and SSB at the beginning of 2021 for different management options in 2020 are presented in Table 4.3.8. Under F *status quo* scenario in 2020 is expected a small decrease in landings with respect to 2019, and a decrease in SSB in 2021 with respect to 2020.

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	0.23	2.00	0.185	1.98	10.81
F0.1	0.25	1.89	0.175	1.95	11.63
F40%	0.40	1.18	0.109	1.65	18.84
F35%	0.35	1.37	0.126	1.76	16.47
F30%	0.30	1.59	0.147	1.86	14.12

The F that maximizes the yield-per-recruit, F_{max}, is estimated at 0.185 which is over F_{sq} (0.093) and which corresponds to a SPR level of 23%. 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 0.175 and it is corresponding to a

SPR level of 25%. The fishing mortality of $F_{30\%}$, $_{35\%}$ and $_{40\%}$ is estimated in 0.147, 0.126 and 0.109 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.

Reference points for this stock have been updated in the Benchmark WKANGLER (ICES, 2018). The accepted values are presented in the following table:

Framework	Reference	Value	Rational
Precautionary approach	Blim	1993 t	Bloss
	Bpa	2769 t	Blim*exp (1.645*0.2)
	Flim	0.56	Stochastic simulations of recruitment with Blim as the breakpoint
	Fpa	0.40	Flim*exp(-0.2*1.645)
MSY approach	F_{MSY}	0.24	Stochastic simulation, F maximises 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 Btrigger	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 2019 is estimated at 13.5 kt which is well above of B_{pa} (2769 t) and MSY $B_{trigger}$ (6283 t). Fishing mortality in 2018 has decreased by 16% related to 2017. F in 2018 is estimated to be at a value of 0.093, below F_{pa} (0.4) and F_{MSY} (0.24). An increase in landings occurred from 1.1 kt in 2011 to 2.0 kt in 2014 and they decreased to 1.1 kt in 2018. The latest 4 recruitments were extremely low being the main concern about the status of the stock.

4.3.8 Quality considerations

The available unallocated and non-reported landings, for years 2011–2018, are included in the stock assessment, as the estimates were considered realistic information. However the importance of unallocated/non-reported landings is difficult to assess and the results of the assessment could be 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 2011.

4.3.9 Management considerations

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

4.3.10 References

Fernández, A.C. and Prista, N. 2012. Portuguese discard data on anglershouthern*Lophiuspiscatorius* and blackbellied angler *Lophiusbudegassa* (2004-2010). Working document-07 presented at WKFLAT2012. ICES CM: ACOM: 46.

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

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4.3.11 Tables and Figures

Table 4.3.1 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a.
Tonnes landed by the main fishing fleets for 1978-2018 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	9	11	895	117	35	1	6	94	253	1 148	4	1 153

n/a: not available

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

Landings BelowMinimumSize	Trawl	Gillnet
Year	Weight (t)	Weight (t)
2018	0.027	0.111

Discards Estimates: Trawl

Year	Weight (t)	CV	% Trawl Catches	% Total Catches
1994	20.9	34.05	2.4	1.0
1995	n/a	n/a	n/a	n/a
1996	n/a	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	n/a	0.1	0.0
2000	6.2	n/a	1.6	0.5
2001	n/a	n/a	n/a	n/a
2002	n/a	n/a	n/a	n/a
2003	26.2	n/a	2.1	1.1
2004	64.9	n/a	4.1	2.0
2005	56.2	n/a	3.1	1.5
2006	99.3	n/a	6.5	3.3
2007	17.2	n/a	1.5	0.7
2008	5.1	n/a	0.5	0.2
2009	24.5	n/a	3.6	1.1
2010	12.5	n/a	2.3	0.8
2011	30.1	n/a	9.1	2.6
2012	66.7	n/a	11.4	4.8
2013	65.8	n/a	17.0	4.3
2014	24.4	n/a	5.2	1.2
2015	20.8	n/a	4.4	1.2
2016	0.03	n/a	0.0	0.0
2017	13.3	n/a	3.1	0.9
2018	4.1	n/a	0.9	0.4

Discards Estimates: Gillnet

Year	Weight (t)	CV	% Gillnet Catches	% Total Catches
2013	143.8	n/a	16.1	9.3
2014	0.0	n/a	0.0	0.0
2015	7.6	n/a	0.8	0.4
2016	24.2	n/a	2.4	1.3
2017	17.0	n/a	1.9	1.2
2018	1.8	n/a	1.9	0.2

n/a: not available
CV: coefficient of variation

Table 4.3.3 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a.
Length composition by fleet and ajusted length composition for total landings (thousands) in 2018.
Ajusted TOTAL: ajusted to landings from fleets without length compostion.

	Div. 8c			Div. 9a				Div. 8c+9a	
	SPAIN			SPAIN	PORTUGAL				
Length (cm)	Trawl	Gillnet	TOTAL	Trawl	Trawl	Artisanal	TOTAL	TOTAL	Ajusted TOTAL
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	0.06	0.00	0.06	0.00	0.36	0.00	0.00	0.06	0.07
32	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00
33	0.27	0.00	0.27	0.00	0.00	0.00	0.47	0.74	0.76
34	0.07	0.00	0.07	0.00	0.10	0.00	0.00	0.07	0.08
35	0.32	0.00	0.32	0.00	1.19	0.00	0.00	0.32	0.34
36	0.37	0.00	0.37	0.00	0.00	0.00	0.00	0.37	0.40
37	0.27	0.00	0.27	0.10	0.27	0.00	0.46	0.74	0.76
38	0.36	0.00	0.36	0.03	0.05	0.00	0.12	0.49	0.50
39	0.52	0.00	0.52	0.03	0.00	0.00	0.03	0.54	0.57
40	0.26	0.00	0.26	0.09	0.00	0.00	0.19	0.45	0.45
41	0.53	0.00	0.53	0.03	0.00	0.00	1.22	1.75	1.75
42	0.32	0.00	0.32	0.03	0.00	0.00	0.03	0.35	0.36
43	0.24	0.00	0.24	0.09	0.00	0.00	0.36	0.60	0.60
44	0.84	0.00	0.84	0.07	0.00	0.00	0.12	0.96	1.00
45	0.23	0.00	0.23	0.11	0.00	0.00	0.11	0.34	0.34
46	0.53	0.00	0.53	0.17	0.10	0.00	0.17	0.70	0.71
47	0.62	0.00	0.62	0.04	0.39	0.00	0.04	0.66	0.68
48	0.75	0.00	0.75	0.04	0.00	0.00	0.04	0.79	0.81
49	0.92	0.04	0.96	0.12	0.00	0.00	0.12	1.08	1.11
50	0.89	0.00	0.89	0.27	0.00	0.05	0.27	1.16	1.19
51	0.51	0.00	0.51	0.27	0.00	0.10	0.27	0.78	0.79
52	0.36	0.07	0.43	0.11	0.00	0.59	0.20	0.63	0.65
53	0.80	0.00	0.80	0.07	0.00	0.00	0.47	1.27	1.32
54	0.38	0.00	0.38	0.34	0.00	0.09	0.34	0.71	0.71
55	0.54	0.05	0.59	0.43	0.11	0.11	0.43	1.02	1.05
56	0.79	0.03	0.81	0.47	0.00	0.70	0.53	1.34	1.36
57	0.81	0.18	0.99	0.37	0.00	0.00	0.47	1.47	1.51
58	0.66	0.22	0.88	0.41	0.00	0.00	1.00	1.87	1.93
59	0.41	0.15	0.56	0.28	0.00	0.00	0.28	0.84	0.87
60	0.62	0.55	1.17	0.29	0.00	0.73	0.38	1.55	1.63
61	0.80	0.67	1.47	0.38	0.11	0.05	0.60	2.07	2.17
62	0.55	0.99	1.54	0.61	0.00	0.05	1.32	2.86	2.96
63	1.16	0.81	1.97	0.60	0.00	0.05	0.60	2.57	2.68
64	0.93	1.20	2.13	0.61	0.00	0.14	0.61	2.74	2.86
65	1.00	0.89	1.89	0.55	0.00	0.29	0.55	2.43	2.52
66	0.78	1.55	2.33	0.71	0.00	0.23	1.44	3.77	3.92
67	1.12	1.92	3.05	0.30	0.00	0.41	0.46	3.50	3.69
68	1.10	1.89	2.99	0.37	0.00	0.19	0.42	3.41	3.61
69	0.83	2.25	3.07	0.76	0.00	0.05	0.82	3.89	4.07
70	0.75	3.05	3.80	0.40	0.04	0.66	0.54	4.34	4.57
71	0.67	2.40	3.07	0.53	0.00	0.00	0.82	3.90	4.09
72	0.76	2.50	3.26	0.87	0.00	0.22	1.11	4.37	4.58
73	1.08	2.40	3.48	0.27	0.00	0.11	0.68	4.16	4.36
74	0.64	2.44	3.08	0.19	0.00	0.00	0.38	3.46	3.67
75	0.84	3.03	3.87	0.52	0.00	0.13	0.57	4.44	4.69
76	0.68	2.29	2.98	0.30	0.00	0.14	1.00	3.98	4.19
77	1.10	2.39	3.49	0.35	0.11	0.48	0.35	3.84	4.08
78	0.67	1.88	2.55	0.34	0.00	0.05	0.56	3.11	3.29
79	0.81	2.28	3.09	0.64	0.00	0.05	0.75	3.84	4.03
80	0.94	2.20	3.14	0.19	0.00	0.10	0.19	3.33	3.53
81	0.68	1.50	2.18	0.32	0.00	0.11	0.45	2.62	2.76
82	0.71	1.97	2.68	0.54	0.04	0.19	0.68	3.36	3.53
83	0.87	2.27	3.14	0.42	0.00	0.10	1.01	4.15	4.35
84	0.52	2.01	2.54	0.24	0.00	0.22	0.30	2.84	3.02
85	0.59	1.32	1.91	0.24	0.00	0.48	0.29	2.21	2.32
86	0.41	1.82	2.23	0.47	0.00	0.05	0.57	2.81	2.95
87	0.87	1.29	2.17	0.27	0.00	0.05	0.38	2.55	2.67
88	0.32	1.76	2.08	0.22	0.00	0.10	0.45	2.53	2.68
89	0.49	1.26	1.76	0.14	0.00	0.10	0.25	2.00	2.13
90	0.61	1.49	2.10	0.15	0.00	0.13	0.37	2.47	2.62
91	0.66	1.07	1.72	0.14	0.00	0.51	0.62	2.34	2.45
92	0.48	1.19	1.67	0.40	0.00	0.00	0.45	2.13	2.22
93	0.49	1.12	1.61	0.25	0.00	0.40	0.30	1.91	2.00
94	0.50	1.04	1.54	0.06	0.00	0.43	0.17	1.71	1.84
95	0.41	1.15	1.55	0.15	0.00	0.05	0.25	1.81	1.90
96	0.34	1.09	1.43	0.00	0.00	0.00	0.13	1.56	1.65
97	0.25	1.22	1.47	0.01	0.00	0.26	0.52	1.99	2.08
98	0.26	0.81	1.07	0.05	0.00	0.00	0.05	1.12	1.19
99	0.19	0.93	1.12	0.13	0.00	0.00	0.53	1.65	1.73
100+	2.16	10.01	12.17	1.50	0.00	2.42	3.92	16.09	16.92
TOTAL	43.3	76.7	120.0	19.5	3.4	11.4	33.5	153.5	160.9
Tonnes	231.9	613.8	845.7	117.4	5.6	94.5	217.5	1063.2	1152.6
Mean Weight (g)	5356	8006	7050	6035	1626	8857	6483	6926	7163
Mean length (cm)	69.6	82.8	78.0	73.5	45.5	84.9	74.3	77.2	77.3

Table 4.3.4 ANGLERFISH (*L. piscatorius*). Divisions 8c and 9a.
Numbers, mean weight and mean length of landings between 1986 and 2018.

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

Table 4.3.5 ANGLERFISH (*L. piscatorius*). Divisions 8c and 9a.
Abundance indices from Spanish and Portuguese surveys.

	SP-NSGFS-Q4 September-October (total area Miño-Bidasoa)					PtGFS-WIBTS-Q4 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

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 4.3.6 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	--	--	--	--	--	--	--	

	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	--

Table 4.3.7 ANGLERFISH (*L. piscatorius*) - Division 8c and 9a.
Summary of the assessment results.

Year	Recruit Age0 (thousands)	Total Biomass (t)	Total SSB (t)	Landings (t)	Yield/SSB	F (30-130 cm)
1980	686	15 462	9 772	4 817	0.49	0.30
1981	1 941	16 492	11 344	5 566	0.49	0.33
1982	7 335	15 556	11 876	5 782	0.49	0.38
1983	1 932	14 357	10 628	6 113	0.58	0.49
1984	777	14 046	8 815	6 031	0.68	0.51
1985	1 828	13 018	8 412	6 139	0.73	0.54
1986	6 525	10 771	7 763	6 870	0.89	0.80
1987	3 721	7 407	4 798	5 139	1.07	0.92
1988	1 074	7 306	3 145	6 321	2.01	1.40
1989	3 336	5 961	2 481	4 995	2.01	1.10
1990	2 231	4 943	2 413	3 790	1.57	0.81
1991	1 063	4 811	2 217	3 640	1.64	0.83
1992	1 320	4 514	2 118	3 382	1.60	0.87
1993	1 700	3 792	1 976	2 329	1.18	0.63
1994	3 131	3 833	2 069	2 007	0.97	0.50
1995	1 819	4 643	2 337	1 835	0.79	0.33
1996	335	6 592	3 298	2 956	0.90	0.39
1997	283	7 547	4 366	3 715	0.85	0.45
1998	225	6 830	4 757	2 981	0.63	0.38
1999	744	5 807	4 602	1 933	0.42	0.29
2000	648	5 120	4 268	1 256	0.29	0.24
2001	3 722	4 967	4 012	788	0.196	0.16
2002	1 615	5 852	4 215	1 093	0.26	0.188
2003	349	7 999	4 840	2 326	0.48	0.29
2004	2 178	9 411	5 913	3 258	0.55	0.33
2005	1 376	9 630	6 855	3 827	0.56	0.38
2006	1 298	9 076	6 577	2 998	0.46	0.34
2007	724	8 891	6 369	2 377	0.37	0.28
2008	796	9 192	6 741	2 372	0.35	0.25
2009	909	9 276	7 140	2 307	0.32	0.25
2010	1 580	9 115	7 272	1 620	0.22	0.178
2011	1 243	9 593	7 640	1 156	0.151	0.128
2012	563	10 884	8 466	1 396	0.165	0.133
2013	882	12 165	9 502	1 540	0.162	0.130
2014	1 740	13 188	10 714	2 033	0.190	0.159
2015	262	13 643	11 339	1 771	0.156	0.137
2016	212	14 401	11 896	1 809	0.152	0.142
2017	185	14 645	12 432	1 447	0.116	0.111
2018	353	14 757	13 116	1 153	0.088	0.093
2019	712*	14 645	13 477			

*geometric.mean(2003-2018)

Table 4.3.8. ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a.
Catch option table.

SSB(2019)	Rec proj	F(30-130cm)	Land(2019)	SSB(2020)
13 477	712	0.093	1050	13 250

Fmult	Fland (30-130cm)	Landings (2020)	SSB (2021)
0	0	0	13 857
0.1	0.0093	93	13 744
0.2	0.0185	185	13 632
0.3	0.028	276	13 522
0.4	0.037	367	13 413
0.5	0.046	456	13 304
0.6	0.056	545	13 197
0.7	0.065	632	13 090
0.8	0.074	719	12 985
0.9	0.083	805	12 881
1	0.093	890	12 777
1.1	0.102	975	12 675
1.2	0.111	1058	12 574
1.3	0.120	1141	12 473
1.4	0.130	1223	12 374
1.5	0.139	1304	12 275
1.6	0.148	1384	12 178
1.7	0.157	1464	12 081
1.8	0.167	1542	11985
1.9	0.176	1620	11890
2	0.185	1697	11797
2.1	0.195	1774	11703
2.2	0.20	1850	11611
2.3	0.21	1925	11520
2.4	0.22	1999	11429
2.5	0.23	2073	11340
2.6	0.24	2146	11251

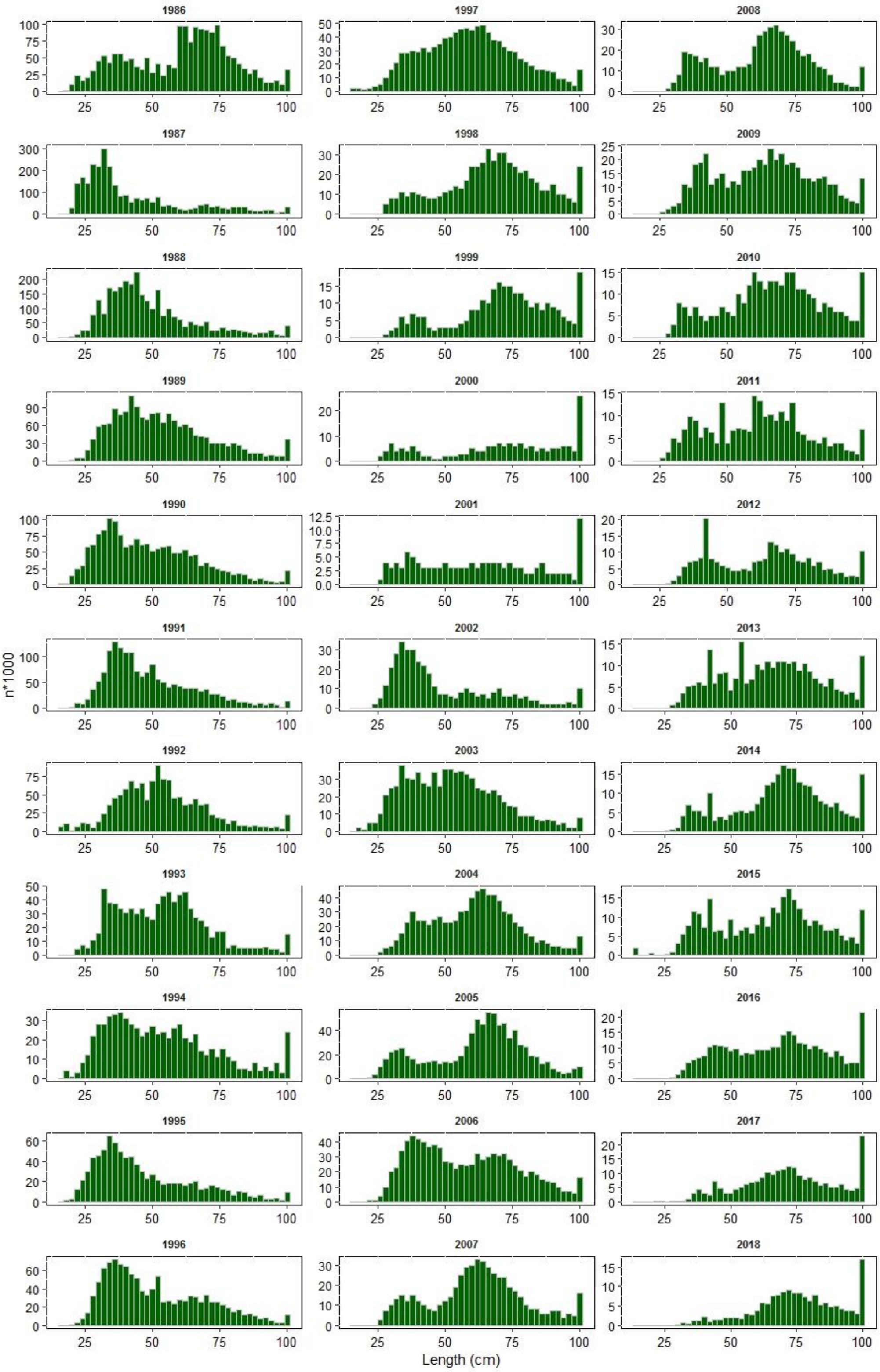


Figure 4.3.1. ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Length distributions of landings (thousands for 1986 to 2018).

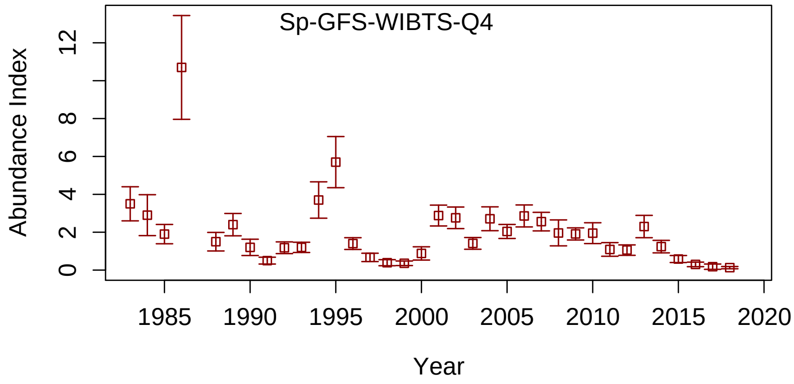


Figure 4.3.2 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a.Abundance index from survey SP-NSGFS-Q4 in numbers/30 min. Bars represent 95% confidence intervals.

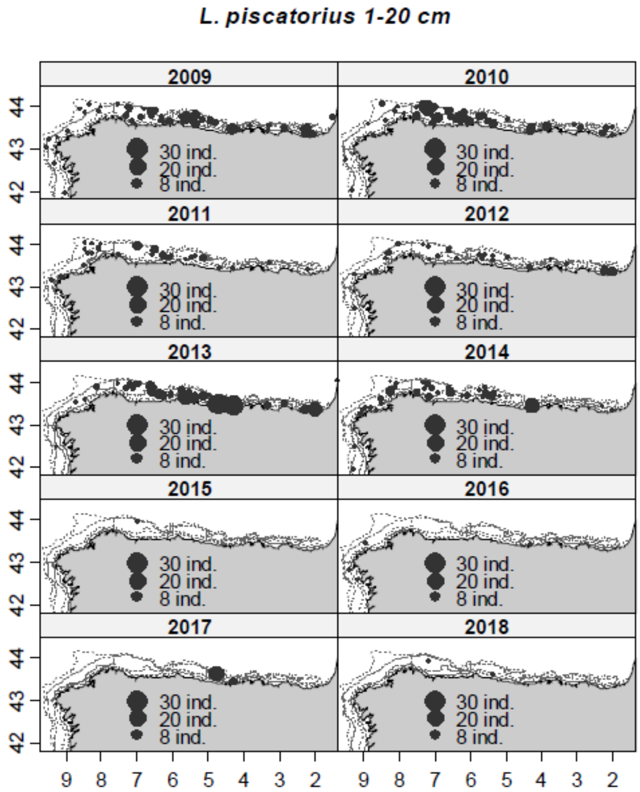


Figure 4.3.3. ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a.Spatial distribution of juveniles (length 0- 20 cm) in North Spanish Coast demersal survey (SP-NSGFS-Q4) between 2009 and 2018.

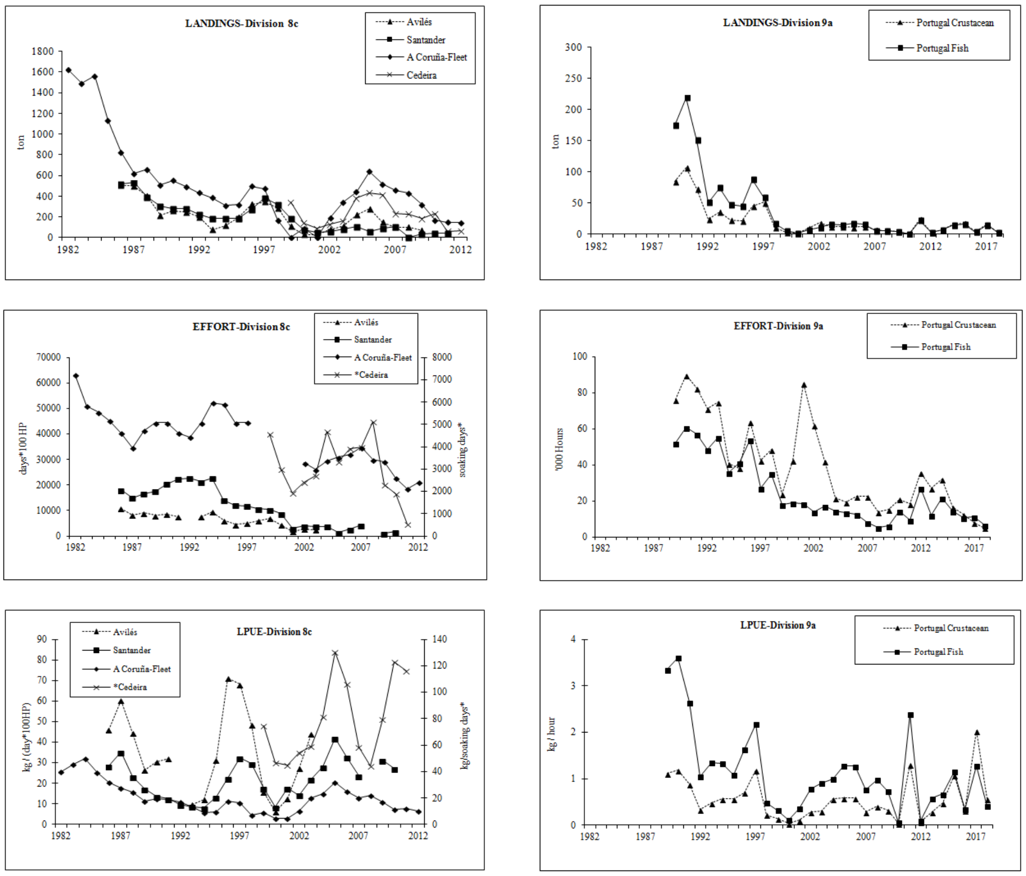


Figure 4.3.4. ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Trawl and gillnet landings, effort and LPUE data between 1986-2018.

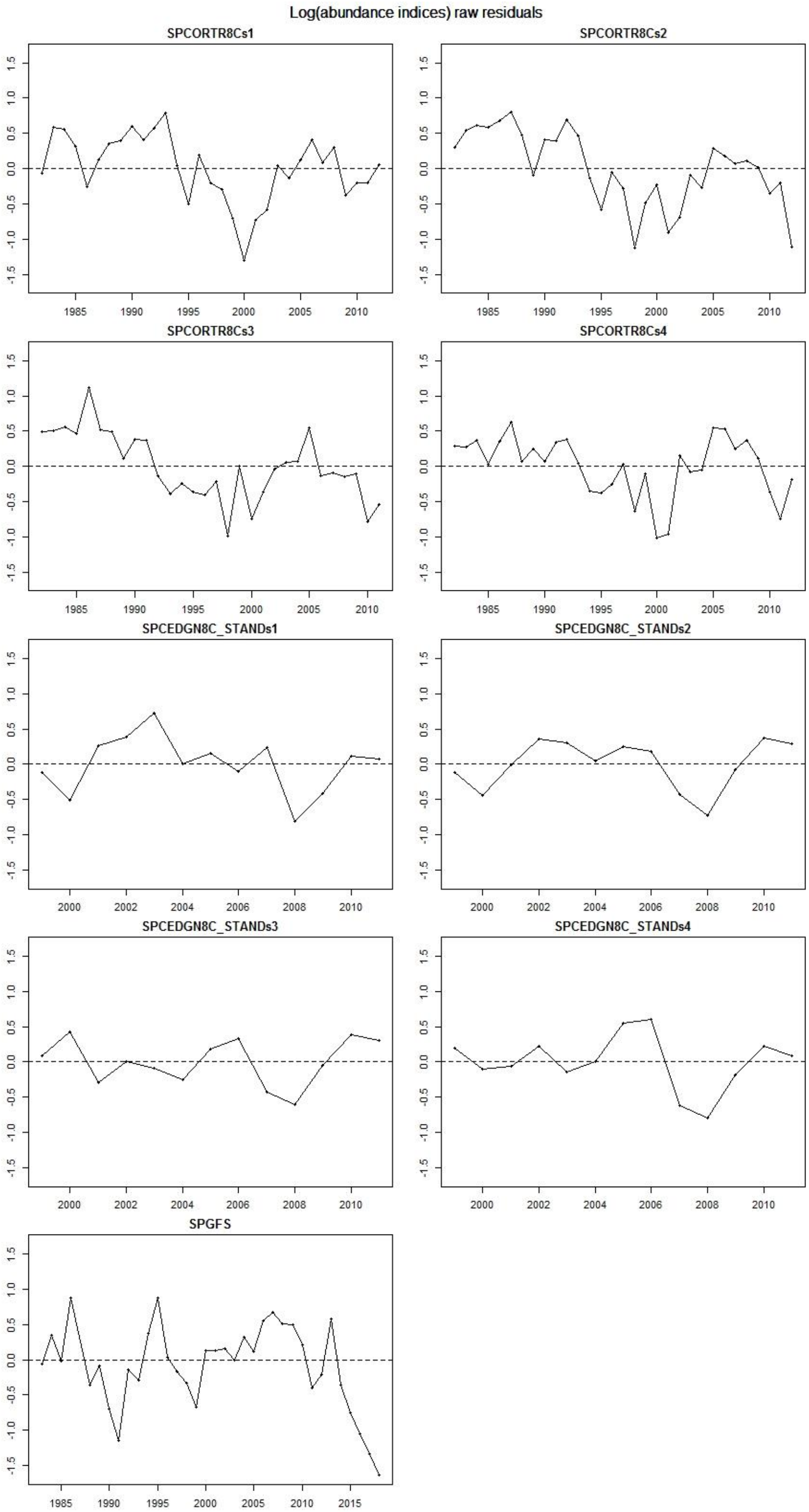


Figure 4.3.5 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Residuals of the fits to the surveys in log(abundance indices). A Coruña and Cedeira are by quarters.

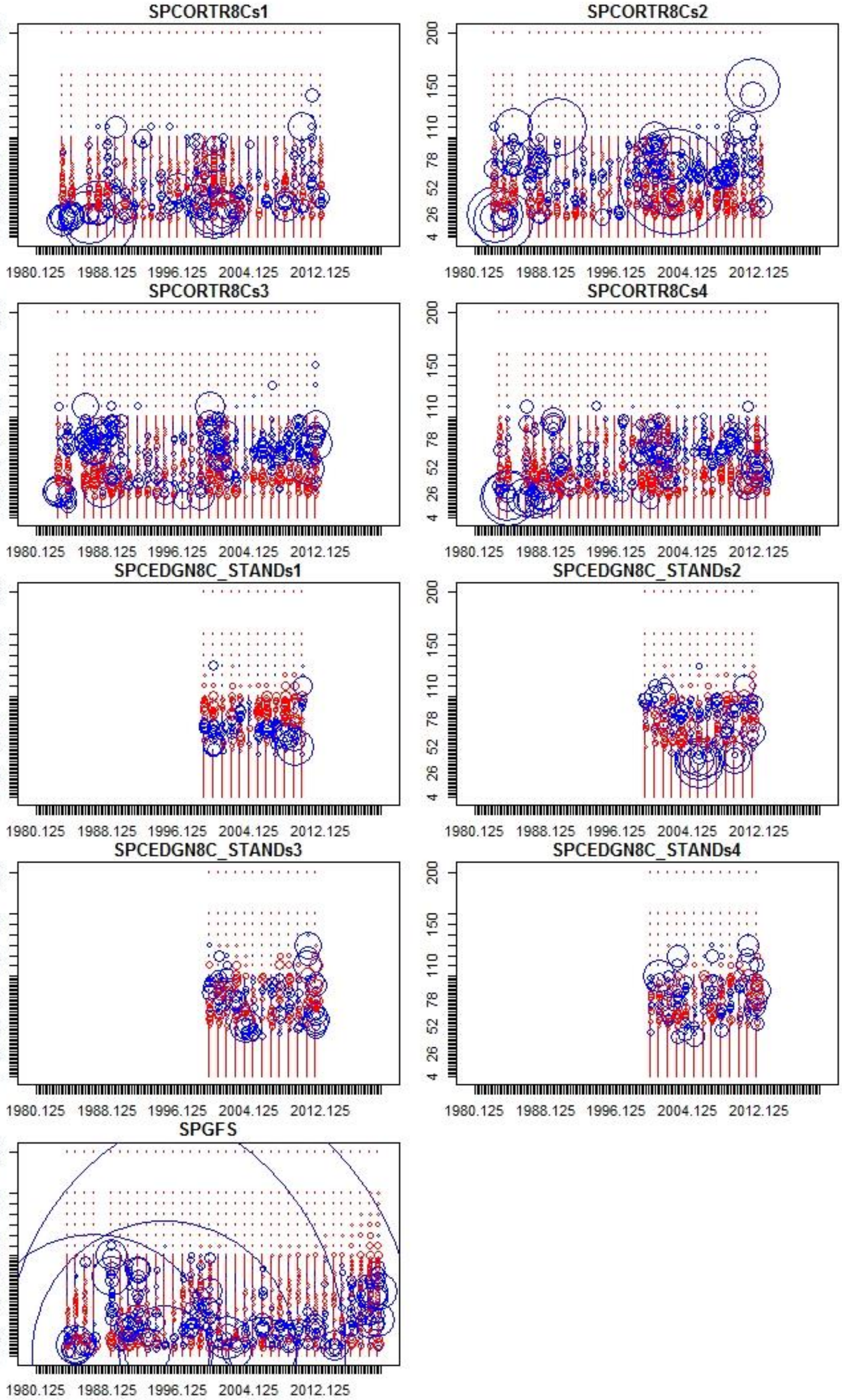


Figure 4.3.6 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Pearson residuals of the fit to the length distributions of the abundance indices. Blue=positive residuals and red=negative residuals.

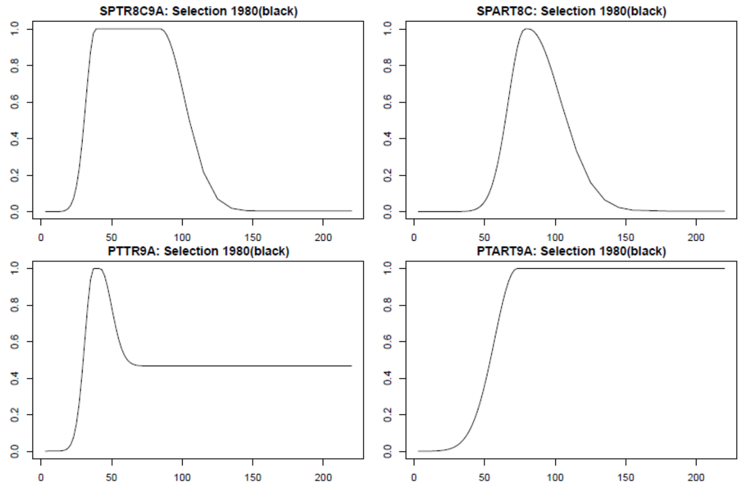


Figure 4.3.7 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Relative selection patterns at length by fishery estimated by SS.

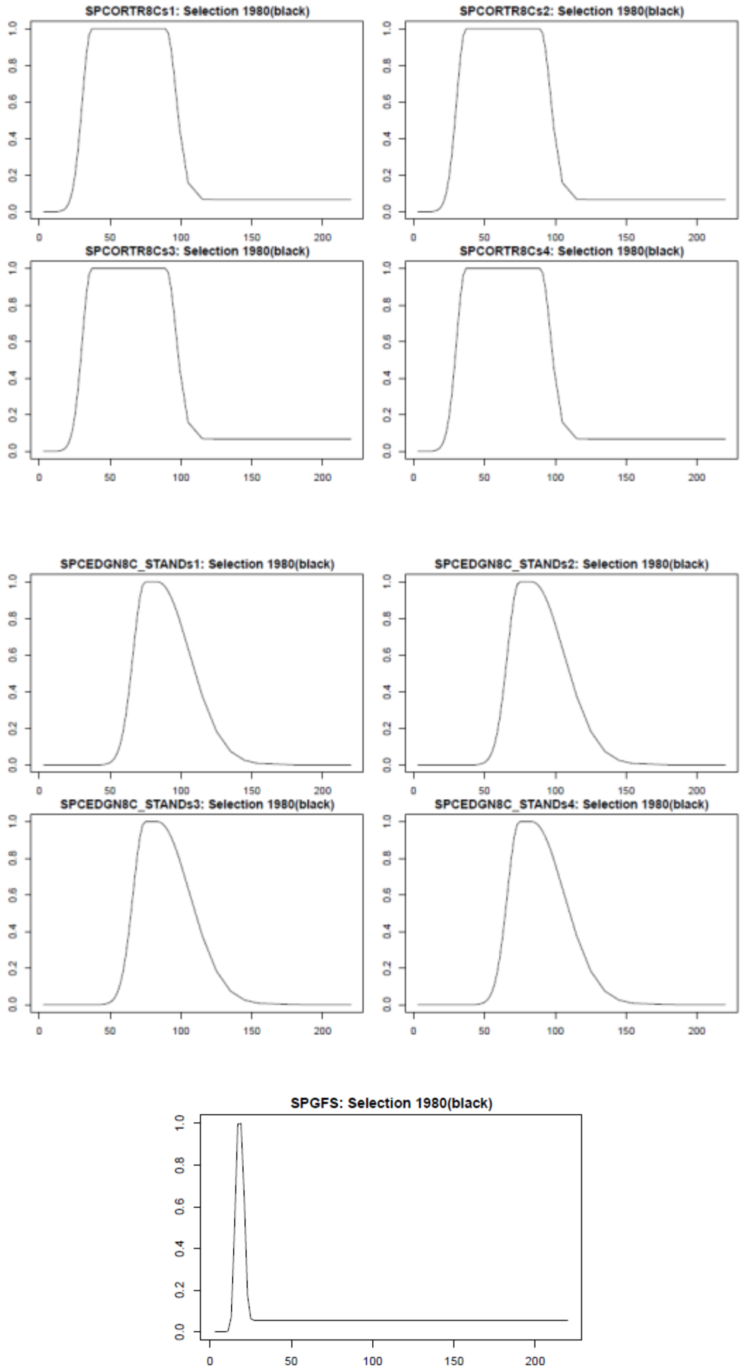


Figure 4.3.8 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a.Relative selection patterns at length by abundance index estimated by SS. A Coruña and Cedeira indices are by quarter.

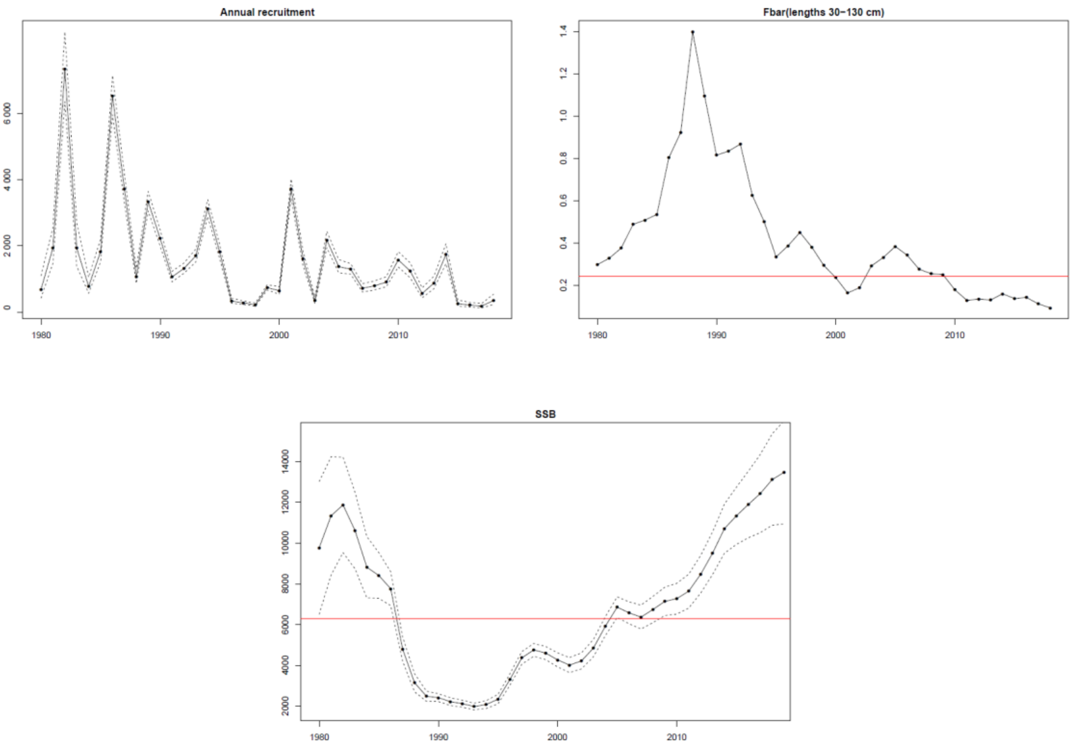


Figure 4.3.9 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Summary plots of stock trends (with 90% intervals).

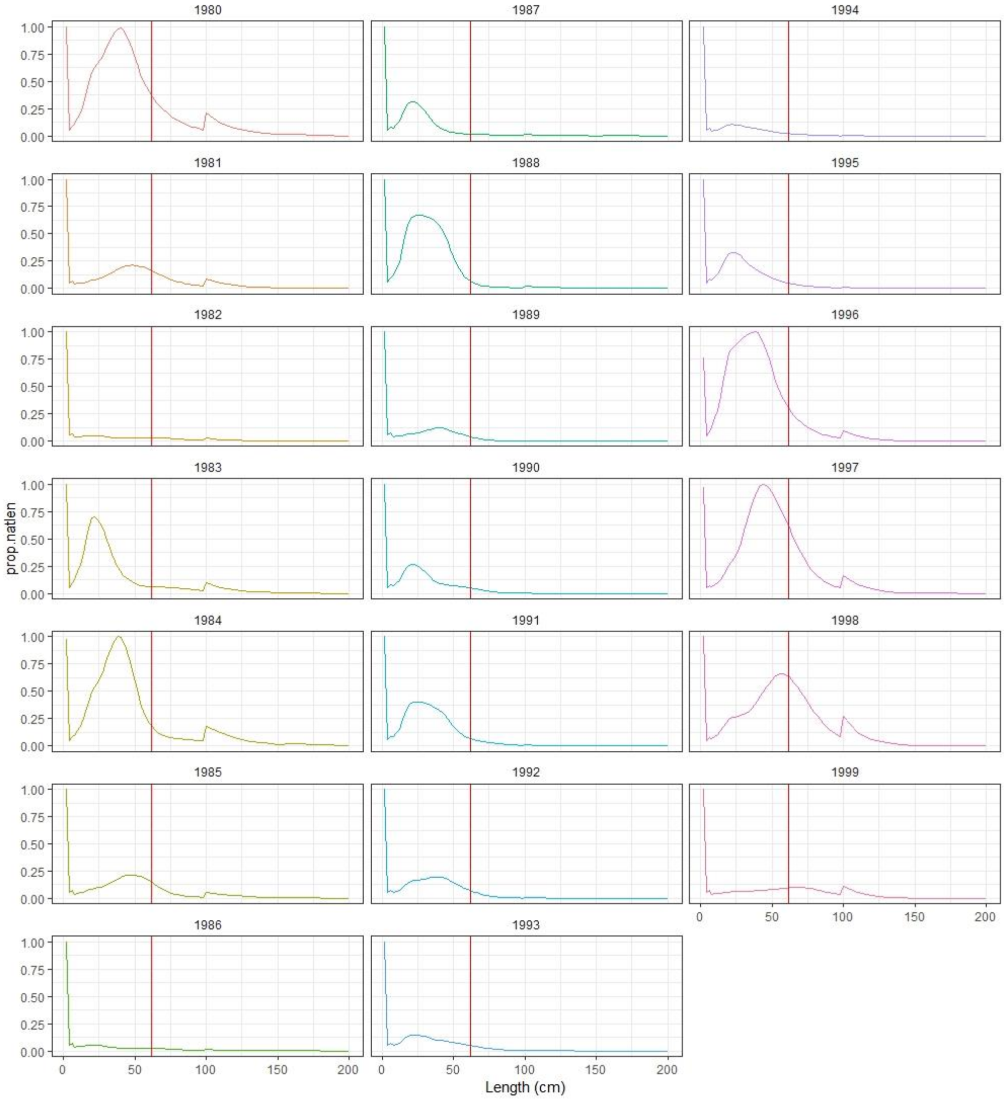


Figure 4.3.10 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Standardized length composition of the population for the time series (1980-2019). The vertical red line indicates the maturity length (L_{50}=61.8 cm).

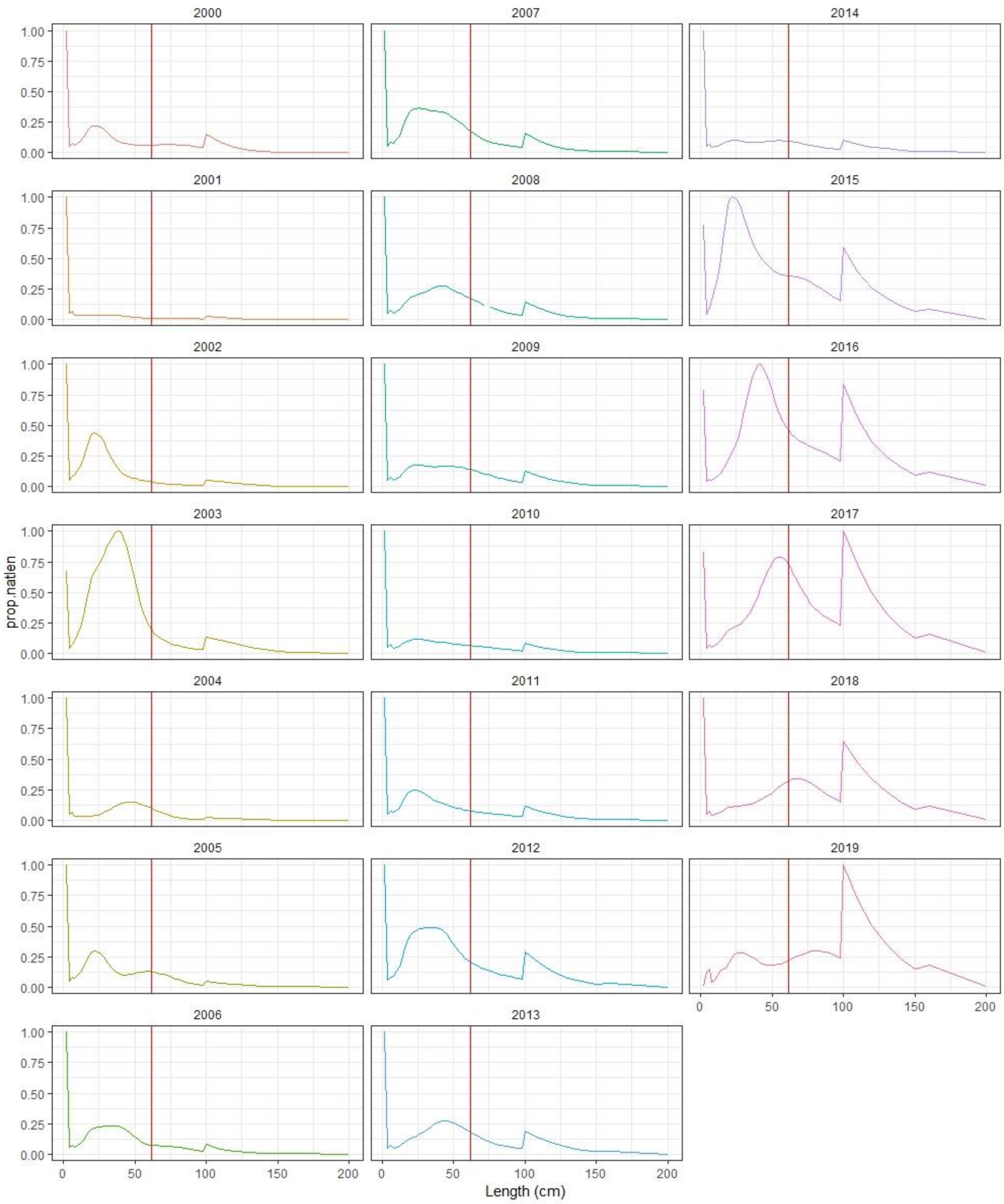


Figure 4.3.10 continued

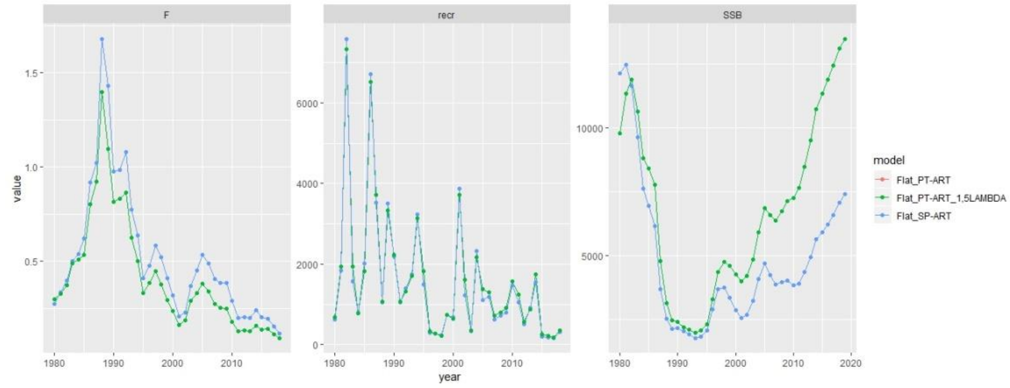


Figure 4.3.11 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Sensitivity analysis: Summary plots of the stock trends.

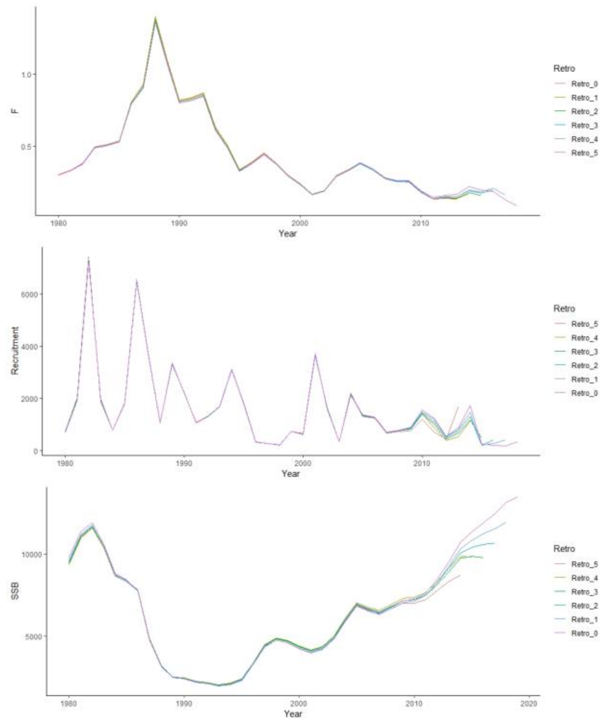


Figure 4.3.12 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Retrospective plots from SS.

4.4 Anglerfish (*Lophius budegassa*) in Divisions 8c and 9a

4.4.1 General

Ecosystem aspects

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

4.4.2 Fishery description

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

The length distribution of the landings varies among fisheries, with the 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 are similar. Since 2008, the Spanish landings were mostly allocated to the trawl fleet (65%; mean lengths in 2018 of 46.7 cm in Divisions 8.c and 9.a), followed by the gillnet fishery (29%; mean length in 2018 of 60.0 cm in Division 8.c) and other fleets (6%). Portuguese landings, for the same period, were derived, in a great extent from the artisanal fleet (70%; mean length of 60.6 cm in 2018), followed by the trawl fleet (30%; mean length of 50.1 cm in 2018). French landings since 2008 correspond, on average, to 66% from the trawl fleet, 34% from the gillnet fleet and <0.5% from others fleets.

4.4.3 Data

4.4.3.1 Commercial catches and discards

Total landings of *L. budegassa* by country and gear for the period 1978–2018, 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). French landing data was available to WGBIE from 2002 to 2018. Unallocated/non reported landings for this stock were available from 2011 to 2016 and again in 2018. Historical landings analysis is available in the Stock Annex. The unallocated/non reported values were considered realistic and are taken into account for the assessment. Estimates of unallocated or non-reported landings were based on the sampled vessels (Spanish concurrent sampling) raised to the total effort for each metier and quarter.

From 2002 to 2007 landings increased to 1 306 t, decreasing afterwards to levels between 754–774 t in 2009–2010. From 2011 to 2016 catches fluctuated between 948 t and 1 141 t but decreased to 861 in 2017 and to 764 t in 2018.

Spanish trawl and gillnet discards estimates of *L. budegassa* in weight and associated coefficient of variation (CV) are shown in Table 4.4.2. The estimated Spanish trawl discards rate observed from 1994–2018, 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 percentage of occurrence of *L. budegassa* discards in the trawl Portuguese fisheries were presented for the 2004–2013 period (Prista *et al*. 2014 – WD3 WGBIE 2014). The maximum occurrence of 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 occurrence of anglerfish in the discards, it is not possible to apply the algorithm used for hake (presented in the WD). For this reason, discards 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.

4.4.3.2 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 2018 are shown in Table 1.4. The métier sampling adopted in Spain and Portugal in 2009, following the requirement of EU Data Collection Framework, can have an effect on the provided data. Spanish sampling levels are similar to previous years but an important 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 2018 (excluding unallocated/non reported landings). 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 2018 are presented in Figure 4.4.1.

In 2002, an increase of smaller individuals is apparent (around 30–35 cm), that is confirmed in the 2003 length distribution. In 2006 and 2007 there was an increase in the number of smaller individuals which was confirmed by the lowest annual mean lengths (37 and 39 cm) observed since 1986. From 2008 to 2013 these small fish were not observed. In 2014, a small mode was observed at smaller lengths decreasing the annual mean length, but since then the levels of small fish in the sampled catches decreased. The total annual landings in numbers, the annual mean length and the mean weight are presented in Table 4.4.4.

In 2005, the estimated total number of landed individuals was low, being 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. This value increased in 2010 and 2011 but has been decreasing to minimum levels since then. The estimated mean weight continued at relative high levels.

4.4.3.3 Abundance indices from surveys

Spanish and Portuguese survey results for the period 1983–2018 are summarized in Table 4.4.5. The Portuguese survey was not performed in 2012. Considering the very small amount of caught anglerfish in the two surveys, these indices were considered unsuitable to evaluate the change in the abundance of this species.

The absence of *L budegassa* in the Portuguese ground fish survey and the near zero numbers of *L. budegassa* less than 21 cm in the Spanish bottom trawl surveys on the Northern Spanish Shelf in 2014-2015 suggests a lack of recruitment in the area surveyed (Figure 4.4.2). The small peak of individuals below 20 cm observed in the 2016 Spanish survey is the first signal of recruitment since 2013 (WD03) but, in recent years, no small fish were observed.

4.4.3.4 Commercial catch-effort data

Landings, effort and LPUE data are given in Table 4.4.6 and Figure 4.4.3 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 is 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.

Since 2013, Spain only provided information for A Coruña port series. Effort data in 2013 for this tuning fleet 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 methods of estimating and sources of information employed.

Three LPUE series were presented in the past for the A Coruña trawler fleet: "A Coruña port" for trips that are exclusively landed in the port, "A Coruña trucks" for trips that are landed in other ports and "A Coruña fleet" that takes into account all the trips of the fleet. The LPUE series used in the assessment (A Coruña fleet) was not updated for 2013-2018. The revision was carried out only for the A Coruña port series and it was not possible during the WG to analyse the potential use of this series for the assessment instead of the incomplete A Coruña fleet series.

For the Portuguese fleets, until 2011, 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. The two LPUE series available were revised from 2012 onwards. To revise the series backwards further refinement of the algorithms is required.

Excluding the Avilés and Santander fleets, from the late eighties to mid-nineties, the overall trend in landings for all fleets was decreasing. A slight increase was then 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 Aviles and Santander fleets show high values during the second half of the 90's. Despite the variability, from 2000 to 2005, a decreasing trend was observed for all fleets and since then a slightly increasing trend can be observed. The LPUE from the Portuguese trawl fleet targeting crustaceans presents an increasing trend and reached a maximum value in 2018. The LPUE from the Portuguese trawl fleet targeting fish is variable but also reached a maximum value recently, in 2016. After a decrease in 2017, the series increased, again, in 2018.

Effort trends are analysed in section 4.3.4.4.

4.4.4 Assessment

In WKANGLER 2018, the assessment of the status of each anglerfish species was carried out separately (ICES, 2018a). A new model was proposed for the assessment of *L. budegassa*, a stochastic production model in continuous-time (SPiCT; Pedersen and Berg, 2017).

The SPiCT model was considered more reliable than the prior model, ASPIC, since it does not require the use of fixed parameters, such as B1/k, to be stable.

The new assessment model (SPiCT) is more optimistic in estimating the status of the stock and hence the ratio between the fishing mortality and F_{MSY} is lower. Consequently, projections under the MSY approach provide higher catch advice. The assessment performed in 2018 showed that, if fishing at F_{MSY}, catches should be increased to ~5500 tonnes, values never reached in this fishery. Looking at the historical catches and respective relative biomass and fishing mortality, it is observed that when catch values attained their maximum (~4000 tonnes) the biomass decreased in the following years. WGBIE 2018 agreed that those values give greater uncertainty especially considering that historical catches have never been at this level before. A stepwise procedure to achieve F_{MSY} was recommended by WKANGLER. WGBIE 2018 agreed that a good stepwise approach to F_{MSY} was the lower confidence interval value of F_{MSY} scenario, which gave fishing opportunities of no more than 2682 tonnes, an increase of 12% when comparing to 2017 advice.

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. The stepwise approach proposed by WGBIE 2018 was rejected by ACOM (ICES, 2018b). 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, using SPiCT results (ICES, 2018b).

4.4.4.1 SPiCT Model

The SPiCT model, accepted at the WGANGLER 2018, assumes the Schaefer population growth model (fixed parameter) and the default biomass and catches observed/process error ratios (alpha and beta, respectively).

The SPiCT data, all assumed at the beginning of the year:

- Total landings since 1980–2018 (discards are considered negligible).
- Portuguese trawl fleet targeting crustaceans (1989–2018) (Index1)
- Portuguese trawl fleet targeting fish (1989–2018) (Index2)
- Spanish A Coruña fleet (1982–2012) (Index3)

The input data are presented in Table 4.4.7. and Figure 4.4.4.

SPiCT settings:

- Euler time step (years): 1/16 (default)
- Production curve shape: assume Schaefer (n=2).
- Alpha (Biomass observation and process errors ratio): estimated by the model (default priors).
- Beta Catch observation and process errors ratio): estimated by the model (default priors).
- Other parameters: default (estimated by the model).

4.4.4.1.1 Assessment diagnostics

No significant bias is observed in the OSA (one-step-ahead) residuals. The diagnostics show some autocorrelation for index 1 - PT-TRC9A (the Portuguese trawl crustacean series) but that was considered not meaningful. Both QQ-plot and the Shapiro test shows normality in the residuals (Figure 4.4.5.).

Some retrospective pattern is observed, suggesting some past underestimation of fishing mortality and overestimation of biomass. However, each peel of the retro is within the 95% confidence intervals of the assessment (Figure 4.4.6.). The Mohn´s rho statistics (Mohn, 1999), to measure the retrospective patterns, were estimated as 0.038 and for -0.048 for B/B_{MSY} and F/F_{MSY}, respectively, indicating no strong retrospective pattern.

4.4.4.1.2 Assessment results

SPiCT results are presented in Tables 4.4.8. and 4.4.9 and in Figure 4.4.7. The stock biomass (B) increased from 2005 to 2016 decreasing in the last three years of the series (the model estimates the biomass value at the beginning of the year so the value from 2019 is presented) and is estimated to be above MSY $B_{trigger}$ proxy over the whole time-series. Fishing mortality (F) has decreased since 1994 and is estimated to have been below F_{MSY} proxy since 1998.

4.4.5 Short-term projections

No projections were performed. The advice for this stock follows the ICES rules for Data Limited Stocks, category 3.2.0.

4.4.6 Biological Reference Points

WKANGLER (ICES, 2018a) reiterated the basis for MSY reference points previously assumed by ICES (2018a). 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 $B_{trigger\ proxy}$	0.5 × $B_{MSY\ proxy}$ = 0.25 × K*	Relative value. B_{MSY} proxy is estimated directly from the assessment model and changes when the assessment is updated.	ICES (2018a, 2018b)
	$F_{MSY\ proxy}$	r/2*	Relative value. The F_{MSY} proxy is estimated directly from the assessment model and changes when the assessment is updated.	ICES (2018a, 2018b)
Precautionary approach	$B_{lim\ proxy}$	0.3 × $B_{MSY\ proxy}$*	Relative value (equilibrium yield at this biomass is 50% of the MSY proxy).	ICES (2018a, 2018b)
	B_{pa}	Not defined		
	$F_{lim\ proxy}$	1.7 × $F_{MSY\ proxy}$*	Relative value (the F that drives the stock to the proxy of B_{lim}).	ICES (2018a, 2018b)
	F_{pa}	Not defined		
Management plan	SSB_{mgt}	Not applicable		
	F_{mgt}	Not applicable		
	MAP MSY $B_{trigger}$	0.5 × $B_{MSY\ proxy}$ = 0.25 × K*	MSY $B_{trigger\ proxy}$	EU (2019)
	MAP B_{lim}	0.3 × $B_{MSY\ proxy}$ *	$B_{lim\ proxy}$	EU (2019)
	MAP F_{MSY}	r/2*	$F_{MSY\ proxy}$	EU (2019)
	MAP range F_{lower}	0.78 $F_{MSY\ proxy}$	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with the MSY (ICES, 2018a).	ICES (2018a) and EU (2019)
	MAP range F_{upper}	$F_{MSY\ proxy}$ (F_{2018} × 3.631)	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with the MSY (ICES, 2018a).	ICES (2018a) and EU (2019)

4.4.7 Comments on the assessment

This stock was benchmarked in 2018 (ICES, 2018a); therefore, the present assessment is not fully comparable with previous years' assessment (see section 4.4.4. Assessment).

The SPiCT diagnostics shows some autocorrelation for PT-TRC9A (the Portuguese trawl series) which was not considered a matter of concern. Some retrospective pattern is observed, suggesting some past underestimation of fishing mortality and overestimation of biomass, however each peel of the retro is within the 95% confidence intervals of the assessment.

The SPiCT (Pedersen and Berg, 2016) model was considered more reliable than ASPIC since it does not require the use of fixed parameters, such as B1/k, to be stable. The SPiCT model with these settings was accepted as the basis for advice (ICES, 2018a).

4.4.8 Quality considerations

Three LPUE series were presented in the past for the A Coruña trawler fleet: "A Coruña port" for trips that are exclusively landed in the port, "A Coruña trucks" for trips that are landed in other ports and "A Coruña fleet" that takes into account all the trips of the fleet. The LPUE series used in the assessment (A Coruña fleet) was not updated for 2013–2018. The revision was carried out only for the A Coruña port series and it was not possible during the WG to analyse the potential use of this series for the assessment instead of the incomplete A Coruña fleet series.

For the Portuguese fleets, until 2011 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 revised from 2012 onwards in 2015. To revise the series backwards further refinement of the algorithms is required.

4.4.9 Management considerations

Management considerations are in section 4.2.

4.4.10 References

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. 17 pp. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0472&from=EN

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.

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

4.4.11 Tables and Figures

Table 4.4.1. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. Tonnes landed by the main fishing fleets for 1978-2018 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	3	4	0	350	126	37	1	52	185	402	752	11	764

Table 4.4.2. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. 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

GILLNETS

TRAWL				
Year	**Weight (t)**	**CV**	**% Trawl Catches**	**% Total Catches**
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

n/a: not available

CV: coefficient of variation

Table 4.4.3. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. Length composition by fleet for landings in 2018 (thousands). 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
15				0.090					
16				0.045					
17				0.045					
18				0.045					
19				0.180					
20				0.361		0.515	0.876	0.876	0.906
21				0.090		0.258	0.348	0.348	0.355
22				0.225		0.515	0.740	0.740	0.759
23				0.845	0.076	0.515	1.436	1.436	1.506
24				1.510	0.167	0.624	2.301	2.301	2.426
25				0.800	0.333	0.109	1.241	1.241	1.308
26				2.995	0.091	0.258	3.343	3.343	3.592
27				0.000	0.499	0.624	1.123	1.123	1.123
28				1.420	0.575	0.367	2.362	2.362	2.480
29				0.767	2.152		2.919	2.919	2.982
30				3.243	0.408		3.651	3.651	3.921
31	0.207		0.207	0.186	0.257	0.109	0.552	0.759	0.795
32	0.417		0.417	1.715	0.408		2.123	2.540	2.725
33	1.267		1.267	3.957	0.348		4.305	5.573	6.028
34	1.418	0.044	1.461	2.300	0.257	0.042	2.599	4.060	4.398
35	1.151	0.000	1.151	2.189	0.257	0.083	2.530	3.680	3.977
36	1.592	0.249	1.841	2.695	0.076	0.042	2.812	4.653	5.063
37	2.606	0.158	2.763	2.708	0.182	0.001	2.890	5.654	6.156
38	2.541	0.110	2.651	3.158	1.764	0.166	5.088	7.738	8.267
39	5.143	0.367	5.510	4.514	0.000	0.125	4.639	10.149	11.077
40	3.359	0.581	3.940	2.289	0.076	0.125	2.489	6.429	7.017
41	5.441	0.646	6.087	3.581	0.000	0.125	3.706	9.793	10.704
42	3.416	0.616	4.032	3.485	0.000	0.042	3.527	7.558	8.256
43	3.155	0.547	3.702	4.484	0.000	2.056	6.540	10.242	10.989
44	3.962	0.158	4.120	3.384	0.138	0.042	3.564	7.684	8.378
45	2.781	1.160	3.941	2.253	0.161	0.000	2.414	6.355	6.945
46	5.216	0.246	5.462	1.389	0.034	0.113	1.536	6.998	7.661
47	3.426	0.256	3.682	1.781	0.109	0.590	2.480	6.162	6.680
48	2.455	0.466	2.921	0.931	0.034	0.471	1.436	4.357	4.730
49	2.051	0.371	2.422	1.560	3.383	1.131	6.074	8.496	8.871
50	2.007	0.559	2.566	0.630	0.078	0.323	1.031	3.597	3.910
51	1.907	0.682	2.589	0.479	0.034	0.265	0.777	3.366	3.670
52	1.497	0.990	2.488	0.884	0.234	1.479	2.597	5.084	5.414
53	2.522	1.130	3.652	0.811	0.111	0.109	1.031	4.683	5.125
54	1.885	1.093	2.978	0.806	0.145	0.013	0.963	3.941	4.314
55	1.277	1.788	3.065	0.614	0.089	0.438	1.141	4.207	4.579
56	1.678	1.329	3.007	0.655	0.011	0.467	1.133	4.140	4.506
57	2.411	1.589	3.999	0.282		6.470	6.752	10.751	11.187
58	0.934	1.383	2.317	0.658	0.133	0.317	1.108	3.425	3.723
59	1.002	3.247	4.249	1.291	0.011	0.109	1.411	5.660	6.218
60	0.615	2.242	2.856	0.304	0.011	0.025	0.340	3.197	3.526
61	0.726	2.226	2.952	0.289		0.957	1.246	4.198	4.535
62	0.927	2.366	3.293	0.434	0.033	0.113	0.580	3.873	4.258
63	0.536	2.201	2.738	1.044			1.044	3.782	4.160
64	0.794	2.083	2.877	0.354		0.109	0.463	3.340	3.674
65	0.728	1.738	2.466	0.160	0.033	0.526	0.719	3.185	3.459
66	0.456	1.087	1.543	0.207		0.156	0.363	1.906	2.086
67	0.767	1.342	2.109	0.115		0.013	0.128	2.236	2.467
68	0.415	1.264	1.679	1.054		4.586	5.640	7.319	7.584
69	0.550	1.192	1.741	0.014	0.011	2.155	2.180	3.921	4.106
70	0.694	0.731	1.425	0.054	0.078	0.025	0.157	1.582	1.735
71	0.534	0.773	1.308	0.867		1.356	2.223	3.531	3.740
72	0.520	0.849	1.369	0.240	0.011	1.296	1.548	2.916	3.080
73	0.437	0.792	1.229	0.127		0.453	0.580	1.808	1.948
74	0.903	0.459	1.362	0.278	2.464	0.429	3.171	4.533	4.696
75	0.313	0.559	0.872	0.167	1.230	3.499	4.896	5.768	5.874
76	0.433	0.395	0.828	0.085	0.011	0.013	0.109	0.936	1.029
77	0.485	0.177	0.662	0.053	0.419	1.444	1.917	2.579	2.651
78	0.626	0.350	0.976	0.054		0.880	0.934	1.910	2.015
79	0.503	0.094	0.598	0.112		0.962	1.074	1.671	1.741
80	0.442	0.151	0.593	0.368	1.306	0.261	1.936	2.528	2.620
81	0.523	0.095	0.618	0.133		0.156	0.289	0.906	0.980
82	0.455	0.046	0.501	0.240	0.011	0.417	0.668	1.169	1.239
83	0.076	0.121	0.197	0.084	0.067	1.051	1.201	1.398	1.426
84	0.107	0.037	0.144	0.322		0.420	0.742	0.886	0.927
85	0.206	0.043	0.249	0.064	0.011	0.013	0.088	0.337	0.367
86	0.126	0.352	0.478	0.147	0.011		0.158	0.637	0.699
87	0.351	0.000	0.351	0.231	0.011		0.242	0.594	0.648
88	0.045	0.068	0.113	0.973		0.646	1.619	1.732	1.825
89	0.219	0.000	0.219	0.111		0.013	0.124	0.342	0.373
90	0.155		0.155	0.150		0.420	0.570	0.724	0.752
91	0.132	0.023	0.155	0.119			0.119	0.274	0.300
92			0.000	0.012	0.067	0.131	0.209	0.209	0.210
93	0.042	0.045	0.087	0.012		0.131	0.143	0.230	0.240
94	0.042	0.022	0.064	0.025			0.025	0.089	0.098
95	0.046		0.046	0.897			0.897	0.943	1.022
96	0.030	0.015	0.045	0.000				0.045	0.049
97									
98				0.012		0.123	0.135	0.135	0.136
99				0.009			0.009	0.009	0.010
100+	0.129					0.447	0.447	0.447	0.460
TOTAL	84	44	128	78	18	42	139	266	285
Landings (t)	186	156	342	126	52	185	364	706	752
Mean Weight (g)	2224	3568	2685	1616	2841	4386	2621	2651	2636
Mean Length (cm)	49.6	60.0	53.2	43.5	50.1	60.6	49.5	51.3	51.3
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. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. Number, mean weight and mean length of landings between 1986 and 2018.

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	297	2672	50
2018	285	2636	51

Table 4.4.5. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. Abundance indices from Spanish (stratified mean) and Portuguese research surveys (simple mean).

	SpGFS-WIBTS-Q4 September-October (total area Miño-Bidasoa)					PtGFS-WIBTS-Q4 October		
Year	Hauls	kg/30 min		N/30 min		Hauls	N/60 min	kg/60 min
		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
1994	118	0.75	0.17	1.00	0.12	94	0.06	0.09
1995	116	0.72	0.12	1.00	0.11	88	0.02	0.08
1996*	114	0.95	0.17	1.30	0.18	71	0.27	0.50
1997	116	1.16	0.20	0.97	0.11	58	0.03	0.01
1998	114	0.88	0.18	0.57	0.09	96	0.02	0.12
1999*	116	0.43	0.12	0.26	0.06	79	0.08	0.07
2000	113	0.66	0.18	0.40	0.08	78	0.13	0.13
2001	113	0.19	0.06	0.52	0.10	58	+	+
2002	110	0.26	0.09	0.33	0.07	67	0	0
2003*	112	0.36	0.11	0.35	0.10	80	0.22	0.21
2004*	114	0.76	0.23	0.44	0.12	79	0.14	0.21
2005	116	0.64	0.20	1.62	0.30	87	0.01	+
2006	115	1.08	0.22	1.16	0.19	88	0.02	0.46

	SpGFS-WIBTS-Q4 September-October (total area Miño-Bidasoa)					PtGFS-WIBTS-Q4 October		
Year	**Hauls**	**kg/30 min**		**N/30 min**		**Hauls**	**N/60 min**	**kg/60 min**
		Yst	**Sst**	**Yst**	**Sst**			
2007	117	0.59	0.12	0.48	0.08	96	0.02	0.03
2008	115	0.35	0.09	0.29	0.05	87	0.07	0.36
2009	117	0.30	0.08	0.35	0.08	93	0.02	+
2010	127	0.35	0.09	0.53	0.09	87	0.09	0.18
2011	111	0.63	0.15	0.52	0.08	86	0.02	0.06
2012	115	0.61	0.10	0.74	0.11	ns	ns	ns
2013**	114	1.27	0.36	1.40	0.35	93	0.02	0.03
2014**	116	1.11	0.27	0.87	0.15	81	0.00	0.00
2015**	114	0.55	0.13	0.36	0.08	90	0.00	0.00
2016**	114	0.51	0.10	0.40	0.06	85	0.02	0.30
2017**	112	0.55	0.15	0.35	0.08	89	0.09	0.05
2018**	113	0.76	0.23	0.29	0.07	53	0.08	0.10

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 Spain Surveys - R/V Miguel Oliver, other years R/V Cornide Saavedra**

Table 4.4.6. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. Landings, fishing effort, standardized fishing effort, landings per unit effort and standardized landings per unit effort for trawl (all but STAND-SP-CEDGNS8C) and gillnet fleets (STAND-SP-CEDGNS8C). For landings the percentage relative to 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	6	12 449	5,2	--	--	--	--	--	--	--	--
2018	79	9	13 247	6,0	--	--	--	--	--	--	--	--

	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	1,17	3,92	183	7	52	18	3,51	10,4
1990	127	5	90	20	1,41	6,19	261	11	61	17	4,29	15,2
1991	101	5	83	17	1,22	6,05	208	10	57	15	3,65	13,5
1992	94	4	71	15	1,32	6,19	193	9	49	14	3,97	14,1
1993	64	3	75	13	0,85	4,78	132	6	56	13	2,37	10,1
1994	26	2	41	8	0,64	3,38	53	3	36	10	1,50	5,5
1995	22	1	38	8	0,58	2,84	46	2	41	9	1,11	5,0
1996	45	3	64	14	0,70	3,11	88	5	54	12	1,62	7,1
1997	38	2	43	11	0,88	3,32	43	2	27	9	1,60	4,9
1998	70	3	48	11	1,45	6,30	111	5	35	10	3,16	11,5
1999	41	2	24	8	1,72	5,00	69	4	18	6	3,85	12,2
2000	66	5	42	10	1,56	6,55	76	6	19	6	4,04	12,6
2001	59	6	85	18	0,69	3,21	42	4	19	5	2,27	8,5
2002	47	6	62	10	0,75	4,81	28	3	14	4	2,00	6,2
2003	30	3	42	10	0,71	3,11	38	4	17	6	2,17	6,7
2004	23	2	21	7	1,07	3,51	27	3	14	4	1,90	6,2
2005	12	1	20	5	0,63	2,42	19	2	13	4	1,38	5,0
2006	18	2	22	5	0,80	3,31	22	2	12	4	1,73	5,6
2007	34	3	22	6	1,53	5,61	31	2	8	3	3,98	10,5
2008	21	2	14	4	1,50	5,40	19	2	5	2	3,56	10,6
2009	18	2	15	--	1,14	--	16	2	6	--	2,65	--
2010	37	5	21	--	1,75	--	34	4	14	--	2,37	--
2011	39	4	18	--	2,15	--	36	4	9	--	3,91	--
2012	81	7	36	--	2,26	--	75	7	16	--	4,73	--
2013	52	5	27	--	1,92	--	48	4	12	--	3,95	--
2014	60	6	17	--	3,52	--	56	6	16	--	3,45	--
2015	66	6	17	--	3,99	--	61	6	14	--	4,29	--
2016	62	6	12	--	5,05	--	57	6	11	--	5,30	--
2017	35	4	9	--	4,55	--	32	4	11	--	2,87	--
2018	27	4	5	--	5,41	--	25	3	6	--	3,90	--

Table 4.4.7. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. SPiCT input data (landings in tonnes, SPCORTR8c LPUE in kg/days*100HP, PT LPUEs in kg/hour).

Year	Catch	SPCORTR8c	PT.crust.tr	PT.fish.tr
1980	2110			
1981	2300			
1982	2369	10.34		
1983	2379	14.99		
1984	1929	11.80		
1985	1833	5.61		
1986	2563	8.71		
1987	3832	19.41		
1988	3700	13.75		
1989	2578	7.74	1.17	3.51
1990	2334	6.49	1.41	4.29
1991	2162	5.56	1.22	3.65
1992	2111	5.41	1.32	3.97
1993	2227	4.47	0.85	2.37
1994	1580	3.89	0.64	1.50
1995	1843	8.28	0.58	1.11
1996	1629	9.05	0.70	1.62
1997	1813	7.65	0.88	1.60
1998	2089	10.94	1.45	3.16
1999	1879	12.42	1.72	3.85
2000	1369	9.55	1.56	4.04
2001	1013	9.40	0.69	2.27
2002	810	3.74	0.75	2.00
2003	934	4.89	0.71	2.17
2004	993	3.63	1.07	1.90
2005	933	2.76	0.63	1.38
2006	1161	4.69	0.80	1.73
2007	1306	6.39	1.53	3.98

Year	Catch	SPCORTR8c	PT.crust.tr	PT.fish.tr
2008	957	8.69	1.50	3.56
2009	774	5.05	1.14	2.65
2010	754	8.75	1.75	2.37
2011	948	7.71	2.15	3.91
2012	1141	8.17	2.26	4.73
2013	1071		1.92	3.95
2014	998		3.52	3.45
2015	1047		3.99	4.29
2016	1014		5.05	5.30
2017	861		4.55	2.87
2018	764		5.41	3.90

Table 4.4.8. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. SPiCT summary results

Model parameter estimates w 95% CI				
	estimate	**cilow**	**ciupp**	**log.est**
alpha1	1.590	0.967	2.617	0.464
alpha2	1.335	0.779	2.290	0.289
alpha3	1.479	0.931	2.348	0.391
beta	0.139	0.023	0.834	-1.974
r	0.481	0.218	1.058	-0.732
rc	0.481	0.218	1.058	-0.732
rold	0.481	0.218	1.058	-0.732
m	2077	1503	2869	7.639
K	17278	7320	40782	9.757
q1	0.000	0.000	0.000	-8.662
q2	0.000	0.000	0.001	-7.974
q3	0.001	0.000	0.003	-6.984
sdb	0.206	0.149	0.284	-1.581
sdf	0.146	0.100	0.213	-1.922
sdi1	0.327	0.220	0.487	-1.117
sdi2	0.275	0.186	0.405	-1.292
sdi3	0.304	0.224	0.414	-1.190
sdc	0.020	0.003	0.118	-3.896

Deterministic reference points (Drp)				
	estimate	**cilow**	**ciupp**	**log.est**
B_{MSYD}	8639	3660	20391	9
F_{MSYD}	0.240	0.109	0.529	-1.425
MSYd	2077	1503	2869	7.639

Stochastic reference points (Srp)					
	estimate	**cilow**	**ciupp**	**log.est**	**rel.diff.Drp**
B_{MSYS}	8148	3515	18886	9	8148
F_{MSYS}	0.230	0.102	0.519	-1.470	0.230
MSYs	1 869	1 357	2 573	8	1 869

States w 95% CI (inp$msytype: s)				
	estimate	**cilow**	**ciupp**	**log.est**
B_2018.00	14689	5636	38283	10
F_2018.00	0.056	0.021	0.145	-2.889
B_2018.00/B_{MSY}	1.803	1.158	2.807	0.589
F_2018.00/F_{MSY}	0.242	0.139	0.420	-1.419

Predictions w 95% CI (inp$msytype: s)				
	prediction	**cilow**	**ciupp**	**log.est**
B_2019.00	13870	5295	36332	10
F_2019.00	0.054	0.020	0.141	-2.928
B_2019.00/B_{MSY}	1.702	1.087	2.665	0.532
F_2019.00/F_{MSY}	0.233	0.130	0.415	-1.458
Catch_2019.00	748	521	1076	7
E(B_inf)	13680			10

Table 4.4.9. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. 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	1.39	2.94	0.66	0.80	1.68	0.38
1981	1.42	2.74	0.74	0.83	1.65	0.41
1982	1.45	2.63	0.8	0.86	1.65	0.45
1983	1.5	2.68	0.84	0.88	1.67	0.46
1984	1.31	2.31	0.75	0.88	1.66	0.47
1985	1.07	1.84	0.62	0.86	1.60	0.47
1986	1.21	2.05	0.71	0.92	1.67	0.50
1987	1.64	2.82	0.95	1.09	2.0	0.60
1988	1.68	2.97	0.95	1.31	2.5	0.69
1989	1.19	2.09	0.68	1.30	2.5	0.68
1990	1.04	1.84	0.59	1.25	2.4	0.66
1991	0.94	1.65	0.53	1.27	2.4	0.67
1992	0.87	1.53	0.49	1.33	2.5	0.70
1993	0.78	1.37	0.45	1.53	2.9	0.80
1994	0.62	1.07	0.36	1.51	2.8	0.80
1995	0.63	1.08	0.37	1.40	2.6	0.76
1996	0.72	1.25	0.42	1.30	2.4	0.69
1997	0.77	1.32	0.45	1.11	2.1	0.60
1998	1.07	1.86	0.61	1.03	1.94	0.54
1999	1.19	2.13	0.67	0.94	1.82	0.49
2000	1.05	1.89	0.58	0.84	1.65	0.43
2001	0.79	1.42	0.44	0.79	1.54	0.40
2002	0.61	1.08	0.34	0.74	1.44	0.38
2003	0.61	1.09	0.34	0.75	1.44	0.39
2004	0.65	1.14	0.37	0.83	1.59	0.43
2005	0.58	1.02	0.33	0.82	1.56	0.43
2006	0.7	1.22	0.4	0.75	1.44	0.40

Year	B/B_{MSY}			F/F_{MSY}		
	Estimate	CI high	CI Low	Estimate	CI high	CI Low
2007	1.02	1.82	0.57	0.70	1.35	0.36
2008	1.05	1.85	0.6	0.59	1.13	0.30
2009	0.9	1.55	0.52	0.48	0.90	0.25
2010	0.98	1.65	0.59	0.40	0.75	0.22
2011	1.18	1.98	0.71	0.38	0.70	0.21
2012	1.47	2.45	0.88	0.39	0.72	0.21
2013	1.58	2.59	0.97	0.37	0.68	0.21
2014	1.64	2.61	1.03	0.33	0.59	0.186
2015	1.81	2.86	1.15	0.30	0.53	0.171
2016	2.03	3.18	1.29	0.29	0.50	0.164
2017	1.83	2.83	1.18	0.27	0.46	0.152
2018	1.8	2.81	1.16	0.24	0.42	0.139
2019	1.7	2.67	1.09	0.23	0.42	0.130
Average	1.16	2	0.68	0.82	1.56	0.43

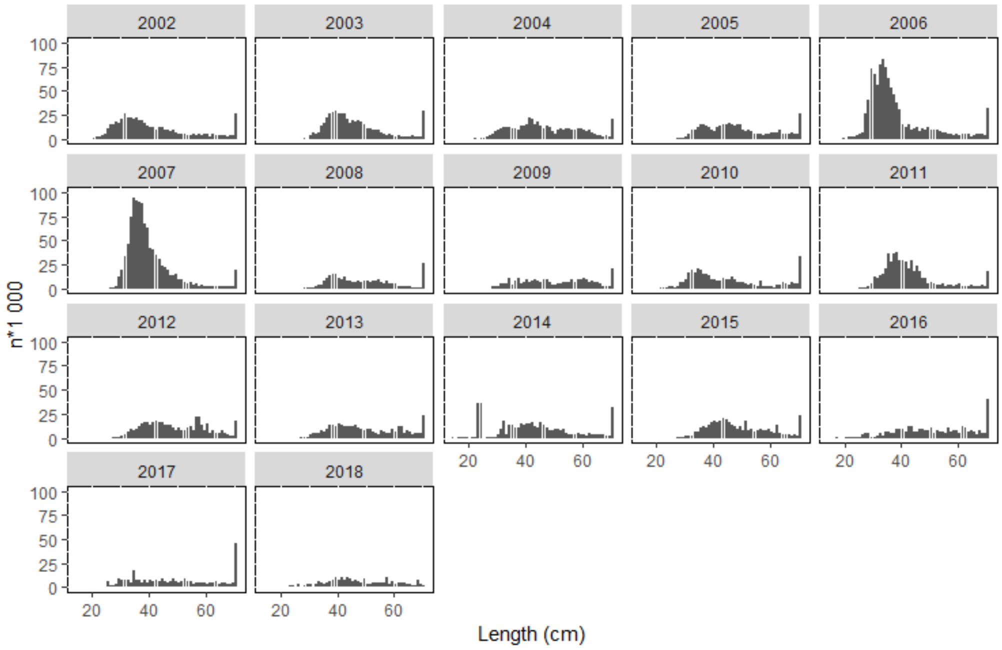


Figure 4.4.1 ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. Length distributions of landings (thousands for 2002–2018).

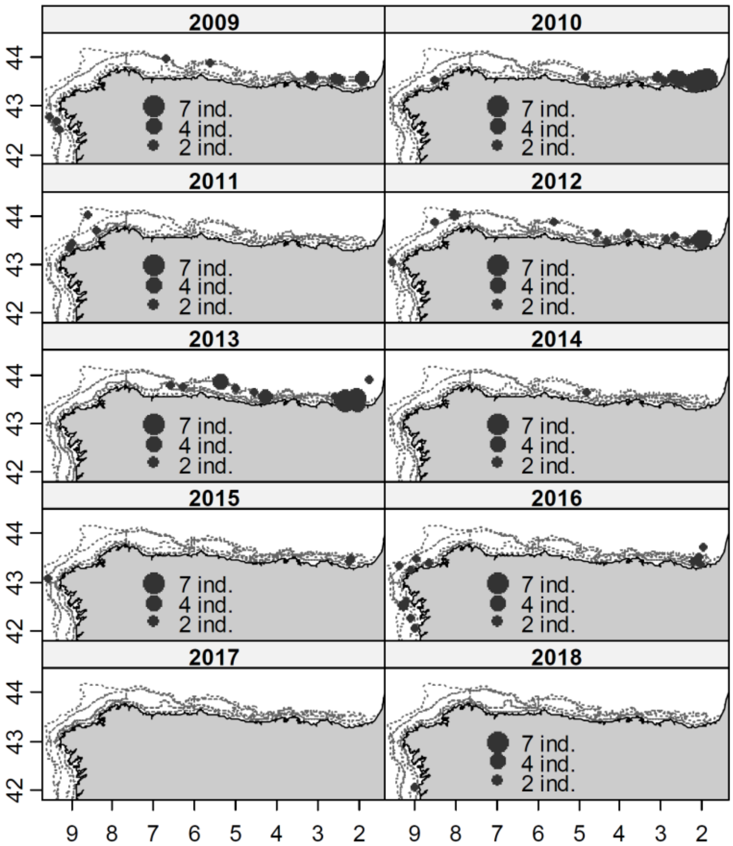


Figure 4.4.2 ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. Distribution of black anglerfish (*L. budegassa*) juveniles (0–20 cm) in SpGFS-WIBTS-Q4 between 2009–2018.

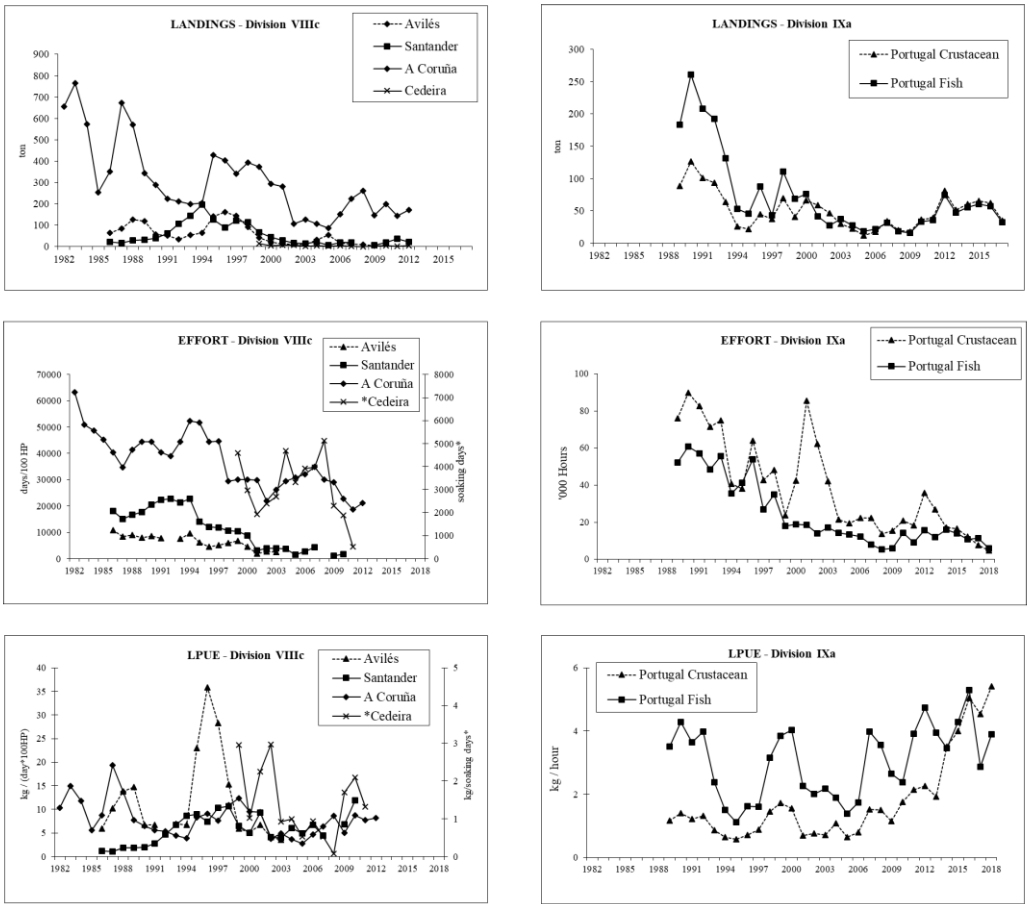


Figure 4.4.3 ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. Trawl and gillnet landings, effort and LPUE data between 1986 and 2018.

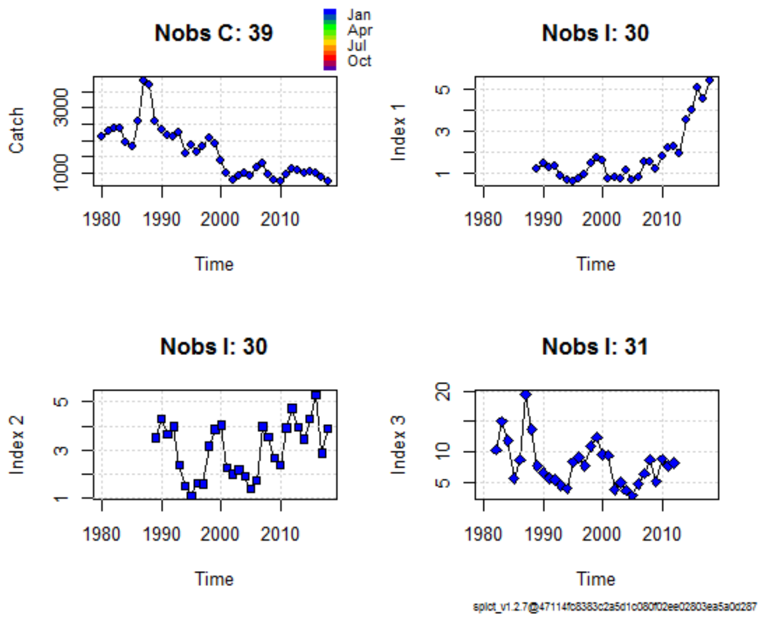


Figure 4.4.4. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. SPiCT input data. Upper panel, Catch and PT-TRC9a LPUE index (Portuguese trawl fleet targeting crustaceans, 1989 - 2018). Lower panel, PT-TRF9a LPUE index (Portuguese trawl fleet targeting fish, 1989 - 2018) and SP-CORTR8C-FLEET LPUE index (A Coruña trawl fleet, 1982 - 2012).

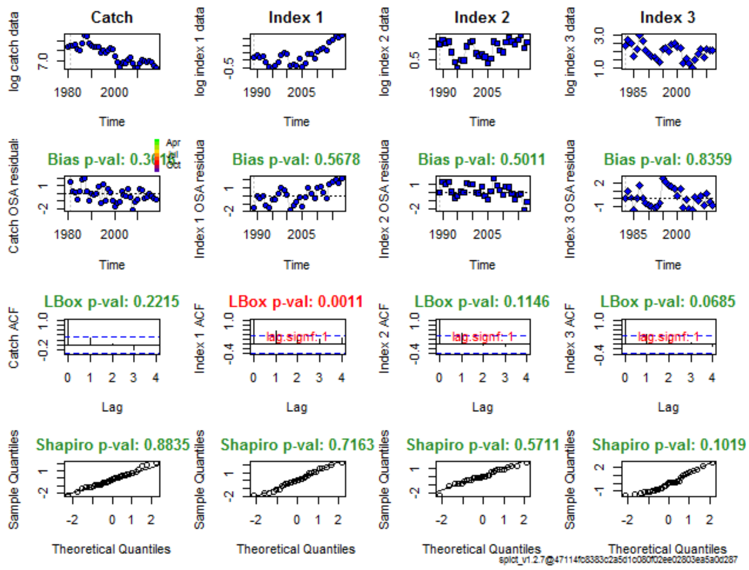


Figure 4.4.5. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. SPiCT diagnostics. Row1, Log of the input data series. Row 2, OSA residuals with the p-value of a test for bias. Row 3, Empirical autocorrelation of the residuals with tests for significant autocorrelation. Row 4, Tests for normality of the residuals, QQ-plot and Shapiro test.

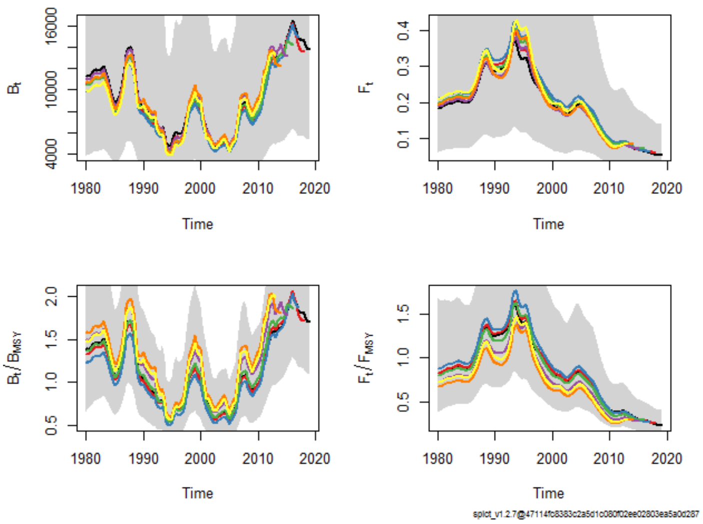


Figure 4.4.6. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. 6 years' retrospective analysis. Upper panel, absolute biomass and fishing mortality. Lower panel, relative biomass and fishing mortality. Grey regions represent 95% CIs.

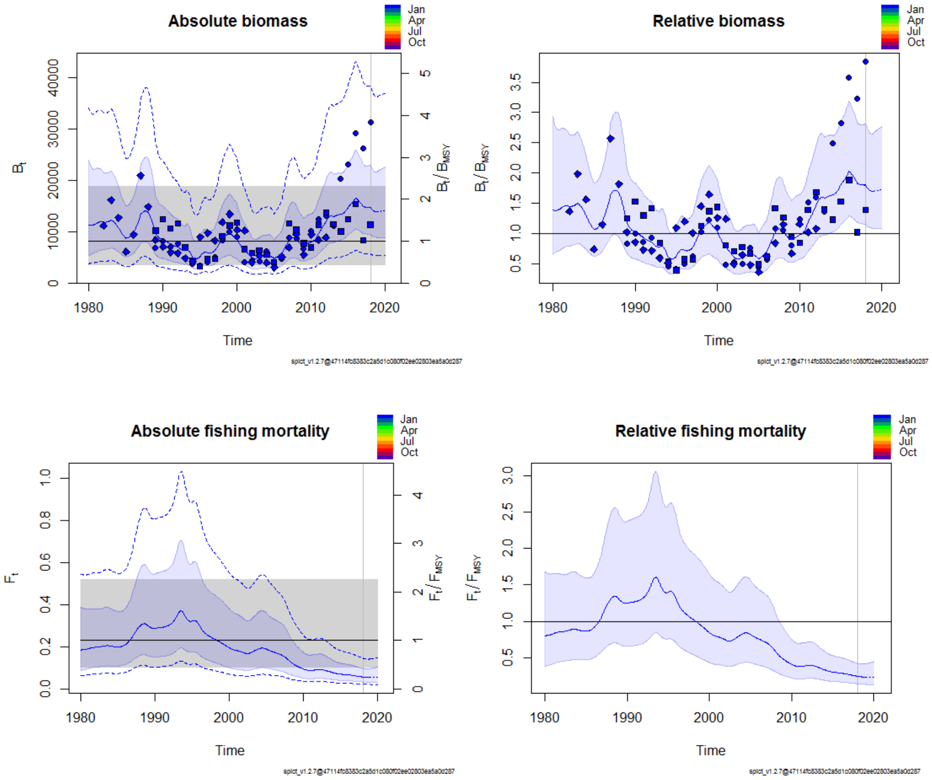


Figure 4.4.7. ANGLERFISH (*L. budegassa*) - Divisions 8c and 9a. SPiCT results: Upper panels, absolute and relative biomass. Lower panels, absolute and relative fishing mortality. Solid blue lines are estimated values; vertical grey lines indicate the time of the last observation beyond which dotted lines indicate forecasts; dashed lines are 95% CIs for absolute estimated values; shaded blue regions are 95% CIs for relative estimates; grey regions represent 95% CIs for estimated absolute reference points; solid circles correspond to the index PT-TRC9a (Portuguese crustacean trawl fleet), squares correspond to the index PT-TRF9a (Portuguese fish trawl fleet) and diamonds correspond to the index SP-CORTR8C-FLEET (A Coruña trawl fleet).

5 Megrim (*Lepidorhombus whiffiagonis* and *L. boscii*) in Divisions 7b-k and 8a,b,d

Lepidorhombus whiffiagonis:

Assessment type: An update assessment has been carried out as this stock was benchmarked in 2016 executing a full assessment for this stock and is now category 1.

Data revisions: data revision was done in the Inter-Benchmark 2016 and no additional revision has been done for this WG.

Lepidorhombus boscii:

Assessment type: First assessment.

Data revisions: First assessment **(**survey indices included)

5.1 General

See Stock annex general aspects related to megrim assessment.

5.1.1 Ecosystem aspects

See Stock annex for ecosystem aspects related to megrim assessment.

5.1.2 Fishery description

Megrim in the Celtic Sea, west of Ireland, and in the Bay of Biscay are caught in a mixed fishery predominantly by French followed by Spanish, UK and Irish demersal vessels. In 2018, the four countries together have reported around 94% of the total landings (Table 5.1.1.1.). Estimates of total landings (including unreported or miss-reported landings) and catches (landings&discards) as used by the Working Group up to 2018 are shown in Table 5.1.1.2.

5.1.3 Summary of ICES advice for 2019 and management for 2018 and 2019

ICES advice for 2019 (as extracted from ICES Advice 2018):

The two megrim species are not separated in the landings and a single TAC covers both of them. ICES considers that management of the two megrim species under a combined TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species. Therefore, this year's advice is based on the single-species F_{MSY} and the ICES precautionary approach for category 6 stocks.

For L. whiffiagonis, ICES advises that when the MSY approach is applied, catches in 2019 should be no more than 18 976 tonnes.

Management of megrim and four-spot megrim under a combined species TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species.

For L. Boscii, ICES has not been requested to provide advice on fishing opportunities for this stock.

Management of four-spot megrim and megrim under a combined species TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species.

If the TAC continues to be set for both megrim species combined, then the combined megrim landings in 2019 should be no more than 18976 t (both megrim species)

Management applicable for 2019:

The agreed TAC for the combined species was set at 13 528 t for 2018 and 19 836 t for 2019.

The minimum landing size of megrim was reduced from 25 to 20 cm length in 2000.

5.2 Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d

5.2.1 General

See general section for both species

5.2.2 Data

5.2.2.1 Commercial catches and discards

Stock catches for the period 1984-2018, as estimated by the WG, are given in Table 5.1.1.1. This is the third year where all landing and discard data have been uploaded to InterCatch, so it has been the tool to extract and make data allocations.

Landings in 2018 are lower than in 2017 (11%), reaching up to 12 279 t.

Since 2011, estimates of unallocated or non-reported landings have been included in the assessment. These were estimated based on the sampled vessels (Spanish concurrent sampling) raised to the total effort for each métier.

Spanish data show a decreasing trend from 2009 onwards. During Inter-Benchmark 2016, France landing dataseries were updated from 2003–2014. Landing data from France shows an increasing trend from 2015 onwards and a decrease this last year. Landing information for year 2018 by Ireland, Belgium and UK show a slight decrease.

Regarding discard data, French discards were provided from 2004–2014 to the Inter-Benchmark 2016, and they have been updated in 2017. There is an increase in all discard information provided by Ireland and Belgium and a significant decrease from France, Spain and UK.

Discard data available by country and the procedure to derive them are summarized in Table 5.2.1.1. The discards decrease in year 2000 can be partly explained by the reduction in the minimum landing size from 25 cm to 20 cm. Since 2000, fluctuating trends are observed with a peak in 2004 and the minimum observed level in year 2015.

In the following table the discard ratio in percentage (%) from catches in weight of the most recent years is presented.

Table 5.2.1.1. Discard ratio in percentage (%) from catches in weight of the years 2002-2018.

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
% Discard	21%	18%	26%	24%	20%	24%	16%	12%	17%	14%	13%

5.2.2.2 Biological sampling

Age and Length distribution provided by countries are explained in Stock Annex- Meg 78 (Annex E).

Age

Ireland, UK and Belgium provided numbers-at-age in InterCatch and consequently completed number and weights at age up to 2018. Age distribution for landings and discards from 2009–2018 are presented in Figure 5.1.2.2.1.

Lengths

Table 5.1.2.2.1 shows the available original length composition of landings by Fishing Unit in 2018.

Natural Mortality

M=0.2 has been used as input data for all ages and years in the final model.

5.2.2.3 Survey data

UK survey Deep Waters (UK-WCGFS-D, Depth > 180 m) and UK Survey Shallow Waters (UK-WCGFS-S, Depth < 180 m) indices for the period 1987–2004 and French EVHOE survey (EVHOE-WIBTS-Q4) results for the period 1997–2018 are summarized in Table 5.1.2.3.1. French EVHOE survey was not updated for year 2017 due to technical problems during the survey and a new time series was provided in 2018.

The UK-WCGFS-D and UK-WCGFS-S show the same pattern in the indices for ages 2 and 3 since 1997; in agreement with the high values of EVHOE-WIBTS-Q4 age 1 index for the years 1998 and 2000. These high indices in the Deep component of the UK Surveys are even more remarkable in 2003 for all ages and in 2004 for the younger ages.

EVHOE-WIBTS-Q4 indices for age 1+2 showed no evident trend. Oscillations of high and low values are present in all the time-series (Figure 5.1.2.3.1). In Figure 5.1.2.3.4 the time-series of the age composition of abundances from 2007 to 2016 of EVHOE survey is presented.

An abundance index in ages was provided for Irish Groundfish Survey (IGFS-WIBTS-Q4) from 2003-2018. For the last five years of the dataseries, the survey provides the lowest values of older ages and a sharp decrease of medium age individuals. For the younger ages, it shows an increasing trend and a slight decrease in the last year.

A revised abundance index in ages was provided for the Spanish Porcupine Groundfish Survey (SpPGFS-WIBTS-Q4) from 2001 to 2018 due to a change in the calculation methodology of the tow trawling time. In Figure 5.1.2.3.3 the time-series of the age composition of abundances from 2007–2018 is presented.

When comparing Spanish, French and Irish survey biomass indices some contradictory signals are detected (Figure 5.1.2.3.1). The EVHOE-WIBTS-Q4 index decreased from 2001 until 2005 and since then has sharply increased until 2011. The SpPGFS-WIBTS-Q4 Porcupine survey (SP-PGFS) shows fluctuation trends until 2014. Afterwards, a decreasing trend is observed until 2018.

Irish Groundfish Survey (IGFS-WIBTS-Q4) gives the highest estimates in 2005. In 2011 a slight increase occurred in agreement with Spanish survey and in the last years remains stable with an increase in 2018.

For a more detailed inspection of the abundances indices of different age groups, these were inspected along the whole dataseries for surveys (Figure 5.1.2.3.2). Ages groups were identified as: i) age 1+age 2; ii) age 3+age 4+age 5 and iii) age 6+age 7 +age 8+age 9+age 10+. The most abundant age group was ii) at the beginning and the end of the dataseries for all the surveys but it shows a decreasing trend in the last three years. Age group i) appear most abundant during years 2005 to 2008. As a consequence it is difficult to conclude on the recent abundance trends by age group.

It must be noted that the areas covered by the three surveys almost do not overlap (Figure 5.1.2.3.5). There is some overlap between the northern component of EVHOE-WIBTS-Q4 and the southern coverage of IGFS-WIBTS-Q4, whereas the eastern boundary of SP-PGFS essentially coincides with the western one of IGFS-WIBTS-Q4.

5.2.2.4 Commercial catch and effort data

For 2012 Benchmark, a new Irish trawler index was provided as the result of the revision carried out for the Irish Otter trawl fleet. Irish beam trawl (TBB) data are limited to TBB with mesh sizes of 80-89mm, larger mesh sizes are disused since 2006.

The general level of effort is described in Figure 5.1.2.4.1. SP-CORUTR7 and SP-VIGOTR7 fleets have decreased sharply until 1993, since then it has been decreasing slightly. SP-VIGOTR7 showed a very slight increase in 2007, decreasing slightly till 2014. SP-CANTAB7 remains quite stable since 1991 and decreased slightly since 2000. In 2009, no effort has been deployed by this fleet but in 2010, some trips were recorded, for the last six years no effort was deployed. The effort of the French benthic trawlers fleet in the Celtic Sea decreased until 2008 and no more information was provided to the WG.

Commercial series of catch-at-age and effort data were available for three Spanish fleets in Subarea 7 (Figure 5.1.2.4.2): A Coruña (SP-CORUTR7) from 1984–2018, Cantábrico (SP-CANTAB7) from 1984–2010 as no effort has been deployed by this fleet in subarea 7 during the six years and Vigo (SP-VIGOTR7) from 1984–2018. The CPUE of SP-CORUTR7 has fluctuated until 1990, when it started to decrease, with a slight increase in 2003 and a peak in CPUE in 2011 and a decrease afterwards. Over the same period, SP-VIGOTR7 has remained relatively stable until 1999, reaching in 2004 the historical maximum. In the last years it was fluctuations with a decreasing trend. SP-CANTAB7 LPUE was fluctuating and after 2011 no effort was deployed.

From 1985 to 2008, LPUEs from four French trawling fleets: FR-FU04, Benthic Bay of Biscay, Gadoids Western Approaches and *Nephrops* Western Approaches were available. (Table 5.1.2.4.1.& Figure 5.1.2.4.3). No data from 2009 onwards was deployed by this fleet.

The LPUE of all Irish beam trawlers fleets oscillates up and down. From 2007 an increase in the LPUE is observed with a peak in 2013 (Figure 5.1.2.4.4).

Summarizing, no particular LPUE changes have been observed.

An analysis of the abundance indices of different age groups in dataseries for commercial fleets was carried out (Figure 5.1.2.4.5). Ages groups were identified as: i) age 1+age 2; ii) age 3+age 4+age 5 and iii) age 6+age 7+age 8+age 9+age 10+. For Spanish and Irish commercial fleets, the most abundant age group was ii) at the beginning of the dataseries. Age group i) appear more abundant than older ages (iii) from 2003 onwards in the Spanish fleet. French fleets appear to land mostly old individual at the beginning of the dataseries but a marked decrease in abundance index of old fish was observed for French fleet. In 2018, an increase of young ages is observed in Irish fleets.

5.2.3 Assessment

An analytical assessment was conducted using updated French landings and discards data. With the inclusion of French discard data, some changes to the model were executed in relation to the discard estimation coefficient and data input from the Bayesian model.

5.2.3.1 Data Exploratory Analysis

In summary, the stock catch-at-age matrix shows three periods: 1984–1989; 1990–1998 and 1999–2018.

The data analysed consist of landed, discarded and catch numbers-at-age and abundance indices-at-age. Five of the available fleets were considered appropriate to inclusion in the assessment model as tuning fleets: Spanish Porcupine survey (SpPGFS_WIBTS-Q4), French Survey (EVHOE-WIBTSQ4), Vigo commercial trawl cpue series separated in two periods: 1984–1998 (VIGO84) and 1999–2010 (VIGO99), and Irish Otter trawlers lpue (IRTBB), based on their representativeness of megrim stock abundance. An exploratory data analyses was performed to examine their ability to track cohorts through time.

Several exploratory analyses were carried out on the data with the software R. The analysis of the standardized log abundance indices for the updated data revealed a slight increase in ages 1 in EVHOE-WIBTSQ4 survey (Figure 5.1.3.1.1). Otherwise, in SpPGFS-WIBTS-Q4 an increase in age 2 was observed. Thus, the figure 5.1.3.1.1. shows little or no cohort tracking in the surveys. Presumably this is a consequence of lack of variability in recruitment, leading to lack of contrast between cohorts.

The analysis of the standardized log abundance indices revealed year trends for VIGO99 and the same decrease in the index of old individuals was detected by this fleet in 2008 and 2009. In the last year an increase of ages 1-2 are observed. However, IRTBB shows a slight decrease of ages 1–2.

The time-series of catch-at-age (Figure 5.1.3.1.2) showed very low catches of ages 1–5 from 1984 to 1989. From 2004 to 2010, the catch of older ages (>6) was remarkably low, whereas catches of ages 1 and 2 increased markedly from 2003. This could be a result of an underestimation of catches of these ages (specially age 1) before this year, probably, due to the sparseness of discard data in that period. For ages 6 and older, large discrepancies in the amount caught before and after 1990 are apparent, with large catches of these ages before 1990 and a decrease of all ages at the end of the dataseries.

The analysis of landings is presented since 1990 (Figure 5.1.3.1.3). Landings of ages 1 and 2 decreased from the beginning of the series to the last years where negative values have increased from 2009 onwards. In fact, the proportion of older ages in the landings decreased significantly from 2004 to 2009, as already discussed in relation to the catch. In 2018, ages 1 increased significantly mainly due to landings from France.

The signal coming from the discard data showed that at the beginning of the dataseries discards of age 1 was low (Figure 5.1.3.1.4-5). Discards of this age increased along the dataseries, particularly from 2003 onwards. From year 2010 to 2013, ages 1 to 3 appear to be highly discarded but in the last four years 2015-2018 general discards decrease.

5.2.3.2 Model

The model explored during the benchmark is an adaptation of one developed originally for the southern hake stock, published in Fernández *et al*. (2010). It is a statistical catch-at-age model that allows incorporating data at different levels of aggregation in different years and also allows for missing discards data by certain fleets and/or in some years. These are all relevant features in the megrim stock.

The model is described in Stock Annex.

5.2.3.3 Results

The model results were analysed looking at three different kinds of plots: convergence plots (to analyse the convergence behaviour of the MCMC chains), diagnostic plots (to analyse the goodness of the fit) and, finally, plots of the models estimates (displaying the estimated stock status over time).

Regarding the settings of the prior for the final run, some changes were done in relation to the inclusion of discards information from France in IBP Megrim 2016, which are included as data instead of being estimated by the model. Settings used in WGBIE 2019 are listed in Table 5.1.3.3.1.

In order to be sure that the model has produced a representative sample of the posterior distribution, the MCMC chain was examined for behaviour ("convergence" properties). This was done by examining trace plots and autocorrelation plots for most parameters in the model (Figure 5.1.3.3.1 to Figure 5.1.3.3.3) showing a good behaviour.

Model diagnostics plots examined were: prior-posterior plots and time-series and bubble plots of the residuals. Prior-posterior distributions are shown in Figures 5.1.3.3.4. Posterior distributions for log-population abundance in first assessment year (1984), log-f(y) and log-catchabilities of abundance indices were much more concentrated than the priors and were often centred at different places. This indicated that the model was able to extract information from the data in order to substantially revise the prior distribution. In these cases, the model fits are mostly driven by the data, with the prior having only a small influence. The posterior distributions for log-rSPD, log-rFR or log-rOTD in the first assessment year (1984) were similar to the prior distributions in most of the cases. This was especially true for log-rOTD, were data directly associated with it was not available to the model. This indicates that the available data does not contain very much information concerning these parameters and that the priors have to be chosen carefully trying to be realistic.

Results of time-series of estimated spawning-stock biomass (SSB), reference fishing mortality (F_{bar}), recruits and catch, landings and discards are shown in Figure 5.1.3.3.5. The SSB shows an overall decreasing trend from the start of the series in 1984–2005 with a marked increasing trend till 2018. The uncertainty in the SSB was low in the whole time-series. The median recruitment fluctuated between 200000 and 300000 thousand in the whole series with an increasing trend in the last years. The fishing mortality showed three marked periods which coincide with the data periods, 1984–1989, 1990–1998 and 1999–2018. The lowest F_{bar} was observed in the first period and the highest one in the year 2005 and then it decreases to its lowest in 2018 with small uncertainty. This decreasing F trend in recent years explains the increase of SSB since catches and recruitment remain relatively constant. Overall, the catches showed weak decreasing trend with a minimum in 2015 with landings showing similar trend. In the last year there is a decreasing trend in landings and discards.

5.2.3.4 Retrospective pattern

Retrospective analysis was conducted for 5 years, the retrospective time-series of most relevant indicators are shown in Figures 5.1.4.1. In terms of SSB, estimates were very similar throughout the entire time-series and there was a downward revision of SSB. The recruitment estimates towards the end of the time-series showed significant revisions in the retrospective analysis, but this is something common, as recruitment in the most recent year(s) is usually not correctly estimated by assessment models. The fishing mortality was revised upward year by year.

5.2.3.5 Short-term forecasts

Short-term projections have been made using Rscript developed by Fernández *et al.* (2010). Some modifications have been done to the script during IBP 2016 as the previous results of the projection were inconsistent with the stock dynamic estimated by the assessment model. During WGBIE 2017 a short R script was added to the short term projection script to enable the change of last year recruitment data if it is not considered credible. As the recruitment at age 1 estimated by the model for the years 2018 and 2019 were not considered credible, it was replaced by geometric mean of all the recruitments since 1984 except the last two years (1984-2016). The Baranov population equation was used to project the recruitment one year forward.

For the current projection, the following short-term forecast settings are agreed: the average of the last three years is used to average F-at-age, the proportion landed-at-age, and the vectors of weight-at-age and maturity-at-age. As there is not a decreasing trend of F in the results of the assessment time-series, F status quo is unscaled and the mean of the last three years is used for the projections. For the recruitment of years 2018 and 2019, the geometric mean of the recruitment posteriors in all assessment years except for the final 2 is used.

Landings in 2020 and SSB in 2021 predicted for various levels of fishing mortality in 2020 are given in Table 5.1.5.1. Maintaining F status quo in 2020 is expected to result in an increase in landings with respect to 2019 and an increase in SSB in 2020 with respect to 2019.

5.2.4 Biological reference points

Biological reference points were calculated in IBP Megrim 2016 and reviewed by WGBIE 2016 and RGPA 2016. The reference points for this stock used methods based on the recommendations from WKMSYREF4 (ICES, 2016). They are listed in Table 5.1.6.1. and in the Stock Annex, were F_{MSY} ranges have been also included.

5.2.5 Conclusions

The incorporation of the requested data, mainly French discards data (but also French landings review) was completed and the script to deal with these new data were updated. The model results show that the new data does not alter substantially the perception of stock status and F compared with the preliminary model performed by WGBIE (2015).

The group considers that the model diagnosis is adequate to evaluate the quality fit. The use of the Bayesian statistical catch-at-age model, the methodology for deriving biological reference points, the methodology for short-term forecast and the estimation of discards are statistically sound and adequate to the stock. The WG considers it can be used for future advice.

However, the increase of assessment years makes the JAGS software not to be so efficient as 8 hours were needed to run the model.

Nevertheless, as in most stock assessments, the stock–recruitment relationship and natural mortality remain uncertain, which have an impact in the assessment and the reference points that should be investigated in the future.

5.2.6 Tables and Figures

Table 5.1.1.1. .Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Nominal landings and catches (t) by country provided by the Working Group.

	Landings									Discards									
	France	Spain	U.K. (England & Wales)	U.K. (Scotland)	Ireland	Northern Ireland	Belgium	Unallocated	Total landings	France	Spain	U.K.	Ireland	Northern Ireland	Belgium	Others	Total discards	Total catches	TAC
1984									**16659**							2169	**2169**	**18828**	
1985									**17865**							1732	**1732**	**19597**	
1986	4896	10242	2048		1563		178		**18927**							2321	**2321**	**21248**	
1987	5056	8772	1600		1561		125		**17114**							1705	**1705**	**18819**	16460
1988	5206	9247	1956		995		173		**17577**							1725	**1725**	**19302**	18100
1989	5452	9482	1451		2548		300		**19233**							2582	**2582**	**21815**	18100
1990	4336	7127	1380		1381		147		**14370**							3284	**3284**	**17654**	18100
1991	3709	7780	1617		1956		32		**15094**							3282	**3282**	**18376**	18100
1992	4104	7349	1982		2113		52		**15600**							2988	**2988**	**18588**	18100
1993	3640	6526	2131		2592		40		**14929**							3108	**3108**	**18037**	21460
1994	3214	5624	2309		2420		117		**13684**							2700	**3284**	**16968**	20330
1995	3945	6129	2658		2927		203		**15862**				422			2230	**2652**	**18514**	22590
1996	4146	5572	2493		2699		199		**15109**				410			2616	**3026**	**18135**	21200
1997	4333	5472	2875		1420		130		**14230**		414		568			2083	**3066**	**17296**	25000
1998	4232	4870	2492		2621		129		**14345**		381		681			4309	**5371**	**19716**	25000
1999	3751	4615	2193		2597		149		**13305**		3135		162				**3297**	**16601**	20000
2000	4173	6047	2185		2512		115		**15031**		1033	208	630				**1870**	**16901**	20000
2001	3645	7575	1710		2767		80		**15778**		1275	250	736				**2262**	**18040**	16800
2002	2929	8797	1787		2413		62		**15987**		1466	435	912				**2813**	**18800**	14900
2003	3227	8340	1732		2249		163		**15711**		3147	279	582				**4008**	**19719**	16000
2004	2817	7526	1622		2288		106		**14358**	1003	4511	257	472				**6243**	**20602**	20200
2005	2972	5841	1764		2155		156		**12888**	697	1831	289	458				**3275**	**16163**	21500
2006	2763	5916	1509		1751		99		**12037**	382	2568	271	529				**3751**	**15788**	20400
2007	2745	6895	1462		1763		195		**13060**	330	2114	272	317				**3033**	**16092**	20400
2008	2578	5402	1387		1514		167		**11048**	329	1479	289	764				**2860**	**13908**	20400
2009	3032	8062	1840		1918	2	209		**15064**	674	1761	389	454				**3278**	**18342**	20400
2010	3651	7095	1805		2283	5	261		**15101**	937	3489	463	453				**5343**	**20444**	20106
2011	3235	3500	1845		2227		330	2089	**13226**	847	2097	898	344				**4187**	**17413**	20106
2012	4012	4055	1744		3047		609	966	**14433**	796	2668	88	152				**3704**	**18137**	19101
2013	4549	4982	2918		3038		538		**16025**	748	3792	53	286		5		**4885**	**20910**	19101
2014	4311	3318	2753	176	2391		179	150	**13277**	795	1337	72	360		5		**2569**	**15846**	19101
2015	3073	2863	2804	147	2436		246	1	**11569**	634	513	47	308		4		**1507**	**13076**	19101
2016	3141	2672	2694	145	2593		302	1	**11548**	1276	649	74	404		42		**2445**	**13992**	20056
2017	5101	3178	2512	176	2458		360		**13784**	783	706	265	378		40		**2173**	**15957**	15043
2018	4812	2276	2337	112	2128	6	347	261	**12279**	726	483	85	495		66		**1855**	**14133**	13528

Table 5.1.1.2. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Nominal landings and catches (t) provided by the Working Group.

	Total landings	Total discards	Total catches	Agreed TAC (1)
1984	16659	2169	18828	
1985	17865	1732	19597	
1986	18927	2321	21248	
1987	17114	1705	18819	16460
1988	17577	1725	19302	18100
1989	19233	2582	21815	18100
1990	14370	3284	17654	18100
1991	15094	3282	18376	18100
1992	15600	2988	18588	18100
1993	14929	3108	18037	21460
1994	13684	2700	16384	20330
1995	15862	3206	19068	22590
1996	15109	3026	18135	21200
1997	14230	3066	17296	25000
1998	14345	5371	19716	25000
1999	13305	3297	16601	20000
2000	15031	1870	16750	20000
2001	15778	2262	18040	16800
2002	15987	2813	18800	14900
2003	15711	4008	19719	16000
2004	14358	6243	20602	20200
2005	12888	3275	16163	21500
2006	12037	3751	15788	20425
2007	13060	3033	16092	20425
2008	11048	2860	13908	20425
2009	15064	3278	18342	20425
2010	15101	5343	20444	20106
2011	13226	4187	17413	20106
2012	14433	3704	18137	19101
2013	16025	4885	20910	19101
2014	13277	2569	15846	19101
2015	11569	1507	13076	19101
2016	11548	2445	13992	20056
2017	13784	2173	15957	15043
2018	12279	1855	14133	13528

(1) for both megrim species and VIIa included.

Table 5.1.2.1.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Discards information and derivation.

	FR	SP	IR	UK
1984	**FR84-85**	-	-	-
1985	**FR84-85**	-	-	-
1986	(FR84-85)	(SP87)	-	-
1987	(FR84-85)	**SP87**	-	-
1988	(FR84-85)	**SP88**	-	-
1989	(FR84-85)	(SP88)	-	-
1990	(FR84-85)	(SP88)	-	-
1991	**FR91**	(SP94)	-	-
1992	(FR91)	(SP94)	-	-
1993	(FR91)	(SP94)	-	-
1994	(FR91)	**SP94**	-	-
1995	(FR91)	(SP94)	**IR**	-
1996	(FR91)	(SP94)	**IR**	-
1997	(FR91)	(SP94)	**IR**	-
1998	(FR91)	(SP94)	**IR**	-
1999	-	**SP99**	**IR**	-
2000	-	**SP00**	**IR**	**UK**
2001	-	**SP01**	**IR**	**UK**
2002	-	(SP01)	**IR**	**UK**
2003	-	**SP03**	**IR**	**UK**
2004	**FR04**	**SP04**	**IR**	**UK**
2005	**FR05**	**SP05**	**IR**	**UK**
2006	**FR06**	**SP06**	**IR**	**UK**
2007	**FR07**	**SP07**	**IR**	**UK**
2008	**FR08**	**SP08**	**IR**	**UK**
2009	**FR09**	**SP09**	**IR**	**UK**
2010	**FR10**	**SP10**	**IR**	**UK**
2011	**FR11**	**SP11 (*)**	**IR**	**UK**
2012	**FR12**	**SP12 (*)**	**IR**	**UK**
2013	**FR13**	**SP13 (*)**	**IR**	**UK**
2014	**FR14**	**SP14 (*)**	**IR**	**UK**
2015	**FR15**	**SP15 (*)**	**IR**	**UK**
2016	**FR16**	**SP16 (*)**	**IR**	**UK**
2017	**FR17**	**SP17 (*)**	**IR**	**UK**
2018	**FR18**	**SP18 (*)**	**IR**	**UK**

- In bold: years where discards sampling programs provided information

- In (): years for which the length distribution of discards has been derived

(*) Scientific estimates were provided

Table 5.1.2.2.1 Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Length composition by fleet (thousands).

Length	FRANCE	SPAIN
class (cm)	OTB_DEF_>=70_99_0_0 (7h)	OTB_DEF_70-99_0_0. Otter trawl-med&deep 7
10		2
11		2
12		3
13		8
14		13
15		12
16		25
17		45
18		61
19		63
20		101
21		145
22		176
23		249
24		296
25		434
26		579
27	152	650
28	171	689
29	311	657
30	994	612
31	974	579
32	1,680	541
33	2,099	484
34	3,644	456
35	2,835	344
36	4,722	332
37	5,799	267
38	6,327	213
39	3,368	194
40	3,410	162
41	2,509	140
42	4,048	129
43	1,645	121
44	2,330	89
45	2,884	75
46	1,471	73
47	1,585	60
48	1,707	41
49	934	48
50	1,085	36
51	591	22
52	190	14
53	95	3
54	279	5
55		0
56		1
57		0
58		0
59		0
60		0
61		0
62		0
63		0
64		0
65		0
66		0
67		0
68		0
69		0
70		0
TOTAL	57840	9249

Table 5.1.2.3.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Abundance Indices for UK-WCGFS-D, UK-WCGFS-S, IGFS, SP-PGFS and FR- EVHOE.

		UK-WCGFS-D							**Effort in hours**	
		Age								
	Effort	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1987	100		863	5758	0	0	0	95	1753	151
1988	100	8	256	59	49	0	228	1008	1262	632
1989	100		70	188	471	2540	788	3067	680	1060
1990	100	8	526	1745	553	2584	1985	974	1154	974
1991	100		415	1375	1250	989	912	1677	593	731
1992	100	7	28	425	414	349	189	206	132	121
1993	100		122	382	1758	1505	728	739	666	718
1994	100		69	1593	1542	2663	1325	1278	825	595
1995	100	47	582	747	1755	1686	1303	548	281	421
1996	100	15	69	475	549	1580	1231	870	327	117
1997	100		329	751	1702	1518	541	149	47	17
1998	100		120	797	1432	1134	866	242	246	13
1999	100		237	270	734	760	302	94	33	17
2000	100		143	1004	619	681	395	67	35	13
2001	100	20	384	690	1426	581	460	376	226	45
2002	100		162	2680	1915	1349	761	690	315	104
2003	100		330	1705	3149	2662	1451	676	417	179
2004	100	168	1001	1382	1069	897	628	208	47	
		UK-WCGFS-S							**Effort in hours**	
		Age								
	Effort	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1987	100		499	3082	641	891	180	794	264	587
1988	100		47	55	585	95	367	0	50	93
1989	100		616	574	547	1540	576	361	297	198
1990	100		375	1057	816	661	1220	195	454	176
1991	100	2	373	829	822	394	460	550	178	293
1992	100		149	278	323	193	109	164	93	36
1993	100		470	877	1140	601	327	321	143	233
1994	100		74	1000	1301	998	521	374	185	153
1995	100	28	435	878	1167	1054	805	488	359	130
1996	100	2	64	401	389	823	592	372	152	43
1997	100	3	284	1028	550	540	289	202	75	29
1998	100	4	30	438	665	381	209	97	48	21
1999	100		69	82	222	214	103	53	41	20
2000	100		72	377	249	313	169	81	52	20
2001	100	2	131	297	594	104	145	122	80	37
2002	100		134	808	506	757	339	326	181	82
2003	100	5	184	289	639	416	328	113	102	36
2004	100	50	343	467	270	394	303	124	49	21
		FR-EVHOE (NEW TIME SERIES PROVIDED IN WGBIE 2018)								
		Age								
	Effort	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1997	100	0.64	1.37	0.96	1.16	1.70	1.57	1.32	0.79	0.56
1998	100	0.64	0.58	0.58	0.64	0.38	1.02	1.02	0.45	0.19
1999	100	1.18	3.04	0.79	2.20	4.02	2.92	1.46	1.20	1.52
2000	100	0.96	1.31	2.26	1.06	1.09	1.12	0.99	1.14	0.71
2001	100	1.03	1.68	0.76	0.67	0.97	1.57	2.58	1.36	1.12
2002	100	1.42	0.58	1.35	1.10	2.01	0.95	1.94	1.07	0.55
2003	100	1.26	1.15	0.82	1.37	0.96	1.94	0.88	0.80	0.71
2004	100	0.40	1.73	1.02	0.88	1.47	1.13	1.05	1.39	0.99
2005	100	0.62	0.91	2.41	0.83	0.76	1.11	1.16	0.56	0.87
2006	100	0.83	0.62	0.95	1.86	0.82	1.10	1.69	0.75	0.84
2007	100	1.91	1.71	1.12	0.64	1.26	1.42	1.75	1.23	1.15
2008	100	0.53	3.18	4.01	2.13	1.49	1.92	1.73	0.57	0.26
2009	100	2.04	2.12	5.41	1.67	1.16	1.17	0.49	0.20	
2010	100	2.01	1.68	1.74	4.08	1.92	1.16	1.11	1.38	2.15
2011	100		2.73	2.81	3.11	2.37	2.70	1.07	0.45	1.01
2012	100	0.78	0.72	1.36	0.72	0.96	0.80	1.25	1.14	0.70
2013	100	1.72	1.91	2.82	3.89	0.96	2.15	2.60	0.35	0.90
2014	100	0.45	3.31	2.16	4.05	2.54	2.46	0.93	0.38	
2015	100	1.57	1.77	4.41	3.06	2.76	1.93	0.72	0.26	0.26
2016	100	0.80	2.26	1.90	2.31	1.84	3.09	1.13	2.72	0.74
2017	No updated data									
2018		1.68	1.60	1.84	3.48	2.96	2.31	0.98	0.73	0.32

		IGFS									
		Age									
	Effort	0	1	2	3	4	5	6	7	8	9
2003	100	0	152	316	368	238	96	36	14	5	2
2004	100	0	153	461	595	454	162	57	30	12	3
2005	100	29	414	643	431	370	215	68	44	18	17
2006	100	44	505	548	481	215	154	68	10	7	5
2007	100	1	100	293	125	91	70	25	7	7	3
2008	100	5	140	481	349	101	66	60	17	12	5
2009	100	3	1	234	371	455	346	159	53	44	23
2010	100	6	1	128	377	259	173	90	38	13	10
2011	100	5	2	121	333	331	144	69	40	25	30
2012	100	4	24	141	140	108	52	36	16	9	33
2013	100	9	31	132	93	83	58	30	10	8	22
2014	100	40	62	143	106	56	57	52	22	23	17
2015	100	26	127	149	154	57	44	30	16	10	7
2016	100	28	211	370	207	108	83	75	37	27	39
2017	100	20	213	273	113	52	32	24	11	22	29
2018	100	23	200	562	193	87	37	18	21	22	30

	NEW	SP-PGFS							
		Age							
	Effort	0	1	2	3	4	5	6	7+
2001	100	43	1770	2208	2842	3434	1941	1357	740
2002	100	6	1069	2502	3168	3997	2237	1107	515
2003	100	11	1081	2913	4105	5262	2789	1284	636
2004	100	7	719	3457	5498	5569	3071	1125	828
2005	100	77	633	626	2279	8249	4959	2605	688
2006	100	5	1776	1443	3275	4719	3312	901	383
2007	100	30	4856	6990	3556	3622	1814	852	399
2008	100	14	260	2219	5406	4010	1807	1219	428
2009	100	6	534	661	5320	7097	1635	877	606
2010	100	39	318	2158	2557	6723	2313	494	476
2011	100	37	393	1174	2510	3940	5141	1452	626
2012	100	5	157	692	3759	2862	3207	2926	1902
2013	100	6	1473	1184	1174	1619	3703	2657	2579
2014	100	39	243	3174	1001	2286	4400	3409	2198
2015	100	23	2220	2188	4056	2078	1847	2099	1830
2016	100	15	1104	6137	3263	4137	2248	2176	1712
2017	100	10	1869	5166	3608	2563	3122	1650	1079
2018	100	5	826	5347	7702	2762	1766	869	988

Table 5.1.2.3.1 (cont). Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Abundance Indices by kilograms and numbers by 30 minutes haul duration.

FR-EVHOEFS Abundance Indices by kilograms and numbers by 30 minutes haul duration

	kg/30'	Nb/30'	
1997	1.93	12.03	
1998	2.12	13.52	
1999	1.82	13.41	
2000	1.45	11.69	
2001	2.19	17.03	
2002	2.04	16.95	
2003	1.79	12.81	
2004	1.50	10.67	
2005	1.45	9.94	
2006	1.69	15.59	
2007	1.97	14.68	
2008	2.05	13.66	
2009	2.49	14.68	
2010	2.57	15.53	
2011	3.22	17.13	
2012	2.93	17.71	
2013	2.89	14.69	
2014	2.07	13.16	
2015	2.51	13.82	
2016	2.63	14.91	
2017			NO updated information
2018	2.67	17	

SP-PGFS Abundance Indices by kilograms and numbers by 30 minutes haul duration

	OLD	SP-PGFS	NEW	SP-PGFS	
	kg/30'	Nb/30'	AÑO	kg/30'	Nb/30'
2001	6.80	143.34	**2001**	6.80	143.34
2002	6.66	147.00	**2002**	6.66	146.00
2003	8.15	180.79	**2003**	8.16	180.81
2004	7.45	167.47	**2004**	9.01	202.72
2005	8.28	170.17	**2005**	9.81	201.19
2006	6.03	125.37	**2006**	7.64	158.14
2007	7.31	177.38	**2007**	9.15	221.18
2008	5.99	109.70	**2008**	8.46	153.61
2009	8.11	113.68	**2009**	11.79	165.49
2010	8.52	112.56	**2010**	11.47	150.76
2011	9.82	126.60	**2011**	11.89	152.72
2012	10.82	130.21	**2012**	13.03	155.08
2013	12.82	124.92	**2013**	12.82	143.96
			2014	15.78	166.68
			2015	13.07	163.42
			2016	14.77	207.93
			2017	14.11	190.65
			2018	11.15	202.65

IGFS Abundance Indices by numbers by 10 square kilometers

2003	1227
2004	1926
2005	2254
2006	2039
2007	725
2008	1238
2009	1724
2010	1103
2011	1116
2012	583
2013	497
2014	593
2015	629
2016	1224
2017	798
2018	1199

Table 5.1.2.4.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. French and Spanish cpues for different bottom-trawl fleets.

	French (single and twin bottom trawls combined) CPUE (kg/h)				Spanish CPUE (kg/(100day*100 hp))			Irish LPUE ('000 h)
	Benthic Bay of Biscay	Benthic Western Approaches	Gadoids Western Approaches	Nephrops Western Approaches	A Coruña -VII	Cantábrico- VII	Vigo-VII	Otter trawlers
1984					16.3	130.1	99.1	-
1985	3.0	5.3	4.7	4.7	9.8	39.5	108.9	-
1986	3.2	4.8	2.8	4.4	21.1	52.8	105.1	-
1987	3.3	5.1	2.7	4.5	8.3	80.7	96.2	-
1988	3.8	5.8	3.0	4.1	9.8	78.3	106.1	-
1989	3.6	5.5	2.6	4.2	14.6	48.1	92.1	-
1990	3.1	4.2	1.8	3.4	15.1	18.4	73.8	-
1991	2.6	4.0	1.3	2.8	12.9	25.9	85.4	-
1992	2.5	4.5	1.5	3.4	6.9	32.8	105.6	-
1993	1.9	4.6	1.2	3.5	5.1	33.5	92.3	-
1994	1.9	4.2	1.2	3.4	7.4	52.7	78.7	-
1995	2.3	4.9	1.4	3.4	7.8	61.3	94.3	13.7
1996	2.6	5.0	1.4	3.5	3.9	58.4	79.3	13.6
1997	3.3	5.6	1.2	3.0	3.0	46.9	96.0	12.1
1998	2.9	6.5	1.5	3.6	2.4	35.7	82.4	10.0
1999	3.0	6.3	0.9	3.4	1.1	32.5	137.0	11.3
2000	2.9	6.8	0.6	4.0	5.5	45.0	128.9	13.4
2001	2.2	6.8	0.7	4.1	1.3	75.6	131.2	13.1
2002	2.1	6.8	0.5	3.2	1.3	76.4	185.3	12.2
2003	1.8	5.8	0.6	3.2	11.2	54.0	192.1	8.2
2004	1.8	4.6	0.5	3.4	3.3	60.0	211.0	9.3
2005	1.9	5.1	0.4	4.2	1.7	58.46	135.3	10.0
2006	2.5	4.8	0.3	3.6	1.4	76.42	146.1	7.5
2007	2.4	5.1	0.4	2.9	2.4	87.86	144.3	8.5
2008	2.2	4.6	0.5	3.1	3.0	37.58	114.0	8.4
2009	NA	NA	NA	NA	8.3	0.00	173.2	10.3
2010	NA	NA	NA	NA	7.9	38.78	198.3	11.8
2011	NA	NA	NA	NA	19.7	0.0	151.2	13.5
2012	NA	NA	NA	NA	6.4	0.0	135.3	19.3
2013	NA	NA	NA	NA	10.0	0.0	210.2	19.4
2014	NA	NA	NA	NA	3.4	0.0	116.7	15.4
2015	NA	NA	NA	NA	4.5	0.0	89.7	17.9
2016	NA	NA	NA	NA	3.3	0.0	96.6	17.8
2017	NA	NA	NA	NA	2.6	0.0	85.5	16.1
2018	NA	NA	NA	NA	1.7	0.0	65.5	11.8

(*) LPUEs, no discards available

Table 5.1.3.3.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. IBP 2016 Prior distributions of final run.

$LN(\mu,\psi)$ denotes the lognormal distribution with median μ and coefficient of variation ψ, and $\Gamma(u,v)$ denotes the Gamma distribution with mean u/v and variance u/v^2.

Parameter and prior distribution	Values used in prior settings
$N(y,1) \sim LN(medrec\ ,2)$	$medrec = 250000$
$N(1984,a) \sim LN(medrec$ $\exp[-(a-1)M - \sum_{j=1}^{a-1} medF(j)],2), a = 2,\ldots,9$	$medrec$ as above, $M = 0.2$, $medF = (0.05,0.1,0.3,0.3,0.3,0.3,0.3,0.3,0.3)$
$N(1984,10+) \sim LN(medrec \exp[-9M -$ $\sum_{j=1}^{9} medF(j)]/\{1-\exp[-M - medF(9)]\}, 2)$	$medrec$, M, $medrecF$ as above
$f(y) \sim LN(med_f, CV_f)$	$med_f = 0.3, CV_f = 1$
$\rho \sim Uniform\ (0,1)$	
$r_L(1984,a) \sim LN(medr_L(a),1), a = 1,\ldots,8$	$medr_L = (0.0005,0.05,1,1,1,1,1,1)$
$r_L(y,9) = r_L(y,10+) = 1$	
$r_{SPD}(1984,a) \sim LN(medr_{SPD}(a),1), a = 1,\ldots,7$	$medr_{SPD} = (0.002,0.02,0.02,0.02,$ $0.01,0.01,0.01)$
$r_{IRD}(1984,a) \sim LN(medr_{IRD}(a),1), a = 1,\ldots,8$	$medr_{IRD} = (0.001,0.01,0.01,0.01,$ $0.005,0.005,0.005,0.001)$
$r_{UKD}(1984,a) \sim LN(medr_{UKD}(a),1), a = 1,\ldots,8$	$medr_{UKD} = (0.00001,0.001,0.001,0.001,$ $0.001,0.001,0.001,0.001)$
$r_{FRD}(1984,a) \sim LN(medr_{FRD}(a),1), a = 1,\ldots,8$	$medr_{FRD} = (0.002,0.02,0.02,0.02,$ $0.01,0.01,0.01,0.01)$
$r_{OTD}(1984,a) \sim LN(medr_{OTD}(a),1), a = 1,\ldots,8$	$medr_{OTD} = (0.002,0.02,0.02,0.02,$ $0.01,0.01,0.01,0.002)$
$r_{SPD}(y,7) = r_{SPD}(y,a) = r_{IRD}(y,a)$ $= r_{UKD}(y,a) = r_{FRD}(y,a) = r_{OTD}(y,a) = 0,\ a = 8,9,10+$	
$\tau_C(a), \tau_L(a), a = 1,2,3; \tau_D(a), a = 1,\ldots,8$	$\Gamma(4,0.345)$
$\tau_C(a), \tau_L(a), a = 4,\ldots,10+$	$\Gamma(10,0.1)$
$\tau_{SPD}(a), a = 1,\ldots,7; \tau_{IRD}(a), \tau_{UKD}(a), \tau_{FRD}(a) a = 1,\ldots,8$	$\Gamma(4,0.345)$
$\log[q_k(a)] \sim N(\mu_{Ik}, \tau_{Ik}), a \le 8,$ index $k = 1,\ldots,5$	$\mu_{Ik} = -7,\ \tau_{Ik} = 0.2$
$q_k(a) = q_k(8), a > 8,$ indices k with ages > 8	
$\tau_k(a)$, index $k = 1,\ldots,5$	$\Gamma(4,0.345)$

Table 5.1.5.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Catch forecast: management option table.

Short term forecast table										
Model: NMEG0-R1										
Projection: 3										
Quantile	Rec_2019	SSB_2019	TSB_2019	Fbar_2019	Catch_2019	Land_2019	Disc_2019	Rec_2020	SSB_2020	TSB_2020
5%	218099	85459	119378	0.2	18169	14139	3688	218099	91962	123659
50%	223736	100393	137702	0.22	19821	15401	4400	223736	108810	141891
95%	229855	115755	157276	0.25	21925	16862	5496	229855	126713	161174
Table for quantile: 0.5										
Fmult	F_2020	Catch_2020	Land_2020	Disc_2020	Rec_2021	SSB_2021	TSB_2021			
0	0	0	0	0	223736	136577	169011			
0.1	0.022	2462	1993	468	223736	133776	166115			
0.2	0.045	4865	3938	926	223736	131068	163363			
0.3	0.067	7212	5833	1377	223736	128419	160591			
0.4	0.089	9508	7685	1819	223736	125823	157877			
0.5	0.112	11747	9490	2254	223736	123300	155271			
0.6	0.134	13931	11251	2680	223736	120845	152779			
0.7	0.157	16070	12969	3099	223736	118469	150318			
0.8	0.179	18153	14650	3509	223736	116131	147860			
0.9	0.201	20198	16287	3912	223736	113796	145505			
1	0.224	22196	17886	4308	223736	111546	143196			
1.1	0.246	24147	19448	4698	223736	109306	140890			
1.2	0.268	26041	20970	5080	223736	107167	138675			
1.3	0.291	27903	22462	5456	223736	105070	136514			
1.4	0.313	29724	23915	5825	223736	103080	134404			
1.5	0.336	31502	25334	6190	223736	101098	132347			
1.6	0.358	33228	26713	6546	223736	99165	130330			
1.7	0.38	34923	28050	6896	223736	97269	128355			
1.8	0.403	36575	29372	7244	223736	95414	126438			
1.9	0.425	38194	30646	7584	223736	93583	124555			
2	0.447	39784	31898	7918	223736	91789	122646			

Table 5.1.6.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Reference points table updated in WGBIE 2018.

From the IBP megrim (ICES, 2016):	Type	Value	Technical Basis
MSY approach	MSY $B_{trigger}$	41 800	BPA, because the fishery has not been at FMSY in the last 10 years
	F_{MSY}	0.191	F giving maximum yield at equilibrium Computed using Eqsim.
	F_{MSY} ranges	0.122-0.289	Stochastic simulations, 5% reduction in long-term yield compared with MSY.
Precautionary approach	B_{lim}	37 100	B_{loss}, which is the lowest biomass observed corresponding to year 2006
	B_{pa}	41 800	$\mathbf{B_{lim}}e^{\mathbf{1.645}\,\sigma}$ where $\boldsymbol{\sigma} = \mathbf{0.07}$isthe standard deviation of the logarithm of SSB in 2014
	F_{lim}	0.533	It is the F that gives 50% probability of SSB being above Blim in the long term. It is computed using Eqsim based on segmented regression with the breakpoint fixed at Blim, without advice/assessment error and without Btrigger
	F_{pa}	0.451	$F_{lim}e^{-1.645\,\sigma}$ where $\boldsymbol{\sigma} = \mathbf{0.105}$ is the standard deviation of the logarithm of F in 2014

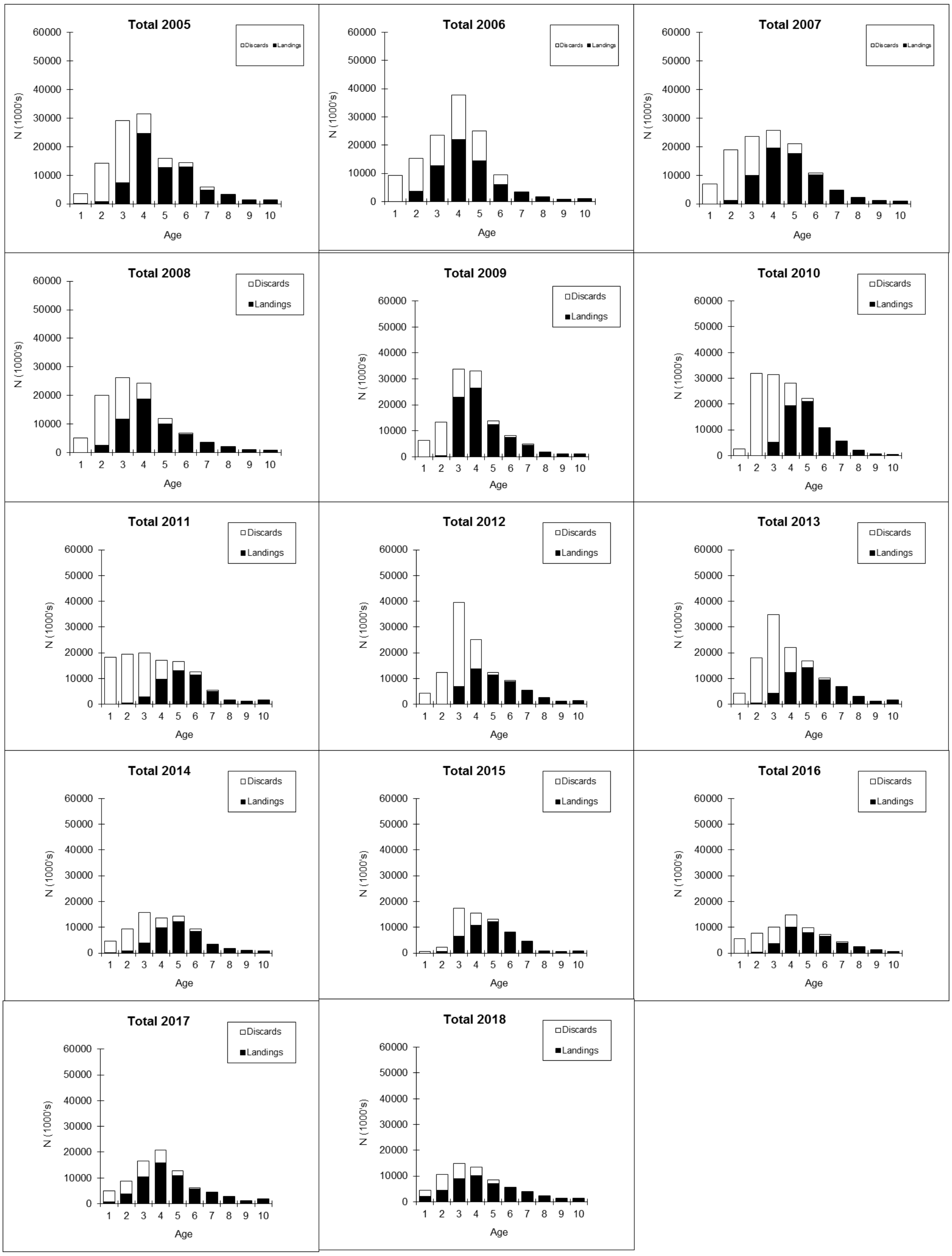


Figure 5.1.2.2.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Age composition of catches for the years 2009–2017.

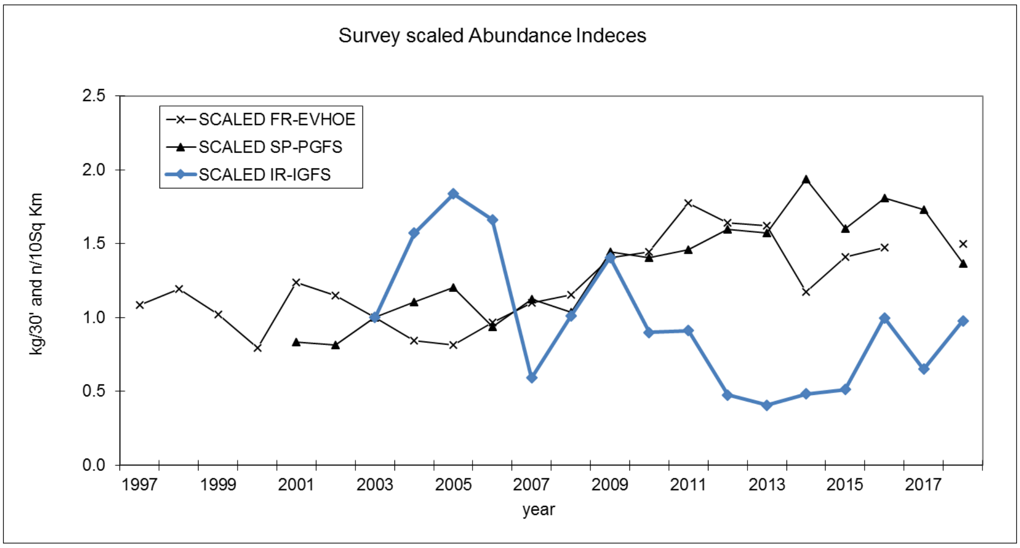


Figure 5.1.2.3.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Scaled Biomass Indices for FR-EVHOE, SP-PGFS and IR-IGFS.

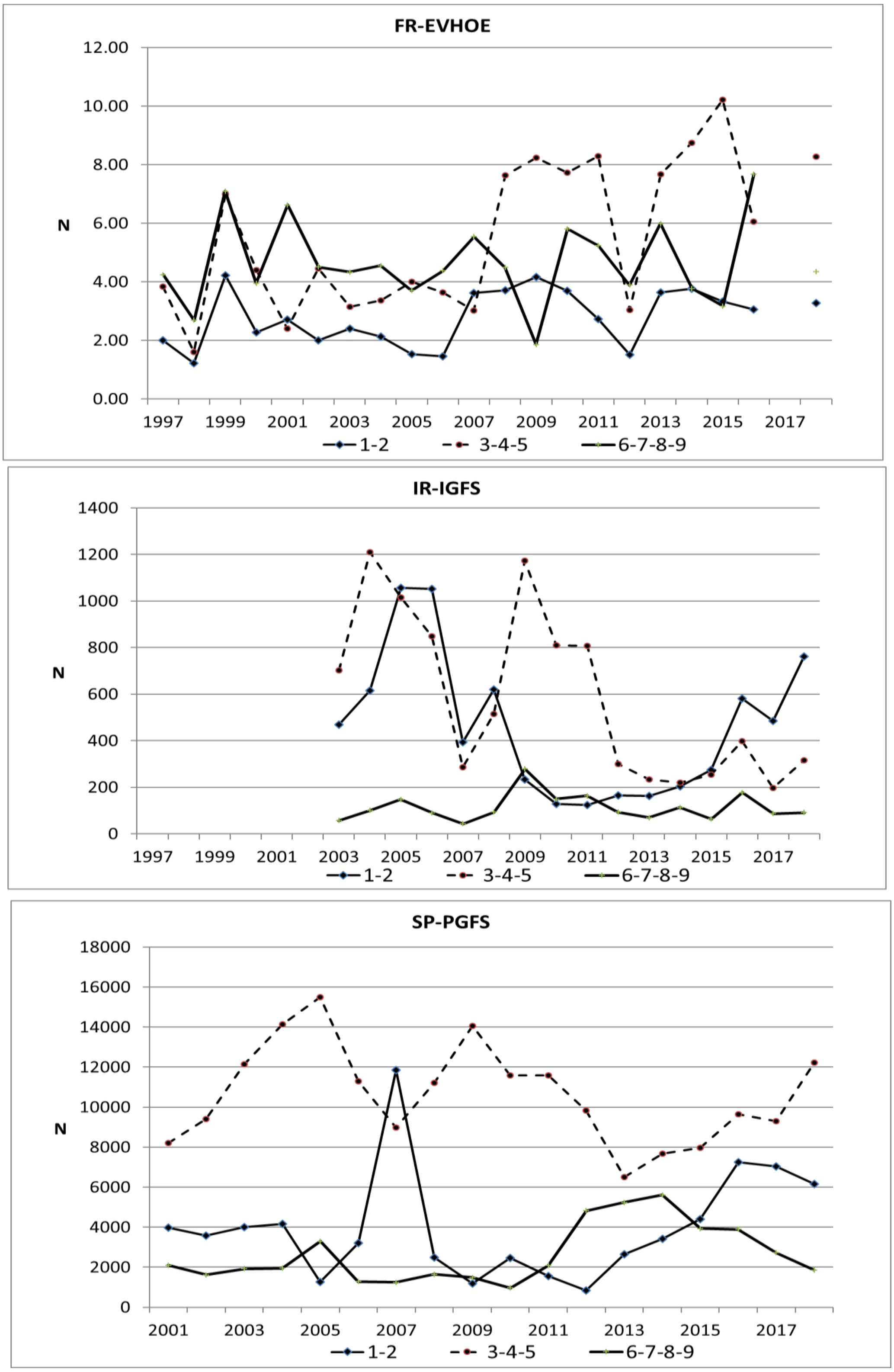


Figure 5.1.2.3.2. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Abundance Indices for EVHOE, IGFS and SP-PGFS by ages grouped: i) 1+2; ii) 3+4+5 and iii) 6+7+8+9+10+.

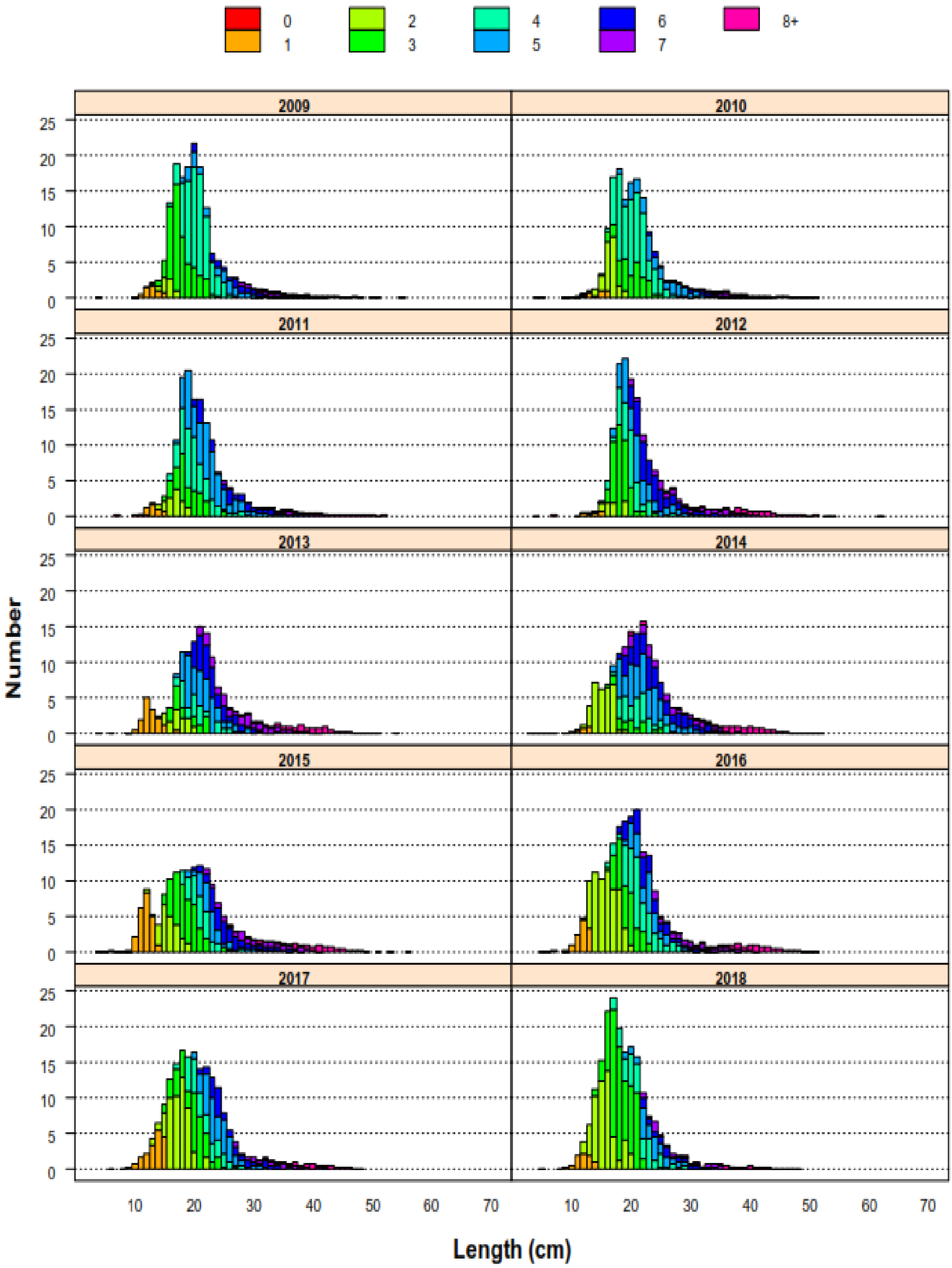


Figure 5.1.2.3.3. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Age composition of SP-PORCUPINE survey in abundance (numbers).

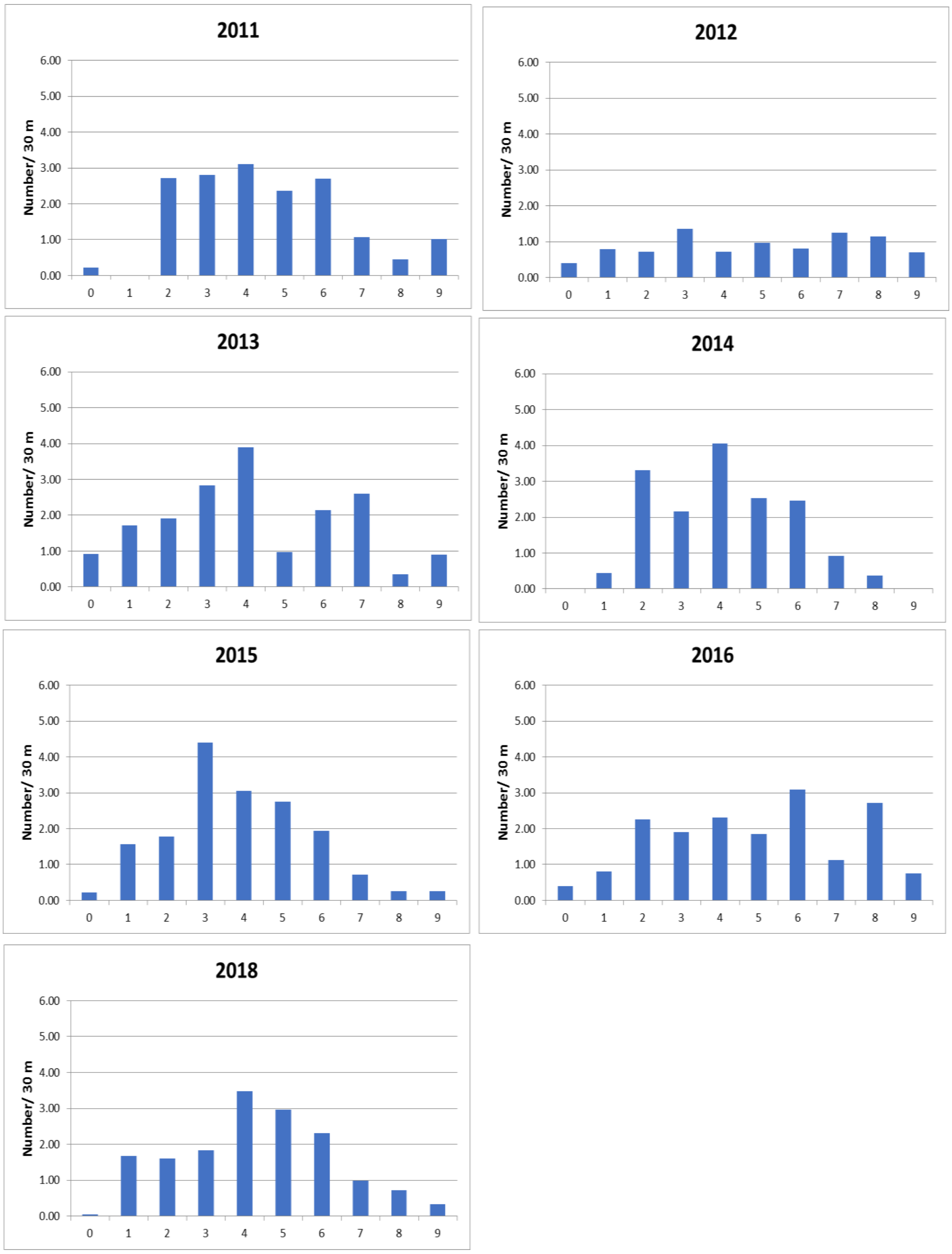


Figure 5.1.2.3.4. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Age composition of FR-EVHOE survey in abundance (numbers/30min haul).

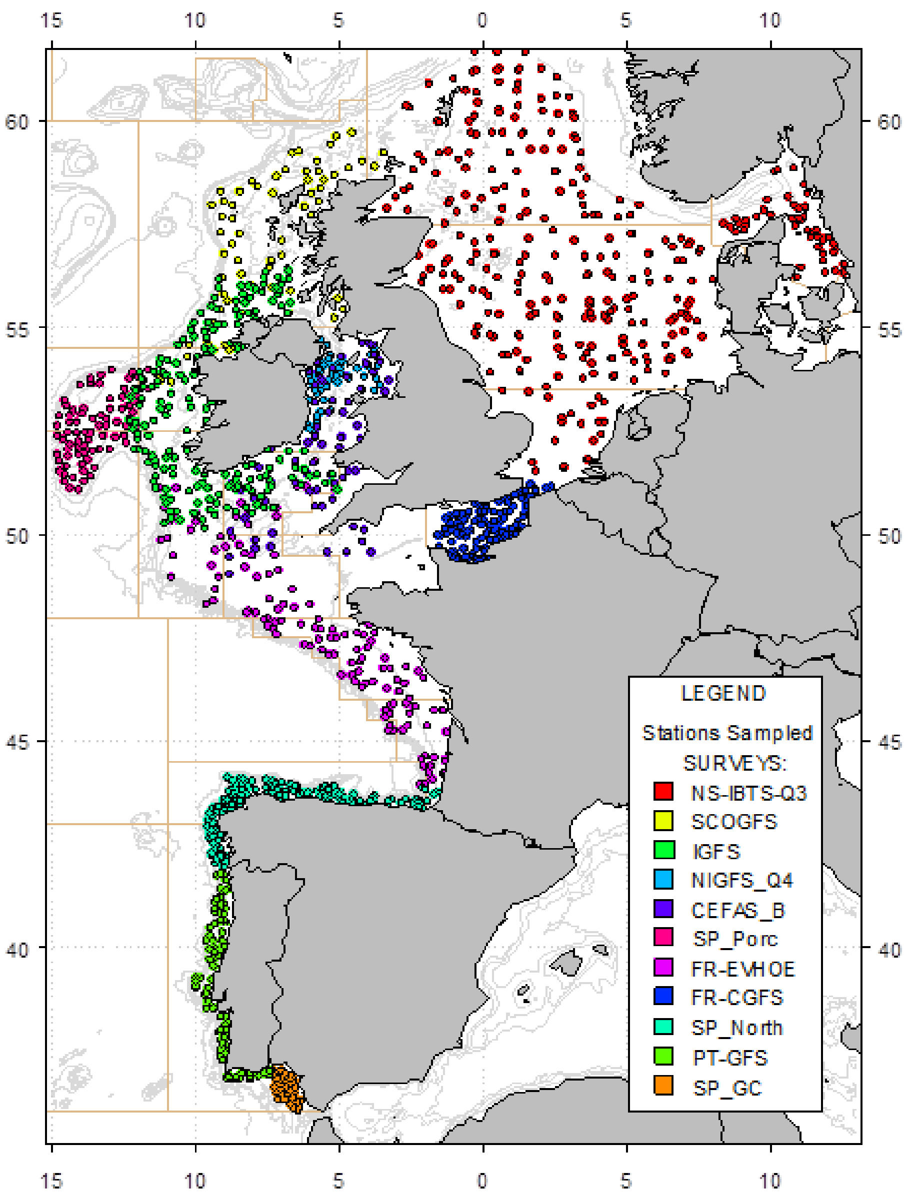


Figure 5.1.2.3.5. Station positions for the IBTS Surveys carried out in the Western Atlantic and North Sea Area in autumn/winter of 2008. (From IBTSWG 2009 Report). Just to be used as general location of the Surveys.

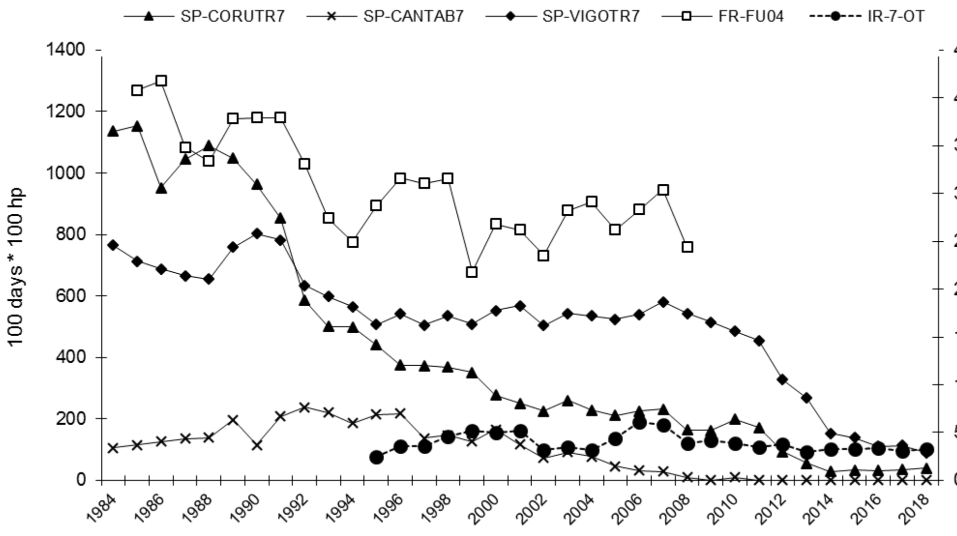


Figure 5.1.2.4.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Evolution of effort for different bottom-trawler fleets.

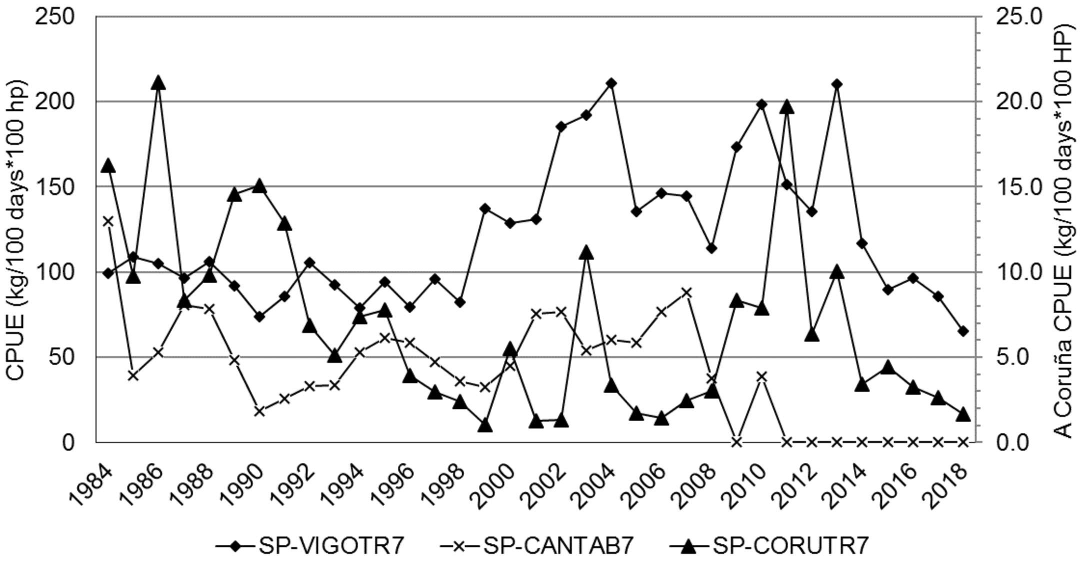


Figure 5.1.2.4.2. Megrim (*L. whiffiagonis*) in Divisions 7b,c,e-k and 8a,b,d. Spanish cpue for different bottom-trawler fleets.

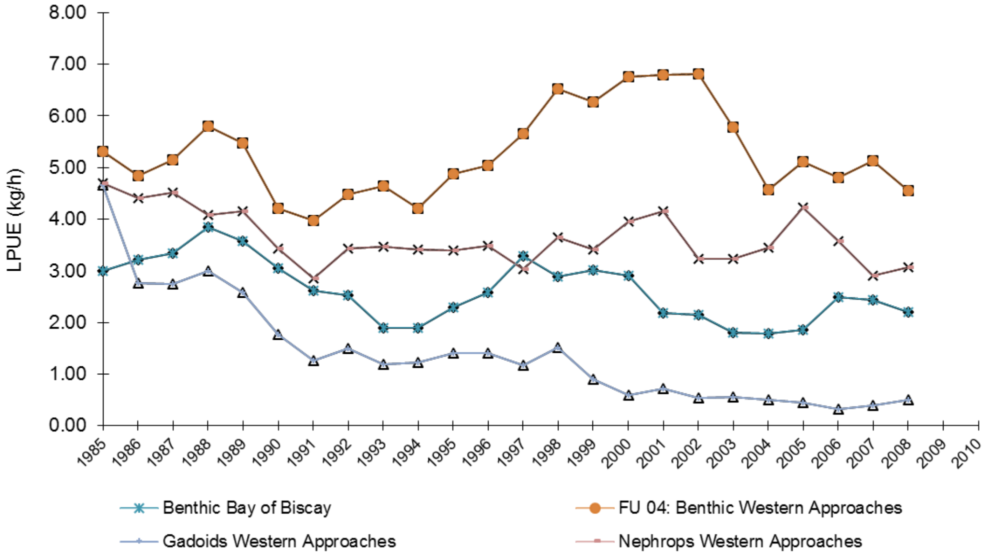


Figure 5.1.2.4.3. Megrim *(L. whiffiagonis*) in Divisions 7b,c,e-k and 8a,b,d. French LPUE for different bottom-trawler fleet.

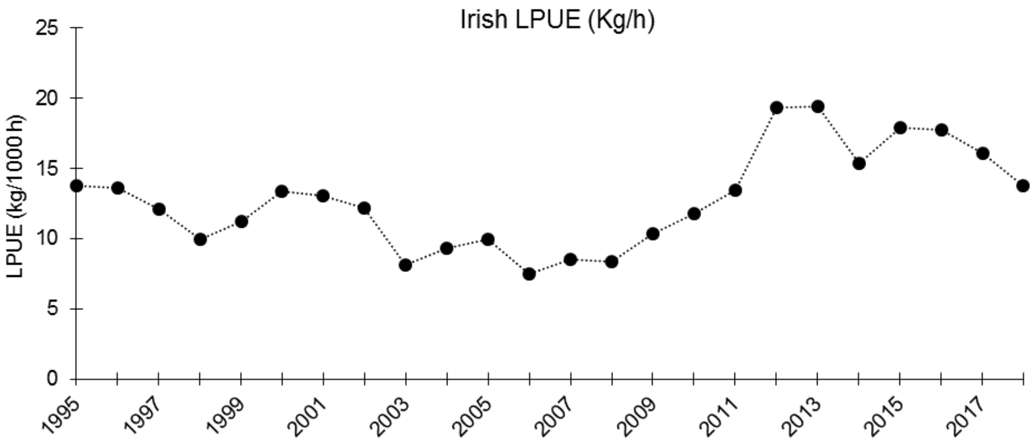


Figure 5.1.2.4.4. Megrim (*L. whiffiagonis*) in Divisions 7b,c,e-k and 8a,b,d. Irish LPUE for beam trawl fleet.

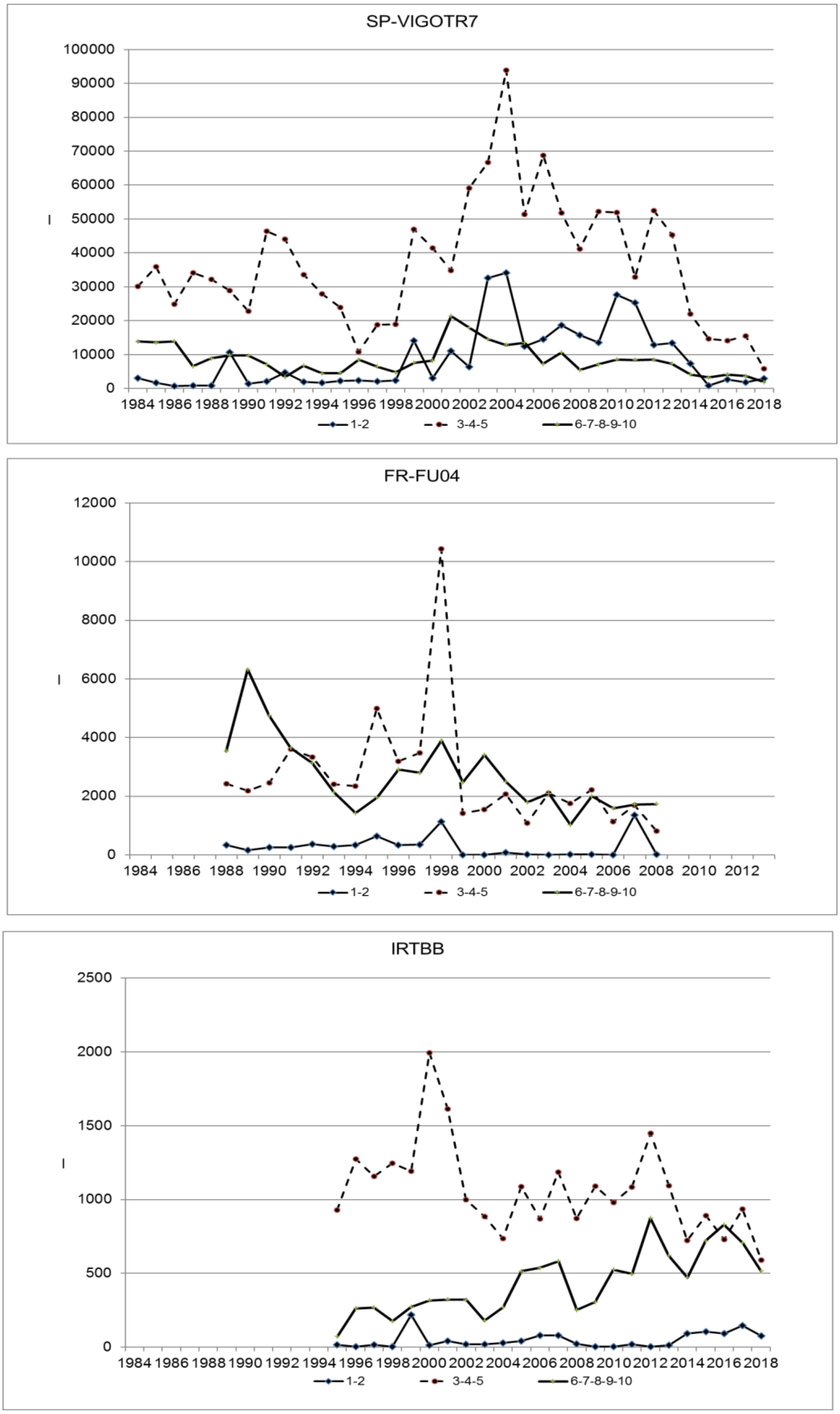


Figure 5.1.2.4.5. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Abundance Indices for SP-VIGOTR7, FR-FU04 and IRTBB by ages grouped: i) 1+2; ii) 3+4+5 and iii) 6+7+8+9+10⁺.

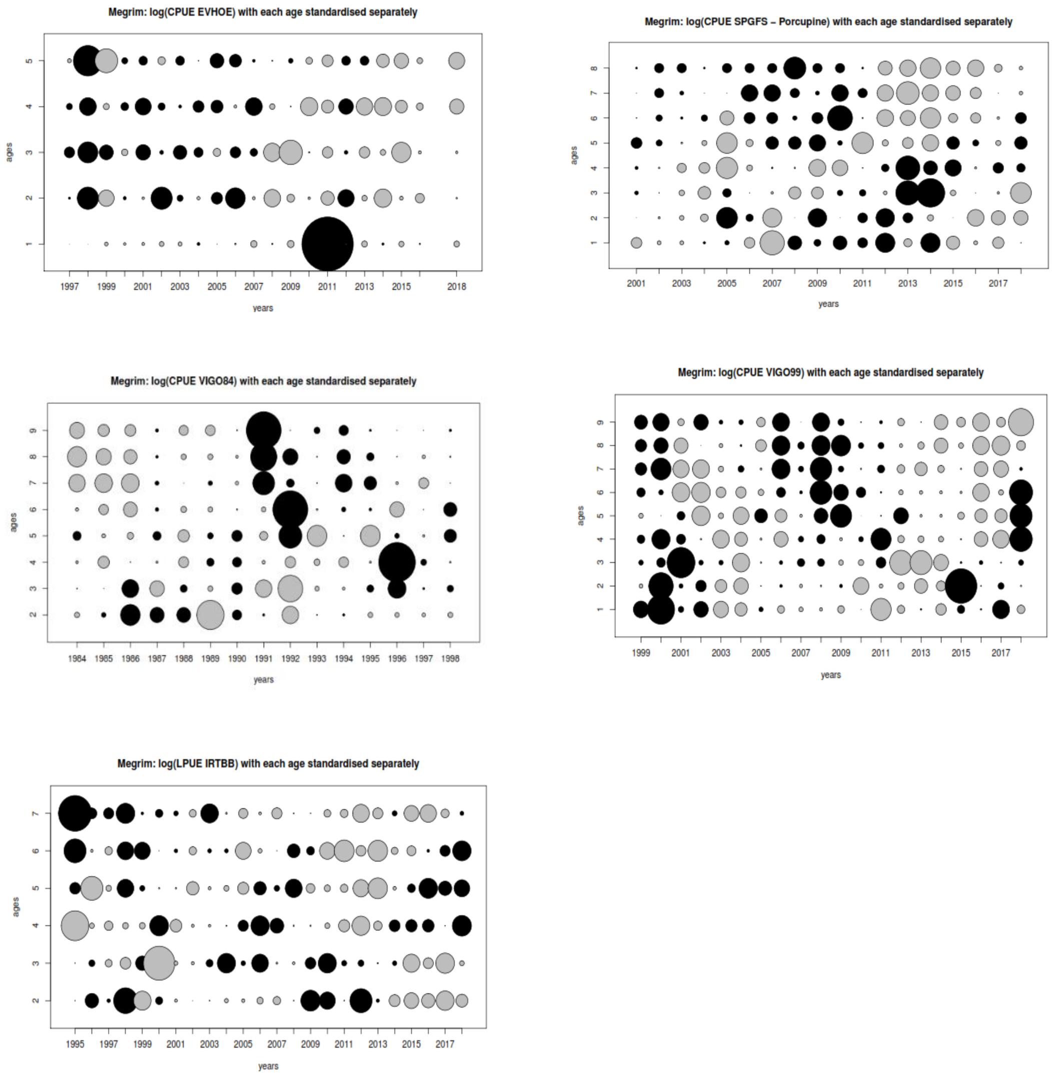


Figure 5.3.1.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Bubble plots of the standardized log abundance indices of the surveys and commercial fleets used as tuning fleets.

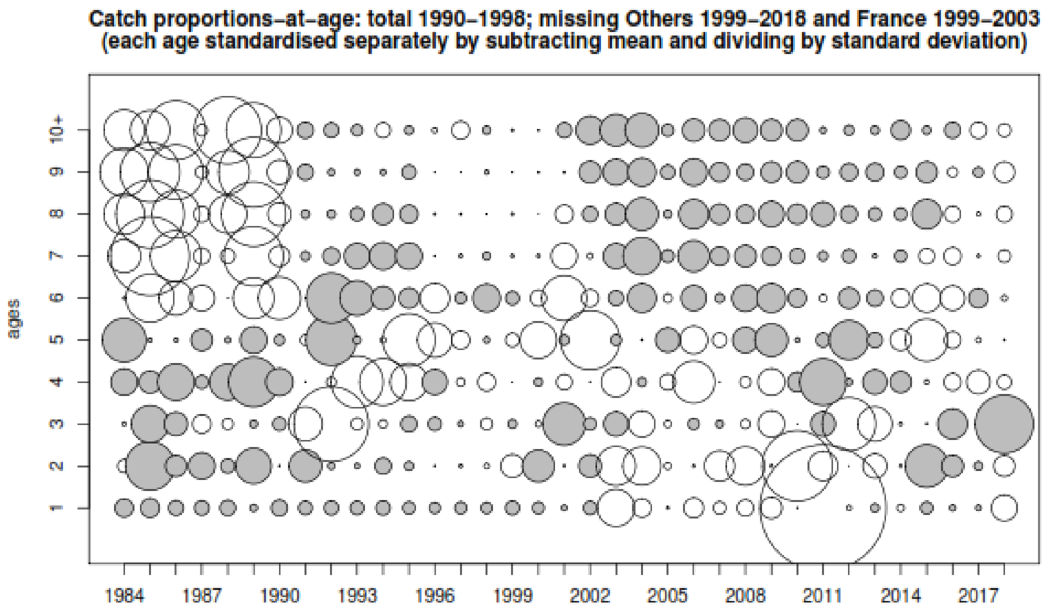


Figure 5.3.1.2. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Bubble plots for catch numbers at age from 1984 to 2018.

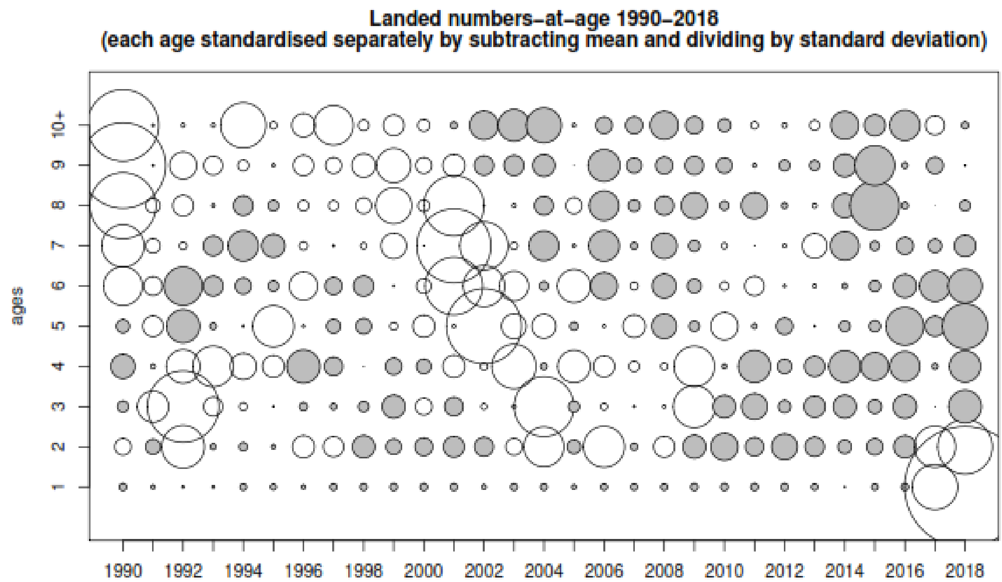


Figure 5.3.1.3. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Bubble plots for landing numbers at age from 1990 to 2018.

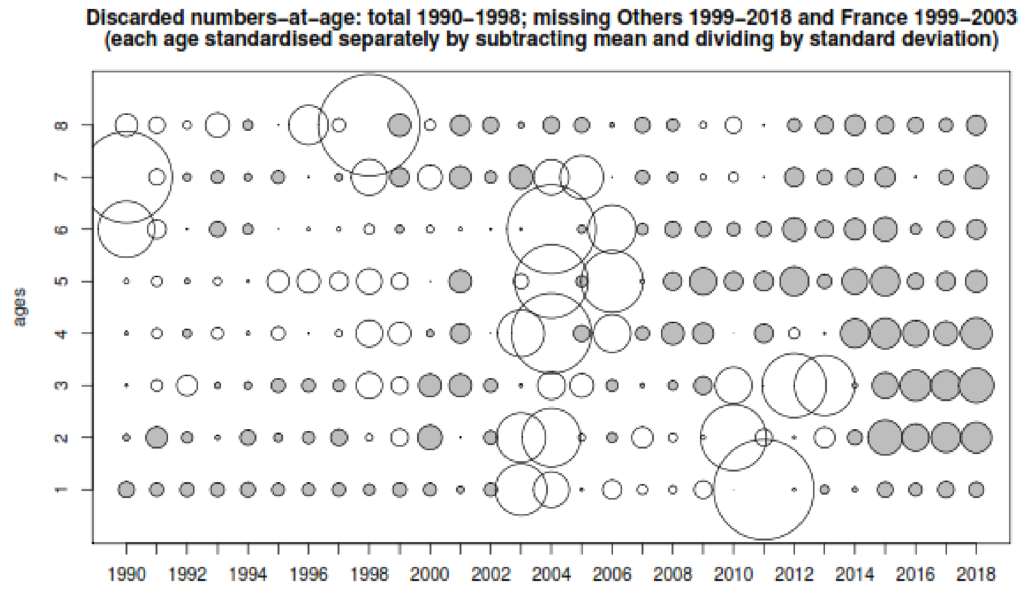


Figure 5.3.1.4. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Bubble plots for discarded numbers at age from 1990 to 2018.

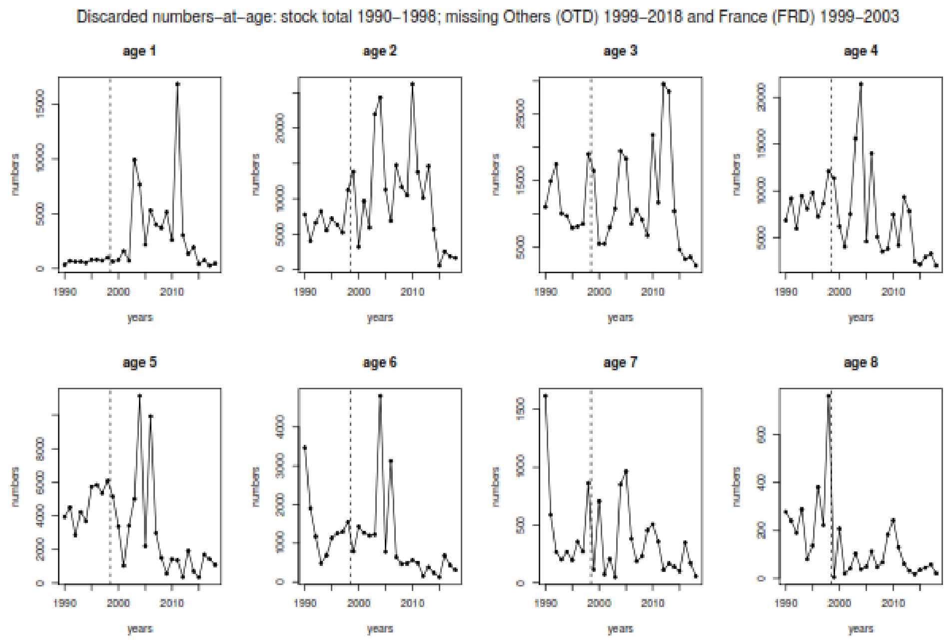


Figure 5.3.1.5. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Discarded numbers at age separated by age from 1990 to 2018.

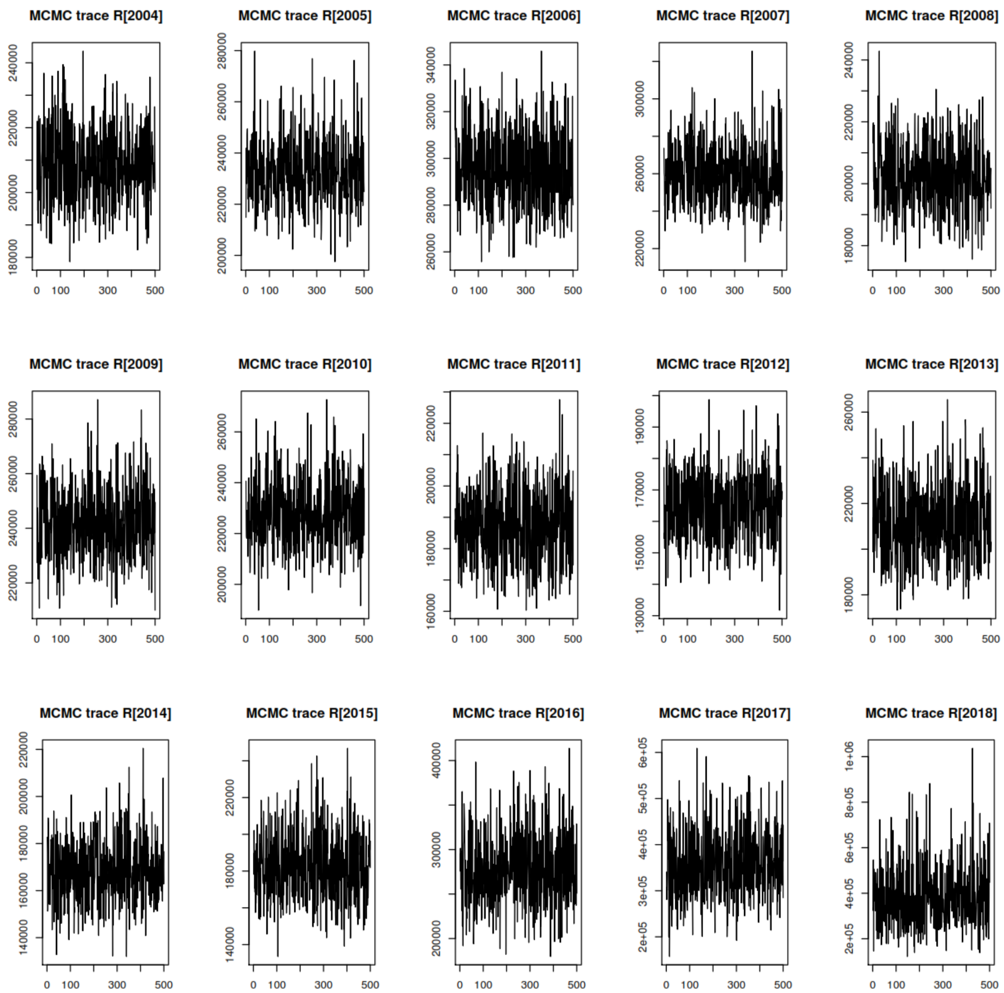


Figure 5.1.3.3.1. Trace plots of recruitment draws from 2004 to 2018.

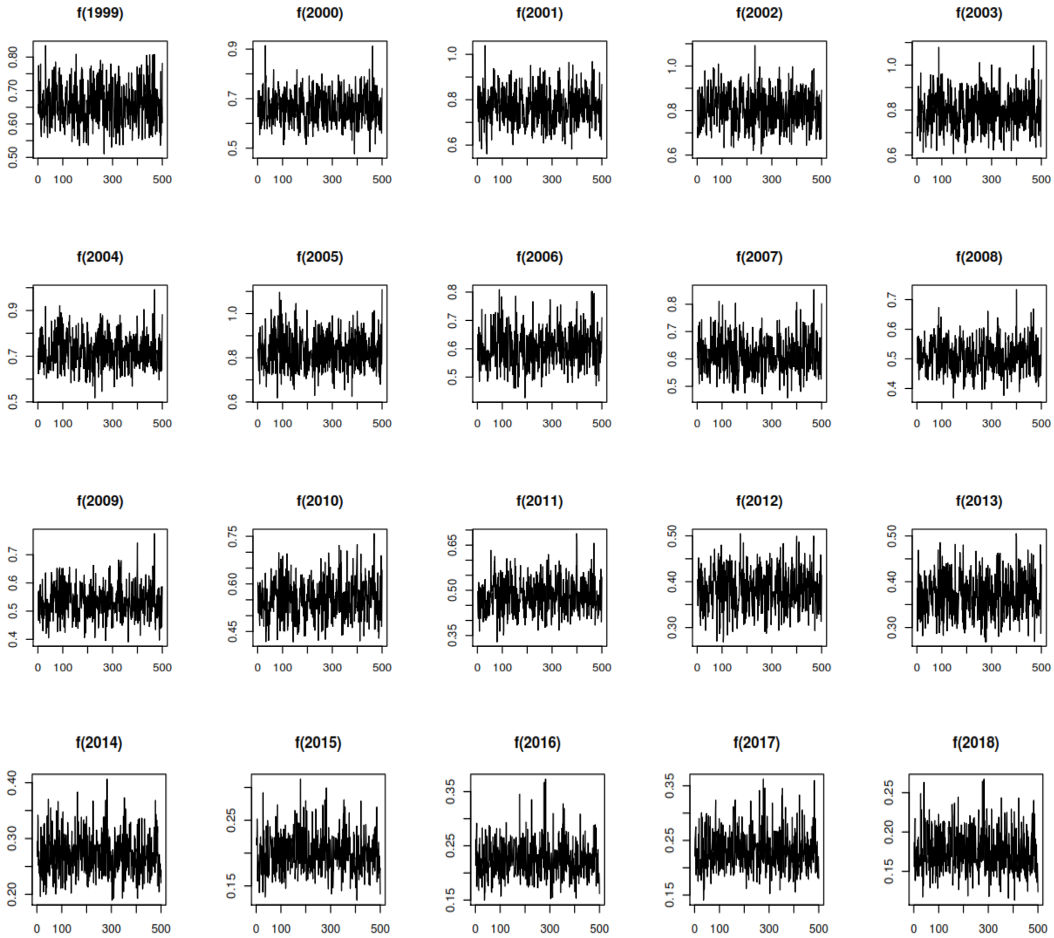


Figure 5.1.3.3.2. Trace plots of f(y) fishing mortality in ages 9 and 10 from 1999 to 2018.

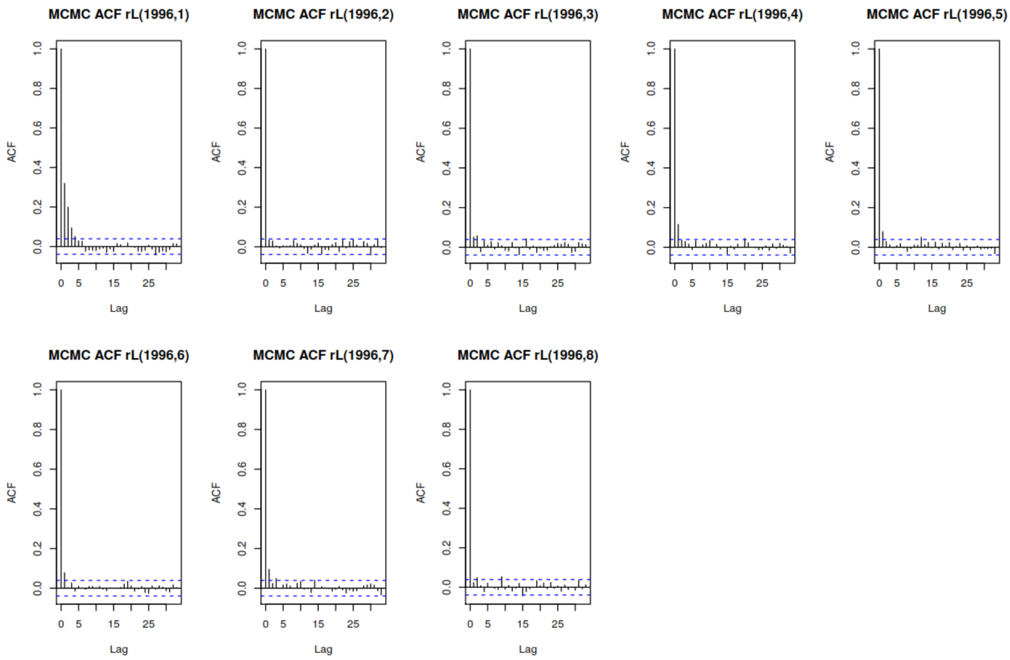
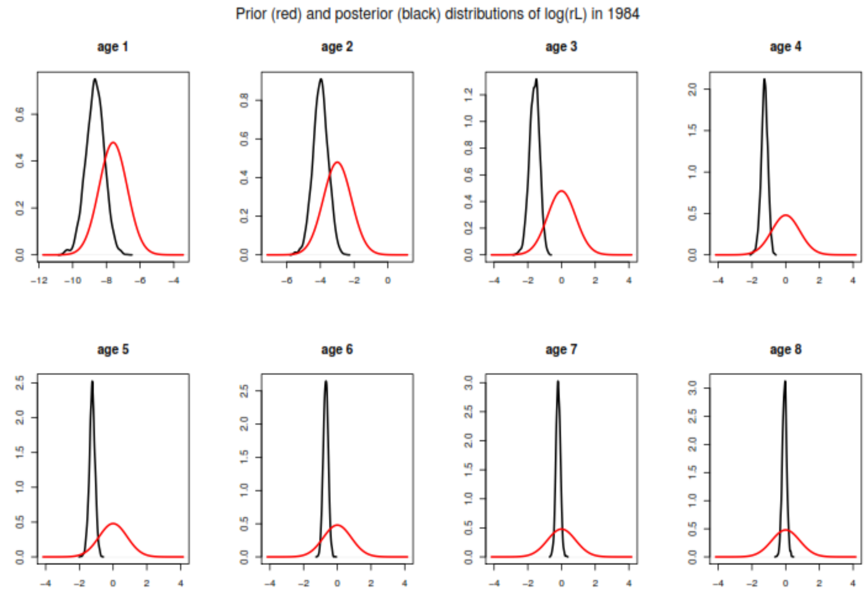
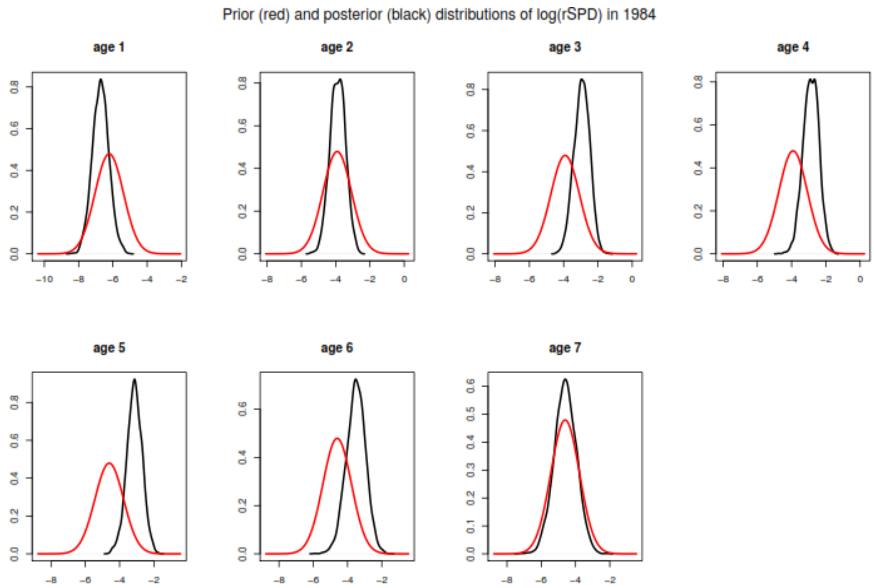


Figure 5.1.3.3.3. Autocorrelation plots of rL for years 1996 and 2018.


Prior (red) and posterior (black) distributions of log(rL) in 1984
age 1
age 2
age 3
age 4
age 5
age 6
age 7
age 8


Prior (red) and posterior (black) distributions of log(rSPD) in 1984
age 1
age 2
age 3
age 4
age 5
age 6
age 7

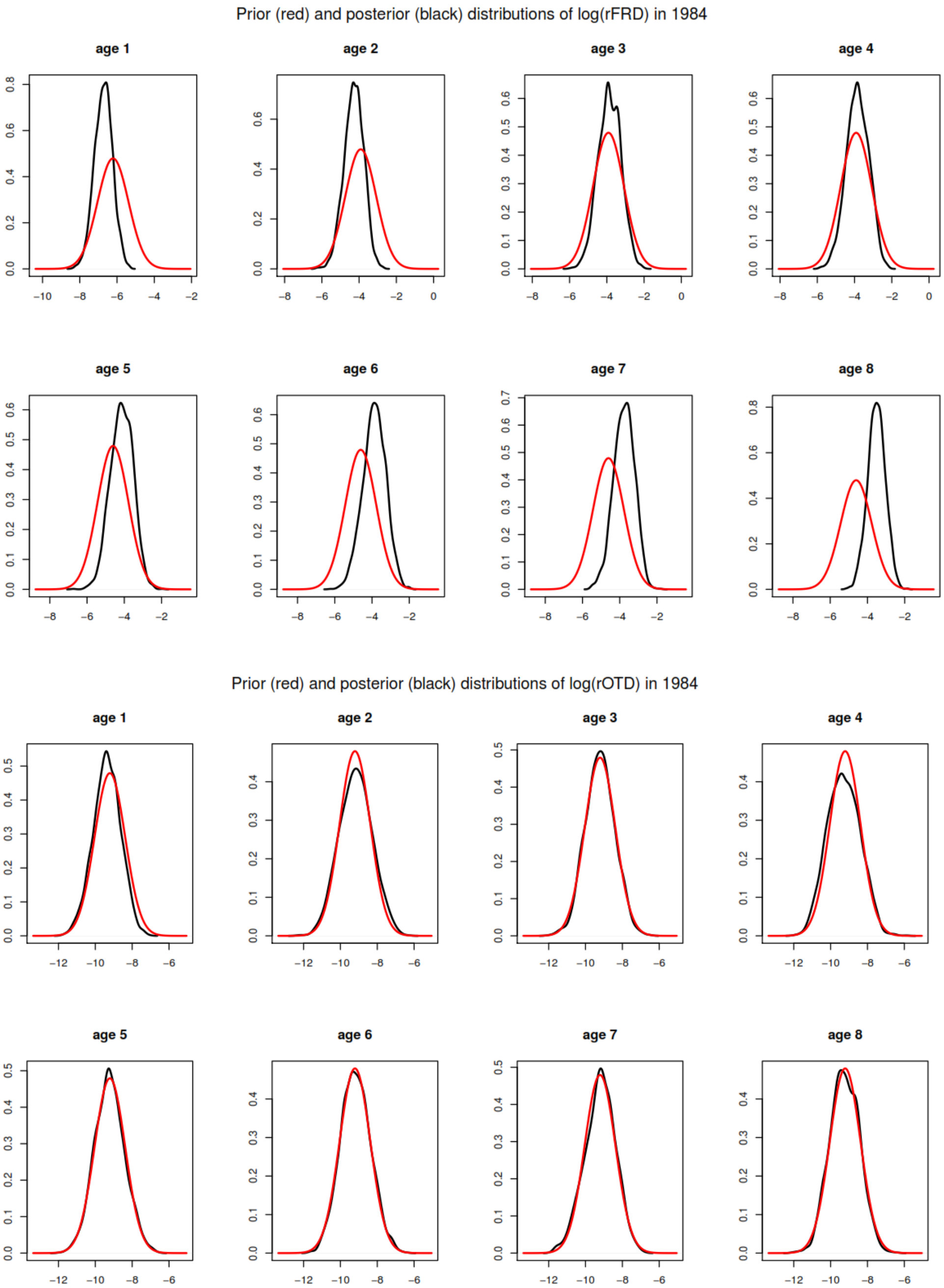


Figure 5.1.3.3.4. Prior (red) and posterior distribution of log (L) in 1984, log (rSPD) at age in 1984, log (rFRD) at age in 1984 and log (rOTD) at age in 1984.

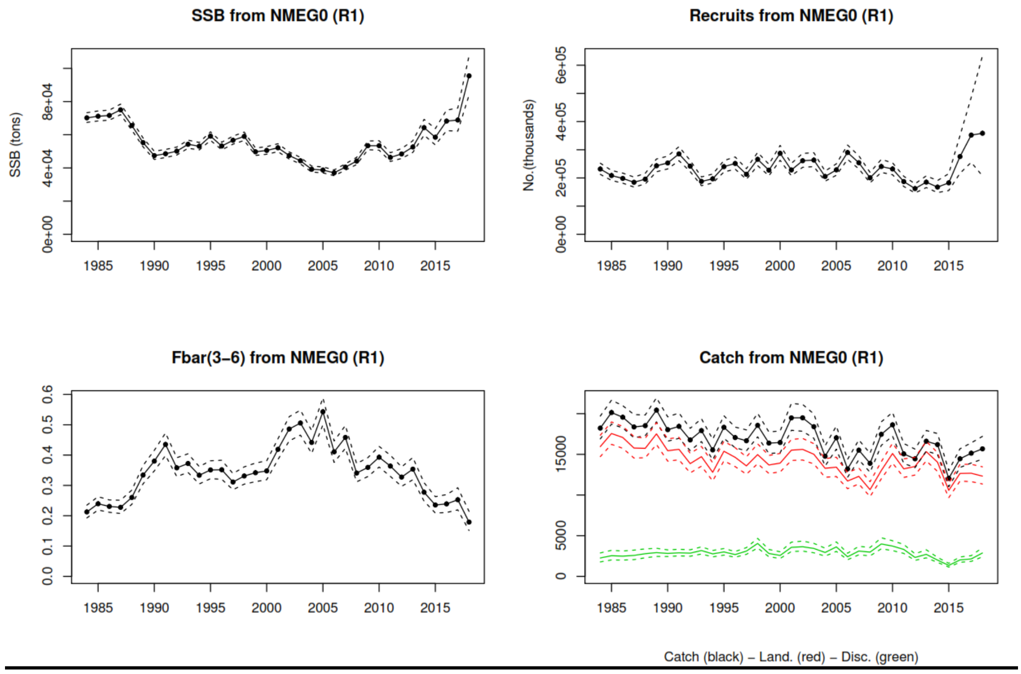


Figure 5.1.3.3.5. WGBIE 2019 results of time series of spawning stock biomass (SSB), recruits, Fbar, catch, landings and discards from 1984 to 2018. The solid dotted lines correspond with the median of the distribution and the dashed lines with 5% and 95% quantiles.

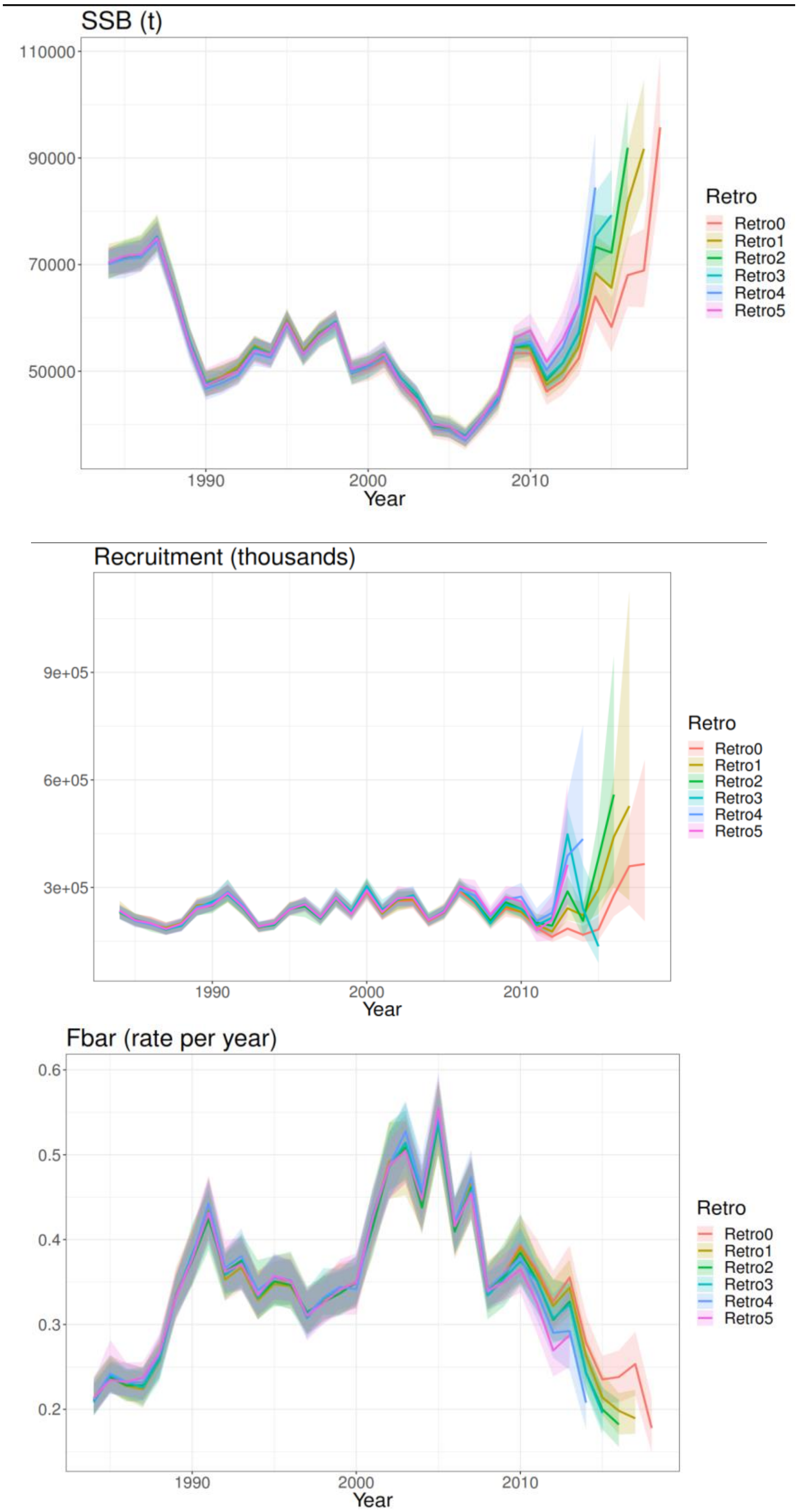


Figure 5.1.4.1. Time series of median SSB, recruitment and F_{bar} in retrospective analysis.

5.3 Four Spot Megrim (*Lepidorhombus boscii*) in Divisions 7b-k and 8a,b,d

Assessment type: No assessment (ICES stock data category 5).

Data revisions: Survey indices updated and commercial landings, discards and length data added.

5.3.1 General

5.3.1.1 Fishery description

Four spot megrim in the Celtic Sea, west of Ireland, and in the Bay of Biscay are caught in a mixed fishery predominantly by French followed by Spanish, UK and Irish demersal vessels (see stock annex for details).

5.3.1.2 Summary of ICES Advice for 2020 and Management applicable for 2019 and 2020

ICES advice for 2020

ICES has not been requested to provide advice on fishing opportunities for four-spot megrim (*Lepidorhombus boscii*) in divisions 7.b–k, 8.a–b, and 8.d.

Management applicable for 2019 & 2020

Management of four-spot megrim and megrim under a combined species TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species.

5.3.2 Data

5.3.2.1 Commercial catches and discards

Four-spot megrim was included in the catch and discard data call for the first time in 2018. Data on commercial catch and discard information was made available to the working group from France, Ireland, Spain and UK. Historical data on commercial catch and discards, going back to 2003, were requested in the 2019 data call however only Ireland and France responded to this request.

Commercial catch of Four-Spot Megrim in 2018 by gear type for French, Irish and Spanish fleets

	Landings (t)	Discards (t)	% discarded
France	16	28	64%
MIS_MIS	0	1	100%
OTB_DEF	16	28	64%
Ireland	64	100	61%
GNS_DEF	1	1	50%
MIS_MIS	4	6	60%
OTB_CRU	6	9	60%
OTB_DEF	38	60	61%
TBB_DEF	15	24	62%
Spain	833	236	22%
GNS_DEF	1	0	0%
MIS_MIS	2	1	33%
OTB_DEF	831	236	22%
UK (England)	0.04	0.01	20%
GNS_DEF	0.04	0.01	20%
Grand Total	913	365	29%

Commercial catch of Four-Spot Megrim in 2018 by year and country. Spanish data were only available for the last 2 years

	Landings (t)					Discards (t)				
Year	**FRA**	**IRL**	**ESP**	**UK(E)**	**Total**	**FRA**	**IRL**	**ESP**	**UK(E)**	**Total**
2005	62	65	NA	NA	NA	44	65	NA	NA	NA
2006	1	53	NA	NA	NA	4	53	NA	NA	NA
2007	123	59	NA	NA	NA	37	59	NA	NA	NA
2009	2	53	NA	NA	NA	1	53	NA	NA	NA
2010	65	42	NA	NA	NA	18	42	NA	NA	NA
2011	39	66	NA	NA	NA	45	31	NA	NA	NA
2012	2	67	NA	NA	NA	1	73	NA	NA	NA
2013	33	69	NA	NA	NA	41	180	NA	NA	NA
2014	31	65	NA	NA	NA	24	428	NA	NA	NA
2015	131	71	NA	NA	NA	41	292	NA	NA	NA
2016	268	71	NA	NA	NA	298	71	NA	NA	NA
2017	25	130	439	NA	594	35	308	334	NA	676
2018	16	64	833	0	913	28	100	236	0	365

5.3.2.2 Biological sampling

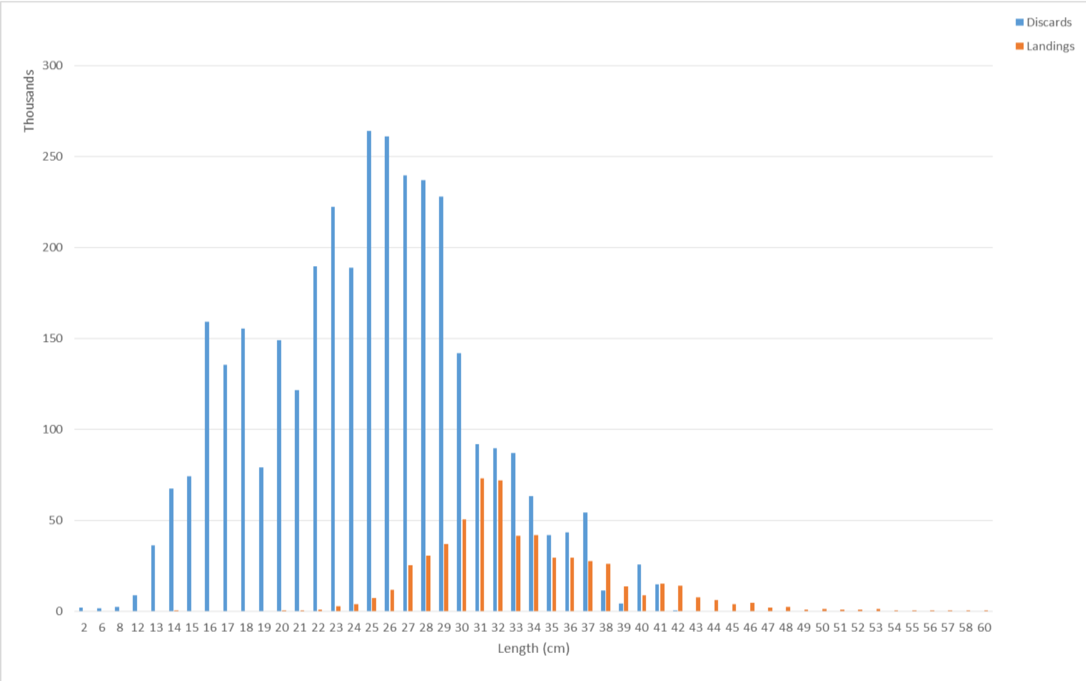
Four-spot megrim was included in the biological sampling data call for the first time in 2018. Data on length were made available to the 2019 working group from Ireland and Spain. Historical data on length, going back to 2003, were requested in the 2019 data call however only Ireland and France responded to this request.

Age

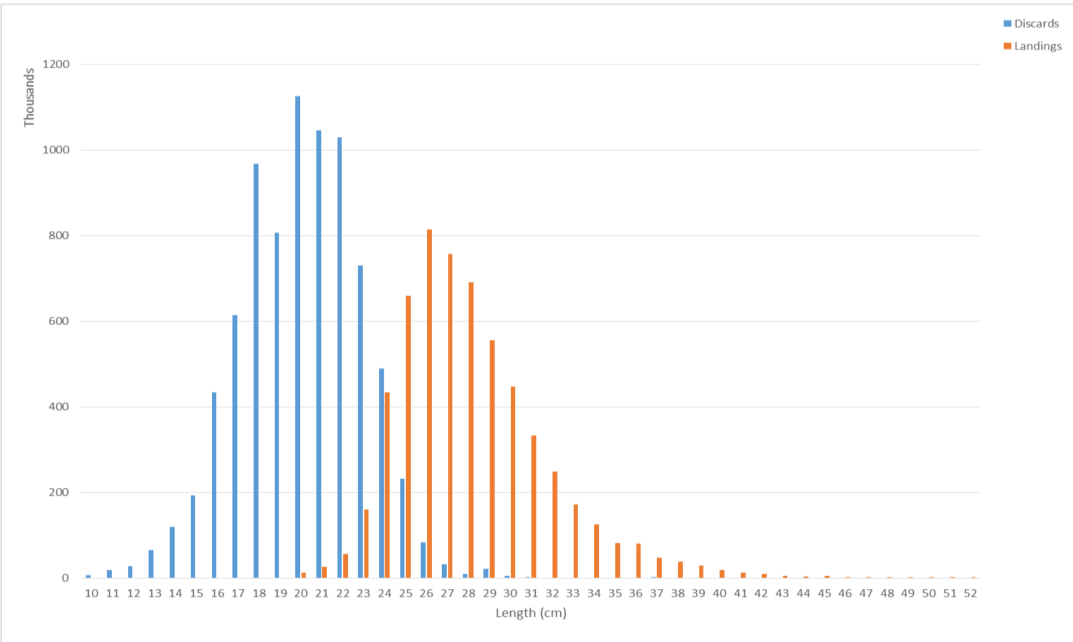
Not available.

Lengths

	Discards		Landings	
	Number of Length Measurements	Number of Length Samples	Number of Length Measurements	Number of Length Samples
Ireland	125	21	66	1
Spain	2,457	345	13,045	82
Total	2,582	366	13,111	83



Length frequency distribution of landings and discards from Irish fleets



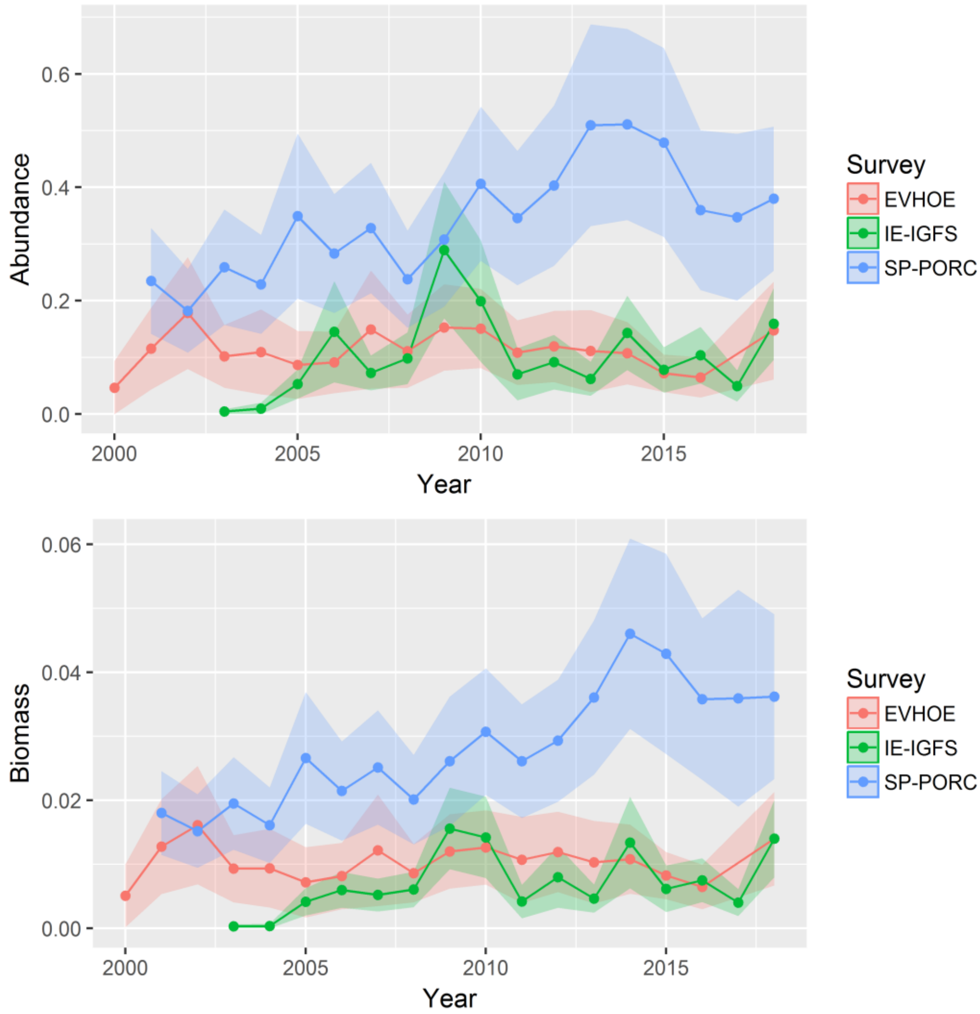
Length frequency distribution of landings and discards from Spanish fleets

Natural Mortality

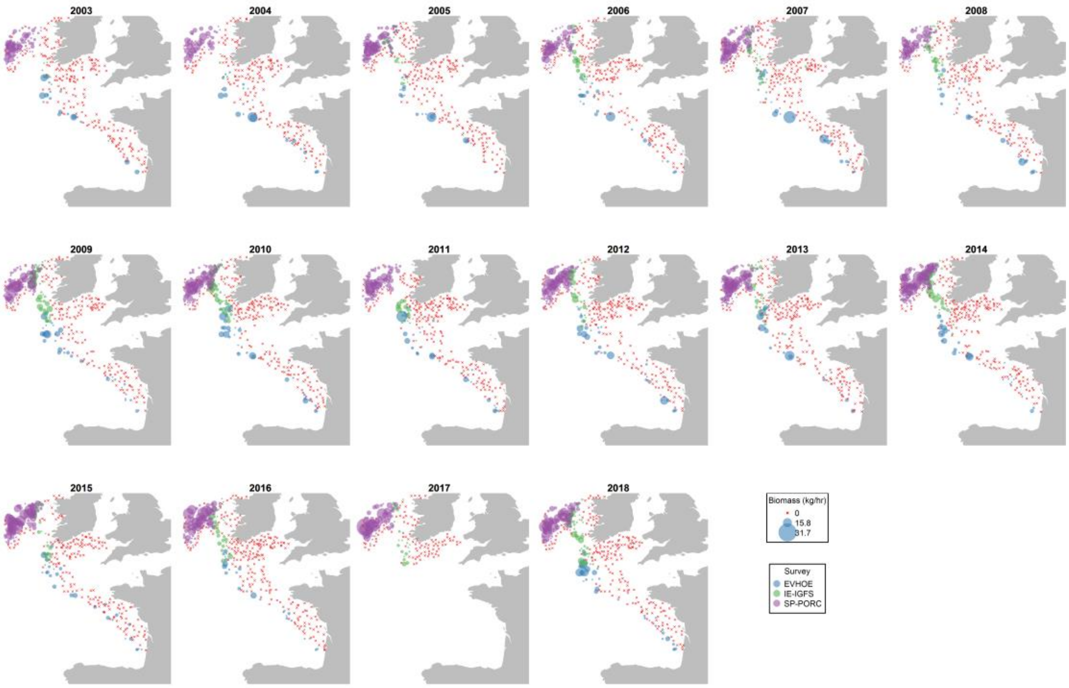
Not included in assessment.

5.3.2.3 Survey data

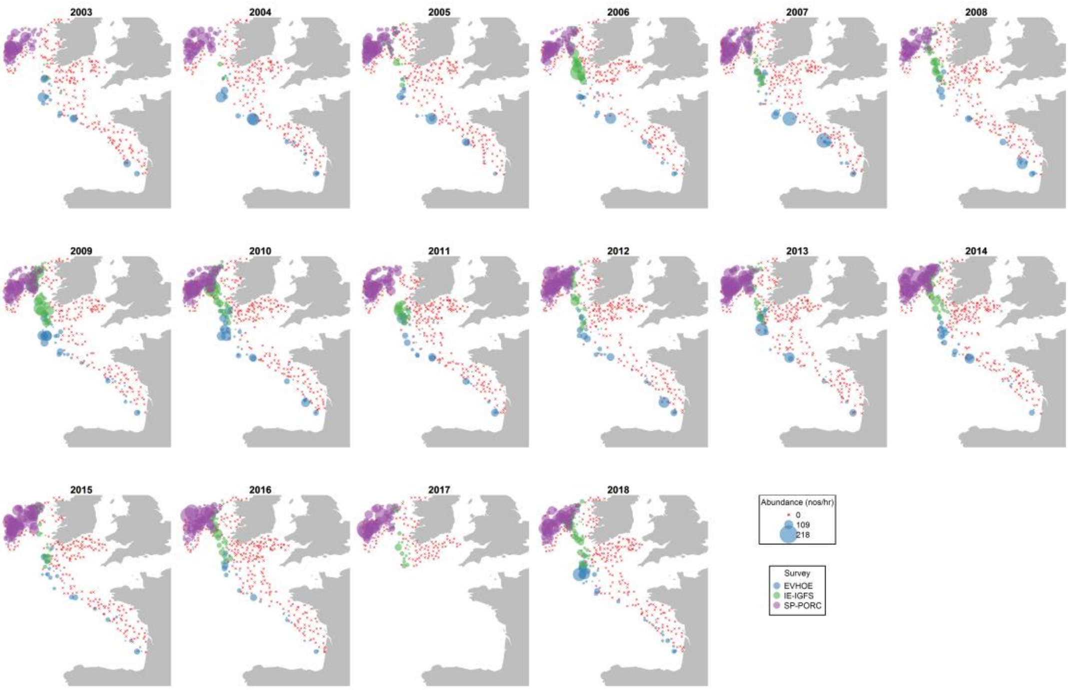
Survey data was extracted from DATRAS for Spanish Porcupine (SpPorc), Irish Groundfish Survey (IE-IGFS) and French EVHOE surveys (French survey data was not available for 2017 but recommenced in 2018). The Spanish Porcupine index was initially down weighted by an arbitrary factor of 10 because the Baka trawl used was highly more efficient at catching megrim than the GOV trawl used in the Irish and French surveys. Due to the large differences in catchability between Baka and GOV gears it was decided not to include the Spanish Porcupine index in the final assessment. Inter-calibration correction will be required based on comparison of Four-spot catches in the area where the Spanish and Irish surveys overlap. No difference was found between the Irish and the French surveys in the area where they overlap.



Biomass and abundance indices of Four-spot megrim from French EVHOE, Irish IGFS and Spanish Porcupine Surveys.



Biomass index of Four-spot megrim from French EVHOE, Irish IGFS and Spanish Porcupine Surveys.



Abundance index of Four-spot megrim from French EVHOE, Irish IGFS and Spanish Porcupine Surveys.

5.3.3 Assessment

No stock assessment was carried out in 2019 although the analysis was updated with data from 2018. The proportion of *Lepidorhombus boscii* averaged over the period 2007-2016 (no EVHOE survey was carried out in 2017) and 2018 in the EVHOE and 2007-2018 in the IGFS surveys was used to split the commercial landings of *Lepidorhombus boscii* and *Lepidorhombus whiffiagonis* .

5.3.3.1 Data Exploratory Analysis

The following exploratory analyses were carried out for quality control reasons: sample weights were checked against expected weights (as estimated from length-weight parameters). Excessive raising factors (from sample to catch weight) were checked. Abundance indices (numbers per hour) were calculated for each survey series using all valid hauls and ignoring the spatial stratification.

5.3.3.2 Model

No model was used in the assessment.

5.3.3.3 Results

The proportion of *Lepidorhombus boscii* averaged over the period 2007-2016 and 2018 in the EVHOE and 2007-2018 in the IGFS surveys was found to be 0.052 and this proportion was used to split the two species in the 2020 advice for *Lepidorhombus whiffiagonis*. The stock status relative to candidate reference points is unknown. The precautionary buffer was applied in 2017. Therefore, the precautionary buffer will not be applied this year. Discards were estimated to be 28.6% in 2018.

5.3.3.4 Retrospective pattern

No retrospective analysis was performed.

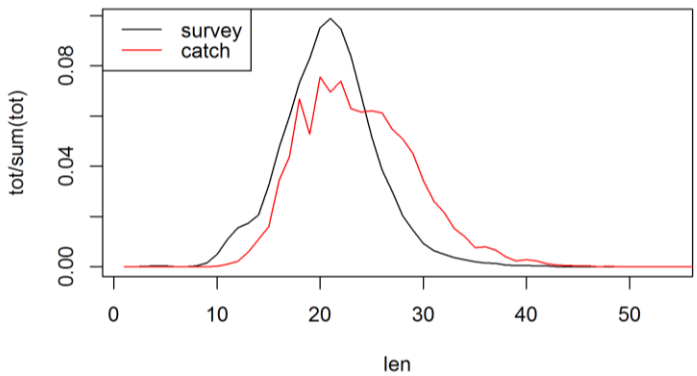
5.3.3.5 Short term forecasts

No short term forecast was produced.

5.3.4 Biological reference points

Length–based indicators

Following the technical guidelines for reference points for stocks in categories 3 and 4, length-based indicators were explored. Because the main country in the fishery (Spain) only submitted data for the last 2 years; there was limited catch data available for this analysis. Therefore, WGBIE decided to also explore the length distributions of the only survey that catches four-spot megrim in reasonable numbers: the Spanish porcupine survey.

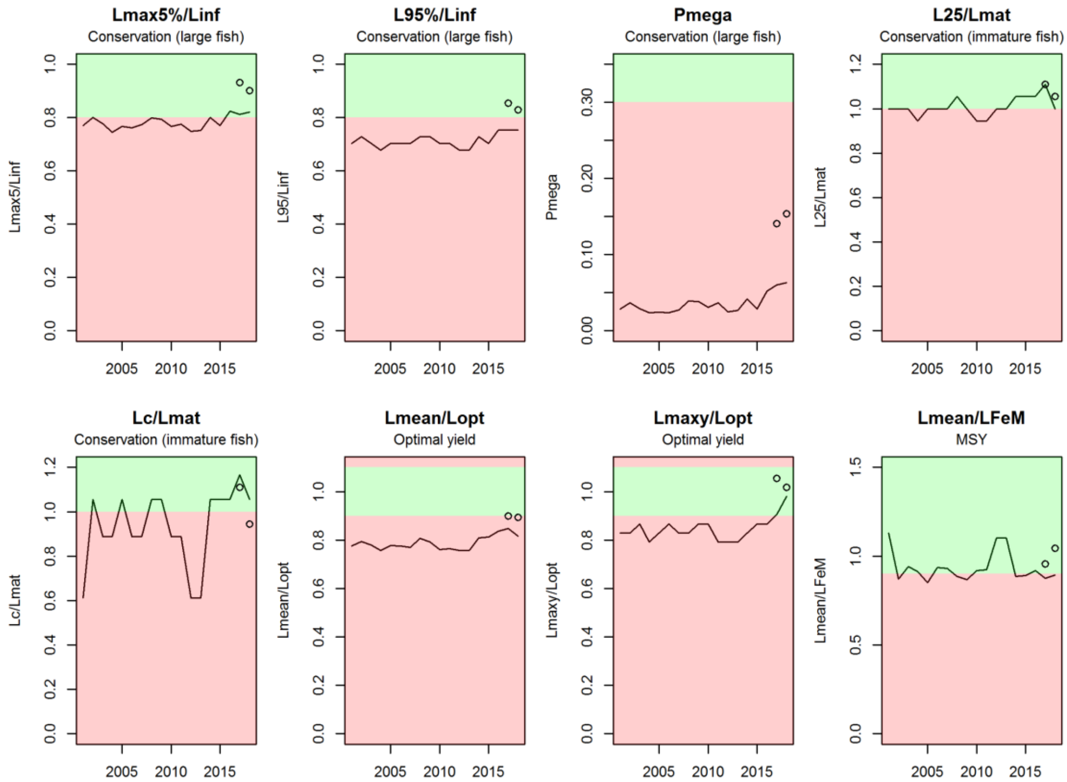


The figure above shows the total length frequency distributions of the catch (2017–18) and the Spanish Porcupine Survey (2001-18).

The following life-history parameters were used in the analysis:

- Growth from fishbase (*L. boscii* in areas 7,8abd)
  - L_{inf} = 39.8 (average fishbase)

- Also explored L_{inf} = 30.9 and 45.6 (min/max from fishbase)
- Length-weight from DATRAS data in stock area
  - a = 0.00735
  - b = 3.03
- Maturity from DATRAS data in stock area
  - L50 = 18cm



The figure above shows the length-based indicators as detailed in the technical guidelines (also see table below from the guidelines). The line represents the indicator for the survey; the points are the indicator for the two years of catch data. The expected range for a good stock status is highlighted in green.

Table 2 Selected indicators for LBI screening plots. Indicator ratios in bold used for stock status assessment with traffic light system.

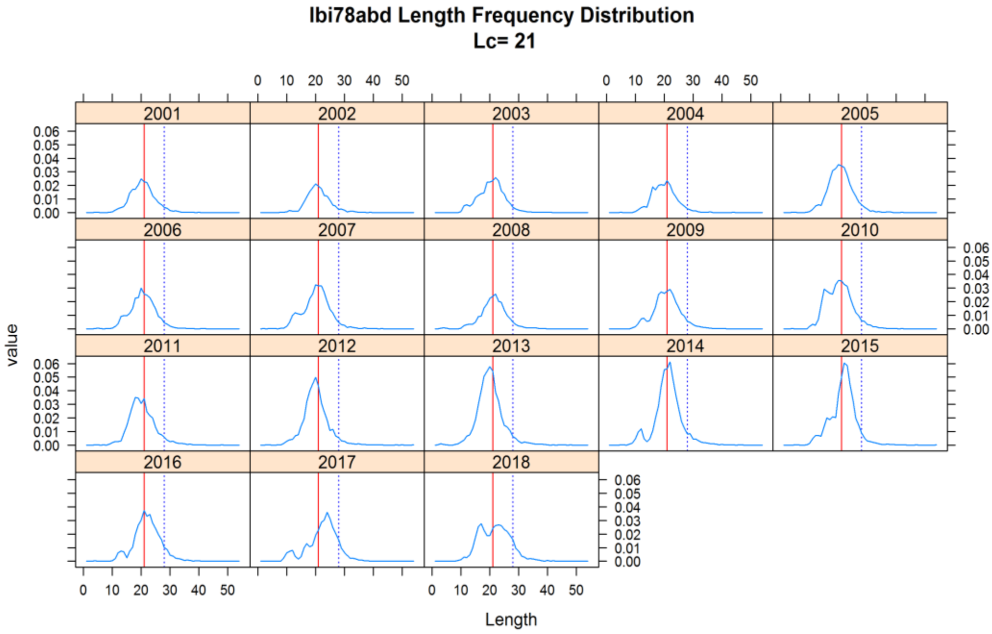
Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above L_{opt} + 10%. (L_{opt} is estimated from L_{inf}).	0.3 – 0.4	Pmega	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	> 1	Conservation (immatures)
L_c	Length at 50% of modal abundance*	L_{mat}	L_c/L_{mat}	> 1	
L_{mean}	Mean length of individuals > L_c	L_{opt} = $^2/_3$ L_{inf}	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{max_y}	Length class with maximum biomass in catch	Lopt = $^2/_3$ L_{inf}	L_{maxy} / L_{opt}	≈ 1	
L_{mean}	Mean length of individuals > L_c	$L_{F=M}$ = (0.75L_c + 0.25L_{inf})	L_{mean} / $L_{F=M}$	≥ 1	MSY

*Note this definition is different from the L_c used for the Mean-length Z estimator.

Overall, the indicators suggest that the stock is not heavily over-exploited; many of them are close to being in a good status. The $L_{mean}/L_{f=m}$ indicator was further explored in relation to its sensitivity to the growth parameters and it was found that the higher value of Linf brought the indicator to around 0.85 while the lower value of Linf resulted in an indicator around 1.0.

Mean length Z

Because there is no time-series of catch available yet, the only length-based method that may be appropriate for this stock is mean-length-Z. The method requires a time-series of length data that is representative of the population. Again, the only time-series available is that from the Spanish Porcupine survey.

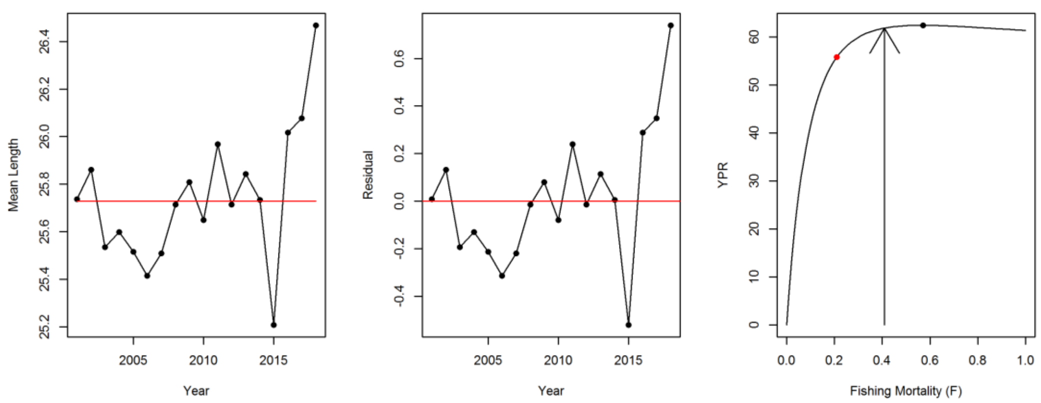


The figure above shows the length frequency distributions of the Spanish porcupine survey. The vertical red line is the assumed length at full selectivity (21cm), which corresponds to the mode of the overall distribution.

The same life-history parameters were used as above with the addition of:

- Natural mortality: 0.2 (same as ldb.27.8c9a)
- Maximum age: 23 (-log(0.01)/M)

No breakpoint was used as adding breakpoints did not improve the fit.



The figure above shows the results of the mean-length-Z analysis. The mean length varied very little over time (25.2-26.4cm). F was estimated to be 0.41 (arrow in right plot) which is well above F01 (red dot in right plot) but below F_{max} (black dot).

WGBIE discussed the mean-length-Z analysis and concluded that the validity of the analysis hinges on the question whether the survey length frequency distributions are representative of the stock. Because the survey only covers a relatively small part of the stock distribution (the Porcupine Bank); it was concluded that this assumption was likely to be invalid and WGBIE therefore decided not to advise on the status of this stock.

5.3.5 Conclusions

This was the third year that an assessment was carried out for this stock and the second year that the stock was included in the WGBIE data call. This year, no catch advice was requested, the commission only requested information on the stock status relative to proxy reference points. WGBIE was not able to provide this due to missing Spanish data for most of the time-series.

The quality of this assessment was improved on the previous year by the addition of commercial landings, discards and length data. However the lack of historical (2003–2018) catch and sampling data from Spain hampered the assessment. There is still a requirement for substantial port sampling to provide an accurate species split for the landings as it is unsure how the survey catches relate to the commercial catches.

6 Megrims (*Lepidorhombus whiffiagonis* and *L. boscii*) in Divisions 8c and 9a

Lepidorhombus whiffiagonis:

Type of assessment in 2019: Update.

Data revisions this year:

No revisions this year.

Lepidorhombus boscii:

Type of assessment in 2019: Update.

Data revisions this year:

No revisions this year.

6.1 General

See Stock annex general aspects related to megrim assessment.

6.1.1 Ecosystem aspects

See Stock annex for ecosystem aspects related to megrim assessment.

6.1.2 Fishery description

See Stock annex for fishery description.

6.2 Summary of ICES advice for 2019 and management for 2018 and 2019

ICES advice for 2019(as extracted from ICES Advice on fishing opportunities, catch and effort 2018):

The two megrim species (*L. whiffiagonis* and *L. boscii*) are not totally separated in the landings. A single TAC covers both species and species specific landings are estimated by ICES (ICES, 2018a). ICES considers that management of the two megrim species under a combined TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species. Therefore, the advice since 2016 is based on the single-species FMSY.

A mixed-fisheries analysis covering the stocks in Iberian waters of hake, megrim, four-spot megrim, and white anglerfish is provided in ICES.

ICES advises that when the MSY approach is applied, catches in 2019 should be no more than 431 tonnes for L. whiffiagonis and 1633 tonnes for L. boscii.

Management applicable for 2018 and 2019:

The agreed combined TAC for megrim and four-spot megrim in ICES Divisions 8c and 9a was 1387 t in 2018 and 1872 t in 2019.

6.3 Megrim (*L. whiffiagonis)* in Divisions 8c and 9a

6.3.1 General

See general section for both species.

6.3.2 Data

6.3.2.1 Commercial catches and discards

Working Group estimates of landings, discards and catches for the period 1986 to 2018 are given in Table 6.1.1. Since 2011, estimates of unallocated or non-reported landings have been included in the assessment. These were estimated based on the sampled vessels (Spanish concurrent sampling) raised to the total effort for each métier. These estimates are considered the best information available at this time. In 2015, data revised for period 2011-2013 were provided. This revision produced an improvement in the allocation of sampling trips and data revised are used in the assessment. The total estimated international landings in Divisions 8c and 9a for 2018 was 315 t. Landings reached a peak of 977 t in 1990, followed by a steady decline till 2002. Some increase in landings has been observed since then, but landings have again decreased annually since 2007 till 2010 were 83 t, the lowest value of the entire series occurred. Since 2011 the stock increased again and it maintains stable. Historical landings for both species combined are shown in Figure 6.1.1. In 2018, international landings are 1129 t, according to last year's values.

Discards estimates were available from "observers on board sampling programme" for Spain in the years displayed in Table 6.1.2(a). Discards in number represent between 10-47% of the total catch, with the exception of the year 2007 when discards have been very low and 2011 with discards extremely high. Following recommendations, during the Benchmark WKSOUTH in 2014, an effort was made to complete the time-series back until 1986 in years without samplings. Total discards are given in tons in Table 6.1.1 and in numbers at age in Table 6.1.2(b), these data are included in the assessment model.

6.3.2.2 Biological sampling

Annual length compositions of total stock landings are displayed in Figure 6.1.2 for the whole period and in Table 6.1.3.(a) for 2018. Unallocated/non reported value is raised to total length distribution. The bulk of sampled specimens corresponds to fish of 20-30 cm.

Sampling levels for both species are given in Table 1.4.

Mean lengths and mean weights in landings since 1990 are shown in Table 6.1.3(b). The mean length and mean weight values in 2013 are the highest in the historic series.

Age compositions of catches are presented in Table 6.1.4 and weights-at-age of catches in Table 6.1.5, from 1986 to 2018. These values were also used as the weights-at-age in the stock.

More biological information, the parameters used in the length-weight relationship, natural mortality and maturity ogive are shown in the stock annex.

6.3.2.3 Abundance indices from surveys

Two Portuguese (PtGFS-WIBTS-Q4, also called "October" survey, and PT-CTS (UWTV (FU 28-29)), also called "Crustacean" survey) and one Spanish (SP-NSGFS-Q4) survey indices are summarised in Table 6.1.6. In 2012, Portuguese surveys were not conducted due to budgetary constraints of national scope turned unfeasible to repair the R/V.

As noted in the Stock Annex, indices from these Portuguese surveys are not considered representative of megrim abundance, due to the very low catch rates.

The Spanish survey (SP-NSGFS-Q4) covers the distribution area and depth strata of this species in Spanish waters 8c and 9a. Total biomass and abundance indices from this survey were higher during the period 1988 - 1990, subsequently declining to lower mean levels, which are common through the rest of the time series. There has been an overall declining trend in the abundance index after year 2000, with the values for 2008 and 2009 being the two lowest in the entire series. Since then, there is a general increasing trend. (Figure 6.1.3(a), bottom right panel). In 2013 the survey was carried out in a new vessel. This year the abundance indices were high for flatfish and benthic species. Although there was an inter-calibration exercise between both vessels, the results were not consistent with the results of the inter-calibration, therefore the working group decided not to include the abundance index value for that year in the assessment model. Since 2014 the gear used was similar to the gear used in the survey before 2013. A new inter-calibration exercise was conducted in 2014 and the index was suitable to include.

The Spanish survey recruitment index for age 1 (Recruitment age) indicate an extremely weak year class in 1994, followed by better values. From 2000 to 2014 year classes appear to be in low values except for 2010. However, since 2015, there is a very important increase in age 1, being the 2016 value the highest for the time series. The 2018 value is a decrease in relation to this last period.

Catch numbers-at-age per unit effort and effort values for the Spanish survey are given in Table 6.1.7. In addition, Figure 6.1.3(b) displays a bubble plot of log (survey indices-at-age), with the values for each age standardised by subtracting the mean and dividing by the standard deviation over the years. The size of the bubbles is related to the magnitude of the standardised value, with white and black bubbles corresponding to positive and negative values, respectively. The figure indicates that the survey is quite good at tracking cohorts through time and highlights the weakness of the last few cohorts.

6.3.2.4 Commercial catch-effort data

The commercial LPUE and effort data of the Portuguese trawlers fishing in Division 9a covers the period 1988–2018 (Table 6.1.8 and Figure 6.1.3(a)).

It is known that the Northern Spanish coastal bottom otter trawl fleet is a fleet deploying a variety of fishing strategies with different target species. In fact, these fishing strategies are identified under the current DCF sampling programme, so that they can be then re-aggregated under two DFC métiers: bottom otter trawl targeting demersal species (OTB_DEF_>=55_0_0) and OTB targeting pelagic stocks accompanied by some demersal species (OTB_MPD_>55_0_0). Therefore, the LPUE of these métiers was recovered backwards (until 1986) and two new time-series of bottom otter trawl targeting demersal species, one per port (A Coruña and Avilés), were provided to the Benchmark WKSOUTH in 2014. These tuning fleets (SP-LCGOTBDEF and SP-AVSOTBDEF) were accepted to tune the assessment model instead of the old ones A Coruña trawl (SP-CORUTR8c) and Avilés trawl (SP-AVILESTR). The LPUEs and effort values are given in Table 6.1.8 and Figure 6.1.3(a).

Commercial fleets used in the assessment to tune the model

Before 2003, A Coruña (SP-LCGOTBDEF) effort was generally stable. After that year, the trend was similar but in lower values. The 2011 effort value is the lowest in the series. In 2014, effort is the highest value and in 2018 decreases again. The LPUE shows a general faintly increasing trend. The 2018 value represents a decrease in relation to previous years.

Avilés (SP-AVSOTBDEF) effort presents a slightly decreasing trend throughout the whole period. The highest value occurred in 1998 and the lowest in 2001. LPUE shows a decreasing from 1986 to 2003. Since then, it has had a further upward and downward fluctuation, with a peak in

2011. A decrease is shown in the last year value. Landed numbers-at-age per unit effort and effort data for these fleets are given in Table 6.1.7.

Figure 6.1.3(c) displays bubble plots of standardised log (landed numbers-at-age per unit effort) values for these commercial fleets, with the standardisation performed by subtracting the mean and dividing by the standard deviation over the years. The panel corresponding to A Coruña trawl fleet clearly indicates below average values from year 2003 to 2010, but since then also many values are above averages. Avilés show a decreasing trend.

Commercial fleets not used in the assessment to tune the model

Portuguese effort values are quite variable, with a slightly decreasing trend, being the last years the lowestones in the time series (Table 6.1.8 and Figure 6.1.3(a)). The Portuguese LPUE series was revised from 2012 onwards. To revise the series backwards further refinement of the algorithms is required. The LPUE shows a steep decrease between 1990 and 1992, and has since remained at low levels, with the exception of a peak in 1997-1998. LPUE for the last years represent a slightly increase in relation to the previous years with a new fall in 2018 value.

6.3.3 Assessment

An update assessment was conducted, according to the Stock Annex specifications. Assessment years are 1986-2018 and ages 1-7+.

6.3.3.1 Input data

It follows the Stock Annex, incorporating discards and landed numbers-at-age resulting in catch numbers-at-age as input data from 1986 to 2018 and the 2018 indices from A Coruña (SP-LCGOTBDEF) tuning fleet and Avilés tuning fleet (SP-AVSOTBDEF) and Spanish survey (SP-NSGFS-Q4).

6.3.3.2 Model

Data screening

Figure 6.1.4(a) shows catch proportion at age where higher proportions can be observed for ages 1 and 2 till 2000 due to the high discards at these ages in this period, and for age 1 also since 2011. The top panel of Figure 6.1.4(b) shows landings proportions at age, indicating that the bulk of the landings consisted of ages 1 and 2 before 1994, shifting after that mostly to ages 2 to 4. The bottom panel of the same figure displays standardised (subtracting the mean and dividing by the standard deviation over the years) proportions at age, indicating the same change around the mid 1990's, with proportions at age decreasing for ages 1 and 2 and increasing for the older ages. Some weak and strong cohorts can be noticed in this figure, particularly around the mid 1990's. The 2010 year shows an increase in landings of older ages, especially ages 5 to 7+. In the last period, the high abundance of age 1 in the Spanish survey in 2010 can be tracked following years. Figure 6.1.4(c) shows discards proportion at age, being more abundant for age 1 from 2000 onwards. Before this year, discarding was higher in age 2. Visual inspection of Figures 6.1.3(b) and 6.1.3(c) indicates that all tuning series are good up to age 5 in relation to their internal consistency. Age 6 is harder to track along cohorts, particularly for the Spanish survey and the A Coruña tuning fleet.

Final run

XSA model was selected for use in this assessment. Model description and settings are those detailed in the Stock Annex.

The retrospective analysis shows a small but consistent pattern of overestimation of SSB and recruitment and underestimation of F in recent years (Figure 6.1.5).

6.3.3.3 Assessment results

Diagnostics from the XSA run are presented in Table 6.1.9 and log catchability residuals plotted in Figure 6.1.6. Residuals in A Coruña tuning fleet in the last years present mainly positive values. Until 1997 many of the survey residuals were negative, whereas many are positive since 1999. Since 2008, there is not a clear trend. Several year effects are apparent in all tuning series. As has been the case in the last few years the model shows that it hasn't converged, however the differences which activate this criteria was so small (0.00059 difference) and close to zero that we have confidence that the assessment has converged. The results presented correspond to a run of 130 iterations, as increasing the number of iterations led to larger total absolute residuals value between iterations.

Fishing mortality and population numbers at age from the final XSA run are given in Tables 6.1.10 and 6.1.11, respectively, and summary results presented in Table 6.1.12 and Figure 6.1.7(a).

Fishing mortality presents an increase in the last year and also in catches.. The SSB values in 2007-2010 are the lowest in the series. Since 2011 values are significantly higher, specially the last two years. After a high recruitment (at age 1) value in the series in 2015 and 2016, the last two years' the recruitments decrease.

Bubble plots of standardised (by subtracting the mean and dividing by the standard deviation over the years) estimated F-at-age and relative F-at-age (F-at-age divided by F_{bar}) are presented in Figure 6.1.7(b). The top panel of the figure indicates that fishing mortality has been lower for all ages since about year 2000 till 2011, when appears to be slightly increasing again. However, since 2017 a decrease in all the ages is observed.. In terms of the relative exploitation pattern-at-age (bottom panel of the figure), the most obvious changes are the reduction for ages 1 and 2 around 1994 and the increase for age 3 soon after that. This might be related to discarding practices. There is no clear pattern over time in the age 4 selection, whereas for ages 5 and older there seems to have been an increase during the mid to late 1990's but they have since come back down to lower values. Since 2010, there appears to have been an increase of the relative exploitation towards older ages, with high values above the average for ages 5 to 7+ for some years.

6.3.3.4 Year class strength and recruitment estimations

The 2015 year class is estimated to have 12.4 million fish at 1 year of age, based on the Spanish survey (SP-NSGFS- Q4) (71% of weight), two commercial fleets SP-LCGOTBDEF (13% of weight) and SP-AVSOTBDEF (12% of weight) and F shrinkage (3%).

The 2016 year class is estimated to have 9.4 million individuals at 1 year of age based on the information from the Spanish survey (SP-NSGFS-Q4) (74% of weight), P-shrinkage (22% of the weight) and F shrinkage (4%).

The 2017 year class is estimated to have 6.2 million fish at 1 year of age, based on the information from the Spanish survey (SP-NSGFS-Q4) (70% of weight), P-shrinkage (25% of the weight) and F shrinkage (5%).

The working group considered that the XSA last year recruitment is well estimated this year. The signal from the survey index is in accordance with the estimated value and also age 1 is well represented in catch data. Working Group estimates of year-class strength used for prediction can be summarised as follows:

Recruitment at age 1:

Year class	Thousands	Basis	Surveys	Commercial	Shrinkage
2015	12400	XSA	71%	25%	3%
2016	9410	XSA	74%	0%	26%
2017	6200	XSA)	70%	0%	30%
2018	3542	GM (98-16)			

6.3.3.5 Historic trends in biomass, fishing mortality and recruitment

From Table 6.1.12 and Figure 6.1.7, we see that SSB decreased from 2379 t in 1990 to 981 t in 1995. From 1996 to 2000, it remained relatively stable at low levels with an average value of around 1300 t. Starting from 2001, SSB is estimated to have been even lower. The values for 2001-2010 are the lowest in the series, with SSB in 2008 (660 t) corresponding to the lowest values. Since 2011, SSB values are significantly increasing, being 2094 t this year value, the highest of the last years.

After a decline from 2006 (0.41) to 2010 (0.08), and a following increasing trend reaching 0.45 in 2015, the last years F presents lower values, being 0.17 in 2018.

Recruitment (at age 1) varies substantially throughout the time series, but shows a general decline from the high levels seen until the 1992 year class. Since 1998 recruitment has been continuously at low levels (recruitment in 2009 is estimated to be the lowest value of the series). In 2010 a good recruitment occurred, with a value more similar to those estimated for the previous decade. However, from 2011 to 2014, values of recruitments decreased again. In the last years the recruitment seem to be very high, with values similar to those of middle nineties, although in 2018 the value is not so high.

6.3.3.6 Catch Options and prognosis

Stock projections were calculated according to the settings specified in the Stock Annex.

6.3.3.7 Short-term projections

Short-term projections have been made using MFDP.

The input data for deterministic short-term predictions are shown in Table 6.1.13. Average F_{bar} for the last three years is assumed for the interim year. The exploitation pattern is the scaled F-at-age computed for each of the last five years and then the average of these scaled five years was weighted to the final year. This selection pattern was split into selection-at-age of landings and discards (corresponding to Fbar = 0.19 for landings and Fbar=0.013 for discards, being 0.18 for catches).

According with stock annex, GM recruitment is computed over years 1998-final assessment year minus 2.

Management options for catch prediction are in Table 6.1.14. Figure 6.1.8 shows the short-term forecast summary. The detailed output by age group is given in Table 6.1.15 for landings and discards.

Under *status quo* F, landings in 2019and 2020 are predicted to be 504 t and 522 t respectively, and discards 18 t and 14 t respectively. SSB would decrease from the 2652 t estimated for 2019 to 2508 t in 2020 and to 2328 t in 2021.

The contributions of recent year classes to the predicted landings in 2020 and SSB in 2021, assuming $GM_{98\text{-}16}$ recruitment, are presented in Table 6.1.16. The assumed $GM_{98\text{-}16}$ age 1 recruitment for the 2018 and 2019 year classes contributes 7% to landings in 2020 and 20% to the predicted SSB at the beginning of 2021. Megrim starts to contribute strongly to SSB at 2 years of age (see maturity ogive in Table 6.1.13).

6.3.3.8 Yield and biomass per recruit analysis

The results of the yield- and SSB-per-recruit analyses are in Table 6.1.17 (see also left panel of Figure 6.1.8, which plots yield-per-recruit and SSB-per-recruit versus Fbar). Assuming s*tatus quo* exploitation Fbar = 0.18 for landings and Fbar=0.013 for discards and $GM_{98\text{-}16}$ for recruitment, the equilibrium yield would be 261 t of landings and 13 t of discards with an SSB of 1331 t.

6.3.4 Biological reference points

The stock-recruitment time series is plotted in Figure 6.1.9. See Stock Annex for information about Biological reference points.

The BRP are:

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	980 t	B_{pa}
	F_{MSY}	0.191	
	F_{MSY} lower	0.122	based on 5% reduction in yield
	F_{MSY} upper (with advice rule)	0.29	based on 5% reduction in yield
	F_{MSY} upper (without advice rule)	0.24	based on 5% reduction in yield
	$F_{P.05}$	0.24	5% risk to B_{lim} without $B_{trigger}$.
	B_{lim}	700 t	B_{loss} estimated in 2015
Precautionary	B_{pa}	980 t	1.4 B_{lim}
Approach	F_{lim}	0.45	Based on segmented regression simulation of recruitment with B_{lim} as the breakpoint and no error
	F_{pa}	0.32	$F_{pa} = F_{lim} \times \exp(-\sigma \times 1.645)$ σ=0.2

6.3.5 Comments on the assessment

The behaviour of commercial fleets with regards to landings of age 1 individuals appears to have changed in time. Hence, data from commercial fleets used for tuning is only taken for ages 3 and older, as how it is set in the stock annex. However, the Spanish survey (SP-NSGFS-Q4) provides good information on age 1 abundance.

Comparison of this assessment with the one performed last year shows that there are quite similar with minor shifts (Figure 6.1.10)

Megrim starts to contribute strongly to SSB at 2 years of age. Around 20% of the predicted SSB in 2021 relies on year classes for which recruitment has been assumed to be $GM_{98\text{-}16}$.

6.3.6 Management considerations.

It should be taken into account that megrim, *L. whiffiagonis,* is caught in mixed fisheries. There is a common TAC for both species of megrim (*L. whiffiagonis* and *L. boscii*), so the joint status of the two species should be taken into consideration when formulating management advice. Megrims are by-catch in mixed fisheries generally directed to white fish. Therefore, fishing mortality of megrims could be influenced by restrictions imposed on demersal mixed fisheries, aimed at preserving and rebuilding the overexploited stocks of southern hake and *Nephrops*.

This is a small stock (average stock SSB since 1986 is 1300 t). Managing according to a very low F for megrim could cause serious difficulties for the exploitation of other stocks in the mixed fishery (choke species effect). Both Iberian megrim stocks are assessed separately but managed together, situation that may produce inconsistencies when these stocks are considered in a mixed fisheries approach. In fact, this effect was observed in the results of the last mixed fisheries analysis developed for Iberian stocks by the WGMIXFISH_METH (ICES, 2013).Of course, any F to be applied for the management of megrim must be in conformity with the precautionary approach.

Working group considers that this stock could be just "the tail" of the much larger stock of megrim in ICES Subarea 7 and Divisions 8abd and suggests to reconsider the stock limits and the inclusion in the Northern megrim stock. This option was studied during the Stock Identification Methods Working Group (SIMWG) in 2015 and the conclusion was that SIMWG did not find strong evidence to support combining the northern and southern stock areas and recommends that the current stock separation stand till more studies are developed (ICES, 2015).

6.3.7 Tables and Figures

Table. 6.1.1 Megrim (*L. whiffiagonis*) in Divisions 8c9a. Landings, discards and catch (t).

	Spain landings			Portugal landings	Unallocated	Total landings	Discards	Total catch
Year	8c	9a*	Total	9a				
1986	508	98	606	53		659	46	705
1987	404	46	450	47		497	40	537
1988	657	59	716	101		817	42	859
1989	533	45	578	136		714	47	761
1990	841	25	866	111		977	45	1022
1991	494	16	510	104		614	41	655
1992	474	5	479	37		516	42	558
1993	338	7	345	38		383	38	421
1994	440	8	448	31		479	13	492
1995	173	20	193	25		218	40	258
1996	283	21	305	24		329	44	373
1997	298	12	310	46		356	52	408
1998	372	8	380	66		446	36	482
1999	332	4	336	7		343	43	386
2000	238	5	243	10		253	35	288
2001	167	2	169	5		175	19	193
2002	112	3	115	3		117	19	137
2003	113	3	116	17		134	15	148
2004	142	1	144	5		149	11	159
2005	120	1	121	26		147	19	166
2006	173	2	175	35		210	16	226
2007	139	2	141	14		155	0.4	155
**2008	114	2	116	17		133	11	144
2009	74	2	77	7		84	11	94
2010	66	8	74	10		83	5	88
^2011	242	0	242	34	26	302	69	371
^2012	151	11	161	18	83	262	31	293
^2013	128	3	131	11	90	231	18	250
2014	225	5	231	30	116	377	23	399
2015	188	2	190	23	63	276	21	297
2016	171	1	172	15	48	235	63	298
2017	189	4	193	16	39	247	41	288
2018	227	8	234	7	74	315	37	352

^Data revised in WG2015
*9a is without Gulf of Cádiz till 2016
** Data revised in WG2010
*** Official data by country and unallocated landings

Table. 6.1.2(a) Megrim (*L. whiffiagonis*) in Divisions 8c9a. Discard/Total Catch ratio and estimated CV for Spain from sampling on board

Year	1994	1997	1999	2000	2003	2004	2005	2006	2007	2008	2009
Weight Ratio	0.03	0.14	0.12	0.13	0.11	0.07	0.14	0.08	0.00	0.08	0.13
CV	50.83	32.23	33.4	48.41	19.93	29.24	43.17	31.62	55.01	58.8	52.9
Number Ratio	0.10	0.38	0.34	0.45	0.26	0.16	0.28	0.21	0.01	0.20	0.36

Year	2010	2011*	2012	2013	2014	2015	2016	2017	2018
Weight Ratio	0.06	0.23	0.12	0.07	0.06	0.07	0.21	0.14	0.10
CV	61.6	23.7	28.8	30.3	44.7	49.8	57.1	28.9	
Number Ratio	0.27	0.57	0.37	0.24	0.20	0.29	0.47	0.34	0.26

All discard data revised in WG2011
*Data revised in WG2013

Table. 6.1.2(b) Megrim (*L. whiffiagonis*) in Divisions 8c9a. Discards in numbers at age (thousands) for Spanish trawlers

Table 6.1.3(a) Megrim (*L. whiffiagonis*) Divisions 8c - 9a. Annual length distributions in landings.

Length (cm)	Total
10	
11	
12	
13	
14	
15	
16	
17	
18	3248
19	9001
20	49567
21	93883
22	147159
23	196466
24	236631
25	266205
26	207432
27	190494
28	155327
29	145422
30	92942
31	76478
32	54374
33	49037
34	30394
35	25853
36	17763
37	13775
38	12392
39	11901
40	14869
41	5240
42	4479
43	4677
44	2633
45	8198
46	868
47	806
48	2978
49	170
50+	80
Total	2130738

Table 6.1.3(b) Megrim (*L. whiffiagonis*) Divisions 8c and 9a.

Mean lengths and mean weights in landings since 1990

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Mean length (cm)	22.3	23.5	24.6	23.4	25.1	24.7	24.6	24.6	24.7	25.3	25.8	25.1	26	25.7	26.1
Mean weight (g)	105	108	129	108	124	121	120	118	119	127	134	124	137	134	137

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Mean length (cm)	25.32	26.15	26.68	26.64	27.58	29.4	27.63	28.2	29.39	28.6	28.72	26.81	26.41	27.18
Mean weight (g)	127	137	148	146.8	163.2	187.4	159.5	163.2	187.5	170.7	172.3	145.7	134.1	147.8

Table 6.1.4 Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Catch numbers at age.

Catch numbers at age Numbers*10**-3

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
1	1352	2359	3316	1099	4569	1357	1401	858	133	848	537
2	2377	2728	3769	2328	2560	2777	817	2128	568	461	1911
3	798	882	1168	808	905	931	807	442	1835	384	167
4	649	404	748	641	878	700	1130	536	552	630	289
5	505	293	534	505	333	647	595	361	625	245	506
6	202	81	182	191	377	142	78	103	330	70	148
+gp	194	71	130	253	558	59	68	36	119	72	81
TOTALNUM	6077	6818	9847	5825	10180	6613	4896	4464	4162	2710	3639
TONSLAND	705	537	858	761	1022	655	558	421	492	258	373
SOPCOF %	95	95	95	99	99	100	100	101	100	101	101

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
1	535	416	491	620	378	369	368	210	346	110	90
2	1919	1307	524	282	387	233	299	264	276	526	161
3	1153	1335	1157	671	331	341	277	211	438	582	232
4	77	891	719	526	253	95	179	247	171	276	297
5	367	218	448	361	221	165	80	187	156	183	142
6	308	329	105	83	161	81	54	102	87	110	81
+gp	116	149	207	161	118	37	48	72	41	36	56
TOTALNUM	4475	4645	3651	2704	1849	1321	1305	1293	1515	1823	1059
TONSLAND	408	482	386	288	194	136	149	160	166	226	155
SOPCOF %	100	100	101	101	100	99	101	100	98	100	100

YEAR	*2008	2009	2010	2011**	2012**	2013**	2014	2015	2016	2017	2018
AGE											
1	133	170	149	2054	812	359	469	712	1187	530	206
2	370	111	39	1087	275	152	705	224	1275	1160	782
3	215	159	53	156	834	320	420	536	218	877	668
4	153	102	112	220	157	612	432	239	116	64	912
5	168	80	97	266	192	81	518	257	87	81	141
6	60	60	81	209	106	61	74	191	85	35	74
+gp	35	29	43	184	139	89	144	82	96	41	78
TOTALNUM	1134	711	574	4176	2515	1674	2762	2241	3064	2788	2861
TONSLAND	144	95	88	371	293	250	399	297	298	288	352
SOPCOF %	100	101	100	100	100	101	100	100	100	101	100

* Data revised in WG2010 from original value presented

** Data revised in WG2014 from original value presented

Table 6.1.5 Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Catch weights at age (kg).

Mean weight at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
1	0.041	0.046	0.043	0.045	0.04	0.035	0.031	0.031	0.039	0.051	0.041
2	0.095	0.079	0.086	0.094	0.091	0.085	0.075	0.073	0.063	0.044	0.08
3	0.113	0.086	0.098	0.114	0.121	0.102	0.116	0.102	0.099	0.087	0.081
4	0.163	0.142	0.149	0.163	0.165	0.145	0.155	0.146	0.13	0.126	0.127
5	0.215	0.175	0.191	0.223	0.206	0.173	0.209	0.194	0.15	0.164	0.164
6	0.315	0.311	0.289	0.292	0.24	0.251	0.318	0.235	0.19	0.21	0.21
+gp	0.477	0.415	0.424	0.52	0.369	0.42	0.534	0.538	0.344	0.34	0.354
SOPCOFAC	0.9502	0.9535	0.9509	0.995	0.9874	1.0041	0.9983	1.005	1.0004	1.0091	1.014

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
1	0.033	0.032	0.033	0.037	0.039	0.038	0.047	0.0480	0.0510	0.057	0.061
2	0.062	0.061	0.058	0.057	0.078	0.07	0.083	0.0820	0.0770	0.082	0.088
3	0.095	0.095	0.084	0.089	0.085	0.111	0.115	0.1090	0.1080	0.11	0.11
4	0.126	0.13	0.118	0.119	0.117	0.115	0.149	0.1300	0.1400	0.15	0.144
5	0.14	0.154	0.159	0.161	0.148	0.162	0.194	0.1570	0.1640	0.174	0.197
6	0.198	0.189	0.216	0.215	0.171	0.205	0.252	0.2030	0.1990	0.223	0.236
+gp	0.341	0.324	0.296	0.296	0.256	0.387	0.382	0.3190	0.3790	0.39	0.366
SOPCOFAC	1.0005	1.0047	1.0057	1.0107	1.0046	0.9944	1.0061	1.0008	0.9847	1.0034	0.9966

YEAR	*2008	2009	2010	2011**	2012**	2013**	2014	2015	2016	2017	2018
AGE											
1	0.033	0.031	0.037	0.026	0.027	0.039	0.035	0.037	0.041	0.038	0.035
2	0.084	0.088	0.091	0.088	0.089	0.079	0.097	0.102	0.086	0.081	0.073
3	0.118	0.135	0.116	0.135	0.138	0.127	0.13	0.133	0.147	0.131	0.107
4	0.145	0.16	0.168	0.134	0.164	0.179	0.166	0.174	0.198	0.184	0.144
5	0.187	0.189	0.203	0.201	0.172	0.232	0.22	0.197	0.244	0.217	0.224
6	0.246	0.246	0.228	0.242	0.228	0.281	0.264	0.277	0.304	0.295	0.243
+gp	0.409	0.404	0.37	0.371	0.343	0.391	0.381	0.388	0.388	0.43	0.438
SOPCOFAC	1.0034	1.0062	0.9989	0.9976	1.0031	1.0124	0.9988	0.9986	1.0012	1.006	1.0033

* Data revised in WG2010 from original value presented

** Data revised in WG2014 from original value presented

Table 6.1.6 Megrim (*L. whiffiagonis*) Divisions 8c9a. Abundance and Recruitment indices from Portuguese and Spanish surveys.

	Biomass Index						Abundance index					At age 1	At age 0	At age 1
	Portugal (k/h)			Spain (k/30 min)			Portugal (n/h)		Spain (n/30 min)			Portugal (n)	Spain (n/30 min)	
	October	Crustaceans	s.e	Mean	s.e.		Crustaceans	s.e.	Mean	s.e.		October		
1983				0.96	0.14	1983			14.0	2.45	1983		1.88	7.72
1984				1.92	0.34	1984			28.0	4.57	1984		0.32	16.08
1985				0.89	0.15	1985			9.0	1.34	1985		0.10	2.74
1986				1.65	0.2	1986			33.0	6.22	1986		13.78	11.19
1987				ns		1987			ns		1987		ns	ns
1988				3.52	0.64	1988			43.0	8.82	1988		0.65	16.60
1989				3.13	0.5332	1989			42.0	7.04	1989		2.90	13.96
1990	0.08			3.08	0.86	1990			28.0	5.5	1990	5	0.11	9.13
1991	0.11			1.22	0.17	1991			10.0	1.67	1991	5	1.26	1.38
1992	0.11			1.39	0.2	1992			18.0	3.35	1992	8	0.01	12.03
1993	0.04			1.46	0.24	1993			15.0	3.23	1993	1	0.00	2.76
1994	0.05			1.02	0.2	1994			8.0	1.87	1994 +		0.60	0.05
1995	0.01			1.03	0.16	1995			11.0	1.86	1995 +		0.41	7.38
A,1996 +				1.64	0.22	A,1996			21.0	3.6	A,1996 +		0.45	11.26
1997 +		1.41	1.04	1.79	0.25	1997	7.22	4.82	20.0	3.26	1997 +		0.15	5.91
1998	0.01	0.20	0.09	1.47	0.23	1998	1.09	0.51	14.8	2.64	1998 +		0.02	2.56
A,B,1999 +		0.11	0.11	1.59	0.29	A,B,1999	0.57	0.53	15.5	3.05	A,B,1999 +		0.56	1.26
2000 +		0.06	0.05	1.8	0.35	2000	0.27	0.17	19.4	4.46	2000 +		0.05	6.92
2001	0	0.04	0.03	1.45	0.28	2001	0.07	0.04	12.8	2.77	2001 +		0.19	1.97
2002	0.04	0.07	0.04	1.26	0.24	2002	0.21	0.10	12.1	2.65	2002 +		0.08	2.53
A,2003	0.01	0.07	0.05	0.82	0.16	A,2003	0.16	0.08	7.2	1.26	A,2003	0.05	0.05	1.91
A,2004	0.01	ns		1.08	0.2	A,2004	ns		8.44	1.39	A,2004 +		0.14	1.83
2005	0.01	0.37	0.20	1.29	0.21	2005	0.71	0.35	9.76	1.73	2005 +		0.08	2.21
2006	0.02	0.29	0.18	1.03	0.18	2006	0.43	0.24	6.38	1.16	2006		0.00	0.89
2007	0	0.15	0.09	1.13	0.24	2007	0.49	0.37	6.87	1.52	2007		0.01	1.87
2008	0	0.25	0.11	0.68	0.15	2008	1.49	0.71	4.33	1.07	2008		0.00	0.23
2009	0.00	*0.05	0.03	0.80	0.12	2009	*0.19	0.10	4.17	0.59	2009		0.19	0.20
2010	0.01	0.20	0.10	0.89	0.16	2010	0.56	0.23	10.15	1.97	2010		0.01	7.63
2011	0.00	0.84	0.67	1.83	0.35	2011	1.75	1.30	17.45	3.86	2011		0.00	1.94
2012	ns	ns	ns	1.38	0.19	2012	ns	ns	9.07	1.29	2012		0.03	0.58
**2013	0	0.20	0.13	2.44	0.39	2013	0.43	0.22	15.89	2.58	2013		0.02	3.24
2014	0.02	0.30	0.18	1.34	0.21	2014	0.81	0.41	9.04	1.26	2014		0.40	1.32
2015	0.06	0.27	0.14	1.86	0.26	2015	0.89	0.39	30.75	5.64	2015		0.28	25.46
2016	0.06	0.26	0.13	2.71	0.28	2016	0.90	0.35	43.10	5.35	2016		0.02	26.31
2017	0.06	0.21	0.09	3.75	0.39	2017	2.04	1.37	50.23	6.04	2017		0.00	15.42
2018	0.04	0.18	0.11	3.42	0.30	2018	1.49	1.01	41.45	4.37	2018		0.05	7.62

- \+ less than 0.04
- ns no survey
- A Portuguese October Survey with different vessel and gear (Capricórnio and CAR net)
- B Portuguese Crustacean Survey covers partial area only with a different Vessel (Mestre Costeiro)
- * Revised in WG2011
- ** Since 2013 new vessel for Spanish survey (Miguel Oliver)

Table 6.1.7 Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Tuning data.

FLT01: SP-LCGOTBDEF 1000 Days by 100 HP (thousand)

1986	2018								
1	1	0	1						
1	7							Eff.	
10	13.0	32.1	24.9	24.3	21.5	11.1	6.7	7.1	1986
10	105.5	114.2	46.8	22.4	15.1	7.5	5.8	12.7	1987
10	18.5	55.0	41.2	32.3	22.9	10.2	5.5	11.3	1988
10	4.6	24.4	23.6	25.7	20.8	9.8	5.7	11.9	1989
10	6.1	23.7	25.3	34.1	32.9	17.6	10.5	8.8	1990
10	6.8	31.1	30.5	36.8	32.3	16.0	9.0	9.6	1991
10	1.2	16.6	21.3	31.1	31.1	16.9	13.5	10.2	1992
10	0.2	12.0	15.1	20.7	17.8	8.2	3.9	7.1	1993
10	0.0	4.9	72.9	40.0	58.6	41.7	8.8	8.5	1994
10	65.1	4.1	19.6	42.9	15.4	4.2	2.9	13.4	1995
10	1.4	64.0	3.2	20.6	54.7	17.2	10.1	11.0	1996
10	1.1	37.2	56.8	5.7	29.0	27.0	9.3	12.5	1997
10	0.7	20.1	56.1	69.8	19.8	40.8	18.4	8.2	1998
10	0.8	8.6	44.3	46.5	38.3	10.7	21.4	8.8	1999
10	1.5	7.0	46.7	64.3	61.6	15.6	18.2	10.5	2000
10	2.6	25.7	25.8	31.0	33.4	27.1	19.0	12.1	2001
10	2.0	12.8	43.6	12.1	32.9	17.3	6.9	11.0	2002
10	25.9	19.2	20.0	20.1	12.2	10.0	8.5	10.2	2003
10	2.2	12.0	13.5	20.4	19.2	14.3	13.5	7.0	2004
10	5.7	12.4	27.6	12.6	13.5	8.3	5.6	7.1	2005
10	3.4	17.9	24.8	17.5	13.3	9.5	3.8	7.8	2006
10	12.9	19.2	21.7	27.7	16.7	10.0	8.0	7.3	2007
10	0.2	21.9	20.2	14.9	16.3	5.5	3.8	9.0	2008
10	6.0	17.2	22.6	12.7	8.8	5.9	2.8	8.0	2009
10	1.6	7.0	12.1	25.4	24.5	18.1	10.3	5.8	2010
10	2.3	134.6	27.5	38.0	31.8	15.8	9.3	5.1	2011
10	2.3	108.1	392.9	68.3	76.2	27.9	18.2	7.6	2012
10	1.6	19.9	54.6	89.3	9.8	7.2	6.8	10.8	2013
10	2.8	33.7	17.9	16.2	17.0	2.6	5.3	13.4	2014
10	16.4	32.2	64.7	25.3	26.3	19.8	7.1	9.8	2015
10	69.4	254.4	24.7	11.1	8.2	7.1	7.3	10.6	2016
10	10.0	178.8	193.9	15.9	19.0	7.0	4.7	8.7	2017
10	1.6	66.4	74.9	108.4	14.5	7.6	4.3	8.1	2018

FLT02: SP-AVSOTBDEF 1000 Days by 100 HP (thousand) (*)

1986	2018								
1	1	0	1						
1	7							Eff.	
10	408.3	516.4	427.9	208.7	181.7	153.1	91.6	3.9	1986
10	589.9	470.6	510.4	242.2	145.3	167.8	55.4	3.0	1987
10	1458.2	905.1	749.0	357.4	154.7	193.1	84.9	3.4	1988
10	835.9	513.9	538.8	252.8	145.1	174.1	67.7	3.3	1989
10	4366.2	949.0	224.8	173.4	45.8	49.9	70.8	3.2	1990
10	980.1	855.3	228.9	99.8	83.6	14.7	7.3	3.5	1991
10								10.2	1992
10	1149.0	1489.5	91.4	99.7	52.6	24.9	19.4	2.4	1993
10	19.0	175.6	547.0	135.3	132.9	51.0	23.7	4.5	1994
10	40.5	2.4	43.0	139.5	69.5	25.9	14.3	3.5	1995
10	135.0	796.8	14.0	116.8	258.6	74.2	62.5	2.3	1996
10	96.0	880.4	621.3	34.1	153.4	127.8	46.3	2.6	1997
10	16.0	308.5	374.9	233.1	51.9	69.5	38.1	5.1	1998
10	10.3	109.8	397.8	262.9	162.2	38.0	69.7	4.9	1999
10	28.7	54.3	238.7	229.5	146.0	35.7	52.8	2.5	2000
10	36.6	199.6	192.6	121.6	115.1	83.5	85.2	1.3	2001
10	54.5	157.6	238.5	64.6	92.9	53.5	46.8	2.0	2002
10	26.1	84.5	105.0	70.5	31.4	24.1	28.1	2.2	2003
10	52.5	231.5	208.5	248.0	193.4	102.9	59.9	1.6	2004
10	118.2	181.5	309.0	117.1	106.9	58.6	26.1	3.0	2005
10	42.8	181.8	235.7	120.5	83.2	45.5	12.4	2.8	2006
10	24.6	48.0	72.4	93.0	40.7	24.5	19.9	2.2	2007
10	5.0	153.3	85.0	50.6	48.7	18.1	15.7	2.0	2008
10	12.4	41.2	66.8	49.6	39.1	38.7	21.2	2.3	2009
10	49.8	45.0	66.0	160.3	135.6	120.9	61.5	2.0	2010
10	6.4	483.1	95.2	133.1	167.6	133.8	109.7	2.2	2011
10	0.4	27.8	117.6	22.7	29.1	17.7	27.9	2.6	2012
10	10.6	35.1	128.7	279.4	38.4	31.1	62.1	1.5	2013
10	7.2	116.4	64.5	72.8	116.6	21.5	53.2	3.0	2014
10	32.8	42.3	100.0	52.4	62.9	62.9	33.0	1.8	2015
10	37.6	261.5	65.3	47.3	43.4	48.0	55.6	1.6	2016
10	40.1	416.5	352.2	21.5	33.9	22.4	45.0	2.0	2017
10	2.0	113.8	149.9	245.6	53.6	29.5	58.2	1.5	2018

FLTO3: SPGFS-WIBTS-Q4 (n/30 min)

1988	2018								
1	1	0.75	0.83						
1	7								
1	16.60	12.48	5.18	4.54	2.66	0.74	0.53	101	1988
1	13.96	11.20	5.38	5.64	1.47	0.48	0.43	91	1989
1	9.13	7.69	3.04	3.61	1.26	1.36	1.57	120	1990
1	1.38	3.23	1.45	1.84	0.87	0.23	0.03	107	1991
1	12.03	1.07	1.57	2.24	1.14	0.21	0.15	116	1992
1	2.76	8.79	0.66	1.69	0.85	0.17	0.01	109	1993
1	0.05	0.65	4.24	1.30	0.71	0.27	0.04	118	1994
1	7.38	0.20	0.55	1.65	0.70	0.17	0.10	116	1995
1	11.26	6.45	0.25	1.03	1.00	0.35	0.27	114	1996
1	5.91	7.54	3.44	0.46	0.99	0.39	0.06	116	1997
1	2.56	4.30	4.33	2.08	0.41	0.60	0.15	114	1998
1	1.26	4.47	4.36	2.50	1.46	0.46	0.77	116	1999
1	6.92	2.46	2.84	3.42	2.14	0.70	0.39	113	2000
1	1.97	4.60	1.14	2.31	1.58	0.61	0.40	113	2001
1	2.53	3.15	3.74	0.44	1.38	0.51	0.29	110	2002
1	1.91	1.44	1.66	1.14	0.52	0.26	0.16	112	2003
1	1.83	1.94	1.31	1.30	0.80	0.66	0.47	114	2004
1	2.21	1.58	2.04	1.43	1.57	0.60	0.25	116	2005
1	0.89	1.40	1.57	0.82	0.88	0.61	0.22	115	2006
1	1.87	0.94	1.27	1.24	0.68	0.44	0.42	117	2007
1	0.23	1.54	1.23	0.56	0.52	0.18	0.08	115	2008
1	0.20	0.44	1.52	0.91	0.40	0.30	0.22	117	2009
1	7.63	0.26	0.28	0.75	0.52	0.50	0.21	114	2010
1	1.94	12.47	1.32	0.30	0.63	0.40	0.39	111	2011
1	0.58	2.22	4.81	0.41	0.16	0.30	0.56	115	2012
0	3.24	1.63	3.29	5.63	0.67	0.35	0.87	114	2013
1	1.32	2.80	1.30	1.38	1.21	0.20	0.42	116	2014
1	25.46	1.24	1.45	0.75	0.73	0.46	0.38	114	2015
1	26.31	14.54	0.88	0.57	0.30	0.30	0.18	114	2016
1	15.42	25.02	8.71	0.33	0.35	0.21	0.15	112	2017
1	7.62	19.01	9.75	4.10	0.33	0.18	0.40	113	2018

Table 6.1.8 Megrim (*L. whiffiagonis*). LPUE data by fleet in Divisions 8c and 9a.

	SP-LCGOTBDEF			SP-AVSOTBDEF			Portugal trawl in 9a		
Year	Landings (t)	Effort	LPUE [1]	Landings (t)	Effort	LPUE [1]	Landings (t)	Effort	LPUE [2]
1986	16	7.1	2.24	83	3.9	21.17			
1987	36	12.7	2.85	52	3.0	17.65			
1988	29	11.3	2.59	83	3.4	24.65	74.9	38.5	1.95
1989	24	11.9	2.03	65	3.3	19.76	92.2	44.7	2.06
1990	27	8.8	3.05	120	3.2	36.91	86.0	39.0	2.20
1991	29	9.6	3.05	52	3.5	14.96	85.5	45.0	1.90
1992	32	10.2	3.10	35	2.3	15.46	32.6	50.9	0.64
1993	11	7.1	1.53	45	2.4	18.55	31.7	44.2	0.72
1994	32	8.5	3.79	52	4.5	11.39	25.8	45.8	0.56
1995	12	13.4	0.86	34	3.5	9.72	21.4	37.0	0.58
1996	26	11.0	2.36	39	2.3	17.13	22.2	46.5	0.48
1997	30	12.5	2.43	51	2.6	19.16	41.5	33.4	1.24
1998	30	8.2	3.65	62	5.1	12.19	60.1	43.1	1.39
1999	23	8.8	2.65	63	4.9	12.67	4.3	25.3	0.17
2000	35	10.5	3.33	26	2.5	10.49	6.9	27.0	0.25
2001	28	12.1	2.30	15	1.3	11.15	1.3	43.1	0.03
2002*	22	11.0	2.01	18	2.0	9.14	1.0	31.2	0.03
2003*	18	10.2	1.73	12	2.2	5.72	15.3	40.5	0.38
2004	12	7.0	1.66	23	1.6	14.77	3.4	35.4	0.10
2005	9	7.1	1.29	33	3.0	11.10	19.0	42.6	0.45
2006	11	7.8	1.44	27	2.8	9.62	26.3	40.3	0.65
2007**	13	7.3	1.78	11	2.2	4.85	10.5	43.8	0.24
2008**	12	9.0	1.30	11	2.0	5.27	14.4	38.4	0.37
2009	9	8.0	1.06	11	2.3	5.05	6.0	49.3	0.12
2010	12	5.8	2.02	24	2.0	11.74	7.3	48.0	0.15
2011	17	5.1	3.43	41	2.2	18.67	24.8	49.4	0.50
2012	43	7.6	5.58	11	2.6	4.40	14.5	30.9	0.47
2013***	33	10.8	3.02	16	1.5	11.07	8.1	28.0	0.29
2014	20	13.4	1.47	26	3.0	8.80	25.7	49.2	0.52
2015	29	9.8	3.00	14	1.8	7.54	18.0	17.7	1.02
2016	40	10.6	3.77	15	1.6	9.55	12.3	16.4	0.75
2017	47	8.7	5.43	25	2.0	12.52	12.7	15.4	0.83
2018	29	8.1	3.53	18	1.5	11.51	5.5	7.9	0.70

[1] LPUE as catch (kg) per fishing day per 100 HP.

[2] LPUE as catch (kg) per hour.

* Effort from Portuguese trawl revised from original value presented

** Effort from Portuguese trawl revised in WG2010 from original value presented

*** Effort from SP-LCGOTBDEF and SP-AVSOTBDEF revised in WG2015 from original value presented

Table 6.1.9. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Tuning diagnostic.

Lowestoft VPA Version 3.1

30/04/2019 20:49

Extended Survivors Analysis

Megrim (L. whiffiagonis.) in Divisions 27.7.8c and 27.7.9a

CPUE data from file fleetw.txt

Catch data for 33 years. 1986 to 2018. Ages 1 to 7.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SP-LCGOTBDEF	1986	2018	3	6	0	1
SP-AVSOTBDEF	1986	2018	3	6	0	1
SP-GFS	1990	2018	1	6	0.75	0.83

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 3

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 3

Catchability independent of age for ages >= 5

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.500

Minimum standard error for population
estimates derived from each fleet = .200

Prior weighting not applied

Tuning had not converged after 130 iterations

Total absolute residual between iterations
129 and 130 = .00059

Final year F values

Age	1	2	3	4	5	6
Iteration **	0.0374	0.1274	0.1235	0.2616	0.5534	0.4686
Iteration **	0.037	0.127	0.124	0.262	0.553	0.468

Regression weights

	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	0	0	1	0	0	0	0.068	0.112	0.064	0.037
2	0	0	0	0	0	0	0.208	0.168	0.153	0.127
3	0	0	0	0	0	0	0.621	0.322	0.167	0.124
4	0	0	0	0	0	0	0.516	0.258	0.147	0.262
5	0	0	0	1	0	1	0.577	0.357	0.289	0.553
6	0.284	0.349	0.744	0.354	0.548	0.603	0.471	0.379	0.237	0.468

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6
2009	1500	1300	1480	900	459	268
2010	7040	1080	963	1070	645	304
2011	5480	5630	847	741	774	440
2012	2990	2630	3630	552	407	393
2013	3260	1710	1900	2210	310	160
2014	2130	2340	1260	1270	1260	181
2015	11900	1320	1280	655	648	562
2016	12400	9130	874	564	320	298
2017	9410	9040	6320	519	357	184
2018	6200	7230	6350	4380	367	219

Estimated population abundance at 1st Jan 2019

0	4890	5210	4600	2760	173

Taper weighted geometric mean of the VPA populations:

5100	3600	2230	1320	739	378

Standard error of the weighted Log(VPA populations) :

0.6754	0.6829	0.593	0.552	0.4628	0.4558

Log catchability residuals.

Fleet : SP-LCGOTBDEF

Age	1986	1987	1988
1	No data for this fleet at this age		
2	No data for this fleet at this age		
3	-0.63	-0.28	-0.05
4	-0.45	-0.65	-0.53
5	-0.45	-0.76	-0.46
6	-0.52	-0.79	-0.49

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.82	-0.65	-0.66	-0.68	-0.78	0.12	-0.64	-1.44	-0.04	-0.09
4	-0.19	-0.21	-0.02	-0.32	-0.48	0.37	-0.14	-0.52	-1	0.43
5	-0.81	0.4	0.25	0.33	-0.51	1.07	-0.33	0.26	-0.15	0.35
6	-0.52	-0.24	0.5	0.59	0.12	1.36	-0.32	0.51	0.35	1.11

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.06	0.46	0.4	0.47	-0.35	-0.52	0.29	-0.01	0.26	-0.01
4	-0.03	0.57	0.26	-0.27	-0.29	-0.28	-0.5	0.09	0.38	-0.06
5	0.11	0.35	-0.04	0.31	-0.37	-0.39	-0.66	-0.47	0.17	0.04
6	0.66	-0.23	0.04	-0.27	-0.48	0.33	-0.72	-0.66	-0.22	-0.32

Age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.03	-0.25	0.78	2.02	0.65	0.05	1.39	0.68	0.7	-0.28
4	-0.48	0.07	0.93	1.82	0.69	-0.39	0.73	-0.05	0.33	0.16
5	-0.6	0.06	0.28	1.92	-0.09	-0.76	0.33	-0.2	0.49	0.31
6	-0.36	0.65	0.26	0.77	0.44	-0.56	0.11	-0.24	0.09	0.09

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6
Mean Log q	-6.3027	-5.9399	-5.4661	-5.4661
S.E(Log q)	0.6811	0.5504	0.5621	0.5444

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.17	-0.719	6.06	0.36	33	0.8	-6.3
4	1.31	-1.375	5.55	0.38	33	0.71	-5.94
5	1.53	-1.657	4.86	0.24	33	0.84	-5.47
6	1.18	-0.731	5.34	0.34	33	0.65	-5.43
1							

Fleet : SP-AVSOTBDEF

Age	1986	1987	1988
1	No data for this fleet at this age		
2	No data for this fleet at this age		
3	0.54	0.43	1.18
4	0.27	0.28	0.43
5	0.38	0.18	0.12
6	0.78	0.94	1.08

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	0.65	-0.1	-0.31	99.99	-0.67	0.49	-1.51	-1.82	0.71	0.15
4	0.66	-0.03	-0.47	99.99	-0.38	0.15	-0.41	-0.26	-0.64	0.18
5	-0.2	-0.56	-0.12	99.99	-0.75	0.57	-0.17	0.48	0.23	-0.01
6	1.02	-0.48	-0.91	99.99	-0.11	0.23	0.11	0.64	0.6	0.32

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	0.48	0.42	0.76	0.49	-0.34	0.6	1.01	0.61	-0.2	-0.22
4	0.25	0.37	0.16	-0.02	-0.5	0.76	0.26	0.54	0.17	-0.28
5	0.23	-0.12	-0.11	0	-0.69	0.64	0.04	0.07	-0.24	-0.18
6	0.68	-0.7	-0.14	-0.43	-0.96	0.95	-0.14	-0.34	-0.68	-0.36

Age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.62	-0.23	0.36	-0.87	-0.17	-0.34	0.17	-0.05	-0.39	-1.23
4	-0.6	0.44	0.74	-0.72	0.35	-0.36	0.05	-0.02	-0.91	-0.45
5	-0.42	0.46	0.64	-0.44	0.05	-0.16	-0.07	0.12	-0.24	0.27
6	0.15	1.18	1.07	-0.91	0.63	0.02	0.03	0.33	-0.16	0.28

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6
Mean Log q	-4.6436	-4.4801	-4.1461	-4.1461
S.E(Log q)	0.7078	0.4489	0.3589	0.6573

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	0.95	0.26	4.81	0.45	32	0.68	-4.64
4	0.86	1.109	4.85	0.68	32	0.38	-4.48
5	0.86	1.199	4.49	0.71	32	0.31	-4.15
6	1.07	-0.253	3.87	0.31	32	0.69	-4

Fleet : SP-GFS

Age		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	1	99.99	-0.28	-0.55	-0.16	-0.1	-1.39	-0.24	-0.04	-0.11	0.02
	2	99.99	-0.07	-0.4	-0.65	-0.13	-0.98	-0.92	-0.17	-0.12	-0.21
	3	99.99	0.1	-0.86	-0.44	-1.12	0.19	-1.4	-1.31	0.01	0.23
	4	99.99	0.7	0.13	0.25	0.1	0.09	-0.31	-0.5	-0.49	0.06
	5	99.99	0.56	0.24	0.62	-0.21	0.34	-0.07	-0.37	-0.16	-0.08
	6	99.99	0.69	-0.3	-0.47	-0.38	-0.01	-0.23	0.01	-0.46	0.48

Age		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	1	0.16	0.67	0.13	0.43	0.25	0.11	0.4	0.08	0.27	-0.31
	2	0.35	0.55	0.54	0.34	0.07	0.2	-0.09	0.18	-0.1	0.05
	3	0.51	0.54	0.14	0.82	-0.02	0	0.53	0.14	0.23	0
	4	0.14	0.72	0.7	-0.54	-0.11	0.03	0.36	0.12	0.39	-0.26
	5 0.22		0.31	0.21	0.44	-0.22	-0.23	0.42	0.18	0.33	-0.09
	6	1.06	-0.05	-0.47	-0.54	-0.86	0.59	-0.09	-0.06	-0.01	-0.44

Age		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	1	-0.22	0.08	-0.17	-0.27	99.99	0.47	0.19	0.19	0.17	0.21
	2	-0.25	-0.42	0.45	0.07	99.99	0.47	0.44	0.03	0.37	0.41
	3	0.06	-1.25	0.56	0.45	99.99	0.32	0.55	0.19	0.39	0.46
	4	-0.09	-0.46	-0.79	-0.2	99.99	0.25	0.34	0.01	-0.54	-0.06
	5	-0.41	-0.51	-0.27	-0.79	99.99	0	0.13	-0.23	-0.23	-0.11
	6	-0.1	0.33	0.05	-0.43	99.99	0.14	-0.27	-0.14	-0.12	-0.27

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6
Mean Log q	-6.6826	-6.5447	-6.3084	-6.3084
S.E(Log q)	0.6226	0.3964	0.3423	0.4242

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.52	4.153	7.79	0.74	28	0.39	-7.19
2	0.63	3.09	7.29	0.72	28	0.42	-6.8

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	0.9	0.543	6.78	0.55	28	0.57	-6.68
4	0.8	1.897	6.66	0.78	28	0.3	-6.54
5	0.77	2.014	6.37	0.75	28	0.25	-6.31
6	1.11	-0.537	6.44	0.48	28	0.47	-6.39

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2017

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF	1	0	0	0	0	0	0
SP-AVSOTBDEF	1	0	0	0	0	0	0
SP-GFS	6020	0.403	0	0	1	0.696	0.03
P shrinkage mea	3602	0.68				0.252	0.05
F shrinkage mea	1329	1.5				0.052	0.131

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4887	0.34	0.3	3	0.9	0.037

Age 2 Catchability dependent on age and year class strength
Year class = 2016

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF	1	0	0	0	0	0	0
SP-AVSOTBDEF	1	0	0	0	0	0	0
SP-GFS	6906	0.301	0.12	0.4	2	0.741	0.098
P shrinkage mean	2234	0.59				0.224	0.275
F shrinkage mean	3056	1.5				0.035	0.208

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5211	0.26	0.33	4	1.232	0.127

Age 3 Catchability constant w.r.t. time and dependent on age
Year class = 2015

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF	3483	0.691	0	0	1	0.133	0.16
SP-AVSOTBDEF	1350	0.719	0	0	1	0.123	0.37
SP-GFS	6321	0.277	0.077	0.28	3	0.711	0.091
F shrinkage mean	1410	1.5				0.032	0.357

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4599	0.24	0.25	6	1.06	0.124

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2014

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF	3935	0.436	0.258	0.59	2	0.179	0.19
SP-AVSOTBDEF	1787	0.386	0.027	0.07	2	0.232	0.38
SP-GFS	2987	0.229	0.09	0.39	4	0.569	0.244
F shrinkage mean	1945	1.5				0.021	0.354

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2761	0.18	0.11	9	0.619	0.262

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2013

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF	254	0.351	0.098	0.28	3	0.174	0.407
SP-AVSOTBDEF	150	0.267	0.38	1.42	3	0.314	0.615
SP-GFS	163	0.198	0.183	0.92	5	0.493	0.578
F shrinkage mean	233	1.5				0.019	0.437

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
173	0.15	0.13	12	0.917	0.553

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5
Year class = 2012

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF	148	0.31	0.225	0.72	4	0.218	0.373
SP-AVSOTBDEF	105	0.255	0.119	0.47	4	0.304	0.492
SP-GFS	100	0.208	0.121	0.58	5	0.459	0.511
F shrinkage mean	181	1.5				0.019	0.315

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
112	0.14	0.09	14	0.615	0.468

Table 6.1.10. Megrim (*L. whiffiagonis*) Div. 8c and 9a. Estimates of fishing mortality at age.

Run title : Megrim (L. whiffiagonis.) in Divisions 27.7.8c and 27.7.9a

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Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE												
1	0.1599	0.2207	0.3694	0.1202	0.4779	0.2865	0.1404	0.1955	0.0665	0.1005	0.0624	0.081
2	0.4087	0.5574	0.6576	0.4831	0.4517	0.6066	0.2796	0.328	0.1919	0.3441	0.3437	0.3297
3	0.3093	0.2598	0.4946	0.2792	0.3494	0.2925	0.3511	0.2398	0.5257	0.192	0.2005	0.3599
4	0.461	0.2538	0.3672	0.5602	0.5575	0.5028	0.7008	0.4173	0.5332	0.3426	0.2164	0.1336
5	0.6497	0.39	0.6281	0.4556	0.6472	1.114	1.134	0.5045	1.338	0.4811	0.5122	0.4695
6	0.4555	0.1975	0.4493	0.481	0.747	0.6426	0.3586	0.5901	1.3189	0.4855	0.6085	0.6878
+gp	0.4555	0.1975	0.4493	0.481	0.747	0.6426	0.3586	0.5901	1.3189	0.4855	0.6085	0.6878
FBAR 2- 4	0.393	0.357	0.5065	0.4408	0.4529	0.4673	0.4438	0.3284	0.417	0.2929	0.2535	0.2744

Table 8 Fishing mortality (F) at age

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE												
1	0.1106	0.2202	0.1904	0.1283	0.1501	0.1444	0.0728	0.1466	0.0535	0.0361	0.0886	0.1335
2	0.2902	0.1984	0.1897	0.1743	0.1088	0.1747	0.1463	0.1293	0.3469	0.1034	0.2038	0.0992
3	0.4033	0.4526	0.4205	0.3558	0.2293	0.1826	0.1798	0.3845	0.4392	0.2528	0.1956	0.1263
4	0.5258	0.3957	0.3825	0.2754	0.1623	0.1806	0.2461	0.2169	0.4476	0.4212	0.2635	0.1338
5	0.6818	0.5532	0.3534	0.2733	0.2911	0.2	0.2911	0.2424	0.3807	0.4381	0.4493	0.2139
6	1.0673	0.8556	0.1829	0.2625	0.1516	0.1451	0.4227	0.2132	0.2695	0.2883	0.3337	0.2843
+gp	1.0673	0.8556	0.1829	0.2625	0.1516	0.1451	0.4227	0.2132	0.2695	0.2883	0.3337	0.2843
FBAR 2- 4	0.4065	0.3489	0.3309	0.2685	0.1668	0.1793	0.1907	0.2436	0.4112	0.2591	0.221	0.1197

Table 8 Fishing mortality (F) at age

YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018	FBAR 16-18
AGE										
1	0.0237	0.5347	0.357	0.1298	0.2796	0.0682	0.1122	0.0642	0.0374	0.0713
2	0.0408	0.24	0.1228	0.1032	0.4041	0.2085	0.1677	0.1529	0.1274	0.1493
3	0.0627	0.2277	0.2933	0.2055	0.4573	0.6207	0.3223	0.1665	0.1235	0.2041
4	0.1231	0.3978	0.3772	0.3646	0.472	0.5158	0.258	0.1466	0.2616	0.222
5	0.1818	0.478	0.7357	0.3408	0.6065	0.5767	0.3569	0.289	0.5531	0.3997
6	0.3494	0.744	0.3542	0.5478	0.6034	0.471	0.3786	0.2366	0.4683	0.3612
+gp	0.3494	0.744	0.3542	0.5478	0.6034	0.471	0.3786	0.2366	0.4683	
FBAR 2- 4	0.0755	0.2885	0.2645	0.2244	0.4445	0.4483	0.2493	0.1553	0.1708	

Table 6.1.11. Megrim (*L. whiffiagonis*) Div. 8c and 9a. Estimates of stocks numbers at age

Run title : Megrim (L. whiffiagonis.) in Divisions 27.7.8c and 27.7.9a

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Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEA	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE												
1	10112	13164	11867	10722	13292	6021	11820	5339	2284	9805	9815	7595
2	7830	7056	8643	6715	7784	6748	3702	8410	3595	1750	7261	7550
3	3315	4260	3308	3666	3391	4057	3012	2291	4960	2429	1016	4215
4	1942	1992	2690	1652	2270	1958	2479	1736	1476	2400	1642	680
5	1168	1003	1265	1525	772	1064	970	1007	936	709	1395	1083
6	610	499	556	553	792	331	286	255	498	201	359	684
+gp	581	436	393	725	1156	136	247	88	175	205	194	254
TOTAL	25558	28409	28722	25558	29458	20315	22516	19127	13925	17500	21682	22063

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE												
1	4390	2746	3952	3469	2925	3026	3304	2805	2334	2809	1734	1504
2	5734	3218	1804	2674	2498	2061	2144	2515	1983	1811	2218	1299
3	4445	3512	2160	1222	1839	1835	1417	1517	1809	1148	1337	1481
4	2408	2432	1829	1162	701	1197	1251	969	845	955	730	900
5	487	1165	1340	1021	722	488	818	801	639	442	513	459
6	554	202	549	771	636	442	327	501	515	357	234	268
+gp	246	392	1059	561	289	391	229	235	167	245	135	129
TOTAL	18266	13667	12693	10880	9611	9440	9491	9342	8293	7768	6901	6040

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	GM 98-16
AGE											
1	7041	5481	2989	3259	2125	11934	12357	9414	6196	0	3542
2	1077	5630	2629	1713	2344	1316	9126	9043	7228	4887	
3	963	847	3626	1904	1265	1281	874	6318	6354	5211	
4	1069	741	552	2214	1269	655	564	519	4379	4599	
5	645	774	407	310	1259	648	320	357	367	2761	
6	304	440	393	160	181	562	298	184	219	173	
+gp	160	382	511	231	347	239	334	214	228	229	
TOTAL	11259	14294	11108	9790	8789	16635	23874	26047	24971	17860	

Table 6.1.12 Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Summary of landings and XSA results.

Run title : Megrim (L. whiffiagonis.) in Divisions 27.7.8c and 27.7.9a

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Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 4
1986	10112	2570	2222	705	0.3173	0.393
1987	13164	2324	1868	537	0.2874	0.357
1988	11867	2548	2137	858	0.4016	0.5065
1989	10722	2680	2298	761	0.3312	0.4408
1990	13292	2801	2379	1022	0.4296	0.4529
1991	6021	1806	1610	655	0.4069	0.4673
1992	11820	1803	1534	558	0.3638	0.4438
1993	5339	1569	1399	421	0.301	0.3284
1994	2284	1294	1212	492	0.4058	0.417
1995	9805	1319	981	258	0.2629	0.2929
1996	9815	1647	1323	373	0.2819	0.2535
1997	7595	1579	1367	408	0.2986	0.2744
1998	4390	1485	1358	482	0.3551	0.4065
1999	2746	1204	1126	386	0.3429	0.3489
2000	3952	1306	1199	288	0.2401	0.3309
2001	3469	1010	900	194	0.2155	0.2685
2002	2925	930	839	136	0.162	0.1668
2003	3026	1058	947	149	0.1573	0.1793
2004	3304	919	797	160	0.2007	0.1907
2005	2805	956	842	166	0.1971	0.2436
2006	2334	913	809	226	0.2795	0.4112
2007	2809	856	727	155	0.2133	0.2591
2008	1734	716	660	144	0.2183	0.221
2009	1504	710	667	95	0.1423	0.1197
2010	7041	909	727	88	0.121	0.0755
2011	5481	1255	1112	371	0.3337	0.2885
2012	2989	1241	1164	293	0.2517	0.2645
2013	3259	1108	1010	250	0.2475	0.2244
2014	2125	1134	1062	399	0.3758	0.4445
2015	11934	1236	931	297	0.3189	0.4483
2016	12357	1830	1417	298	0.2103	0.2493
2017	9414	2237	1927	288	0.1494	0.1553
2018	6196	2290	2094	352	0.1681	0.1708
Arith. Mean	6292	1492	1292	372	0.2724	0.3059
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.1.13. Megrim (*L. whiffiagonis*) in Division 8c9a. Prediction with management option table: Input data

MFDP version 1a
Run: meg
Time and date: 22:08 30/04/2019
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

Age	2019	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. Spaw.	Prop. of M bef. Spaw.	Weight in Stock	Exploit pattern	Weight CWt	Exploit pattern	Weight DWt
	1	3542	0.2	0.34	0	0	0.037	0.0050	0.060	0.0665	0.035
	2	4887	0.2	0.9	0	0	0.088	0.1135	0.099	0.0314	0.060
	3	5211	0.2	1	0	0	0.130	0.2042	0.132	0.0069	0.086
	4	4599	0.2	1	0	0	0.173	0.2176	0.174	0.0019	0.110
	5	2761	0.2	1	0	0	0.220	0.3516	0.221	0.0006	0.041
	6	173	0.2	1	0	0	0.277	0.3134	0.277	0.0009	0.017
	7	229	0.2	1	0	0	0.405	0.3143	0.405	0.0000	0.000

Age	2020	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. Spaw.	Prop. of M bef. Spaw.	Weight in Stock	Exploit pattern	Weight CWt	Exploit pattern	Weight DWt
	1	3542	0.2	0.34	0	0	0.037	0.0050	0.060	0.0665	0.035
	2		0.2	0.9	0	0	0.088	0.1135	0.099	0.0314	0.060
	3		0.2	1	0	0	0.130	0.2042	0.132	0.0069	0.086
	4		0.2	1	0	0	0.173	0.2176	0.174	0.0019	0.110
	5		0.2	1	0	0	0.220	0.3516	0.221	0.0006	0.041
	6		0.2	1	0	0	0.277	0.3134	0.277	0.0009	0.017
	7		0.2	1	0	0	0.405	0.3143	0.405	0.0000	0.000

Age	2021	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. Spaw.	Prop. of M bef. Spaw.	Weight in Stock	Exploit pattern	Weight CWt	Exploit pattern	Weight DWt
	1	3542	0.2	0.34	0	0	0.037	0.005	0.060	0.067	0.035
	2		0.2	0.9	0	0	0.088	0.114	0.099	0.031	0.060
	3		0.2	1	0	0	0.130	0.204	0.132	0.007	0.086
	4		0.2	1	0	0	0.173	0.218	0.174	0.002	0.110
	5		0.2	1	0	0	0.220	0.352	0.221	0.001	0.041
	6		0.2	1	0	0	0.277	0.313	0.277	0.001	0.017
	7		0.2	1	0	0	0.405	0.314	0.405	0.000	0.000

Input units are thousands and kg - output in tonnes

Table 6.1.14. Megrim (*L. whiffiagonis*) in Div. 8c and 9a catch forecast: management option table

MFDP version 1a
Run: meg
Time and date: 22:08 30/04/2019
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

2019		Catch	Landings		Discards	
Biomass	SSB	FMult	FBar	Yield	FBar	Yield
2782	2652	1	0.1784	504	0.0134	18

2020		Catch	Landings		Discards		2021	
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
2619	2508	0	0.0000	0	0.0000	0	3078	2966
.	2508	0.1	0.0178	59	0.0013	1	3006	2894
.	2508	0.2	0.0357	116	0.0027	3	2936	2824
.	2508	0.3	0.0535	172	0.0040	4	2868	2756
.	2508	0.4	0.0714	226	0.0054	6	2801	2690
.	2508	0.5	0.0892	279	0.0067	7	2737	2625
.	2508	0.6	0.1071	330	0.0080	9	2674	2563
.	2508	0.7	0.1249	380	0.0094	10	2613	2502
.	2508	0.8	0.1427	429	0.0107	11	2553	2442
.	2508	0.9	0.1606	476	0.0121	13	2495	2385
.	2508	1	0.1784	522	0.0134	14	2439	2328
.	2508	1.1	0.1963	567	0.0147	15	2384	2274
.	2508	1.2	0.2141	610	0.0161	16	2331	2221
.	2508	1.3	0.2320	653	0.0174	18	2279	2169
.	2508	1.4	0.2498	694	0.0188	19	2229	2119
.	2508	1.5	0.2677	734	0.0201	20	2179	2070
.	2508	1.6	0.2855	774	0.0214	22	2132	2022
.	2508	1.7	0.3033	812	0.0228	23	2085	1976
.	2508	1.8	0.3212	849	0.0241	24	2040	1930
.	2508	1.9	0.3390	885	0.0255	25	1996	1886
.	2508	2	0.3569	920	0.0268	26	1953	1844

Input units are thousands and kg - output in tonnes

Table 6.1.15. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Single option prediction: Detail Tables.

MFDP version 1a
Run: meg
Time and date: 22:08 30/04/2019
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

Year: 2019 F multiplier: 1 Fleet1 HCFbar: 0.1784 Fleet1 DFbar: 0.0134

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.005	16	1	0.0665	206	7	3542	132	1204	45	1204	45
2	0.1135	469	46	0.0314	130	8	4887	429	4398	386	4398	386
3	0.2042	872	116	0.0069	29	3	5211	675	5211	675	5211	675
4	0.2176	817	142	0.0019	7	1	4599	797	4599	797	4599	797
5	0.3516	746	165	0.0006	1	0	2761	609	2761	609	2761	609
6	0.3134	42	12	0.0009	0	0	173	48	173	48	173	48
7	0.3143	56	23	0	0	0	229	93	229	93	229	93
Total		3019	504		374	18	21402	2782	18576	2652	18576	2652

Year: 2020 F multiplier: 1 Fleet1 HCFbar: 0.1784 Fleet1 DFbar: 0.0134

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.005	16	1	0.0665	206	7	3542	132	1204	45	1204	45
2	0.1135	259	26	0.0314	72	4	2700	237	2430	213	2430	213
3	0.2042	580	77	0.0069	20	2	3461	449	3461	449	3461	449
4	0.2176	614	107	0.0019	5	1	3454	598	3454	598	3454	598
5	0.3516	817	180	0.0006	1	0	3023	666	3023	666	3023	666
6	0.3134	389	108	0.0009	1	0	1589	440	1589	440	1589	440
7	0.3143	59	24	0	0	0	240	97	240	97	240	97
Total		2733	522		305	14	18011	2619	15403	2508	15403	2508

Year: 2021 F multiplier: 1 Fleet1 HCFbar: 0.1784 Fleet1 DFbar: 0.0134

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.005	16	1	0.0665	206	7	3542	132	1204	45	1204	45
2	0.1135	259	26	0.0314	72	4	2700	237	2430	213	2430	213
3	0.2042	320	42	0.0069	11	1	1912	248	1912	248	1912	248
4	0.2176	408	71	0.0019	4	0	2295	397	2295	397	2295	397
5	0.3516	614	135	0.0006	1	0	2271	501	2271	501	2271	501
6	0.3134	426	118	0.0009	1	0	1740	481	1740	481	1740	481
7	0.3143	269	109	0	0	0	1094	443	1094	443	1094	443
Total		2311	502		295	13	15554	2439	12946	2328	12946	2328

Input units are thousands and kg - output in tonnes

Table 6.1.16 **Megrim (L. whiffiagonis) in Divisions 8c and 9a**
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to catches and SSB (by weight) of these year classes

Year-class			2015	2016	2017	2018	2019
Stock No. (thousands) of 1 year-olds			12357	9414	6196	3542.2332	3542.2332
Source			XSA	XSA	XSA	GM98-16	GM98-16
Status Quo F:							
% in	2019	catch	27.3	22.7	10.3	1.5	-
% in	2020		33.5	20.1	14.7	5.6	1.5
% in	2019	SSB	30.0	25.4	14.5	1.7	-
% in	2020	SSB	26.6	23.8	17.9	8.5	1.8
% in	2021	SSB	20.7	21.5	17.1	10.7	9.1

GM : geometric mean recruitment

Megrim (L. whiffiagonis) in Divisions 8c and 9a : Year-class % contribution to

a) 2020 catches **b) 2021 SSB**

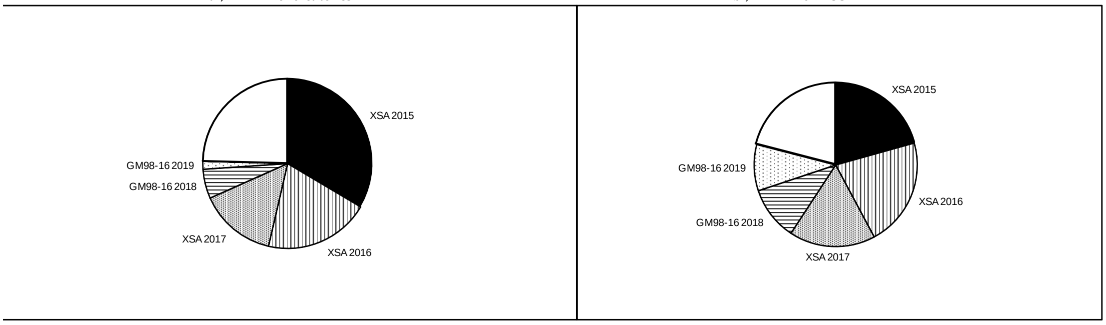


Table 6.1.17. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a, yield per recruit results.

MFYPR version 2a
Run: meg
Time and date: 22:17 30/04/2019
Yield per results

Catch	Landings			Discards								
FMult	Fbar	CatchNos	Yield	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	0	0	0	5.5167	1.1647	4.7748	1.133	4.7748	1.133
0.1	0.0178	0.0894	0.0242	0.0013	0.0088	0.0004	5.0272	0.9873	4.2859	0.9556	4.2859	0.9556
0.2	0.0357	0.1563	0.0405	0.0027	0.0175	0.0008	4.6509	0.8547	3.9102	0.823	3.9102	0.823
0.3	0.0535	0.208	0.0517	0.004	0.0261	0.0012	4.3516	0.7522	3.6115	0.7206	3.6115	0.7206
0.4	0.0714	0.2488	0.0594	0.0054	0.0345	0.0015	4.1072	0.671	3.3676	0.6395	3.3676	0.6395
0.5	0.0892	0.2816	0.0647	0.0067	0.0428	0.0019	3.9031	0.6053	3.1641	0.5738	3.1641	0.5738
0.6	0.1071	0.3085	0.0684	0.008	0.0509	0.0022	3.7298	0.5512	2.9914	0.5198	2.9914	0.5198
0.7	0.1249	0.3306	0.0708	0.0094	0.059	0.0026	3.5804	0.5061	2.8425	0.4747	2.8425	0.4747
0.8	0.1427	0.3491	0.0724	0.0107	0.0669	0.0029	3.4499	0.4678	2.7126	0.4365	2.7126	0.4365
0.9	0.1606	0.3647	0.07	0.0121	0.0746	0.0033	3.33	0.4352	2.598	0.4039	2.598	0.4039
1	0.1784	0.3778	0.0738	0.0134	0.0823	0.0036	3.2322	0.407	2.4959	0.3757	2.4959	0.3757
1.1	0.1963	0.3889	0.0739	0.0147	0.0898	0.0039	3.14	0.3824	2.4043	0.3512	2.4043	0.3512
1.2	0.2141	0.3984	0.0738	0.0161	0.0973	0.0042	3.0566	0.3608	2.3215	0.3297	2.3215	0.3297
1.3	0.232	0.4065	0.0734	0.0174	0.1046	0.0045	2.9807	0.3418	2.2461	0.3107	2.2461	0.3107
1.4	0.2498	0.4135	0.073	0.0188	0.1118	0.0048	2.9113	0.3248	2.1772	0.2938	2.1772	0.2938
1.5	0.2677	0.4194	0.0724	0.0201	0.1189	0.0051	2.8473	0.3097	2.1138	0.2786	2.1138	0.2786
1.6	0.2855	0.4244	0.0718	0.0214	0.126	0.0054	2.7882	0.296	2.0552	0.265	2.0552	0.265
1.7	0.3033	0.4287	0.0711	0.0228	0.1329	0.0057	2.7333	0.2837	2.0008	0.2528	2.0008	0.2528
1.8	0.3212	0.4323	0.0703	0.0241	0.1397	0.006	2.6822	0.2725	1.9502	0.2416	1.9502	0.2416
1.9	0.339	0.4354	0.0696	0.0255	0.1465	0.0063	2.6344	0.2622	1.9029	0.2314	1.9029	0.2314
2.0	0.3569	0.4379	0.0688	0.0268	0.1531	0.0065	2.5896	0.2529	1.8586	0.2221	1.8586	0.2221

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar(2-4)	1	0.1784
FMax	1.091	0.1947
F0.1	0.6017	0.1074
F35%SPR	0.9247	0.165

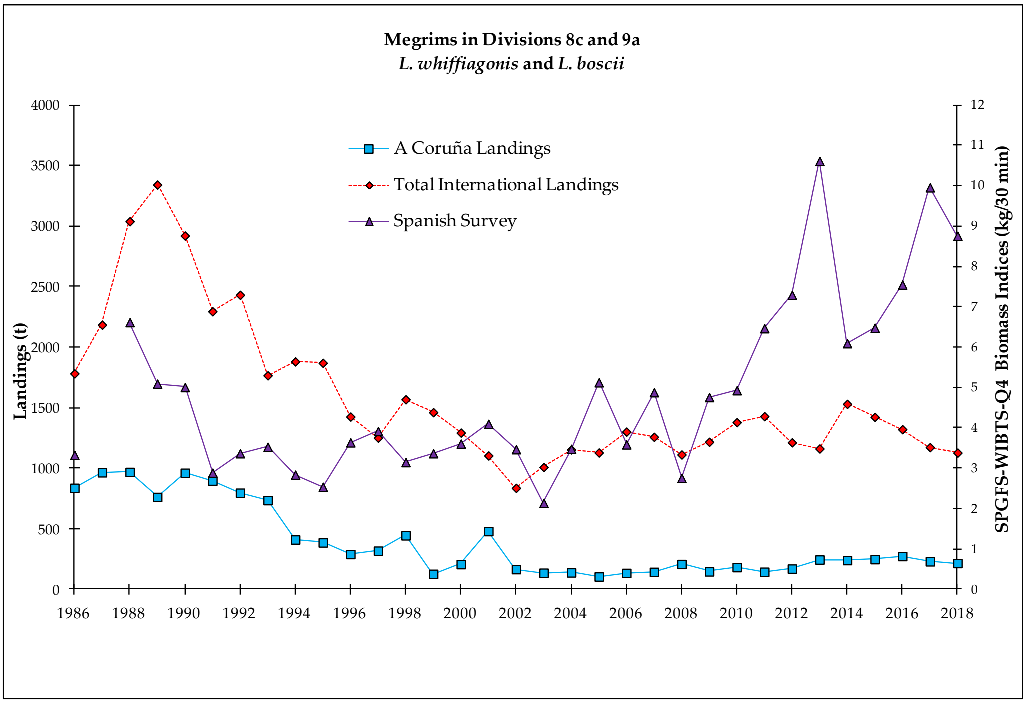


Figure 6.1.1 Historical landings and biomass indices of Spanish survey of megrims (both species combined).

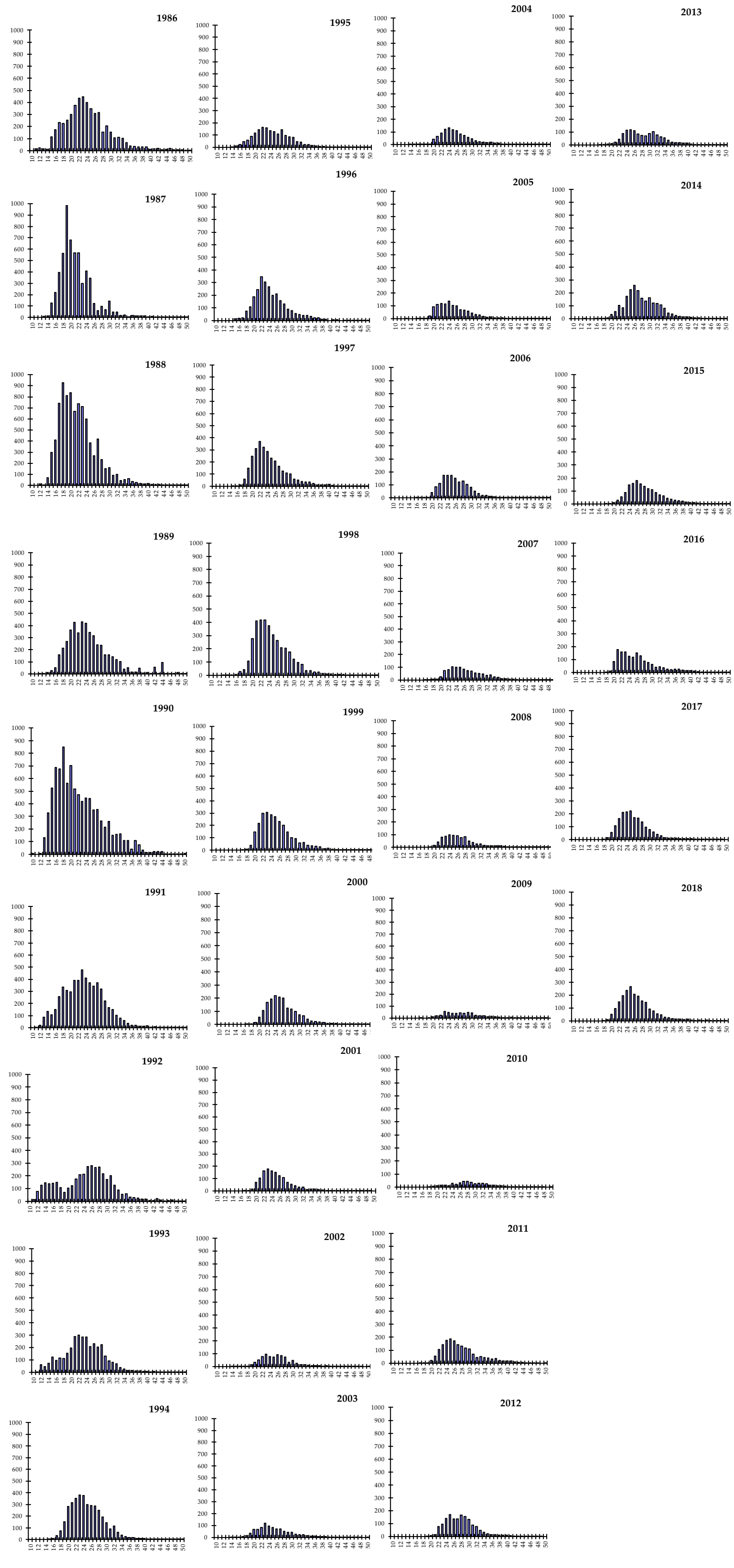


Figure 6.1.2 Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Annual length compositions of landings ('000)

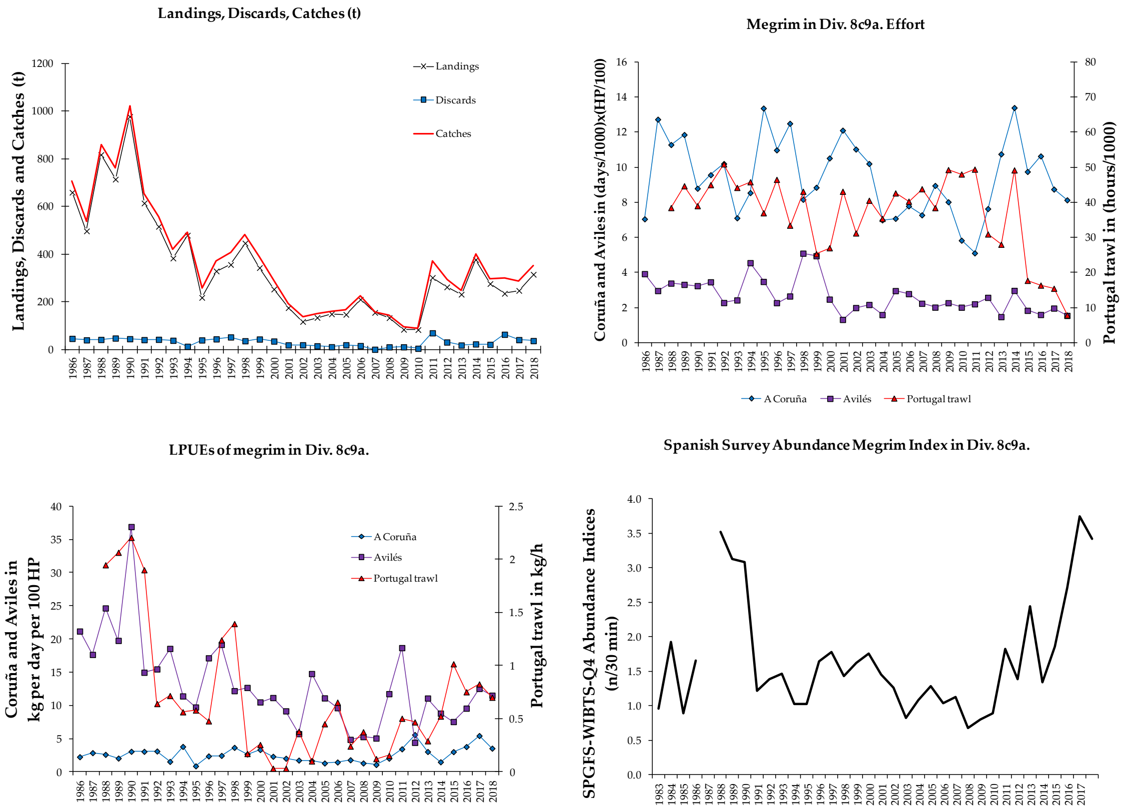
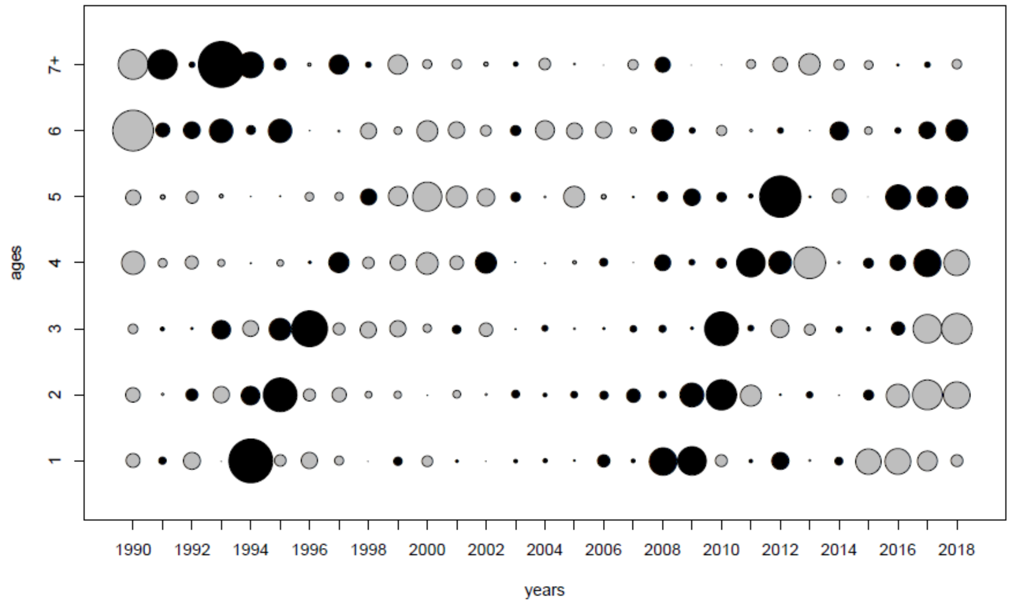


Figure 6.1.3(a) Megrim (*L.whiffiagonis*) in Divisions 8c9a. Catches (t), Efforts, LPUEs and Abundance Indices.

Standardized log (abundance index at age) from survey SP-NSGFS-Q4

(black bubbles means <0)

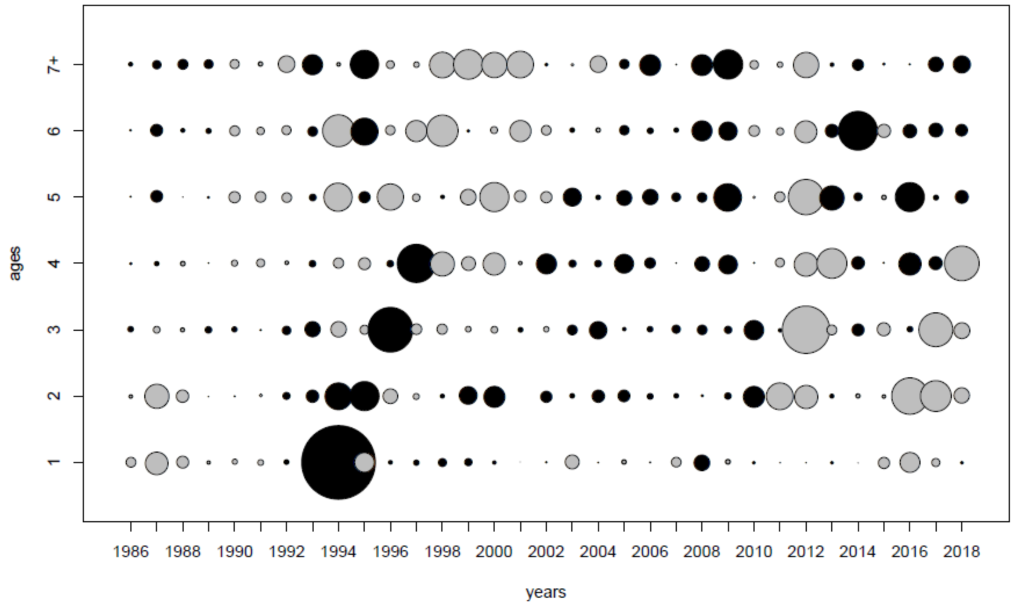


*** 2013 data not included in the assessment**

Figure 6.1.3(b): Megrim (*L. whiffiagonis*) in Divisions 8c & 9a

Standardized log (abundance index at age) from A Coruña fleet (SP-LCGOTBDEF)

(black bubble means < 0)



Standardized log (abundance index at age) from Avilés fleet (SP-AVSOTBDEF)

(black bubble means < 0)

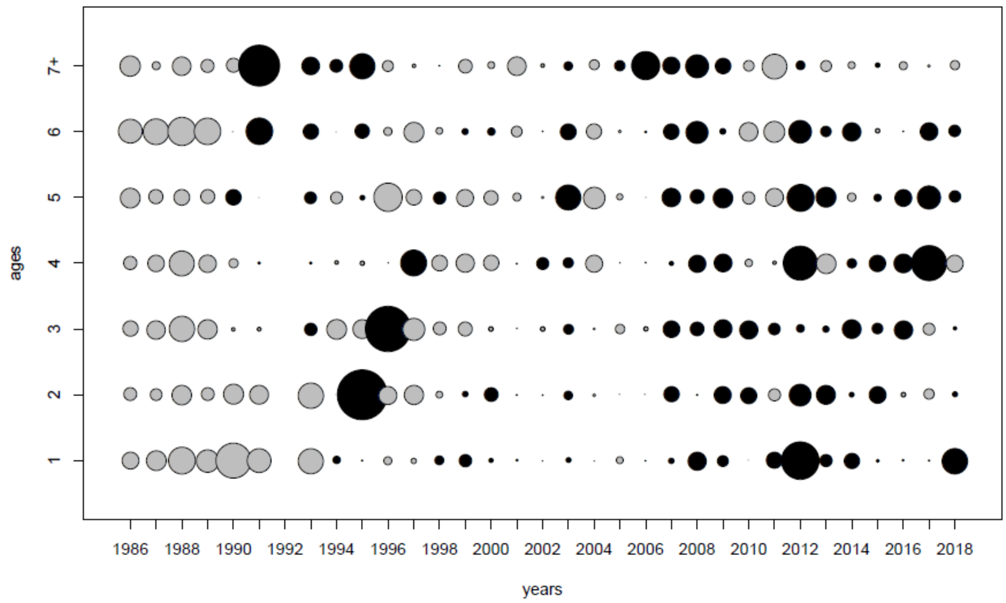
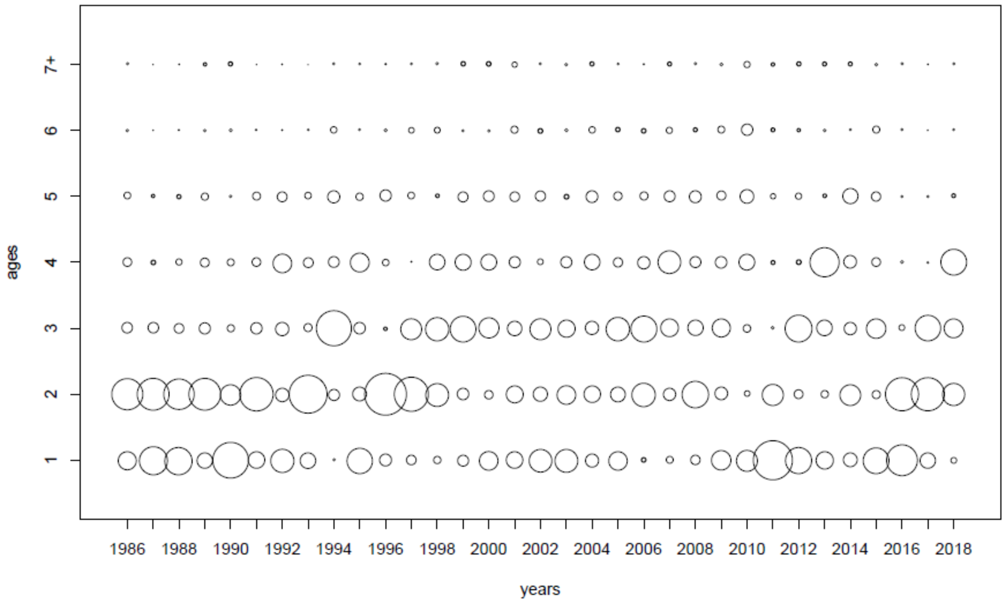


Figure 6.1.3(c): Megrim (*L. whiffiagonis*) in Divisions 8c & 9a

Catches proportions at age



Standardized catches proportions at age (black bubble means < 0)

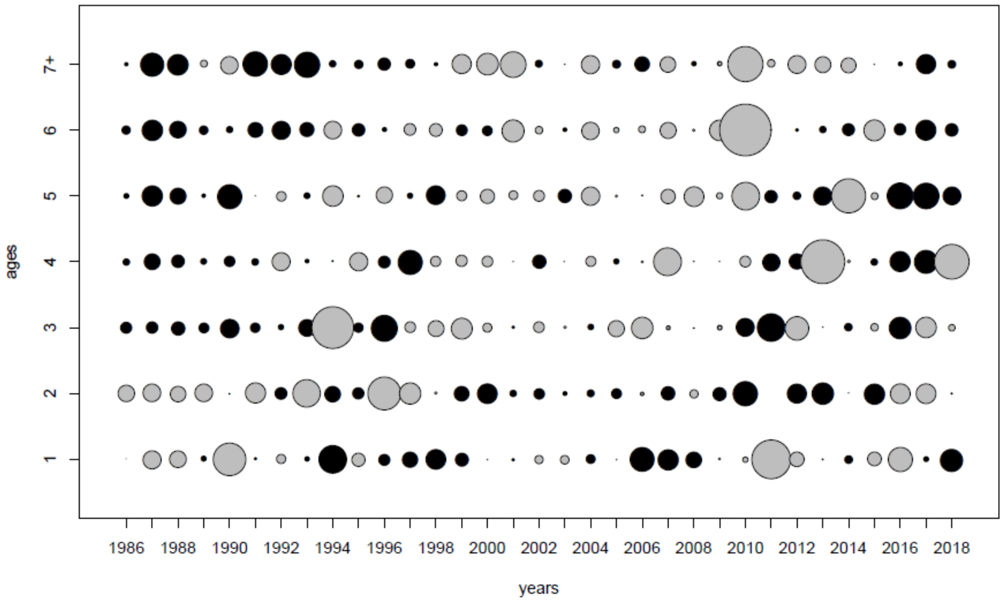
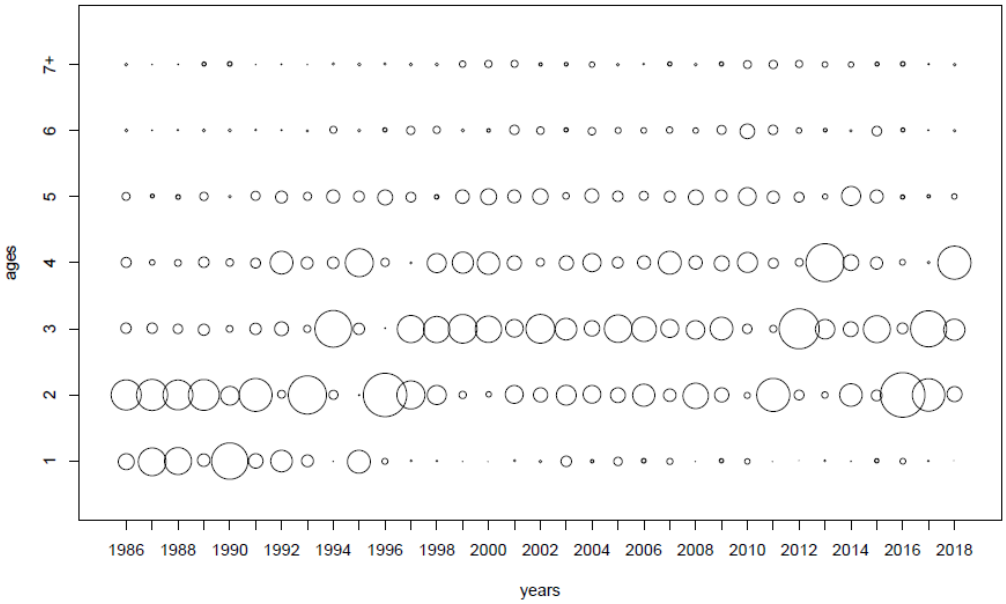


Figure 6.1.4(a). Megrim (*L. whiffiagonis*) in Divisions 8c & 9a.

Landings proportions at age



Standardized landings proportions at age (black bubble means < 0)

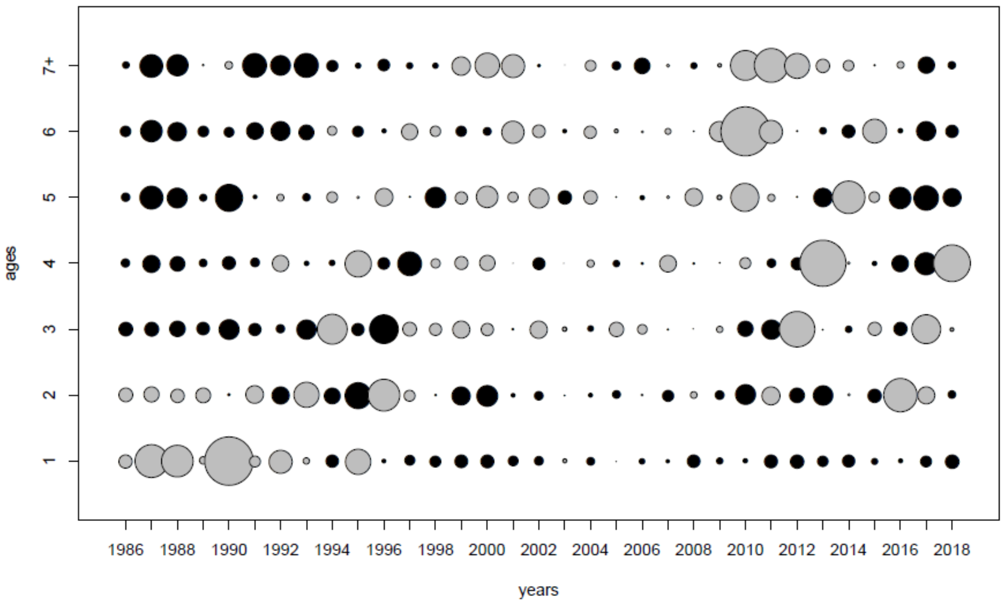
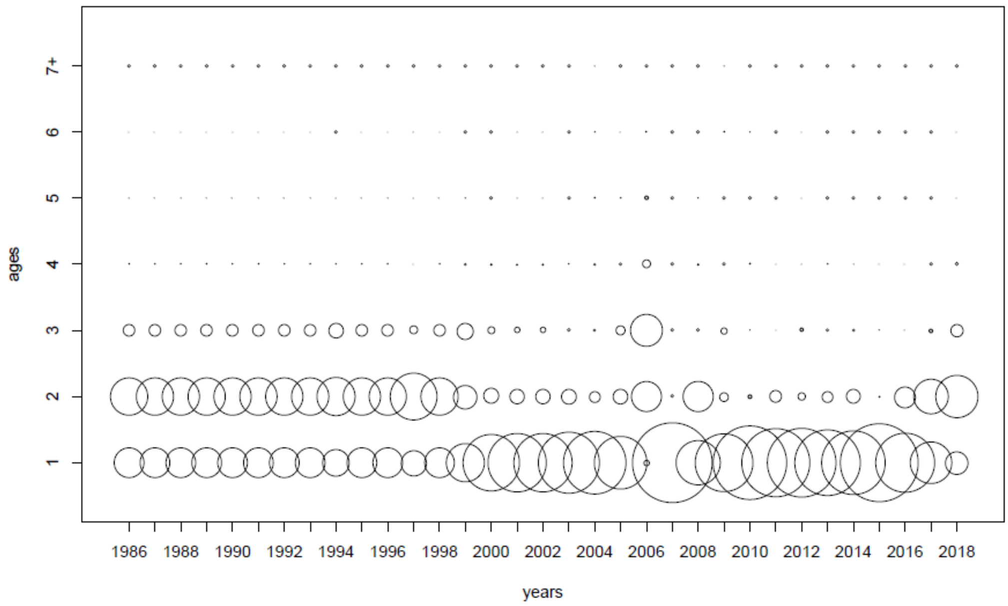


Figure 6.1.4(b). Megrim (*L. whiffiagonis*) in Divisions 8c & 9a.

Discards proportions at age



Standardize discards proportions at age (black bubble means < 0)

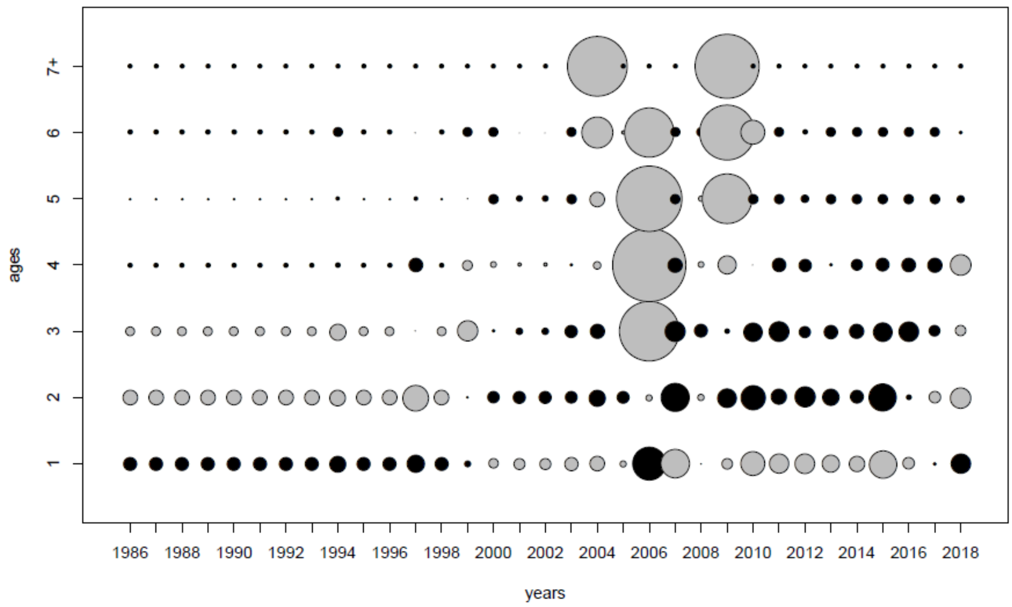


Figure 6.1.4(c). Megrim (*L. whiffiagonis*) in Divisions 8c & 9a.

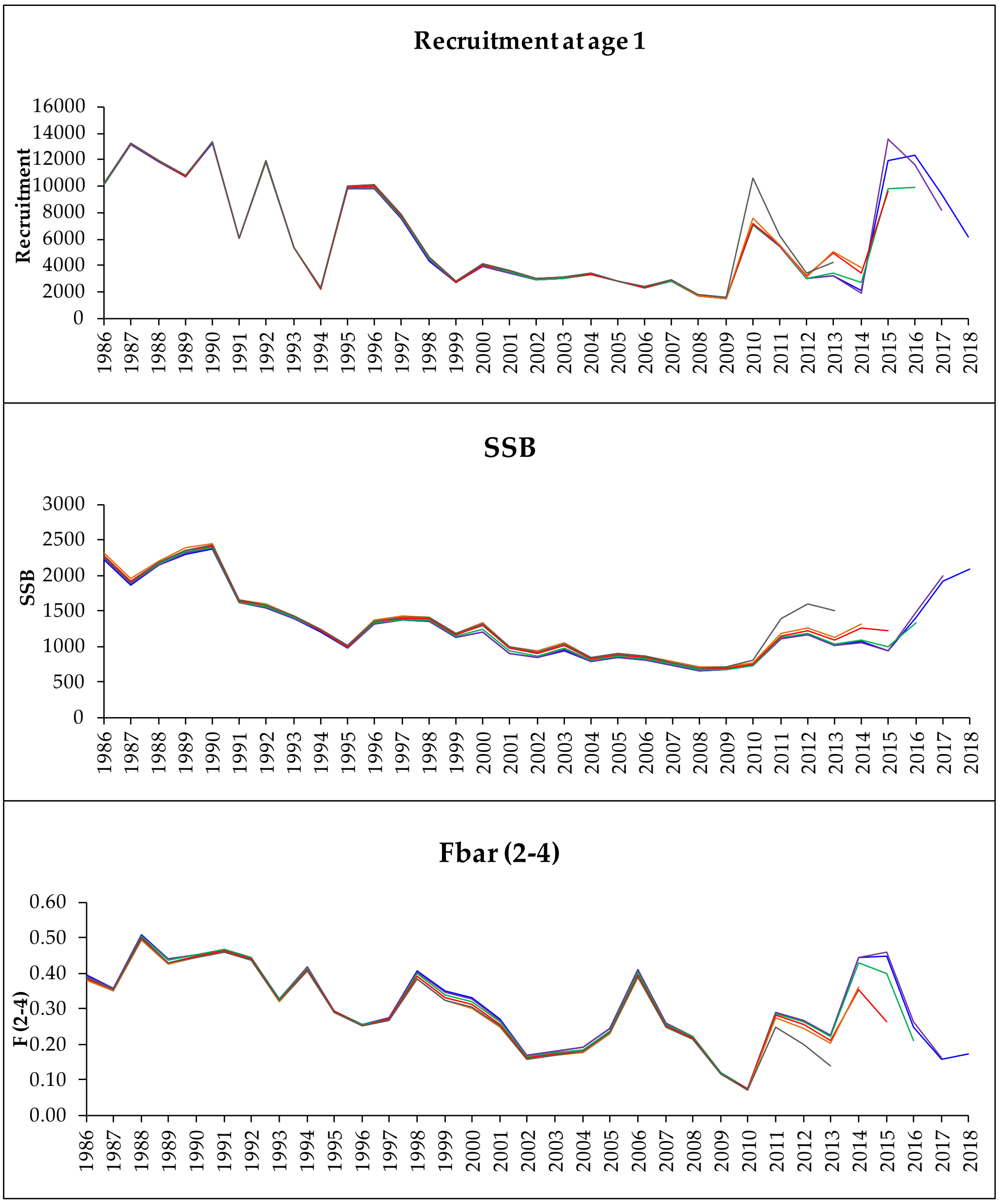


Figure 6.1.5. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Retrospective XSA

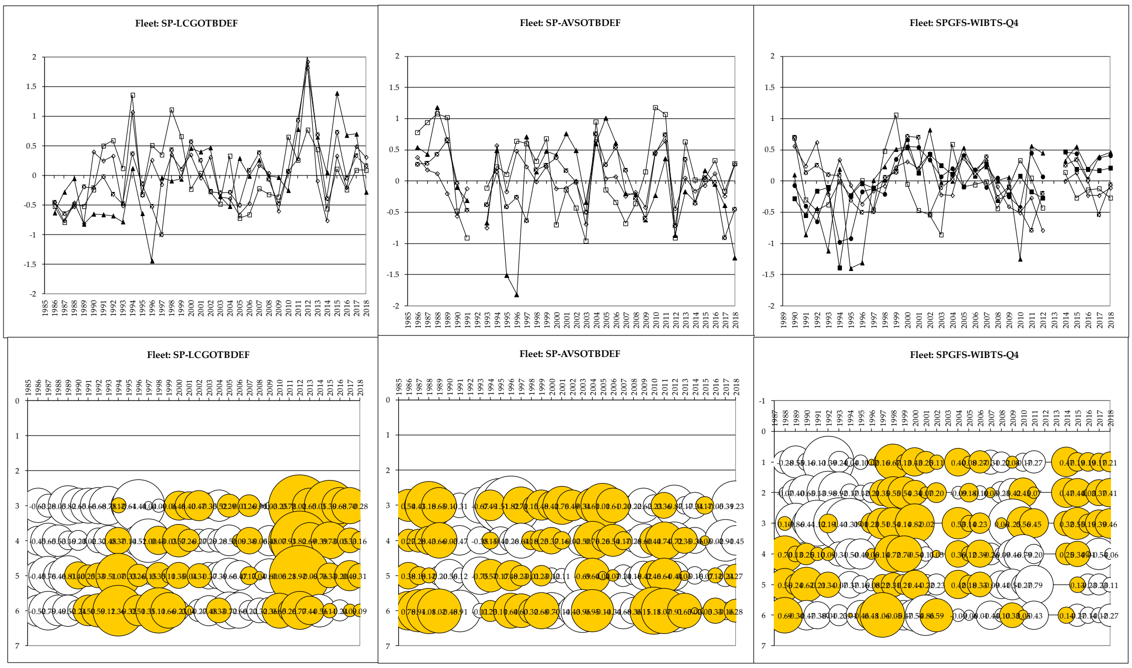


Figure 6.1.6. Megrim in Divisions 8c and 9a. LOG CATCHABILITY RESIDUAL PLOTS (XSA)

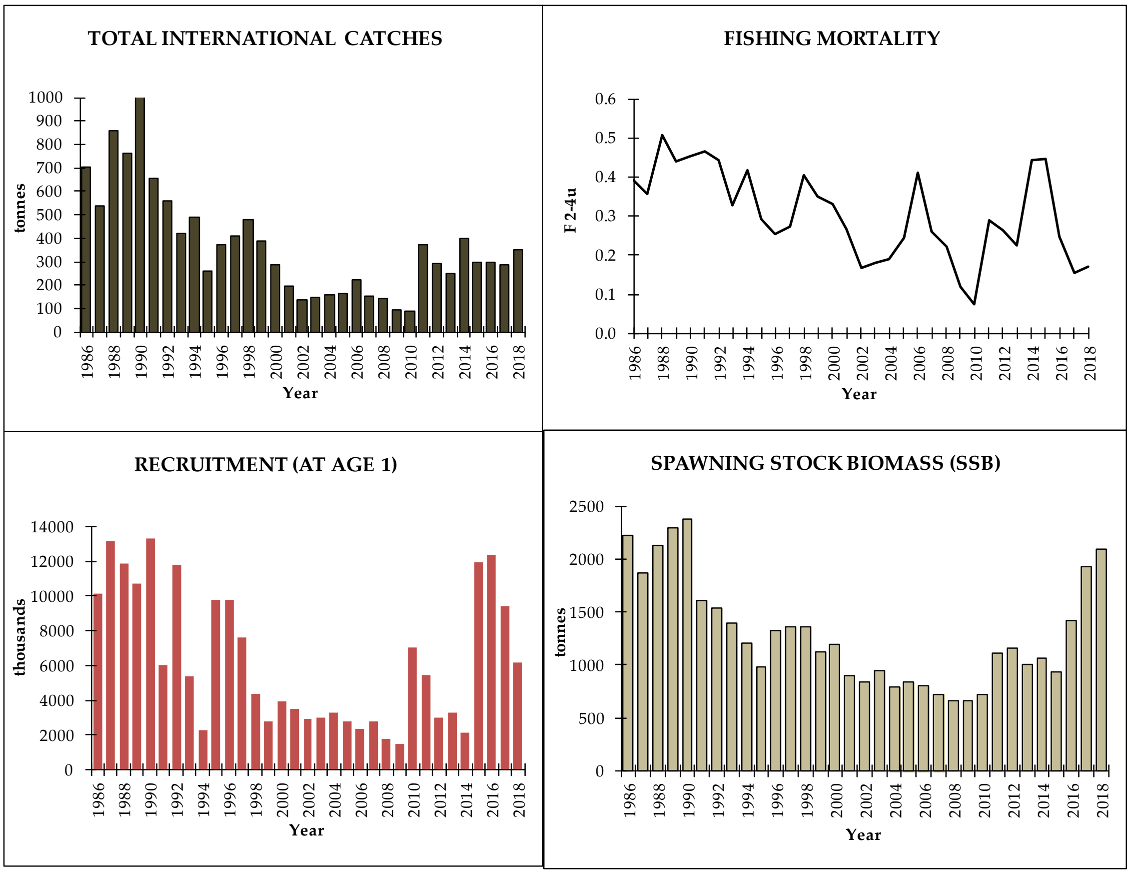
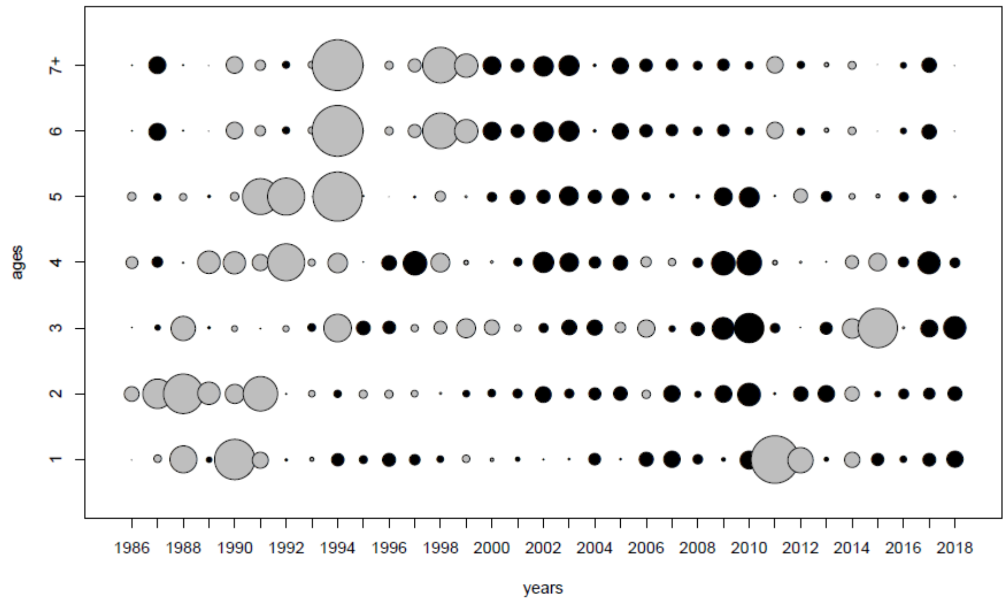


Figure 6.1.7(a) Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Stock Summary

Standardized F-at-age (black bubbles means <0)



Standardized relative F-at-age (black bubble means < 0)

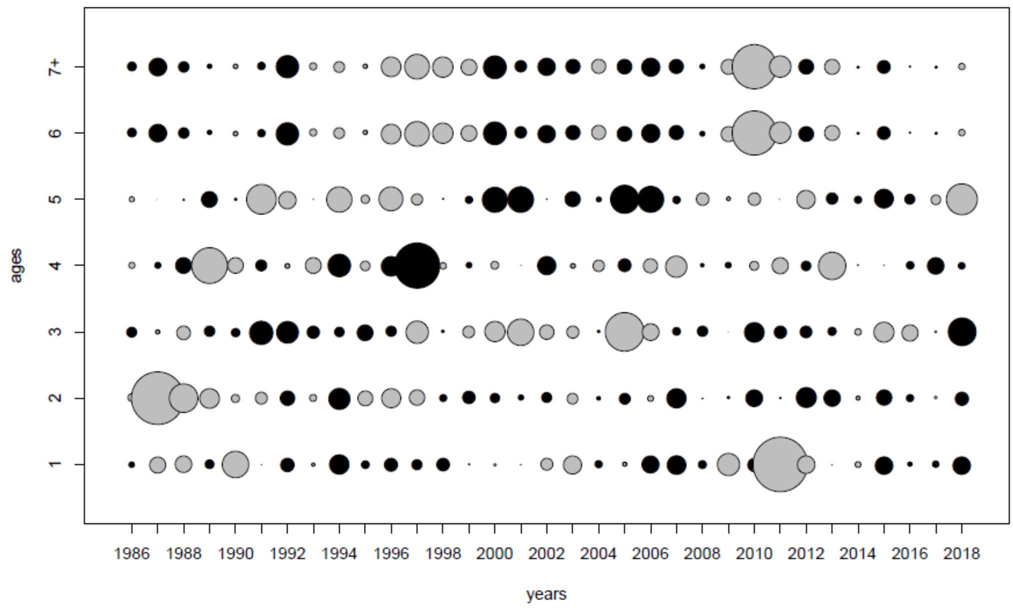
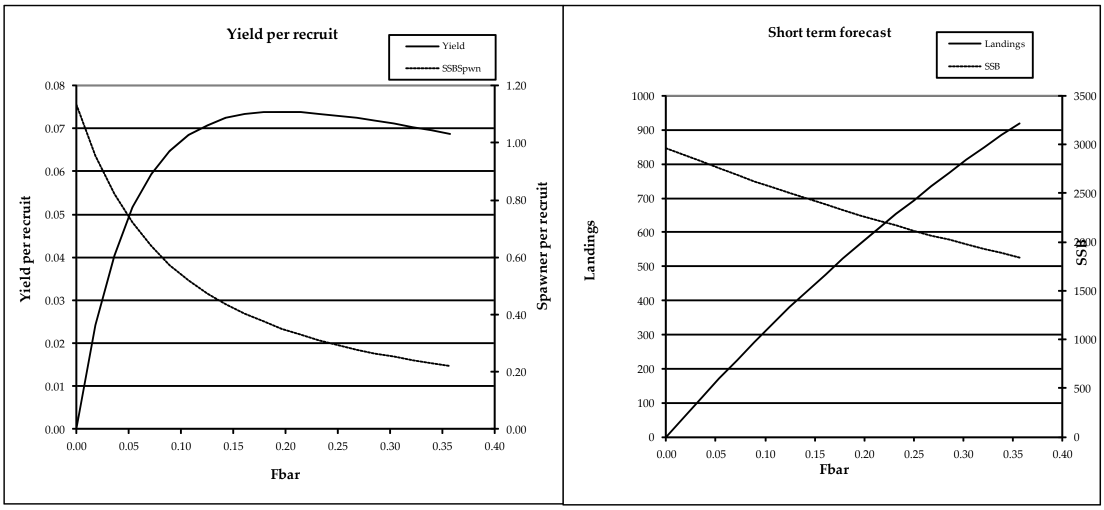


Figure 6.1.7(b): Megrim (*L. whiffiagonis*) in Divisions 8c & 9a



MFYPR version 2a
Run: meg
Time and date: 22:17 30/04/2019

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar	1.0000	0.2784
FMax	0.7402	0.2061
F0.1	0.4149	0.1155
F35%SPR	0.6353	0.1769

MFDP version 1a
Run: meg
Time and date: 22:08 30/04/2019
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

Input units are thousands and kg - output in tonnes

Figure 6.1.8. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a, forecast summary

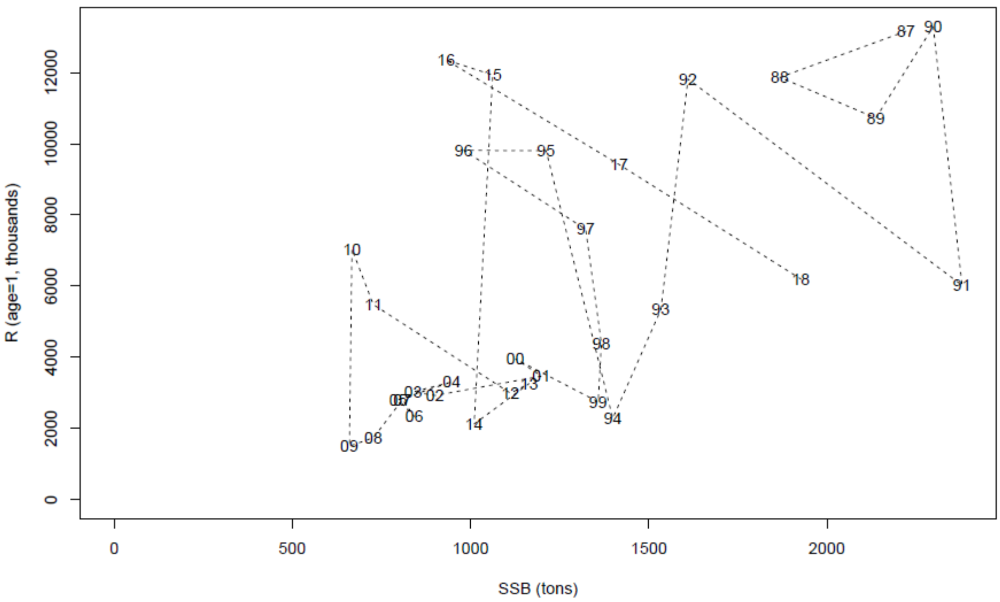


Figure 6.1.9. Megrim (*L.whiffiagonis*) in Divisions 8c and 9a. SSB-Recruitment plot.

(numbers in graph, 1987–2018, are recruitment years)

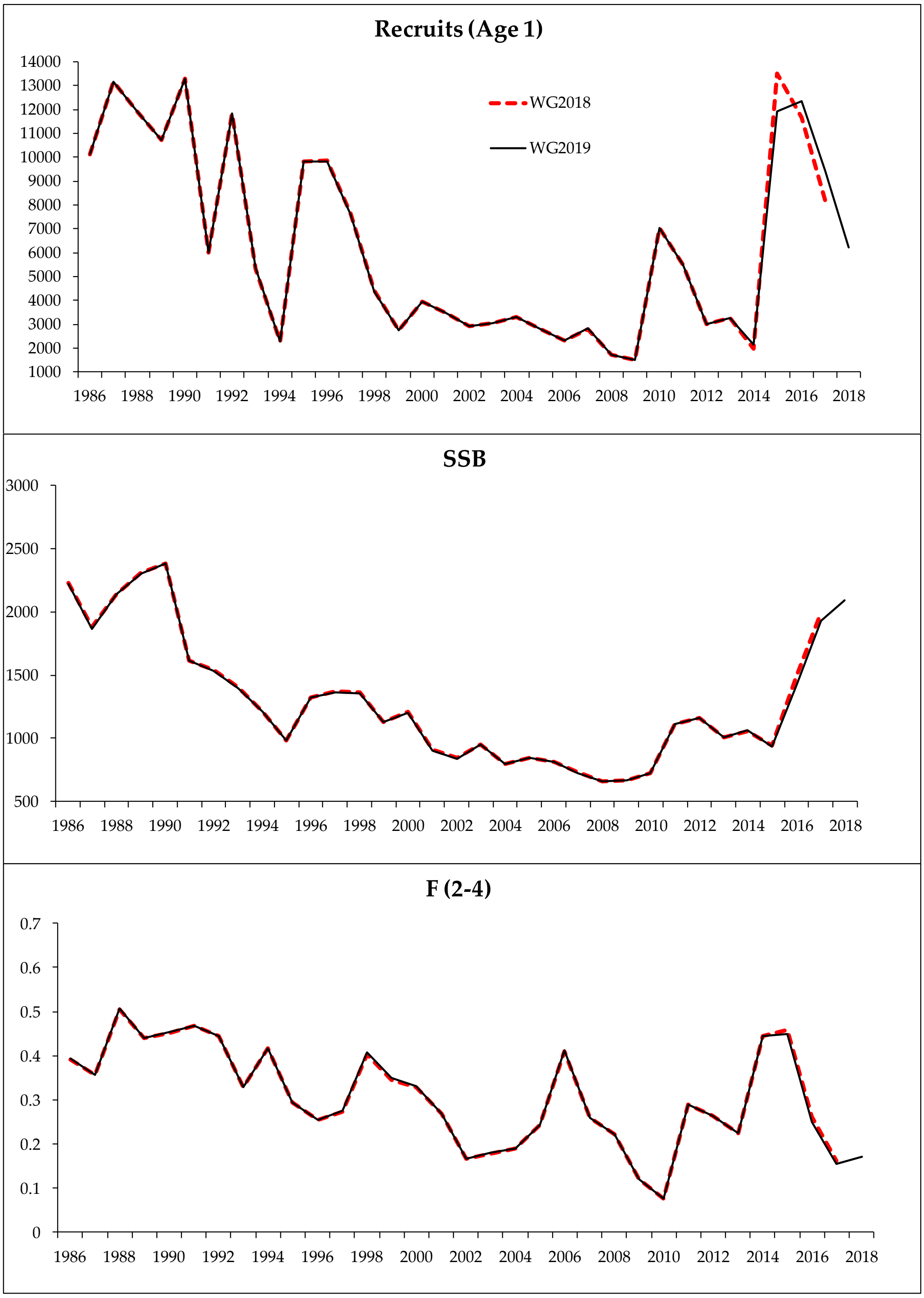


Figure 6.1.10. Megrim (*L. whiffiagonis*) in Div. 8c and 9a. Recruits, SSB and F estimates from WG18 and WG19

6.4 Four-spot megrim (*Lepidorhombus boscii*)

6.4.1 General

See general section for both species.

6.4.2 Data

6.4.2.1 Commercial catches and discards

The WG estimates of four-spot megrim international landings, discards and catches for the period 1986 to 2018 are given in Table 6.2.1. Since 2011, estimates of unallocated or non-reported landings have been included in the assessment. These were estimated based on the sampled vessels (Spanish concurrent sampling) raised to the total effort for each métier. These estimates are considered the best information available at this time. In 2015, data revised for period 2011-2013 were provided. This revision produced an improvement in the allocation of sampling trips and data revised are used in the assessment. Landings reached a peak of 2629 t in 1989 and have generally declined since then to their lowest value of 720 t in 2002. There has been some increase again in the last few years. Landings in 2010 are 1297 t, the highest value after 1995. In 2018, the landings value of 814 t is the lowest of the time series..

Discards estimates were available from "observers on board sampling programme" for Spain in the years displayed in Table 6.2.2(a). Discard / Total Catch ratio and CV are also presented, where discards in number represent between 39-67% of the total catch. Following the ICES recommendations in the advice sheet and using the same methodology described for *L. whiffiagonis* in section 6.1.2.1, discards missing data were also estimated for *L. boscii* in the Benchmark WKSOUTH in 2014. Spanish discards in numbers-at-age are shown in Table 6.2.2(b), indicating that the bulk of discards (in numbers) is for ages 1 to 3. Total discards are given in tons in Table 6.2.1

6.4.2.2 Biological sampling

Annual length compositions of total stock landings are given in Figure 6.2.1 and Table 6.2.3(a) for the period 1986-2018. Unallocated/non reported value is raised to total length distribution.

Mean length and weights in landings since 1990 are shown in the Table 6.2.3(b).

Age compositions of catches are presented in Table 6.2.4 Weights-at-age of catches (given in Table 6.2.5) were also used as weights-at-age in the stock. There is some variability in the weights-at-age through the historical time series.

For more information about biological data see Stock Annex.

6.4.2.3 Abundance indices from surveys

Portuguese and Spanish survey indices are summarised in Table 6.2.6.

Two Portuguese surveys, named"Crustacean" (PT-CTS (UWTV(FU28-29))) and "October" (PtGFS-WIBTS-Q4), provide indices for 2018. The October survey was conducted with a different vessel and gear in 2003 and 2004. Excluding these two years, the biomass indices from this survey in 2017 was the highest observed since 1994, whereas the value in 2010 is the second lowest in the series. In 2011, both the biomass and abundance indices from the Crustacean survey are the highest in the time series. In 2012, Portuguese Survey was not carried out due to budgetary constraints of national scope turned unfeasible to repair the R/V. Last year values are decreasing for October survey. In Crustacean survey, both biomass and abundance indices increase signally.

Total biomass, abundance and recruitment indices from the Spanish Groundfish Survey (SP-NSGFS-Q4) are also presented in Table 6.2.6. Total biomass indices from this survey generally remained stable after a maximum level in 1988 till 2003, when a very low value was obtained (as done in previous years, the 2003 index has been excluded from the assessment, as it was felt to be too much in contradiction with the rest of the time series). Since then, this was followed by the period of the higher values till present days, with the only exception of 2008. In 2013, the biomass and the abundance indices were the highest of the series. For the same raison that for *L. whiffiagonis*, survey carried out in a new vessel, the abundance values of 2013 is not included in the assessment models. In 2017, the survey presents the second highest values in both indices followed by a slightly decrease in 2018.

The recruitment index for age 0 in 2005 was very high and also in 2009 and 2014. The 2018 value is one of the lowest. The high index in 2009 applies to all ages and not just the recruitment (see Table 6.2.7, which gives abundance indices by age, and Figure 6.2.2, which is a bubble plot of log(abundance index at age) standardised by subtracting the mean and dividing by the standard deviation over the years). Since 2009, almost all ages appears to be above average. From Figure 6.2.2, the survey appears to have been quite good at tracking cohorts, in the last ten years, good cohorts of 2005, 2009 and 2014 can be followed, specially the last two.

6.4.2.4 Commercial catch-effort data

Two new commercial tuning indices were provided also for this stock as in the case of *L. whiffiagonis*. The LPUEs of the métiers of bottom otter trawl targeting demersal species, previously describe in section 6.1.2.4, one per port (A Coruña and Avilés), were made available for the benchmark WKSOUTH in 2014. From these new tuning fleets, SP-LCGOTBDEF and SP-AVSOTBDEF, only the first one was accepted to tune the assessment model. The LPUEs and effort values and landed numbers-at-age are given in Table 6.2.7 and Figure 6.2.3(a).

These fleets operate in different areas, each covering only a small part of the distribution of the stock, which may partly explain differences between patterns from these fleets and those from the Spanish survey in some years. Furthermore, commercial catches are mostly composed of ages 3 and 4, while the Spanish survey catches mostly fish of ages 1 and 2.

Table 6.2.8 displays landings (in tonnes), fishing effort and LPUE for the Spanish trawl fleets SP-LCGOTBDEF for the period 1986-2018 ,SP-AVSOTBDEF for the period 1986-2015 and for the Portuguese trawl fleet fishing in Division 9a for the period 1988–2018 (see also Figure 6.2.3). As SP-AVSOTBDEF is not use in the assessment, the sampling for this species in this port has been suspended since 2015. After very high value in 2010, the LPUE of Coruña (SP-LCGOTBDEF) shows in 2018 a small increase in relation to last year. For the Portuguese fleets, until 2011 most log-books were filled in paper but have thereafter been progressively replaced by e-logbooks. In 2013 more than 90% of the log-books are being completed in the electronic version. The LPUE series were revised from 2012 onwards. To revise the series backwards further refinement of the algorithms is required.

Commercial fleets used in the assessment to tune the model

Because of the trend in the residuals, A Coruña fleet (SP-LCGOTBDEF) was split in two (SP-LCGOTBDEF -1 and SP-LCGOTBDEF-2) for tuning, considering values until 1999 and from 2000 to 2018, as indicated in the Stock Annex. In Figure 6.2.3(b), the bubble plots of log (abundance index at age) standardised by subtracting the mean and dividing by the standard deviation over the years) of these two fleets are presented. Some cohorts can be followed in the time series. The effort of this fleet had been generally stable till year 2009, when effort is declining to its lowest value in the series, reached in 2011. After this year, the effort is increasing till 2014 the highest value of the time series, 2018 value represents a small decrease in relation to last year.

Commercial fleets not used in the assessment to tune the model

The effort of the Avilés fleet (SP-AVSOTBDEF) present two periods, the first one with a mean value of 3.2 and the second with 2.2 (days/1000)x(HP/100). The value in 2013 is one of the lowest of the series and was similar in 2015.

The effort of the Portuguese trawl fleet shows a slightly declining trend until these the last year, the lowest of the time series.

The LPUE series from the Avilés trawl fleet (SP-AVSOTBDEF) shows a generally upwards trend during all the series. The LPUE of the Portuguese trawl fleet has generally declined since 1992, with an increase in the last year till 2010, when the values started a decreasing trend. Since 2014, there is an increasing trend and 2018 value is the highest over the years.

6.4.3 Assessment

An update assessment was conducted, according to the Stock Annex specifications. Assessment years are 1986-2018 and ages 0-7+.

6.4.4 Model

Data screening

Figures 6.2.4(a), (b) and (c) are bubble plots representing catch, landings and discards proportions at age. These plots clearly indicate that the bulk of the landings generally corresponds to ages 2 to 4 and the discards at ages 1-2. Although in the last years, it seems to be an increase in age 5 and a decrease in age 2. The bottom panel of Figures 6.2.4(a), (b) and (c) also present bubble plots corresponding to standardized catch, landings and discards proportions at age, showing that the one corresponding to landings is the best to follow cohorts.

Very weak cohorts corresponding to year classes of 1993 and 1998 can be clearly identified from the standardized landing proportions at age matrix and good cohorts corresponding to year classes of 1991, 1992, 1995, 2005 and 2009 can also be tracked.

Final XSA run

Settings for the assessment are those detailed in the Stock Annex.

The retrospective analysis shows no particular worrying features (Figure 6.2.5). The model has a tendency to underestimate F and an overestimate SSB in the last years.

6.4.4.1 Assessment results

Diagnostics from the XSA final run are presented in Table 6.2.9 and log catchability residuals plotted in Figure 6.2.6. Diagnostics and residuals are similar to those found in the previous assessment. Many of the survey residuals are negative until the 2000's. After that, positive survey residuals are more abundant in this period.

Table 6.2.10 presents the fishing mortality-at-age estimates. F_{bar} (=$F_{2\text{-}4}$) is estimated to be 0.09 in 2018.

Population numbers-at-age estimates are presented in Table 6.2.11.

6.4.4.2 Year class strength and recruitment estimations

The 2016 year class estimate is 66 million individuals, obtained by averaging estimates coming from the Spanish survey tuning data (97% of weight) and F-shrinkage (3% weight).

The 2017 year class estimate is 18 million individuals, estimated from the Spanish survey (95% of weight) and F-shrinkage (5% weight).

The 2018 year class estimate is 14 million individuals, obtained a value from the Spanish survey (100% weight).

The working group considered that the XSA last year recruitment is poorly estimated. Following the procedure stated in the Stock Annex, the geometric mean of estimated recruitment over the years 1990–2016 has been used for computation of 2018 and subsequent year classes, for prediction purposes. Working Group estimates of year-class strength used for prediction are:

Recruitment at age 0:

Year class	Thousand	Basis	Survey	Commercial	Shrinkage
2016	66747	XSA	97%	-	3%
2017	18468	XSA	95%	-	5%
2018	45233	$GM_{90\text{-}16}$		-	
2019	45233	$GM_{90\text{-}16}$			

6.4.4.3 Historic trends in biomass, fishing mortality, and recruitment

Estimated fishing mortality and population numbers-at-age from the XSA run are given in Tables 6.2.10 and 6.2.11. Further results, including SSB estimates, are summarised in Table 6.2.12 and Figure 6.2.7(a).

SSB decreased gradually from 6732 t in 1988 to 3224 t in 2001, the lowest value in the series, and has since increased. In 2018 the SSB is estimated at 7450 t, the highest of the time series.

Recruitment has fluctuated around 47 million fish during all the series. Very weak year classes are found in 1993 and 1998. The second highest value occurred in 2012, while 2014 value is the highest in the series, with 75 million fish. The last two years values are the lowest of the time series.

Estimates of fishing mortality values show two different periods: an initial one with higher values from 1986 to 1996 and, following a decrease in 1997, a second period stabilised at a lower level than the first, with small ups and downs. From 2007, the F has been decreasing till 2013. After two years of higher values, the last three represents a fall in F, giving the lowest of the time series.

There seems to be interannual variability in the relative fishing exploitation pattern at age (F over F_{bar}, see Figure 6.2.7(b), bottom panel), with alternating periods of time with higher and lower relative exploitation pattern on the older ages.

6.4.5 Catch options and prognosis

Stock projections were calculated according to the settings specified in the Stock Annex.

6.4.5.1 Short-term projections

Short-term projections have been made using MFDP software. The input data for deterministic short-term projections are given in Table 6.2.13. Average F_{bar} for the last three years is assumed for the interim year. The exploitation pattern was the scaled F-at-age computed for each of the last five years and then the average of these scaled five years was weighted to the final year. This selection pattern was split into selection-at-age of landings and discards (corresponding to F_{bar} =

0.09 for landings and F_{bar} = 0.07 for discards, being 0.17 for catches). The recruitment in 2018 (age 0) has been replaced by GM (according with stock annex, GM is computed over years 1990-final assessment year minus 2), age 1 in 2019 has been recalculated from GM reduced by total estimated mortality obtained from the fishing mortality of age 0 of the last year and the natural mortality.

Table 6.2.14 gives the management options for 2020, and their consequences in terms of projected landings and stock biomass. Figure 6.2.8 (right panel) plots short-term yield and SSB versus F_{bar}. The detailed output by age group, assuming F *status quo*, is given in Table 6.2.15 for landings and discards. Under this scenario, projected landings for 2019 and 2020 are 1361 and 1435 t, respectively. Projected discards for the same years are 235 and 213 t.

Under F *status quo*, projected SSB values for 2020 and 2021 are about 8850 t in 2020and 8948 t in 2021.

The contributions of recent year classes to the projected landings and SSB are presented in Table 6.2.16. The year classes for which GM_{90-16} recruitment is assumed contribute in a 9% to catches in 2020 and with a 34% to SSB in 2021.

6.4.5.2 Yield and biomass per recruit analysis

The analysis is conducted following the Stock Annex specifications and results presented in Table 6.2.17. The left panel of Figure 6.2.8 plots yield-per-recruit and SSB-per-recruit versus F_{bar}.

Under F s*tatus quo* (F_{bar} = 0.09 for landings and F_{bar} = 0.07 for discards and assuming GM_{90-16} recruitment of 45 million, the equilibrium yield would be around 1371 t of landings and 240 t of discards, with an SSB value of 8825 t.

6.4.5.3 Biological reference points

The stock-recruitment time series is plotted in Figure 6.2.9. See Stock Annex for more information about Biological reference points.

The BRP are:

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	4600 t	Bpa
	F_{MSY}	0.193	
	F_{MSY} lower	0.125	based on 5% reduction in yield
	F_{MSY} upper (with advice rule)	0.29	based on 5% reduction in yield
	F_{MSY} upper (without advice rule)	0.29	based on 5% reduction in yield
	$F_{P.05}$	0.40	5% risk to B_{lim} without $B_{trigger}$.
	B_{lim}	3300 t	B_{loss} estimated in 2015
Precautionary	B_{pa}	4600 t	1.4 B_{lim}
Approach	F_{lim}	0.57	Based on segmented regression simulation of recruitment with B_{lim} as the breakpoint and no error
	F_{pa}	0.41	$F_{pa} = F_{lim} \times \exp(-\sigma \times 1.645)$ σ=0.2

6.4.6 Comments on the assessment

Two commercial fleets (SP-LCGOTBDEF-1 and SP-LCGOTBDEF-2) and the Spanish survey (SP-NSGFS-Q4) were used for tuning. The commercial fleet data used for tuning corresponds to ages 3 and older, which are not well represented in the survey. The Spanish survey covers a large part of the distribution area of the stock. The survey appears to have been quite good at tracking cohorts.

Since the benchmark in 2014, the model converges. It seems that the convergence issue was solved for this stock.

Comparison of this assessment with the one performed in 2018 shows minor differences in SSB and in Recruitment in recent years (Figure 6.2.10).

6.4.7 Management considerations

This assessment indicates that SSB decreased substantially between 1988 and 2001, the year with lowest SSB, and that there has been a smooth increasing trend from 2001 to present. Fishing at *status quo* F during 2019 would result in some biomass increase for 2019 and 2020.

There is no evidence of reduced recruitment at low stock levels.

As with *L. whiffiagonis,* it should be noted that four-spot megrim (*L. boscii*) is caught in mixed fisheries, and management measures applied to this species may have implications for other stocks. Both species of megrim are subject to a common TAC, so the joint status of these species should be taken into account when formulating management advice.

6.5 Combined Forecast for Megrims (*L. whiffiagonis* and *L. boscii*)

Figure 6.3.1 plots total international landings and estimated stock trends for both species of megrim in the same graph, in order to facilitate comparisons. The two species of megrim are included in the landings from ICES Divisions 8c and 9a. Both are taken as by-catch in mixed bottom trawl fisheries.

Assuming status quo F for both species in 2019 (average of estimated F over 2016–2018, corresponding to $F_{bar} = 0.18$ for landings and $F_{bar} = 0.01$ for discards for *L. whiffiagonis* and $F_{bar} = 0.09$ for landings and $F_{bar} = 0.07$ for discards for *L. boscii*), Figure 6.3.2 gives the combined predicted landings for 2020 and individual SSB for 2021, under different multiplying factors of their respective status quo F values. The combined projected values for the two species have been computed as the sum of the individual projected values obtained for each species separately under its assumed exploitation pattern. As usual, the exploitation pattern for each species has been assumed to remain constant during the forecast period.

At status quo F (average F over 2016–2018) for both species, predicted combined landings in 2020 are 1957 t and individual SSBs in 2021 are 2328 t for *L. whiffiagonis* and 8948 t for *L. boscii*.

Tables and Figures

Table 6.2.1. Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Total landings (t).

	Spain landings			Portugal landings	Unallocated/ Non reported	Total landings	Discards	Total catch
Year	8c	9a*	Total	9a				
1986	799	197	996	128		1124	284	1408
1987	995	586	1581	107		1688	333	2021
1988	917	1099	2016	207		2223	363	2586
1989	805	1548	2353	276		2629	408	3037
1990	927	798	1725	220		1945	409	2354
1991	841	634	1475	207		1682	447	2129
1992	654	938	1592	324		1916	437	2353
1993	744	419	1163	221		1384	438	1822
1994	665	561	1227	176		1403	517	1920
1995	685	826	1512	141		1652	406	2058
1996	480	448	928	170		1098	368	1466
1997	505	289	794	101		896	308	1204
1998	725	284	1010	113		1123	378	1501
1999	713	298	1011	114		1125	317	1442
2000	674	225	899	142		1041	373	1414
2001	629	177	807	124		931	290	1221
2002	343	247	590	130		720	308	1028
2003	393	314	707	169		876	191	1067
2004	534	295	829	177		1006	348	1354
2005	473	321	794	189		983	375	1358
2006	542	348	891	201		1092	335	1427
2007	591	295	886	218		1104	292	1396
**2008	546	262	808	172		980	202	1182
2009	577	342	919	215		1134	279	1413
2010	616	484	1100	197		1297	265	1562
^2011	390	384	774	181	172	1128	269	1397
^2012	240	239	479	98	374	952	369	1321
^2013	338	283	621	80	230	931	496	1427
2014	427	313	739	142	273	1154	788	1942
2015	460	255	715	137	296	1148	597	1745
2016	403	276	679	105	303	1087	332	1419
2017	346	265	611	144	172	926	246	1173
2018	381	231	612	130	72	814	92	906

^Data revised in WG2015

*9a is without Gulf of Cádiz till 2016

** Data revised in WG2010

* Official data by country and unallocated landings

Table. 6.2.2(a) Four-spot megrim (*L. boscii*) in Divisions 8c9a. Discard/Total Catch ratio and estimated CV for Spain from sampling on board

Year	1994	1997	1999	2000	2003	2004	2005	2006	2007	2008	2009
Weight Ratio	0.30	0.28	0.24	0.29	0.21	0.30	0.32	0.27	0.25	0.20	0.23
CV	23.2	11.2	14.4	16.5	10.2	23.1	24.0	48.4	18.3	22.6	21.1
Number Ratio	0.50	0.63	0.59	0.61	0.47	0.55	0.55	0.42	0.47	0.42	0.39

Year	2010	2011*	2012	2013	2014	2015	2016	2017	2018
Weight Ratio	0.19	0.24	0.39	0.35	0.41	0.34	0.23	0.21	0.10
CV	18.8	16.0	15.5	23.2	17.8	20.1	16.4	15.2	
Number Ratio	0.62	0.50	0.52	0.63	0.67	0.60	0.47	0.39	0.24

**All discard data revised in WG2011

*Data revised in WG2013

Table. 6.2.2(b) Four-spot megrim (*L. boscii*) in Divisions 8c9a. Discards in numbers at age (thousands) for Spanish trawlers

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	1289	1289	1289	1289	1289	1289	1289	1289	678	1289	1289
1	3322	3322	3322	3322	3322	3322	3322	3322	2741	3322	3322
2	4322	4322	4322	4322	4322	4322	4322	4322	4134	4322	4322
3	2211	2211	2211	2211	2211	2211	2211	2211	2710	2211	2211
4	605	605	605	605	605	605	605	605	581	605	605
5	94	94	94	94	94	94	94	94	189	94	94
6	20	20	20	20	20	20	20	20	55	20	20
7	4	4	4	4	4	4	4	4	11	4	4

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	256	1289	2933	354	208	208	238	33	10	1	100
1	3273	3322	3954	6148	5673	5673	4479	6393	3515	1233	3248
2	6099	4322	2734	1207	1750	1750	989	3053	5482	2497	4541
3	2108	2211	1815	1888	1025	1025	495	693	609	1445	757
4	146	605	1088	1218	477	477	50	163	183	486	105
5	90	94	3	171	67	67	2	27	56	168	44
6	3	20	0	12	4	4	0		23	22	7
7	0	4	1	2	1	1			6	9	1

	2008	2009	2010	2011*	2012	2013	2014	2015	2016	2017	2018
0	202	2	2879	30	682	275	0	157	2	0	0
1	2342	1525	10362	5132	5313	5499	5645	2437	1606	526	209
2	2374	2490	1301	3595	2480	4379	11089	7061	5506	2116	1066
3	1384	1970	696	544	1057	3030	2139	4588	785	2305	638
4	52	480	283	174	15	707	582	532	232	363	297
5	10	51	83	37	5	39	161	26	70	29	16
6	3	7	11	1	2	12	11	4	30	1	3
7	3		1		0	2	0	0	1	0	0

Table 6.2.3(a) Four-spot megrim (*L. boscii*) Divisions 8c and 9a. Annual length distributions in landings.

Length (cm)	Total
10	
11	
12	
13	
14	889
15	1886
16	5883
17	21796
18	107993
19	333221
20	654262
21	976855
22	1039881
23	864291
24	780965
25	575469
26	483653
27	307988
28	267224
29	184479
30	153060
31	93135
32	52118
33	26010
34	19157
35	7954
36	7847
37	3680
38	4672
39	832
40	899
41	908
42	72
43	45
44	
45	
46	
47	
48	
49	
50+	
Total	6977122

Table 6.2.3(b) Four-spot megrim (*L. boscii*) Divisions 8c and 9a.

Mean lengths and mean weights in landings since 1990

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Mean length (cm)	23.1	23.5	23.8	24.2	23.3	22.3	23	23.3	23.3	23.5	24.2	23.8	23.1	22.9	22.7
Mean weight (g)	116	118	122	128	111	96	107	112	109	113	121	114	105	101	98

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Mean length (cm)	22.7	22.9	23.5	23.6	23.6	24.1	23.7	23.7	23.9	24.2	24.1	24.2	23.7	24.0
Mean weight (g)	97.0	99.4	109.1	109.7	110.7	118.4	112.2	112.0	114.0	117.8	117.4	118.6	111.8	115.6

Table 6.2.4 Four-spot megrim (*L. boscii*) in Divisions 8c9a. Catch numbers at age.

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
0	1289	1289	1289	1289	1289	1289	1289	1289	678	1289	1289
1	3432	5605	4847	4055	4766	4482	4168	3868	2824	4743	3719
2	7797	15902	14414	11462	9506	8001	6989	6656	7049	6527	6458
3	5901	7284	7666	7603	4096	5539	6211	4307	7225	8349	3478
4	4545	4198	5384	6514	4434	2516	5784	4404	2849	6201	4419
5	1226	1438	2460	3573	2405	2744	2294	1245	1801	1150	1990
6	869	589	1181	1798	1403	1048	758	655	894	602	224
+gp	233	145	467	634	807	483	71	282	457	284	555
TOTALNUM	25292	36450	37708	36928	28706	26102	27564	22706	23777	29145	22132
TONSLAND	1408	2021	2586	3037	2354	2129	2353	1822	1920	2058	1466
SOPCOF %	100	100	100	100	100	99	103	99	100	100	100

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
0	256	1289	2933	354	208	208	238	33	10	1	100
1	3308	3367	3992	6193	5840	5863	4846	6785	3638	1267	3257
2	7343	5526	3895	1862	2888	4139	3791	5568	8004	5232	6147
3	4978	6447	4596	3533	2276	3386	3368	3777	3604	5951	3390
4	890	3545	4996	4000	2870	1220	1526	2602	2024	2639	2705
5	1714	792	1405	2020	1937	454	501	1155	1426	1156	1909
6	1069	849	235	797	941	240	447	279	802	274	855
+gp	443	353	489	840	358	360	142	337	399	228	461
TOTALNUM	20001	22168	22541	19599	17318	15870	14859	20536	19907	16748	18824
TONSLAND	1204	1501	1442	1414	1221	1028	1067	1354	1358	1427	1396
SOPCOF %	102	100	101	100	100	100	101	101	100	101	101

YEAR	*2008	2009	2010	2011**	2012**	2013**	2014	2015	2016	2017	2018
AGE											
0	202	2	2879	30	682	275	0	157	2	0	0
1	2357	1546	10377	5139	5342	5499	5646	2438	1610	527	209
2	3935	3136	2364	4397	3260	4919	11954	7412	6739	2458	1296
3	4879	4887	3568	2454	4101	4820	4249	7742	2844	4986	2050
4	2204	4640	3817	2833	1926	4113	3214	3622	2495	2469	2754
5	1003	1662	2529	2711	1620	1363	2983	1580	1936	1817	1388
6	354	640	496	1164	991	846	751	1105	1153	684	954
+gp	298	222	438	399	422	371	562	462	559	618	555
TOTALNUM	15232	16735	26468	19127	18344	22206	29359	24518	17338	13559	9206
TONSLAND	1182	1413	1562	1397	1321	1427	1942	1745	1419	1173	906
SOPCOF %	101	100	101	101	101	101	100	100	100	101	101

* Data revised in WG2010 from original value presented

** Data revised in WG2014 from original value presented

Table 6.2.5 Four-spot megrim (*L. boscii*) in Divisions 8c9a. Mean weights at age in Catchs (kg).

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
0	0.004	0.004	0.004	0.004	0.003	0.004	0.004	0.003	0.005	0.004	0.003
1	0.013	0.027	0.027	0.027	0.019	0.022	0.021	0.014	0.023	0.030	0.023
2	0.034	0.046	0.049	0.055	0.051	0.055	0.052	0.052	0.056	0.046	0.043
3	0.055	0.062	0.069	0.079	0.081	0.097	0.093	0.092	0.082	0.082	0.054
4	0.090	0.089	0.100	0.108	0.134	0.114	0.120	0.136	0.114	0.096	0.106
5	0.129	0.125	0.138	0.144	0.154	0.164	0.159	0.174	0.148	0.143	0.135
6	0.159	0.151	0.167	0.167	0.183	0.190	0.225	0.218	0.178	0.168	0.209
+gp	0.263	0.239	0.280	0.275	0.272	0.263	0.351	0.295	0.243	0.255	0.231
SOPCOFAC	1.0014	1.0022	1.0034	0.9996	1.0009	0.9930	1.0284	0.9892	1.0015	0.9963	0.9993

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
0	0.004	0.004	0.006	0.006	0.004	0.006	0.008	0.006	0.0060	0.006	0.005
1	0.016	0.019	0.018	0.023	0.024	0.024	0.025	0.027	0.021	0.023	0.022
2	0.030	0.040	0.045	0.057	0.050	0.057	0.066	0.053	0.050	0.06	0.045
3	0.063	0.073	0.072	0.066	0.073	0.090	0.088	0.081	0.083	0.091	0.079
4	0.091	0.105	0.090	0.087	0.099	0.109	0.123	0.108	0.108	0.104	0.114
5	0.123	0.137	0.147	0.126	0.122	0.163	0.142	0.131	0.122	0.136	0.123
6	0.180	0.179	0.197	0.169	0.166	0.209	0.201	0.175	0.132	0.176	0.152
+gp	0.252	0.293	0.268	0.228	0.255	0.247	0.247	0.235	0.197	0.233	0.198
SOPCOFAC	1.0171	1.0027	1.009	1.001	1.0012	0.9993	1.0129	1.0069	1.0038	1.0066	1.0109

YEAR	*2008	2009	2010	2011**	2012**	2013**	2014	2015	2016	2017	2018
AGE											
0	0.005	0.004	0.004	0.003	0.009	0.004	0.002	0.008	0.004	0.001	0.001
1	0.017	0.025	0.012	0.02	0.033	0.017	0.024	0.026	0.022	0.029	0.013
2	0.053	0.045	0.056	0.039	0.052	0.045	0.044	0.04	0.048	0.044	0.041
3	0.079	0.069	0.084	0.078	0.076	0.063	0.071	0.066	0.086	0.067	0.068
4	0.112	0.104	0.108	0.099	0.105	0.099	0.101	0.099	0.107	0.096	0.093
5	0.151	0.142	0.141	0.128	0.127	0.131	0.133	0.136	0.13	0.126	0.126
6	0.201	0.175	0.182	0.168	0.159	0.159	0.165	0.172	0.149	0.164	0.156
+gp	0.235	0.288	0.271	0.24	0.199	0.21	0.222	0.23	0.217	0.212	0.224
SOPCOFAC	1.0063	1.0011	1.0104	1.009	1.006	1.0065	1.0046	1.0018	1.0032	1.0054	1.0073

* Data revised in WG2010 from original value presented

** Data revised in WG2014 from original value presented

Table 6.2.6 Four-spot megrim (*L. boscii*) Divisions 8c9a

. **Abundance and Recruitment indices of Portuguese and Spanish surveys.**

	Biomass Index						Abundance index					Recruitment index		
												At age 1	At age 0	At age 1
	Portugal (k/h)			Spain (k/30 min)			Portugal (n/h)		Spain (n/30 min)			Portugal (n)	Spain (n/30 min)	
	October	Crustacean	SE	Mean	SE		Crustacean	SE	Mean	SE		October		
1983				0.67	0.13	1983			11.80	1.80	1983		0.98	5.74
1984				0.76	0.08	1984			15.80	2.00	1984		1.80	7.83
1985				0.71	0.11	1985			14.00	1.74	1985		0.15	7.45
1986				1.68	0.28	1986			32.60	3.82	1986		2.99	16.36
1987				ns	-	1987			ns	-	1987		ns	ns
1988				3.10	0.33	1988			59.20	6.49	1988		2.90	24.64
1989				1.97	0.28	1989			40.75	6.24	1989		8.49	16.68
1990	0.26			1.93	0.14	1990			40.30	3.00	1990	153	0.44	19.06
1991	0.18			1.67	0.17	1991			27.70	2.62	1991	26	2.53	9.25
1992	0.14			1.98	0.20	1992			49.10	5.20	1992	42	2.37	35.00
1993	0.11			2.07	0.25	1993			43.30	5.39	1993	8	0.30	21.38
1994	0.16			1.82	0.23	1994			26.90	3.63	1994	2	3.48	2.94
1995	0.08			1.51	0.12	1995			32.30	2.78	1995	4	1.92	19.58
^1996	0.10			2.00	0.19	^1996			44.80	4.05	^1996	16	3.57	20.56
1997	0.06	2.97	1.31	2.17	0.22	1997	31.57	15.52	43.50	3.84	1997	1	3.54	13.34
1998	0.04	2.66	0.87	1.80	0.20	1998	26.46	10.68	34.30	4.45	1998	+	0.27	9.57
^<1999	+	0.04	0.02	1.93	0.24	^<1999	1.23	1.07	29.30	3.22	^<1999	+	0.94	7.46
2000	0.08	2.18	0.84	1.89	0.28	2000	20.61	8.47	33.00	4.56	2000	16	1.07	13.96
2001	0.09	1.72	0.75	2.65	0.25	2001	17.17	7.08	42.70	3.35	2001	25	0.59	16.95
2002	0.02	2.78	1.02	2.21	0.22	2002	40.61	13.69	34.60	3.33	2002	1	1.04	9.95
^2003	1.36	3.65	1.20	1.32	0.16	^2003	60.80	20.97	16.90	1.54	^2003	8	0.65	4.95
^2004	1.27	ns		2.40	0.24	^2004	ns		43.94	3.71	^2004	5	1.19	21.10
2005	0.05	2.62	0.85	3.84	0.41	2005	34.51	12.03	62.89	6.16	2005	+	4.71	17.70
2006	0.10	1.63	0.56	2.56	0.24	2006	19.89	6.49	41.47	3.02	2006		0.59	14.70
2007	0.14	2.20	0.70	3.75	0.35	2007	32.30	11.30	51.10	4.30	2007		0.88	11.30
2008	0.07	2.50	0.87	2.08	0.22	2008	26.27	9.60	32.20	3.00	2008		0.37	8.13
2009	0.06	*1.50	0.65	3.96	0.32	2009	*12.22	5.88	52.83	3.97	2009		3.37	7.42
2010	0.03	4.03	1.44	4.04	0.38	2010	63.78	22.64	72.75	6.82	2010		0.65	34.22
2011	0.14	4.55	1.78	4.64	0.39	2011	68.56	26.34	69.26	5.72	2011		0.91	8.90
2012	ns	ns	ns	5.92	0.47	2012	ns	ns	82.14	5.98	2012		1.71	11.58
**2013	0.10	1.45	0.51	8.17	1.13	2013	23.81	8.02	119.99	17.48	2013		1.32	25.86
2014	0.12	1.40	0.56	4.75	0.28	2014	20.31	8.18	67.42	3.72	2014		3.72	12.32
2015	0.13	1.66	0.52	4.62	0.48	2015	27.29	8.25	78.00	7.47	2015		1.12	33.18
2016	0.12	1.80	0.65	4.84	0.32	2016	35.62	12.16	86.70	5.19	2016		2.43	18.06
2017	0.22	1.91	0.74	6.21	0.96	2017	37.79	14.77	111.24	13.61	2017		1.03	23.69
2018	0.11	3.59	1.70	5.35	0.45	2018	57.65	27.61	88.04	7.05	2018		0.46	6.36

+ less than 0.04
ns no survey
^ Portuguese October Survey with different vessel and gear (Capricórnio and CAR net)
< Portuguese Crustacean Survey covers partial area only with a different Vessel (Mestre Costeiro)
* Revised in WGHMM2011
** From 2013 new vessel for Spanish survey (Miguel Oliver)

Table 6.2.7 Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Tuning data

FLT01: SP-LCGOTBDEF1. 1000 Days by 100 HP (thousand)

1986	1999									
1	1	0	1							
1	7								Eff.	
10		98	376	337	251	95	30	13	7.1	1986
10		473	963	565	318	97	31	16	12.7	1987
10		35	202	200	163	76	30	19	11.3	1988
10		11	86	126	136	83	39	22	11.9	1989
10		5	104	60	174	105	73	38	8.8	1990
10		10	89	145	93	189	80	41	9.6	1991
10		0.4	20	100	168	105	39	2	10.2	1992
10		0.1	37	98	227	85	46	17	7.1	1993
10		0	62	208	169	156	87	46	8.5	1994
10		1	33	278	301	124	83	24	13.4	1995
10		1	33	34	222	133	20	51	11.0	1996
10		0.4	23	111	40	143	125	59	12.5	1997
10		0.3	82	420	350	98	127	62	8.2	1998
10		0.3	62	210	331	165	33	45	8.8	1999

FLT02: SP-LCGOTBDEF2. 1000 Days by 100 HP (thousand)

2000	2018									
1	1	0	1							
1	7								Eff.	
10		0.4	70	144	349	303	164	153	10.5	2000
10		14	148	219	475	436	242	83	12.1	2001
10		7	126	214	91	66	45	70	11.0	2002
10		19	287	363	214	75	67	22	10.2	2003
10		29	341	496	440	219	60	81	7.0	2004
10		10	248	383	253	196	114	68	7.1	2005
10		7	364	625	305	151	41	40	7.8	2006
10		2	261	403	415	298	143	82	7.3	2007
10		3	313	727	481	227	88	81	9.0	2008
10		8	145	524	640	226	87	34	8.0	2009
10		0.1	146	520	743	616	132	105	5.8	2010
10		0	48	224	424	594	323	133	5.1	2011
10		1	107	719	562	505	302	123	7.6	2012
10		0	87	336	806	313	170	65	10.8	2013
10		0.1	119	332	427	431	99	55	13.4	2014
10		0.1	67	619	625	322	218	80	9.8	2015
10		0.1	244	402	449	383	230	117	10.6	2016
10		0.1	77	641	494	417	154	132	8.7	2017
10		0.2	87	530	821	392	238	118	8.1	2018

FLT03: SP-NSGFS-Q4 (n/30 min)

1988	2018									
1	1	0.75	0.83							
0	7								Eff.	
1	2.9	24.6	20.6	7.3	1.9	1.1	0.4	0.3	101	1988
1	8.5	16.7	8.4	3.6	2.1	1.1	0.3	0.1	91	1989
1	0.4	19.1	13.0	2.2	2.8	1.6	0.7	0.4	120	1990
1	2.5	9.3	9.3	3.7	1.6	1.0	0.2	0.1	107	1991
1	2.4	35.0	4.1	4.1	2.1	1.0	0.4	0.0	116	1992
1	0.3	21.4	16.7	2.3	1.5	0.5	0.4	0.2	109	1993
1	3.5	2.9	11.2	6.3	1.5	0.7	0.4	0.4	118	1994
1	1.9	19.6	2.4	4.4	3.2	0.3	0.2	0.2	116	1995
1	3.6	20.6	14.4	1.4	1.9	2.4	0.3	0.3	114	1996
1	3.5	13.3	14.0	8.7	1.1	1.5	1.0	0.3	116	1997
1	0.3	9.6	10.0	9.2	3.6	0.7	0.8	0.3	114	1998
1	0.9	7.5	10.9	6.0	2.9	1.0	0.2	0.3	116	1999
1	1.1	14.0	5.4	5.2	4.1	1.7	0.6	0.9	113	2000
1	0.6	17.0	12.7	4.7	3.8	2.2	1.0	0.7	113	2001
1	1.0	10.0	12.7	7.4	1.8	0.7	0.3	0.6	110	2002
0	0.7	5.0	4.1	4.1	1.7	0.6	0.5	0.3	112	2003
1	1.2	21.1	11.3	6.1	2.7	0.8	0.2	0.5	114	2004
1	4.7	17.7	22.4	11.2	4.0	1.6	0.6	0.7	116	2005
1	0.6	14.7	13.3	8.2	2.5	1.0	0.5	0.6	115	2006
1	0.9	11.3	21.3	10.2	4.9	1.4	0.7	0.3	117	2007
1	0.4	8.1	11.7	7.9	2.6	0.8	0.5	0.3	115	2008
1	3.4	7.4	13.6	14.1	9.6	3.1	1.1	0.5	117	2009
1	0.6	34.2	16.6	10.8	7.2	2.2	0.5	0.6	114	2010
1	0.9	8.9	33.8	13.8	7.7	2.8	0.9	0.5	111	2011
1	1.7	11.6	22.1	31.1	9.6	3.4	1.7	1.0	115	2012
0	1.3	25.9	29.6	35.7	21.1	3.9	1.5	1.0	114	2013
1	3.7	12.3	21.8	12.1	7.6	8.0	1.1	0.7	116	2014
1	1.1	33.2	14.3	15.9	7.6	3.3	1.9	0.7	114	2015
1	2.4	18.1	45.4	10.6	4.3	2.8	2.0	1.1	114	2016
1	1.0	23.7	31.2	40.1	8.38	4.31	1.17	1.29	112	2017
1	0.5	6.4	32.1	22.4	19.3	3.7	2.6	1.0	113	2018

Table 6.2.8 Four-spot megrim (*L. boscii*). LPUE data by fleet in Divisions 8c9a.

	SP-LCGOTBDEF			SP-AVSOTBDEF***			Portugal trawl in 9a		
Year	Landings (t)	Effort	LPUE [1]	Landings (t)	Effort	LPUE [1]	Landings (t)	Effort	LPUE [2]
1986	69.0	7.1	9.8	26.5	3.9	6.8			
1987	189.8	12.7	14.9	30.7	3.0	10.4			
1988	78.6	11.3	7.0	47.3	3.4	14.0	146	38.5	3.8
1989	72.9	11.9	6.2	36.1	3.3	10.9	183	44.7	4.1
1990	68.8	8.8	7.8	63.8	3.2	19.7	164	39.0	4.2
1991	94.0	9.6	9.8	42.1	3.5	12.2	166	45.0	3.7
1992	67.2	10.2	6.6	35.2	2.3	15.5	280	50.9	5.5
1993	55.2	7.1	7.8	38.9	2.4	16.1	180	44.2	4.1
1994	90.8	8.5	10.6	63.7	4.5	14.0	146	45.8	3.2
1995	147.6	13.4	11.0	85.9	3.5	24.7	121	37.0	3.3
1996	78.7	11.0	7.2	37.1	2.3	16.4	155	46.5	3.3
1997	99.0	12.5	7.9	49.5	2.6	18.7	76	33.4	2.3
1998	117.4	8.2	14.4	56.2	5.1	11.0	83	43.1	1.9
1999	103.9	8.8	11.7	55.9	4.9	11.3	73	25.3	2.9
2000	172.3	10.5	16.4	34.1	2.5	13.8	93	27.0	3.4
2001	245.0	12.1	20.2	16.5	1.3	12.5	89	43.1	2.1
2002	143.8	11.0	13.0	22.5	2.0	11.3	97	31.2	3.1
2003	118.7	10.2	11.6	12.4	2.2	5.7	117	40.5	2.9
2004	127.3	7.0	18.2	23.5	1.6	14.8	111	35.4	3.1
2005	96.0	7.1	13.6	45.0	3.0	15.2	140	42.6	3.3
2006	123.5	7.8	15.9	32.3	2.8	11.6	149	40.3	3.7
2007*	130.5	7.3	17.9	19.9	2.2	8.9	165	43.8	3.8
2008*	196.8	9.0	22.0	14.5	2.0	7.2	146	38.4	3.8
2009	138.8	8.0	17.3	42.0	2.3	18.5	183	49.3	3.7
2010	170.7	5.8	29.3	51.1	2.0	25.4	150	48.0	3.1
2011	126.9	5.1	24.8	43.1	2.2	19.6	134	49.4	2.7
2012	127.8	7.6	16.7	11.1	2.6	4.3	78	30.9	2.5
2013**	212.8	10.8	19.8	19.5	1.5	13.2	59	28.0	2.1
2014	220.8	13.4	16.5	31.9	3.0	10.7	120	49.2	2.4
2015	219.1	9.8	22.5	13.8	1.8	7.5	109	17.7	6.1
2016	233.8	10.6	22.0				84.9	16.4	5.2
2017	183.0	8.7	20.9				117.6	15.4	7.6
2018	187.5	8.1	23.0				108.5	7.9	13.8

[1] LPUE as catch (kg) per fishing day per 100 HP
[2] LPUE as catch (kg) per hour
* Effort from Portuguese trawl revised in WG2010 from original value presented
** Effort from SP-LCGOTBDEF and SP-AVSOTBDEF revised in WG2015 from original value presented
*** Sampling suspended in 2015

Table 6.2.9. Four-spot megrim (*L.boscii*) in Divisions 8c and 9a. Tuning diagnostic.

Lowestoft VPA Version 3.1

30/04/2019 12:10

Extended Survivors Analysis

Four spot megrim (L. boscii) Divisions 27.7.8c and 27.7.9a

CPUE data from file fleetb.txt

Catch data for 33 years. 1986 to 2018. Ages 0 to 7.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SP-LCGOTBDEF1	1986	2018	3	6	0	1
SP-LCGOTBDEF2	2000	2018	3	6	0	1
SP-GFS	1988	2018	0	6	0.75	0.83

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 5

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 33 iterations

Regression weights

	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0	0	0.066	0.001	0.011	0.006	0	0.003	0	0	0
1	0.078	0.248	0.160	0.164	0.114	0.169	0.045	0.043	0.011	0.015
2	0.161	0.165	0.157	0.145	0.224	0.388	0.349	0.167	0.087	0.033
3	0.276	0.279	0.257	0.216	0.330	0.308	0.471	0.218	0.179	0.097
4	0.458	0.362	0.373	0.330	0.350	0.383	0.472	0.27	0.298	0.142
5	1	0	0	0	0	0	0	0.5	0.323	0.272
6	0	0	0	0	0	0	0	0.427	0.329	0.28

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6
2009	63800	22700	23300	22400	13900	4070	2020
2010	50000	52200	17200	16200	13900	7220	1830
2011	47600	38400	33400	12000	10000	7920	3620
2012	69400	38900	26800	23300	7570	5660	4030
2013	49400	56200	27000	19000	15400	4450	3170
2014	75500	40200	41000	17700	11200	8880	2410
2015	51200	61900	27800	22800	10600	6220	4570
2016	66700	41800	48400	16100	11700	5430	3670
2017	18500	54600	32800	33600	10600	7280	2700
2018	14400	15100	44300	24600	23000	6440	4320

Estimated population abundance at 1st Jan 2019

0	11800	12200	35100	18300	16300	4010

Taper weighted geometric mean of the VPA populations:

43800	37000	27500	16700	9130	4180	1830

Standard error of the weighted Log(VPA populations) :

0.3891	0.3512	0.3642	0.3727	0.43	0.4495	0.5431

Log catchability residuals.

Fleet : SP-LCGOTBDEF1

Age	1986	1987	1988
0	No data for this fleet at this age		
1	No data for this fleet at this age		
2	No data for this fleet at this age		
3	0.56	0.87	-0.09
4	0.3	0.28	-0.6
5	0.06	-0.25	-0.83
6	-0.28	-0.17	-0.41

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.41	-0.76	-0.19	-0.46	-0.03	-0.1	0.37	-0.56	-0.31	0.7
4	-0.54	-0.2	-0.58	-0.08	0.32	0.49	0.13	0.05	-0.46	0.64
5	-0.85	-0.19	0.42	-0.02	-0.24	0.53	0.79	-0.33	-0.06	0.77
6	-0.24	0.14	0.79	0.03	0.32	0.69	0.99	-0.08	0.33	0.54

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	0.41	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	0.27	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	0.18	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	0.61	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6
Mean Log q	-6.7076	-5.8404	-5.4023	-5.4023
S.E(Log q)	0.5012	0.4158	0.5121	0.5044

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	0.57	2.064	8.03	0.66	14	0.26	-6.71
4	0.95	0.178	6	0.53	14	0.41	-5.84
5	-29.32	-4.671	91.97	0	14	9.31	-5.4
6	1.17	-0.537	4.81	0.45	14	0.53	-5.17
1							

Fleet : SP-LCGOTBDEF2

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	99.99	-0.56	0.38	-0.23	0.24	0.47	0.14	0.55	0.21	0.21
4	99.99	0	0.81	-0.44	-0.33	0.44	-0.28	-0.14	0.2	0.28
5	99.99	-0.19	1.01	-0.61	-0.21	-0.02	0.22	-0.49	0.37	-0.05
6	99.99	0.2	0.26	-0.3	0.05	0.26	0.09	-0.53	0.17	-0.04

Age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.11	0.21	-0.35	0.14	-0.37	-0.32	0.12	-0.07	-0.36	-0.28
4	-0.03	0.08	-0.16	0.39	0.04	-0.25	0.21	-0.29	-0.09	-0.43
5	-0.09	0.3	0.16	0.29	0.06	-0.28	-0.28	0.11	-0.18	-0.13
6	-0.41	0.07	0.32	0.09	-0.24	-0.47	-0.37	-0.03	-0.17	-0.24

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6
Mean Log q	-5.7136	-5.0363	-4.7345	-4.7345
S.E(Log q)	0.3207	0.3278	0.3595	0.2763

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.25	-1.05	4.72	0.51	19	0.4	-5.71
4	1.16	-0.812	4.37	0.59	19	0.39	-5.04
5	0.94	0.362	4.96	0.68	19	0.35	-4.73
6	1	-0.016	4.8	0.81	19	0.28	-4.8

Fleet : SP-GFS

Age		1986	1987	1988
	0	99.99	99.99	0.48
	1	99.99	99.99	0.4
	2	99.99	99.99	0.1
	3	99.99	99.99	-0.38
	4	99.99	99.99	-1.11
	5	99.99	99.99	-0.5
	6	99.99	99.99	-0.01

Age		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	0	1.62	-1.05	0.24	0.25	-1.11	0.83	0.03	0.98	1.3	-0.88
	1	-0.11	0.11	-0.29	0.52	0.1	-1.13	0.25	0.05	-0.03	0
	2	-0.39	-0.22	-0.48	-0.91	-0.2	-0.5	-1	0.03	-0.29	-0.25
	3	-0.92	-1.06	-0.87	-0.61	-0.76	-0.6	-0.73	-0.6	0.15	-0.13
	4	-0.65	-0.35	-0.71	-0.37	-0.64	-0.23	-0.42	-0.74	-0.13	0.02
	5	-0.62	0.21	-0.13	-0.05	-0.84	-0.25	-0.48	0.1	-0.15	0.39
	6	-0.08	0.2	-0.35	0.02	0.06	0.05	-0.34	0.06	-0.06	-0.02

Age		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	0	-0.14	-0.07	-0.7	-0.2	99.99	0.01	1.03	-1.03	-0.32	-0.88
	1	0.28	0.38	0.47	-0.1	99.99	0.3	0.39	-0.24	-0.43	-0.45
	2	0.22	0.03	0.34	0.28	99.99	0.02	0.52	0.21	0.14	-0.44
	3	-0.16	0.13	0.55	0.4	99.99	0.08	0.59	0.26	0.52	-0.36
	4	-0.5	0.39	0.86	0.4	99.99	0.11	0.29	-0.21	0.51	-0.25
	5	-0.53	-0.25	1.08	-0.12	99.99	-0.49	0.64	-0.42	0.27	-0.68
	6	-0.17	-0.25	-0.09	-0.07	99.99	-0.21	0.07	0.21	0.1	-0.1

Age		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	0	0.5	-0.85	-0.52	-0.25	99.99	0.43	-0.38	0.13	0.55	0
	1	-0.24	0.59	-0.52	-0.27	99.99	-0.23	0.23	0.01	-0.01	-0.04
	2	0.03	0.53	0.58	0.36	99.99	0.11	0.05	0.51	0.46	0.14
	3	0.22	0.28	0.81	0.92	99.99	0.33	0.48	0.22	0.79	0.45
	4	0.48	0.12	0.53	0.99	99.99	0.42	0.54	-0.28	0.5	0.44
	5	0.79	-0.22	-0.08	0.36	99.99	0.85	0.2	0.33	0.32	0.26
	6	0.29	-0.39	-0.49	0	99.99	0.17	-0.02	0.3	0.01	0.3

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	0	1	2	3	4	5	6
Mean Log q	-10.1904	-7.5653	-7.1886	-7.2152	-7.247	-7.3367	-7.3367
S.E(Log q)	0.7301	0.3727	0.4114	0.5754	0.5301	0.4863	0.208

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
0	0.73	1.066	10.32	0.37	29	0.53	-10.19
1	0.81	1.127	8.11	0.57	29	0.3	-7.57
2	0.94	0.304	7.38	0.47	29	0.39	-7.19
3	1.07	-0.218	7.05	0.28	29	0.63	-7.22
4	1.31	-1.029	6.68	0.29	29	0.69	-7.25
5	0.92	0.413	7.42	0.48	29	0.45	-7.34
6	0.94	0.984	7.38	0.9	29	0.19	-7.36
1							

Terminal year survivor and F summaries :

Age 0 Catchability constant w.r.t. time and dependent on age

Year class = 2018

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF1	1	0	0	0	0	0	0
SP-LCGOTBDEF2	1	0	0	0	0	0	0
SP-GFS	11753	0.743	0	0	1	1	0
F shrinkage mean	0	1.5				0	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
11753	0.74	0	1	0	0

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2017

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF1	1	0	0	0	0	0	0
SP-LCGOTBDEF2	1	0	0	0	0	0	0
SP-GFS	13260	0.338	0.24	0.71	2	0.951	0.014
F shrinkage mean	2377	1.5				0.049	0.077

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12191	0.33	0.32	3	0.958	0.015

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2016

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF1	1	0	0	0	0	0	0
SP-LCGOTBDEF2	1	0	0	0	0	0	0
SP-GFS	37515	0.263	0.054	0.2	3	0.969	0.031
F shrinkage mean	4239	1.5				0.031	0.244

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
35068	0.26	0.23	4	0.872	0.033

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2015

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF1	1	0	0	0	0	0	0
SP-LCGOTBDEF2	13848	0.329	0	0	1	0.361	0.126
SP-GFS	22355	0.24	0.165	0.69	4	0.62	0.08
F shrinkage mean	5242	1.5				0.019	0.303

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
18291	0.19	0.16	6	0.849	0.097

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2014

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF1	1	0	0	0	0	0	0
SP-LCGOTBDEF2	10994	0.236	0.035	0.15	2	0.503	0.204
SP-GFS	25457	0.222	0.091	0.41	5	0.481	0.093
F shrinkage mean	5810	1.5				0.016	0.357

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
16309	0.16	0.17	8	1.066	0.142

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2013

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF1	1	0	0	0	0	0	0
SP-LCGOTBDEF2	3628	0.203	0.019	0.09	3	0.584	0.297
SP-GFS	4752	0.225	0.119	0.53	5	0.399	0.235
F shrinkage mean	2488	1.5				0.018	0.409

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4013	0.15	0.07	9	0.495	0.272

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2012

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF1	1	0	0	0	0	0	0
SP-LCGOTBDEF2	2216	0.177	0.072	0.4	4	0.56	0.329
SP-GFS	3361	0.207	0.089	0.43	6	0.427	0.229
F shrinkage mean	4627	1.5				0.013	0.171

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2673	0.13	0.08	11	0.63	0.28

Table 6.2.10 Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Estimates of fishing mortality at age.

Run title : Four spot megrim (L. boscii) Divisions 27.7.8c and 27.7.9a

At 30/04/2019 12:13

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988
AGE			
0	0.02	0.0276	0.0253
1	0.064	0.1136	0.1377
2	0.2431	0.4685	0.4747
3	0.3788	0.3769	0.4336
4	0.7234	0.5112	0.5333
5	0.6292	0.5279	0.6493
6	1.0242	0.7217	1.1957
+gp	1.0242	0.7217	1.1957
0 FBAR 2	0.4484	0.4522	0.4805

Table 8 Fishing mortality (F) at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
0	0.027	0.036	0.0228	0.0245	0.0495	0.0158	0.0242	0.0338	0.0094	0.0688
1	0.1035	0.1317	0.169	0.0955	0.0955	0.146	0.1458	0.0904	0.114	0.1642
2	0.5559	0.3745	0.3407	0.4319	0.2174	0.2524	0.5864	0.3025	0.2591	0.2828
3	0.4966	0.3923	0.3905	0.486	0.522	0.3884	0.5368	0.7321	0.4044	0.3815
4	0.8288	0.6126	0.447	0.9399	0.7808	0.8068	0.6884	0.6149	0.4115	0.5683
5	0.8464	0.8722	1.0187	0.9879	0.5277	0.894	0.9459	0.4914	0.5149	0.806
6	1.6931	1.0174	1.3509	0.909	0.8863	0.9406	0.8914	0.4696	0.5385	0.5233
+gp	1.6931	1.0174	1.3509	0.909	0.8863	0.9406	0.8914	0.4696	0.5385	0.5233
FBAR 2- 4	0.6271	0.4598	0.3927	0.6193	0.5067	0.4825	0.6039	0.5498	0.3583	0.4109

Table 8 Fishing mortality (F) at age

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
0	0.0934	0.0109	0.0062	0.0058	0.0052	0.001	0.0002	0	0.0029	0.008
1	0.3137	0.2911	0.2503	0.2414	0.1803	0.1993	0.143	0.033	0.089	0.0877
2	0.2905	0.2356	0.2138	0.2826	0.2429	0.3247	0.3823	0.3147	0.2215	0.1477
3	0.4035	0.4676	0.5052	0.4175	0.3925	0.4073	0.3614	0.5496	0.3463	0.275
4	0.5792	0.7516	0.8953	0.5627	0.3357	0.6044	0.399	0.4933	0.5221	0.3985
5	0.4627	0.4901	1.0868	0.3282	0.4763	0.4602	0.8112	0.4187	0.8288	0.3718
6	0.596	0.5237	0.4461	0.3529	0.6295	0.5361	0.6844	0.3474	0.6343	0.3458
+gp	0.596	0.5237	0.4461	0.3529	0.6295	0.5361	0.6844	0.3474	0.6343	0.3458
FBAR 2- 4	0.4244	0.4849	0.5381	0.421	0.3237	0.4455	0.3809	0.4526	0.3633	0.2737

Table 8 Fishing mortality (F) at age

YEAR	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	FBAR 16-18
AGE											
0	0	0.0657	0.0007	0.0109	0.0062	0	0.0034	0	0	0	0
1	0.0781	0.248	0.1603	0.1644	0.1144	0.1685	0.0445	0.0435	0.0107	0.0154	0.0232
2	0.1612	0.1646	0.1575	0.1447	0.2244	0.3884	0.3487	0.167	0.0865	0.0329	0.0955
3	0.2764	0.2786	0.2573	0.216	0.33	0.3085	0.4707	0.2175	0.1794	0.0966	0.1645
4	0.4584	0.362	0.3733	0.3303	0.3501	0.3834	0.4719	0.27	0.298	0.1422	0.2367
5	0.5995	0.4895	0.4754	0.3799	0.413	0.4641	0.3292	0.5004	0.3226	0.2723	0.3651
6	0.4322	0.3557	0.4386	0.3171	0.3492	0.4217	0.3109	0.427	0.3288	0.2799	0.3452
+gp	0.4322	0.3557	0.4386	0.3171	0.3492	0.4217	0.3109	0.427	0.3288	0.2799	0.3452
FBAR 2- 4	0.2987	0.2684	0.2627	0.2303	0.3015	0.3601	0.4304	0.2182	0.188	0.0906	

Table 6.2.11 Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Estimates of stock numbers at age.

Run title : Four spot megrim (L. boscii) Divisions 27.7.8c and 27.7.9a

At 30/04/2019 12:13

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1986	1987	1988
AGE			
0	71873	52282	57073
1	61179	57679	41638
2	39926	46984	42152
3	20681	25634	24078
4	9756	11593	14396
5	2902	3875	5693
6	1498	1266	1871
+gp	394	308	725
TOTAL	208210	199619	187626

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
0	53544	40326	63225	58745	29491	47938	59485	42875	30298	21439
1	45561	42672	31850	50598	46930	22978	38635	47536	33937	24575
2	29705	33633	30624	22021	37655	34923	16258	27340	35554	24792
3	21468	13949	18935	17833	11705	24806	22214	7405	16540	22465
4	12777	10697	7714	10491	8981	5686	13772	10633	2916	9038
5	6915	4567	4746	4039	3356	3368	2078	5665	4707	1582
6	2435	2429	1563	1403	1231	1621	1128	661	2837	2303
+gp	835	1372	704	129	522	815	523	1621	1163	948
TOTAL	173240	149645	159361	165260	139870	142135	154093	143735	127953	107141

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
0	36342	35990	37131	39878	50960	36894	52721	51640	38014	27990
1	16386	27100	29146	30212	32461	41507	30177	43155	42278	31033
2	17073	9804	16584	18578	19430	22192	27844	21415	34186	31668
3	15298	10454	6342	10965	11466	12478	13131	15554	12799	22427
4	12559	8366	5362	3133	5913	6340	6798	7490	7350	7411
5	4192	5762	3230	1793	1461	3461	2836	3735	3744	3570
6	578	2161	2890	892	1058	743	1788	1032	2012	1338
+gp	1190	2254	1089	1328	332	888	878	852	1072	1118
TOTAL	103619	101891	101775	106780	123081	124503	136174	144873	141455	126556

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	GM 90-16
AGE												
0	63768	50025	47591	69411	49438	75544	51233	66747	18468	14355	0	45233
1	22734	52207	38352	38937	56212	40228	61850	41804	54646	15121	11753	
2	23275	17214	33354	26750	27046	41047	27827	48433	32769	44263	12191	
3	22367	16218	11954	23329	18951	17692	22790	16076	33556	24605	35068	
4	13947	13890	10050	7567	15390	11155	10641	11654	10589	22962	18291	
5	4074	7220	7919	5665	4453	8878	6225	5434	7284	6435	16309	
6	2015	1831	3623	4030	3172	2412	4570	3667	2698	4319	4013	
+gp	693	1605	1231	1704	1381	1790	1898	1762	2420	2497	4219	
TOTAL	152872	160211	154075	177395	176043	198746	187033	195577	162429	134557	101843	

Table 6.2.12 Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Summary of landings and XSA results.

Run title : Four spot megrim (L. boscii) Divisions 27.7.8c and 27.7.9a

At 30/04/2019 12:13

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 4
1986	71873	5172	4294	1408	0.3279	0.4484
1987	52282	7298	6027	2021	0.3353	0.4522
1988	57073	7820	6732	2586	0.3841	0.4805
1989	53544	7786	6725	3037	0.4516	0.6271
1990	40326	6731	5957	2354	0.3952	0.4598
1991	63225	6615	5747	2129	0.3705	0.3927
1992	58745	6363	5428	2353	0.4335	0.6193
1993	29491	6008	5305	1822	0.3434	0.5067
1994	47938	6391	5572	1920	0.3446	0.4825
1995	59485	5909	4977	2058	0.4135	0.6039
1996	42875	5202	4393	1466	0.3337	0.5498
1997	30298	4421	3872	1204	0.3109	0.3583
1998	21439	5040	4546	1501	0.3301	0.4109
1999	36342	4562	4059	1442	0.3552	0.4244
2000	35990	4421	3818	1414	0.3703	0.4849
2001	37131	3823	3224	1221	0.3787	0.5381
2002	39878	4158	3412	1028	0.3013	0.421
2003	50960	4740	3750	1067	0.2845	0.3237
2004	36894	5006	4078	1354	0.332	0.4455
2005	52721	4921	4085	1358	0.3324	0.3809
2006	51640	5670	4683	1427	0.3047	0.4526
2007	38014	5486	4623	1396	0.3019	0.3633
2008	27990	6019	5345	1182	0.2211	0.2737
2009	63768	5995	5277	1413	0.2678	0.2987
2010	50025	6439	5767	1562	0.2709	0.2684
2011	47591	6056	5348	1397	0.2612	0.2627
2012	69411	7568	6109	1321	0.2162	0.2303
2013	49438	6466	5616	1427	0.2541	0.3015
2014	75544	7282	6394	1942	0.3037	0.3601
2015	51233	7758	6413	1745	0.2721	0.4304
2016	66747	7776	6716	1419	0.2113	0.2182
2017	18468	8183	7172	1173	0.1636	0.188
2018	14355	7878	7450	906	0.1216	0.0906
Arith. Mean	46750	6090	5240	1608	0.3121	0.3985
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.2.13 Four-spot megrim (*L. boscii*) in Divisions 8c and 9a.

Prediction with management option table: Input data

MFDP version 1a
Run: ldb
Time and date: 14:55 30/04/2019
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

2019 Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. Spaw.	Prop. of M bef. Spaw.	Weight in Stock	Exploit pattern	Weight LWt	Exploit pattern	Weight DWt
0	45233	0.2	0	0	0	0.003	0.0000	0.002	0.0003	0.003
1	37033	0.2	0.55	0	0	0.023	0.0000	0.034	0.0330	0.023
2	12191	0.2	0.86	0	0	0.043	0.0104	0.067	0.1048	0.040
3	35068	0.2	0.97	0	0	0.072	0.0860	0.085	0.0785	0.054
4	18291	0.2	0.99	0	0	0.099	0.1861	0.104	0.0309	0.067
5	16309	0.2	1	0	0	0.130	0.2912	0.131	0.0090	0.091
6	4013	0.2	1	0	0	0.161	0.2845	0.161	0.0032	0.113
7	4219	0.2	1	0	0	0.221	0.2875	0.221	0.0002	0.069

2020 Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. Spaw.	Prop. of M bef. Spaw.	Weight in Stock	Exploit pattern	Weight LWt	Exploit pattern	Weight DWt
0	45233	0.2	0	0	0	0.003	0.0000	0.002	0.0003	0.003
1		0.2	0.55	0	0	0.023	0.0000	0.034	0.0330	0.023
2		0.2	0.86	0	0	0.043	0.0104	0.067	0.1048	0.040
3		0.2	0.97	0	0	0.072	0.0860	0.085	0.0785	0.054
4		0.2	0.99	0	0	0.099	0.1861	0.104	0.0309	0.067
5		0.2	1	0	0	0.130	0.2912	0.131	0.0090	0.091
6		0.2	1	0	0	0.161	0.2845	0.161	0.0032	0.113
7		0.2	1	0	0	0.221	0.2875	0.221	0.0002	0.069

2021 Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. Spaw.	Prop. of M bef. Spaw.	Weight in Stock	Exploit pattern	Weight LWt	Exploit pattern	Weight DWt
0	45233	0.2	0	0	0	0.003	0.0000	0.002	0.0003	0.003
1		0.2	0.55	0	0	0.023	0.0000	0.034	0.0330	0.023
2		0.2	0.86	0	0	0.043	0.0104	0.067	0.1048	0.040
3		0.2	0.97	0	0	0.072	0.0860	0.085	0.0785	0.054
4		0.2	0.99	0	0	0.099	0.1861	0.104	0.0309	0.067
5		0.2	1	0	0	0.130	0.2912	0.131	0.0090	0.091
6		0.2	1	0	0	0.161	0.2845	0.161	0.0032	0.113
7		0.2	1	0	0	0.221	0.2875	0.221	0.0002	0.069

Input units are thousands and kg - output in tonnes

Table 6.2.14. Megrim (*L. boscii*) in Div. 8c and 9a catch forecast: management option table

MFDP version 1a
Run: ldb
Time and date: 14:55 30/04/2019
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

2019

		Catch	Landings		Discards	
Biomass	**SSB**	**FMult**	**FBar**	**Yield**	**FBar**	**Yield**
9546	8854	1	0.0942	1361	0.0714	235

2020 / 2021

		Catch	Landings		Discards		2021	
Biomass	**SSB**	**FMult**	**FBar**	**Yield**	**FBar**	**Yield**	**Biomass**	**SSB**
9596	8850	0	0.0000	0	0.0000	0	11638	10870
.	8850	0.1	0.0094	161	0.0071	23	11423	10656
.	8850	0.2	0.0188	317	0.0143	45	11213	10448
.	8850	0.3	0.0283	470	0.0214	67	11008	10244
.	8850	0.4	0.0377	618	0.0286	89	10807	10045
.	8850	0.5	0.0471	763	0.0357	110	10612	9851
.	8850	0.6	0.0565	904	0.0428	132	10421	9662
.	8850	0.7	0.0659	1042	0.0500	152	10235	9477
.	8850	0.8	0.0753	1176	0.0571	173	10054	9296
.	8850	0.9	0.0848	1307	0.0643	193	9876	9120
.	8850	1	0.0942	1435	0.0714	213	9703	8948
.	8850	1.1	0.1036	1559	0.0785	233	9534	8781
.	8850	1.2	0.1130	1680	0.0857	253	9369	8617
.	8850	1.3	0.1224	1799	0.0928	272	9208	8457
.	8850	1.4	0.1318	1914	0.1000	291	9051	8301
.	8850	1.5	0.1413	2026	0.1071	310	8897	8148
.	8850	1.6	0.1507	2136	0.1142	328	8747	8000
.	8850	1.7	0.1601	2243	0.1214	347	8601	7854
.	8850	1.8	0.1695	2347	0.1285	365	8458	7713
.	8850	1.9	0.1789	2448	0.1357	382	8318	7574
.	8850	2	0.1883	2547	0.1428	400	8182	7439

Input units are thousands and kg - output in tonnes

Table 6.2.15 Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Single option prediction. Detail Tables.

MFDP version 1a
Run: ldb
Time and date: 14:55 30/04/2019
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

Year: 2019 F multiplier: 1 Fleet1 HCFbar: 0.0942 Fleet1 DFbar: 0.0714

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0.0003	12	0	45233	145	0	0	0	0
1	0	0	0	0.033	1090	25	37033	844	20368	464	20368	464
2	0.0104	109	7	0.1048	1096	44	12191	529	10484	455	10484	455
3	0.086	2527	215	0.0785	2307	124	35068	2511	34016	2436	34016	2436
4	0.1861	2783	290	0.0309	462	31	18291	1814	18108	1796	18108	1796
5	0.2912	3737	491	0.009	115	10	16309	2123	16309	2123	16309	2123
6	0.2845	904	146	0.0032	10	1	4013	647	4013	647	4013	647
7	0.2875	960	212	0.0002	1	0	4219	932	4219	932	4219	932
Total		11020	1361		5094	235	172357	9546	107517	8854	107517	8854

Year: 2020 F multiplier: 1 Fleet1 HCFbar: 0.0942 Fleet1 DFbar: 0.0714

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0.0003	12	0	45233	145	0	0	0	0
1	0	0	0	0.033	1090	25	37023	844	20362	464	20362	464
2	0.0104	262	18	0.1048	2637	105	29335	1273	25228	1095	25228	1095
3	0.086	641	54	0.0785	585	31	8895	637	8628	618	8628	618
4	0.1861	3706	386	0.0309	615	41	24356	2416	24113	2392	24113	2392
5	0.2912	2762	363	0.009	85	8	12054	1569	12054	1569	12054	1569
6	0.2845	2227	359	0.0032	25	3	9890	1594	9890	1594	9890	1594
7	0.2875	1150	254	0.0002	1	0	5055	1117	5055	1117	5055	1117
Total		10748	1435		5051	213	171841	9596	105331	8850	105331	8850

Year: 2021 F multiplier: 1 Fleet1 HCFbar: 0.0942 Fleet1 DFbar: 0.0714

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0.0003	12	0	45233	145	0	0	0	0
1	0	0	0	0.033	1090	25	37023	844	20362	464	20362	464
2	0.0104	262	18	0.1048	2636	105	29327	1273	25221	1095	25221	1095
3	0.086	1543	131	0.0785	1408	76	21404	1533	20762	1487	20762	1487
4	0.1861	940	98	0.0309	156	11	6178	613	6116	607	6116	607
5	0.2912	3678	483	0.009	114	10	16051	2090	16051	2090	16051	2090
6	0.2845	1646	266	0.0032	19	2	7310	1178	7310	1178	7310	1178
7	0.2875	2088	461	0.0002	1	0	9177	2028	9177	2028	9177	2028
Total		10156	1457		5436	229	171703	9703	105000	8948	105000	8948

Input units are thousands and kg - output in tonnes

Table 6.2.16 **Four-spot megrim (*L. boscii*) in Divisions 8c and 9a**
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to catches and SSB (by weight) of these year classes

Year-class	2016	2017	2018	2019	2020
Stock No. (thousands) of 0 year-olds	66747	18468	45233	45233	45233
Source	XSA	XSA	GM90-15	GM90-15	GM90-15
Status Quo F:					
% in 2019 catch	21.2	3.2	1.6	0.0	-
% in 2020	25.9	5.2	7.5	1.5	0.0
% in 2019 SSB	27.5	5.1	5.2	0.0	-
% in 2020 SSB	27.0	7.0	12.4	5.2	0.0
% in 2021 SSB	23.4	6.8	16.6	12.2	5.2

GM : geometric mean recruitment

Four-spot megrim (*L. boscii*) in Divisions 8c and 9a : Year-class % contribution to

a) 2020 catches **b) 2021 SSB**

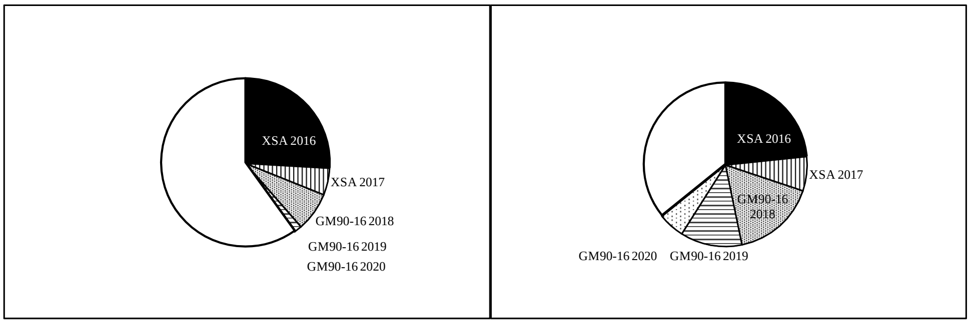


Table 6.2.17 Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Yield per recruit results.

MFYPR version 2a
Run: ldb
Time and date: 15:27 30/04/2019
Yield per results

Catch	Landings			Discards								
FMult	Fbar	CatchNos	Yield	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	0	0	0	5.5167	0.5319	4.0334	0.5146	4.0334	0.5146
0.1	0.0094	0.0559	0.0096	0.0071	0.0142	0.0006	5.1675	0.4612	3.6849	0.444	3.6849	0.444
0.2	0.0188	0.0972	0.0163	0.0143	0.0279	0.0012	4.8939	0.4069	3.412	0.3897	3.412	0.3897
0.3	0.0283	0.1282	0.0209	0.0214	0.0412	0.0018	4.6731	0.3641	3.192	0.3469	3.192	0.3469
0.4	0.0377	0.152	0.0242	0.0286	0.0541	0.0024	4.4908	0.3294	3.0103	0.3123	3.0103	0.3123
0.5	0.0471	0.1704	0.0265	0.0357	0.0666	0.0029	4.3373	0.301	2.8575	0.2839	2.8575	0.2839
0.6	0.0565	0.1848	0.0281	0.0428	0.0788	0.0034	4.2061	0.2772	2.727	0.2602	2.727	0.2602
0.7	0.0659	0.1959	0.0291	0.05	0.0906	0.0039	4.0923	0.2571	2.6138	0.2401	2.6138	0.2401
0.8	0.0753	0.2047	0.0298	0.0571	0.102	0.0044	3.9925	0.2399	2.5147	0.2229	2.5147	0.2229
0.9	0.0848	0.2114	0.03	0.0643	0.1131	0.0048	3.90	0.225	2.427	0.2081	2.427	0.2081
1	0.0942	0.2166	0.0303	0.0714	0.1239	0.0053	3.8252	0.212	2.3487	0.1951	2.3487	0.1951
1.1	0.1036	0.2205	0.0303	0.0785	0.1345	0.0057	3.7541	0.2006	2.2782	0.1837	2.2782	0.1837
1.2	0.113	0.2233	0.0301	0.0857	0.1447	0.0061	3.6897	0.1905	2.2144	0.1737	2.2144	0.1737
1.3	0.1224	0.2253	0.0299	0.0928	0.1546	0.0065	3.631	0.1815	2.1562	0.1647	2.1562	0.1647
1.4	0.1318	0.2266	0.0296	0.1	0.1643	0.0069	3.5771	0.1735	2.103	0.1567	2.103	0.1567
1.5	0.1413	0.2273	0.0292	0.1071	0.1737	0.0073	3.5275	0.1662	2.054	0.1495	2.054	0.1495
1.6	0.1507	0.2275	0.0288	0.1142	0.1829	0.0076	3.4816	0.1597	2.0086	0.143	2.0086	0.143
1.7	0.1601	0.2272	0.0283	0.1214	0.1919	0.008	3.4389	0.1537	1.9665	0.1371	1.9665	0.1371
1.8	0.1695	0.2266	0.0279	0.1285	0.2006	0.0083	3.3991	0.1483	1.9273	0.1317	1.9273	0.1317
1.9	0.1789	0.2257	0.0274	0.1357	0.2091	0.0086	3.3619	0.1433	1.8907	0.1267	1.8907	0.1267
2.0	0.1883	0.2246	0.0269	0.1428	0.2173	0.0089	3.3270	0.1387	1.8563	0.1222	1.8563	0.1222

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar(2-4)	1	0.0942
FMax	1.0353	0.0975
F0.1	0.6268	0.059
F35%SPR	1.1347	0.1069

Weights in kilograms

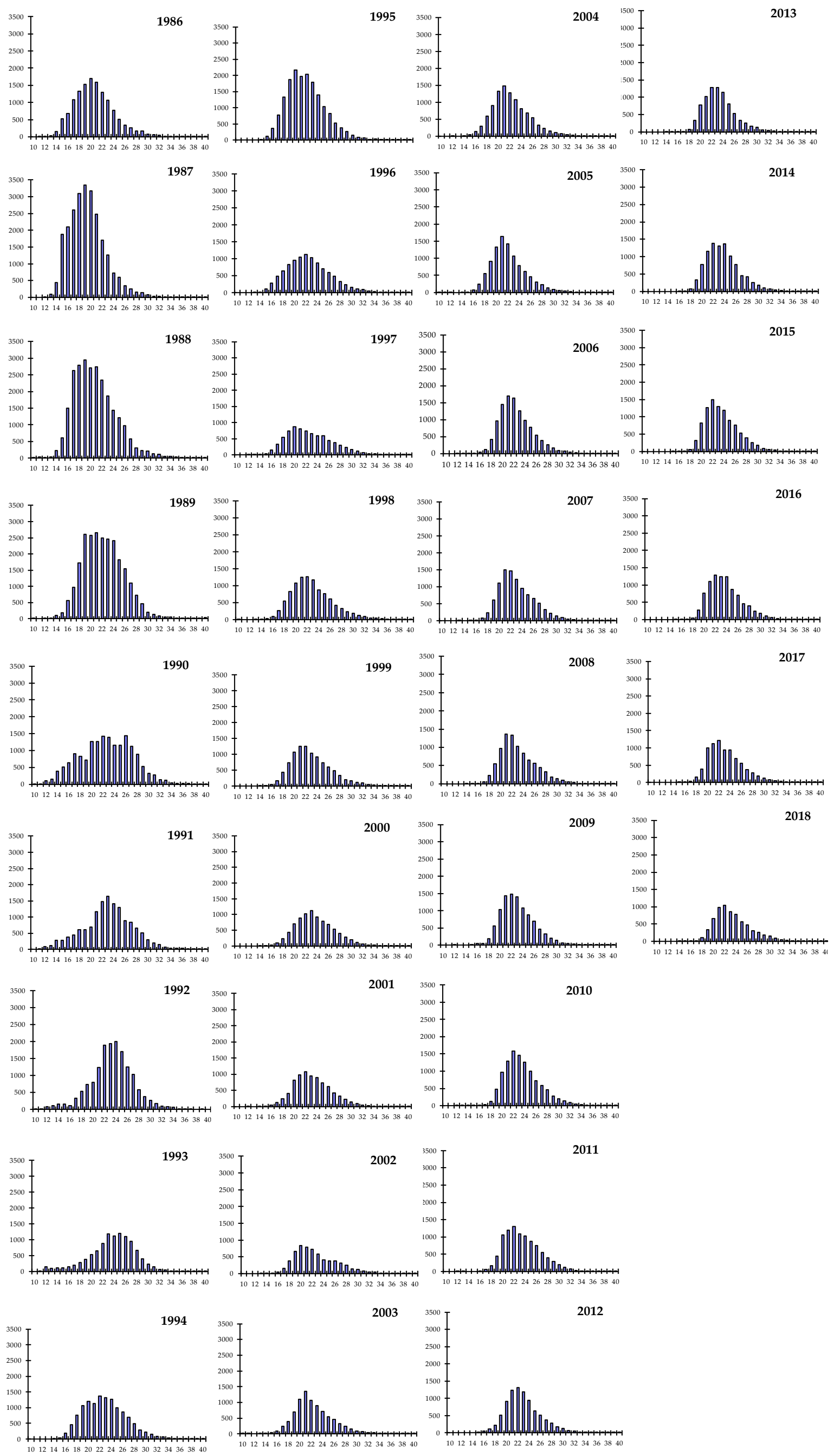


Figure 6.2.1 Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Annual length compositions of landings ('000)

Standardized log(abundance index at age) from SP-NSGFS-Q4

(black bubble means < 0)

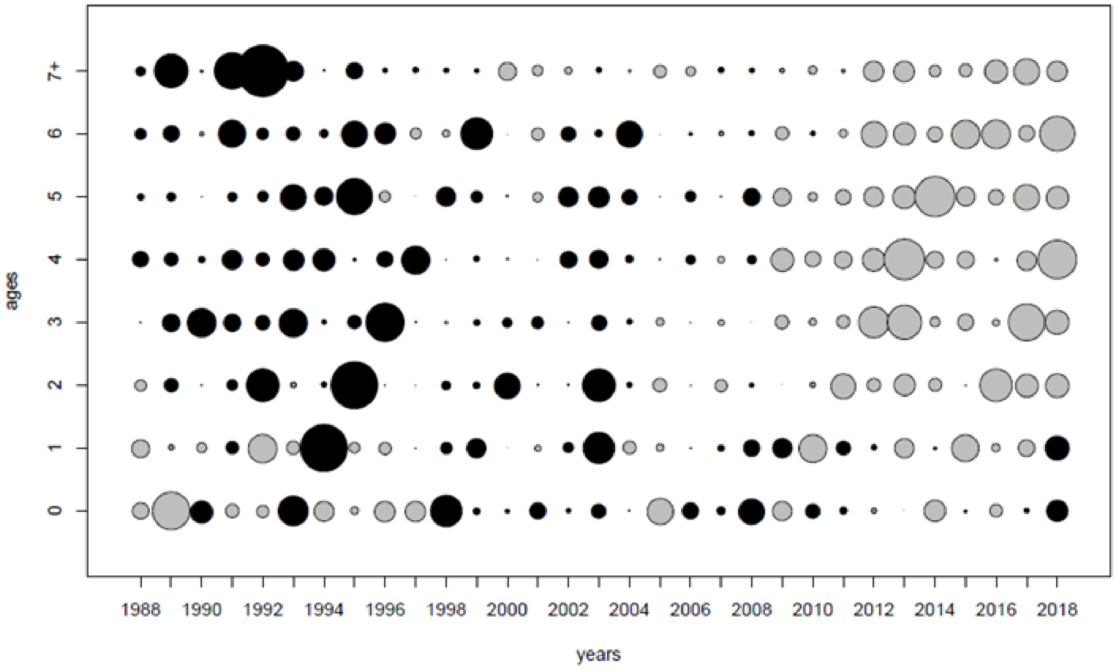
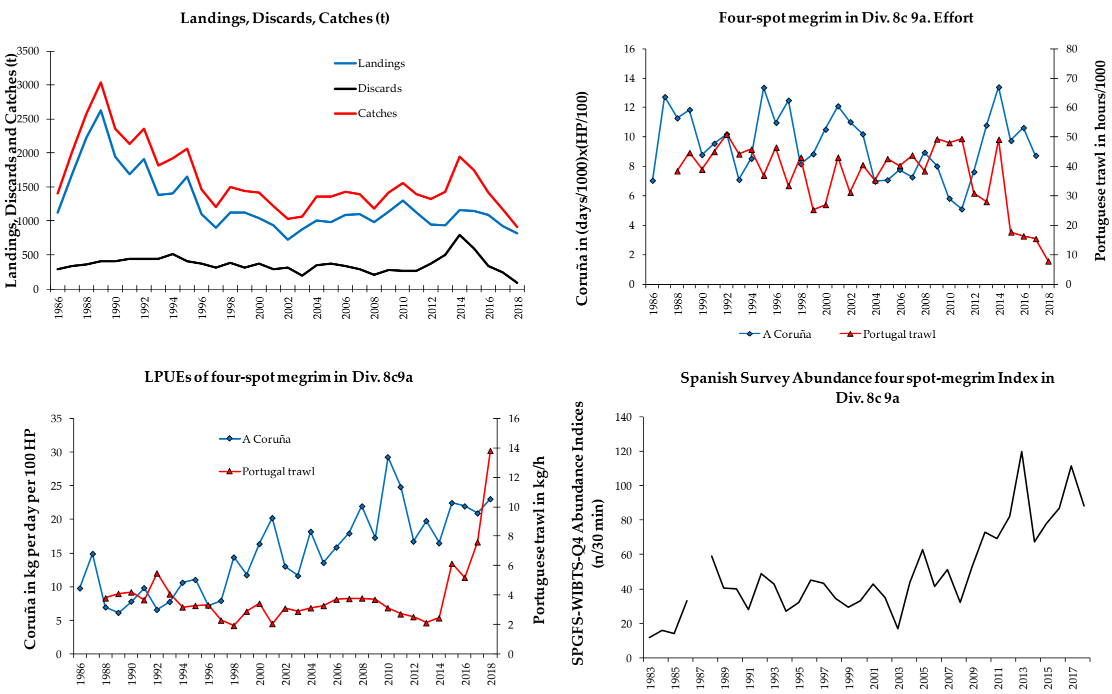


Figure 6.2.2: Four-spot megrim (*L. boscii*) in Divisions 8c&9a



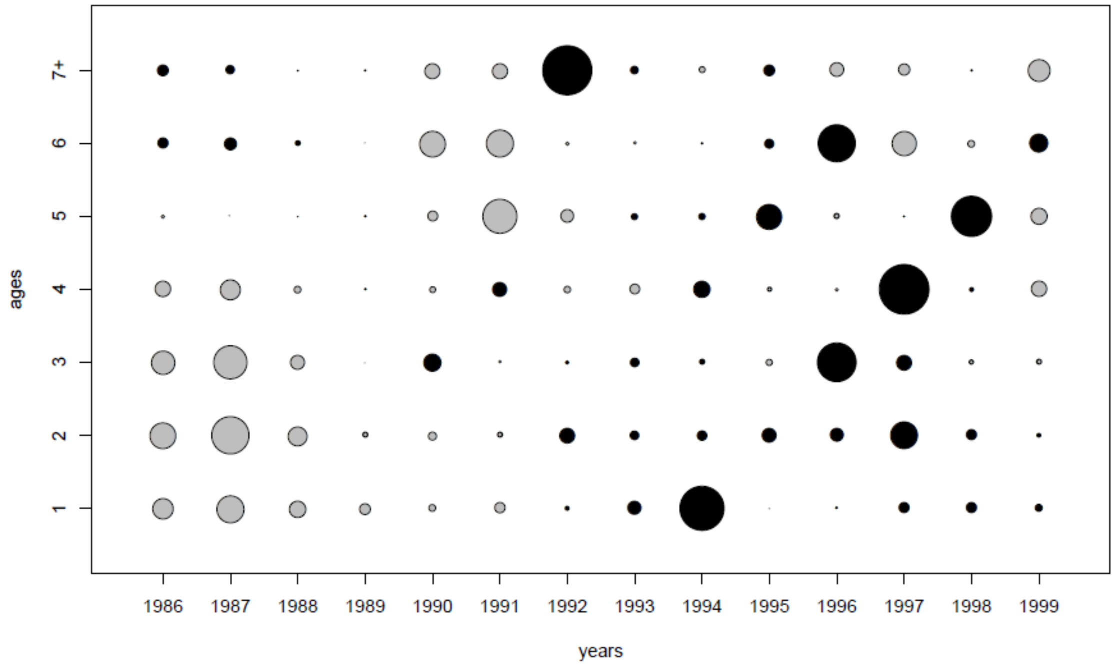
* Spanish Landings of 2008 revised in WG2010 from original value presented

* Portuguese Trawl Effort of 2007 and 2008 revised in WG2010 from original value presented

Figure 6.2.3(a) Four-spot megrim (*L.boscii*) in Divisions 8c and 9a. Landings (t), Efforts, LPUEs and Abundance Indices.

Standardized log(abundance index at age) from SP-LCGOTBDEF-1

(black bubble means < 0)



Standardized log(abundance index at age) from SP-LCGOTBDEF-2

(black bubble means < 0)

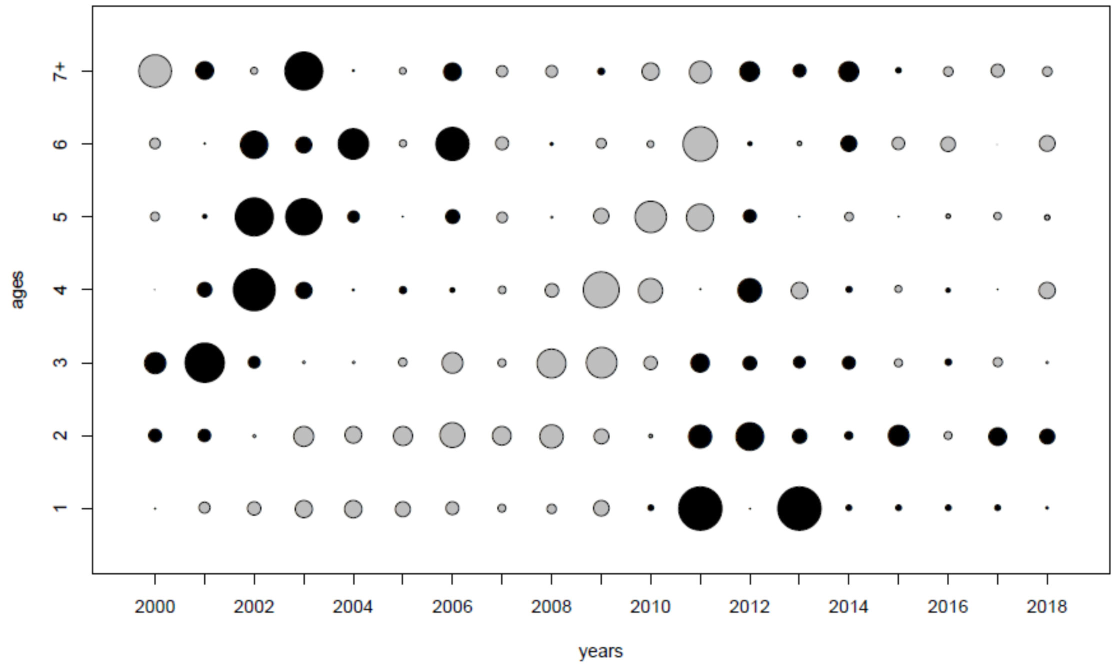
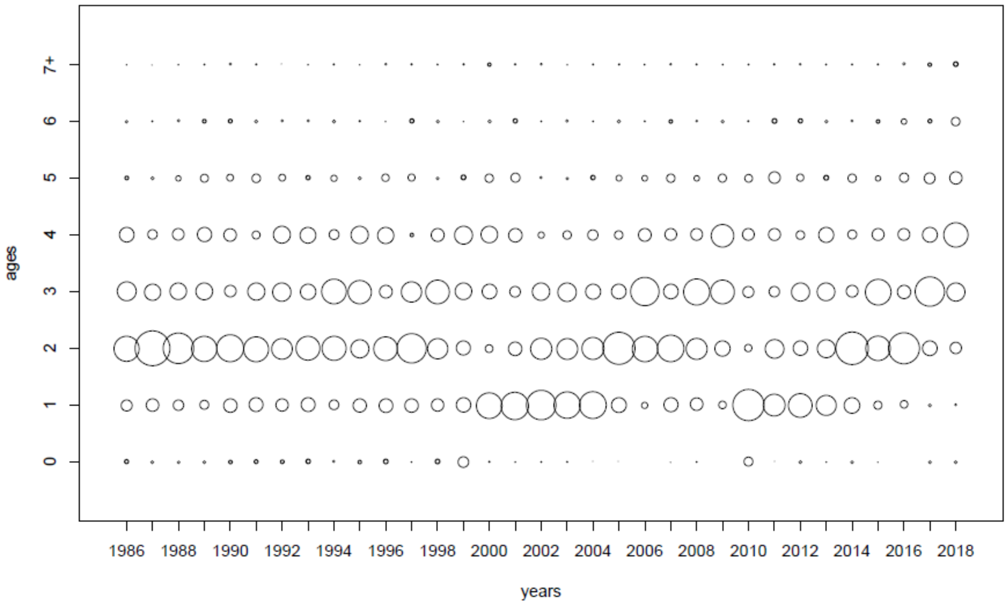


Figure 6.2.3(b): Four-spot megrim (*L. boscii*) in Divisions 8c&9a

Catches proportions at age



Standardized catches proportions at age (black bubble means < 0)

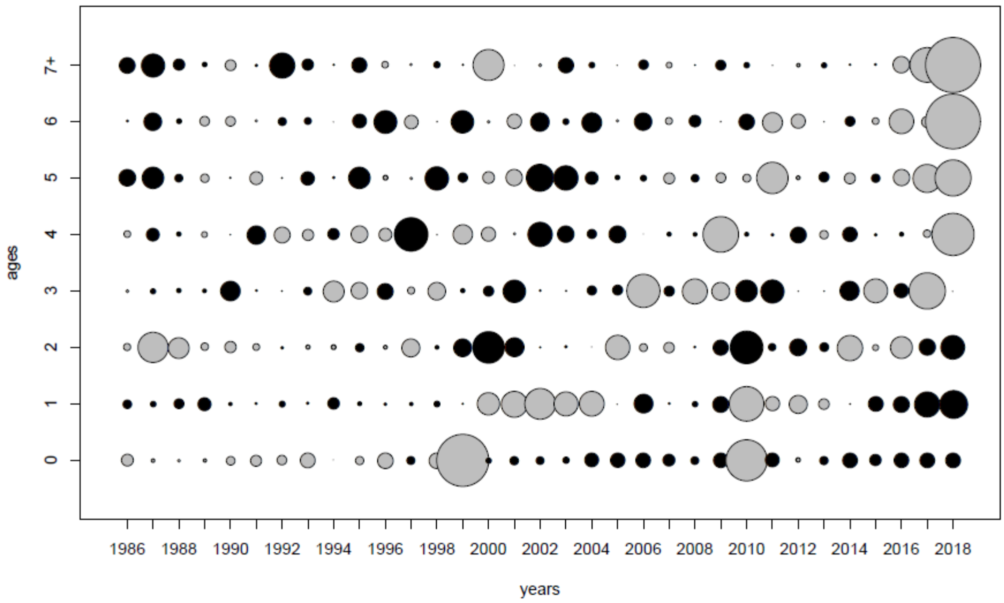
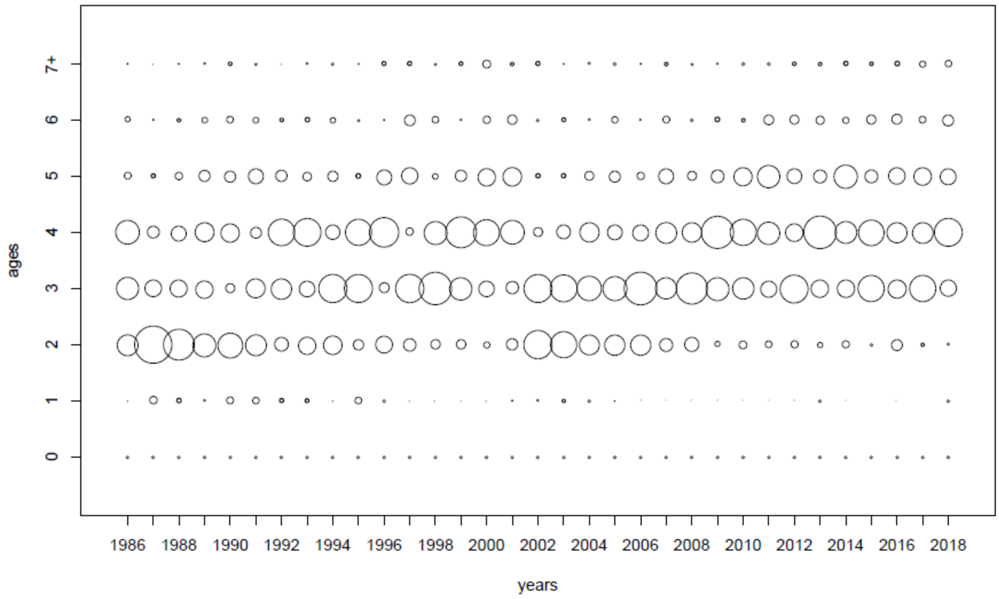


Figure 6.2.4(a). Four-spot megrim (L. boscii) in Divisions 8c & 9a.

Landings proportions at age



Standardized landings proportions at age (black bubble means < 0)

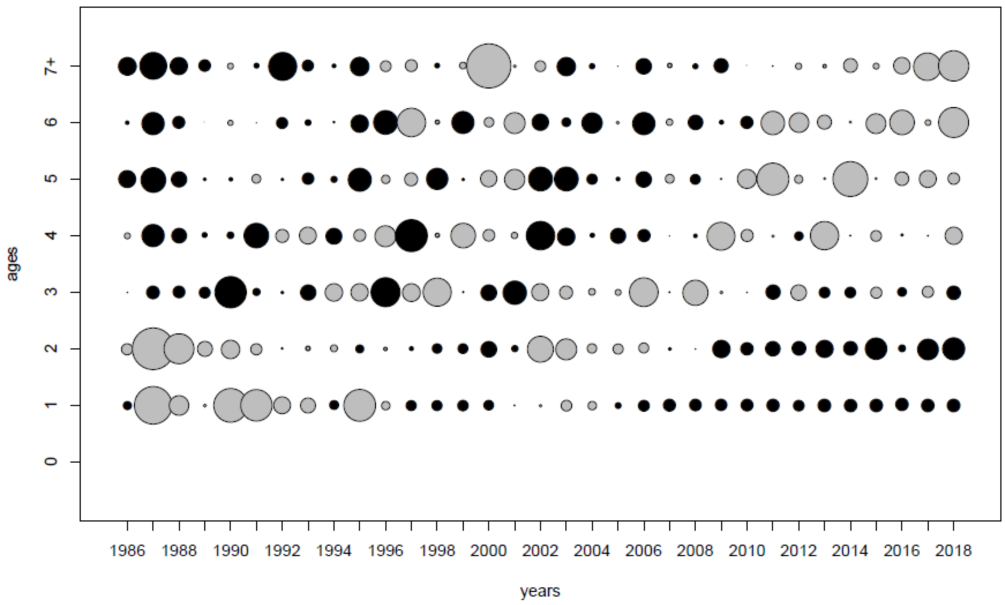
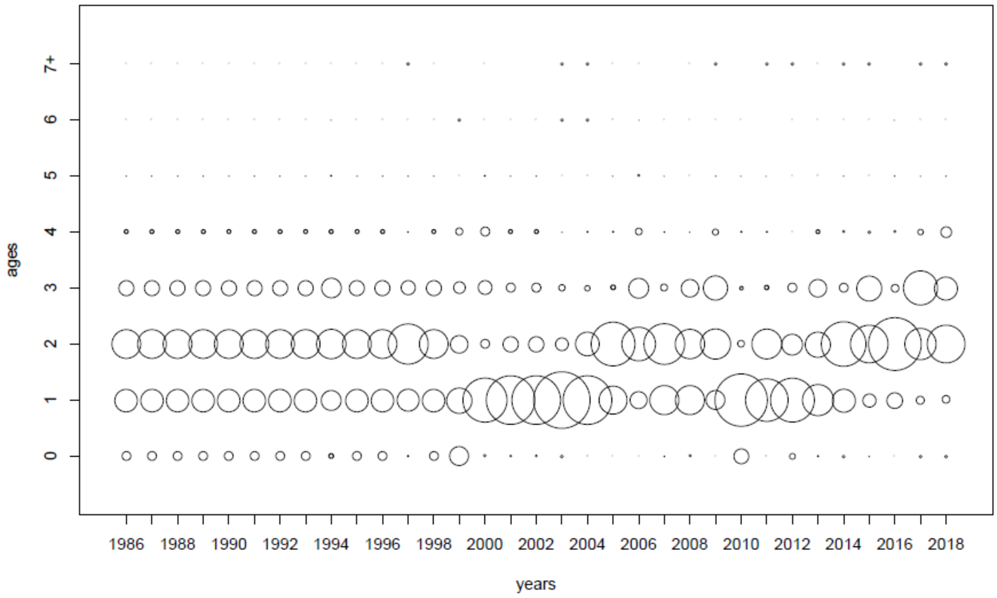


Figure 6.2.4(b). Four-spot megrim (*L. boscii*) in Divisions 8c & 9a.

Discards proportions at age



Standardized discards proportions at age (black bubble means < 0)

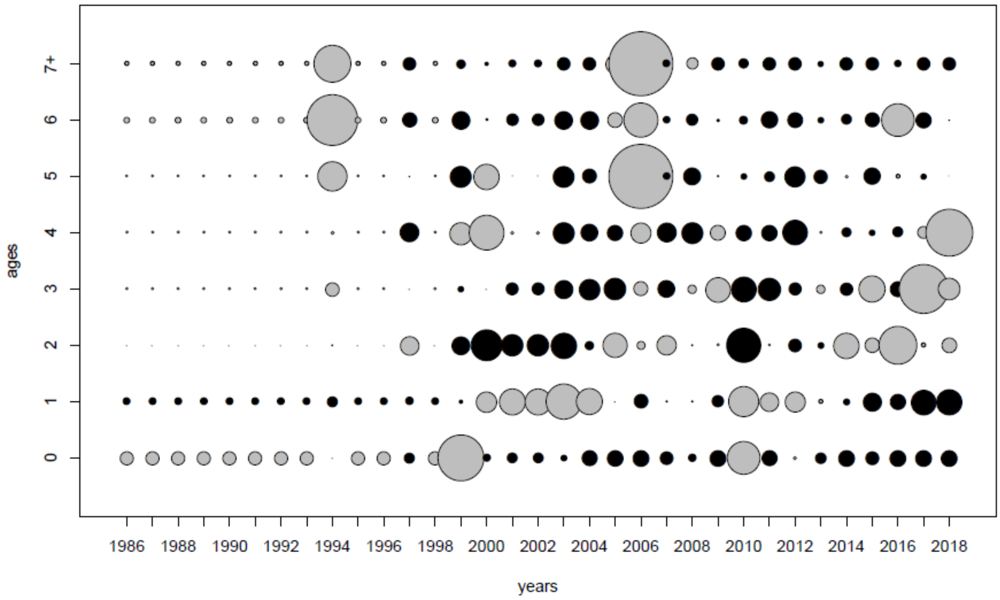


Figure 6.2.4(c). Four-spot megrim (*L. boscii*) in Divisions 8c & 9a.

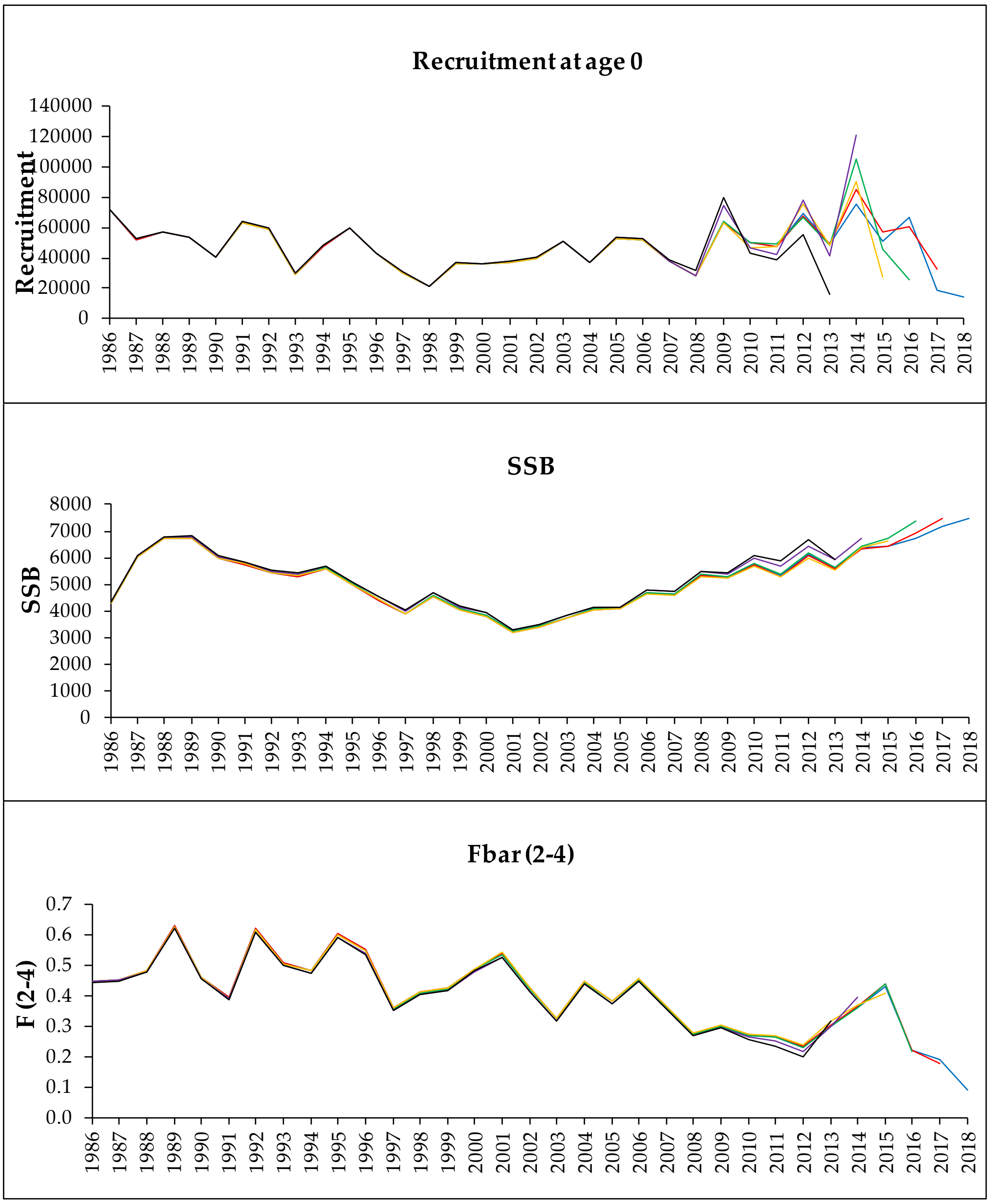


Figure 6.2.5. Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Retrospective XSA

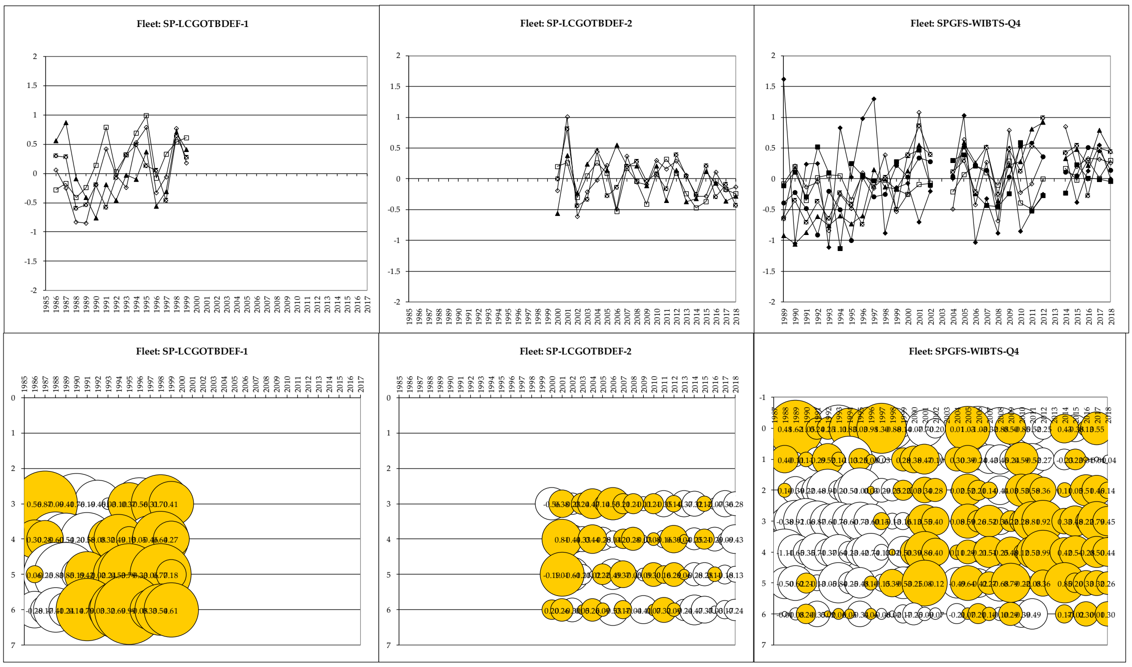


Figure 6.2.6. Four spot megrim (*L. boscii*) in Divisions 8c and 9a. LOG CATCHABILITY RESIDUAL PLOTS (XSA)

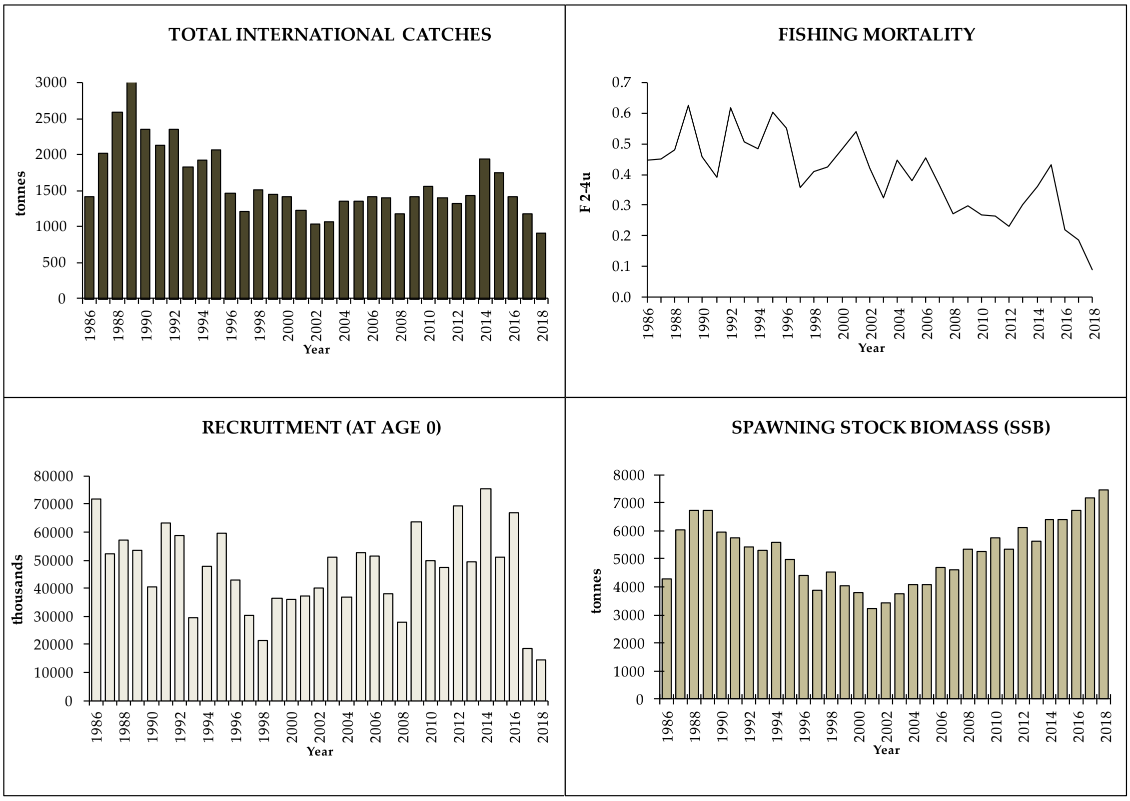
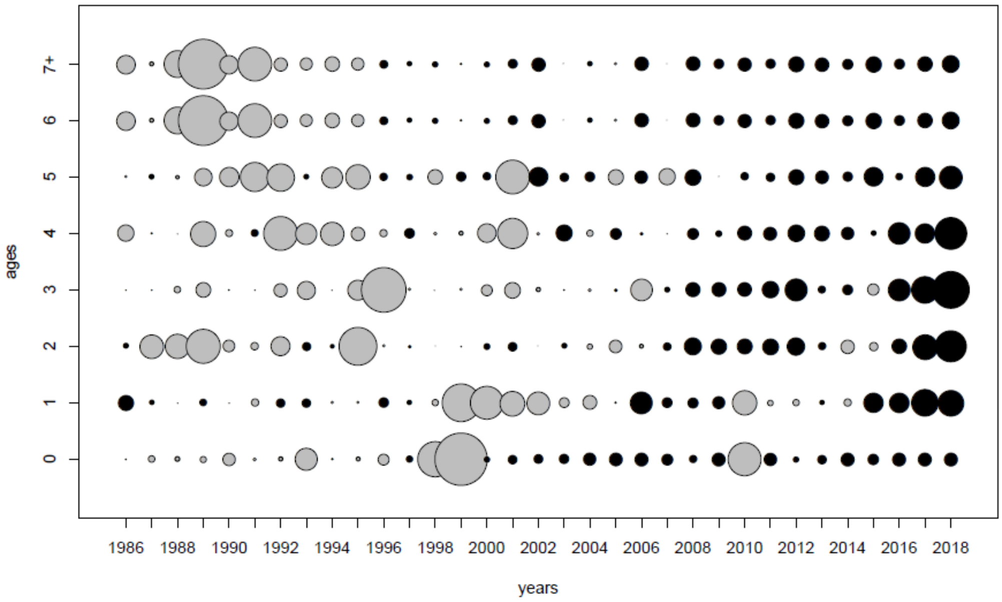


Figure 6.2.7(a). Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Stock Summary

Standardized F-at-age (black bubbles means <0)



Standardized relative F-at-age (black bubble means < 0)

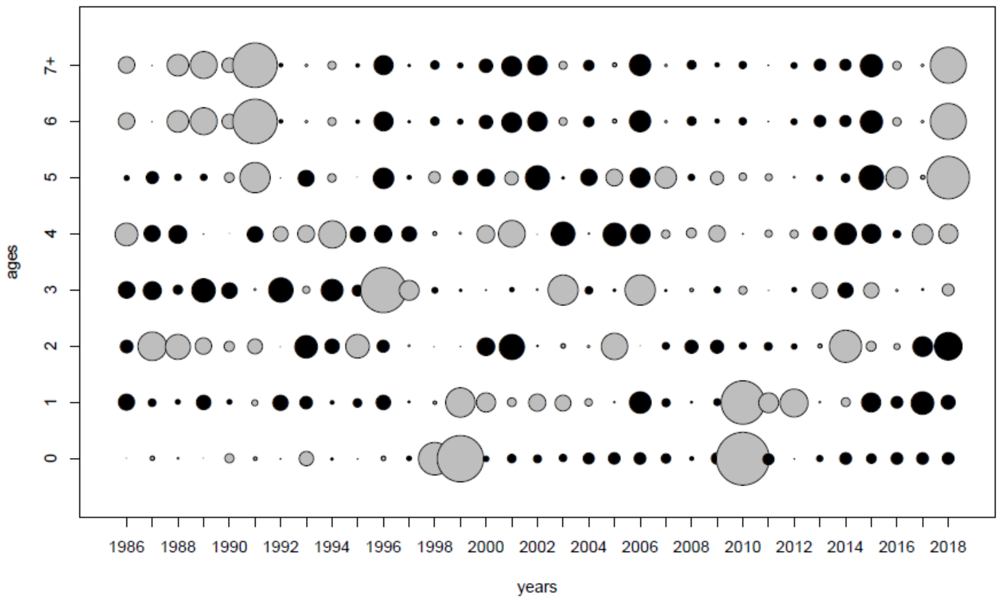
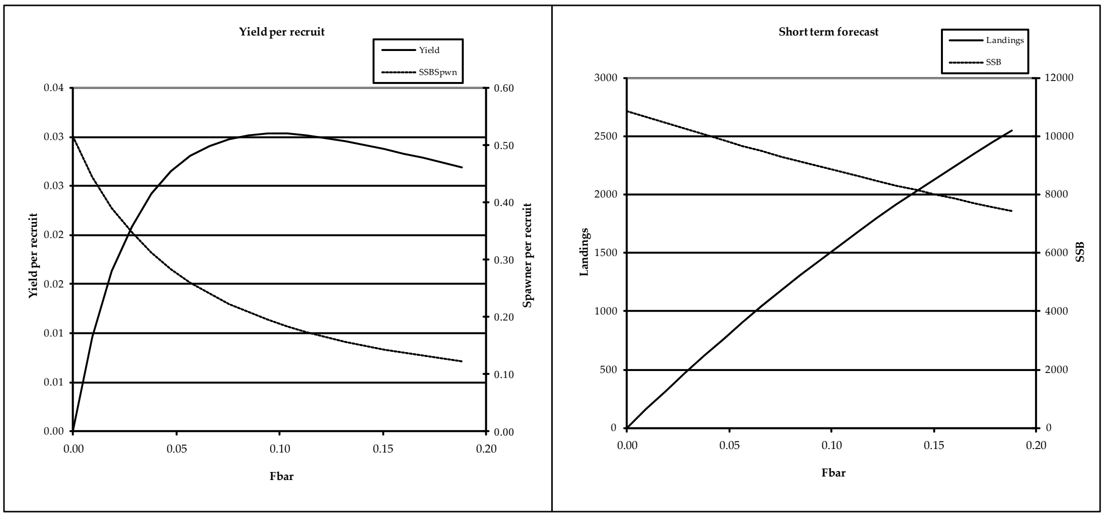


Figure 6.2.7(b): Four-spot megrim (*L. boscii*) in Divisions 8c&9a



MFYPR version 2a
Run: ldb
Time and date: 15:27 30/04/2019

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar	1.0000	0.0942
FMax	1.0353	0.0975
F0.1	0.6268	0.0590
F35%SPR	1.1347	0.1069

MFDP version 1a
Run: ldb
Time and date: 14:55 30/04/2019
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

Input units are thousands and kg - output in tonnes

Figure 6.2.8. Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Forecast summary

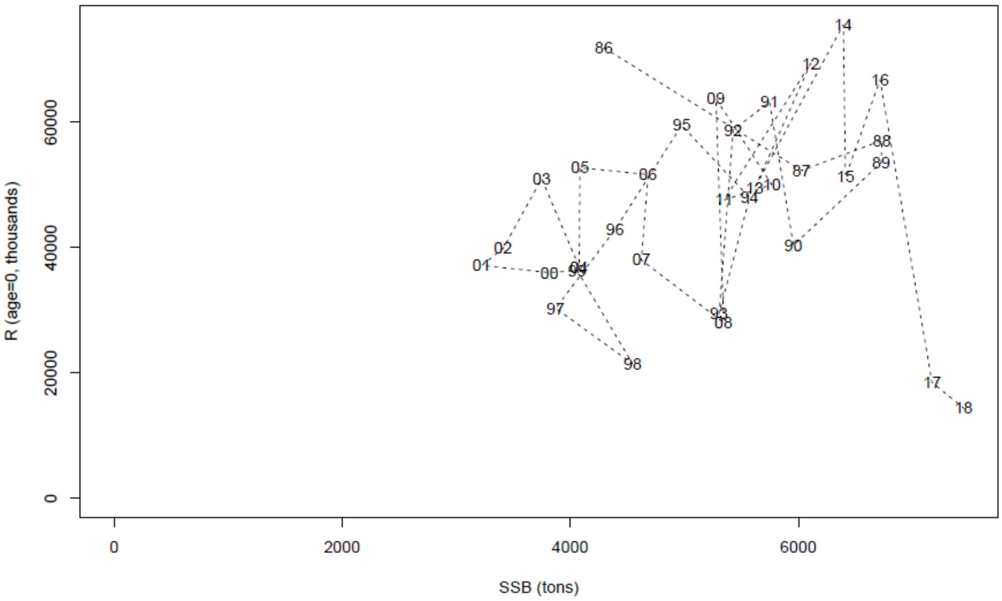


Figure 6.2.9. Four spot megrim (*L.boscii*) in Divisions 8c and 9a. SSB-Recruitment plot.

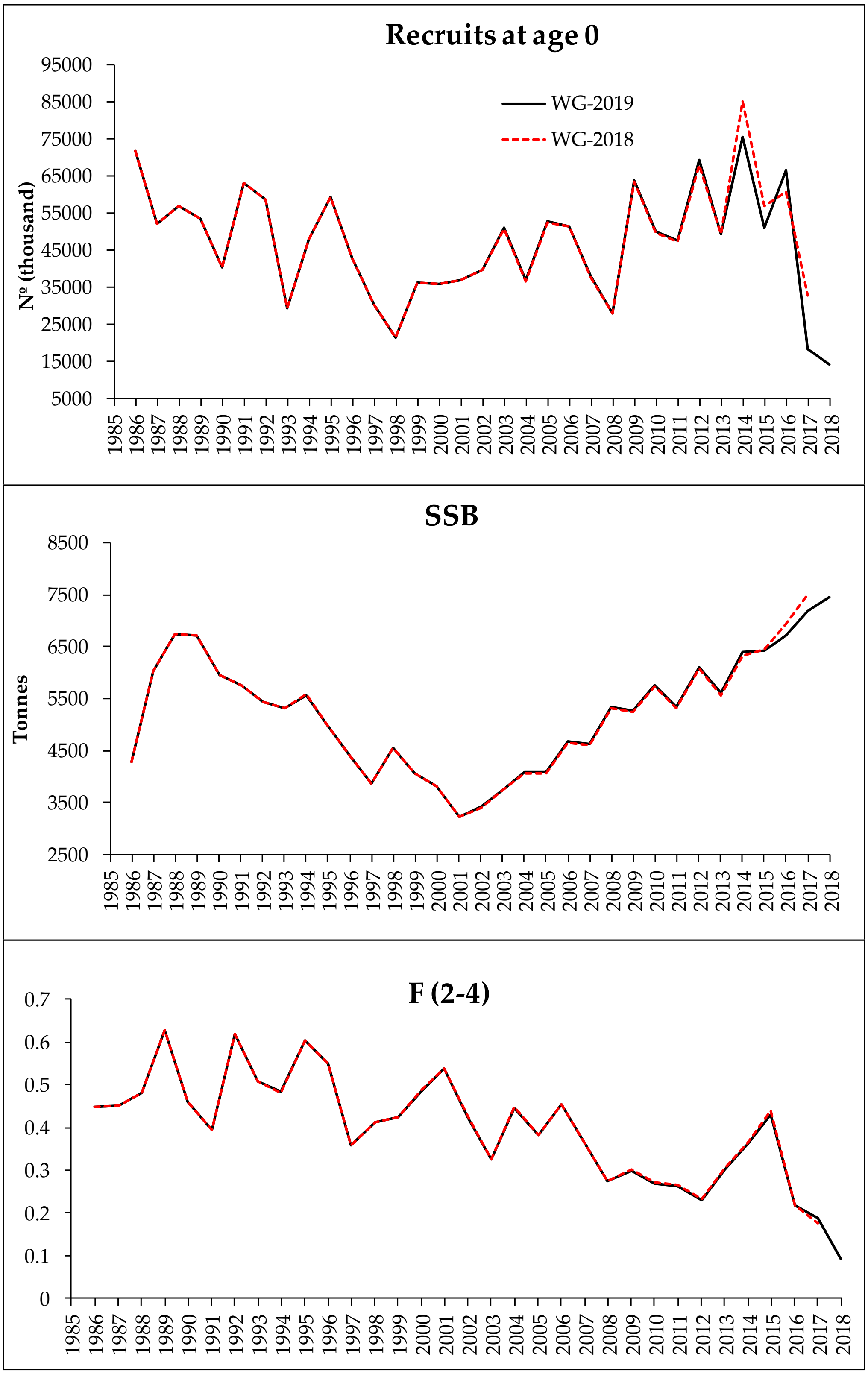


Figure 6.2.10. Four-spot megrim (*L. boscii*). Recruits, SSB and Fs from WG18 and WG19

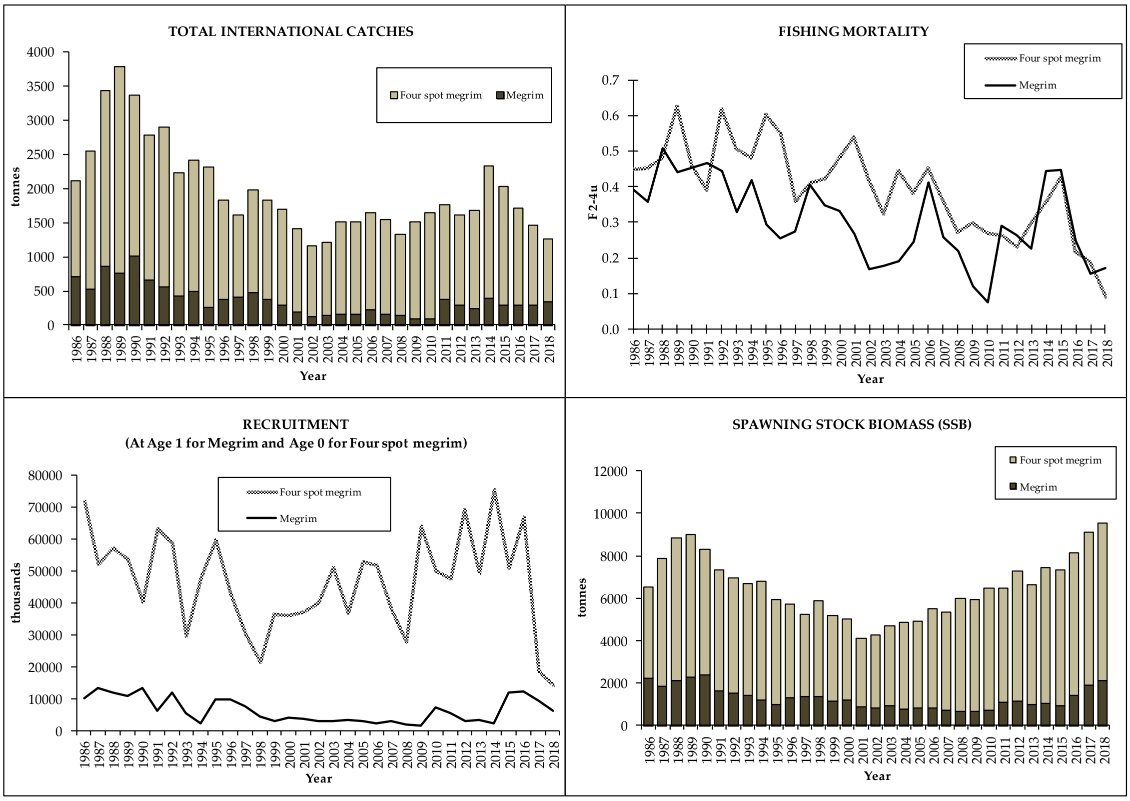
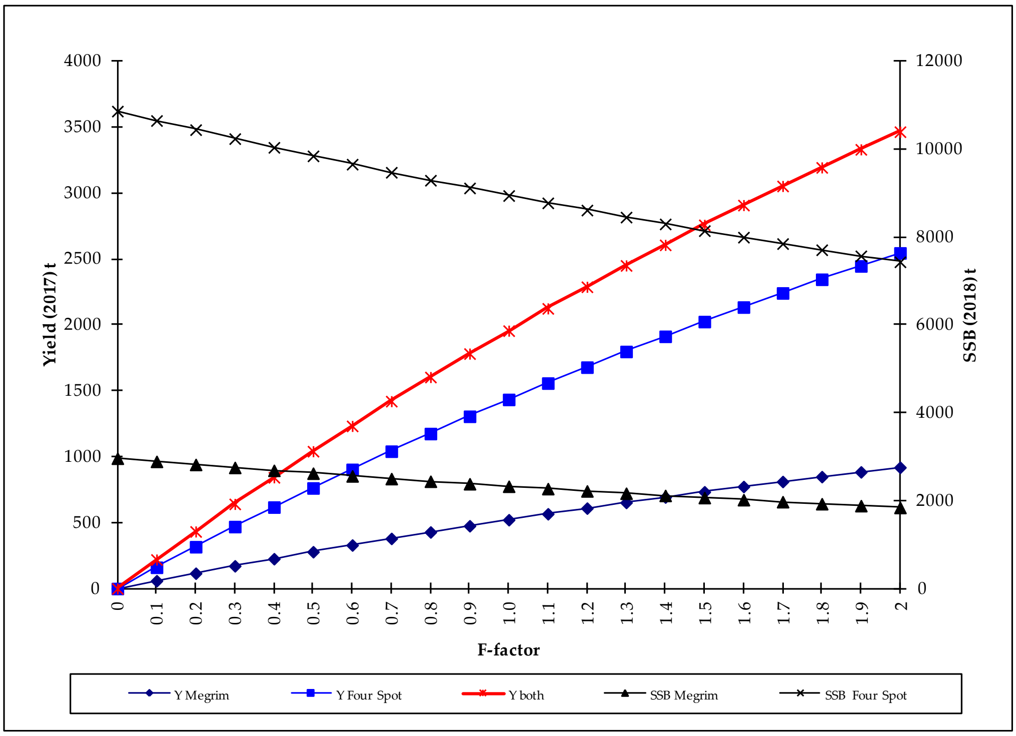


Figure 6.3.1. Stock trends for both stocks. Megrin and Four-spot megrim in Divisions 8c and 9a.



Combined Short Term Forecasts assuming status quo in 2017 and 2018

Figure 6.3.2. Megrims (*L. whiffiagonis and L. boscii*) in Divisions 8c and 9a.

7 Bay of Biscay Sole

Type of assessment in 2019 : update.

Data revisions in 2019 : Compared to last year's assessment, there is only very limited change in ORAGHO survey CPUE.

7.1 General

7.1.1 Ecosystem aspects

See Stock Annex

7.1.2 Fishery description

See Stock Annex

7.1.3 Summary of ICES advice for 2019 and management applicable to from 2017

ICES advice for 2018

ICES advises that when the MSY approach is applied, catches in 2019 should be no more than 3967 tonnes. ICES assesses that fishing pressure on the stock is below F_{MSY}, F_{pa}, and F_{lim}, while spawning stock size is above MSY Bt_{rigger}, B_{pa}, B_{lim}.

A discard rate is used to estimate the total catches (1.64% in 2015, 4% in 2016, 1.7% in 2017 and 2.4% in 2018).

Management applicable to 2017

The sole landings in the Bay of Biscay are subject to a TAC regulation. The 2017 TAC was set at 3621 t.

The minimum landing size is 24 cm and the minimum mesh size is 70 mm for trawls and 100 mm for fixed nets, when directed on sole. Since 2002, the hake recovery plan has increased the minimum mesh size for trawl to 100 mm in a large part of the Bay of Biscay but since 2006 trawlers using a square mesh panel were allowed to use 70 mm mesh size in this area.

Since the end of 2006, the French vessels must have a European Fishing Authorization when their sole annual landing is above 2 t or be allowed to have more than 100 kg on board. The Belgian vessel owners get monthly non-transferable individual quota for sole and the amount is related to the capacity of the vessel.

A regulation establishing a management plan was adopted in February 2006. The objective was to bring the spawning stock biomass of Bay of Biscay sole above the precautionary level of 13 000 tonnes in 2008 by gradually reducing the fishing mortality rate on the stock. Once this target is reached, the Council has to decide on a long-term target fishing mortality and a rate of reduction in the fishing mortality for application until the target has been reached. However, although the stock was estimated above the SSB target in 2008 by ICES in 2009, the long-term target fishing mortality rate and the associated rate of reduction have not yet been set.

A proposal for a management plan for sole in the Bay of Biscay was evaluated by ICES (2013) (ICES 2013). The plan aims to decrease fishing mortality by applying a constant TAC until F is estimated to have reached FMSY. The plan has provisions to reduce the TAC if F increases in two consecutive years, and to base the TAC on F = FMSY if SSB is estimated to be below Bpa. ICES considered the plan to be precautionary for all the constant TAC values tested (up to 4500 t) and that values not exceeding 4300 t would allow reaching FMSY by 2020.

In addition of this proposal the industry implemented a mesh size restriction of >=80 mm for the bottom trawls for the periods 1 January to 31 May and from 1 October to 31 December.

A season closure was also applied during the spawning period, 1 January to the 31 March, for the directed fishery for common sole. The fishery during the spawning period is closed for 21 days, which consists of 3 periods of seven consecutive days.

Since 2015, the French sole fishery in the Bay of Biscay (ICES divisions 8ab) has been subjected to additional management measures aimed at reducing fishing mortality and improving the recruitment level of the stock. Since 2016, these measures have concerned a fishing stop of at least 15 days during the first quarter for netters and a reinforcement of the selectivity for at least 8 months of the year (including the first quarter) for trawlers.

7.2 Data

7.2.1 Commercial catches and discards

The WG estimates of landings and catches are shown in Table 7.1a. The French catches are predominant.

The official landings are lower than the WG landings estimates before 2008 but they become largely higher in 2009–2010. This discrepancy was caused in 2009 by a new method that has been implemented to calculate the French official landings. This important discrepancy in 2009-2010 was likely caused by some assumptions in the algorithm implemented to calculate French official landings in these years which was modified in 2011. Consequently, the official and the WG landing estimates are closer since 2011. The WG method to estimate landings is considered to continue to provide the best available estimates of the landing series.

In 2002, landings increased to 5486 t due to very favourable weather conditions for the fixed nets' fishery (frequent strong swell periods in the first quarter). In the absence of such apparently rare conditions, the landings in 2003–2008 ranged between 4000 t and 4800 t before falling to 3650 t in 2009 and increasing to 4632 t in 2011 Tab. 1. Since 2015, the landings are fluctuating between 3230 and 3700 t.

The 2019 landings (3387) is 6 % below the landings constraint set at 3621 in 2019.

Discards estimates were provided for the French offshore trawler fleet from 1984 to 2003 using the RESSGASC surveys. The monitoring was stopped in 2004 and they discards are not used in the assessment. However, the survey shown that discards of offshore trawlers are low at age 2 and above.

This low discard rates were confirmed by observations at sea in recent years. These observations have also shown that discards of beam trawlers and gillnetters are generally low but that the inshore trawlers fleet may have occasionally high discards of sole. Unfortunately, they are difficult to estimate because the effort data of inshore trawlers are not precise enough to allow estimating them by relevant areas.

The analyse of the discards with the data from the Obsmer project shows that the overall discards rate for the sole in the Bay of Biscay are less or close to 5 %.

7.2.2 Biological sampling

The quarterly French sampling for length compositions is by gear (trawl or fixed net) and by boat length (below or over 12 m long). The split of the French landings in these components is made as described in Stock Annex. The observed split between fleets is presented in the Tab. 7.1.b.

French and Belgian data were extracted from InterCatch for 2018.

Even though age reading from otoliths now uses the same method as in France and Belgium (see Stock Annex), the discrepancy between French and Belgian mean weight at age, noticed by preceding WGs, are still present. Work was carried out in the beginning of 2012 (PGCCDBS, 2012) to compare the age reading methods. The conclusion is that there was no bias between readers from the three countries using otoliths prepared with the staining technique. All readers produced the same age estimates (i.e. no bias) of otoliths with or without staining. However, a likely effect of the weight-at-age samples process may also be presumed (weight-length relationship used in France and straight estimate in Belgium) and should be investigated. International age compositions are estimated using the same procedure as in previous years, as described in the Stock Annex. International mean weights-at-age of the catch are French-Belgian quarterly weighted mean weights. The catch numbers-at-age are shown in Tab. 2 and Figures 7.2 a b, & c and the mean catch weight-at-age in Table 7.4.

7.2.3 Abundance indices from surveys

Since 2007, a beam trawl survey (ORHAGO) is carried out by France to provide a sole abundance index in the Bay of Biscay. This survey is coordinated by the ICES WGBEAM.

During the 2013 WGBEAM meeting, several CPUE series were compared. The one based on all the reference stations and carried out by daylight was estimated to provide the abundance index to retain for the Bay of Biscay sole.

The 2013 WGHMM assessment was carried out according to a 2013 revised stock annex, which adds the ORHAGO survey to the tuning files. This was a consequence of the interim Benchmark during the WGHMM 2013 which considered that the addition of the survey tuning fleet appears to be useful to the assessment.

In 2015, the survey vessel was changed, however the gear configuration and method were the same as in the previous year and the conclusion of the WGBEAM2016 was: "This change has had no consequence on the gear configuration". On this basis, the WG agreed to retain the ORHAGO abundance indices in the assessment.

The figure 7.3 shows the tuning fleets' time series and their internal consistencies.

7.2.4 Commercial catch-effort data

The French La Rochelle and Les Sables trawler series of commercial fishing effort data and LPUE indices were completely revised in 2005. A selection of fishing days (or trips before 1999) was made by a double threshold (sole landings > 10% and *nephrops* landings <= 10%) for a group of vessels. The process is described in the Stock Annex.

The risk that the sole 10 % threshold may lead to an underestimate of the decrease in stock abundance was pointed out by RG in 2010. This general point is acknowledged by this working group. However, in this particular case and by using the knowledge about the fishery this threshold was set to avoid the effect of changing target species, which may also affect the trend in LPUE. Indeed, the choice of target species may affect effort repartition between sole major habitat and peripheral areas where sole abundance is lower. Because 10% is a minimum for sole percentage in catch when carrying out mixed species trawling on sole grounds, according to fishermen, this percentage was retained to ensure that sole LPUE are not driven by a fishing strategy evolution (the targeting of cephalopods more particularly).

The La Rochelle LPUE series (FR-ROCHELLE) shows a decreasing trend from 1990 to 2001. Later on, the series does not exhibit any trend but some up and down variations (Table 7.5.a and Figure 7.3). The Les Sables d'Olonne LPUE series (FR-SABLES) shows also a declining trend up to 2003. Thereafter, it shows a short increase in 2004–2005 but the trend is flat from 2005 onwards.

Two new series of tuning were added to the assessment according to the WKFLAT 2011: the Bay of Biscay offshore trawler fleet (14–18 m) in the second quarter (FR-BB-OFF-Q2) and the Bay of Biscay inshore trawler fleet (10–12 m) in the fourth quarter (FR-BB-IN-Q4) for 2000 to the last year. A selection of fishing days was made by a double threshold (sole landings > 6% and *nephrops* landings <= 10%). The process is described in the Stock Annex.

Unfortunately, the fishing effort for the FR-BB-OFF-Q2 is not available since 2013. This is due to the use of the electronic logbooks, for which the fishing effort is not a required value. This data is not well exported in the official database, and the majority of the fishing effort is equal to 1. Therefore, the commercial LPUE could not be calculated for this fleet.

However, LPUE for the FR-BB-IN-Q4 fleet is provided using paper logbooks which are still used by this fleet.

For the ORHAGO survey, the trend of the CPUE shows an increase since 2008 despite some annual fluctuations.

ORHAGO shows a slight decrease in numbers at age 2 (Fig.3) since the last 5 years but the index is about the average of the time series. In general, ORHAGO and FR-BB-IN-Q4 are consistent among ages. Both show a decrease of the age 3 indices.

7.3 Assessment

7.3.1 Input data

See stock annex

7.3.2 Model

The model used in 2019 to assess sole in the Bay of Biscay is FLXSA.

The age range in the assessment is 2–8+, as last year assessment.

The year range used is 1984–2018.

Result of XSA runs

The final XSA was run using the same settings than in last year assessment.

The Figure 7.3 shows a distribution of landings at age. As last year the landings are concentrated on age 3 and 4.

			2018 XSA		2019 XSA
Catch data range			84–16		84–17
Catch age range			2–8+		2–8+
Fleets	FR – SABLES	91-09	2–7	91–09	2–7
	FR – ROCHELLE	91-09	2–7	91–09	2–7
	FR-BB-IN-Q4	00-17	3–7	00–18	3–7
	FR-BB-OFF-Q2	00-12	2–6	00–12	2–6
	FR-ORHAGO	07-17	2–8	07–18	2–8
Taper			No		No
Ages catch dep. Stock size			No		No
Q plateau			6		6
F shrinkage se			1.5		1.5
Year range			5		5
age range			3		3
Fleet se threshold			0.2		0.2
F bar range			3–6		3–6

The results are given in Table 7.7. The log-catchability residuals are shown in Figure 7.5 a & b and retrospective results in Figure 7.6. The retrospective pattern shows a well estimation on F, SSB for 2016 data.

The table 7.8 gives the results of the Mohn’s rho calculation that is the results from the most recent assessments and five retrospective assessments with terminal years (2012–2017). Mohn’s Rho value is 0.193 for the recruits, 0.027 for SSB and 0.053 for F.
Because of the lack of the FR-BB-OFF-Q2 abundance indices in the tuning data, the estimated survivors at age 2 are only based on the ORHAGO survey. The recruits at age 2 were well estimated for 2017.

At age 3, the only one commercial fleet which estimated survivors to have a significant weight is the FR-BB-INQ4 (around 24 %) and it increases by 58 % at age 7. The FR-BB-OFF-Q2 has no weight in the evaluation, is around 0.5% for age 7. The two discontinued commercial fleets FR-SABLES and FR-ROCHELLE have no more weight at all ages. At age 6, the fleets FR-BB-IN-Q4 and FR-ORHAGO have more or less the same estimated survivors around, respectively, 52 % and 47 %.

Fishing mortalities and stock numbers-at-age are given in Tables 7.9 and 7.10 respectively. The results are summarised in Table 7.11. Trends in yield, F, SSB and recruitments are plotted in Figure 7.7. Fishing mortality in 2017 is estimated by XSA to have been at 0.3. Fishing mortality was 0.47 in 2015, and 0.41 in 2016.

7.3.2.1 Estimating year class abundance

In this year's assessment the retrospective analyses show that since 2012 the recruitments were well estimated by XSA (except for 2014). As the estimate of the recruitment for last year (2016 in this year's assessment) is well estimated, as shown by the retrospective pattern for recruits, the estimated value by the assessment model is kept for short term projection.

Recruitment at age 2

Year class	Thousands	Basis	Survey	Commercial	Shrinkage
2016	14 323	XSA	95 %	0 %	5 %
2017 & subsequent	20 833	GM(93-16)			

Historic trends in biomass, fishing mortality and recruitment

A full summary of the time series of XSA results are given in Table 7.11 and illustrated in Figure 7.7.

Since 1984, fishing mortality gradually increased, peaked in 2002 and decreased substantially the following two years. It increased in 2005 and, later on stabilised at around F_{pa} (= 0.43). 2017 was below F_{MSY} but 2018 is in between F_{MSY} and $F_{pa.}$

The SSB trend in earlier years increases from 12 300 t in 1984 to 16 300 t in 1993, afterwards it shows a continuous decrease to 9600 t in 2003. After an increase between 2003 and 2006, the SSB remains close to 11 000 t from 2007 to 2009. Since 2004, the SSB although above the new Bpa (10 600 t) has been decreasing since 2012. The SSB value for 2014 and 2015 are below the Bpa. The last é estimated SSB are above $MSYB_{trigger}$.

The recruitment values are lower since 1993. Between 2004 and 2008, the series is stable around 17 or 18 million and the 2007 year class is the highest value since 1984. The 2010 and 2011 values are closed to the $GM_{93–15}$ (21 million). However, the 2012 and 2013 values are the lowest of the series (around 13 million). The last recruitments are still at low values.

7.3.3 Catch options and prognosis

The exploitation pattern is the mean over the period 2016–2018 scaled at the last year.

As the TAC is taken at more than 80%, a TAC constraint for the intermediate year is used and set at 3967 Tonnes (Catch advice from 2018)

The recruits at age 2 from 2019 to 2020 are assumed equal to GM_{93-15}. Stock numbers at age 3 and above are the XSA survivor estimates.

Weights at age in the landings are the 2016–2018 means using the new fresh/gutted transformation coefficient of French landing which was changed from 1.11 to 1.04 in 2007. Weights at age in the stock are the 2016–2018 means using the old fresh/gutted transformation coefficient of French landing (1.11). The predicted spawning biomass is consequently still comparable to the biomass reference point.

7.3.3.1 Short term predictions

Input values for the catch forecast are given in Table 7.12.

The landings forecasts (Table 7.13) is 3967 t in 2019 (equal to 2019 catch advice). The F corresponding to assumption about catch for this run is 0.395.

Assuming recruitment at $GM_{93–16}$, the SSB is predicted to increase to 13047 t in 2020. It will continue to increase at F_{MSY}, to reach 14178 t in 2021 (Tables 7.13 and 7.14).

7.3.4 Biological reference points

WKMSYRef4 for MSY approach reference points are given below with technical basis with the value adopted for the precautionary approach reference points:

	Type	Value	Technical basis
MSY	MSY Btrigger	10 600 t	Bpa
Approach	F_{MSY}	0.33	F_{MSY} without Btrigger
	Blim	7600 t	Blim = Bpa / exp(σ x 1.645)
Precautionary	Bpa	10 600 t	The third lowest value
Approach	Flim	0.6	In equilibrium gives a 50% probability of SSB>Blim
	Fpa	0.43	Fpa = Flim x exp(-σ x 1.645)

The fishing mortality pattern is known with a low uncertainty because of the limited discards and the satisfactory sampling level of the catches.

7.3.5 Comments on the assessment

Sampling

The sampling level for this stock is considered to be satisfactory.

The ORHAGO survey provides information on several year classes at age 2. At other ages, it is particularly useful to have a survey in the tuning file because the new use of electronic logbooks has caused some obvious wrong recordings of effort which limit available commercial tuning data in 2012 and 2013 and the lack of FR-BB-OFF-Q2 (since 2013) abundance indices.

Stopping the use of fleets of La Rochelle and Les Sables tuning series led to a paucity of information at age 2 in 2013, which were only provided by the Offshore Q2 tuning fleet (when the data was available). That is no more the case with incorporation of the ORHAGO survey in the assessment.

The same age reading method is now adopted by France and Belgium, however a discrepancy still exists between French and Belgian weights-at-age which has to be investigated.

Discarding

Available data on discards have shown that discards may be important at age 1 for some trawlers. Discard at age 2 were assumed to be low in the past because the high commercial value of the sole catches but there are some reports of high-grading practices due to the landing limits adopted by some producers' organisations. The data available for discards do not seem representative to use them in the assessment.

Consistency

Since the 2013 assessment, the ORHAGO survey has been included in the tuning fleets. This survey is the only one tuning fleet which provides a recruit index series up to 2013 because no

LPUE data are available since 2013 for the only one commercial tuning fleet which can also provide a recruitment index.

The GM is used only for recruitments prediction (2018–2020) recruitment; this GM estimate has a low contribution in predicted landings and SSB because the recruits in terminal year is 16402 million and the GM_{93-16} is 20833 million. Furthermore, it is worth noting that variability of the recruit series has increased since 2001 and that, in recent period (until 2011).

The retrospective pattern in F shows a well estimation in 2016 (Figure 7.6).

The definition of reference groups of vessels and the use of thresholds on species percentage to build the French series of commercial fishing effort data and LPUE indices are considered to provide representative LPUE of change in stock abundance by limiting the effect of long-term change in fishing power (technological creep) and of change in fishing practices in the sole fishery.

The figure 7.9 shows the difference between the assessments in 2017 and in 2018. The SSB, the F and recruits at age 2 have been very little revised.

Misreporting

Misreporting is likely to be limited for this stock but it may have occurred for fish of the smallest market size category in some years. There are some reports of high-grading practices due to the landing limits adopted by some producers' organisations.

Industry input

The traditional meeting with representatives of the fishing industry was not organized in France prior to the WG to present the data used by the 2019 WGBIE to assess the state of the Bay of Biscay sole stock.

Since 2015, the French sole fishery in the Bay of Biscay (ICES divisions 8ab) has been subjected to additional management measures aimed at reducing fishing mortality and improving the recruitment level of the stock. Since 2016, these measures have concerned a fishing stop of at least 15 days during the first quarter for netters and a reinforcement of the selectivity for at least 8 months of the year (including the first quarter) for trawlers.

In addition to the European measures of the management plan of the Bay of Biscay sole ((EC) 2006) stock and the harvest control rules defined in the framework of the South West Waters Advisory Council, France has set up from 2015 a national management regime towards the French sole fishery in the Bay of Biscay . This management regime provides in 2019 for:

- a fishing stop of 15 days per period of 5 consecutive days during the first quarter of the year, for netters holding a European fishing authorization for sole in the Bay of Biscay (AEP SGG). From 2016 to 2018, these vessels were subjected to a fishing stop of 21 days per period of 7 consecutive days in the first quarter;
- the obligation to use a mesh size greater than or equal to 80 mm (the regulatory mesh size being 70 mm) from 1 January to 31 May and for at least 3 consecutive months from 1 June to 31 December, for bottom trawlers holding a AEP SGG.

The actual effectiveness of these management measures is not fully assessed, but

- Stopping netters during the months when harvest yields are the most important should significantly reduce landings. A study made by IFREMER (Ifremer 2015) quantified that stopping the fishery 5 days per month during the first quarter corresponds to a reduction of 16% of the annual landings of the netters, under identical conditions of activity elsewhere.

- The increase in the mesh size of the bottom trawls should also limits catches of sole that have not reached maturity (26 cm). A study made by AGLIA [Aglia2009] showed that size compositions of the 70 mm and 80 mm trawl catches differed and catches of sole less than 28 cm are considerably reduced.

Management considerations

The assessment indicates that SSB has decreased continuously to 9593 t in 2003, since a peak in 1993 (16 324 t), and has increased to 14665 t in 2011. After another decrease between 2011 to 2015, the SSB is now increasing in last year. It is estimated to be 13 182 t (above B_{pa} = 10 600 t) in 2018 assuming $GM_{93–15}$ recruitment value for 2018, and an increase is predicted by the short-term prediction, and SSB is assumed to increase in 2019 and 2020.

The (EC) 388/2006 management plan is agreed for the Bay of Biscay sole but a long-term F target has not yet been set. This plan has not been evaluated by ICES.

7.4 Tables and Figures

Table 7.1 a: Bay of Biscay sole (Division 8a,b). Internationals landings and catches used by the Working Group (in tonnes).

Table **7.1 a** : Bay of Biscay sole (Division 8a,b). Internationnal landings and catches used by the Working Group (in tonnes).

	Official landings						WG	Discards [2]	WG
Years	Belgium	France	Nether.	Spain	Others	Total	landings		catches
1979	0	2376		62*		2443	2619	-	-
1980	33*	2549		107*		2689	2986	-	-
1981	4*	2581*	13*	96*		2694	2936	-	-
1982	19*	1618*	52*	57*		1746	3813	-	-
1983	9*	2590	32*	38*		2669	3628	-	-
1984	na	2968	175*	40*		3183	4038	99	4137
1985	25*	3424	169*	308*		3925	4251	64	4315
1986	52*	4228	213*	75*		4567	4805	27	4832
1987	124*	4009	145*	101*		4379	5086	198	5284
1988	135*	4308		0		4443	5382	254	5636
1989	311*	5471		0		5782	5845	356	6201
1990	301*	5231		0		5532	5916	303	6219
1991	389*	4315		3		4707	5569	198	5767
1992	440*	5928		0		6359	6550	123	6673
1993	400*	6096		13		6496	6420	104	6524
1994	466*	6627		2***		7095	7229	184	7413
1995	546*	5326		0		5872	6205	130	6335
1996	460*	3842		0		4302	5854	142	5996
1997	435*	4526		0		4961	6259	118	6377
1998	469*	3821	44	0		4334	6027	127	6154
1999	504	3280		0		3784	5249	110	5359
2000	451	5293		5***		5749	5760	51	5811
2001	361	4350	201	0		4912	4836	39	4875
2002	303	3680		2***		3985	5486	21	5507
2003	296	3805		4***		4105	4108	20	4128
2004	324	3739		9***		4072	4002	-	-
2005	358	4003		10		4371	4539	-	-
2006	393	4030		9		4432	4793	-	-
2007	401	3707		9		4117	4363	-	-
2008	305	3018		11	2*	3336	4299	-	-
2009	364	4391				4755	3650	-	-
2010	451	4248				4699	3966	-	-
2011	386	4259				4645	4632	-	-
2012	385	3819				4204	4321	-	-
2013	312	4181				4492	4235	-	-
2014	307	3793		10		4110	3928	-	-
2015	302	3465		8		3775	3644	62^	3706
2016	288	3054		4		3346	3232	134^	3366
2017	274	2953		8		3236	3249	55^	0
2018	295	3165		8		3468	3547**	220^	3767

[1] including reported in VIII or VIIIc,d [2] Discards = Partial estimates for the French offshore trawlers fleet

* reported in VIII ** Preliminary *** reported as *Solea* spp (*Solea lascaris* and *solea solea*) in VIII

^ Calculated from the landings estimate and an estimated discard rate

Table **7.1 b** : Bay of Biscay sole (Division 8a,b). Contribution (in %) to the total landings by differents fleets.

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Shrimp trawlers	7	7	8	11	6	5	4	3	3	2	2	2	1	1	1
Inshore trawlers	29	28	27	25	31	29	30	25	27	25	17	13	13	12	13
Offshore otter trawlers	61	62	60	60	59	60	45	45	47	46	41	41	39	31	28
Offshore beam trawlers	0	1	0	0	0	0	1	1	2	3	5	5	7	7	6
Fixed nets	3	3	5	4	4	6	20	26	20	24	35	39	40	49	52

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Shrimp trawlers	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inshore trawlers	11	13	12	11	10	5	8	9	7	8	9	7	8	9	6
Offshore otter trawlers	29	26	26	30	30	24	21	24	18	24	23	21	19	21	19
Offshore beam trawlers	6	9	8	7	8	10	8	8	6	7	8	8	9	9	7
Fixed nets	52	53	54	52	52	61	63	59	70	60	60	63	64	61	69

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Shrimp trawlers	0	0	0	0	0	0	0	0		
Inshore trawlers	6	8	7	8	7	8	7	8	8	7
Offshore otter trawlers	21	19	17	17	18	18	15	15	16	14
Offshore beam trawlers	10	11	8	9	7	8	8	9	8	9
Fixed nets	63	61	67	66	68	65	70	68	68	70

Table 7.3: Bay of Biscay Sole, Catch number at age (in thousands)

	year									
age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	5901	8493	6126	3794	4962	4918	7122	4562	4640	1897
3	3164	4606	4208	5634	5928	6551	6312	6302	7279	7816
4	2786	2479	2673	3578	4191	3802	4423	4512	4920	6879
5	2034	1962	2301	2005	2293	3147	2833	2083	2991	3661
6	1164	906	1512	1482	1388	2046	972	1113	2236	1625
7	880	708	1044	690	874	967	1018	1063	1124	566
8	1181	729	1235	714	766	499	870	981	951	708

	year									
age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	2603	3249	3027	3801	4096	2851	5677	3180	5198	4274
3	5502	5663	5180	9079	5550	5113	7015	6528	4777	6309
4	8803	6356	5409	5380	6351	4870	5143	4948	4932	2236
5	5040	3644	2343	3063	2306	2764	2542	1776	3095	1220
6	1968	1795	1697	1578	1237	1314	955	899	1269	729
7	970	843	1366	692	785	902	421	513	615	377
8	696	986	1319	877	1188	977	444	486	432	250

	year									
age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	3411	3976	3535	3885	3173	2860	2084	1516	1302	2312
3	5415	3464	4436	5181	4794	3986	7707	5222	4680	2939
4	3291	3738	2747	2615	2886	2233	3758	8347	4264	3777
5	917	2309	2012	1419	1353	1501	1272	1019	3787	3205
6	661	991	1030	1262	938	946	484	570	1008	1450
7	272	461	530	686	892	541	269	275	225	286
8	333	508	1537	946	1193	960	284	516	517	635

	year				
age	2014	2015	2016	2017	2018
2	3767	2531	1144	1544	1562
3	3198	3365	3368	3656	3080
4	1769	1742	2682	2202	2183
5	2426	2057	1193	1023	1603
6	1810	1305	762	607	1017
7	791	939	759	588	717
8	522	636	867	950	1378

Table 7.4: Bay of Biscay Sole, Catch weight at age (in kg)

age \ year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	0.12100	0.10600	0.10200	0.14100	0.13400	0.13600	0.13100	0.14300	0.14600	0.14500
3	0.16800	0.17400	0.17300	0.20100	0.19000	0.18800	0.17900	0.19200	0.19600	0.19700
4	0.21300	0.25200	0.24500	0.28500	0.27200	0.25800	0.24100	0.26000	0.26200	0.26700
5	0.26900	0.31300	0.32800	0.37600	0.35700	0.35400	0.34800	0.32500	0.34100	0.34100
6	0.32900	0.39000	0.40900	0.46700	0.49500	0.43700	0.43600	0.43700	0.40400	0.43900
7	0.36800	0.45700	0.49800	0.49700	0.50300	0.54300	0.60100	0.53500	0.49000	0.56900
8	0.57300	0.69800	0.65700	0.68200	0.60400	0.79900	0.85400	0.71500	0.71500	0.67700

age \ year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0.14700	0.16000	0.15900	0.14200	0.16100	0.17700	0.17100	0.15200	0.17100	0.18000
3	0.19500	0.20600	0.20400	0.19300	0.21200	0.21900	0.20700	0.22000	0.20800	0.22600
4	0.25100	0.25200	0.26800	0.25600	0.25700	0.24600	0.27600	0.26500	0.26300	0.30700
5	0.32400	0.30800	0.31900	0.31900	0.33500	0.30500	0.34300	0.34100	0.32000	0.36100
6	0.42100	0.40300	0.39900	0.40600	0.41000	0.40400	0.45200	0.42800	0.46600	0.48700
7	0.56900	0.48400	0.45300	0.50200	0.50100	0.53300	0.57300	0.51900	0.59200	0.65700
8	0.77400	0.65800	0.62500	0.67800	0.70000	0.58200	0.75500	0.61900	0.68100	0.64200

age \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0.19000	0.18900	0.19500	0.17600	0.17400	0.17000	0.17900	0.19300	0.18200	0.20800
3	0.22700	0.22600	0.24200	0.22500	0.22900	0.21500	0.20600	0.22300	0.22400	0.24000
4	0.29000	0.29800	0.28200	0.29800	0.28700	0.27500	0.27200	0.25300	0.25700	0.27200
5	0.39100	0.36700	0.34700	0.32600	0.35200	0.31700	0.33700	0.34200	0.30700	0.30400
6	0.49300	0.43000	0.42000	0.38800	0.39200	0.36100	0.41400	0.43200	0.36900	0.36800
7	0.64300	0.46800	0.45500	0.41900	0.40100	0.44700	0.47700	0.48900	0.41400	0.51800
8	0.81000	0.65600	0.53300	0.51100	0.51900	0.60100	0.76800	0.60600	0.58500	0.52100

age \ year	2014	2015	2016	2017	2018
2	0.17700	0.19700	0.18800	0.20761	0.17601
3	0.24100	0.22500	0.23700	0.22856	0.22816
4	0.28100	0.31600	0.28500	0.28965	0.27481
5	0.29600	0.31200	0.35100	0.36192	0.34557
6	0.34800	0.38700	0.37100	0.41737	0.38242
7	0.39400	0.36500	0.38100	0.41079	0.38786
8	0.57600	0.51700	0.52500	0.50374	0.45229

(*) for 2007 to 2018, French catch weight at age computed using the new fresh/gutted transformation coefficient (1.04).

Before 2007, the French fresh/gutted transformation coefficient is 1.11.

The Belgian fresh/gutted transformation coefficient is 1.04 in 2016.

Table 7.6. Sole 8ab, available tuning data (landings); commercial landings (N in 10-3) and survey catch - Fishing effort in hours. Series, year and range used in tuning are shown in bold type.**

Table 7.6 : Sole 8ab, available tuning data (landings)

SOLE VIIIa,b commercial landings (N in 10**-3) and survey catch - Fishing effort in hc

Series, year and range used in tuning are shown in bold type

FR - SABLES									
Year	Fishing effort	1	**2**	**3**	**4**	**5**	**6**	**7**	8
1991	33763	30,5	**242,1**	**332,8**	**194,7**	**73,8**	**32,4**	**23,6**	19,5
1992	30445	3,7	**236,8**	**285,8**	**130,2**	**59,5**	**32,1**	**15,0**	11,9
1993	34273	3,7	**152,0**	**441,3**	**224,0**	**75,7**	**27,0**	**8,0**	10,9
1994	20997	1,2	**94,1**	**157,4**	**184,3**	**77,3**	**24,2**	**13,4**	10,8
1995	31759	7,3	**173,4**	**228,1**	**177,1**	**69,1**	**34,1**	**15,9**	19,5
1996	31518	13,0	**193,0**	**222,6**	**169,8**	**55,6**	**37,8**	**29,4**	23,2
1997	27040	5,0	**140,9**	**290,9**	**114,2**	**49,0**	**26,7**	**10,6**	11,4
1998	16260	0,8	**86,9**	**112,1**	**113,6**	**31,4**	**13,8**	**8,1**	7,7
1999	12528	0,0	**64,9**	**53,2**	**39,7**	**26,8**	**15,0**	**15,2**	17,6
2000	11271	3,4	**81,3**	**121,3**	**45,0**	**15,7**	**8,4**	**4,7**	4,7
2001	9459	2,3	**32,9**	**64,5**	**35,2**	**9,5**	**5,5**	**3,1**	2,2
2002	10344	7,2	**76,9**	**60,3**	**37,5**	**19,3**	**8,4**	**3,9**	1,7
2003	7354	1,5	**38,9**	**49,1**	**14,3**	**7,8**	**4,0**	**1,7**	0,6
2004	6909	2,7	**38,4**	**36,5**	**22,7**	**5,7**	**3,8**	**1,7**	1,8
2005	6571	6,6	**46,4**	**26,6**	**25,2**	**15,3**	**6,4**	**3,3**	3,2
2006	6223	7,7	**63,1**	**29,7**	**11,9**	**6,6**	**3,7**	**2,4**	6,3
2007	5954	1,0	**32,6**	**28,4**	**18,0**	**12,4**	**10,6**	**6,6**	8,2
2008	4321	0,0	**22,8**	**22,8**	**16,4**	**8,1**	**5,2**	**4,9**	7,8
2009	3577	0,7	**23,0**	**22,2**	**9,8**	**7,1**	**4,2**	**2,4**	5,7
FR - ROCHEL									
Year	Fishing effort	1	**2**	**3**	**4**	**5**	**6**	**7**	8
1991	15250	14,7	**134,8**	**157,4**	**88,9**	**30,3**	**11,6**	**6,7**	5,5
1992	12491	0,8	**99,4**	**130,1**	**58,7**	**21,2**	**9,1**	**4,5**	2,8
1993	12146	0,6	**53,3**	**126,5**	**51,8**	**17,2**	**6,4**	**2,1**	2,0
1994	8745	0,7	**42,4**	**56,5**	**52,9**	**19,4**	**6,4**	**2,7**	1,5
1995	4260	1,9	**25,9**	**31,3**	**20,7**	**7,2**	**2,4**	**1,1**	1,1
1996	10124	10,6	**113,1**	**74,6**	**34,3**	**8,8**	**5,0**	**3,1**	2,8
1997	12491	3,8	**74,1**	**117,6**	**35,8**	**12,6**	**7,3**	**2,6**	2,6
1998	10841	1,6	**77,7**	**65,4**	**57,9**	**11,3**	**4,7**	**2,9**	2,8
1999	8311	0,0	**53,7**	**31,6**	**19,0**	**10,1**	**6,4**	**4,3**	2,1
2000	8334	4,8	**64.0**	**44.4**	**19.2**	**6.7**	**2.8**	**1.5**	2.5
2001	7074	2,3	**24,7**	**39,9**	**23,7**	**5,5**	**3,3**	**1,9**	1,8
2002	6957	9,0	**89,2**	**36,3**	**11,8**	**5,4**	**2,3**	**1,3**	0,4
2003	5028	2,2	**37,8**	**40,0**	**9,1**	**3,7**	**1,7**	**0,5**	0,2
2004	1899	1,0	**12,1**	**11,8**	**4,4**	**1,0**	**0,7**	**0,3**	0,4
2005	3292	2,4	**17,3**	**10,5**	**8,8**	**5,2**	**2,4**	**1,1**	1,3
2006	2304	1,5	**11,0**	**8,3**	**3,9**	**2,4**	**1,3**	**0,6**	1,9
2007	2553	0,2	**12,3**	**21,5**	**4,5**	**1,8**	**1,6**	**0,7**	1,0
2008	1887	0,2	**11,3**	**14,6**	**5,4**	**2,1**	**1,1**	**1,1**	1,5
2009	1176	0,1	**4,8**	**7,1**	**2,3**	**1,3**	**0,7**	**0,4**	0,6
FR-BB-IN-Q4									
Year	Fishing effort	3	4	5	6	7	8		
2000	1445	**11,55**	**3,44**	**1,03**	**0,35**	**0,23**	**0,09**		
2001	1803	**6,56**	**2,03**	**0,77**	**0,66**	**0,32**	**0,52**		
2002	2276	**11,09**	**1,62**	**1,00**	**0,99**	**0,64**	**0,51**		
2003	2913	**32,18**	**4,54**	**0,87**	**0,53**	**0,38**	**0,50**		
2004	3105	**24,68**	**9,01**	**3,58**	**3,05**	**0,57**	**1,42**		
2005	5055	**16,43**	**13,19**	**5,35**	**2,13**	**1,12**	**2,73**		
2006	7334	**27,98**	**6,95**	**4,78**	**4,03**	**2,70**	**6,27**		
2007	4143	**16,22**	**7,33**	**3,75**	**3,11**	**0,69**	**2,21**		
2008	3820	**16,05**	**8,70**	**3,02**	**1,69**	**1,25**	**1,25**		
2009	3615	**14,71**	**3,36**	**1,81**	**1,53**	**0,64**	**1,37**		
2010	4603	**36,00**	**10,16**	**3,24**	**1,01**	**0,48**	**1,14**		
2011	5148	**22,91**	**13,82**	**3,64**	**1,82**	**0,80**	**1,65**		
2012	3088	**21,55**	**14,44**	**7,58**	**1,50**	**0,98**	**1,17**		
2013	3333	**8,64**	**8,23**	**3,36**	**2,99**	**1,08**	**2,04**		
2014	5261	**17,80**	**5,41**	**4,08**	**3,01**	**0,94**	**1,19**		
2015	2777	**8,56**	**2,88**	**2,36**	**1,47**	**1,00**	**0,56**		
2016	3214	**13,07**	**3,51**	**2,46**	**1,58**	**0,70**	**2,84**		
2017	4679	**23,60**	**7,93**	**2,23**	**2,32**	**1,52**	**2,05**		
2018	4518	**9,70**	**4,67**	**3,28**	**2,01**	**1,36**	**2,55**		

Table 7.6: cont'd

FR-BB-OFF-Q2									
Year	Fishing effort	1	2	3	4	5	6	7	8
2000	5567	0,00	**22,92**	**28,32**	**23,17**	**9,54**	**2,72**	0,90	1,66
2001	5039	0,01	**14,87**	**30,25**	**20,82**	**5,69**	**3,64**	1,42	1,08
2002	5604	0,01	**36,79**	**33,91**	**17,16**	**9,07**	**4,09**	2,12	0,53
2003	3324	0,02	**22,88**	**27,61**	**6,99**	**1,85**	**0,81**	0,08	0,03
2004	4809	0,00	**13,97**	**43,91**	**14,51**	**1,37**	**0,70**	0,26	0,40
2005	4535	3,67	**13,13**	**19,61**	**16,22**	**5,78**	**0,56**	0,43	0,57
2006	2235	0,00	**3,50**	**9,56**	**2,91**	**1,50**	**0,97**	0,33	0,31
2007	4013	0,00	**13,41**	**46,11**	**6,41**	**1,18**	**1,69**	0,24	0,54
2008	3211	0,00	**16,58**	**23,51**	**7,36**	**2,33**	**0,40**	0,83	0,49
2009	968	0,00	**0,70**	**5,05**	**1,69**	**0,53**	**0,16**	0,10	0,22
2010	2279	0,00	**1,55**	**27,23**	**7,96**	**2,16**	**0,12**	0,03	0,07
2011	2882	0,00	**0,97**	**12,40**	**23,98**	**1,61**	**0,82**	0,39	1,11
2012	2047	0,00	**4,33**	**14,92**	**7,59**	**4,66**	**0,42**	0,32	0,37

FR-ORHAGO									
Year	Fishing effort	2	3	4	5	6	7	8	
2007	100	**159,0**	**67,6**	**27,0**	**15,2**	**9,2**	**0,8**	**1,9**	
2008	100	**124,3**	**68,0**	**21,6**	**4,1**	**2,3**	**2,7**	**1,3**	
2009	100	**477,1**	**95,0**	**18,5**	**4,5**	**1,8**	**0,3**	**2,2**	
2010	100	**192,7**	**157,1**	**19,9**	**2,4**	**0,1**	**0,9**	**0,6**	
2011	100	**205,9**	**75,4**	**29,6**	**2,9**	**1,6**	**2,0**	**3,2**	
2012	100	**89,0**	**101,8**	**54,9**	**22,5**	**5,4**	**3,3**	**5,5**	
2013	100	**84,2**	**50,5**	**61,9**	**24,2**	**15,9**	**4,7**	**3,4**	
2014	100	**227,8**	**50,8**	**27,8**	**23,1**	**18,7**	**7,5**	**6,9**	
2015	100	**191,9**	**55,5**	**22,9**	**17,6**	**14,7**	**7,1**	**8,2**	
2016	100	**188,3**	**112,1**	**26,2**	**18,7**	**8,4**	**4,8**	**5,6**	
2017	100	**164,7**	**96,8**	**39,9**	**14,1**	**12,9**	**7,1**	**10,3**	
		178,4	**64,2**	**35,7**	**24,6**	**9,7**	**8,3**	**9,6**	

Table 7.7: XSA tuning diagnostic

CPUE data from indices

Catch data for 35 years. 1984 to 2018. Ages 2 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	FR-SABLES	2	7	1991	2009	0	1
2	FR-ROCHELLE	2	7	1991	2009	0	1
3	FR-BB-IN-Q4	3	7	2000	2018	0.75	1
4	FR-BB-OFF-Q2	2	6	2000	2012	0.25	0.5
5	FR-ORHAGO	2	7	2007	2018	0.83	0.96

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for all ages

Catchability independent of age for ages > 6

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.5

Minimum standard error for population
estimates derived from each fleet = 0.2

prior weighting not applied

Regression weights

year										
age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

year										
age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2	0.093	0.094	0.081	0.105	0.191	0.273	0.160	0.075	0.132	0.099
3	0.368	0.344	0.319	0.338	0.321	0.389	0.370	0.295	0.322	0.371
4	0.449	0.624	0.677	0.413	0.444	0.291	0.337	0.502	0.285	0.288
5	0.567	0.441	0.300	0.664	0.554	0.505	0.568	0.361	0.321	0.308
6	0.542	0.317	0.320	0.483	0.509	0.620	0.495	0.376	0.281	0.537
7	0.490	0.256	0.267	0.180	0.217	0.511	0.678	0.530	0.492	0.550
8	0.490	0.256	0.267	0.180	0.217	0.511	0.678	0.530	0.492	0.550

XSA population number (Thousand)

year	age 2	3	4	5	6	7	8
2009	33751	13598	6495	3645	2377	1468	2593
2010	24426	27819	8513	3753	1871	1251	1317
2011	20569	20119	17840	4128	2186	1232	2306
2012	13790	17170	13237	8203	2766	1436	3293
2013	13966	11239	11084	7921	3820	1544	3420
2014	16601	10438	7374	6436	4119	2077	1364
2015	17982	11438	6403	4990	3516	2005	1350
2016	16638	13863	7149	4136	2558	1940	2206
2017	13167	13966	9340	3917	2608	1590	2557
2018	**17472**	**10445**	**9160**	**6357**	**2571**	**1782**	**3408**

Table 7.7: Cont'd

```
Estimated population abundance at 1st Jan  2019
      age
year   2     3    4    5    6    7   8
  2019 0 14323 6522 6211 4227 1359 931


 Fleet:  FR-SABLES

 Log catchability residuals.

   year
age   1991   1992   1993   1994   1995   1996   1997   1998   1999   2000   2001  2002
  2 -0.233 -0.139 -0.382 -0.410 -0.085 -0.210 -0.124 -0.037 -0.184  0.191 -0.173 0.216
  3  0.102 -0.191  0.156 -0.112 -0.178 -0.031  0.201 -0.014 -0.425  0.387  0.063 0.251
  4  0.125 -0.277 -0.095  0.361  0.135  0.010  0.007  0.437 -0.231  0.128 -0.062 0.126
  5  0.071 -0.167 -0.117  0.220 -0.013 -0.128 -0.247  0.148  0.275 -0.096 -0.285 0.336
  6 -0.196  0.162 -0.396  0.025 -0.247  0.237 -0.027 -0.402  0.427 -0.028 -0.233 0.344
  7 -0.060 -0.149 -0.263  0.188  0.071  0.487  0.001  0.110  0.543  0.102 -0.195 0.072
   year
age   2003   2004   2005   2006   2007  2008   2009
  2 -0.127  0.295  0.483  0.817  0.262 0.151 -0.311
  3  0.009 -0.296 -0.184 -0.009 -0.025 0.158  0.139
  4 -0.303 -0.188 -0.155 -0.472  0.058 0.345  0.052
  5 -0.185 -0.504  0.233 -0.743  0.340 0.319  0.542
  6  0.043 -0.352  0.153 -0.538  0.269 0.330  0.428
  7  0.074 -0.119  0.051 -0.156  0.667 0.365  0.328


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2        3        4        5        6        7
Mean_Logq -15.0676 -14.5137 -14.4688 -14.6504 -14.6453 -14.6453
S.E_Logq    0.2744   0.2744   0.2744   0.2744   0.2744   0.2744


 Fleet:  FR-ROCHELLE

 Log catchability residuals.

   year
age   1991   1992   1993   1994   1995   1996   1997   1998   1999   2000   2001   2002
  2 -0.090 -0.182 -0.458 -0.397 -0.043  0.325 -0.060  0.191 -0.028  0.188 -0.235  0.696
  3  0.190 -0.046 -0.014 -0.219 -0.114  0.053  0.109 -0.106 -0.494 -0.275 -0.086  0.181
  4  0.439  0.120 -0.219  0.291  0.301 -0.151 -0.078  0.472 -0.255 -0.119  0.136 -0.330
  5  0.450  0.167 -0.087  0.188  0.209 -0.361 -0.359  0.005  0.184 -0.172 -0.067 -0.067
  6  0.109  0.330 -0.261  0.108 -0.355 -0.113 -0.014 -0.536  0.523 -0.287  0.084 -0.017
  7  0.013  0.075 -0.026 -0.001 -0.054 -0.090 -0.095  0.026  0.228 -0.201  0.143 -0.093
   year
age   2003   2004   2005   2006   2007  2008   2009
  2  0.158  0.366  0.122 -0.002  0.068 0.212 -0.831
```

```
3  0.225 -0.093 -0.381 -0.249  0.584 0.582  0.153
4 -0.071 -0.235 -0.213 -0.291 -0.179 0.365  0.018
5 -0.077 -0.479  0.319 -0.287 -0.269 0.272  0.431
6  0.105 -0.215  0.400 -0.053 -0.238 0.143  0.286
7 -0.232 -0.024  0.181 -0.012 -0.193 0.237  0.186
```

Table 7.7: Cont'd

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7
Mean_Logq	-15.0019	-14.555	-14.7718	-15.1246	-15.1827	-15.1827
S.E_Logq	0.2640	0.264	0.2640	0.2640	0.2640	0.2640

Fleet: FR-BB-IN-Q4

Log catchability residuals.

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
3	0.342	-0.301	0.344	0.763	0.323	-0.203	0.016	0.053	0.204	-0.077	-0.161	-0.423
4	0.495	-0.423	-0.599	0.221	0.428	0.201	-0.413	0.284	0.629	-0.282	0.465	-0.033
5	0.120	-0.316	-0.093	-0.698	0.534	0.254	-0.480	0.265	0.217	-0.017	0.184	-0.029
6	-0.477	-0.025	0.582	-0.348	0.829	-0.021	0.020	0.025	-0.026	0.081	-0.532	-0.208
7	-0.210	-0.126	0.551	0.274	0.215	-0.143	0.463	-0.561	-0.223	-0.353	-0.927	-0.503

age \ year	2012	2013	2014	2015	2016	2017	2018
3	0.202	-0.379	0.020	-0.181	-0.162	0.070	-0.450
4	0.591	0.156	-0.446	-0.259	-0.170	-0.188	-0.658
5	0.846	-0.105	-0.203	0.199	0.102	-0.353	-0.427
6	0.016	0.330	-0.099	-0.128	0.013	-0.081	0.047
7	-0.018	-0.029	-0.673	0.208	-0.391	0.176	0.037

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	3	4	5	6	7
Mean_Logq	-14.5353	-14.9984	-15.2011	-15.0619	-15.0619
S.E_Logq	0.3598	0.3598	0.3598	0.3598	0.3598

Fleet: FR-BB-OFF-Q2

Log catchability residuals.

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2	0.424	0.461	0.888	0.936	0.443	0.386	-0.253	0.562	0.930	-1.684	-1.422	-1.959
3	-0.434	-0.139	0.213	0.155	0.187	-0.180	-0.189	0.778	0.409	-0.098	0.006	-0.700
4	0.352	0.232	0.138	-0.019	-0.067	-0.019	-0.653	-0.378	0.037	-0.194	0.294	0.442
5	0.724	0.455	0.792	-0.195	-0.921	0.255	-0.563	-0.982	0.004	-0.122	0.350	-0.326
6	0.708	1.143	1.371	0.394	-0.508	-0.752	0.314	-0.003	-0.774	-0.373	-1.361	0.171

age \ year	2012
2	0.288
3	-0.008

```
  4 -0.166
  5  0.528
  6 -0.330


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2        3        4        5        6
Mean_Logq -15.9021 -14.5009 -14.7306 -15.3401 -15.8684
S.E_Logq    0.6472   0.6472   0.6472   0.6472   0.6472
```

Table 7.7: Cont'd

```
 Fleet:  FR-ORHAGO

 Log catchability residuals.

   year
age   2007   2008   2009   2010   2011   2012   2013   2014   2015  2016  2017  2018
  2  0.052 -0.295  0.346 -0.237 -0.011 -0.428 -0.419  0.476  0.125 0.107 0.258 0.025
  3  0.049  0.138  0.219 -0.015 -0.448  0.028 -0.264 -0.124 -0.144 0.300 0.170 0.093
  4  0.130  0.003 -0.169 -0.210 -0.505  0.176  0.500 -0.030 -0.041 0.131 0.012 0.002
  5  0.424 -0.796 -0.477 -1.248 -1.279  0.408  0.417  0.534  0.574 0.637 0.373 0.434
  6  0.274 -0.630 -0.722 -3.574 -0.954  0.173  0.953  1.139  0.944 0.596 0.921 0.880
  7 -1.243 -0.365 -2.078 -1.029 -0.205  0.065  0.378  0.813  0.942 0.451 1.008 1.101


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

               2       3       4        5        6        7
Mean_Logq -9.0371 -9.3691 -9.8068 -10.2284 -10.4947 -10.4947
S.E_Logq   0.7413  0.7413  0.7413   0.7413   0.7413   0.7413


 Terminal year survivor and F summaries:

 Age 2 Year class =2016

source
          scaledWts survivors yrcls
FR-ORHAGO     0.956     14692  2016
fshk          0.044      8209  2016

 Age 3 Year class =2015

source
            scaledWts survivors yrcls
FR-BB-IN-Q4     0.319      4157  2015
FR-ORHAGO       0.660      7160  2015
fshk            0.021      7227  2015
```

```
 Age 4 Year class =2014

source
            scaledWts survivors yrcls
FR-BB-IN-Q4     0.250      3216  2014
FR-ORHAGO       0.723      6222  2014
fshk            0.027      4600  2014

 Age 5 Year class =2013

source
            scaledWts survivors yrcls
FR-BB-IN-Q4     0.749      2759  2013
FR-ORHAGO       0.185      6522  2013
fshk            0.065      2587  2013

 Age 6 Year class =2012

source
            scaledWts survivors yrcls
FR-BB-IN-Q4     0.879      1425  2012
FR-ORHAGO       0.049      3276  2012
fshk            0.072      1667  2012

 Age 7 Year class =2011

source
            scaledWts survivors yrcls
FR-BB-IN-Q4     0.773       966  2011
FR-ORHAGO       0.123      2800  2011
fshk            0.105      1480  2011
```

Table 7.8: Mohn's Rho tables for R, SSB and R

SSB	R	F
0.027	0.193	0.053

Table 7.9. Bay of Biscay Sole, Fishing mortality (F) at age

```
 Fishing mortalities
   year
age  2009  2010  2011  2012  2013  2014  2015  2016  2017  2018
  2 0.093 0.094 0.081 0.105 0.191 0.273 0.160 0.075 0.132 0.099
  3 0.368 0.344 0.319 0.338 0.321 0.389 0.370 0.295 0.322 0.371
  4 0.449 0.624 0.677 0.413 0.444 0.291 0.337 0.502 0.285 0.288
  5 0.567 0.441 0.300 0.664 0.554 0.505 0.568 0.361 0.321 0.308
  6 0.542 0.317 0.320 0.483 0.509 0.620 0.495 0.376 0.281 0.537
  7 0.490 0.256 0.267 0.180 0.217 0.511 0.678 0.530 0.492 0.550
  8 0.490 0.256 0.267 0.180 0.217 0.511 0.678 0.530 0.492 0.550
```

Table 7.10. Bay of Biscay Sole, Stock number at age (start of year) Numbers*10-3**

```
XSA population number (Thousand)
      age
year       2     3     4    5    6    7    8
  2009 33751 13598  6495 3645 2377 1468 2593
  2010 24426 27819  8513 3753 1871 1251 1317
  2011 20569 20119 17840 4128 2186 1232 2306
  2012 13790 17170 13237 8203 2766 1436 3293
  2013 13966 11239 11084 7921 3820 1544 3420
  2014 16601 10438  7374 6436 4119 2077 1364
  2015 17982 11438  6403 4990 3516 2005 1350
  2016 16638 13863  7149 4136 2558 1940 2206
  2017 13167 13966  9340 3917 2608 1590 2557
  2018 17472 10445  9160 6357 2571 1782 3408
```

Table 7.11. Bay of Biscay Sole, Summary

Year	Recruitment	SSB	Landings	Mean F
	Age 2			Ages 3-6
	thousands	tonnes	tonnes	
1984	24150	12315	4038	0.31
1985	29511	13358	4251	0.31
1986	28307	14466	4805	0.37
1987	24892	15458	5086	0.37
1988	26724	15331	5382	0.40
1989	28130	14432	5845	0.50
1990	32075	14779	5916	0.45
1991	35698	14736	5569	0.42
1992	35317	15928	6550	0.61
1993	24876	16328	6420	0.53
1994	26191	15797	7229	0.65
1995	23560	14194	6205	0.58
1996	29367	13770	5854	0.55
1997	23700	13280	6259	0.61
1998	22577	13199	6027	0.54
1999	24385	12298	5249	0.63
2000	24969	11813	5760	0.63
2001	16902	10547	4836	0.57
2002	24809	9779	5486	0.83
2003	24369	9609	4108	0.49
2004	17042	11122	4002	0.37
2005	18157	11489	4539	0.46
2006	18362	12087	4793	0.44
2007	17587	11138	4363	0.46
2008	18364	11025	4299	0.50
2009	33751	10837	3650	0.48
2010	24426	12757	3966	0.43
2011	20569	14572	4632	0.40
2012	13790	14153	4321	0.47
2013	13966	13245	4235	0.46
2014	16601	10597	3928	0.45
2015	17982	10175	3644	0.44
2016	16638	10619	3232	0.38
2017	13167	12527	3264	0.30
2018	17472	11394	3547	0.38
2019	20833*			

Table 7.13. management option table

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
F_{MSY}	3663	3543	120	0,33	14179	9
F_{MSY}low	2147	2077	70	0,18	15931	22
F_{MSY}up	5051	4886	165	0,49	12580	-4
F_{MSY}	3663	3543	120	0,33	14179	9
0	0	0	0	0	18425	41
F_{pa}	4556	4407	149	0,43	13150	1
F_{lim}	5888	5695	193	0,6	11621	-11
SSB=BLIM	9446	9137	309	1,26	760	-42
SSB=BPA	6770	6548	222	0,73	10600	-19
F2019	4020	4020	136	0,38407	13610	4
TACSqWanted-Catch	3872	3872	131	0,36695814	13786	6
TACSqTotalCatch	3745	3745	127	0,35256877	13937	7
0.01	125,584819	125,584819	4,24828026	0,01	18273,6613	40,0504665
0.02	249,896199	249,896199	8,45348264	0,02	18124,1489	38,9045945
0.03	372,948327	372,948327	12,6160871	0,03	17976,1863	37,7706001
0.04	494,755223	494,755223	16,7365679	0,04	17829,7561	36,6483498
0.05	615,330744	615,330744	20,8153937	0,05	17684,841	35,5377122
0.06	734,68858	734,68858	24,8530277	0,06	17541,4242	34,4385569
0.07	852,842262	852,842262	28,8499276	0,07	17399,4889	33,3507555
0.08	969,805163	969,805163	32,8065458	0,08	17259,0183	32,2741807
0.09	1085,59049	1085,59049	36,7233293	0,09	17119,9963	31,2087072

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
0.1	1200,21132	1200,21132	40,6007197	0,1	16982,4065	30,1542107
0.11	1313,68054	1313,68054	44,4391537	0,11	16846,233	29,1105685
0.12	1426,0109	1426,0109	48,2390627	0,12	16711,46	28,0776596
0.13	1537,21502	1537,21502	52,0008731	0,13	16578,0718	27,0553642
0.14	1647,30535	1647,30535	55,7250061	0,14	16446,0529	26,0435638
0.15	1756,2942	1756,2942	59,4118783	0,15	16315,3883	25,0421415
0.16	1864,19374	1864,19374	63,0619011	0,16	16186,0626	24,0509817
0.17	1971,01598	1971,01598	66,6754814	0,17	16058,0611	23,0699702
0.18	2076,77281	2076,77281	70,253021	0,18	15931,369	22,0989941
0.19	2181,47598	2181,47598	73,7949172	0,19	15805,9717	21,1379418
0.2	2285,13708	2285,13708	77,3015626	0,2	15681,8549	20,186703
0.21	2387,7676	2387,7676	80,7733452	0,21	15559,0044	19,2451688
0.22	2489,37886	2489,37886	84,2106486	0,22	15437,406	18,3132315
0.23	2589,98208	2589,98208	87,6138517	0,23	15317,046	17,3907846
0.24	2689,58832	2689,58832	90,9833292	0,24	15197,9105	16,477723
0.25	2788,20852	2788,20852	94,3194512	0,25	15079,986	15,5739427
0.26	2885,85351	2885,85351	97,6225837	0,26	14963,2592	14,6793409
0.27	2982,53398	2982,53398	100,893088	0,27	14847,7167	13,7938161
0.28	3078,26049	3078,26049	104,131322	0,28	14733,3455	12,917268
0.29	3173,04349	3173,04349	107,337639	0,29	14620,1326	12,0495974

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
0.3	3266,89329	3266,89329	110,512388	0,3	14508,0652	11,1907062
0.31	3359,82011	3359,82011	113,655914	0,31	14397,1307	10,3404975
0.32	3451,83401	3451,83401	116,768558	0,32	14287,3166	9,49887566
0.33	3542,94498	3542,94498	119,850658	0,33	14178,6106	8,66574596
0.34	3633,16286	3633,16286	122,902546	0,34	14071,0004	7,84101486
0.35	3722,49738	3722,49738	125,924552	0,35	13964,474	7,02458993
0.36	3810,95817	3810,95817	128,917002	0,36	13859,0195	6,21637977
0.37	3898,55475	3898,55475	131,880217	0,37	13754,625	5,41629408
0.38	3985,29651	3985,29651	134,814515	0,38	13651,279	4,62424359
0.39	4071,19275	4071,19275	137,720211	0,39	13548,9698	3,84014006
0.4	4156,25265	4156,25265	140,597615	0,4	13447,6862	3,06389629
0.41	4240,4853	4240,4853	143,447035	0,41	13347,4169	2,29542609
0.42	4323,89967	4323,89967	146,268774	0,42	13248,1508	1,53464425
0.43	4406,50462	4406,50462	149,063133	0,43	13149,8768	0,78146656
0.44	4488,30894	4488,30894	151,830407	0,44	13052,5842	0,03580979
0.45	4569,32128	4569,32128	154,570891	0,45	12956,2621	-0,70240833
0.46	4649,55021	4649,55021	157,284873	0,46	12860,9	-1,43326912
0.47	4729,00421	4729,00421	159,972641	0,47	12766,4875	-2,15685298
0.48	4807,69165	4807,69165	162,634478	0,48	12673,014	-2,87323934
0.49	4885,62079	4885,62079	165,270663	0,49	12580,4694	-3,58250674

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
0.5	4962,79983	4962,79983	167,881474	0,5	12488,8436	-4,28473282
0.51	5039,23685	5039,23685	170,467184	0,51	12398,1265	-4,97999431
0.52	5114,93984	5114,93984	173,028062	0,52	12308,3082	-5,66836706
0.53	5189,9167	5189,9167	175,564378	0,53	12219,379	-6,34992604
0.54	5264,17524	5264,17524	178,076394	0,54	12131,3292	-7,02474536
0.55	5337,72319	5337,72319	180,564372	0,55	12044,1492	-7,69289829
0.56	5410,56818	5410,56818	183,028571	0,56	11957,8295	-8,35445725
0.57	5482,71775	5482,71775	185,469245	0,57	11872,3609	-9,00949381
0.58	5554,17937	5554,17937	187,886647	0,58	11787,7341	-9,65807874
0.59	5624,9604	5624,9604	190,281026	0,59	11703,94	-10,300282
0.6	5695,06814	5695,06814	192,652629	0,6	11620,9696	-10,9361727
0.61	5764,5098	5764,5098	195,0017	0,61	11538,8138	-11,5658192
0.62	5833,29249	5833,29249	197,328479	0,62	11457,464	-12,1892892
0.63	5901,42326	5901,42326	199,633205	0,63	11376,9114	-12,8066493
0.64	5968,90908	5968,90908	201,916114	0,64	11297,1474	-13,4179656
0.65	6035,75682	6035,75682	204,177437	0,65	11218,1635	-14,0233034
0.66	6101,9733	6101,9733	206,417407	0,66	11139,9512	-14,6227272
0.67	6167,56523	6167,56523	208,636249	0,67	11062,5022	-15,2163009
0.68	6232,53926	6232,53926	210,834189	0,68	10985,8084	-15,8040874
0.69	6296,90199	6296,90199	213,01145	0,69	10909,8615	-16,3861491

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
0.7	6360,65989	6360,65989	215,168251	0,7	10834,6535	-16,9625477
0.71	6423,81941	6423,81941	217,304809	0,71	10760,1765	-17,533344
0.72	6486,38689	6486,38689	219,421341	0,72	10686,4226	-18,0985983
0.73	6548,36862	6548,36862	221,518057	0,73	10613,3841	-18,6583702
0.74	6609,7708	6609,7708	223,595168	0,74	10541,0532	-19,2127185
0.75	6670,59957	6670,59957	225,652883	0,75	10469,4224	-19,7617014
0.76	6730,86101	6730,86101	227,691405	0,76	10398,4841	-20,3053764
0.77	6790,56112	6790,56112	229,710939	0,77	10328,231	-20,8438005
0.78	6849,70583	6849,70583	231,711685	0,78	10258,6558	-21,3770298
0.79	6908,301	6908,301	233,693841	0,79	10189,751	-21,90512
0.8	6966,35244	6966,35244	235,657604	0,8	10121,5096	-22,428126
0.81	7023,86589	7023,86589	237,603167	0,81	10053,9246	-22,9461022
0.82	7080,847	7080,847	239,530723	0,82	9986,98878	-23,4591022
0.83	7137,3014	7137,3014	241,440461	0,83	9920,69534	-23,9671792
0.84	7193,23461	7193,23461	243,332568	0,84	9855,03739	-24,4703858
0.85	7248,65212	7248,65212	245,207231	0,85	9790,00817	-24,9687738
0.86	7303,55936	7303,55936	247,064631	0,86	9725,60097	-25,4623945
0.87	7357,96167	7357,96167	248,904951	0,87	9661,80917	-25,9512988
0.88	7411,86435	7411,86435	250,72837	0,88	9598,62623	-26,4355368
0.89	7465,27265	7465,27265	252,535065	0,89	9536,04567	-26,915158

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
0.9	7518,19174	7518,19174	254,32521	0,9	9474,0611	-27,3902116
0.91	7570,62674	7570,62674	256,09898	0,91	9412,66618	-27,8607461
0.92	7622,58271	7622,58271	257,856546	0,92	9351,85466	-28,3268093
0.93	7674,06467	7674,06467	259,598076	0,93	9291,62035	-28,7884488
0.94	7725,07756	7725,07756	261,323739	0,94	9231,95714	-29,2457113
0.95	7775,62627	7775,62627	263,0337	0,95	9172,85897	-29,6986433
0.96	7825,71566	7825,71566	264,728122	0,96	9114,31988	-30,1472905
0.97	7875,35049	7875,35049	266,407168	0,97	9056,33394	-30,5916983
0.98	7924,53552	7924,53552	268,070998	0,98	8998,89532	-31,0319114
0.99	7973,27541	7973,27541	269,71977	0,99	8941,99823	-31,4679742
1	8021,57479	8021,57479	271,35364	1	8885,63696	-31,8999305
1.01	8069,43824	8069,43824	272,972764	1,01	8829,80585	-32,3278235
1.02	8116,87028	8116,87028	274,577294	1,02	8774,49932	-32,7516962
1.03	8163,87539	8163,87539	276,167381	1,03	8719,71185	-33,1715907
1.04	8210,45799	8210,45799	277,743177	1,04	8665,43797	-33,5875491
1.05	8256,62246	8256,62246	279,304827	1,05	8611,67228	-33,9996127
1.06	8302,37312	8302,37312	280,852479	1,06	8558,40944	-34,4078224
1.07	8347,71425	8347,71425	282,386278	1,07	8505,64417	-34,8122187
1.08	8392,65008	8392,65008	283,906366	1,08	8453,37124	-35,2128416
1.09	8437,1848	8437,1848	285,412886	1,09	8401,58549	-35,6097308

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
1.1	8481,32254	8481,32254	286,905976	1,1	8350,28182	-36,0029253
1.11	8525,0674	8525,0674	288,385776	1,11	8299,45517	-36,3924638
1.12	8568,42341	8568,42341	289,852422	1,12	8249,10056	-36,7783847
1.13	8611,39459	8611,39459	291,30605	1,13	8199,21304	-37,1607257
1.14	8653,98488	8653,98488	292,746793	1,14	8149,78773	-37,5395243
1.15	8696,1982	8696,1982	294,174785	1,15	8100,81981	-37,9148175
1.16	8738,03842	8738,03842	295,590155	1,16	8052,3045	-38,2866418
1.17	8779,50937	8779,50937	296,993033	1,17	8004,23708	-38,6550335
1.18	8820,61483	8820,61483	298,383547	1,18	7956,61288	-39,0200283
1.19	8861,35854	8861,35854	299,761825	1,19	7909,42729	-39,3816616
1.2	8901,74421	8901,74421	301,12799	1,2	7862,67573	-39,7399684
1.21	8941,77549	8941,77549	302,482167	1,21	7816,3537	-40,0949833
1.22	8981,45601	8981,45601	303,824479	1,22	7770,45673	-40,4467405
1.23	9020,78934	9020,78934	305,155046	1,23	7724,9804	-40,7952739
1.24	9059,77903	9059,77903	306,473988	1,24	7679,92035	-41,1406169
1.25	9098,42858	9098,42858	307,781424	1,25	7635,27227	-41,4828026
1.26	9136,74146	9136,74146	309,077471	1,26	7591,03187	-41,8218637
1.27	9174,72107	9174,72107	310,362245	1,27	7547,19494	-42,1578326
1.28	9212,37083	9212,37083	311,63586	1,28	7503,75731	-42,4907414
1.29	9249,69407	9249,69407	312,89843	1,29	7460,71483	-42,8206215

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
1.3	9286,69411	9286,69411	314,150066	1,3	7418,06344	-43,1475044
1.31	9323,37422	9323,37422	315,39088	1,31	7375,79908	-43,4714211
1.32	9359,73765	9359,73765	316,620981	1,32	7333,91777	-43,792402
1.33	9395,78761	9395,78761	317,840479	1,33	7292,41555	-44,1104776
1.34	9431,52726	9431,52726	319,049479	1,34	7251,28852	-44,4256777
1.35	9466,95974	9466,95974	320,248088	1,35	7210,53282	-44,7380319
1.36	9502,08816	9502,08816	321,436411	1,36	7170,14461	-45,0475696
1.37	9536,91557	9536,91557	322,614552	1,37	7130,12013	-45,3543197
1.38	9571,44502	9571,44502	323,782613	1,38	7090,45563	-45,6583109
1.39	9605,67951	9605,67951	324,940696	1,39	7051,14742	-45,9595714
1.4	9639,62199	9639,62199	326,088902	1,4	7012,19185	-46,2581293
1.41	9673,27542	9673,27542	327,22733	1,41	6973,58529	-46,5540124
1.42	9706,6427	9706,6427	328,356077	1,42	6935,32417	-46,847248
1.43	9739,72669	9739,72669	329,475242	1,43	6897,40495	-47,1378632
1.44	9772,53024	9772,53024	330,584919	1,44	6859,82414	-47,4258848
1.45	9805,05617	9805,05617	331,685205	1,45	6822,57828	-47,7113394
1.46	9837,30723	9837,30723	332,776194	1,46	6785,66394	-47,9942532
1.47	9869,2862	9869,2862	333,857978	1,47	6749,07773	-48,2746521
1.48	9900,99579	9900,99579	334,930649	1,48	6712,81632	-48,5525618
1.49	9932,43869	9932,43869	335,994298	1,49	6676,87639	-48,8280077

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
1.5	9963,61755	9963,61755	337,049016	1,5	6641,25467	-49,1010148
1.51	9994,53502	9994,53502	338,094892	1,51	6605,94791	-49,3716079
1.52	10025,1937	10025,1937	339,132012	1,52	6570,95292	-49,6398117
1.53	10055,5961	10055,5961	340,160466	1,53	6536,26652	-49,9056504
1.54	10085,7449	10085,7449	341,180338	1,54	6501,88558	-50,169148
1.55	10115,6426	10115,6426	342,191715	1,55	6467,80701	-50,4303283
1.56	10145,2915	10145,2915	343,19468	1,56	6434,02772	-50,6892148
1.57	10174,6943	10174,6943	344,189316	1,57	6400,54471	-50,9458307
1.58	10203,8534	10203,8534	345,175707	1,58	6367,35495	-51,2001991
1.59	10232,7711	10232,7711	346,153935	1,59	6334,45549	-51,4523426
1.6	10261,4498	10261,4498	347,124078	1,6	6301,84339	-51,7022837
1.61	10289,892	10289,892	348,086219	1,61	6269,51574	-51,9500448
1.62	10318,0999	10318,0999	349,040435	1,62	6237,46969	-52,1956478
1.63	10346,0758	10346,0758	349,986805	1,63	6205,70237	-52,4391144
1.64	10373,8221	10373,8221	350,925406	1,64	6174,211	-52,6804662
1.65	10401,341	10401,341	351,856315	1,65	6142,99278	-52,9197246
1.66	10428,6347	10428,6347	352,779607	1,66	6112,04497	-53,1569105
1.67	10455,7055	10455,7055	353,695357	1,67	6081,36484	-53,3920449
1.68	10482,5556	10482,5556	354,603639	1,68	6050,94972	-53,6251483
1.69	10509,187	10509,187	355,504527	1,69	6020,79693	-53,8562411

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
1.7	10535,602	10535,602	356,398093	1,7	5990,90385	-54,0853435
1.71	10561,8027	10561,8027	357,284409	1,71	5961,26788	-54,3124754
1.72	10587,7911	10587,7911	358,163545	1,72	5931,88643	-54,5376567
1.73	10613,5694	10613,5694	359,035573	1,73	5902,75696	-54,7609067
1.74	10639,1396	10639,1396	359,90056	1,74	5873,87695	-54,9822449
1.75	10664,5037	10664,5037	360,758576	1,75	5845,2439	-55,2016903
1.76	10689,6638	10689,6638	361,60969	1,76	5816,85536	-55,4192619
1.77	10714,6217	10714,6217	362,453967	1,77	5788,70887	-55,6349783
1.78	10739,3796	10739,3796	363,291476	1,78	5760,80204	-55,848858
1.79	10763,9393	10763,9393	364,12228	1,79	5733,13246	-56,0609194
1.8	10788,3027	10788,3027	364,946447	1,8	5705,69778	-56,2711804
1.81	10812,4718	10812,4718	365,764039	1,81	5678,49566	-56,4796591
1.82	10836,4485	10836,4485	366,575121	1,82	5651,5238	-56,6863732
1.83	10860,2346	10860,2346	367,379756	1,83	5624,77989	-56,8913401
1.84	10883,8319	10883,8319	368,178005	1,84	5598,26169	-57,0945772
1.85	10907,2423	10907,2423	368,969932	1,85	5571,96696	-57,2961017
1.86	10930,4676	10930,4676	369,755597	1,86	5545,89347	-57,4959305
1.87	10953,5096	10953,5096	370,53506	1,87	5520,03905	-57,6940804
1.88	10976,37	10976,37	371,308381	1,88	5494,40152	-57,890568
1.89	10999,0506	10999,0506	372,07562	1,89	5468,97874	-58,0854098

sc	Catch2020	Wanted_Catch	Unwanted_Catch	F_{bar}2020	SSB2021	SSB_change_2020-2021(%)
1.9	11021,5531	11021,5531	372,836834	1,9	5443,76858	-58,2786219
1.91	11043,8792	11043,8792	373,592082	1,91	5418,76897	-58,4702205
1.92	11066,0307	11066,0307	374,341422	1,92	5393,9778	-58,6602215
1.93	11088,0092	11088,0092	375,084908	1,93	5369,39305	-58,8486406
1.94	11109,8163	11109,8163	375,822599	1,94	5345,01266	-59,0354934
1.95	11131,4537	11131,4537	376,554549	1,95	5320,83463	-59,2207953
1.96	11152,923	11152,923	377,280813	1,96	5296,85698	-59,4045615
1.97	11174,2259	11174,2259	378,001445	1,97	5273,07774	-59,5868071
1.98	11195,3638	11195,3638	378,7165	1,98	5249,49496	-59,767547
1.99	11216,3385	11216,3385	379,42603	1,99	5226,10671	-59,946796
2	11237,1514	11237,1514	380,130088	2	5202,91109	-60,1245686

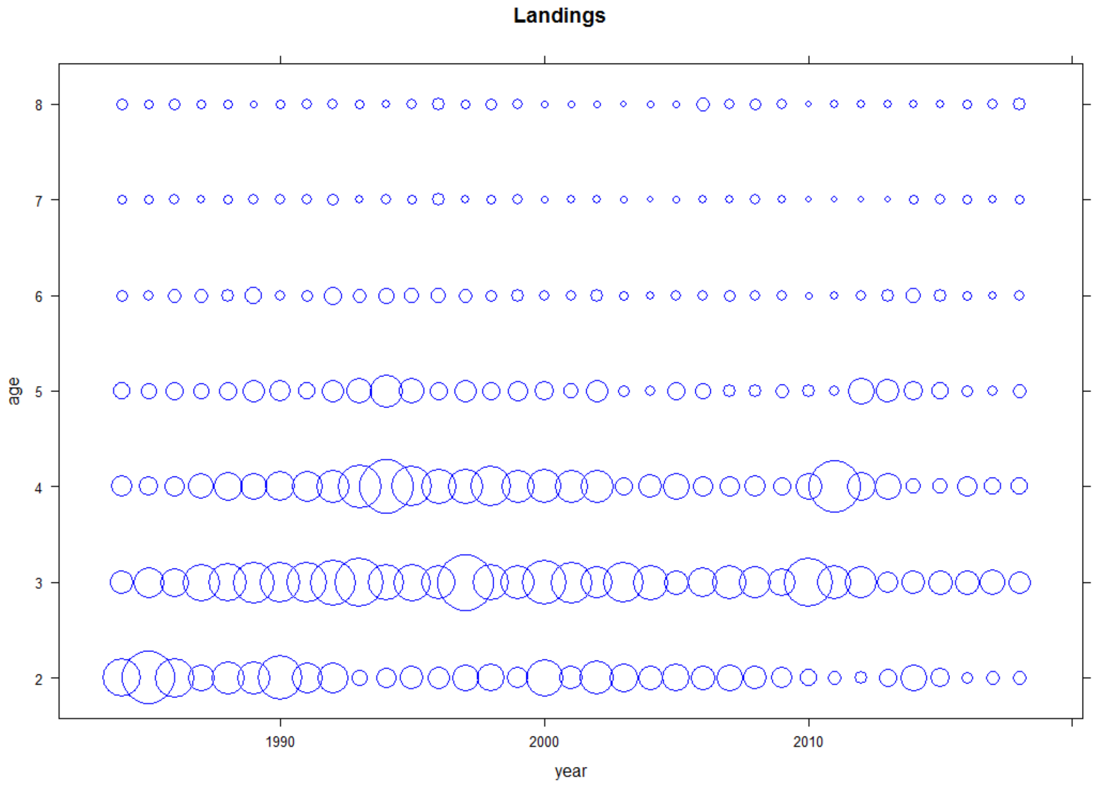


Figure 7.2: Bay of Biscay sole landings age distributions

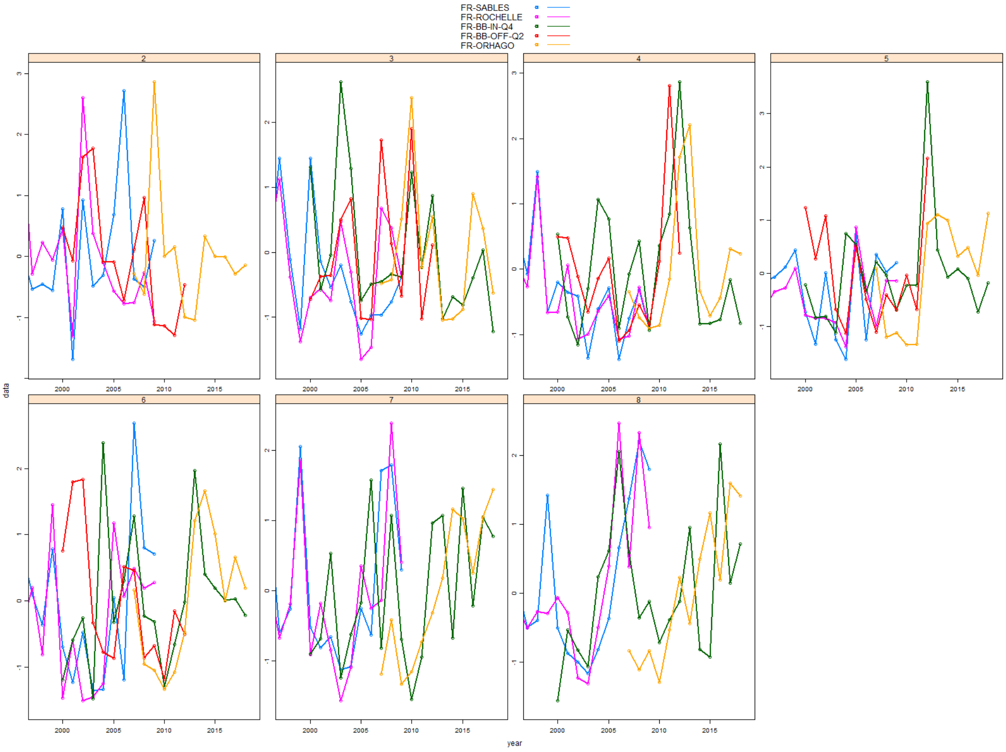


Figure 7.3: Tuning fleet's time series

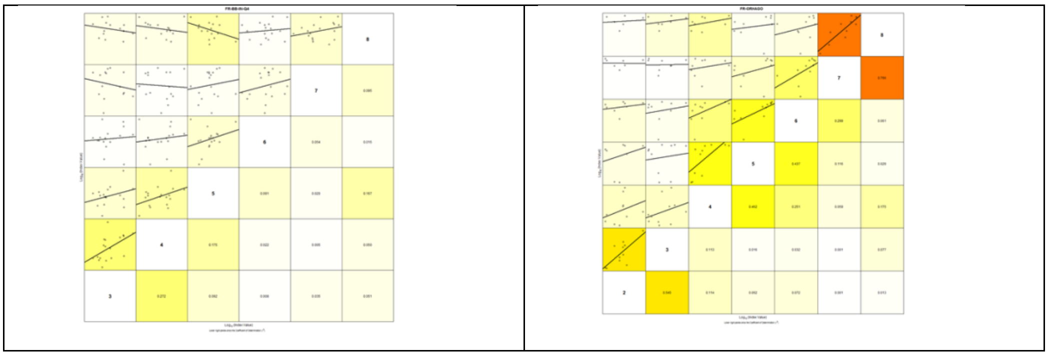


Figure 7.3: Tuning fleets internal consistencies

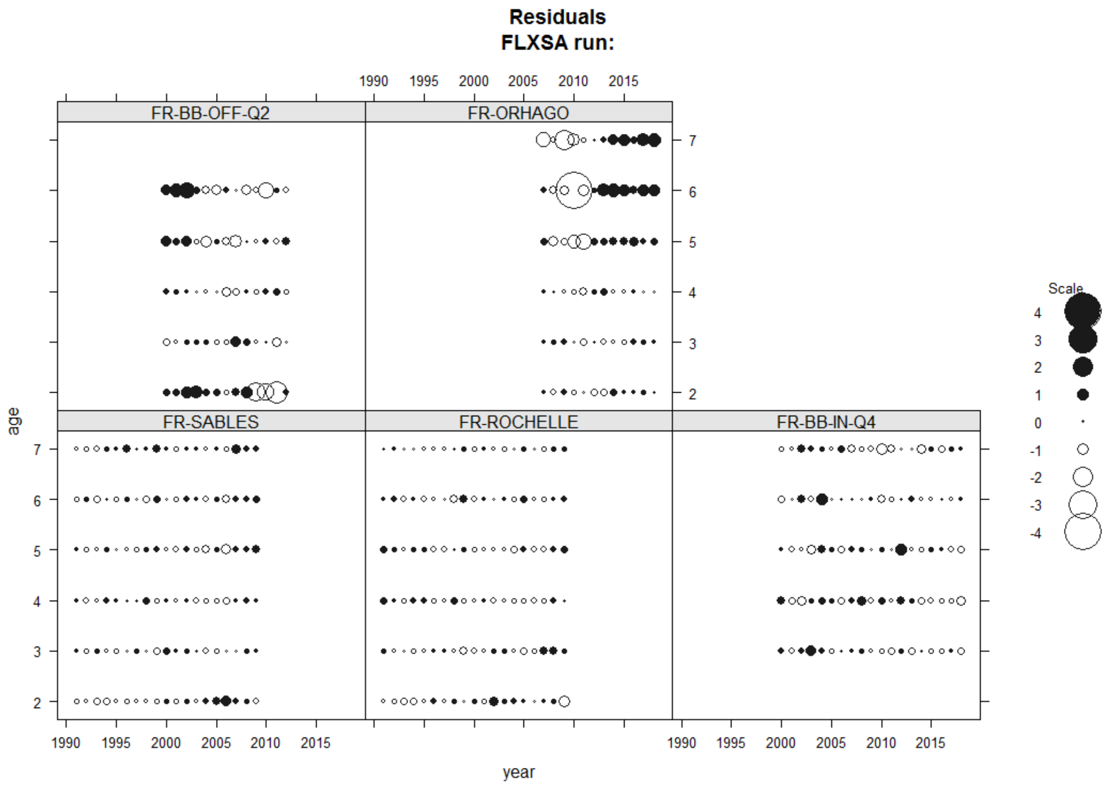


Figure 7.5a: Bay of Biscay sole (Division 8a,b), assessment residuals

XSA (No Taper, mean q, s.e. shrink = 2.5, s.e. min = .2)

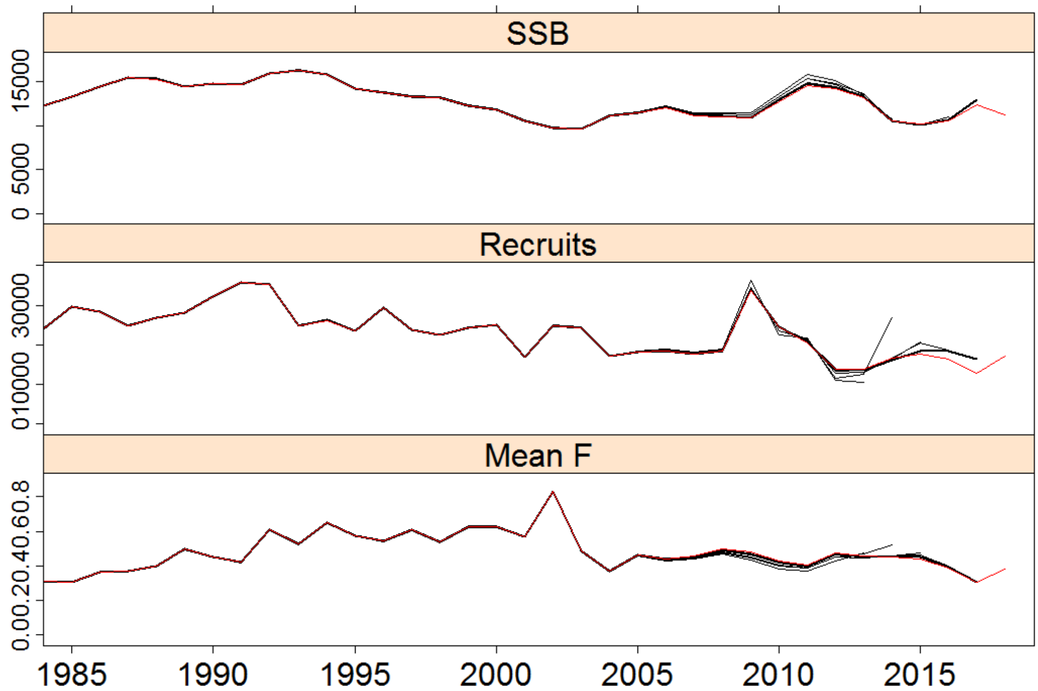


Figure 7.6: Bay of Biscay sole (Division 8a,b) - Retrospective results

(No taper, q indep. stock size all ages, q indep. of age>=6, shr.=1.5)

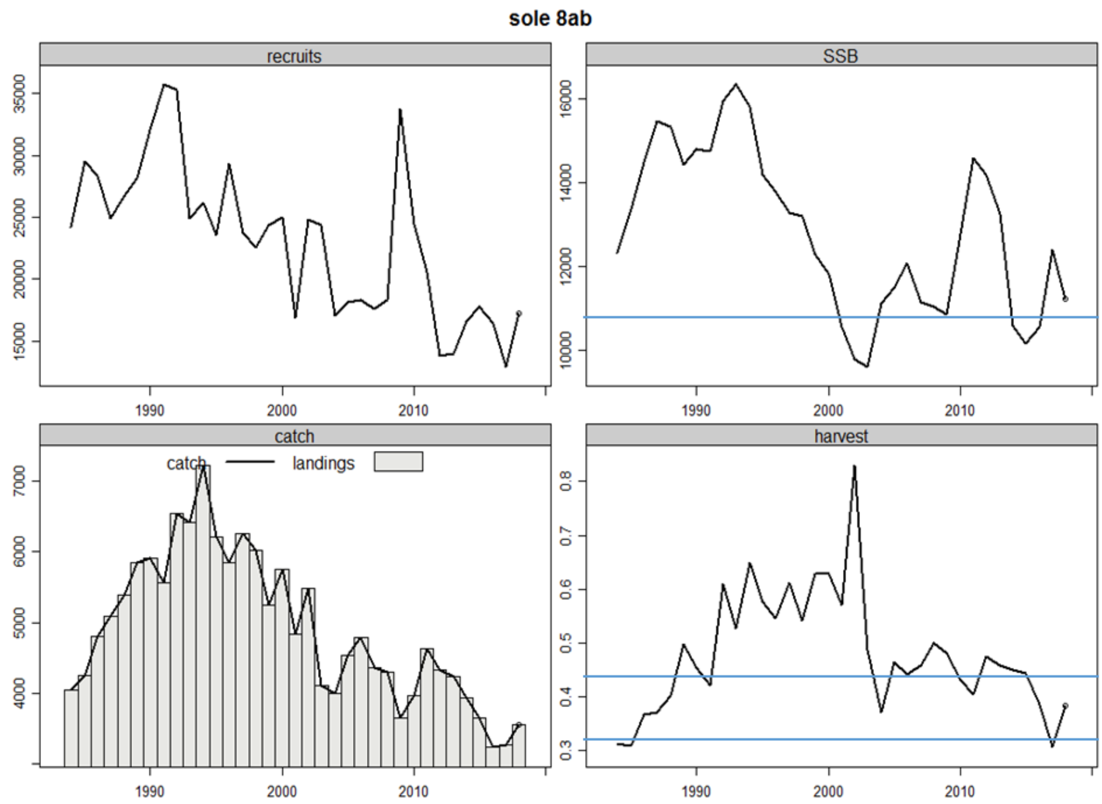


Figure 7.7: Sole in Division 8a,b (Bay of Biscay) – Trends for Landings, F, R, SSB

8 Sole (*Solea solea*) in Divisions 8.c and 9.a

8.1 General biology

Common sole (*Solea solea*) spawning takes place in winter/early spring and varies with latitude starting earlier in the south (Vinagre, 2007). Larvae migrate to estuaries where juveniles concentrate until they reach approximately 2 years of age and move to deeper waters. In Portuguese waters, sole length of first maturity is estimated as 25cm for males and 27 cm for females (Jardim, *et al.*, 2011). Sole is a nocturnal predator and therefore more susceptible to be captured by fisheries at night than in daytime. It feeds on polychaetes, molluscs and amphipods. *S. solea* is abundant in the Tagus estuary and uses this habitat as its nursery ground (Cabral and Costa, 1999).

Growth studies based on *S. solea* otolith readings in the Portuguese coast indicate L_{inf} of 52.1cm for females and 45.7cm for males. The growth coefficient (k) estimate of females (K=0.23) was slightly higher than for males (k=0.21) and to -0.11 and 1.57 for females and males respectively (Teixeira and Cabral, 2010). Maximum length observed between 2004 and 2011 from the landings sampling program (PNAB-DCF) attained 60cm. According to Vinagre (2007) *S. solea* off the Portuguese coast presents higher growth rates compared with the northern European coasts.

8.2 Stock identity and possible assessment areas

There is no clear information to support the definition of the common sole stock for ICES Subdivision 8.c and 9.a.

8.3 Management regulations (TACs, minimum landing size)

The minimum landing size of sole is 24 cm. There are other regulations regarding the mesh size for trammel and trawl nets, fishing grounds and vessel's size. A precautionary TAC is in place for *Solea spp*. in ICES divisions 8.ce, subareas 9 and 10. Sole is under the Landing Obligation in Divisions 8.abde (all bottom trawls, mesh sizes between 70 mm and 100 mm, all beam trawls, mesh sizes between 70 mm and 100 mm and all trammel and gill nets, mesh size larger or equal to 100 mm) and in Division 9.a (all trammel nets and gill nets, mesh size larger or equal to 100 mm). In Portugal all catches of sole from all gears and mesh sizes are under the Landing Obligation (more restrictively than required by European regulations).

8.4 Fisheries data

Table 8.4.1 presents sole species landings from the official statistics for Division 8.c and 9.a. There is some evidence that *Solea* spp. may have been misclassified in the past for both Portuguese and Spanish landings, which means *Solea solea* official landings might not then have corresponded only to this species but a mix of *Solea solea* with very few *Solea senegalensis* and some *Pegusa lascaris*. Using port sampling length data, it was possible to separate the *Solea* spp. and apply the proportions to provide a raised landings total for: *Solea solea* and an additional mix, for Portuguese landings in Division 9.a (Borges, et al**.**, 2014).

Landings of *Pegusa lascaris* are not considered here, since the species is not under a TAC management regime.

Based on the DCF discard sampling in Portugal and Spain, discards for Sole (*Solea solea*) are considered negligible (almost zero in last three years). Presently, only damaged specimens are discarded, while specimens under the minimum conservation reference size are landed under the landing obligation (in negligible numbers).

Based on negligible discards, Figure 8.4.1. shows the trend in landings for the available time series.

This species is mostly fished by artisanal fisheries (96%), while trawl caught only a 4% of the total catches (Figure 8.4.2).

Landings length compositions for *Solea solea* (MLS = 24 cm) are presented for both areas 8.c and 9.a for all the time series (Figure 8.4.3) and at seasonal level (Figure 8.4.4).

8.5 Survey data, recruit series

The bathymetric range for *Solea solea* is from 0 to 150 m of depth, but usually found between 0 and 80 m. This species is rarely caught in the existing Portuguese bottom-trawl research surveys (Jardim *et al*., 2011). A series of abundance indices (Figures 8.5.1 and 8.5.2) and length-frequency distribution (Figures 8.5.3) from Spanish SP-SPNGFS trawl research surveys is available. However, it worth to be mentioned, that few individuals are caught during the surveys due to the fact that the first bathymetric strata of the survey is from 70 to 120 m, while this species is mostly found in a bathymetric range between 0 and 80 m.

8.6 Biological sampling

Existing biological sampling is based on fishery data from commercial vessel landings.

8.7 Population biology parameters and a summary of other research

Solea solea maturity ogives by sex, length-weight relationship, sex-ratio by length are based on port sampling and are available from 2012 for Division 9.a (Jardim, *et al*., 2011).

8.8 Assessment

Until now no assessment model was performed for this species. This year a first approximation was done using a catch-only-model with sampling-importance resampling (COM-SIR) (see WD entitled "*Applying catch-only-model with sampling-importance resampling (COM-SIR) to common sole (Solea solea) species in 8c9a areas.*").

8.9 General problems

Solea solea (SOL) is officially reported to ICES from Spain and Portugal and to the EWG in INTERCATCH by Division since 2011. For the other sole species known to be distributed in 8.c and 9.a, namely *Solea senegalensis*, the information is only partially available in the official catches reported to ICES. The best option would presently appear to be to provide advice for *Solea solea* from the official landings. This may be provided to the EU which can set a TAC for common sole in Divisions 8.c and 9.a and request a delegated TAC for the other species to be defined by Spain and Portugal.

Advice has been provided on the basis of a category 5 stock, but this may be progressed to a category 4 o 3 next year.

8.10 References

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8.11 Tables and Figures

Table 8.4.1. *Solea solea* in Divisions 8.c and 9.a. Landings in tonnes.

Year	*Solea solea*	*Solea* spp*	Total
2000	159	741	900
2001	189	653	842
2002	115	508	623
2003	116	670	786
2004	171	668	839
2005	520	446	966
2006	467	203	670
2007	380	180	560
2008	454	211	665
2009	450	199	649
2010	581	283	864
2011	644	86	730
2012	589	39	628
2013	687	34	721
2014	681	41	722
2015	646	43	689
2016	557	-	557
2017	595	-	595
2018	579	-	579

* *Solea* spp. (*S. solea,* and *S. senegalensis*).

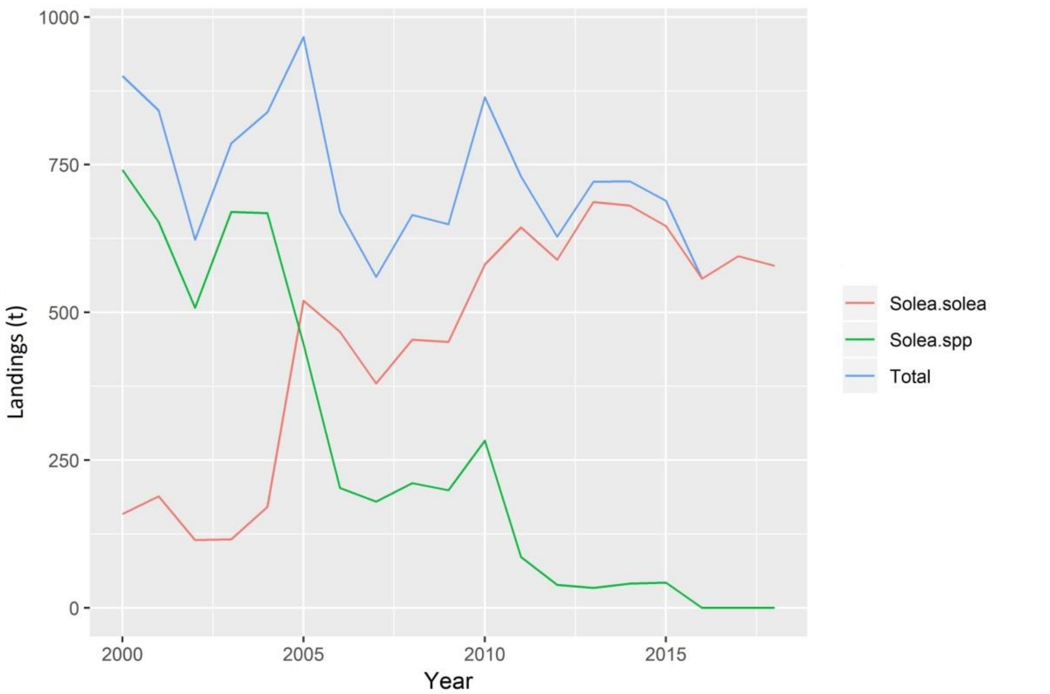

Figure 8.4.1. –*Solea solea* catches from 2000, including *Solea senegalensis* in *Solea* spp. and the total of the two.

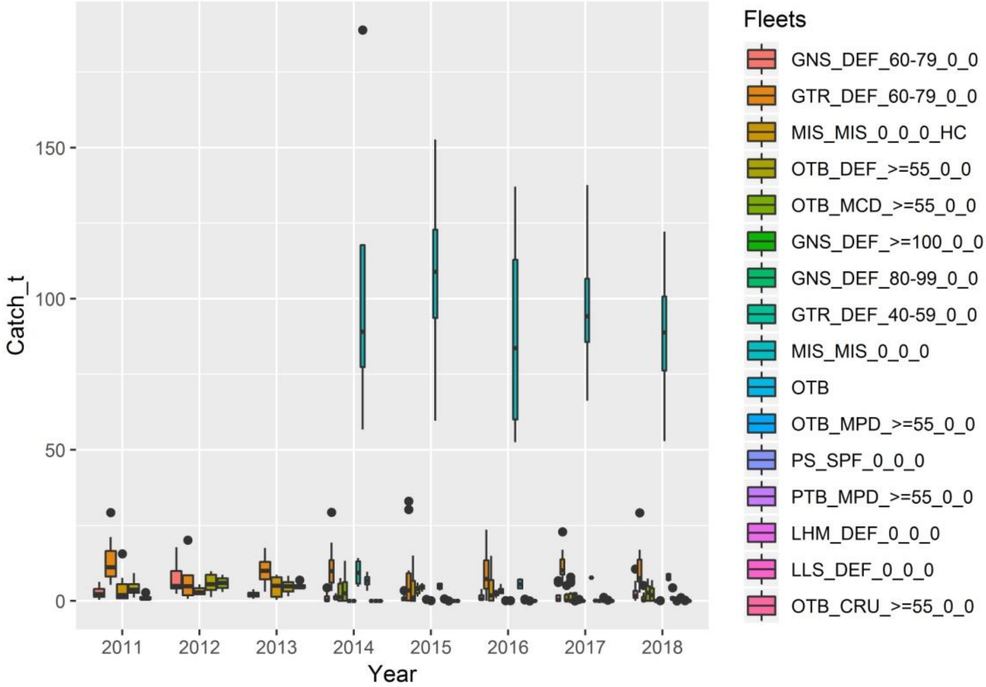

Figure 8.4.2. –*Solea solea* catches from 2011 divided by metiers.

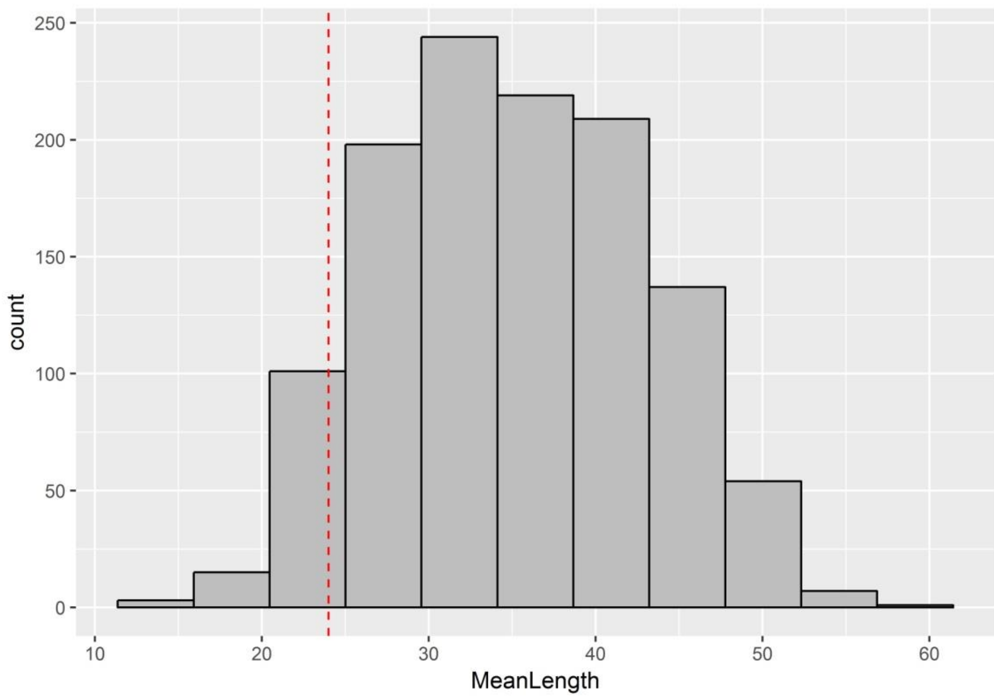

Figure 8.4.3- Divisions 9.a and 8.c. *Solea solea* sampling length frequency from all métiers. The dashed red line represent the minimum landings size of 24 cm.

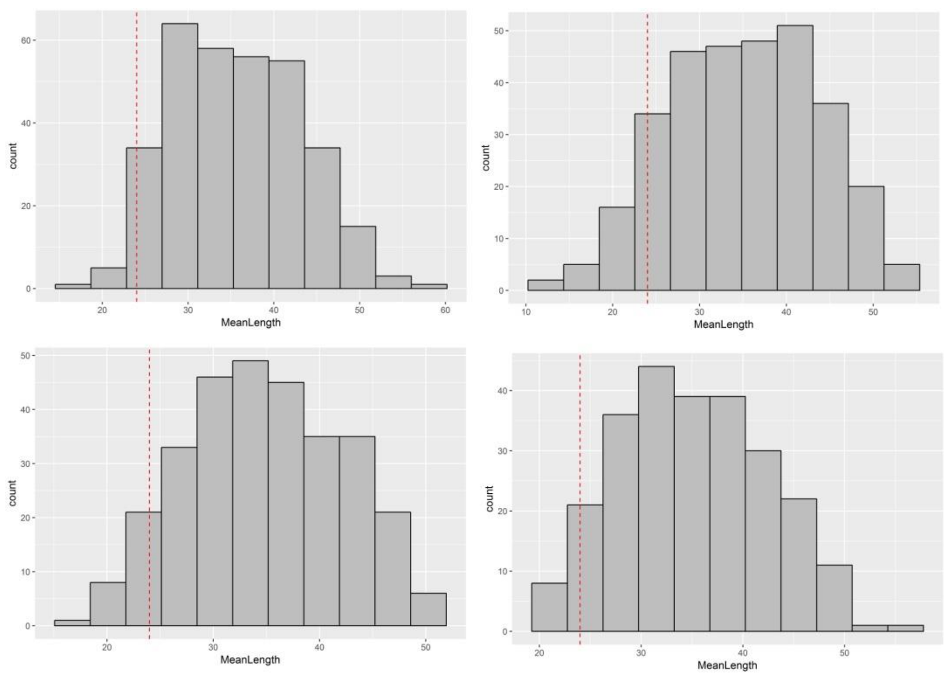

Figure 8.4.4. – Quarterly length-frequency distribution for *Solea solea* from ICES 8.c and 9.a. from 2011-2018. The dashed red line represents the minimum landings size of 24 cm.

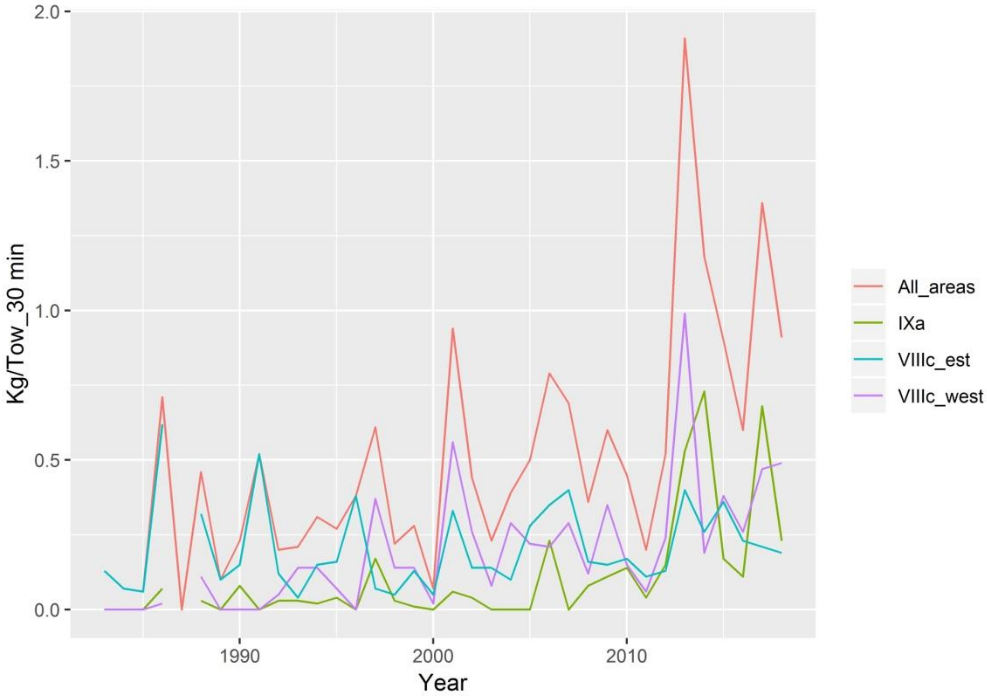

Figure 8.5.1. – Spanish Survey derived abundance index for *Solea solea* (kg/tow 30 minutes).

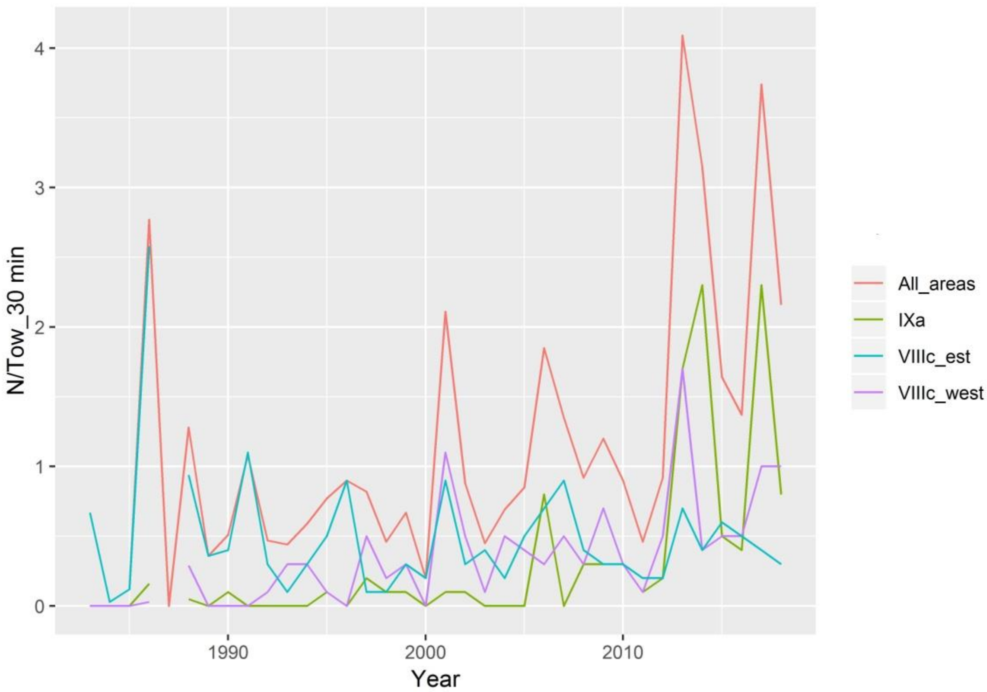

Figure 8.5.2. – Spanish Survey derived abundance index for *Solea solea* (Number individuals/tow 30 minutes).

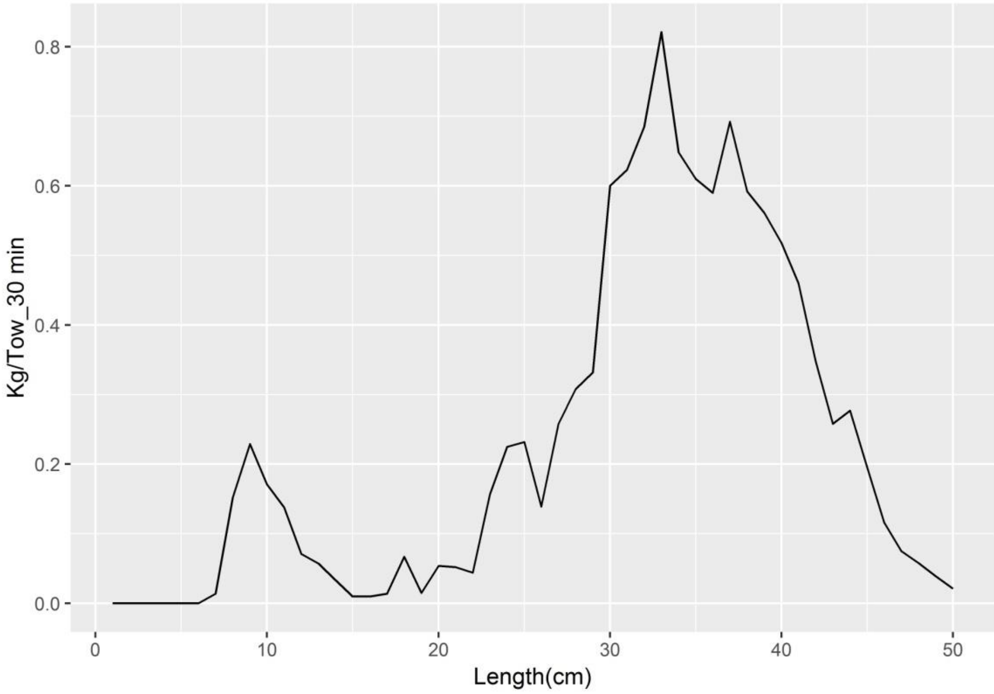

Figure 8.5.3. – Spanish Survey derived length-frequency distribution for *Solea solea* (Kg/tow 30 minutes).

9 Hake in Division 3.a, Subareas 4, 6 and 7 and Divisions 8.a,b,d (Northern stock)

Type of assessment: update (stock benchmarked in 2014), inter-benchmarked in 2019, stock on observation list. **Data revisions**: EVHOE survey index revised. **Review Group issues:** Not issues identified

9.1 General

9.1.1 Stock definition and ecosystem aspects

This section is described in the Stock Annex.

9.1.2 Fishery description

The general description of the fishery is now presented in the Stock Annex.

9.1.3 Summary of ICES advice for 2020 and management for 2017 and 2018

ICES advice for 2020

The stock was considered to be above any potential MSY $B_{trigger}$. Following the ICES MSY framework implied fishing mortality to be increased to 0.26, resulting in landings of 97 949 t and total catches of 101 065 t in 2020.

Like the main stocks of the EU, the Northern hake stock is managed by a TAC and quotas. The TACs for recent years are presented below:

TAC (t)	2012	2013	2014	2015	2016	2017	2018	2019
3a, 3b,c,d (EC Zone)	1661	2093	2466	2738	2997	3371	3136	4286
2a (EC Zone), 4	1935	2438	2874	3190	3492	3928	3653	4994
Vb (EC Zone), 6, 7, XII, XIV	30900	38938	45896	50944	61902	67658	62536	79762
8a,b,d,e	20609	25970	30610	33977	40393	44808	42460	52118
Total Northern Stock [IIa-8abd]	55105	69 440	81846	90849	108784	119765	111785	141160

Management for 2018 and 2019

The minimum legal sizes for fish caught in Sub areas 4–6–7 and 8 is set at 27 cm total length (30cm in Division 3a) since 1998 (Council Reg. no 850/98).

From the 14th of June 2001, an Emergency Plan was implemented by the Commission for the recovery of the Northern hake stock (Council Regulations N°1162/2001, 2602/2001 and 494/2002). In addition to a TAC reduction, two technical measures were implemented. A 100 mm minimum mesh size has been implemented for otter-trawlers when hake comprises more than 20% of the total amount of marine organisms retained onboard. This measure did not apply to vessels less than 12 m in length and which return to port within 24 hours of their most recent departure. Furthermore, two areas have been defined, one in Sub area 7 and the other in Sub area 8, where a 100 mm minimum mesh size is required for all otter-trawlers, whatever the amount of hake caught.

There are explicit management objectives for this stock under the EC Reg. No 811/2004 implementing measures for the recovery of the northern hake stock. It is aiming at increasing the quantities of mature fish to values equal to or greater than 140 000 t. This is to be achieved by limiting fishing mortality to 0.25 and by allowing a maximum change in TAC between years of 15%.

According to ICES advice for 2012, due to the new perspective of historical stock trends, resulting from the new assessment, the previously defined precautionary reference points are no longer appropriate. In particular, the absolute levels of spawning biomass, fishing mortality, and recruitment have shifted to different scales. As a consequence, the TAC corresponding to the current recovery plan (EC Reg. No. 811/2004) should not be considered, because the plan uses target values based on precautionary reference points that are no longer appropriate.

The TACs for 2017 and 2018 (111 785 t and 141 160 t, respectively) were slightly below the ICES advised TAC (115 335 t and 142 240 t, respectively). The difference was due to the way the STECF calculated the TAC adjustments for stocks subject to the landing obligation.

9.2 Data

9.2.1 Commercial catches and discards

Total landings from the Northern stock of hake by area for the period 1961-2017 as used by the WG are given in Table 9.1. They include landings from Division 3a, Subareas 4, 6 and 7, and Divisions 8a,b,d, as reported to ICES. Unallocated landings are also included in the table; they are high over the first decade (1961-1970), when the uncertainties in the fisheries statistics were high. In the years 2011, 2012 and 2013, they have increased again due to differences between official statistics and scientific estimations. In 2014 and 2015, the differences between scientific and official landings decreased greatly which produced a big decrease in unallocated landings. The 2016 unallocated landings were reported by area and in 2017 there were no unallocated landings, so they disappeared from Table 9.1. Table 1 of the Stock Annex provides a historical perspective of the level of aggregation at which landings have been available to the WG.

Except for 1995, landings decreased steadily from 66 500 t in 1989 to 35 000 t in 1998. Up to 2003, landings fluctuated around 40 000 t. Since then, with the exception of 2006, landings have been increasing up to 107 500 t in 2016, the highest in the whole time series. From 2009 to 2015 the landings and in 2016 the catches were above the TAC advice. In 2017 and 2018, the catches, 111 770 t and 96 168 t, were below it, 119 765 t and 111 785 t, respectively.

The discard data sampling and data availability are presented in the Stock Annex. Table 9.2 presents discard data available to the group from 2006 to 2018. The discards had an increasing trend until 2011 and decreased steadily afterwards. The increase was general to all the fleets. It is remarkable the case of gillnetters which did not discard before 2012 and since that year they have had high level of discards. In 2016, the discards increased for all the fleets expect for Spanish trawlers in area seven. In turn, the number of individuals increased in a higher proportion, for all the fleets except for OTHER. In 2017, the mean weight of the discarded individuals decreased by 50% and in 2018 there were no significant changes observed. In 2017, the total discards decreased for all the fleets, except for the Spanish trawlers, with an overall decrease of 36%. The increase in the Spanish trawlers in division 8.a,b,d was equal to 38%. In some fleets such as the Spanish trawlers in area 7, Gillnetters in area 7 and 8abd and Others, there was a significant decrease in the mean weight of the individuals discarded. The mean weight of the discarded individuals in GILLNET and OTHER fleets, fleets which discarded bigger individuals, has decreased to more than 50% in 2017 and 2018. In 2018, the discards increased in Spanish trawlers in area 7 and in the trawl others fleet but decreased in all the rest of the fleets.

9.2.2 Biological sampling

The sampling level is given in Table 1.3.

Length compositions of the 2016 landings by Fishery Unit and quarter were provided by Ireland, France, Scotland, Spain, UK(E&W) and Denmark.

Length compositions samples are not available for all FUs of each country in which landings are observed (see Stock Annex). Only the main FUs are sampled (Table 9.3).

9.2.3 Abundance indices from surveys

Four surveys provide relative indices of hake abundance over time. The French RESSGASC survey was conducted in the Bay of Biscay from 1978 to 2002, the EVHOE-WIBTS-Q4 survey conducted in the Bay of Biscay and in the Celtic Sea with a new design since 1997, the SpPGFS-WIBTS-Q4 survey conducted on the Porcupine Bank since 2001, and the Irish Groundfiother sh Survey (IGFS-WIBTS-Q4) beginning in 2003 in the west of Ireland and the Celtic Sea. A brief description of each survey is given in the Stock Annex. Figure 9.1 present the abundances indices obtained for these surveys.

From 1985 until the end of the survey in 2002, the index from RESSGASC followed a slightly decreasing trend. The index from 2002 is not considered reliable and is not presented on the figure.

Throughout the available time series, the abundance index provided by EVHOE-WIBTS-Q4 showed five peaks in 2002, 2004, 2008, 2012 and 2016. The index obtained in 2012 reached the highest value of the series, 193% higher than previous year. In 2013 and 2014, the index accumulated a decrease of 78%. In 2015 and 2016, the index increased and in 2016 it almost tripled the value of 2015. In 2017, the index was not available. In 2018, the index value decreased relative to the 2016 value and was around the value in 2016.

The abundance index provided by IGFS-WIBTS-Q4 is consistent with EVHOE WIBTS-Q4 survey over recent years. It showed a peak in 2008 and the abundance index obtained in 2012 achieved the higher value of the series, 268% higher than previous year index. The accumulated decrease in 2013 and 2014 was equal to 86%. The index increased moderately from 2015 to 2017. However, the increase in 2016 was not as sharp as that observed in EVHOE index. In 2018, the index decreased.

SpPGFS-WIBTS-Q4 survey is conducted on Porcupine's Bank since 2001. The abundance index follows an increasing trend since 2003, reaching its highest value in 2009 and slightly decreases in 2010 and 2011. After two years of an increasing trend with an accumulated increase of 218%, the index decreased sharply in 2015 and moderately in 2016. The peaks detected by EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4 are detected in this survey one year after as confirms the sharp increase observed in 2017. This is consistent with the fact that this survey catches bigger individuals. In 2018 the index decreased and was slightly above the 2016 level.

The spatial distribution of the EVHOE-WIBTS-Q4, IGFS-WIBTS-Q4 and SpPGFS-WIBTS-Q4 index of biomass (Kg/hr) is given in Figure 9.2 from 2003. The SpPGFS-WIBTS-Q4 index of biomass shows a homogenous spatial distribution in the sampled area along the time series. Among the three surveys, the SpPGFS-WIBTS-Q4 shows the higher biomasses values in the maps, confirming that this survey catches bigger individuals. A contraction of the spatial distribution is visible from 2014, being the 2018 the year with the greatest contraction (Figure 9.2). For the IGFS-WIBTS-Q4 the spatial distribution of the index of biomass was stable along the times series, with a slight decrease in 2018. The southern region of the sampled area showed a higher biomass index in the last years. For the IGFS-WIBTS-Q4, waters closer to the continental French shelf seem to be the ones with higher biomass. Overall for this survey, as well as for the others, a contraction of the spatial distribution is visible from 2015.

9.2.4 Commercial catch-effort data

A description of the commercial LPUE indices available to the group is given in the Stock Annex. They are not used in the assessment model.

Effort and LPUE data for the period 1982-2016 are given in Table 9.4 and Figure 9.3.

Since the start of the time series the effort of A Coruña and Vigo trawler fleets operating in Subarea 7 show a decreasing trend. Since 1985, the LPUE of A Coruña trawlers has fluctuated with an increasing trend. In 2012 and 2013, it decreased sharply and has an increasing trend since 2014 reaching its maximum value in 2017. Over the same period, LPUE from Vigo trawlers operating in Subarea 7 has fluctuated without any clear trend until 2008 when it started increasing. Since 2016, the index shows a decreasing trend with a steep slope. It must be noted that while A Coruña trawl fleet targets hake, the Vigo trawl fleet is directed to megrim, taking hake only as bycatch.

LPUE from Ondarroa pair trawlers operating in Divisions 8a,b, shows an increasing trend until 2009. The increase in LPUE in 2008 and 2009 was very high, especially in 2009. Until 2012 the LPUE decreased, although not to the low levels similar to the beginning of the time series. In 2013, it increased slightly again followed by a decrease in 2014. Since 1999, the effort has a decreasing trend. The LPUE has not been updated since 2015 due to a change in the way data was reported as it is now using e-logbooks for the first time.

9.3 Assessment

This is an update assessment in relation to the assessment carried out in the Interbenchmark working group carried out at the beginning of the year (ICES, 2019).

9.3.1 Input data

See Stock Annex (under "*Input data for SS3*").

9.3.1.1 Data Revisions

France revised the EVHOE index. The differences between both indices are minor in general but there were major differences in some years. The new index do not lead to a different perception of the stock status.

9.3.2 Model

The Stock Synthesis 3 (SS3) assessment model (Methot and Wetzel 2013) was selected for use in this assessment. Model description and settings are presented in the Stock Annex (under "*Current assessment*" for model description and "*SS3 settings (input data and control files)*" for model settings).

9.3.3 Model results

Residuals of the fits to the surveys log(abundance indices) are presented in Figure 9.4. The upward trend, in relative abundance observed until 2017 in all three contemporary trawl surveys (EVHOE-WIBTS-Q4, SpPGFS-WIBTS-Q4 and IGFS-WIBTS-Q4), has been captured by the model. In the last year, the model has over-estimated the indices, especially EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4. Pearson residuals of their length frequency distributions show a year pattern for the three surveys in the most recent years i.e., the model was not able to explain the high abundance of small individuals observed in the distribution of the indices. Otherwise, their behaviour is "fairly random" with no trend or lack of fit (Figure 9.5, where blue and red circles denote positive and negative residuals, respectively). Residuals of the length frequency distributions of the commercial fleets landings and discards (not presented in this report but available on the Share-point) show some patterns, as mentioned in the benchmark report (ICES, 2014a).

The assessment model includes estimation of size-based selectivity functions (selection pattern at length) for commercial fleets and for population abundance indices (surveys). For commercial fleets total catch is subsequently partitioned into discarded and retained portions. Figure 9.6 presents selectivity (for the total catch; solid lines) and retention functions by fleet (dashed lines) estimated by the model. The selection curve is assumed constant over the whole period for all the fleets except for that operating outside areas 7 and 8 (the *others* fleet). For the Spanish trawl fleets in 7, three retention functions are estimated, one for years 1978–1997 (black), a second one for 1998-2009 (red) and a third one for 2010-present (green). For the Spanish trawl fleets in area 8, two retention functions are estimated: one for years 1978–1997 and a second one for 1998-present The change in retention in 1998 for both trawl fleets was clearly observed when examining the length frequency distributions of the landings and might be due to a stricter enforcement of the minimum landing size. The most recent change in retention of Spanish trawl fleet in area 7 was motivated by the observed change in the mean size of discards from 23.6 cm before 2010 to 28.8 cm after that year. For the French trawlers targeting *Nephrops* in area 8, the same retention function is assumed throughout the entire assessment period (1978–present). For the other fleets, both selection and retention curves are considered constant until 2002 and can vary from year to year since then. The variation is modelled using a random walk as described in the stock annex. The selection pattern has changed significantly since 2002 but in the last four years the change observed has been slight (Figure 9.6, bottom left and right plots). The change in the mean weight of the discarded individuals in this fleet seems to be motivated by the increase in the abundance of small individuals and the decrease in the overall selection rather that in the decrease of the retention ogive.

The retrospective analysis (Figure 9.7) shows that for the three summary indicators (F, SSB and Recruitment) the model results are sensitive to the exclusion of recent data, especially recruitment. The inclusion of new data impacted the recruitment estimates in the whole time series without any trend. In turn, a change in the recruitment estimates provokes a small retrospective pattern in the SSB and fishing mortality. In recent years, the revision of these indicators is mostly upwards for SSB, year by year, and downwards for F. The highest mohn rho was obtained for recruitment (0.01). Figure 9.8 shows the differences of the time series in percentage in comparison with the last year estimates. The differences with the time series corresponding to assessment with data up to year 2013 are relevant without a clear pattern. However, from 2015 onwards, the agreement between time series is high. The biggest differences are observed in the estimates of the most recent recruitments.

Summary results from SS3 are given in Table 9.5 and Figure 9.9.

For recruitment, fluctuations appear to be without substantial trend over the whole series. The recruitment in 2008 was the highest in the whole series, 765 millions of individuals. After a low recruitment in 2015 (245 millions), the recruitment in 2017 was the second highest in the series and the recruitment in 2018 was below the historical mean (~ 310 millions).

From high levels at the start of the series (100 000 t in 1980), the SSB decreased steadily to a low level at the end of the 1990s (24 000 t in 1998). Since that year, SSB has increased to the highest value of the series in 2016 (358 000 t) and decreased since then.

The fishing mortality is calculated as the average annual F for sizes 15–80 cm. This measure of F is nearly identical to the average F for ages 1–5. Values of F increased from values around 0.5-0.6 in the late 70s and early 80s to values around 1.0 during the 90s. Between 2006 and 2011, F declined sharply. Since 2012, F is quite stable and slightly below F_{MSY} (0.27). The F estimate for 2018 is equal to 0.22 and the three-year mean equal to 0.24.

The 90% confidence intervals are quite narrow (Figure 9.9). These intervals correspond with the uncertainty estimated by the SS3 model and do not include all the existing uncertainty. For example, it does not include the uncertainty in the input data. In the next benchmark the data weighting in SS3 should be revisited in order to get more realistic confidence intervals.

9.4 Catch options and prognosis

9.4.1 Replacement of recruitment in 2017 and 2018 by the geometric mean recruitment

The estimate of recruitment for 2017 was second highest in the time series. This recruitment had a big impact in the short-term forecast of the population. The biomass of 2020 was composed in a 39% by the biomass three-year class, i.e. the year class recruited in 2017.

The data that contributes to the estimation of this year class was analysed by the working group to see if they are indicative of a strong year class for 2017. These data are the length frequency distribution of catches and abundance indices in 2017 and 2018 and the overall biomass indices in 2017 and 2018.

The model overestimated all the survey indices in 2018 (Figure 9.10). Regarding, length frequency distributions, that of 2017 had two modes around 10 cm and 30 cm, which corresponded with recruits and age zero individuals (Figure 9.10). The peak for recruits was especially high. In turn, for 2018, the index had very few individuals of age 0 and most of them around age 1. However, the overall biomass index was low (Figure 9.1). Both data together, suggest that the recruits in 2017 and 2018 were not high and that the recruitment in 2018 was lower than that of 2017. The EVHOE index did not show any mode around 30 cm in 2018, i.e., the index did not detect any strong year class in 2017 (Figure 9.10). The PORCUPINE index had a mode around 20 cm corresponding with age 1 individuals in 2018. However, the low value of the index (Figure 9.1) did not indicate a strong year class in this year.

The length frequency distribution of catches usually shows a mode around 30 cm corresponding with age 1 individuals (Figure 9.11). The length frequency distribution of catches in 2018 showed a mode around 30 cm. However, lower than the peak observed in 2017 distribution and similar to the distribution in the rest of the years. Furthermore, the catches in 2018 were the lowest since 2013. All the information together indicated that the recruitment in 2017 was lower than the recruitments in those years.

All these facts together with the retrospective pattern showed by the assessment of this stock over the years led to the replacement of the recruitments in the last two historical years, 2017 and 2018, by the geometric mean recruitment which was considered more in accordance with the observe data and more precautionary.

9.4.2 Short – Term projection

For the current projection, unscaled F is used, corresponding to F(15-80cm) = 0.24.

The recruitment used for projections in this WG is the GM calculated from 1990 to the final assessment year minus 2.

Landings in 2018 and SSB in 2019 predicted for various levels of fishing mortality in 2018 are given in Table 9.6 and Figure 9.12. Maintaining status quo F in 2019 is expected to result in an increase in catch and SSB with respect to 2018.

9.4.3 Yield and biomass per recruit analysis

Options for long term projection are indicated in the Stock Annex.

Results of equilibrium yield and SSB per recruit are presented in Table 9.7 and Figure 9.13. The F-multiplier in Table 9.7 is with respect to status quo F (average F in the final 3 assessment years, 2014-2016). Considering the yield and SSB per recruit curves, F_{max}, $F_{0.1}$, $F_{35\%}$ and $F_{30\%}$ are respectively estimated to be 122%, 78%, 87% and 100% of status quo F. The maximum equilibrium yield per recruit is similar to the equilibrium yield at $F_{sq.}$

9.5 Biological reference points

Biological reference points for the stock of Northern Hake were calculated in 2019 after the inter-benchmark carried out in February (WD6).

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	56 000	B_{pa} (WD6)
Approach	F_{MSY}	0.27	F_{MSY} in the segmented regression stock recruitment relationship (WD6)
	B_{lim}	40 000	The median of the breakpoints in the segmented stock recruitment relationship estimated with a Bayesian Model.
Precautionary	B_{pa}	56 000	1.4Blim (WD6)
Approach	F_{lim}	0.84	Fishing mortality resulting in a 5% probability of SSB falling below B_{lim} (WD6)
	F_{pa}	0.6	F_{lim}/1.4 (WD6)
MAP	F_{low}	0.18	The lowest F that produces catch in the long term 5% below of the catch at F_{MSY}. (WD6)
	F_{upp}	0.4	The lowest F that produces catch in the long term 5% below of the catch at F_{MSY}. (WD6)

9.6 Comments on the assessment

The retrospective pattern in 2008 recruitment was partially corrected in last benchmark (ICES, 2014a) but it worsen again in the following assessment working group when 2013 data was included (ICES, 2014). The retrospective pattern in recruitment increased with the revision of 2014 LFD data in the 2016 assessment working group. The retrospective pattern improved significantly in 2018 with the revision of the EVHOE survey and the update of the recruitment settings in the SS3 control file (ICES, 2018).

The range of some selection and retention curves have been widen because the model estimates were hitting the bounds.

The estimation of the growth parameters with the latest data available, inside or outside the model, is considered critical. The growth was fixed in 2013 to the estimate of 2011 assessment year estimates but the parameters could be incorrect as the model is no longer able to estimate the parameters consistently year by year. The revision of growth parameters could also help improve the quality of the assessment fit. A complete list of issues to be considered in the next benchmark is available.

There are evidences that the weight at length has decreased in recent years (WD). The variability in weight impacts the perception of the stock and the reference points. However, it was not possible to estimate the impact because apart from using different settings in the SS3, it requires a reconstruction of the catch-at-age time series since 2011.

9.7 Management considerations

The significant increase in SSB and the decrease in fishing mortality are the consequence of the strong recruitments in 2008 and 2012. However, the increase rate should be taken with caution as limited information is currently available to explain the variation in abundance of large fish and the model is very sensitive to the data and settings used. It must be noted that the fast growth rate estimated by the model combined with the assumed high natural mortality rate (M=0.4 since the 2010 benchmark) generates a rapid turnover of the hake stock dynamic. This means that short-term predictions in SSB and landings are strongly related to variations in recruitment.

9.8 References.

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9.9 Tables and Figures

Table 9.1. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock. Estimates of landings ('000 t) by area for 1961-2017.

Year	3	4	6	7	8abd	Unn.	Total	3	4	6	7	8abd	Total	Total
1961			-	-	-	95600	95600						-	95600
1962			-	-	-	86300	86300						-	86300
1963			-	-	-	86200	86200						-	86200
1964			-	-	-	76800	76800						-	76800
1965			-	-	-	64700	64700						-	64700
1966			-	-	-	60900	60900						-	60900
1967			-	-	-	62100	62100						-	62100
1968			-	-	-	62000	62000						-	62000
1969			-	-	-	54900	54900						-	54900
1970			-	-	-	64900	64900						-	64900
1971		8500		19400	23400	0	51300						-	51300
1972		9400		14900	41200	0	65500						-	65500
1973		9500		31200	37600	0	78300						-	78300
1974		9700		28900	34500	0	73100						-	73100
1975		11000		29200	32500	0	72700						-	72700
1976		12900		26700	28500	0	68100						-	68100
1977		8500		21000	24700	0	54200						-	54200
1978		8000		20300	24500	-2249	50551						-	50551
1979		8700		17600	27200	-2404	51096						-	51096
1980		9700		22000	28400	-2835	57265						-	57265
1981		8800		25600	22300	-2782	53918						-	53918
1982		5900		25200	26200	-2306	54994						-	54994
1983		6200		26300	27100	-2093	57507						-	57507
1984		9500		33000	22900	-2114	63286						-	63286
1985		9224		27459	21044	-1628	56099						-	56099
1986		7320		27408	23903	-1539	57092						-	57092
1987		7800		32900	24700	-2031	63369						-	63369
1988		8800		30900	26600	-1477	64823						-	64823
1989		7375		26938	31957	203	66473						-	66473
1990		6680		23011	34424	-4161	59954						-	59954
1991		8328		21546	31635	-3380	58129						-	58129
1992		8561		22475	23465	2116	56617						-	56617
1993		8484		20465	19849	3346	52144						-	52144
1994		5421		21080	24727	31	51259						*	51259
1995		5335		24056	28144	86	57621						-	57621
1996		4445		24738	18036	-9	47210						-	47210
1997		3312		18949	20339	-135	42465						-	42465
1998		3208		18705	13147	0	35060						-	35060
1999		4256		23955	11604	-1	39814						*	39814
2000		4033		25991	11998	4	42026						*	42026
2001		4367		23065	9244	0	36675						-	36675
2002		2944		21226	15935	0	40105						-	40105
2003*		3284		25438	14440	0	43162						1393	44555
2004*		4438		27483	14494	0	46416						2614	49029
2005*		5461		26623	14467	0	46550						4583	51133
2006*		6127		24709	10633	0	41469						1222	42691
2007*		7017		27456	10620	0	45093						2165	47258
2008*		10654		22834	14334	0	47822						3368	51190
2009*		13057		25300	20424	0	58781						11033	69814
2010*		14187		33500	25073	0	72760						12118	84878
2011*		18789		18574	16604	32000 (4)	87540						13903	101443
2012*		22415		22166	16716	19300 (4)	85677						14870	100547
2013*	292	10684	5232	28500	19900	13100 (4)	77708	313	2942	1545	6583	4059	15400	93108
2014*	348	12077	11415	40536	25552	0 (4)	89928	287	3105	951	4021	1458	9800	99728
2015*	447	14618	7065	44396	28497	0 (4)	95023	93	3444	71	4208	3096	10900	105923
2016*	695	19603	11365	49377	26490	0 (4)	107530	142	4189	344	2281	4150	11114	118644
2017*	775	19690	9614	45737	28853	0	104669	148	1777	314	1168	3692	7099	111768
2018*	698	18915	7274	36906	25894	0	89688	287	1395	273	2281	2257	6493	96181

(1) Spanish data for 1961-1972 not revised, data for Sub-area VIII for 1973-1978 include data for
Divisions VIIIa,b only. Data for 1979-1981 are revised based on French surveillance data.
Divisions IIIa and IVb,c are included in column "IIIa, IV and VI" only after 1976.
There are some unallocated landings (moreover for the period 1961-1970).

(2) Discard estimates from observer programmes. In years marked with *,
partial discard estimates are available and used in the assessment.
For remaining years for which no values are presented,
some estimates are available but not considered valid and thus not used in the assessment
In the years with data only Spanish discards and discards from French Nephrops trawlers are included.

(3) From 1978 total catches used for the Working Group.

(4) Unallocated landings for years 2011-2014 were revised in 2015.

	Landings (1)							Discards (2)						Catches (3)
Year	3	4	6	7	8abd	Unn.	Total	3	4	6	7	8abd	Total	Total
1961			-	-	-	95600	95600						-	95600
1962			-	-	-	86300	86300						-	86300
1963			-	-	-	86200	86200						-	86200
1964			-	-	-	76800	76800						-	76800
1965			-	-	-	64700	64700						-	64700
1966			-	-	-	60900	60900						-	60900
1967			-	-	-	62100	62100						-	62100
1968			-	-	-	62000	62000						-	62000
1969			-	-	-	54900	54900						-	54900
1970			-	-	-	64900	64900						-	64900
1971		8500		19400	23400	0	51300						-	51300
1972		9400		14900	41200	0	65500						-	65500
1973		9500		31200	37600	0	78300						-	78300
1974		9700		28900	34500	0	73100						-	73100
1975		11000		29200	32500	0	72700						-	72700
1976		12900		26700	28500	0	68100						-	68100
1977		8500		21000	24700	0	54200						-	54200

	Landings (1)							Discards (2)						Catches (3)
Year	**3**	**4**	**6**	**7**	**8abd**	**Unn.**	**Total**	**3**	**4**	**6**	**7**	**8abd**	**Total**	**Total**
1978		8000		20300	24500	-2249	50551						-	50551
1979		8700		17600	27200	-2404	51096						-	51096
1980		9700		22000	28400	-2835	57265						-	57265
1981		8800		25600	22300	-2782	53918						-	53918
1982		5900		25200	26200	-2306	54994						-	54994
1983		6200		26300	27100	-2093	57507						-	57507
1984		9500		33000	22900	-2114	63286						-	63286
1985		9224		27459	21044	-1628	56099						-	56099
1986		7320		27408	23903	-1539	57092						-	57092
1987		7800		32900	24700	-2031	63369						-	63369
1988		8800		30900	26600	-1477	64823						-	64823
1989		7375		26938	31957	203	66473						-	66473
1990		6680		23011	34424	-4161	59954						-	59954
1991		8328		21546	31635	-3380	58129						-	58129
1992		8561		22475	23465	2116	56617						-	56617
1993		8484		20465	19849	3346	52144						-	52144
1994		5421		21080	24727	31	51259						*	51259

	Landings (1)							Discards (2)						Catches (3)
Year	3	4	6	7	8abd	Unn.	Total	3	4	6	7	8abd	Total	Total
1995		5335		24056	28144	86	57621						-	57621
1996		4445		24738	18036	-9	47210						-	47210
1997		3312		18949	20339	-135	42465						-	42465
1998		3208		18705	13147	0	35060						-	35060
1999		4256		23955	11604	-1	39814						*	39814
2000		4033		25991	11998	4	42026						*	42026
2001		4367		23065	9244	0	36675						-	36675
2002		2944		21226	15935	0	40105						-	40105
2003*		3284		25438	14440	0	43162						1393	44555
2004*		4438		27483	14494	0	46416						2614	49029
2005*		5461		26623	14467	0	46550						4583	51133
2006*		6127		24709	10633	0	41469						1222	42691
2007*		7017		27456	10620	0	45093						2165	47258
2008*		10654		22834	14334	0	47822						3368	51190
2009*		13057		25300	20424	0	58781						11033	69814
2010*		14187		33500	25073	0	72760						12118	84878
2011*		18789		18574	16604	32000 [4]	87540						13903	101443

	Landings (1)								Discards (2)						Catches (3)
Year	3	4	6	7	8abd	Unn.		Total	3	4	6	7	8abd	Total	Total
2012*		22415		22166	16716	19300	(4)	85677						14870	100547
2013*	292	10684	5232	28500	19900	13100	(4)	77708	313	2942	1545	6583	4059	15400	93108
2014*	348	12077	11415	40536	25552	0	(4)	89928	287	3105	951	4021	1458	9800	99728
2015*	447	14618	7065	44396	28497	0	(4)	95023	93	3444	71	4208	3096	10900	105923
2016*	695	19603	11365	49377	26490	0	(4)	107530	142	4189	344	2281	4150	11114	118644
2017*	775	19690	9614	45737	28853	0		104669	148	1777	314	1168	3692	7099	111768
2018*	698	18915	7274	36906	25894	0		89688	287	1395	273	2281	2257	6493	96181

(1) Spanish data for 1961–1972 not revised, data for Sub-area VIII for 1973–1978 include data for
Divisions 8.a,b only. Data for 1979-1981 are revised based on French surveillance data.
Divisions 3.a and 4.b,c are included in column "3.a, 4 and 6" only after 1976.
There are some unallocated landings (moreover for the period 1961-1970).

(2) Discard estimates from observer programmes. In years marked with *,
partial discard estimates are available and used in the assessment.
For remaining years for which no values are presented,
some estimates are available but not considered valid and thus not used in the assessment
In the years with data only Spanish discards and discards from French Nephrops trawlers are included.

(3) From 1978 total catches used for the Working Group.

	Landings (1)							Discards (2)						Catches (3)
Year	3	4	6	7	8abd	Unn.	Total	3	4	6	7	8abd	Total	Total
(4) Unallocated landings for years 2011–2014 were revised in 2015.														

Table 9.2. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Summary of discards data available (weight (t) in bold, numbers ('000) in italic)). The discards of Fleet 2 and Fleet 3 (in red) are not included in the assessment,

SS3 Fleets		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SPTRAWL7	weight	na	**537**	**1712**	**2010**	**5674**	**5077**	**5054**	**3495**	**1464**	**2604**	**615**	**652**	**902**
	number	na	*4526*	*21437*	*17542*	*27619*	*27954*	*26452*	*38293*	*8335*	*5241*	2006	3556	4945
TRAWLOTH	weight	**na**	**na**	**na**	**1025**	**1192**	**130**	**1142**	**2934**	**2510**	**1560**	**1665**	**829**	**2013**
	number	*na*	*na*	*na*	*6814*	*3831*	*1037*	*5101*	*16863*	*7483*	*4460*	11269	4786	10904
FRNEP8	weight	**532**	**767**	**858**	**4283**	**726**	**871**	**624**	**1475**	**392**	**1133**	**2310**	**1819**	**798**
	number	*18031*	*24277*	*18245*	*68524*	*14709*	21208	*25228*	*32535*	*4099*	19126	50343	34579	15958
SPTRAWL8	weight	**206**	**471**	**352**	**580**	**101**	**292**	**364**	**379**	**184**	**589**	**655**	**907**	**346**
	number	*3397*	*10002*	*7153*	*7925*	*1719*	*5036*	*5329*	*5552*	*2718*	*8011*	16293	14871	5604
GILLNET	weight	**na**	**na**	**na**	**na**	**na**	**na**	**1503**	**1256**	**42**	**857**	**1175**	**656**	**472**
	number	*na*	*na*	*na*	*na*	*na*	*na*	*4061*	*3283*	*53*	*623*	1600	1143	916
LONGLINE	weight	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**558**	3	1	4
	number	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*402*	0	0	14
OTHER	weight	**484**	**390**	**446**	**3135**	**4425**	**7533**	**6183**	**6287**	**4343**	**4151**	**4675**	**2235**	**1949**
	number	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*16855*	*4866*	4171	4435	5730	4333
Total Weight (t)		**1222**	**2165**	**3368**	**11033**	**12118**	**13903**	**14870**	**15826**	**8935**	**11452**	**11098**	**7099**	**6480**
Total Number ('000)		*21428*	*39654*	*47488*	*101349*	*48325*	*58210*	*66171*	*113381*	*27554*	42034	85946	64665	42660

Table 9.3. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Landings (L) and Length Frequency Distribution (LFD) provided in 2018.

Country		France	Ireland	Spain	UK(E+W)	Scotland	Denmark	Others
Unit	Quarter							
1 + 2	1	L		L+LFD	L	L		
	2	L		L+LFD	L	L		
	3	L		L+LFD	L	L		
	4	L		L+LFD	L	L		
3	1	L	L+LFD	L	L+LFD	L		
	2	L	L+LFD	L	L+LFD	L		
	3	L+LFD	L+LFD	L	L+LFD	L		
	4	L	L+LFD	L	L+LFD	L		
4 + 5 + 6	1	L+LFD	L+LFD	L+LFD	L+LFD	L		
	2	L+LFD	L+LFD	L+LFD	L+LFD	L		
	3	L+LFD	L+LFD	L+LFD	L+LFD	L		
	4	L+LFD	L+LFD	L+LFD	L+LFD	L		
8	1	L+LFD			L+LFD	L		L
	2	L+LFD			L+LFD	L		L
	3	L+LFD			L+LFD	L		L
	4	LFD			L+LFD	L		L
9	1	L+LFD						
	2	L+LFD						
	3	L+LFD						
	4	L+LFD						
10 + 14	1	L+LFD		L+LFD				
	2	L+LFD		L+LFD				L
	3	L+LFD		L+LFD				
	4	L		L+LFD				
12	1	L+LFD		L+LFD				
	2	L+LFD		L+LFD				
	3	L		L+LFD				
	4	L+LFD		L+LFD				
13	1	L		L+LFD				
	2	L		L+LFD				
	3	L+LFD		L+LFD				
	4	L+LFD		L+LFD				
15	1	L+LFD	L+LFD		L+LFD	L		L
	2	L+LFD	L+LFD		L+LFD	L		L
	3	L+LFD	L+LFD		L+LFD	L		L
	4	L+LFD	L+LFD		L	L		L
16	1	L+LFD			L+LFD	L+LFD	L+LFD	L+LFD
	2	L+LFD			L+LFD	L+LFD	L+LFD	L+LFD
	3	L+LFD			L+LFD	L+LFD	L+LFD	L+LFD
	4	L+LFD			L+LFD	L+LFD	L+LFD	L

Table 9.4. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Effort and LPUE values of commercial fleets.

	A Coruña trawl in VII			Vigo trawl in VII		
Year	Landings(t)	Effort(days)	LPUE(Kg/day)	Landings(t)	Effort**	LPUE**
1982				2051	75194	27
1983				3284	75233	44
1984				3062	76448	40
1985	5612	14268	393	1813	71241	25
1986	4253	11604	366	2311	68747	34
1987	8191	12444	658	2485	66616	37
1988	6279	12852	489	3640	65466	56
1989	6104	12420	491	1374	75853	18
1990	4362	11328	385	2062	80207	26
1991	3332	9852	338	2007	78218	26
1992	3662	6828	536	1813	63398	29
1993	2670	5748	464	1338	59879	22
1994	3258	5736	568	1858	56549	33
1995	4069	4812	846	1461	50696	29
1996	2770	4116	673	1401	54162	26
1997	1858	4044	459	1099	50576	22
1998	2476	3924	631	1201	53596	22
1999	2880	3732	772	1652	50842	32
2000	3628	2868	1265	1487	55185	27
2001	2585	2640	979	1071	56776	19
2002	1534	2556	600	1152	50410	23
2003	3286	3084	1065	1486	54369	27
2004	2802	2820	994	1595	53472	30
2005	2681	2748	976	1323	52455	25
2006	2498	2688	929	1422	53677	26
2007	2529	2772	912	1459	58123	25
2008	2042	1872	1091	1159	54324	21
2009	2418	1884	1284	1493	51551	29
2010	4934	2484	1986	1326	48432	27
2011	5108	2232	2288	1321	43533	30
2012	2819	1452	1942	1122	32760	34
2013	1474	903	1632	725	26834	27
2014	996	496	2008	482	15297	32
2015	972	397	2449	497	13954	36
2016	872	334	2611	508	11030	46
2017	902	384	2350	366	11450	32
2018	931	369	2524	221	9076	24

* Before 1988 landings and effort refer to Vigo trawl fleet only, from 1988 to 2002 t

** Effort in days/100HP; LPUE in kg/(day/100HP)

Sub-area VIII

	Ondarroa pair trawl in VIIIabd			Pasajes pair trawl in VIIIa,b,d		
Year	Landings(t)*	Effort(days)	LPUE(Kg/day)	Landings(t)*	Effort(days)	LPUE(Kg/day)
1993	64	68	930	na	na	na
1994	815	362	2250	540	423	1276
1995	3094	959	3226	2089	746	2802
1996	2384	1332	1790	2519	1367	1843
1997	2538	1290	1966	3045	1752	1738
1998	2043	1482	1378	2371	1462	1622
1999	2135	1787	1195	2265	1180	1920
2000	2004	1214	1651	2244	1233	1820
2001	1899	1153	1648	941	587	1603
2002	4314	1281	3368	2570	720	3571
2003	3832	1436	2669	2187	754	2902
2004	3197	1288	2482	1859	733	2535
2005	3350	1107	3026	658	252	2611
2006	4173	1236	3377	516	182	2837
2007	3815	1034	3691	278	105	2644
2008	5473	791	6916	0	0	na
2009	6716	633	10610	0	0	na
2010	8056	844	9545	0	0	na
2011	6357	893	7115	0	0	na
2012	4769	799	5969	0	0	na
2013	4562	518	8801	0	0	na
2014	3467	545	6356	0	0	na

Table 9.5. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Summary of landings and assessment results.

Year	Recruit Age 0	Total Biomass	Total SSB	Landings	Discards[1]	Catch	Yield/SSB	F (15-80 cm)
1978	316562	110368	71702	50551	NA	50551	0,71	0,54
1979	291398	119193	91895	51096	NA	51096	0,56	0,58
1980	321687	117436	94241	57265	NA	57265	0,61	0,68
1981	608284	100771	80167	53918	NA	53918	0,67	0,69
1982	418243	93068	64406	54994	NA	54994	0,85	0,72
1983	147050	100073	62898	57507	NA	57507	0,91	0,67
1984	293380	106123	76056	63286	NA	63286	0,83	0,7
1985	643145	91992	72957	56099	NA	56099	0,77	0,85
1986	373157	76128	54100	57092	NA	57092	1,06	0,96
1987	449506	72464	39906	63369	NA	63369	1,59	1,05
1988	511711	74110	43169	64823	2	64825	1,5	1,06
1989	495038	74596	42492	66473	73	66546	1,56	1,14
1990	503507	68450	39704	59954	NA	59954	1,51	1,08
1991	277635	65342	38676	58129	NA	58129	1,5	1,03
1992	303104	64388	37236	56617	NA	56617	1,52	1,07
1993	532745	57152	36649	52144	NA	52144	1,42	1,1
1994	300750	51453	28823	51259	356	51615	1,78	1,13
1995	152607	57792	28062	57621	NA	57621	2,05	1,19
1996	372604	52776	33133	47210	NA	47210	1,42	1,04
1997	262295	45173	28370	42465	NA	42465	1,5	1,12
1998	432554	42728	22678	35060	NA	35060	1,55	1,04
1999	213948	47023	26026	39814	349	40163	1,53	1,03
2000	192163	52250	28722	42026	83	42109	1,46	0,97
2001	354782	51791	34027	36675	NA	36675	1,08	0,8
2002	281646	54517	34673	40107	NA	40107	1,16	0,86
2003	163911	59642	35009	43162	2110	45272	1,23	0,87
2004	343418	61790	40085	46417	2552	48969	1,16	0,87
2005	221999	57585	38523	46550	4676	51226	1,21	1,02
2006	296671	53571	30822	41467	1816	43283	1,35	0,92
2007	453127	59328	36353	45028	2191	47219	1,24	0,82
2008	756719	73294	41909	47739	3248	50987	1,14	0,68
2009	251180	114996	62188	58818	10590	69408	0,95	0,57
2010	267234	186932	114775	72799	9978	82777	0,63	0,42
2011	274040	239615	190397	87540	14156	101696	0,46	0,33
2012	527664	255481	215395	85677	12680	98357	0,4	0,27
2013	392229	265216	218143	77753	15886	93639	0,36	0,26
2014	230026	298994	233524	89940	9913	99853	0,39	0,25
2015	239321	338241	277274	93670	9820	103490	0,34	0,23
2016	411718	357907	312407	109106	12741	121847	0,35	0,24
2017	687119	340727	297848	104671	7386	112057	0,35	0,26
2018	270587	339643	277482	89671	6512	96183	0,32	0,22
Arith.Mean	361865	120735	88607	59892	6053	62992		
Units	Thousands of Individuals	Thousands	Tonnes	Tonnes	Tonnes	Tonnes	percentage	

[1] Discards used in the assessment. In years with (-) discards are not available or considerent unreliable.

Table 9.6. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Catch option table.

SSB(2019)	Rec proj	F(15-80cm)	Catch(2019)	Land(2019)	SSB(2020)
285371	310754	0,24	100240	93834	276565

Fmult	Fcatch(15-80cm)	Catch(2020)	Land(2020)	Disc(2020)	SSB(2021)
0	0	0	0	0	363109
0,1	0,0239	11244	10550	694	352367
0,2	0,0479	22130	20757	1373	341971
0,3	0,0718	32670	30633	2038	331909
0,4	0,0957	42877	40188	2689	322170
0,5	0,1196	52761	49434	3327	312742
0,6	0,1436	62333	58381	3951	303616
0,7	0,1675	71602	67039	4563	294781
0,8	0,1914	80580	75417	5163	286227
0,9	0,2154	89276	83526	5750	277946
1	0,2393	97699	91373	6326	269927
1,1	0,2632	105857	98968	6890	262162
1,2	0,2871	113761	106319	7442	254643
1,3	0,3111	121418	113434	7984	247361
1,4	0,335	128836	120321	8515	240308
1,5	0,3589	136023	126987	9035	233477
1,6	0,3828	142986	133440	9546	226861
1,7	0,4068	149734	139688	10046	220452
1,8	0,4307	156272	145736	10536	214243
1,9	0,4546	162609	151591	11017	208227
2	0,4786	168749	157260	11489	202399

Table 9.7. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Yield per recruit summary table.

SPR level	Fmult	F(15-80cm)	YPR(catch)	YPR(landings)	SSB PR
1	0	0	0	0	3,2
0,86	0,1	0,02	0,08	0,08	2,76
0,75	0,2	0,05	0,14	0,14	2,40
0,66	0,3	0,07	0,19	0,18	2,09
0,58	0,4	0,09	0,22	0,21	1,84
0,51	0,5	0,12	0,25	0,24	1,63
0,45	0,6	0,14	0,27	0,26	1,45
0,41	0,7	0,16	0,29	0,27	1,30
0,37	0,8	0,19	0,30	0,28	1,17
0,33	0,9	0,21	0,31	0,29	1,06
0,30	1	0,23	0,31	0,29	0,96
0,27	1,1	0,26	0,31	0,29	0,87
0,25	1,2	0,28	0,32	0,29	0,80
0,23	1,3	0,31	0,32	0,29	0,73
0,21	1,4	0,33	0,32	0,29	0,68
0,20	1,5	0,35	0,32	0,29	0,62
0,18	1,6	0,38	0,31	0,29	0,58
0,17	1,7	0,4	0,31	0,28	0,54
0,16	1,8	0,42	0,31	0,28	0,50
0,15	1,9	0,45	0,31	0,28	0,47
0,14	2	0,47	0,30	0,27	0,44

	SPR level	Fmult	F(15-80cm)	YPR(catch)	YPR(landings)	SSB PR
Fmax	0,25	1,21	0,28	0,32	0,29	0,79
F0.1	0,38	0,77	0,18	0,29	0,28	1,21
F35%	0,35	0,84	0,2	0,3	0,28	1,12
F30%	0,3	1	0,23	0,31	0,29	0,96

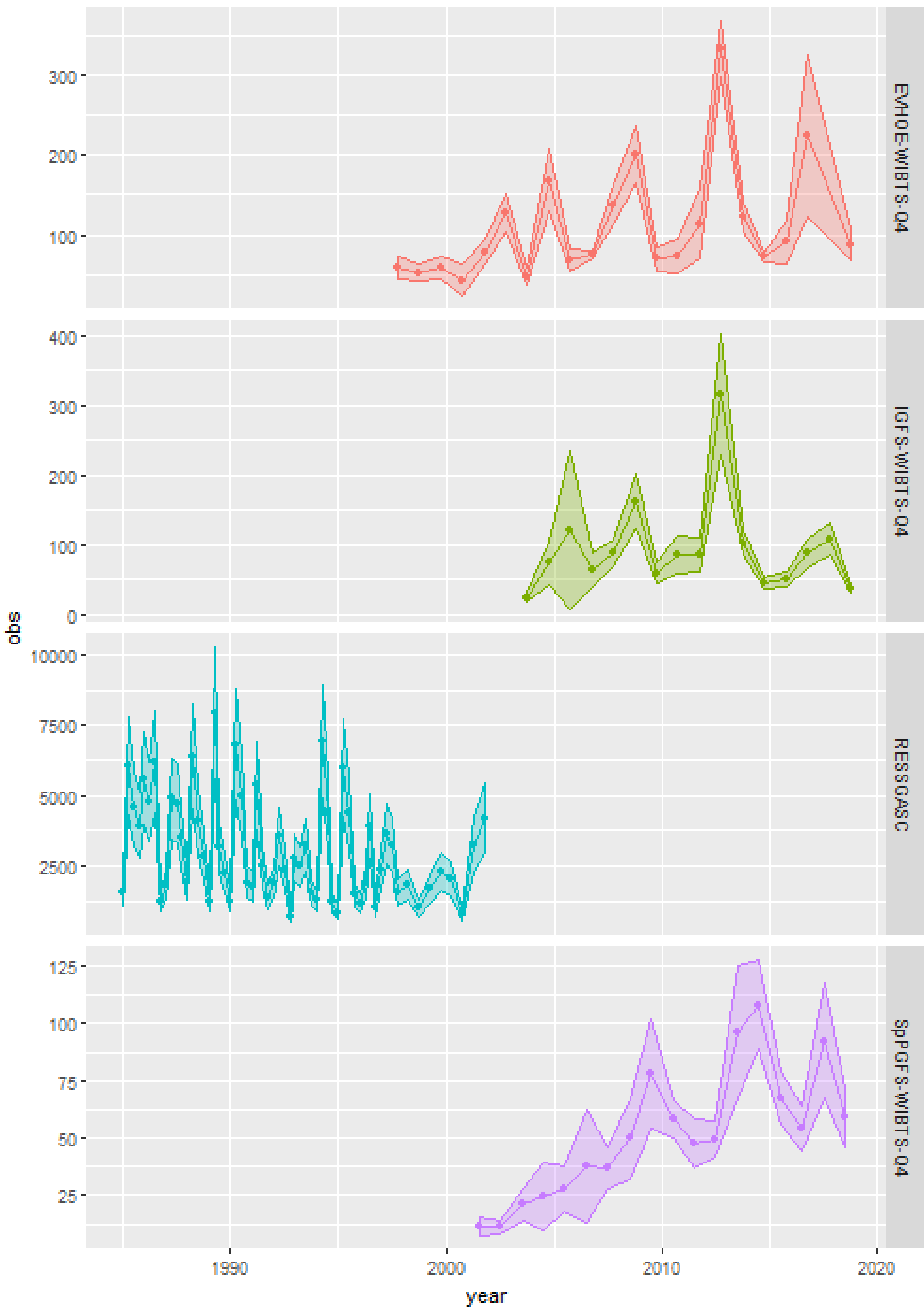


Figure 9.1. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Abundance indices from surveys.

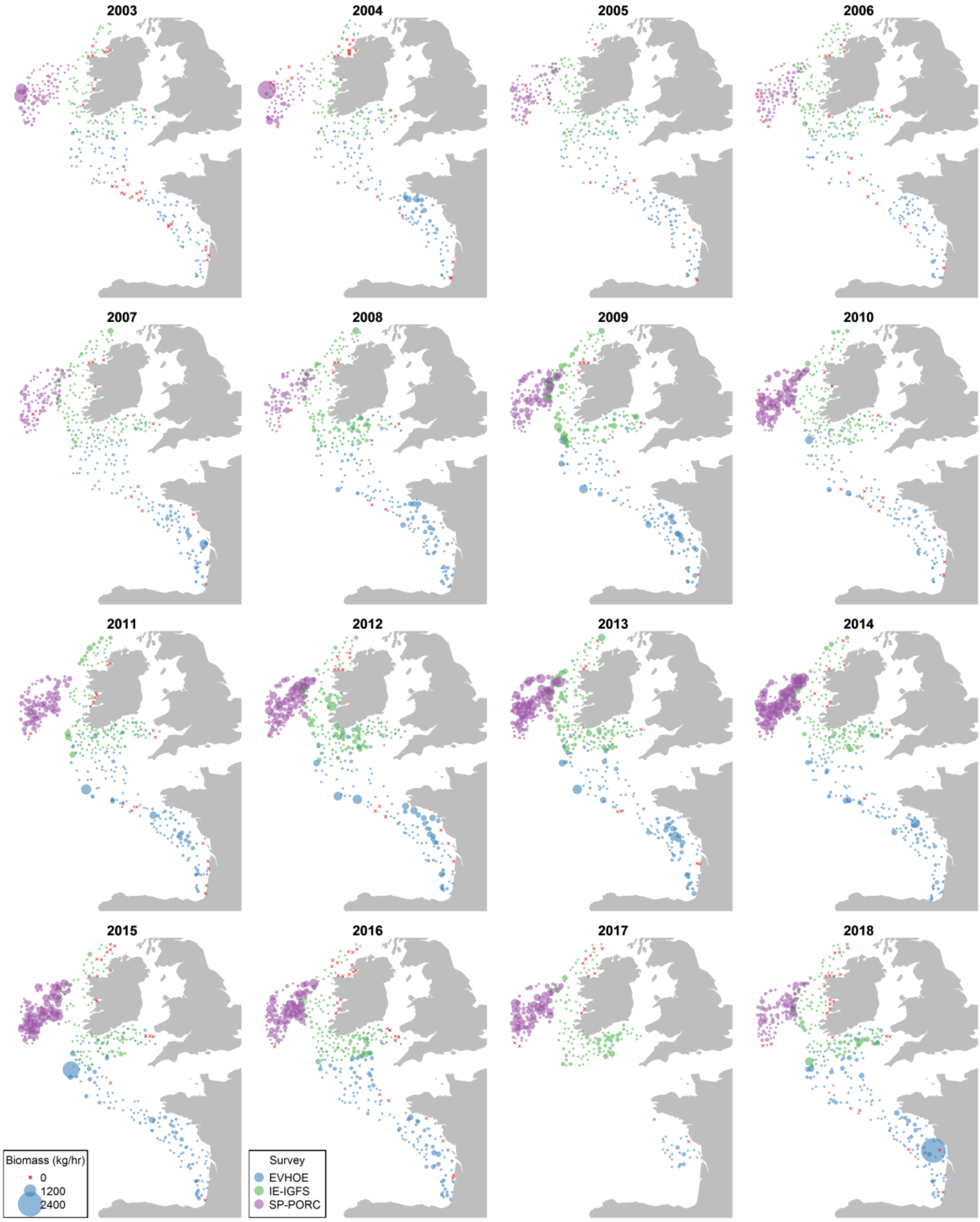


Figure 9.2. Spatial distribution of the EVHOE-WIBTS-Q4, IGFS-WIBTS-Q4 and SpPGFS-WIBTS-Q4 index of biomass (Kg/hr) from 2003 to 2018.

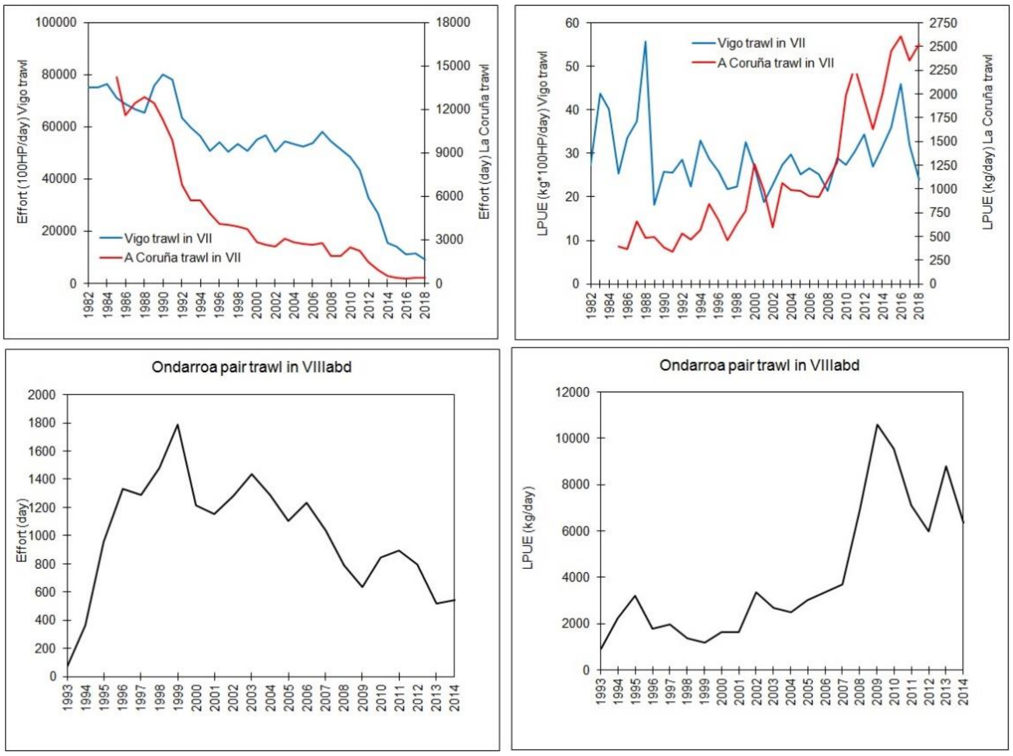
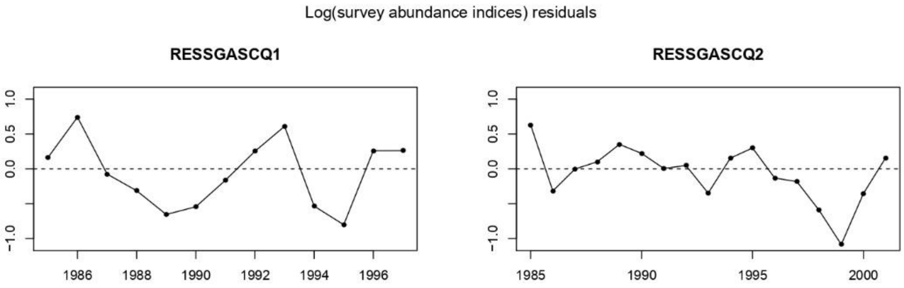


Figure 9.3. Northern Hake. Effective effort indices and LPUE values of commercial fleets estimated by National laboratories.



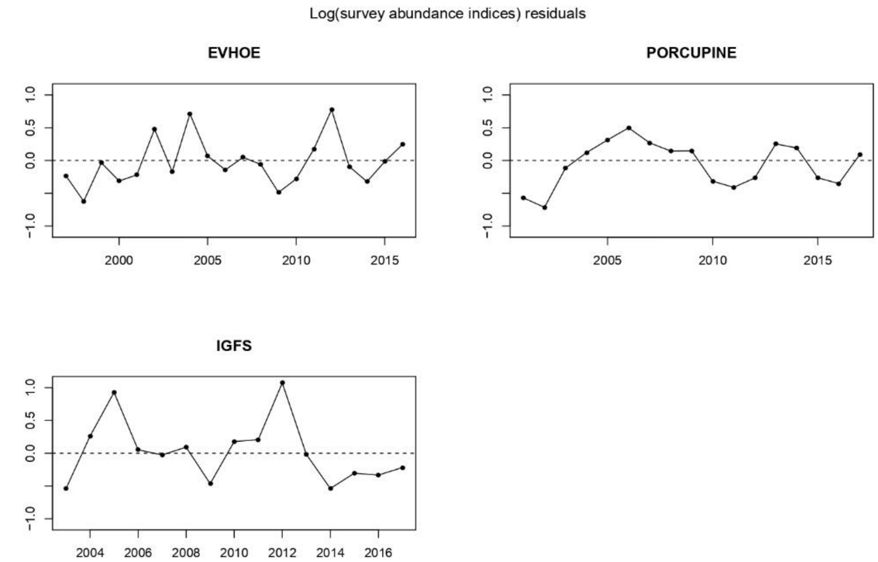


Figure 9.4. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Residuals of the fits to the surveys log(abundance indices). For RESSGASC, EVHOE, PORCUPINE and IGFS, fits are by quarter.

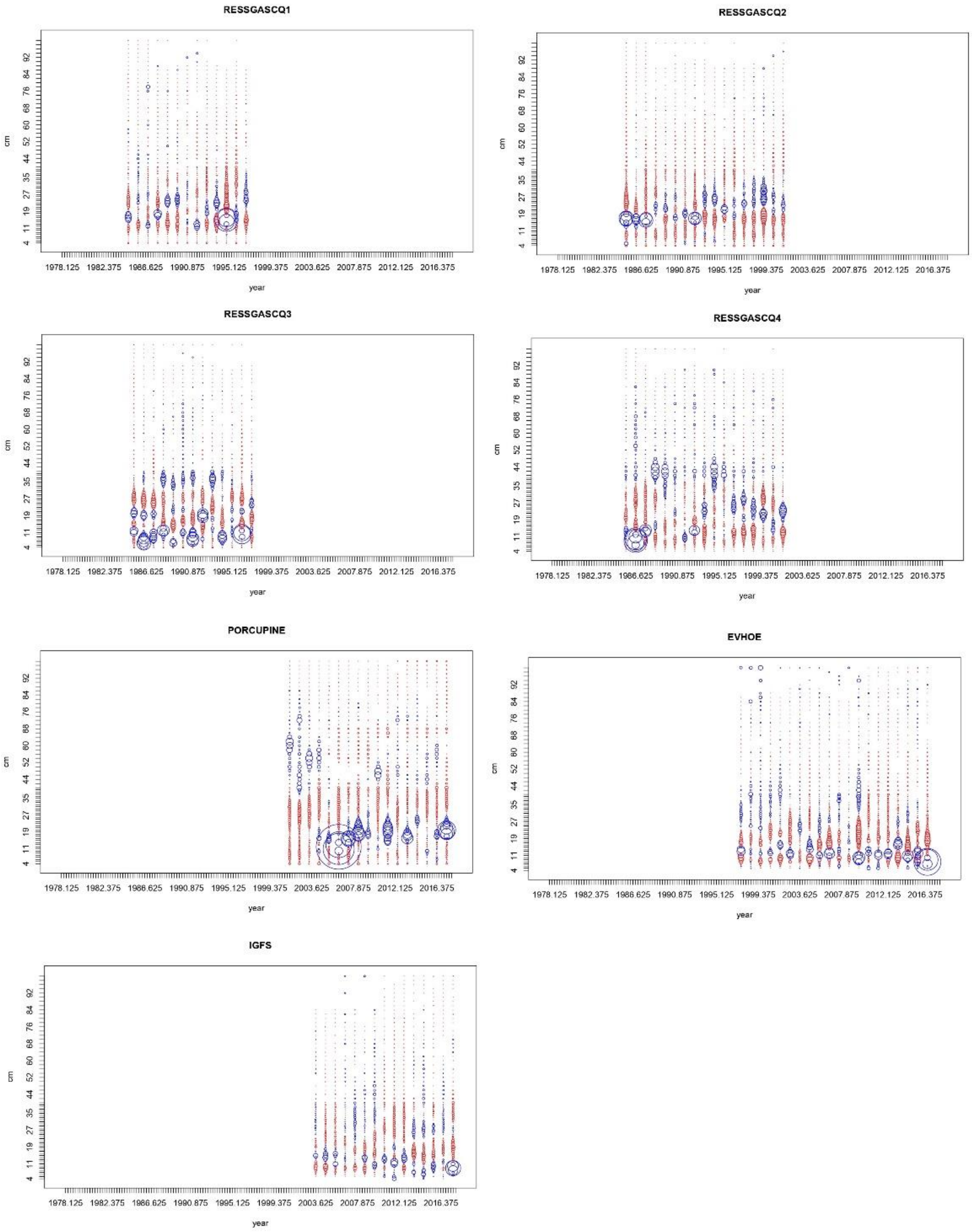


Figure 9.5. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Pearson residuals of the fit to the length distributions of the surveys abundance indices. For RESSGASC, fits are by quarter. Blue and red denote positive and negative residuals, respectively.

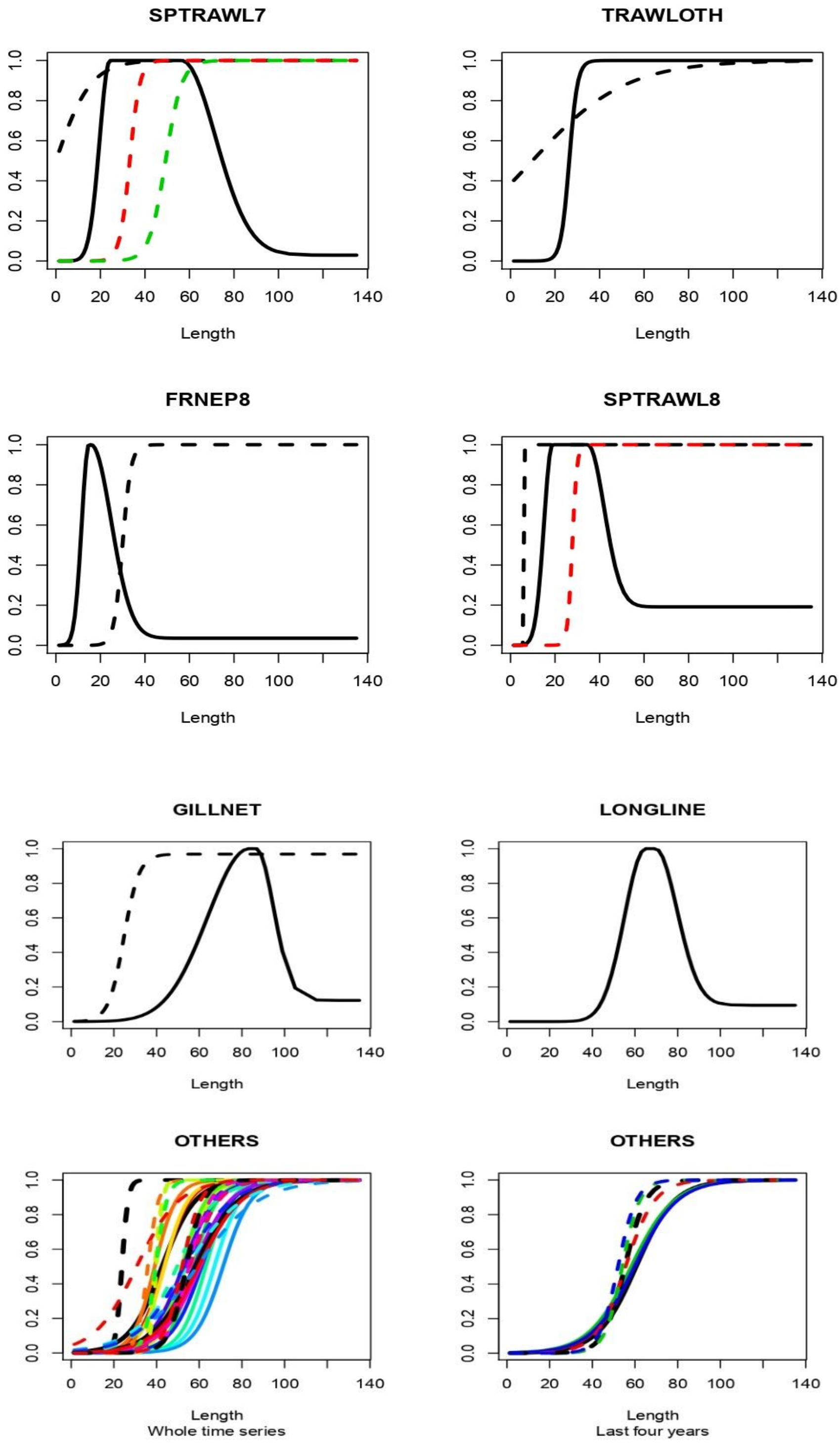


Figure 9.6. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Selection patterns (solid lines) and retention functions (dashed lines) at length by commercial fleet estimated by SS3. For SPTRAWL7, retention functions for 1978-1997, 1998-2009 and 2010-2013 are in black, red and green respectively. For SPTRAWL84, retention functions for 1978-1997 and 1998-2013 are in black and red respectively. For OTHERS, the plot in the left correspond with the selectivities in the whole series, black lines correspond with the selection and retention functions from 1978 to 2002, for the rest of the years the yellow and red colours correspond with the beginning of the series since 2003, the purple-pink colours with the last years and the green-yellow colours with the years in the middle of the series. The plot in the right shows the selectivity curves in the last five years, 2013 (black), 2014 (red), 2015 (blue), 2016 (green) and 2017 (blue light).

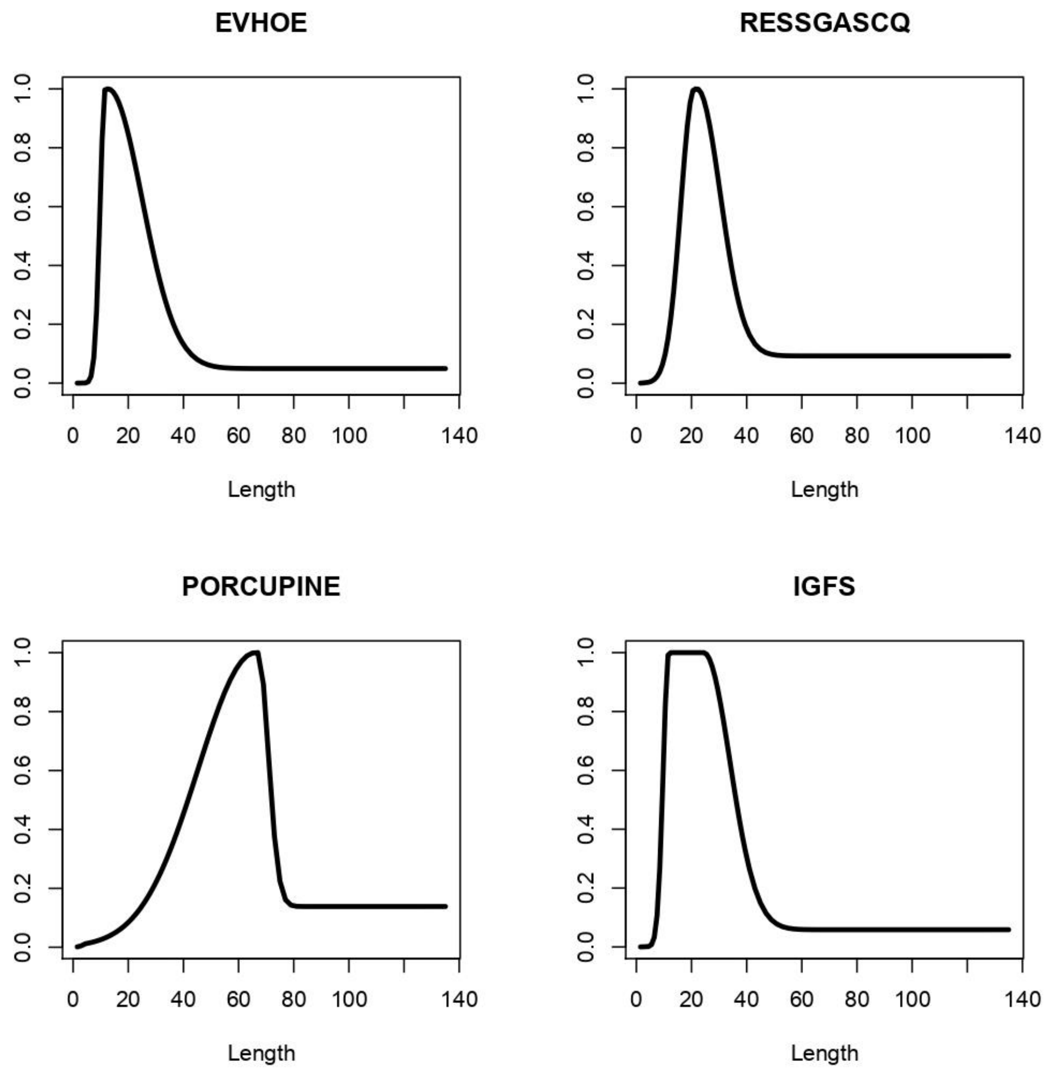


Figure 9.6. (continued). Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Selection patterns at length for surveys estimated by SS3.

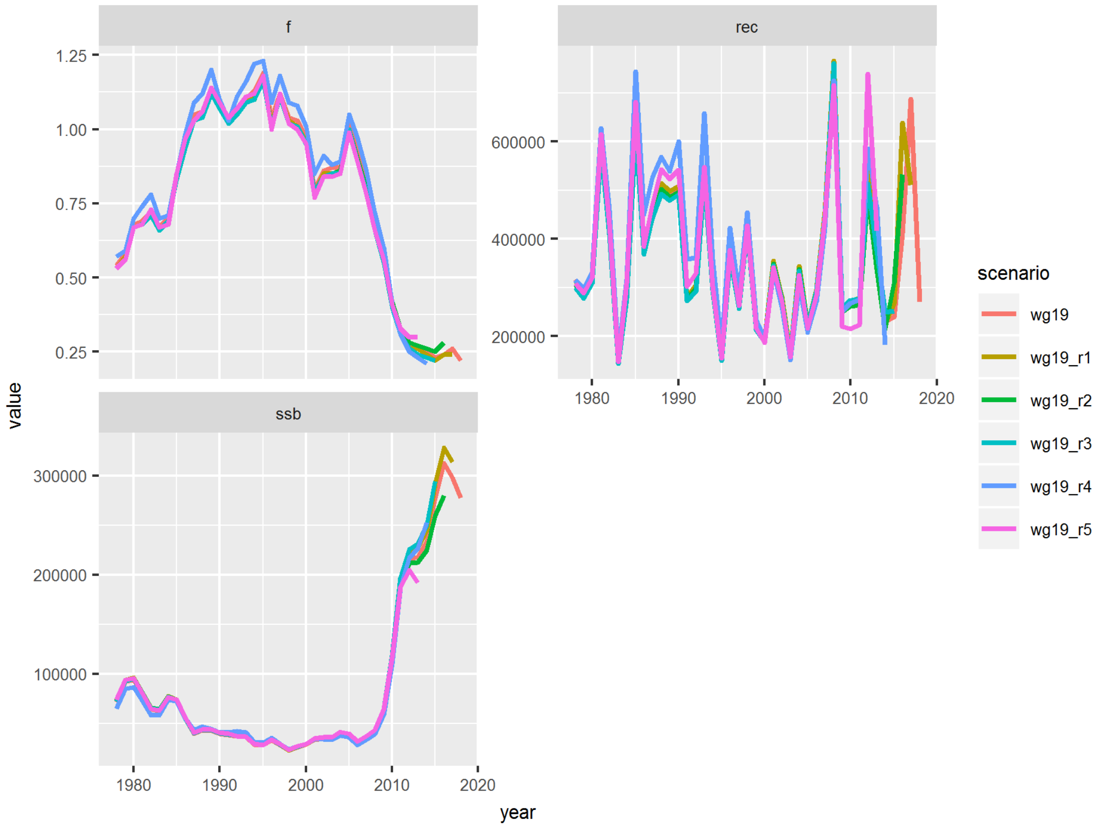


Figure 9.7. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Retrospective plot from SS3.

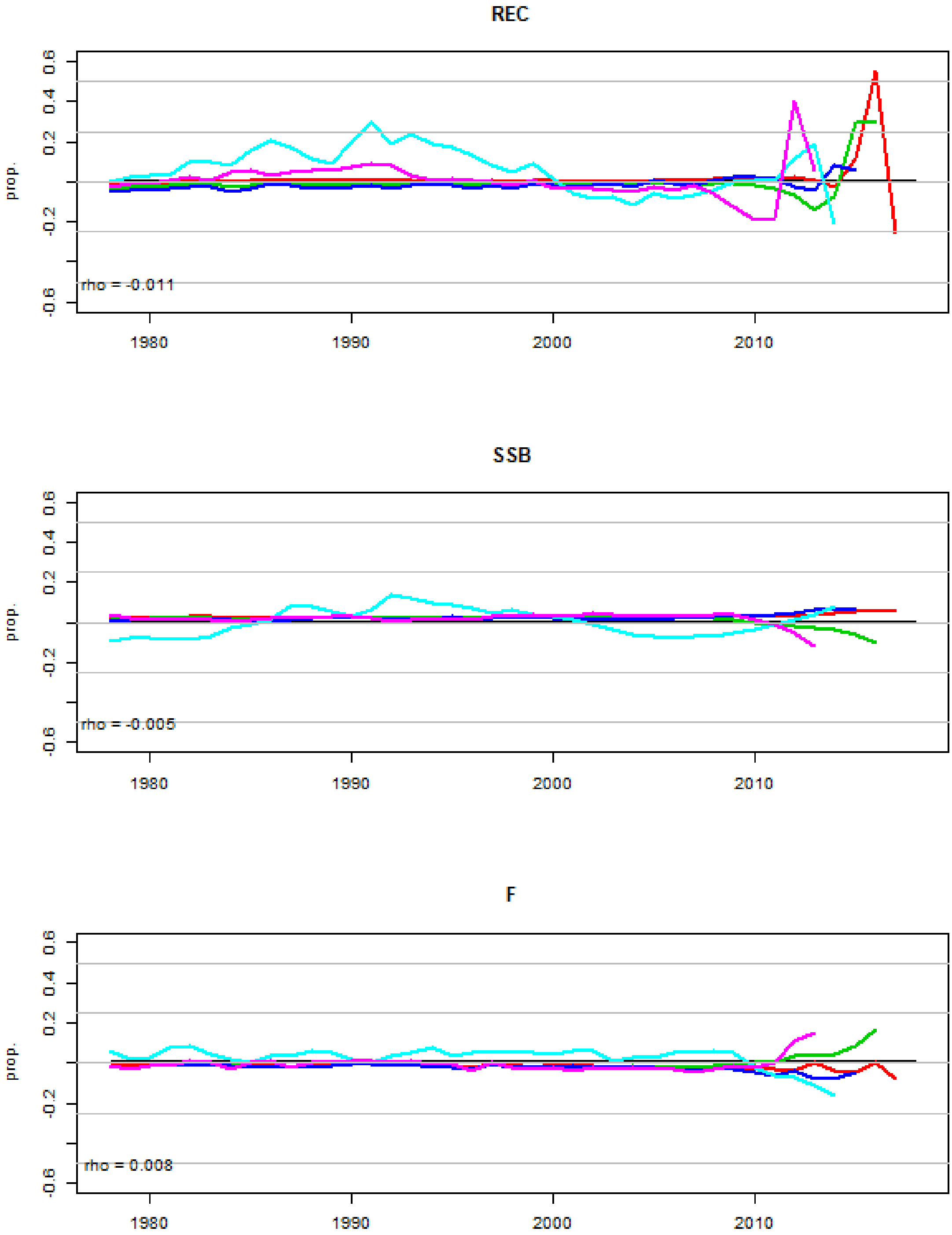


Figure 9.8. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Differences between time series in the retrospective analysis plot from SS3 for 2009-2015. The number in the bottom-left of the plot corresponds with the mohn rho.

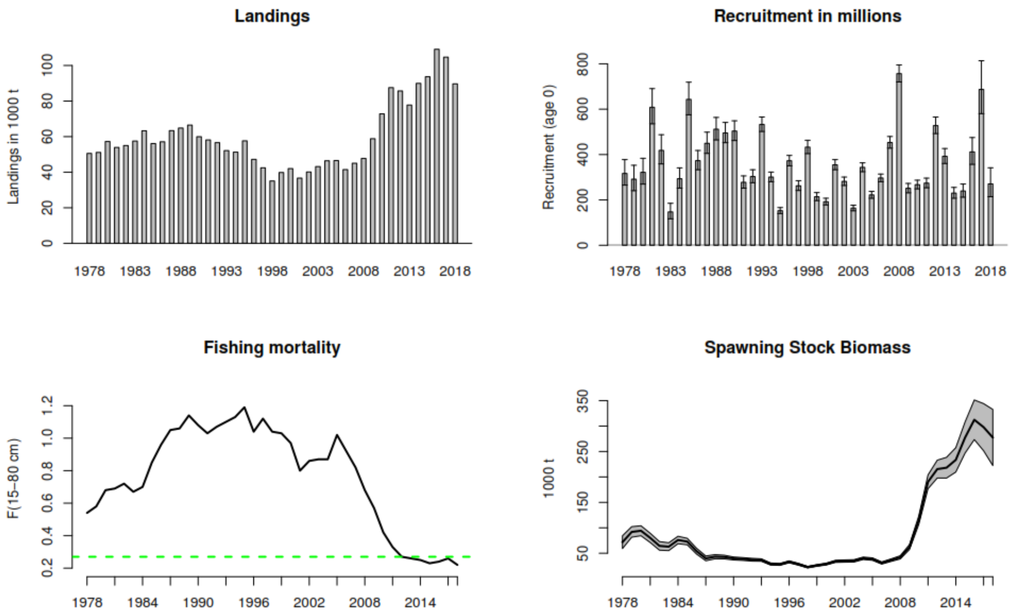


Figure 9.9. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Summary plot of stock trends.

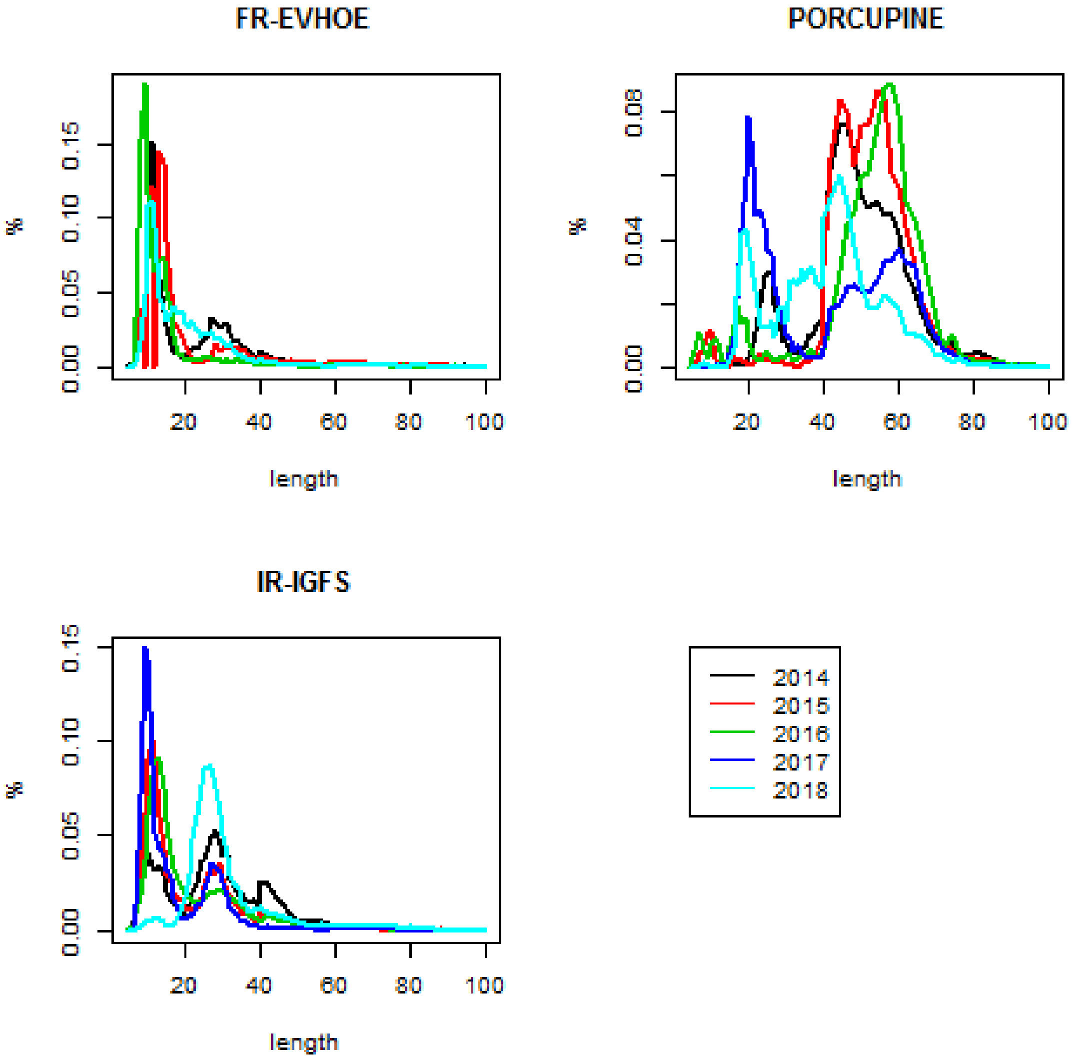


Figure 9.10. Length frequency distribution of the scientific surveys, FR-EVHOE, PORCUPINE and IR-IGFS n the last 5 years. EVHOE index is not available in 2017.

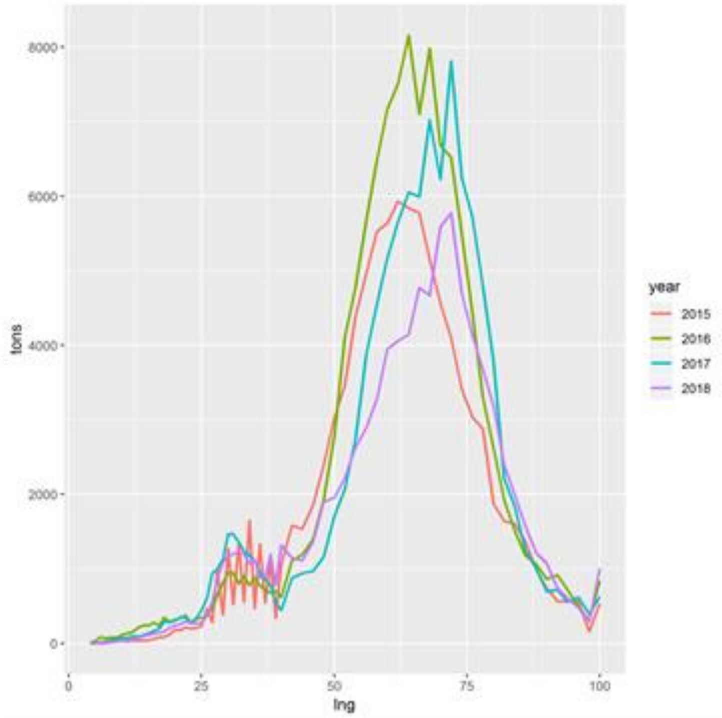


Figure 9.11. Length frequency distribution of catches from 2015 to 2018.

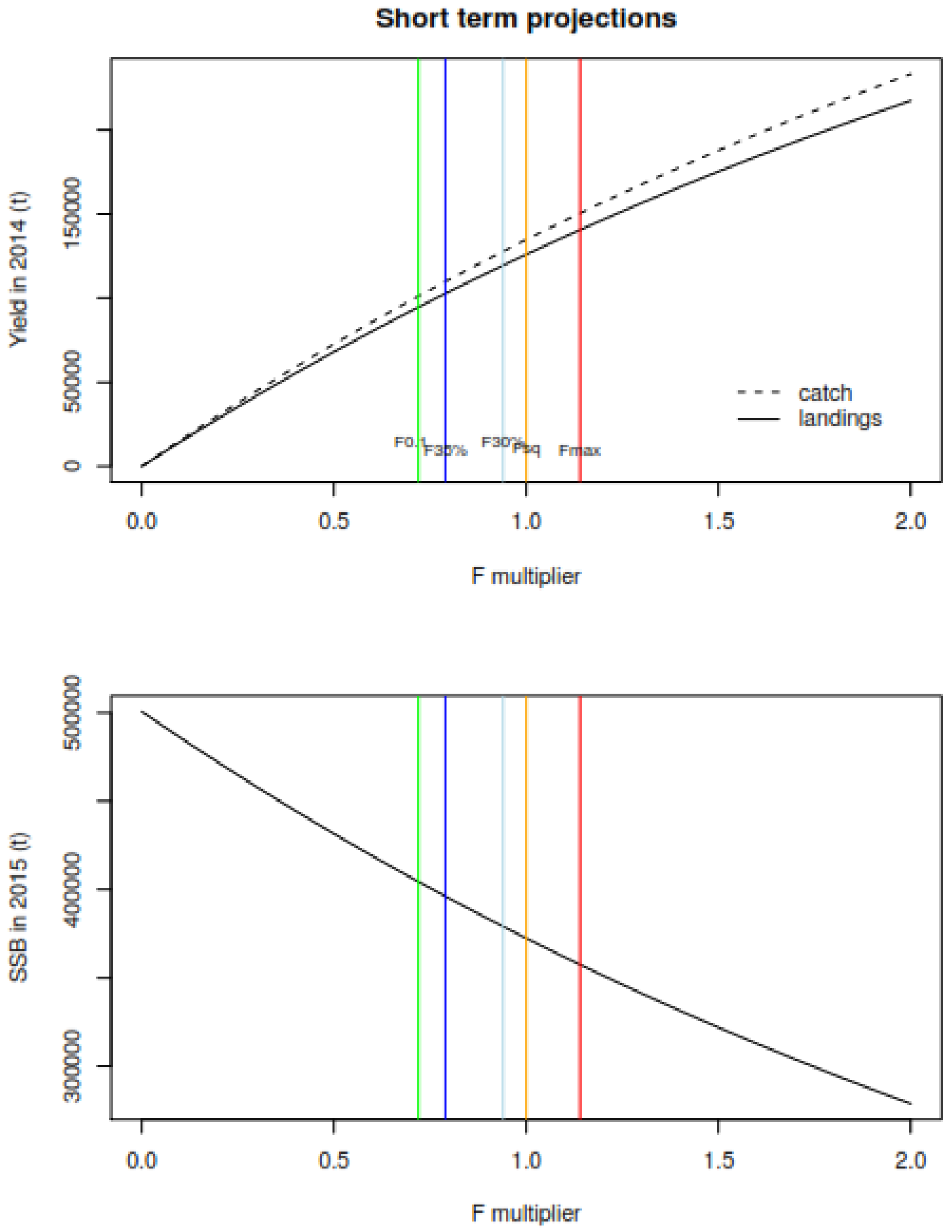


Figure 9.12. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Short term projections

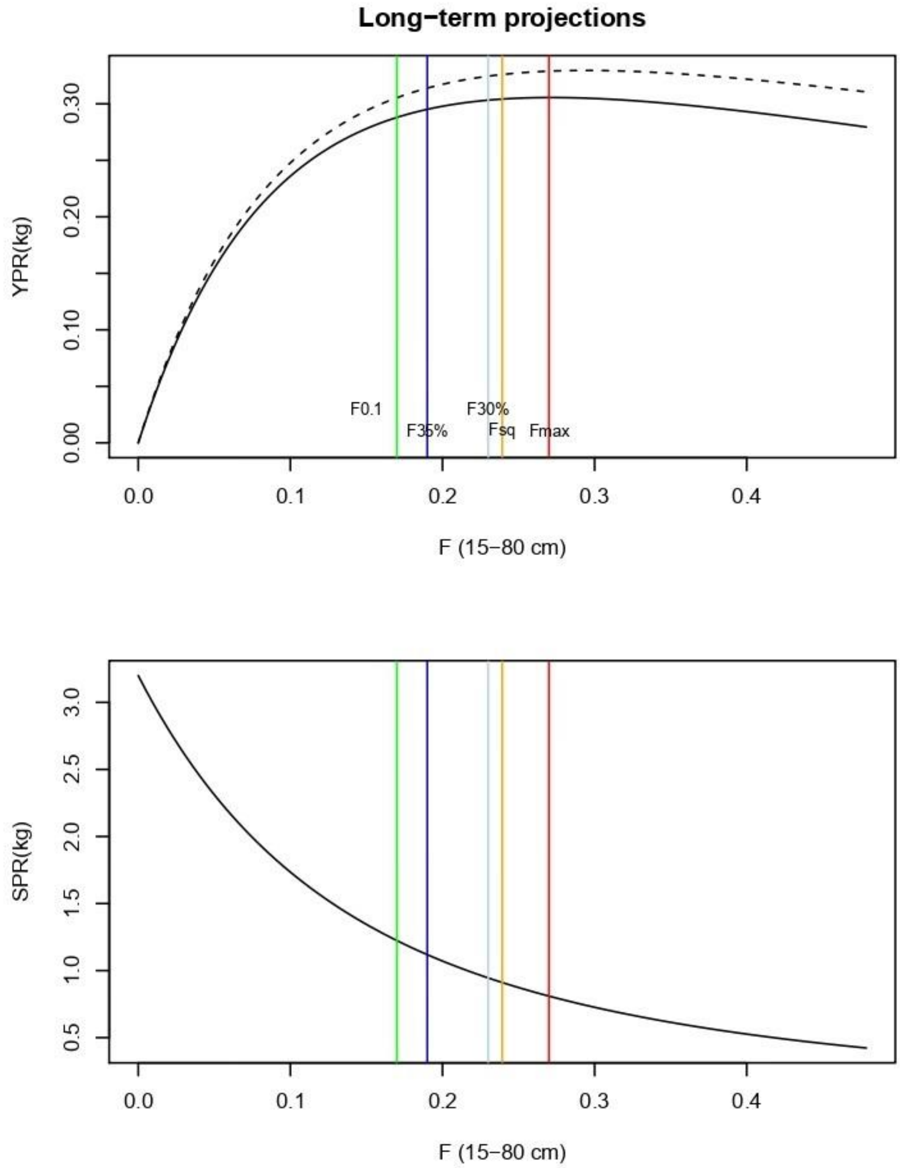


Figure 9.13. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Equilibrium yield and SSB per recruit.

9.10 Review of new estimation of Biological Reference points for Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock (Greater North Sea, Celtic Seas, and the northern Bay of Biscay)

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Introduction

In 2019 the stock was benchmarked in an inter-benchmark workshop (IBPHake) considering new discard information (ICES, 2019) changing the perception of the stock status. However reference points were not produced by IBPHake given the lack of time. Updated reference points were presented now in WGBIE. I was the reviewer of the IBPHake report and I was also member of WGBIE. I was suggested as a reviewer of this work afterwards and, after an in-deep reading on ICES guides for reference points in category 1, which are under discussion in http://community.ices.dk/Advice/Advice2019/TechnicalGuidelines/Draft_advice/12.04.03.01%20Reference%20points%20for%20category%201%20and%202.docx?web=1, I found a couple of potential deviations to this guide. However I do not think they affect the validity of these reference points.

- The full analysis was presented as WD-6 in WGBIE 2019 report. The same software and the same procedure used in WKMSYREF4 in 2015 (ICES, 2017) was implemented. Estimated reference points are presented in Annex I. A couple of deviations from ICES guides were identified and discussed in the end of this document.

Precautionary reference points

- Biomass-reference points were estimates assuming a Type 2 stock-recruitment relationship. It is arguable whether Type 5 can be also feasible looking at the SSB-R scatter plot. However, given the depleted stock status at the beginning of 2000's with low SSB's and recruitments, Type 2, with Blim set at the regression break point seems more appropriate. Blim (39 821 tons) was rounded to 40 000 tons.
- F reference points were not estimated based on the ICES guides as the "F that in equilibrium will maintain the stock above Blim with a 50% probability." Instead it was estimated with the long term simulation with a probability of 5%, i.e. equal to Fp0.5.

MSY reference points with long-term simulations

- A combination of Ricker, Beverton-Holt and segmented regression were fit together in a Bayesian model to explore stock-recruitment options to the long-term simulations. However the segmented regression model contributed with ~85% to the likelihood and was used alone in the long-term simulations with the posterior parameters distribution. The same decision was taken in WKREFMSY4 (ICES, 2017). This can drive the slope at origin to be underestimated increasing the risk of collapse in the simulations.
- No variability was considered in the biological parameters for the long term simulations. Mean weight, proportion of mature and M follow the same constant values than those in the SS3 model. This can underestimate the error in the projections and then biases the precautionary analysis. However, given the difference between Fupper (0.40) and Fpa (0.6), which is probably underestimated (see my next comment), we can consider Fupper inside precautionary limits.

- Fishing mortality reference points (Fmsy, Flower, Fupper, Fpa and Flim) were defined using stochastic long-term projections based on the scenario without Btrigger, i.e. with constant fishing mortality. Fp0.1 (0.84 without Btrigger and 1.04 with Btrigger) were used as precautionary references. Fmsy and ranges were calculated as the F values that maximizes median yield and fit 95% yield. Flim was set as F resulting in a 5% probability of SSB falling below Blim (Flim=0.84). However the ICES guide says "Determining the F = F lim that, in equilibrium, gives a 50% probability of SSB > B lim (preferred method)".
- Fmsy and ranges in the WGBIE report and those in the WD are not the same. I consulted the expert (Dorleta Garcia) who confirmed that the true figures (See Annex I)

Conclusion

In general the procedure follows the ICES guides, and deviations to these guides are not critical from the precautionary point of view since controversial decisions are risk-averse (e.g. S-R relationship as type 2 instead of 5, using segmented regression alone instead of a combined S-R models, or estimate Flim as Fp05 instead of using the usual 50% probability). The lack of errors in biological parameters are probably neither critical given the high difference between Fupper and Fpa. Taking this in consideration it is not expected they affect the precautionary consideration of the suggested MSY reference points.

References

ICES. 2017. Report of the Workshop to consider FMSY ranges for stocks in ICES catego-ries 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp..

ICES 2019. Inter-benchmark of Hake (Merluccius merluccius) in subareas 4, 6, and 7 and divisions 3.a, 8.a–b, and 8.d, Northern stock (Greater North Sea, Celtic Seas, and the northern Bay of Biscay) (IBPhake). ICES Scientific Reports, 1:4: 28 pp.

ICES Guides to Category 1 Stocks. http://community.ices.dk/Advice/Advice2019/TechnicalGuidelines/Draft_advice/12.04.03.01%20Reference%20points%20for%20category%201%20and%202.docx?web=1

WD-6 in WGBIE 2019 Report.

Annex I. Summary table of proposed stock reference points for method from WD-6.

Stock		
MSY Reference point	Value	Rational
B_{lim}	40 000	The median of the segmented regression breakpoint. (Type 2 stock recruitment type REF)
B_{pa}	56 000	$B_{lim}*e^{0.2*1.645}$REF
F_{lim}	0.84	
Fpa	0.6	$F_{lim}/1.4$
F_{MSY} without $B_{trigger}$	0.26*	
F_{MSY} lower without $B_{trigger}$	0.18	
F_{MSY} upper without $B_{trigger}$	0.40	
$F_{P.05}$ (5% risk to B_{lim} without $B_{trigger}$)	0.84	
MSY $B_{trigger}$	56 000(Bpa)	
$F_{P.05}$ (5% risk to Blim with Btrigger)	1.02	
F_{MSY} with Btrigger	0.27	
F_{MSY} lower with Btrigger	0.17	
F_{MSY} upper with Btrigger	0.42	
MSY	119 000 t	
Median SSB at FMSY	200 000 t	
Median SSB lower (median at F_{MSY} upper)	178 000 t	
Median SSB upper (median at F_{MSY} lower)	452686t	

*** F_{MSY} without Btrigger corrected to 0.26 following WD authors (0.28 in the original document)**

10 Southern Stock of Hake

10.1 General

The type of assessment is "update" based on a previous benchmark assessment (WKSOUTH, 2014).

This year assessment was updated with 2018 data with no reviews of previous year's data.

10.1.1 Fishery description

Fishery description is available in the Stock Annex (Annex G).

10.1.2 ICES advice for 2019 and Management applicable to 2018 and 2019.

ICES Advice for 2019

ICES advised that when the MSY approach is applied, catches in 2019 should be no more than 8281tonnes. Since this stock is only partially under the EU landing obligation, ICES was not in a position to advice on landings corresponding to the advised catch.

Management Applicable for 2018 and 2019

Hake is managed by TAC, effort control and technical measures. The agreed TAC for Southern Hake in 2018 was 9258t and in 2019 it is 9258 t.

Southern hake is included in the Multiannual Management Plan for Western Waters (EU, 2019). The target fishing mortality, in line with the ranges of F MSY, shall be achieved by 2020.

EU (CR 2018/1209, annex II-b) regulation includes effort management measures, limiting days at sea for each country. This stock is under partial landing obligation since 2016and with a *de minimis* exemption. During this year, ongoing studies to evaluate *de minimis* exemption for the southern hake stock are being carried out by regional scientific and administration bodies with the collaboration of the SWWAC (South Western Waters Advisory Council).

Technical measures applied to this stock include: (i) minimum landing size of 27 cm, (ii) protected areas, and (iii) minimum mesh size. These measures are set, depending on areas and gears, by several national regulations.

According to the Spanish Regulations progressively implemented after 2011 AAA/1307/2013, the Spanish quota is shared by individual vessels. This regulation was updated in 2015 (AAA/2534/2015) including a fishing plan for trawlers. Regulations (EU Reg. 850/98) also established a closure for trawling off the southwest coast of Portugal, between December and February.

10.2 Data

10.2.1 Commercial Catch: landings and discards

Catches: landings and discards

Southern Hake catches by country and gear for the period 1972-last year, as estimated by the WG, are given in Table 10.1. Since 2011, estimates of unallocated or non-reported landings have been included in the assessment. These were estimated based on the sampled vessels (Spanish concurrent sampling) multiplied to the total effort for each métier.

Overall landings increased from 9 171 t in 2017to 10183 t in 2018. Portuguese official landings were 1 489 t, very similar to the 1484 t landed in2017. Spanish official landings were 6441t in 2018while they had been 6857t in 2017. Non-reported landings in 2018 increased from 763 t in 2017 to2193t. Total discards in 2018 were 1942 t, slightly higher from the estimated 1676 t in 2017.Total catches were 12 125t in 2018, higher than the10 847 observed in 2017.TheTAC for 2018 was9 258 which means total catches overpass the advised TAC.

Length distributions for 2018 landings and discards are presented in Figure 10.1 and in Table 10.2. Mean size has lately been stable in landings but shows a small decrease from 34.64 cm in 2017 to 32.3 in 2018.In opposition, discards this year increased in mean size from 19.4 cm in 2017 to 24.2 cm. This increase in the mean length of discards is reflected in the mean catch size (from 26.3 cm in 2017 to 29.3 cm)

Growth, Length-weight relationship and M

An international length-weight relationship for the whole period (a=0.00659; b=3.01721) has been used since 1999. The assessment model follows a constant von Bertalanffy model with fixed L_{inf} = 130 cm, t_0=0 and estimating k parameter. Natural mortality was assumed to be 0.4 year^{-1} for all ages and years.

Maturity ogive

The stock is assessed with annual maturity ogives for males and females together. The maturity proportion in this assessment year is shown in Figure 10.2. L_{50} have oscillated from 34.5 in 2016, to 30.3 cm in both 2017 and 2018 (historical low).

10.2.2 Abundance indices from surveys

Biomass, abundance and recruitment indices for the Portuguese and Spanish surveys, respectively, are presented in Table 10.3 and Table10.4, and in Figure 10.3. The Spanish (SpGFS-WIBTS-Q4 and SPGFS-caut-WIBTS-Q4) and the Portuguese (PtGFS-WIBTS-Q4) surveys are used to tune the model, by fitting the model estimates to the observed length proportions and survey trends. The three surveys together cover the whole geographic area of the stock and are conducted simultaneously in autumn to minimize any sources of variability. They are part of the IBTS system (ICES, 2017), which further ensures the methodology employed is the same.

The Portuguese Autumn survey (PtGFS-WIBTS-Q4) showed variable abundance indices with a maximum in 1981 and a minimum in 1993 (the survey did not take place in 2012). It shows low values for biomass and abundance in the early 2000s and increases after 2004 showing the maximum historical values in 2008-10, 2012 and 2015. Values in 2016,2017 and 2018 are rather stable and near the historical mean. The Portuguese research vessel had some technical problems during the 2018 survey and 12 fishing stations, mainly in the Southwest area, were carried out with a different fishing gear. Data have been standardized to allow for comparable hauls. The Spanish ground fish survey (SpGFS-WIBTS-Q4) shows similar trend with low values for biomass and abundance in the early 2000s. These values increased after 2004 with maximum in 2009-12 and 2015. The estimates from 2017 and 2018 are very similar and lightly above the historical mean. The recruitment indices of the SpGFS-WIBTS-Q4, SPGFS-caut-WIBTS-Q4 and PtGFS-WIBTS-Q4 (Figure 10.3) were highly variable in the past, showing good recruitments in recent years. In 2014 the 3 surveys decreased below historical means, but in 2015 the PtGFS-WIBTS-Q4 reached a historical maximum, while both SpGFS-WIBTS-Q4 and SPGFS-caut-WIBTS-Q4 returned to above average values. In the latest years, all surveys carry the same trends with a peak in 2015 followed by a decrease in 2016 and 2017. During 2018 theSpGFS-WIBTS-Q4, and PtGFS-WIBTS-Q4 shows an increase in recruitment as opposed to the decrease estimated by the SPGFS-caut-WIBTS-Q4.

For modelling purposes, length distribution calibration is made from the three surveys (SpGFS-WIBTS-Q4, SPGFS-caut-WIBTS-Q4 and PtGFS-WIBTS-Q4). Surveys used for trend calibration are only SpGFS-WIBTS-Q4, and PtGFS-WIBTS-Q4.

Commercial catch-effort data

Effort and respective landings series are collected from Portuguese log-books maintained in DGRM and compiled by IPMA. For the Portuguese fleets, until 2011 most log-books were filled in paper but have thereafter been progressively replaced by e-logbooks for those vessels covered by the obligation (vessels longer than 15m). All vessels in the recovery plan are required to be equipped with an e-logbook system. The standardized CPUE from the Portuguese bottom-trawl fleet targeting groundfish is calculated by fitting a GLM to log-book data on landings and effort (modulated by additional fleet and catch characteristics), following the methods described in the stock annex and accepted by WKROUND (2010). The latest series is based on a renewed extraction of the complete logbook dataset housed in the DGRM (Portuguese administration) databases, which includes both paper and e-logbooks.

Spanish sales' notes and Owners Associations data were compiled by IEO to estimate fleet effort until 2012. After 2012 effort is reported following logbooks. LPUE data are presented in Figure 10.4 and Table 10.5. 2018 data was not presented. Changes in effort and landings estimation method prevent use of these data as a continuous series. The increased surveillance and the implementation of management regulations after 2011, have altered the fleet behaviour, preventing its use as a new fleet for model calibration purposes.

The two fleets included in the assessment model are SP-CORUTR (from 1985 to 2012) and P-TR (from 1989 to 2018). Since 2008, P-TR LPUE has been consistently above the historical mean (41.88 kg/hour)with a peak in 2015.The 2018 LPUE(43.63 kg/hour) is above the average and shows a small increase compared to 2017.

10.3 Assessment

The assessment carried out used the GADGET model (length-age based) as decided by WKSOUTH (2014) and described in the stock annex (Annex G).

10.3.1 Model diagnostics

Likelihood profiles for each parameter estimated by the model are presented in Figure 10.5. The plot shows the parameter value *versus* the estimated likelihood. The values on the horizontal axes of the plots represent multiplicative factors with respect to the estimated parameter value 1 ± 10%. To check for convergence, the minimum likelihood value must correspond to the estimated parameter value (i.e. the multiplier 1). Due to the distinct impact that each parameter has on the likelihood value, the plots are presented with two different options (scaled and unscaled y axis). This diagnostic confirms that all parameter estimates correspond to the minimum of the likelihood.

Residuals for surveys and abundance indices (SpGFS-WIBTS-Q4 and PtGFS-WIBTS-Q4) and commercial fleets (SP-CORUTR and P-TR) are presented in Figures 10.6a-b, grouped in 15 cm classes (from 4 to 49 cm in surveys and 25 to 70 cm in commercial fleets). Most residuals are within the range of -1 to 1 (±1 s.d.). Surveys' residuals show a random distribution, to the possible exception of PtGFS-WIBTS-Q4 for lengths 4-19 cm and for lengths 19–34 cm, which appear to display some trend. This means that abundance at these two length groups can be underestimated by the model in recent years.

P-TR (25–40 cm) showed negative residuals with a downward trend between 2005 and 2010, but has since then returned to lower residuals. The perceived trend is within acceptable bounds. In 2018, catches of larger individuals were less frequent in the Portuguese trawl fleet, the residuals for this year show an isolated negative value for the two indices P-TR (40–55 cm and 55-70) that could mean an overestimation of large fish by the model. Apart from this, the fits for these 3 length groups in the remaining years are quite consistent. The SP-CORUTR (1994–2012) shows also quite consistent random residuals to the exception of the length group 55–70 cm, which shows positive residuals for 6 years (2007–2012).

Figures 10.6 (c-i) present bubble plot of residuals for proportions at length. These proportions are grouped in 2 cm classes for all "fleets" used in the model calibration (see Stock Annex for descriptions). The model fits these proportions at length assuming a constant selection pattern for every "fleet" in the years and quarters in which length distributions are observed. The quality of the fit is different for different data sets, but not all of them contribute equally to the overall model fit. Projections are based on the selection patterns estimated only for landings (10.6-d) and discards (10.6-f). The residual analysis shows that there is an underestimation (positive residuals) in the most exploited lengths and overestimation on the larger sizes (negative residuals). Such patterns are not of major concern since the residual values are quite small (maximum ~0.3). The model accounts for data precision, when weighing individual likelihood components (defined in the Stock Annex). So, data sets with larger model residuals will have less impact on the overall model fit.

10.3.2 Assessment results

Estimated parameters

The model estimates selection parameters for each "fleet" for which length proportions are fitted. Furthermore, it estimates the von Bertalanffy growth parameter k. Results are presented in Figure 10.7. The selection patterns of different "fleets" of catches (catches in 1982–93; landings in 1994–latest; discards 1992–latest and Cadiz landings (1982–2004) are presented in the upper panel. The pattern corresponding to catches during 1982–93 shows higher relative efficiency for smaller fish (when compared with catches from 1994 onwards), in agreement with our assumption that before 1992 (when the minimum landing size was implemented) the importance of discards was relatively low. The discard selection pattern was similar to that of the Cadiz landings selection pattern in years prior to 2005. Since then, the Cadiz fleet increased its landings length and are now modelled together with the rest of the landings (1994–end). The discards (1992-latest) and landings (1994–latest) selection patterns are used for projections. Survey selection patterns are presented in the middle panel. The Portuguese survey PtGFS-WIBTS-Q4 catches relatively larger fish than the Spanish surveys (SpGFS-WIBTS-Q4 and SPGFS-caut-WIBTS-Q4). Both Spanish surveys show a similar pattern. They are both performed with the same vessel and gear in every year, but since 2013 a new vessel has been used (without a significant impact in hake abundance estimates).

The von Bertalanffy k parameter was estimated to be 0.164, the same as in previous assessments.

Historic trends in biomass, fishing mortality, yield and recruitment

Model estimates of abundance at length in the beginning of the 4th quarter are presented in Figure 10.8. The figure shows a general increase of small fish in 2005-09, that contributes to an increase of large fish in more recent years. Abundance of smaller fishes in 2018 were estimated to be relatively higher than in 2017.Table 10.6 and Figure 10.9 present summary results with estimated annual values for fishing mortality (averaged over ages 1–3), recruitment (age 0) and SSB, as well as observed landings and discards.

Recruitment (age 0) is highly variable with some definable periods: one from 1982 to 2004with mean values around 70 million (ranging from 40 to 120 mill); another between 2005 and 2009, with mean values of 123million; since 2010 recruitment has been oscillating around 62 to 92 million individuals. Recruitment in 2018was replaced with the geometric mean of years 1989-17(78620 millions).

Fishing mortality increased from the beginning of the time series (F=0.36 in 1982) peaking in 1995–97 to around 1.16-1.19; then declining to 0.79 in 1999 and remaining relatively stable until 2016(F=0.83) with the exception of a period between 2006-2009 where F reached values averaging 0.95. Fishing mortality in the last two years has been decreasing reaching 0.62 in 2017 and 0.60 in 2018.The SSB was very high at the beginning of the time series with values around 45 000 t, then decreased to a minimum of 5 706t in 1998. Since then, biomass has been increasing, peaking in 2011 (16 461 t) and remaining slightly below this figure peaking again in 2018 with 16619 t.

Retrospective pattern for SSB, fishing mortality, yield and recruitment

Figure 10.10 presents the results of the assessments performed using the retrospective data series from 2018–2013. There is a clear trend in the retrospective pattern for recruitment, F and SSB, as in previous years. Recruitment shows high variability, whereas SSB shows a tendency to be overestimated, in contrast to F which shows a tendency to be underestimated. Mohn's Rho index for the last 6 years were estimated for recruitment (-1.06), F (-0.30) and SSB (0.45). The recruitment estimate in the last assessment year is usually very uncertain and is replaced with the geometric mean of the available time series. The values of the Mohn's Rho index are considered high and could decrease the reliability of the assessment and advice. A simulation was performed to quantify the impact of the retrospective pattern in the advice. This simulation consists on comparing last year advice for catches in 2019 at F_{MSY} (0.25) with the expected catches for 2019 at F_{MSY} projected this year. The following table shows the result of this comparison:

	SSB19	Catch19	SSB20
WG18	23904	8221	36104
WG19	19452	6619	26586
%Overestimation	23%	25%	36%

The results show that SSB at the beginning of 2019 was estimated by WGBIE-2018 as a 23% higher than this year, as a consequence the predicted catches at F_{MSY} in 2019 were also overestimated at 25% and the overestimation of SSB in 2020 increases to 36%, showing that the initial bias in the assessment is further increased in the future. The F corresponding to the8221 t. catches advised last year as F_{MSY} would be now around F=0.33, below the F_{MSY}upper = 0.36.

Last year and to better understand the causes of this pattern, a retrospective analysis of the parameters estimated by the GADGET model was performed and the group was unable to identify any relevant parameter that might have produced the observed retrospective pattern. During this year, further analysis and discussions to investigate the causes for the retrospective bias indicated that the trend observed in the maturity ogive and possible growth differences (as observed in the northern hake stock) could have further enhanced the assessment model retrospective bias. Further work is required to identify the causes of this pattern.

ICES is aware of the problem and is planning a workshop to be held this year in November (WKFORBIAS) to quantify the severity and, to the extent and possible, identify causes for this bias, and to suggest measures for bias correction of the TAC advice.

10.4 Catch options and prognosis

10.4.1 Short-term projections

Short term projections are presented in Figure 10.11 and Table 10.7. The methodology used was developed during the latest benchmark (WKSOUTH, 2014) and WKMSREF4 (2015), and is described in the Stock Annex. The 2018recruitment is replaced with the geometric mean(1989–2017) and F is scaled to the mean of the last 3 years; this results in a higher F than the estimated for 2018, but it is considered a more appropriate precautionary assumption given the observed retrospective pattern. This procedure improves the estimate of the hake population size at the start of 2020 and provides the most suitable basis for the calculation of catch options for 2020. However, it should be noted that it results in a likely overestimate of the catch in 2019 and, therefore, the 2019 catch value should not be interpreted as a prediction of the likely catch in this year.

Note that mortality in GADGET is length based and F multipliers do not apply linearly, e.g. if Fmult=1, F is 0.68and if Fmult=0.5, F is 0.33.

In 2019the expected SSB is 17 430 t. F_{sq} for the intermediate year (2019) is 0.68. Recruitment for 2018-19is 78 620thousands. During the intermediate year, 2019, the expected catch is 14 368t and the SSB at the end of the year is expected to be 17 448t.As noted earlier, catches in 2019 (14368 t) are likely an overestimate as a consequence of the settings chosen for F under the retrospective pattern.

Different F multipliers applied in 2020provide management alternatives according to different scenarios. Under equal F (Fmult=1), F would be 0.68, the expected catch would be 14 452t and SSB in 2021would be 17 564t. Under the new Multiannual Plan (MAP), with F_{MSY} (F=0.25), Fmult would be 0.39, the yield and catch5 679t and 6 615 t, respectively and SSB in 2021would be29 972t.

10.4.2 Long-term projections

Long-term projections are plotted in Figure 10.12. This projection lasts until the year 2050 with a recruitment equal to the geometric mean of years 1989–2017. The F_{max} estimated as 0.25 confirm the stability of F_{MSY} from year to year.

The following table shows the expected long-term figures for different reference Fs:

	F (1-3)	Yield	SSB
F_{sq}	0.68	12575	17799
F_{MSY}lower	0.17	17723	100971
F_{MSY}	0.25	18357	71604
F_{MSY}upper	0.36	17381	47279

10.5 Biological reference points

Reference points were estimated by WKMSYRef4 (ICES 2016). MSY $B_{trigger}$ was set as B_{pa} by ACOM (ICES, 2016).

Reference points

PA Reference points	Value	Rational
B_{lim}	8 000	Hockey stick breakpoint (8 000 t if rounded)
B_{pa}	11 100	Blim * 1.4
F_{lim}	1.05	F corresponding to the slope of the hockey stick SSB-Rec relationship
F_{pa}	0.75	Flim / 1.4
MSY Reference points		
F_{MSY}	0.25	
F_{MSY} lower	0.17	
F_{MSY} upper	0.36	
B_{MSY}	73 330	
MSY	18 139	
MSY Btrigger	11 100	

10.6 Comments on the assessment

Updates of the index SP-CORUTR since 2013 were not included in the model.

Given the lack of abundance indices for large fish at the beginning of the time series, the SSB estimates for this period should be considered with caution.

Recruitment was quite high between 2005 and 2009, after which it returned to values around the historical mean ranging between 63 747 (2010) and 92 259 (2015)

SSB and F in the last years have been relatively stable showing a small increase and decrease in the trends, respectively. However, the strong retrospective pattern observed in SSB (overestimate) and F (underestimate) could hamper the reliability of this assessment.

10.7 Management considerations

The stock is in a healthy status (SSB in 2019is 17 430 t above B_{pa} = 11 100 t). However, the stock continues to be overexploited (F 2018=0.60, well above F_{MSY}= 0.25), although inside precautionary limits (F_{pa}=0.75). The stock has been exploited above F_{MSY} since the beginning of the assessment period (1982). This implies that there is less potential yield extracted from the stock, even though it can withstand the fishing pressure.

Southern hake is included in the Multiannual Management Plan for Western Waters (EU, 2019). The target fishing mortality, in line with the ranges of F_{MSY}, shall be achieved by 2020. Notwithstanding, fishing opportunities may be fixed in accordance with the upper range of F_{MSY} in order to limit variations in fishing opportunities between consecutive years to not more than 20%.

The retrospective pattern shows a general trend to overestimate SSB and underestimate F. The causes of this pattern are not yet well understood and should be further explored to identify the causes for this bias.

Hake is a top predator eating mainly blue whiting, horse mackerel and other hake (cannibalism, particularly of juveniles by adults). There may be some impact of this in the rate of recovery of the population, particularly in areas of greater aggregations. The main hake predators in the area are common and bottlenose dolphin.

10.8 Table and Figure

Table 10.1 Hake southern stock. Catch estimates (´000 t) by country and gear.

	SPAIN									PORTUGAL				FRANCE		TOTAL		
YEAR	ART	GILLNET	LONGLINE	Cd-Trw	Pr-Bk TRW	Pa-Trw	Ba-Trw	DISC	LAND	ART	TRAWL	DISC	LAND	TOTAL	UNALLOCATED	DISC	LAND	CATCH
1972	7.10	-	-	-	10.20				17.3	4.70	4.10	-	8.8			-	26.1	26.1
1973	8.50	-	-	-	12.30				20.8	6.50	7.30	-	13.8	0.20		-	34.8	34.8
1974	1.00	2.60	2.20	-	8.30				14.1	5.10	3.50	-	8.6	0.10		-	22.8	22.8
1975	1.30	3.50	3.00	-	11.20				19.0	6.10	4.30	-	10.4	0.10		-	29.5	29.5
1976	1.20	3.10	2.60	-	10.00				16.9	6.00	3.10	-	9.1	0.10		-	26.1	26.1
1977	0.60	1.50	1.30	-	5.80				9.2	4.50	1.60	-	6.1	0.20		-	15.5	15.5
1978	0.10	1.40	2.10	-	4.90				8.5	3.40	1.40	-	4.8	0.10		-	13.4	13.4
1979	0.20	1.70	2.10	-	7.20				11.2	3.90	1.90	-	5.8	-		-	17.0	17.0
1980	0.20	2.20	5.00	-	5.30				12.7	4.50	2.30	-	6.8	-		-	19.5	19.5
1981	0.30	1.50	4.60	-	4.10				10.5	4.10	1.90	-	6.0	-		-	16.5	16.5
1982	0.27	1.25	4.18	0.49	3.92				10.1	5.01	2.49	-	7.5	-		-	17.6	17.6
1983	0.37	2.10	6.57	0.57	5.29				14.9	5.19	2.86	-	8.0	-		-	22.9	22.9
1984	0.33	2.27	7.52	0.69	5.84				16.7	4.30	1.22	-	5.5	-		-	22.2	22.2
1985	0.77	1.81	4.42	0.79	5.33				13.1	3.77	2.05	-	5.8	-		-	18.9	18.9
1986	0.83	2.07	3.46	0.98	4.86				12.2	3.16	1.79	-	4.9	0.01		-	17.2	17.2
1987	0.53	1.97	4.41	0.95	3.50				11.4	3.47	1.33	-	4.8	0.03		-	16.2	16.2
1988	0.70	1.99	2.97	0.99	3.98				10.6	4.30	1.71	-	6.0	0.02		-	16.7	16.7
1989	0.56	1.86	1.95	0.90	3.92				9.2	2.74	1.85	-	4.6	0.02		-	13.8	13.8
1990	0.59	1.72	2.13	1.20	4.13				9.8	2.26	1.14	-	3.4	0.03		-	13.2	13.2
1991	0.42	1.41	2.20	1.21	3.63				8.9	2.71	1.25	-	4.0	0.01		-	12.8	12.8
1992	0.40	1.48	2.05	0.98	3.79			0.14	8.7	3.77	1.33	0.33	5.1	-		0.5	13.8	14.3
1993	0.37	1.26	2.74	0.54	2.67			0.24	7.6	3.04	0.87	0.44	3.9	-		0.7	11.5	12.2
1994	0.37	1.90	1.47	0.32		0.82	1.90	0.29	6.8	2.30	0.79	0.71	3.1	-		1.0	9.9	10.9
1995	0.37	1.59	0.96	0.46		2.34	2.94	0.93	8.6	2.56	1.03	1.18	3.6	-		2.1	12.2	14.3
1996	0.23	1.15	0.98	0.98		1.46	2.17	0.91	7.0	2.01	0.76	0.99	2.8	-		1.9	9.7	11.6
1997	0.30	1.04	0.76	0.88		1.32	1.78	1.07	6.1	1.52	0.90	1.20	2.4	-		2.3	8.5	10.8
1998	0.32	0.75	0.62	0.53		0.88	1.95	0.57	5.0	1.67	0.97	1.11	2.6	-		1.7	7.7	9.4
1999	0.33	0.60	0.00	0.57		0.87	1.59	0.35	4.0	2.12	1.09	1.17	3.2	-		1.5	7.2	8.7
2000	0.26	0.85	0.15	0.58		0.83	1.98	0.62	4.7	2.09	1.16	1.21	3.3	-		1.83	7.90	9.7
2001	0.32	0.55	0.11	1.20		1.06	1.12	0.37	4.4	2.02	1.20	1.29	3.2	-		1.66	7.58	9.2
2002	0.22	0.58	0.12	0.88		1.37	0.75	0.38	3.9	1.81	0.97	1.11	2.8	-		1.49	6.70	8.2
2003	0.37	0.43	0.17	1.25		1.36	1.07	0.41	4.7	1.13	0.96	1.05	2.1	-		1.46	6.74	8.2
2004	0.48	0.42	0.13	1.06		1.66	1.13	0.22	4.9	1.27	0.80	0.69	2.1	-		0.91	6.94	7.9
2005	0.72	0.63	0.09	0.88		2.77	1.14	0.38	6.2	1.10	0.96	1.60	2.1	-		1.98	8.30	10.3
2006	0.48	0.71	0.35	0.63		4.70	1.81	2.65	8.7	1.22	0.91	0.61	2.1	-		3.26	10.80	14.1
2007	0.83	1.80	0.89	0.50		6.71	2.07	1.19	12.8	1.41	0.72	1.31	2.1	-		2.50	14.93	17.4
2008	1.12	2.64	1.51	0.53		6.32	2.44	1.45	14.6	1.27	0.94	0.86	2.2	-		2.31	16.77	19.1
2009	1.41	2.92	2.10	0.55		7.37	2.54	0.98	16.9	1.39	0.96	1.96	2.4	-		2.93	19.24	22.2
2010	0.72	1.71	1.88	0.68		6.33	1.71	1.00	13.0	1.61	0.73	0.58	2.3	0.36		1.58	15.74	17.3
2011	0.42	1.09	0.76	0.53		2.18	1.48	1.21	6.5	1.72	0.49	0.74	2.2		8.40	1.95	17.07	19.0
2012	0.34	0.85	1.08	0.50		1.64	1.42	1.35	5.8	1.79	0.81	0.47	2.6		6.14	1.82	14.57	16.4
2013	0.64	1.75	1.11	0.62		1.86	1.16	2.22	7.2	1.93	0.81	0.33	2.7	0.31	1.46	2.55	11.66	14.2
2014	0.75	1.46	1.60	0.54		1.72	1.18	2.02	7.3	1.71	0.66	0.58	2.4	0.14	2.25	2.60	12.01	14.6
2015	0.90	1.11	1.23	0.36		2.01	1.13	2.06	6.8	1.24	0.76	0.23	2.0	0.24	2.8	2.29	11.79	14.1
2016	0.91	1.64	1.30	0.42		2.28	1.51	2.15	8.06	1.22	0.75	0.16	1.97	0.23	2.17	2.31	12.44	14.8
2017	0.69	1.51	1.71	0.27		1.60	1.08	1.43	6.86	0.91	0.57	0.24	1.48	0.07	0.76	1.68	9.17	10.8
2018	0.76	1.64	1.00	0.39		1.54	1.10	1.77	6.44	0.79	0.70	0.18	1.49	0.06	2.19	1.94	10.18	12.1

Table 10.2 Hake southern stock - length compositions (thousands)

Length (cm) (4 to 100+ each 2)	Land	Disc	Catch
4	0	0	0
6	0	0	0
8	5	28	33
10	121	151	272
12	617	239	856
14	1148	248	1396
16	1499	625	2125
18	1165	1659	2824
20	1122	2786	3908
22	781	3480	4261
24	1157	2294	3451
26	2202	2342	4544
28	3303	1757	5060
30	2956	942	3898
32	2578	281	2858
34	2499	180	2679
36	2364	51	2414
38	1449	25	1475
40	851	17	869
42	706	78	784
44	486	59	546
46	445	59	504
48	394	0	394
50	363	5	368
52	347	0	347
54	284	0	284
56	253	0	253
58	225	0	225
60	196	0	196
62	158	0	158
64	143	0	143
66	98	0	98
68	81	0	81
70	55	0	55
72	40	0	40
74	31	0	31
76	20	0	20
78	14	0	14
80	12	0	12
82	10	0	10
84	7	0	7
86	6	0	6
88	3	0	3
90	3	0	3
92	2	0	2
94	2	0	2
96	1	0	1
98	0	0	0
TOTAL	30202	17306	47510
Weight (000' tons)	10.18	1.94	12.13
SOP	10.13	1.94	12.08
SOP / NW	1.00	1.00	1.00
Mean length (cm)	32.3	24.2	29.3

*** without France landings (0.07 thousand t)**

Table 10.3 Hake southern stock - Portuguese groundfish surveys; biomass, abundance and recruitment indices.

Year	Winter (ptGFS-WIBTS-Q1)					Summer					Autumn (ptGFS-WIBTS-Q4)					
	Biomass (kg/h)		Abundance (N/h)			Biomass (kg/h)		Abundance (N/h)			Biomass (kg/h)		Abundance (N/h)			
	Mean	s.e.	Mean	s.e.	hauls	Mean	s.e.	Mean	s.e.	hauls	Mean	s.e.	Mean	s.e.	n/hour < 20 cm (1)	hauls
1979 *						11.7		80.4		55	9.5		na			55
1980 * (**)	11.3		178.1		36	15.4		153.0		63	12.5		108.7			62
1981 (Autumn **)	10.7	0.7	122.4	15.5	67	9.9	1.3	87.8	15.5	69	24.4	0.5	734.8	29.3		111
1982	18.1	2.5	265.6	37.5	69	11.0	2.7	93.0	32.8	70	10.6	1.8	119.5	34.7		190
1983 (Autumn **)	27.0	6.0	530.5	151.0	69	15.1	2.3	120.5	20.8	98	13.4	0.5	121.8	4.8		117
1984																
1985						14.3	0.8	170.7	15.6	101	11.0	0.7	128.7	8.4	86.7	150
1986						27.4	1.8	249.4	15.1	118	17.7	1.2	165.6	28.4	90.2	117
1987											8.6	0.9	37.4	3.7	7.3	81
1988											15.3	1.7	177.8	30.8	111.7	98
1989						11.9	0.9	80.8	8.6	114	8.4	0.5	59.6	4.6	19.8	130
1990						9.8	1.0	95.6	13.5	98	11.8	1.0	157.2	26.3	97.2	107
1991						14.2	1.2	104.2	11.3	119	20.9	4.3	195.3	41.5	92.3	80
1992	14.5	1.2	176.4	32.3	88	10.9	1.1	74.1	11.4	81	11.7	1.7	65.2	11.1	18.8	51
1993	9.0	0.7	78.7	16.8	75	11.3	1.7	105.0	34.7	66	5.5	0.8	54.4	12.9	28.4	58
1994											9.9	1.0	98.9	12.1	52.9	77
1995						15.0	1.4	129.3	16.3	81	14.8	1.7	85.8	10.7	7.9	80
1996***											9.2	1.1	109.9	17.8	18.2	63
1997						19.0	1.4	206.5	16.9	86	24.6	9.3	208.0	92.5	62.1	51
1998						10.5	0.8	71.6	8.6	87	15.6	2.0	140.6	21.7	75.9	64
1999***						11.8	0.7	116.2	10.1	65	11.6	1.5	118.3	17.1	14.4	71
2000						16.4	1.6	123.0	15.2	88	11.8	1.8	102.7	19.9	49.2	66
2001						16.6	1.7	132.5	14.2	83	15.6	2.8	164.2	38.5	89.9	58
2002											13.0	2.1	117.6	26.9	60.6	66
2003 ***											9.8	1.0	94.2	8.0	11.9	71
2004 ***											18.4	3.3	402.3	85.2	78.2	79
2005	17.7	2.6	384.0	53.8	68						19.0	1.9	214.2	23.5	131.7	87
2006	16.0	2.0	377.5	55.4	66						16.5	1.8	126.2	11.0	54.7	88
2007	22.4	3.4	609.1	114.1	63						25.8	2.8	370.2	46.7	240.0	96
2008	31.1	4.8	700.6	170.8	67						34.6	4.3	293.6	33.9	87.7	87
2009											37.5	4.4	476.4	75.9	318.6	93
2010											38.2	4.3	418.0	49.8	249.8	87
2011											18.7	1.5	272.9	25.2	179.4	86
								No surveys								
2013											35.2	3.4	473.1	62.1	289.0	93
2014											17.1	1.5	195.7	23.9	93.9	81
2015											37.2	4.3	602.1	65.0	393.2	90
2016											18.7	1.5	272.9	25.2	179.4	86
2018											19.7	2.6	256.1	57.9	136.6	89
2018											18.1	3.3	252.0	45.3	154.7	65

Data marked with * relate to 40 mm cod end mesh size, else 20 mm; *** R/V Capricornio, other years R/V Noruega; (1) n/hour <20 cm converted to Noruega and NCT; (**) whole area not covered

Since 2002 tow duration is 30 min for autumn survey

Depth strata: from 1979 to 1988 covers 20-500 m depth; from 1989 to 2004 covers 20-750 m depth; since 2005 covers 20-500 m depth

Data in 2014-2016 reviewed in 2018

Table 10.4 Hake southern stock - Spanish groundfish surveys; biomass, abundances and recruitment indices.

	Spanish Survey (SpGFS-WIBTS-Q4) (/30 min)						Cadiz Survey (SPGFS-caut-WIBTS-Q4) (/hour)				Cadiz Survey (SPGFS-cspr-WIBTS-Q1) (/hour)			
	Biomass index (Kg)		Abundance Index (nº)			Recruits (<20cm)	Biomass index (Kg)			Rec (<20cm)	Biomass index (Kg)			Rec (<20cm)
Year	Mean	s.e.	Hauls	Mean	s.e.	Mean	Mean	s.e.	hauls	Mean	Mean	s.e.	hauls	mean
1983	7.04	0.65	107	192.4	25.0	177								
1984	6.33	0.60	94	410.4	53.5	398								
1985	3.83	0.39	97	108.5	14.0	98								
1986	4.16	0.50	92	247.8	46.5	239								
1987														
1988	5.59	0.69	101	390.0	67.4	382								
1989	7.14	0.75	91	487.9	73.1	477								
1990	3.34	0.32	120	85.9	9.1	78								
1991	3.37	0.39	107	166.8	15.8	161								
1992	2.14	0.19	116	59.3	5.4	52								
1993	2.49	0.21	109	80.0	8.0	73					3.04	0.53	30	
1994	3.98	0.33	118	245.0	24.9	240					2.68	0.33	30	
1995	4.58	0.44	116	80.9	8.4	68					4.66	1.28	30	71.5
1996	6.54	0.59	114	345.2	40.5	335					7.66	1.14	31	72.7
1997	7.27	0.78	119	421.4	56.5	410	5.28	2.77	27	26.7	3.34	0.52	30	72.5
1998	3.36	0.28	114	75.9	8.7	65	2.66	0.42	34	6.6	2.93	0.67	31	18.6
1999	3.35	0.25	116	95.3	10.6	89	2.71	0.44	38	23.9	3.03	0.37	38	44.6
2000	3.01	0.43	113	66.9	7.4	59	2.03	0.61	30	18.6	3.02	0.47	41	39.7
2001	1.73	0.29	113	42.0	7.6	37	2.57	0.45	39	22.7	6.01	0.79	40	72.4
2002	1.91	0.23	110	57.1	8.8	53	3.39	0.78	39	118.6	2.74	0.25	41	22.4
2003	2.61	0.27	112	92.8	11.6	86	1.61	0.28	41	17.5				
2004	3.94	0.40	114	177.0	23.5	170	2.72	0.69	40	85.8	3.65	0.47	40	92.7
2005	6.46	0.53	116	344.8	32.2	335	6.68	1.29	42	100.6	10.77	5.65	40	184.3
2006	5.50	0.39	115	224.5	21.9	211	4.99	2.00	41	212.3	2.15	0.40	41	3.7
2007	4.97	0.43	117	158.2	15.0	150	6.92	1.43	37	200.3	3.22	0.68	41	51.1
2008	4.93	0.46	115	99.3	11.5	81	4.33	0.60	41	64.4	3.48	0.67	41	50.5
2009	9.32	0.94	117	559.7	93.9	789	7.35	0.97	43	95.0	4.24	0.06	40	65.6
2010	8.36	0.65	114	201.0	14.9	175	5.82	0.83	44	46.0	6.91	1.09	36	202.5
2011	8.98	0.68	111	241.5	21.0	216	2.97	0.38	40	48.2	3.75	0.50	42	32.2
2012	8.44	0.75	115	297.3	39.5	280	5.38	0.90	37	44.0	3.49	0.65	33	62.9
2013	5.59	0.78	114	136.9	13.6	118	12.52	2.04	43	285.6	5.50	0.56	40	76.5
2014	3.72	0.44	116	78.0	9.6	68	9.33	1.38	45	63.0	6.01	0.65	40	60.4
2015	9.87	0.85	114	316.8	33.7	296	13.67	2.61	43	186.8	6.01	0.69	43	165.3
2016	7.67	0.65	114	211.3	18.3	185	5.90	0.92	45	87.6	6.50	0.76	44	118.5
2017	6.58	0.57	112	158.8	14.5	140	4.74	0.89	44	151.1	3.39	0.52	45	38.0
2018	6.54	0.59	113	300.8	34.8	291	8.00	1.22	45	34.4	5.78	1.48	41	134.6

Since 1997 new depth stratification: 70-120m, 121-200m and 201-500 m

Before 1997: 30-100m, 101-200m and 201-500 m

Table 10.5. Hake southern stock. Landings (tonnes), Catch per unit effort and effort for trawl fleets.

	A Coruña Trawl			Portugal trawl			
YEAR	Landings	lpue (Kg/day x100 HP)	Effort	Landings	lpue (Kg/hour std)	s.e. (lpue)	Effort
1985	945	21	45920				
1986	842	21	39810				
1987	695	20	34680				
1988	698	17	42180				
1989	715	16	44440	1847	43.2	3.4	42711
1990	749	17	44430	1138	40.4	3.2	28190
1991	501	12	40440	1245	36.3	4.5	34275
1992	589	15	38910	1325	34.2	2.8	38785
1993	514	12	44504	870	28.1	2.7	30930
1994	473	12	39589	789	34.2	3.7	23084
1995	831	20	41452	1026	43.0	3.9	23850
1996	722	20	35728	758	39.3	3.9	19298
1997	732	21	35211	897	45.9	5.1	19524
1998	895	27	32563	970	39.4	3.4	24647
1999	691	23	30232	1090	47.5	3.6	22964
2000	590	20	30102	1158	33.9	4.3	34157
2001	597	20	29923	1198	43.5	4.6	27556
2002	232	11	21823	965	42.9	3.0	22513
2003	274	15	18493	962	39.0	2.0	24653
2004	259	12	21112	799	39.1	1.9	20419
2005	330	16	20663	965	42.0	2.0	22963
2006	518	27	19264	908	39.2	2.8	23163
2007	621	29	21201	724	37.4	1.6	19334
2008	762	38	20212	936	45.0	1.9	20818
2009	640	40	16162	964	42.1	1.8	22871
2010	553	40	13744	727	42.2	1.9	17225
2011	538	47	11532	493	42.6	2.2	11585
2012	498	42	11887	814	50.2	1.9	16199
2013*	542	37	14736	812	47.6	1.8	17059
2014*	493	27	18060	661	46.6	1.9	14180
2015*	411	31	13309	763	60.1	1.8	12703
2016*	514	38	13718	752	45.4	1.3	16565
2017*	303	24	12449	575	42.6	1.4	13505
2018*				697	43.6	1.3	15968

Spanish LPUEs are scientific estimations from a selection of ships that may change from year to year.
*Spanish sampling method changed for effort and landings - not used in the model

Table 10.6. Hake southern stock. Assessment summary.

Year	Mort (1-3)	SSB ('000 tn)	R (million)	Catch ('000 tn)	Land ('000 tn)	Disc ('000 tn)
1982	0.36	41.10	98.40	17.59	17.59	NA
1983	0.44	45.80	81.48	22.95	22.95	NA
1984	0.45	43.05	69.48	22.18	22.18	NA
1985	0.42	43.14	44.09	18.94	18.94	NA
1986	0.45	40.02	40.96	17.16	17.16	NA
1987	0.51	36.77	50.14	16.18	16.18	NA
1988	0.65	27.03	71.24	16.65	16.65	NA
1989	0.65	19.90	78.05	13.79	13.79	NA
1990	0.70	16.28	82.33	13.19	13.19	NA
1991	0.69	16.45	70.00	12.83	12.83	NA
1992	0.84	15.51	52.27	14.27	13.80	0.47
1993	0.91	12.77	61.11	12.17	11.48	0.68
1994	0.89	8.90	119.48	10.86	9.86	0.99
1995	1.19	7.09	51.17	14.34	12.24	2.10
1996	1.16	8.51	101.26	11.62	9.71	1.91
1997	1.18	6.48	80.72	10.77	8.50	2.27
1998	0.94	5.71	58.00	9.36	7.68	1.68
1999	0.79	7.40	66.81	8.69	7.17	1.52
2000	0.89	8.67	70.30	9.74	7.90	1.83
2001	0.87	8.79	49.30	9.24	7.58	1.66
2002	0.83	9.16	70.95	8.18	6.69	1.49
2003	0.85	8.88	60.14	8.21	6.74	1.46
2004	0.74	8.83	78.18	7.86	6.94	0.91
2005	0.79	9.16	127.91	10.31	8.33	1.98
2006	0.91	10.43	96.26	14.08	10.82	3.26
2007	0.98	12.21	172.95	17.44	14.93	2.50
2008	0.94	11.96	115.00	19.11	16.80	2.31
2009	0.98	13.98	106.30	22.17	19.24	2.93
2010	0.74	13.84	63.75	16.95	15.37	1.58
2011	0.85	16.46	86.06	19.01	17.06	1.95
2012	0.87	15.25	89.73	16.40	14.57	1.82
2013	0.75	13.17	66.81	13.91	11.35	2.55
2014	0.86	15.53	82.91	14.48	11.88	2.60
2015	0.79	13.27	92.26	13.84	11.55	2.29
2016	0.83	13.23	62.18	14.52	12.21	2.31
2017	0.62	14.20	71.30	10.78	9.10	1.68
2018	0.60	16.62	104.93	12.06	10.12	1.94

Landings do not include France data presented in table 10.1
Discards estimation began in 1992, the year of implementation of MLS (27 cm). Before that zero discards assumed.

Table 10.7. Hake southern stock. Short term projections

SSB 2019	BIO 2019	F 2019	Yield 2019	Catch 2019	SSB 2020	BIO 2020
17430	22113	0.6808	12296	14368	17448	22231

Fmult	F 2020	Yield 2020	Catch 2020	SSB 2021	
0.00	0.00	0	0	40956	*F = 0*
0.27	0.17	4033	4694	33123	*F = FMSY lower*
0.30	0.19	4459	5191	32305	
0.39	0.25	5679	6615	29972	*MAP FMSY*
0.40	0.26	5874	6843	29600	
0.44	0.29	6359	7406	28680	*TAC constraint (-20%)*
0.50	**0.33**	**7106**	**8284**	**27266**	
0.55	0.36	7709	8991	26131	*F = FMSY upper*
0.57	0.37	7937	9258	25703	*equal TAC*
0.60	0.39	8293	9675	25038	
0.70	0.46	9407	10983	22962	
0.71	0.47	9515	11110	22762	*TAC constraint (+20%)*
0.80	0.53	10453	12214	21029	
0.91	0.61	11506	13454	19101	*Rec. Plan: F (2020) = Fsq - 10%*
1.00	0.68	12351	14452	17564	*equal F*
1.01	0.69	12415	14528	17448	*equal SSB*
1.09	0.75	13140	15387	16137	*Fpa*
1.48	1.05	15906	18682	11204	*Flim*
1.48	1.06	15965	18752	11100	*SSB (2021) = Bpa = MSY Btrg*
1.81	1.33	17725	20875	**8000**	*SSB (2021) = Blim*

There is a EC Recovery Plan (-10% annual F redution; +-15% TAC constrain)
Fmsy = 0.25
TAC 2019 = 9258 (-+20% [11110, 7406])
Recruitment = 78 620 mill (geometric mean 1989-17)

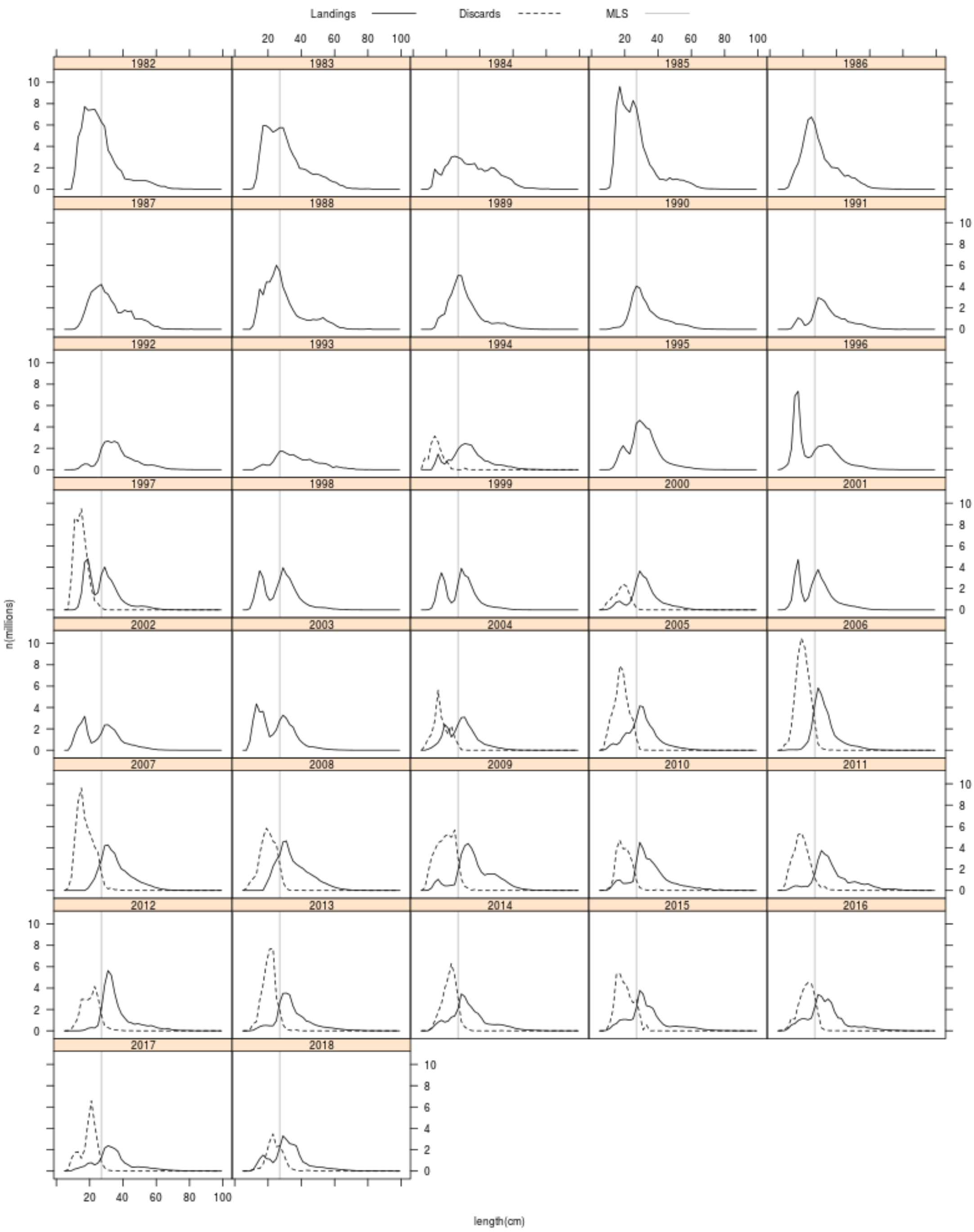


Figure 10.1.Length distribution of catches used in the assessment. Landings (1982–latest year) plus Cadiz landings from 1994–2004. Discards from 1992–latest year (dashed line). Minimum landing size (MLS) since 1992 at 27 cm.

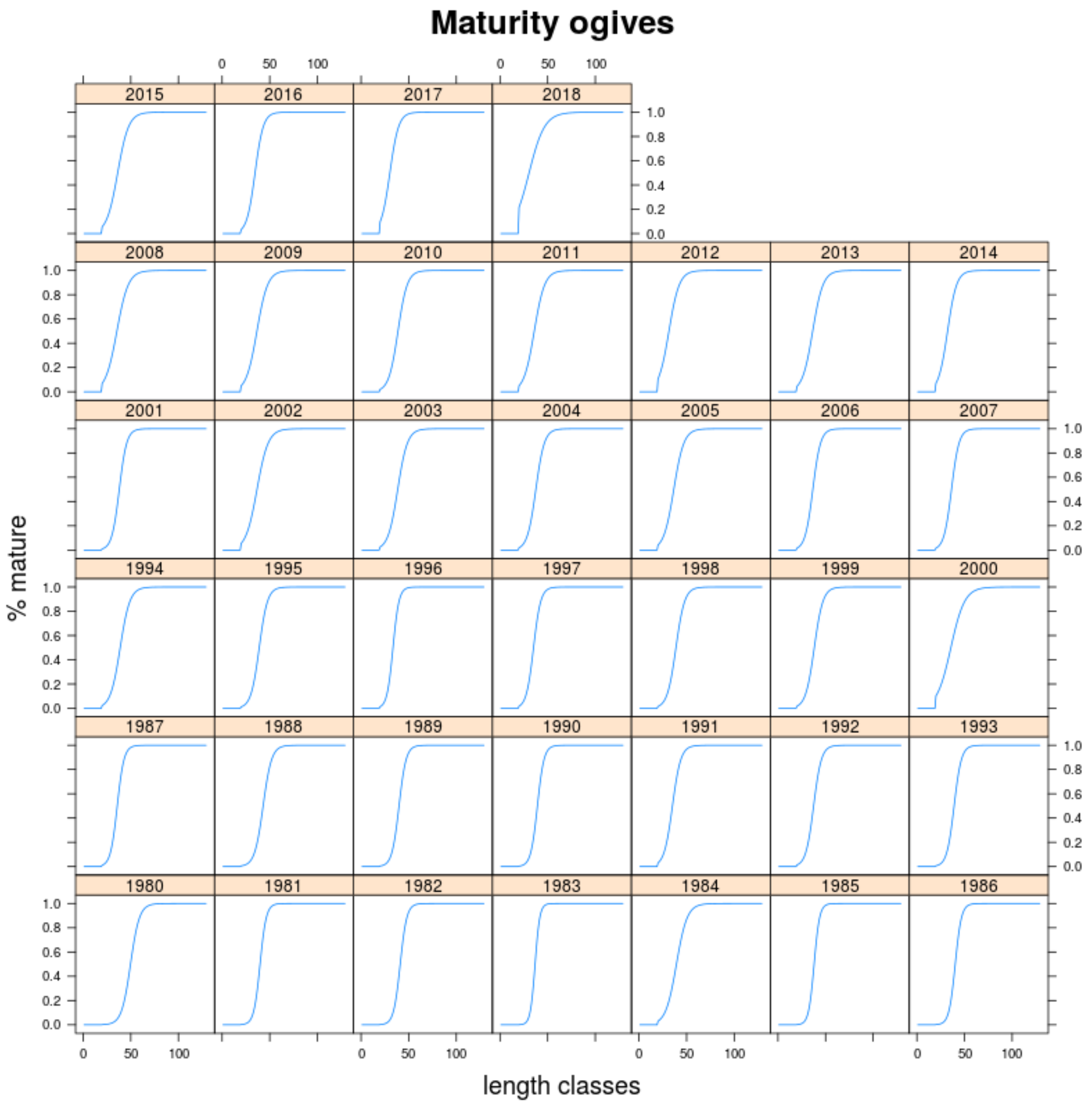


Figure 10.2. Maturity ogives from 1986 to 2018.

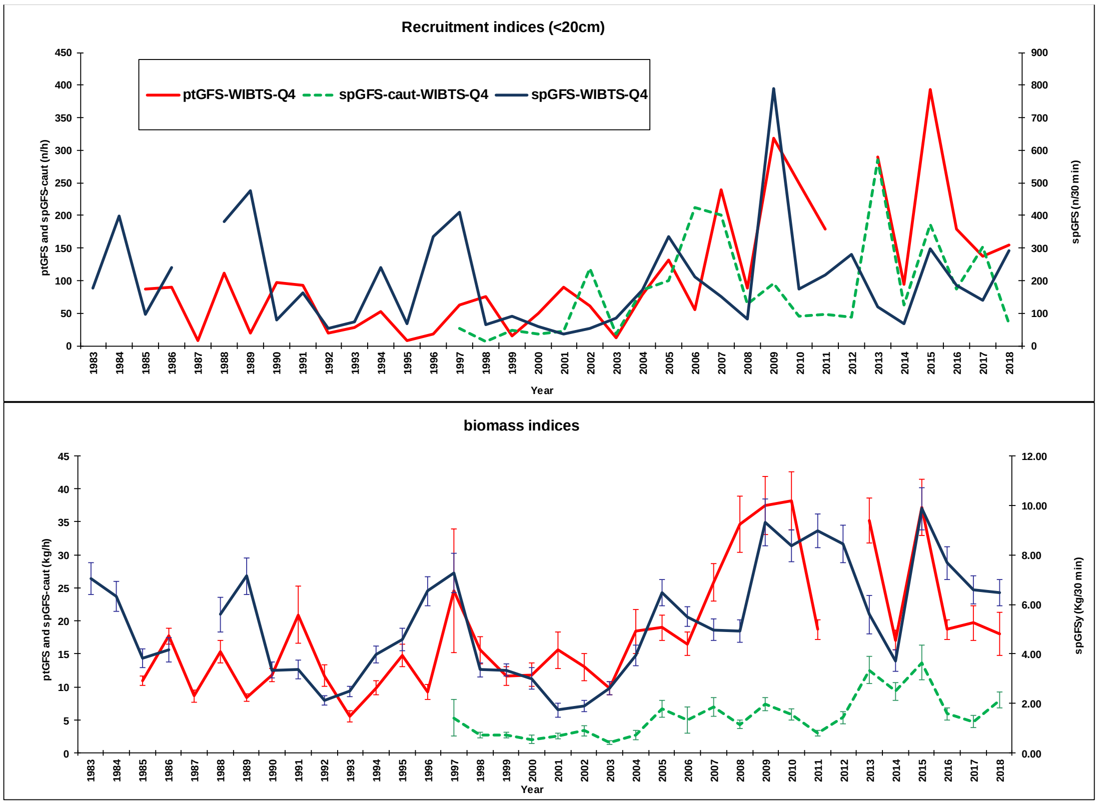


Figure 10.3. Hake southern stock - Recruitment and biomass Indices from groundfish surveys. Vertical bars = 90% CI.

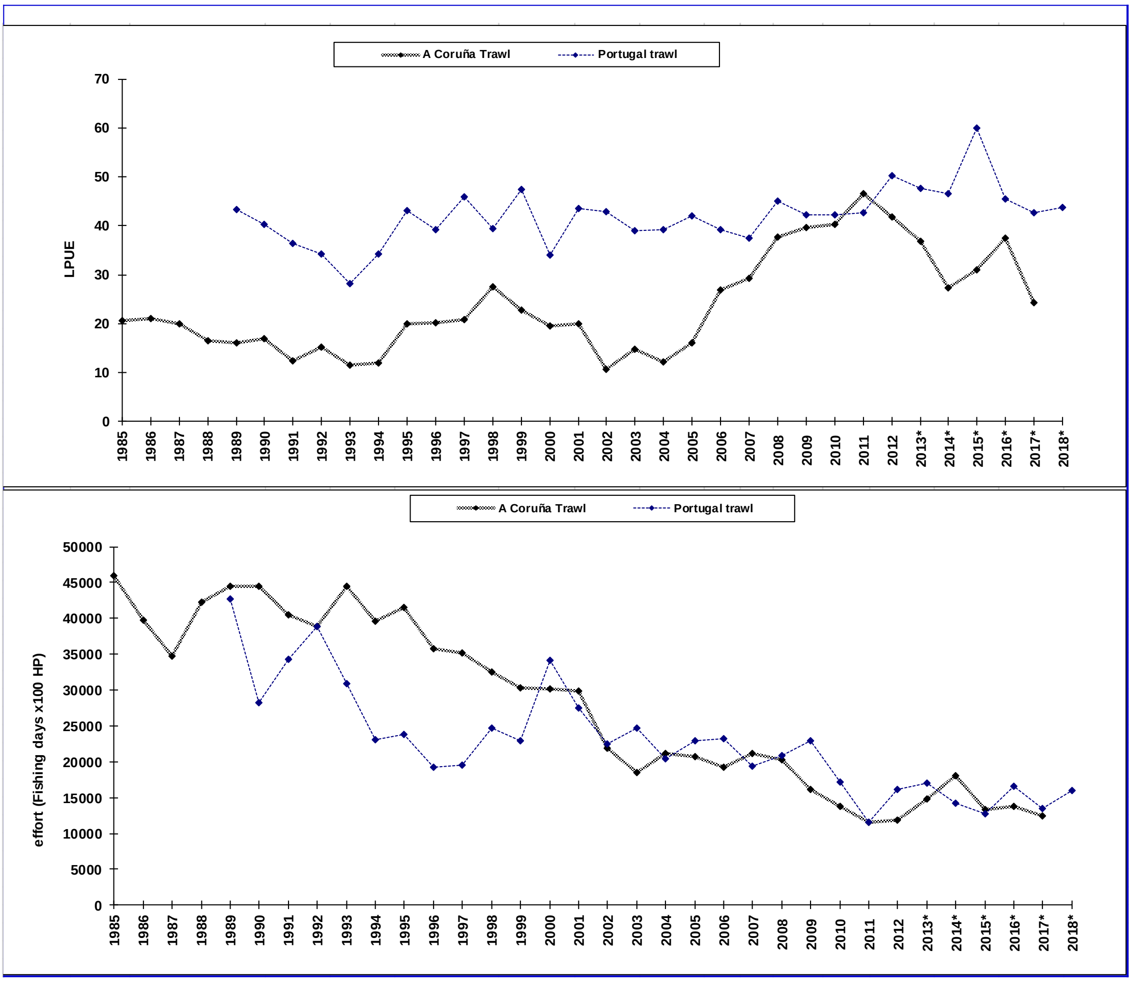


Figure 10.4. Hake southern stock- LPUE and fishing effort trends for trawl fleets. Vertical bars = 90% CI.

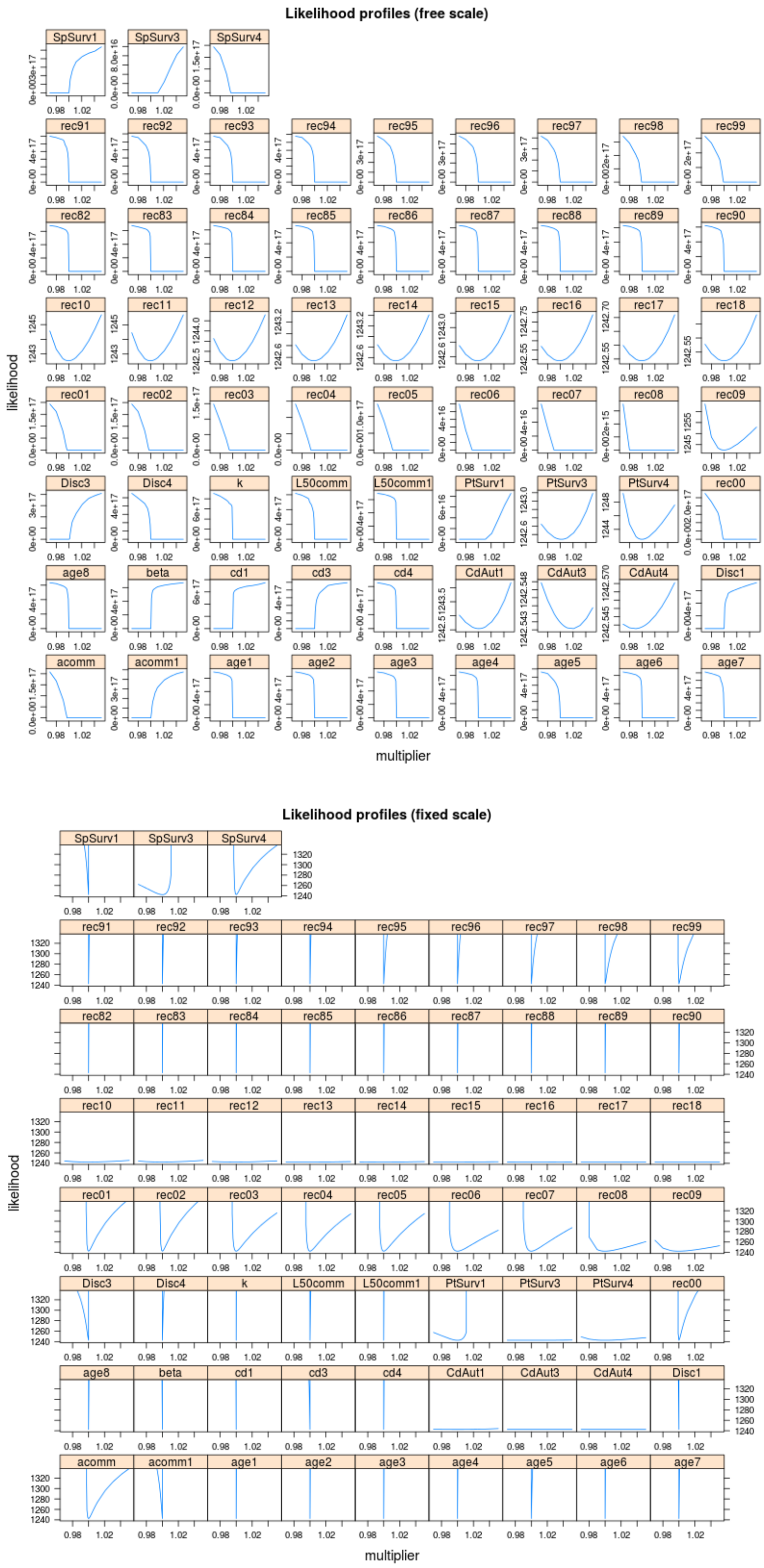


Figure 10.5. Gadget convergence with likelihood profiles. Free scaled (upper panel) and fixed scaled (lower panel)

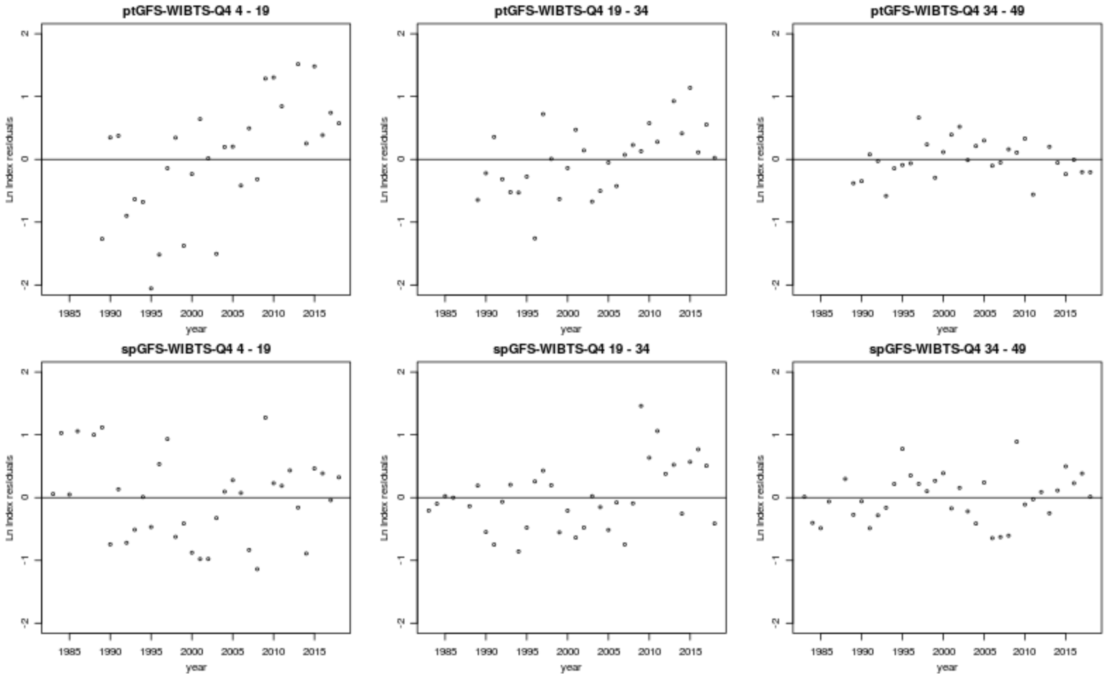
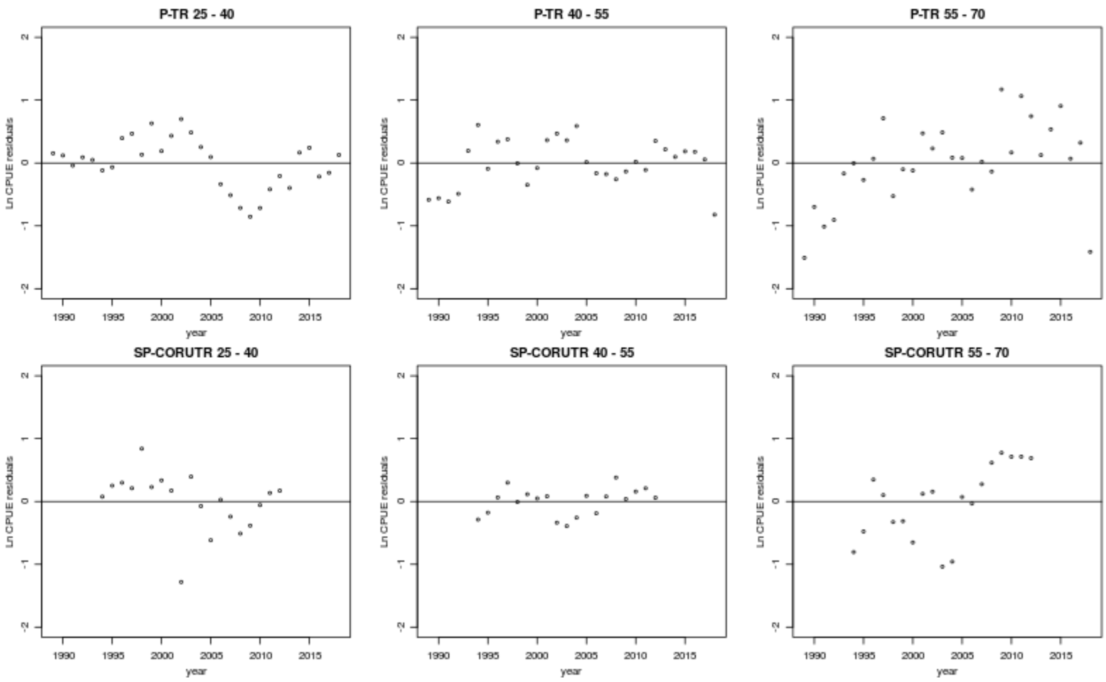
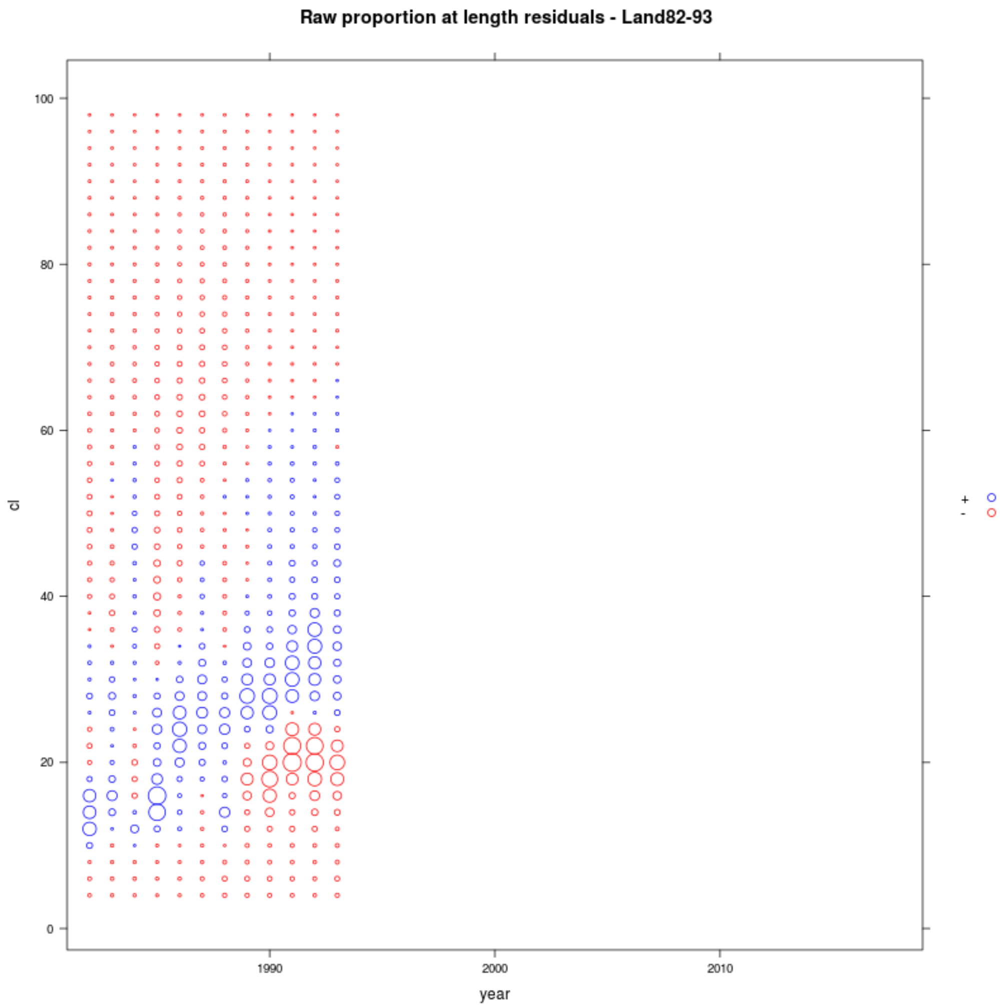


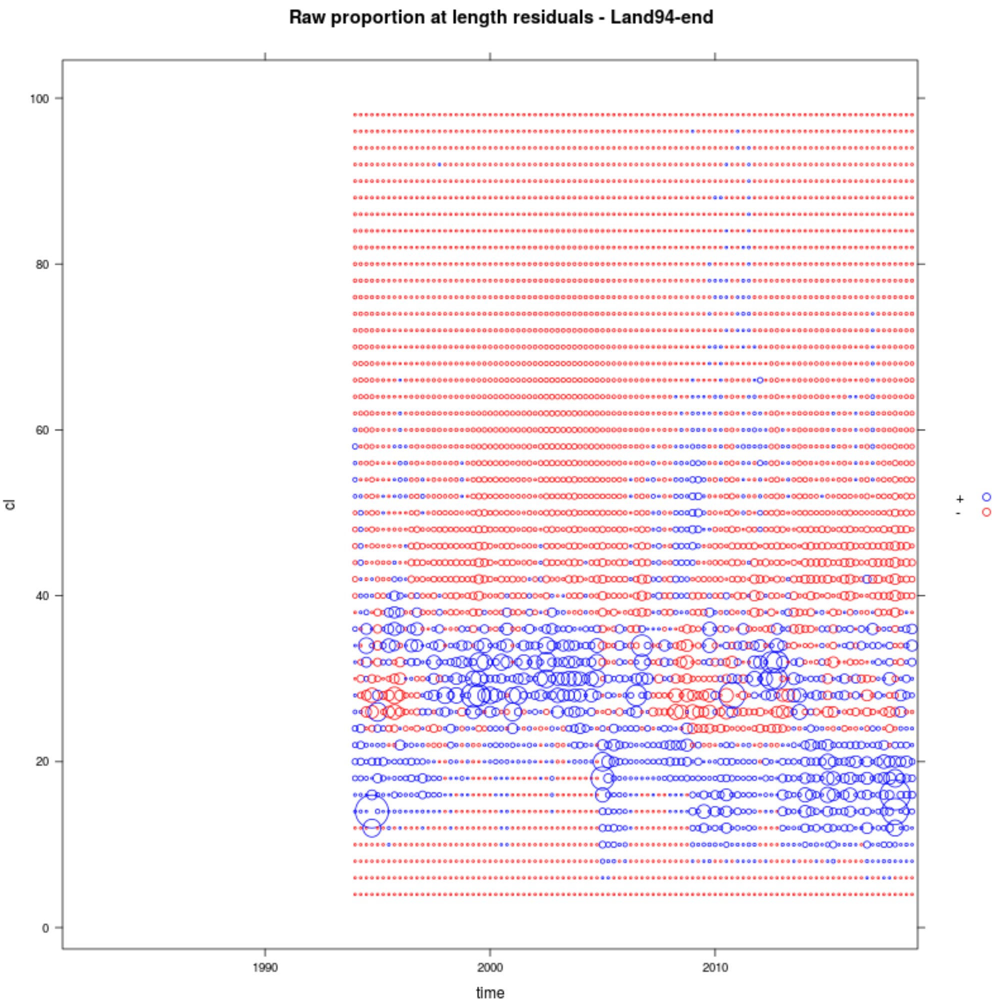
Figure 10.6. Diagnostics Residuals (from 10.6 a to b) and Observed vs. expected length prop (from 10.6c to 10.6i). (10.6 a).Survey residuals by 15 cm groups (4–19, 19–34, 34–49 cm)



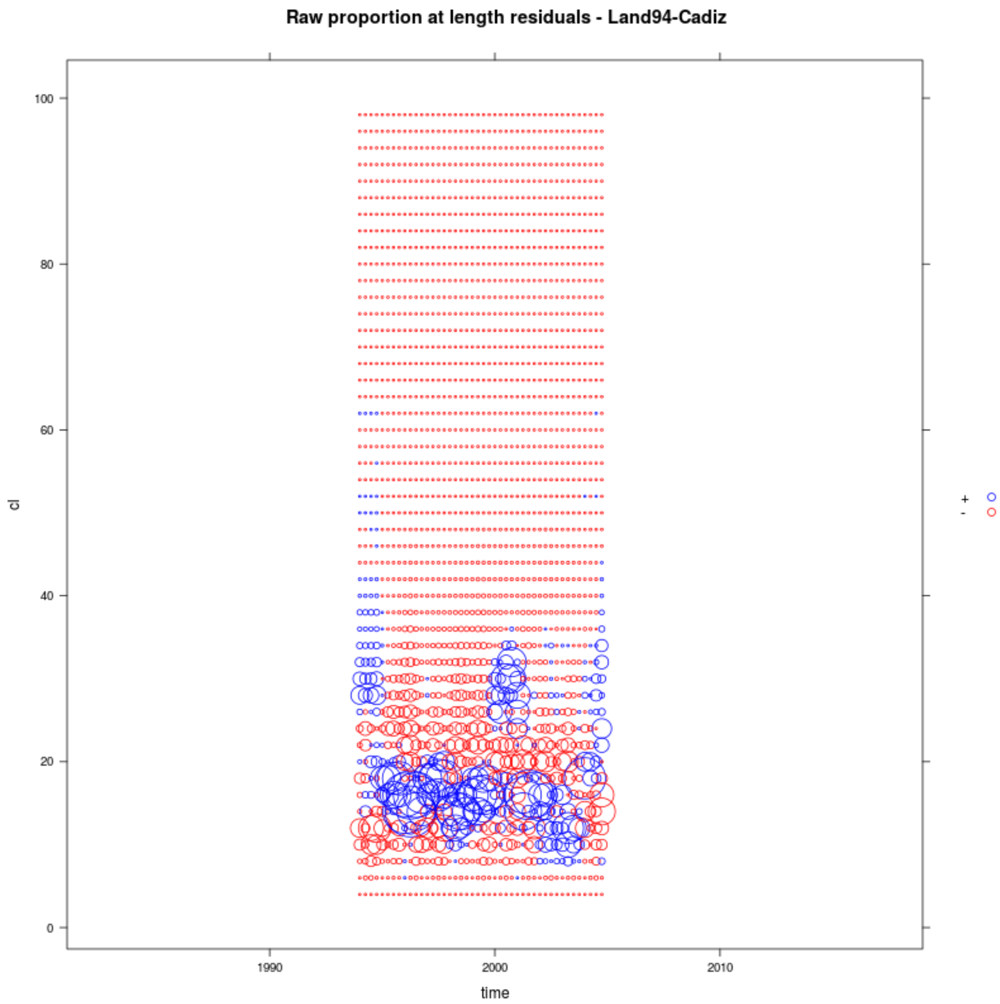
(10.6 b).LPUE residuals by 15 cm groups (25–40, 40–55, 55–70 cm)



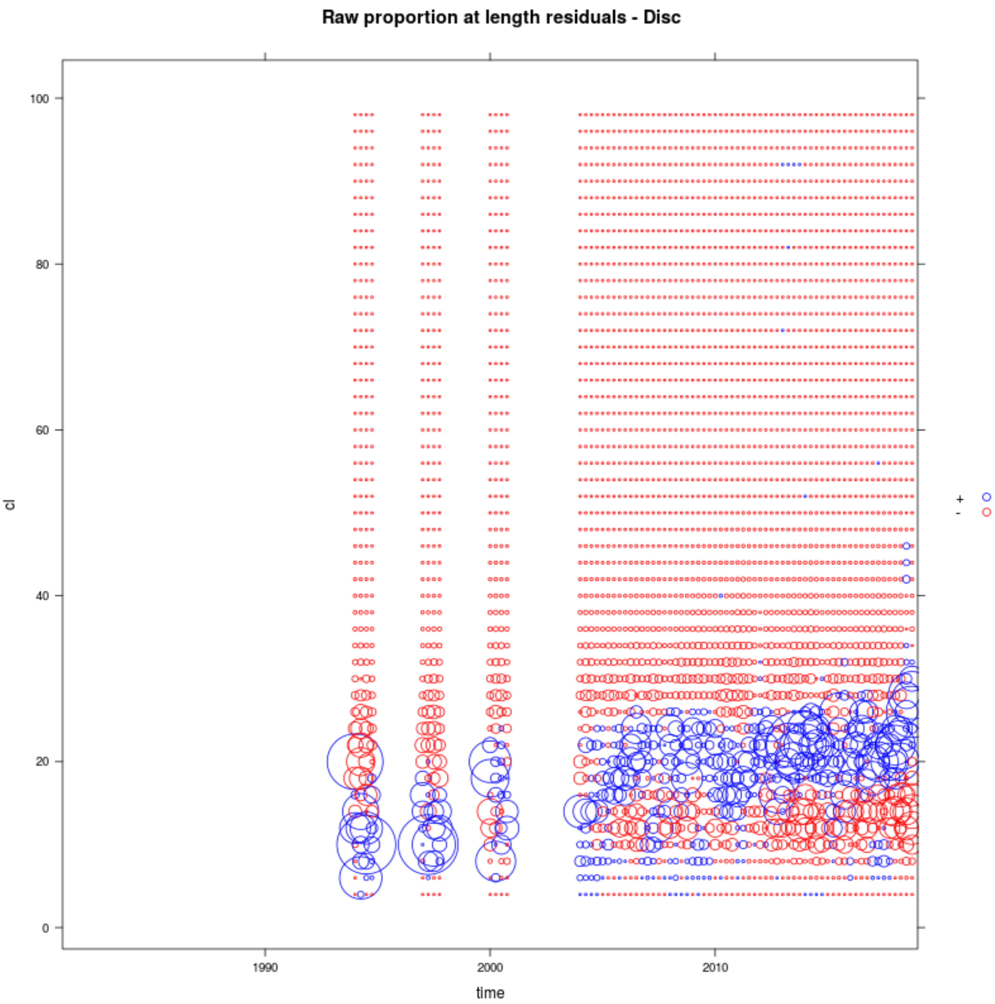
(10.6 c). Bubble plot for landings length distribution from 1982 to 1993.



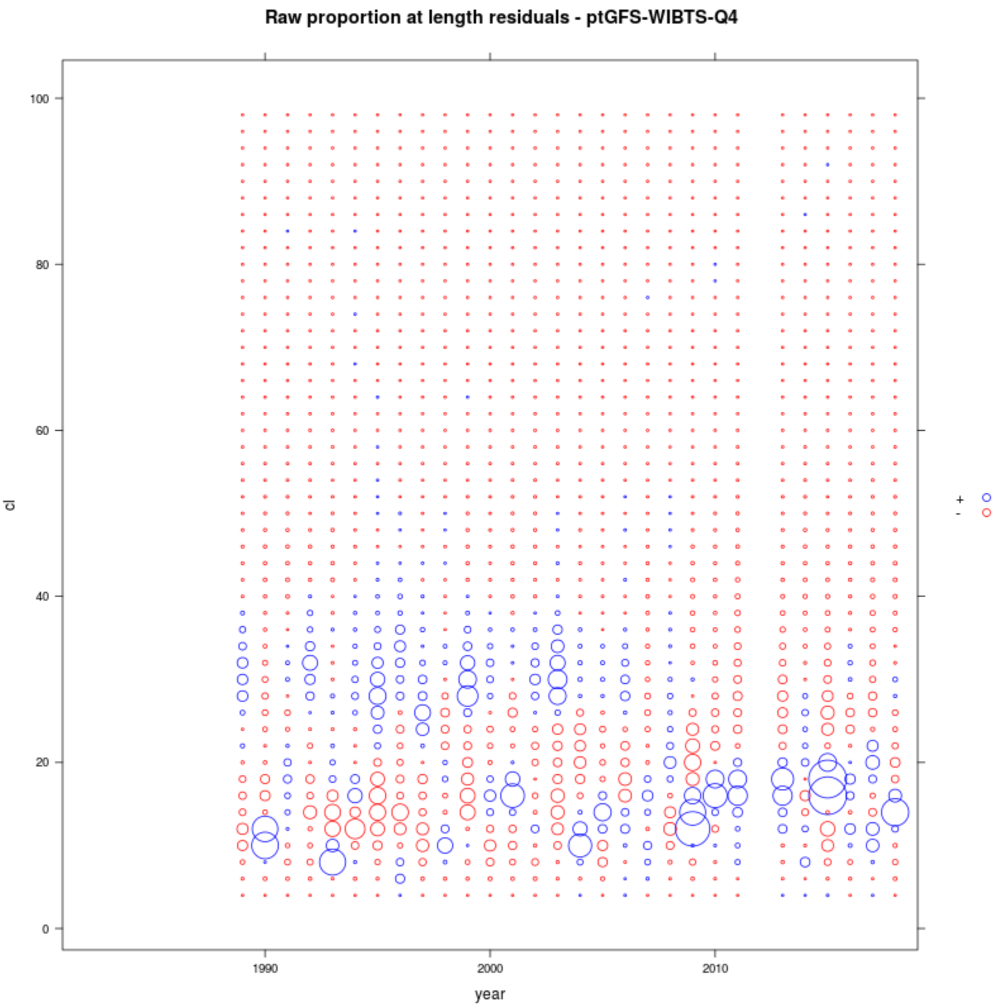
(10.6 d). Bubble plot for landings length distribution from 1994 to last year



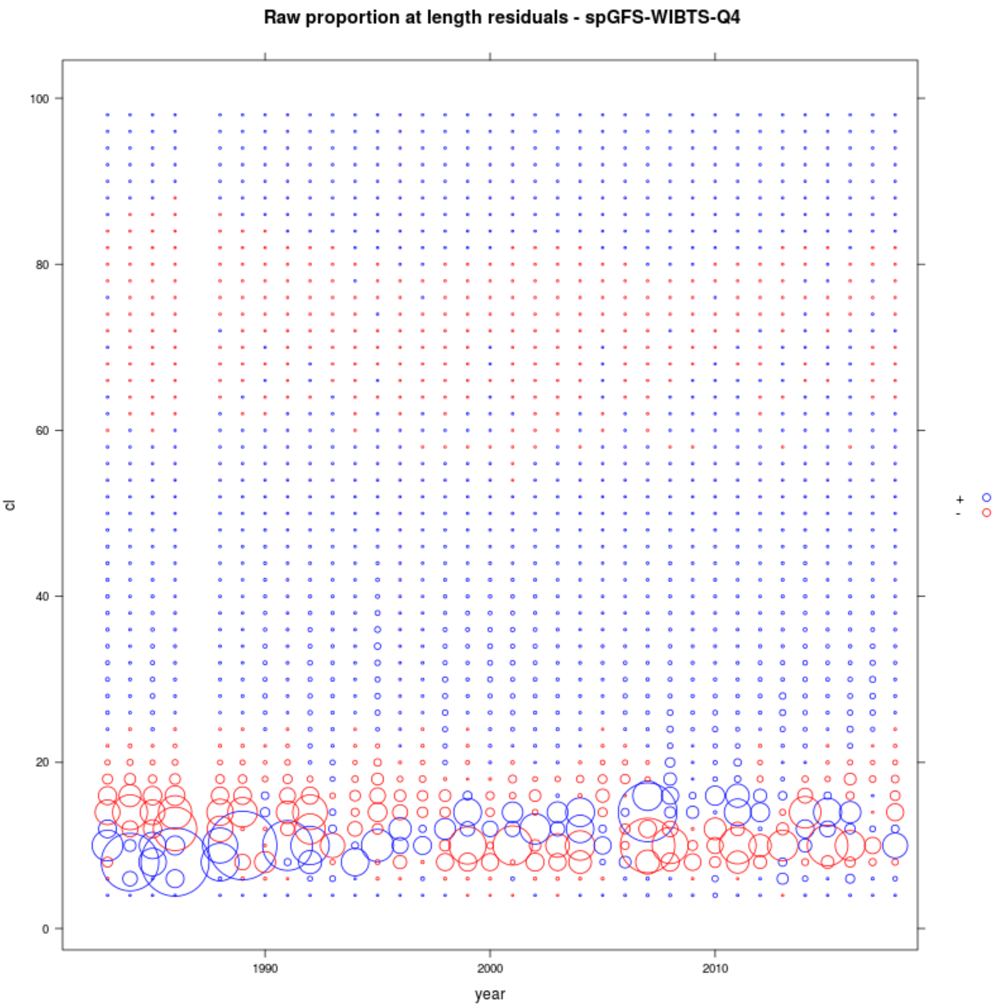
(10.6 e). Bubble plot for Cadiz landings length distribution from 1982 to 2004



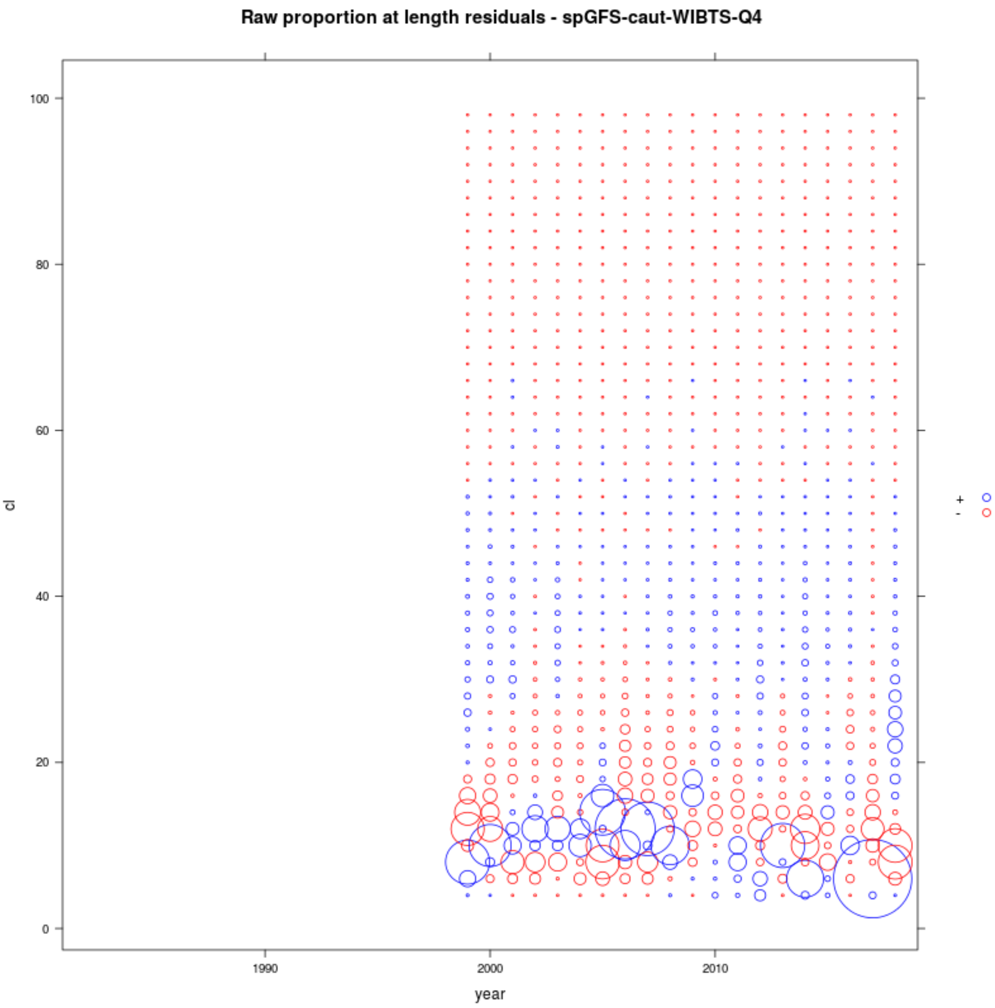
(10.6 f). Bubble plot for Discards length distribution for years 1993,97,99, 2004–end



(10.6 g). Bubble plot for Portuguese demersal survey (ptGFS-WIBTS-Q4)



(10.6 h). Bubble plot for North Spain demersal survey (spGFS-WIBTS-Q4)



(10.6 i). Bubble plot for South Spain (Cadiz) demersal survey (spGFS-caut-WIBTS-Q4)

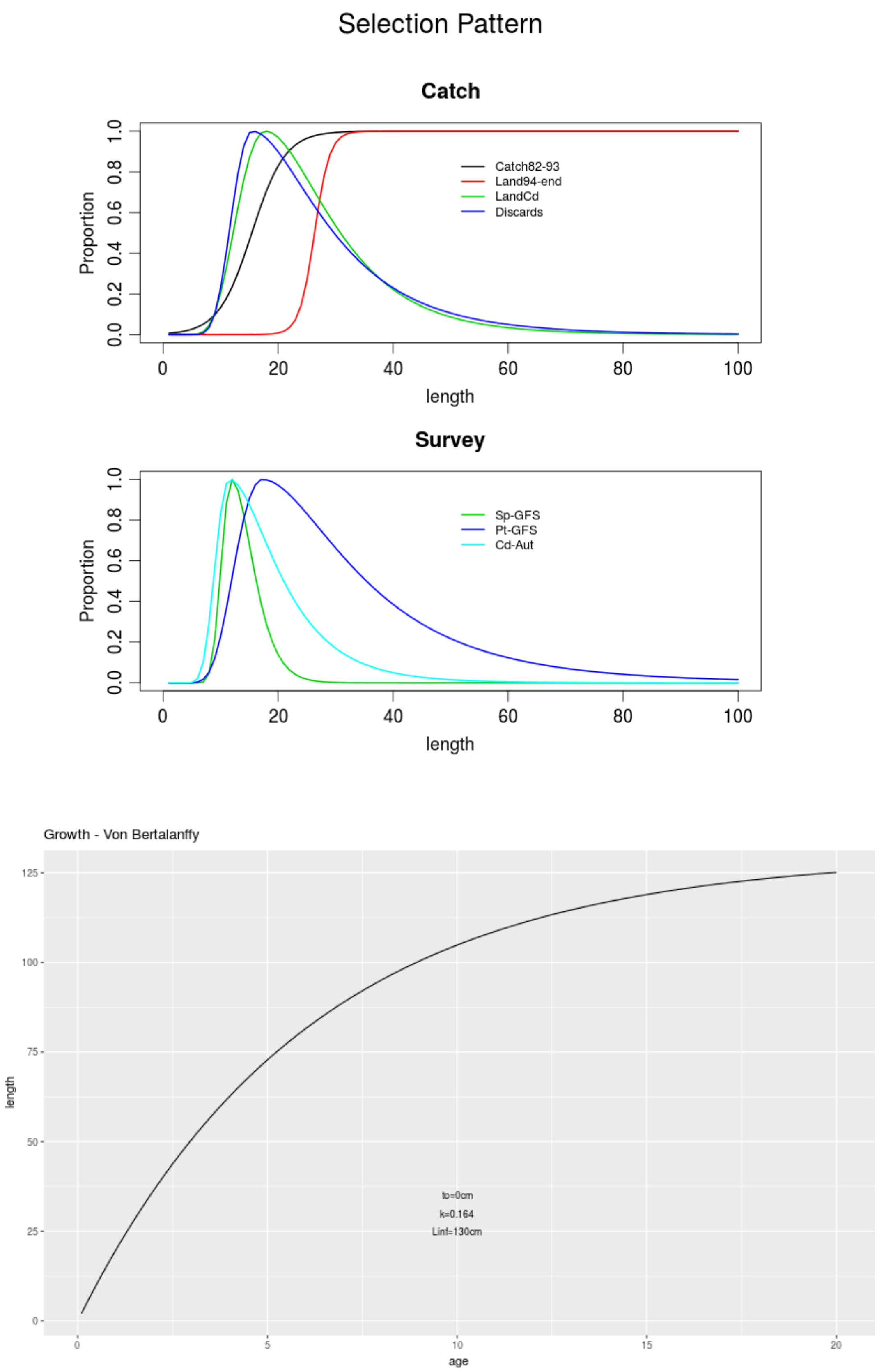


Figure 10.7. Selection pattern (upper panel) and von Bertalanffy growth with k parameter estimated by the model (lower panel)

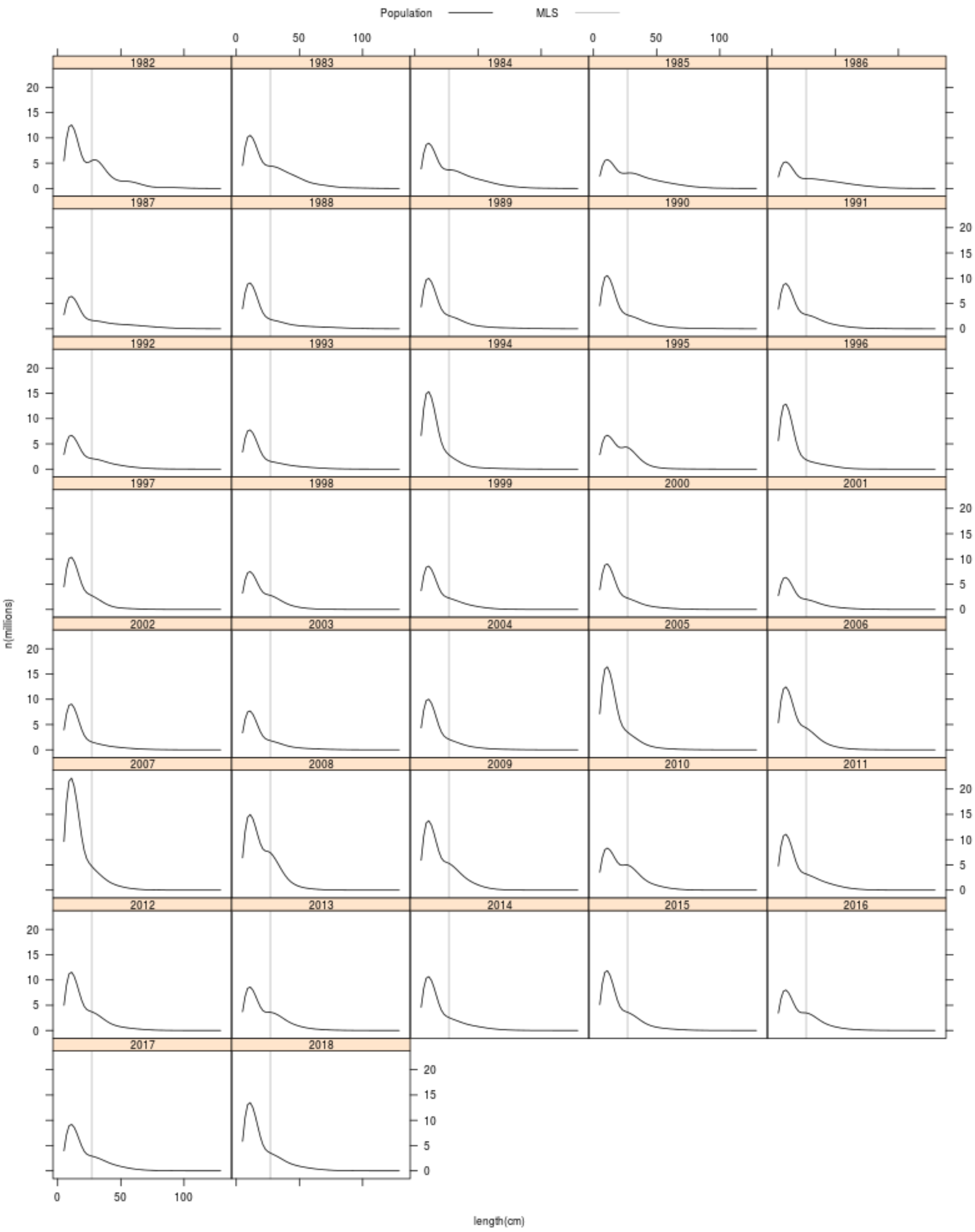


Figure 10.8. Population length distribution at the beginning of the 4th quarter.

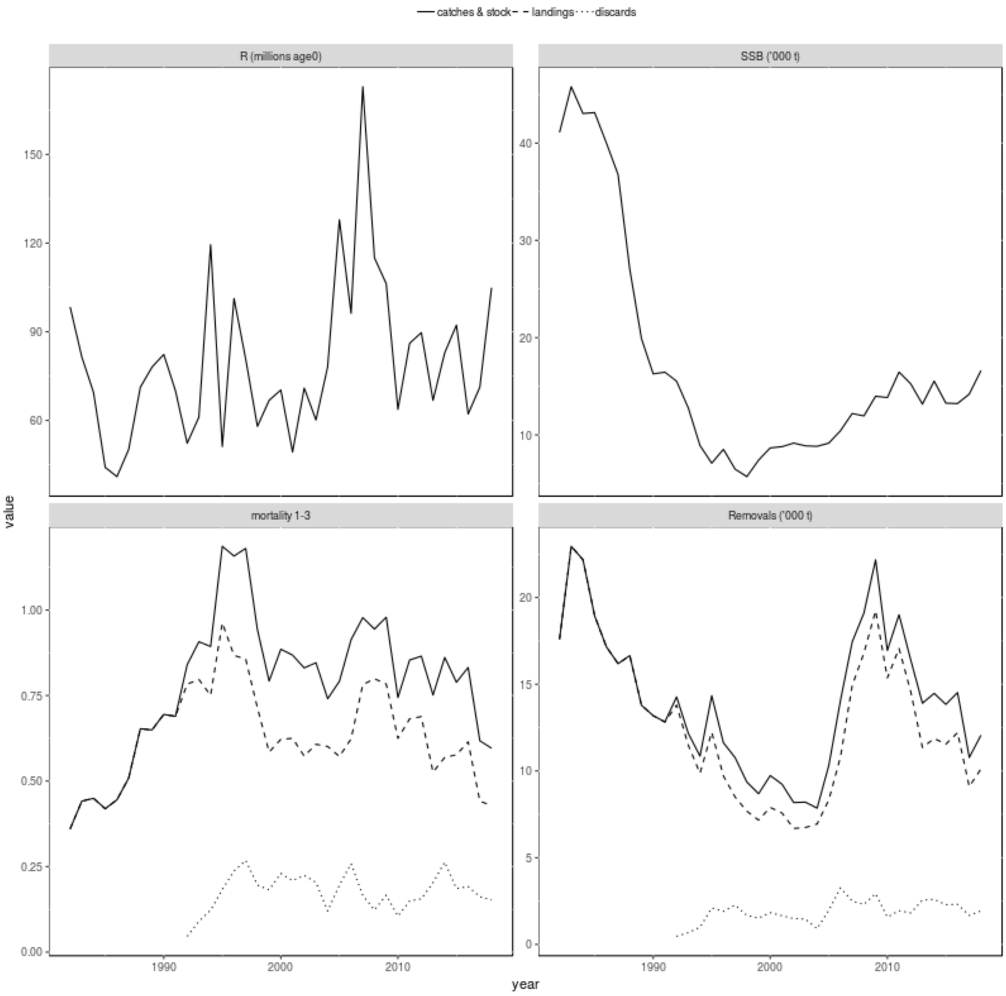


Figure 10.9. Summary plot. SSB and removals (catch, landings and discards). Fishing mortality (F) for ages 1–3.

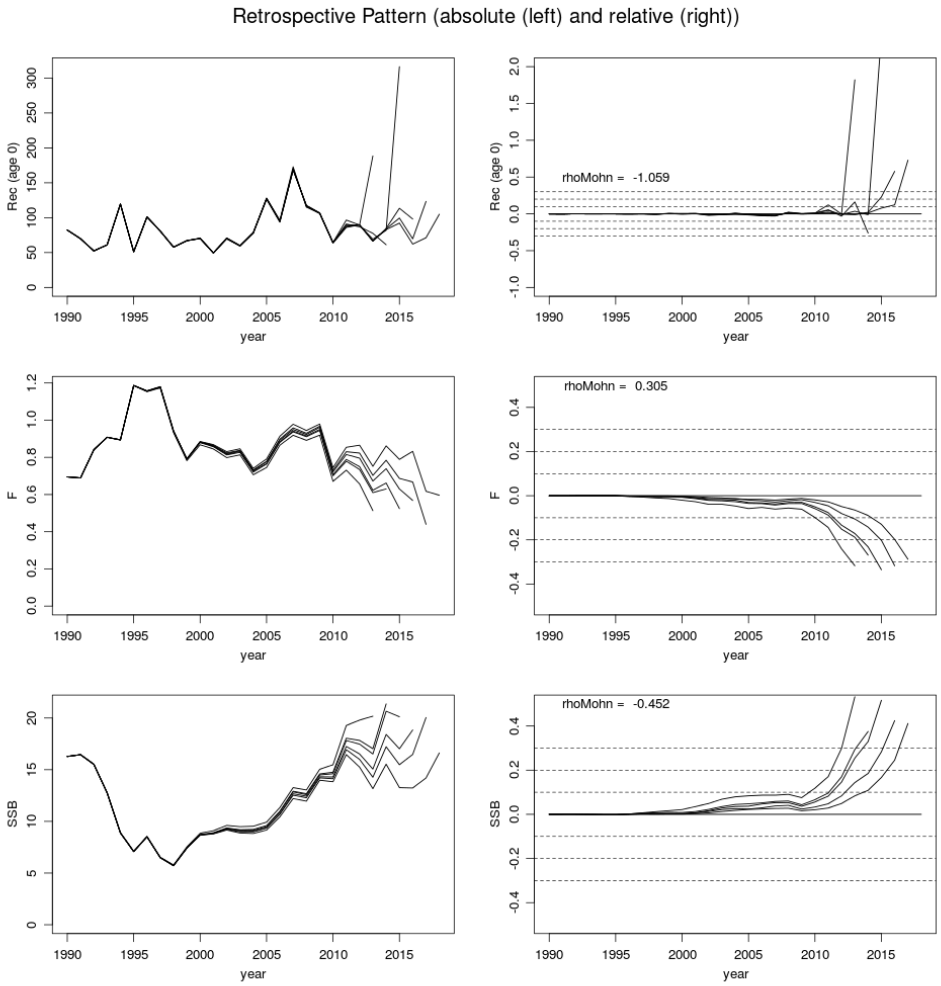


Figure 10.10. Retrospective plots (absolute and relative).

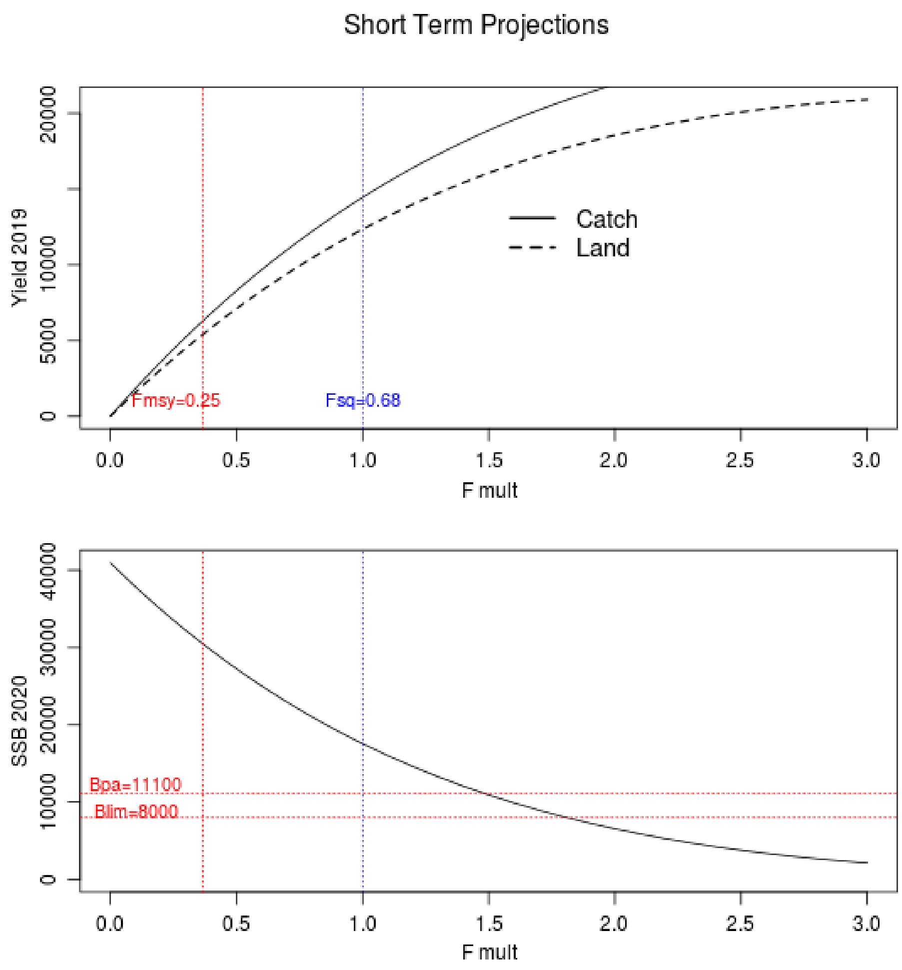


Figure 10.11. Short term projections for yield and SSB. Vertical red line is the F_{MSY} and blue the assumed F_{sq}.

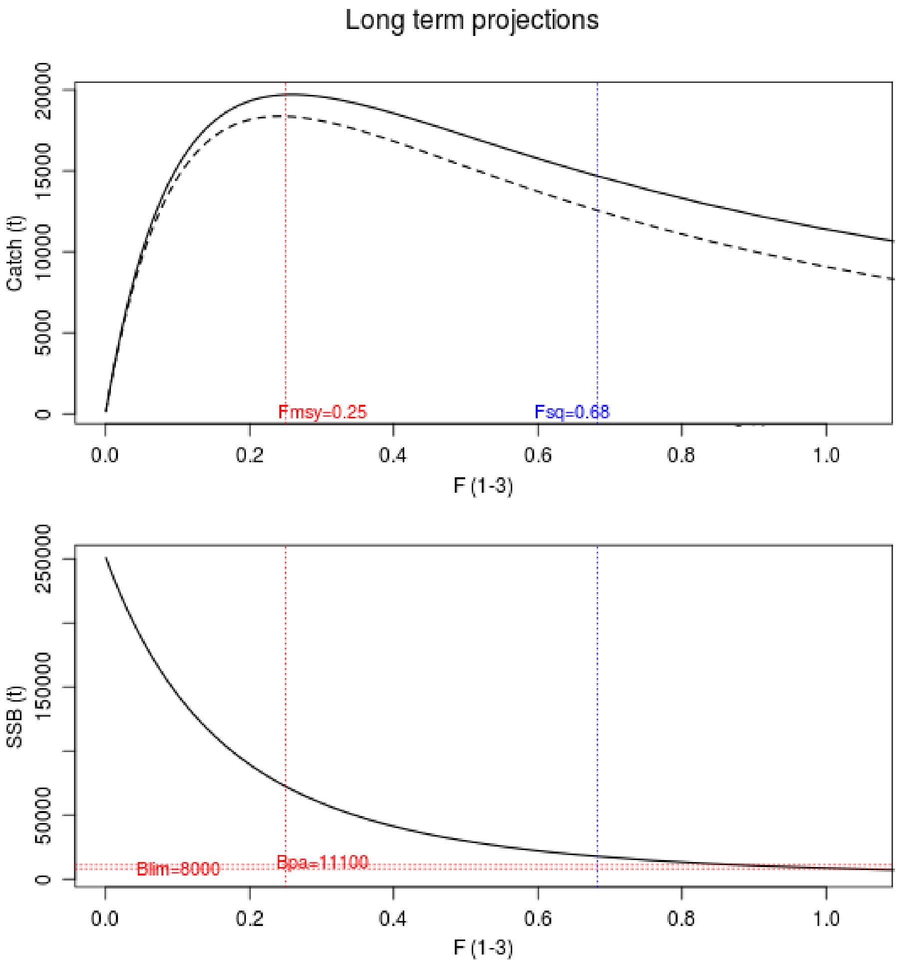


Figure 10.12. Long term yield and SSB per recruit. Vertical red line is the F_{MSY} and blue the assumed F_{sq} .

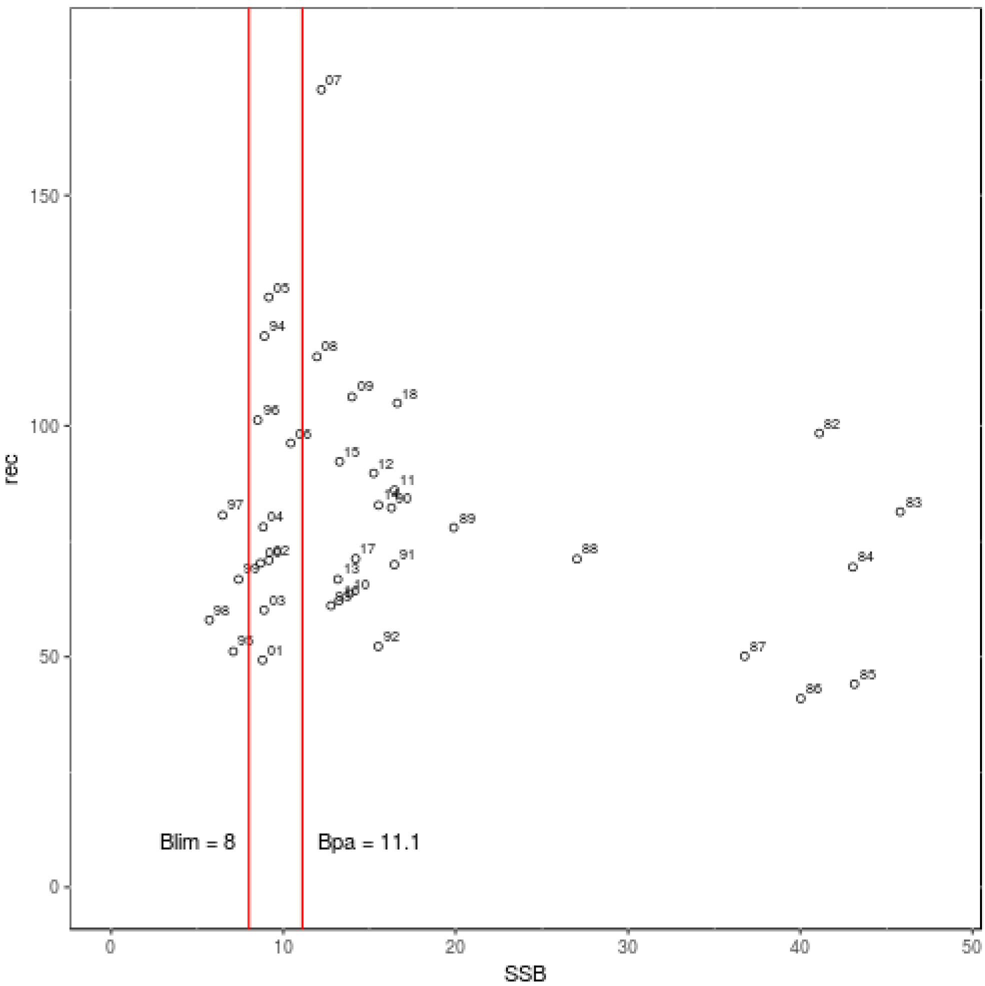


Figure 10.13. Stock-Recruitment plot

11 *Nephrops* (Divisions 8.ab, FU 23-24)

Type of assessment: Update assessment

Main changes from the last assessment (WGBIE2018): No major change compared to the last year. In 2016, the stock was benchmarked and assessment based on UWTV survey conducted since 2014 was validated as analytical method. The stock was upgraded from category 3 to 1. Previously, some changes had occurred since the IBP *Nephrops* 2012 when the stock was assessed by XSA model:

- - Methodology for discard derivation (probabilistic approach replaced the proportional one).
- - Scientific time series provided by the survey LANGOLF included in the tuning data (although the survey was stopped in 2014).

ICES description 8.a,b

Functional Units Bay of Biscay North, 8.a (FU 23)

Bay of Biscay South, 8.b (FU 24)

11.1 General

11.1.1 Ecosystem aspects

This section is detailed in Stock Annex.

11.1.2 Fishery description

The general features of the fishery are given in Stock Annex.

11.1.3 ICES Advice for 2019

For many years the advice was biennial. The stock was classified under category 3 and only trends of the yearly assessment were taken into account for the advice. The UWTV survey routinely carried out since 2014 was validated as standard assessment method by the 2016's benchmark workshop (WKNEP). As consequence of that, the advice became yearly and the stock was categorised in group 1. The latest advice provided in 2018 recommended:

"…when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2015–2017, catches in 2019 should be no more than 6221 tonnes" corresponding to 3 878 tonnes of landings."

11.1.4 Management applicable for 2018 and 2019

2018

Species:	Norway lobster *Nephrops norvegicus*	**Zone:**	8a, 8b, 8d and 8e (NEP/8ABDE.)
Spain	217		
France	3 397		
Union	3 614		
TAC	3 614		Analytical TAC

2019

Species:	Norway lobster *Nephrops norvegicus*	**Zone:**	8a, 8b, 8d and 8e (NEP/8ABDE.)
Spain	233		
France	3 645		
Union	3 878		
TAC	3 878		Analytical TAC

The *Nephrops* fishery is managed by TAC [articles 3, 4, 5(2) of Regulation (EC) No 847/96] along with technical measures. The agreed TAC for 2018 was 3 614 t (against 3 899 t which was the TAC for years 2013-2016 before the validation of the UWTV survey as standard assessment method and 4 160 t for 2017). For 2019, as consequence of the 2018's advice based on the validated UWTV survey 2018 the TAC was fixed at 3 878 t. In 2018, total nominal landings reached the historically lowest level of 2 125 t.

For a long-time, a minimum landing size of 26 mm CL (8.5 cm total length) was adopted by the French producers' organisations (larger than the EU MLS set at 20 mm CL *i.e.* 7 cm total length). Since December 2005, a new French MLS regulation (9 cm total length) has been established. This change has already significantly impacted on the data used by the WG (see report WGHMM 2007).

A mesh change was implemented in 2000 and the minimum codend mesh size in the Bay of Biscay was 70 mm instead of the former 55 mm for *Nephrops*, which had replaced 50 mm mesh size in 1990-91. 100 mm mesh size is required in the *Hake* box. For 2006 and 2007, *Nephrops* trawlers were allowed to fish in the hake box with mesh size smaller than 100 mm once they have adopted a square mesh panel of 100 mm. This derogation was maintained onwards.

As annotated in the Official Journal of the European Union (p.4, art. 27): "In order to ensure sustainable exploitation of the hake and Norway lobster stock and to reduce discards, the use of the latest developments as regards selective gears should be permitted in ICES zones 8.a, 8.b and 8.d."

In agreement with this, the National French Committee of Fisheries (deliberations 39/2007, 1/2008) fixed the rules of trawling activities targeting *Nephrops* in the areas 8.a, 8.b applicable from the 1st April 2008. All vessels catching more than 50 kg of *Nephrops* per day must use a selective device from at least one of the following: (1) a ventral panel of 60 mm square mesh; (2)

a flexible grid or (3) a 80 mm codend mesh size. The majority of *Nephrops* directed vessels (Districts of South Brittany) chose the increase of the codend mesh size whereas the ventral squared panel was adopted by multi-purpose trawlers (mainly in harbours outside Brittany).

A licence system was adopted in 2004 and, since then, there has been a cap on the number of *Nephrops* trawlers operating in the Bay of Biscay of 250 (180 in 2018). In the beginning of 2006, the French producers' organisations adopted regulations (*e.g.* monthly quotas) which had some effects on fishing effort limitation. From 2017 onwards, some additional decisions such as spreading sails of landings over many days were taken by the producers' organisations at the aim of preventing any productivity excess and quota overshot.

11.2 Data

11.2.1 Commercial catches and discards

Total catches, landings and discards, of *Nephrops* in division 8.a,b for the period 1960–2018 are given in Table 11.1.

Throughout the mid-60's, the French landings gradually increased to a peak value of 7 000 t in 1973-1974, then fluctuated between 4 500 and 6 000 t during the 80's and the mid-90's. An increase has been noticeable during the early 2000's. Landings remained stable between 2008 and 2009 (3 030 t and 2 987 t) whereas they had decreased compared with previous years (3 176 in 2007, 3 447 t in 2006 and 3 991 t in 2005). In 2010 and 2011, total landings increased (3 398 t and 3 559 t respectively), but in 2012 and 2013 a strong reduction of the landings occurred (2 520 t and 2 380 t respectively). During the period 2014-2016, landings increased continuously (2 807 t in 2014; 3 569 t in 2015; 4 091 t in 2016). In 2017 landings decreased by -17% (3 412 t) nevertheless under the more constraining regulations cited above. In 2018, the historically lowest level of landings was observed (2 125 t). Landings since 2008 have been reached under the new selectivity regulations.

Males usually predominate in the landings (sex ratio, defined as number of females divided by total, fluctuates between 0.28 and 0.46 for the overall period 1987-2018 with the historically lowest value in 2017. In 2018, the sex ratio of landings was equal to 0.36. The same predominance although in a lesser degree is observed for the removals (sex ratio in the range 0.35-0.49, sex ratio of 2018 equal to 0.45). Females are less accessible in winter because of burrowing and, also, they have a lower growth rate.

Discards represent most of the catches of the smallest individuals as indicated by the available data (Figure 11.1). The average weight of discards per year in the period up to early 2000's (not routinely sampled) is about 1 551 t whereas discard estimates of the recent sampled years (2003-2018) reached a higher level of 2 018 t. This change in the amount of discards could be due to the restriction of individual quotas, the strength of some recruitments in the middle of 2000's and the change in the MLS (which tends to increase the discards), although improvements in the selectivity pattern should tend to reduce the discards. The relative contribution of each of these three factors remains unknown. In 2018, 152 million individuals were estimated to have been discarded (1 627 t) and the discard rate moved upwards (65% against 55% in 2016 and 58% in 2017).

11.2.2 Biological sampling

Landings

French sampling plan at auction started in 1984, but only from 1987 onwards the data can be used on quarterly basis. Since 2003, additional database of landings was also provided by sampling routinely performed onboard under the European DCF aiming for discard estimates. As the landed fraction of *Nephrops* is usually size graded the sampling plan is time and commercial category *vs.* size stratified.

During the first two quarters of 2017, the French onshore sampling program at auction was discontinued due to a planned shift in its implementation and a move towards a subcontracted program as already performed for the French onboard sampling. The delay in the call for tenders disrupted the onshore sampling for six months. Compared to other onshore species, the Bay of Biscay *Nephrops* was impacted in a lesser degree because complementary sampling in the first half of the year was carried out owing to other European projects of biological parameters (such as maturity) sampling. The numbers of sampling units by quarter and for the whole year as well as the numbers of landed sampled *Nephrops* are respectively presented in Tables 11.2 and 11.3.

In order to tackle the lack of landings data in Q1 and Q2 2017 a simulation was performed and presented in the WGBIE 2018 generating missing sampling units at auction from those sampled onboard on the basis of stratified estimators (quarter/harbour/commercial category *vs.* size). This method was not developed for the FU23-24 *Nephrops* and only actually sampled units were retained for quarterly and global estimates.

The particular problem of lower sampling rate for landings during the 1st and 2nd quarters 2017 due to the delay on the sampling shift between operators as explained above affected the precision of estimates (decrease of the sampling units and of measured *Nephrops* at auction) although it did not change the overall perception for the stock status (LFDs and mean weight for landings). As shown by recent unpublished studies on recent DCF sampled years (2014–2017), the LFDs for landings by sex did not significantly change their overall shape when the raising is undertaken on the exclusive database from the sampling onboard although the CVs are higher. This problem was resolved in 2018 and the global sampling levels were more satisfactory than previously.

Discards

Discard data by sampling on board are available for 1987, 1991, 1998 and from 2003. For the intermediate years up to 2002, since the former WGNEPH, numbers discarded at length were derived by the "proportional method" calculating discards by sex for years with no sampling onboard by applying identical quarterly LFDs of the preceding sampled year raised to the quarterly landings *i.e.* for years 1992-1997 derivation used quarterly LFDs from 1991. This method was suspected to induce inter-dependence throughout the time series, therefore, lack of contrast for annual recruitment. IBP *Nephrops* 2012 even not finally conclusive investigated the probabilistic (logistic) approach developed for the WGHMM since 2007 (Table 11.4; see Stock Annex) and compared with the previous discard derivation. The probabilistic calculation provides wider variations on number of removals for age group 1 and 2 after conversion of the size composition to an age one (under assumptions involving in individual growth by sex according to Von Bertalanffy's function as used by previous WGs). Since the WGHMM 2012, the probabilistic method has been chosen: the derivation is performed by sex and quarter using logistic function describing the s-shaped hand-sorting onboard and assuming symmetrical densities of probability for yearly LFDs as tested on years with sampling onboard before MLS change (up to 2005).

Since 2003, discards have been estimated from sampling catch programmes on board *Nephrops* trawlers (646 trips and 1 787 hauls have been sampled over 16 years). In spite of improvements in agreement between logbook declarations and auction hall sales since the middle of 2000's, the quality of crossed information fluctuates between years. *e.g.* for years 2007-2018 the percentage of cross-validation item by item between logbooks and sales was comprised in a wide range of 69 to 90% with an improvement in the last period (85% for 2016, 88% in 2017, 90% in 2018). Therefore, the total number of trips usually not well known in the past is more accurately provided for the recent years and can be reliably used as raising factor for discards. Nevertheless, the number of trips mostly represented by the number of sales at auction is heterogeneous as in the northern part of the Bay of Biscay the boats conduct daily trips whereas in the southern part trips last 2-3 days with a more multi-purpose profile of catches. Discard sampling from the southern part of the fishery was carried out only once in the past (2005), but the sampling plan has been routinely applied since 2010. The numbers of sampling units by quarter and for the whole year and those of discarded sampled *Nephrops* are given by Table 11.5.

The length distribution of landings, discards, catches and removals are presented in Tables 11.6.a-h and in Figure 11.1. Removals at length are obtained by adding the landings and "dead discards" and applying a discard mean survival rate of 30% (Charuau et *al.*, 1982). Combined sex mean lengths are presented for catches, landings and discards in Figure 11.2. Figure 11.3 provides yearly by sex LFDs and their CVs for landings and discards 2018.

11.2.3 Abundance indices from surveys

Trawl survey (LANGOLF)

For many years, abundance indices were not available for this stock. A survey specifically designed to evaluate abundance indices of *Nephrops* commenced in 2006 (with the most appropriate season: 2nd quarter, hours of trawling: around dawn and dusk and fishing gear: twin trawl). This survey (called LANGOLF; see Stock Annex) occurred once a year in May and its sampling design was stratified *vs.* sedimentary structure. Therefore, as regards the investigations carried out during the IBP *Nephrops* 2012, its results for abundance indices were included in the assessment (WGHMM 2012, 2013; WGBIE 2014). Nevertheless, the relative improvement in retrospective analysis did not substantially modify the quality of the stock assessment performed by XSA model. The time series provided by this survey was interrupted in 2014.

UWTV survey (LANGOLF-TV)

A new experimental survey counting UWTV burrows as routinely operated for many *Nephrops* stocks on areas VI and VII has been undertaken since 2014 on a yearly basis. The UWTV survey named "LANGOLF-TV" aimed to demonstrate the technical feasibility of such a survey in the local context and to identify the necessary competences and equipment for its sustainability. The burrows counting was carried out by the Irish scientific vessel "Celtic Voyager" on the basis of a systematic sampling plan. For the first two years, UWTV experiments were combined with trawling operations by two commercial vessels applying the same sampling plan (stratified random) and using the same twin trawls (20 mm codend mesh size) as those of the former LANGOLF trawl survey for the purpose of providing *Nephrops* LFDs by sex and estimating the proportion of other burrowing crustaceans (mainly *Munida*) which can induce bias in the burrows counting.

From 2016 onwards, the trawling operations were not conducted any more as they were considered not necessary for the further analytical investigations on the stock exclusively based on the UWTV tools. A longer survey duration in the period 2016-2018 allowed to cover the area contained in the outline of the Central Mud Bank no belonging to any sedimentary stratum: this area known as not trawled due to rough sea bottom is crossed by muddy channels and concentrate a moderate fishing effort targeting *Nephrops* (Fig. 11.4a). Investigations on the basis of stratified statistical estimators (Table 11.7) as well as on geostatistics (Table 11.8; Fig. 11.5 and 11.6) were carried out and examined by WKNEP 2016 which validated the UWTV approach. The number of sampled stations decreased between 2016 and 2017 (from 196 validated ones to 124) because a larger area than the Central Mud Bank was covered in 2017 (Fig. 11.4b) in order to accurately limit the actual outline of the stock accordingly to recommendations of the WGNEPS 2016. In 2018, 184 validated stations were sampled in the area. Between 2016 and 2017, the total number of burrows decreased by -19% (3,373 billion in 2017 against 4,168) whereas an increase (+12%) was observed in 2018 (3,788 billion).

The survey occurred in different seasons within year (September 2014, July 2015, May 2016 and 2017, end of April 2018) as it is constrained by the schedule time for UWTV Irish equipment and staff.

A new survey was carried out during the WGBIE 2019 meeting (beginning of May) and its results will be available for assessment and advice in the late summer.

11.2.4 Commercial catch-effort data.

Up to 1998, the majority of the vessels were not obliged to keep logbooks because of their size and fishing forms were established by inquiries. Since 1999, logbooks became compulsory for all vessels longer than 10 m. The available log-book data cannot be currently considered as representative for the fishing effort of the whole fishery during the overall time series. Hence, since 2004, it was attempted to define a better effort index.

Effort data indices, landings and LPUE for the "Le Guilvinec District" *Nephrops* trawlers in the 2nd quarter (noted GV-Q2) are available for the overall time series (Table 11.9; Figure 11.7). Effort increased from 1987 to 1992, but there has been a decreasing trend since then. In the recent years, the lowest fishing effort for the whole period was observed. In 2018, the fishing effort decreased slightly compared to 2017 (-8%). The downwards trend in effort can be explained by the decrease in the number of fishing vessels following the decommissioning schemes implemented by the EU. The LPUEs of the GV-Q2 fleet were reasonably stable for a long period, fluctuating around a long-term average of 13.3 kg/hour (Figure 11.7), with three pics values occurring in the past (1988, 2001 and 2010). LPUE increased steeply between 2009 and 2010 (+35%: from 13.8 kg/h to 18.6 kg/h), then strongly decreased in the period 2011-2013 (15.1 kg/h in 2011, 15.2 kg/h in 2012, 12.8 kg/h in 2013) . The GV-Q2 LPUE index remained stable in 2014 (12.7 kg/h), but it reached the historically highest level in the latter period (2015: 19.5 kg/h; 2016: 19.7 kg/h; 2017: 21.9 kg/h). In 2018, this index decreased by -22% (17.0 kg/h).

Changes in fishing gear efficiency and individual catch capacities of vessels, imply that the time spent at sea may not be a good indicator of effective effort and hence LPUE trends are possibly biased. Since the early 90's, the number of boats using twin-trawls increased (10% in 1991, more than 90% in recent years, almost 100% in the northern part of the fishery) and also the number of vessels using rock-hopper gear on the rough sea bottom of the extreme NW part of the central mud bank of the Bay of Biscay. Moreover, an increase in onboard computer technology has occurred. The effects of these changes are difficult to quantify as twin-trawling is not always recorded explicitly in the fisheries statistics and improvement due to computing technology is not continuous for the overall time series.

11.3 Assessment

Analytical assessment based on the recently adopted UWTV survey was carried out for the first time in November 2016 after the WKNEP benchmark in order to propose advice 2017 for the stock. Afterwards, the assessment is performed in spring of each year on the averaged LFDs and mean weights for landings and discards on the three preceding years but the results from the UWTV survey of the same year are not yet provided. Details of this assessment performed in

2018 are given below. The estimated *status quo* harvest rates for the period 2016-2018 calculated as removals divided by the UWTV for each year were respectively equal to 7.2%, 8.4% and 5.0%. It is noticeable that the harvest rate 2017 was above the MSY target (7.7%).

Variable	Value	Source	Notes
Abundance in TV assessment	3787.769	ICES (2018)	UWTV 2018 (available in the latter summer 2018; advice in autumn 2018)
Mean weight in landings	24.708	ICES (2018)	Average 2015-2017
Mean weight in discards	11.831	ICES (2018)	Average 2015-2017
Discard rate (total)	52.55%	ICES (2018)	Average 2015-2017 (proportion by number)
Discard survival rate	30%	ICES (2018)	Only applies in scenarios where discarding is allowed.
Dead discard rate (total)	43.70%	ICES (2018)	Average 2015-2017 (proportion by number), only applies in scenarios where discarding is allowed.

11.4 Catch options and prognosis

For 2019, the catch option table containing updated information on the fishery (mean weight for landings and discards, discard rate, survival rate for discards) is given below.

Variable	Value	Source	Notes
Abundance in TV assessment	Available in autumn 2019	ICES (2019)	UWTV 2019 (May)
Mean weight in landings	24.861	ICES (2019)	Average 2016-2018
Mean weight in discards	11.725	ICES (2019)	Average 2016-2018
Discard rate (total)	59.46%	ICES (2019)	Average 2016-2018 (proportion by number)
Discard survival rate	30%	ICES (2019)	Only applies in scenarios where discarding is allowed.
Dead discard rate (total)	50.71%	ICES (2019)	Average 2016-2018 (proportion by number), only applies in scenarios where discarding is allowed.

11.5 Biological reference points

A F_{MSY} proxy was provided for this stock as part of the response to the EU request to provide a framework for the classification of stock status relative to MSY proxies for selected category 3 and category 4 stocks (ICES, 2016). With the availability of UWTV surveys, ICES has now been able to assess the stock as a category 1 one. The MSY reference point proxies provided previously for this stock have therefore been replaced by MSY reference points.

The F_{MSY} reference point (harvest rate of 7.7%; ICES, 2016) is based on the average realised harvest rates of functional units with an observed history of sustainable exploitation, while also taking into account the low harvest rates applied to the FUs 23-24 stock in the recent past.

11.6 Comments on the assessment

The French *Nephrops* trawlers onboard sampling programme avoids the use of “derived” data for missing years (13 years on 32). Since 2009, there has been a relevant improvement of the sampling design as many trips were sampled in the Southern part of the fishery. Derivation based on probabilistic approach should improve knowledge in further analytical retrospective investigations on this stock.

The upgrade to category 1 stocks is the consequence of a representative sampling on the whole Central Mud Bank of the Bay of Biscay as performed in 2016-2018. In addition to unbiased spatial fishery information as VMS this results demonstrates the accurate knowledge of the stock area and of its sedimentary heterogeneous structure.

11.7 Information from the fishing industry

Many exchanges occurred between scientists and the fishing industry prior to the WG in the case of the partnership for the UWTV survey conducted on years 2017-2019 and intended to be continued for the period 2020-2022 (scientific methodological and financial supporting project). Many discussions prior to the WG underlined the steep decrease of landings in the period 2016-2018 which was considered by the industry as a temporary status and not as a signal of a declining trend. They moderated conclusions about such a decrease as they pointed out many additional regulations aiming to control productivity of *Nephrops* trawlers and to avoid quotas overshot. They argued that this situation had already observed in the recent past: the positive dynamics in 2014-2016 occurred after the downwards moving in 2011-2013. As in previous years, the industry underlined the heterogeneous feature of the whole area of the stock and debated about the overall falling trend for the southern part of the Bay of Biscay which is considered problematic. Divergent interpretations were advanced for this decline although all of them converge that it should be the consequence of a gradual modification of the sediment nature of this area from typically muddy to more mixed one.

The industry stressed a point to recent studies (Mérillet *et al*., 2018) suggesting a higher discard survival rate than the historical one of 30% used for the stock assessment. As consequence, a preliminary exemption to the landing obligation for the *Nephrops* fishery due to high survival was granted for the period 2016-2018. The industry wishes that this upwards estimate should be the basis for the future assessments.

11.8 Management considerations

Many positive signals on recent years (increase of LPUEs, landings, removals) and relative stability of burrow indices from UWTV surveys 2014–2016 suggested a stock status within safety limits. Although steep decrease of the UWTV indices in 2017 in spite of a slighter increase in 2018 combined with the historically lowest landings level in 2018 suggest to consider cautiously the current situation which will be examined reliably only after compilation of the 2018’s UWTV survey data.

11.9 Tables and Figures

Table 11.1. Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) - Estimates of catches (t) by FU for 1960-2018

	Landings (1)					Total Discards		Catches
Year	FU 23-24 (2)	FU 23	FU 24	Unallocated (MA N)(3)	Total VIIIa,b	FU 23-24		Total
	VIIIa,b	VIIIa	VIIIb		used by WG	VIIIa,b		VIIIa,b
1960	3524	-	-	-	3524	-		3524
1961	3607	-	-	-	3607	-		3607
1962	3042	-	-	-	3042	-		3042
1963	4040	-	-	-	4040	-		4040
1964	4596	-	-	-	4596	-		4596
1965	3441	-	-	-	3441	-		3441
1966	3857	-	-	-	3857	-		3857
1967	3245	-	-	-	3245	-		3245
1968	3859	-	-	-	3859	-		3859
1969	4810	-	-	-	4810	-		4810
1970	5454	-	-	-	5454	-		5454
1971	3990	-	-	-	3990	-		3990
1972	5525	-	-	-	5525	-		5525
1973	7040	-	-	-	7040	-		7040
1974	7100	-	-	-	7100	-		7100
1975	-	6460	322	-	6782	-		6782
1976	-	6012	300	-	6312	-		6312
1977	-	5069	222	-	5291	-		5291
1978	-	4554	162	-	4716	-		4716
1979	-	4758	36	-	4794	-		4794
1980	-	6036	71	-	6107	-		6107
1981	-	5908	182	-	6090	-		6090
1982	-	4392	298	-	4690	-		4690
1983	-	5566	342	-	5908	-		5908
1984	-	4485	198	-	4683	-		4683
1985	-	4281	312	-	4593	-		4593
1986	-	3968	367	99	4335	-		4335
1987	-	4937	460	64	5397	1767	*	7164
1988	-	5281	594	69	5875	4123		9997
1989	-	4253	582	77	4835	2634		7470
1990	1	4613	359	87	4972	627		5599
1991	1	4353	401	55	4754	1213	*	5967
1992	0	5123	558	47	5681	1354		7034
1993	0	4577	532	49	5109	1007		6116
1994	0	3721	371	27	4092	741		4833
1995	0	4073	380	14	4452	706		5159
1996	0	4034	84	15	4118	495		4614
1997	2	3450	147	41	3610	805		4415
1998	2	3565	300	40	3865	1453	*	5318
1999	2	2873	337	26	3209	1148		4357
2000	0	2848	221	36	3069	1455		4523
2001	1	3421	309	22	3730	2537		6267
2002	2	3323	356	36	3679	2620		6299
2003	1	3564	322	49	3886	1977	*	5863
2004	na	3223	348	5	3571	1932	*	5503
2005	na	3619	372	na	3991	2698	*	6689
2006	na	3026	420	na	3447	4544	*	7990
2007	na	2881	292	na	3176	2411	*	5587
2008	na	2774	256	na	3030	2123	*	5154
2009	na	2816	212	na	2987	1833	*	4820
2010	na	3153	245	na	3398	1275	*	4673
2011	na	3240	319	na	3559	1263	*	4822
2012	na	2290	230	na	2520	1012	*	3532
2013	na	2195	185	na	2380	1521	*	3900
2014	na	2699	108	na	2807	1326	*	4133
2015	na	3425	144	na	3569	1822	*	5391
2016	na	3873	217	na	4091	2531	*	6622
2017	na	3283	129	na	3412	2387	*	5799
2018	na	2038	86	na	2125	1627	*	3752

(1) WG estimates
(2) landings from VIIIa and VIIIb aggregated until 1974
(3) outside FU 23-24

Table 11.2. ***Nephrops*** **in FUs 23-24 Bay of Biscay (8.a,b). Quarterly and yearly numbers of units for the landings sampling program.**

	Q1			Q2			Q3			Q4		
year	auction	sea	Σ	auction	sea	Σ	auction	sea	Σ	auction	sea	Σ
2014	96	23	119	122	82	204	107	64	171	106	30	136
2015	119	37	156	119	71	190	123	70	193	114	12	126
2016	108	30	138	139	93	232	112	109	221	142	23	165
2017	26	30	56	27	36	63	63	47	110	92	19	111
2018	70	14	84	90	45	135	86	43	129	70	16	86
Total	419	134	553	497	327	824	491	333	824	524	100	624

Table 11.3. ***Nephrops*** **in FUs 23-24 Bay of Biscay (8.a,b). Quarterly and yearly numbers of sampled landed individuals.**

Year	Q1			Q2			Q3			Q4		
	auction	sea	Σ	auction	sea	Σ	auction	sea	Σ	auction	sea	Σ
2014	3774	855	4629	5400	3662	9062	4957	2321	7278	4642	1115	5757
2015	5347	1488	6835	5520	2760	8280	5695	2835	8530	4905	345	5251
2016	4562	1130	5692	6367	3340	9707	4801	3751	8552	6150	765	6915
2017	951	949	1900	1191	1606	2797	2863	1259	4122	4080	670	4750
2018	3528	554	4082	4285	1911	6196	3630	1661	5291	2991	471	3462
Total	18162	4976	23138	22763	13279	36042	21946	11827	33773	22768	3366	26135

Table 11.4. Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) - Derivation and estimations of discards

1987	sampled
1988-1990	from 1987's logistic function of sorting by quarter+density of probability
1991	sampled
1992-1997	from 1991's logistic function of sorting by quarter+density of probability
1998	sampled
1999-2002	from 1998's logistic function of sorting by quarter+density of probability
since 2003	sampled

Table 11.5. *Nephrops* in FUs 23-24 Bay of Biscay (8.a,b). Quarterly and yearly discards sample program onboard.

year	quarter	sampled FO	total FO	nb_trips	total trips	Nb *Nephrops*
2014	1	7	13	4	2689	377
	2	25	91	13	5615	1146
	3	21	99	12	5274	712
	4	10	27	8	3973	436
	total	63	230	37	17551	2671
2015	1	16	28	7	2785	655
	2	36	124	14	5598	1334
	3	28	131	13	4999	747
	4	7	31	3	3480	194
	total	87	314	37	16862	2930
2016	1	16	39	7	3441	549
	2	40	119	15	6207	1168
	3	46	153	17	5443	1135
	4	15	85	8	3906	256
	total	117	396	47	18997	3108
2017	1	20	97	9	3719	516
	2	29	138	12	6139	932
	3	23	55	9	4850	793
	4	10	26	17	3498	332
	total	82	316	37	18206	2573
2018	1	8	25	6	3015	237
	2	28	65	11	5784	1222
	3	25	67	14	4895	898
	4	14	48	9	3058	324
	total	75	205	40	16752	2681

Table 11.6.a Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) landings length distributions in 1987-2002

Landings CL mm/Y	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0
16	0	158	59	0	0	0	0	0	0	0	14	0	0	0	0	0
17	149	230	77	12	35	62	0	0	0	0	0	0	0	0	0	0
18	331	553	131	64	30	0	0	31	20	0	0	0	0	14	13	0
19	1296	1886	901	48	79	138	0	72	61	0	0	0	0	11	38	0
20	3129	4227	2791	529	474	450	464	206	341	48	448	25	72	116	284	107
21	6476	8882	7039	1947	1572	1595	1285	482	1573	414	1313	288	219	433	643	925
22	13501	16050	12971	5913	4733	3948	3878	2824	2395	1311	2799	985	849	1015	2116	1122
23	21337	25374	18073	10910	7854	9701	7398	5366	5523	2799	4638	3171	1888	2531	6261	5513
24	24339	33950	21960	13293	15521	20948	11949	9650	8731	6071	10005	6484	4032	5462	8915	10061
25	32476	36294	25650	16440	19747	27876	21011	15079	14348	13239	19837	13980	10717	11357	17106	12951
26	29670	29808	22747	18205	22106	26617	23732	18312	19769	16779	19380	13535	10590	10212	13745	21403
27	28086	28380	22091	16109	21900	28410	26044	21181	25126	18384	22823	16602	12724	11528	17098	19433
28	24925	26017	19087	19595	21214	32091	27580	20488	20914	15744	19466	14432	12058	12639	15835	22074
29	18703	20920	14227	16250	17138	24760	20627	16527	15909	16332	20878	11832	9448	11473	13779	16559
30	18407	17862	13688	12055	14762	19828	21414	15903	19164	20214	21487	16335	16187	13888	16168	18105
31	11419	13156	9037	11088	12408	14281	13452	11207	13333	14009	9791	8539	9209	9828	11316	9989
32	10185	12822	8410	8540	8635	12786	12711	11490	13667	14392	9622	9237	9745	8936	11335	10284
33	8528	8848	7127	10649	7273	9297	11369	7022	7117	8576	6334	5947	6000	6333	8250	7813
34	5926	7812	6967	10543	7987	7318	7355	6684	7584	6524	4816	6619	5910	5225	6185	5308
35	5763	5935	6214	7637	5425	5928	6307	5646	4677	6578	4737	6700	5267	4895	5213	4309
36	4033	5064	4532	6274	4979	4998	4608	4337	3709	4133	2568	5308	4291	3242	4037	3157
37	4024	3754	3545	4841	4541	4195	4089	3752	3496	4226	2135	4722	3230	2946	2901	2049
38	3131	3106	3193	4966	2993	3933	2991	2771	2879	2788	1142	3527	2588	2687	2369	2224
39	2151	2778	2154	3339	2869	2987	2290	1841	1746	1596	927	2169	2186	2027	2297	1559
40	2425	2159	2175	2766	2414	2574	2206	1738	2015	1956	982	3084	2353	1862	1908	1398
41	1375	1753	1461	1951	2076	1546	1452	1150	1123	1250	520	1558	1362	1020	941	764
42	1350	1542	1130	1668	1662	1599	1111	1118	1558	1142	508	1490	1124	797	863	632
43	1150	1209	1087	1908	1495	1348	1069	687	1039	610	370	1049	761	534	530	640
44	965	704	1192	1401	1089	1050	745	500	915	414	219	748	708	413	383	432
45	641	581	1194	955	1058	766	684	550	700	464	253	902	429	421	523	416
46	645	689	669	713	666	734	584	353	460	374	135	525	424	248	294	328
47	509	391	641	715	431	567	417	407	437	397	140	327	276	213	368	241
48	343	333	526	863	636	588	456	270	494	264	92	382	104	205	188	188
49	290	254	378	470	377	263	145	178	254	205	57	132	151	177	183	79
50	319	216	351	230	263	256	238	273	255	179	76	154	159	154	160	115
51	135	241	240	181	210	107	126	156	214	123	38	191	58	109	135	73
52	192	48	180	335	180	159	202	107	175	77	30	115	93	85	102	46
53	137	70	150	121	124	111	55	136	91	84	26	156	23	133	82	51
54	111	112	218	99	189	94	120	77	55	75	11	93	11	63	40	20
55	76	85	187	53	63	61	128	66	91	53	9	114	16	75	53	30
56	111	41	123	26	28	66	50	49	47	62	12	7	5	18	24	13
57	74	39	116	43	34	61	72	36	77	48	8	31	14	20	46	6
58	39	65	70	2	11	68	58	47	88	48	9	14	5	16	29	6
59	32	60	36	13	17	28	13	31	36	30	8	10	2	7	26	3
60	21	7	30	5	24	7	54	26	32	9	5	8	4	2	21	11
61	21	15	15	4	11	0	25	12	4	4	0	0	3	8	7	0
62	0	0	21	10	0	44	3	8	0	9	1	10	0	1	2	0
63	19	13	10	0	3	28	0	5	20	4	5	4	0	0	5	1
64	0	7	0	0	0	14	7	10	0	0	0	0	0	4	0	0
65	8	0	4	0	0	0	30	16	4	0	0	4	2	1	0	1
66	0	0	0	0	0	0	7	0	20	2	4	0	0	0	0	0
67	0	0	0	0	0	0	18	3	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
69	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**288974**	**324498**	**244875**	**213779**	**217338**	**274286**	**240638**	**188879**	**202294**	**182041**	**188694**	**161549**	**135304**	**133383**	**172819**	**180442**
Weights	**5397**	**5875**	**4835**	**4972**	**4754**	**5681**	**5109**	**4092**	**4452**	**4118**	**3610**	**3865**	**3209**	**3069**	**3730**	**3679**

Table 11.6.b Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) landings length distributions in 2003-2018

Landings CL mm/Y	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	20	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	14	0	25	5	4	12	0	0	0	0	0	0	0	0	6	0
19	0	14	27	0	0	0	0	0	1	0	5	0	0	0	18	0
20	87	47	82	5	4	77	37	14	22	35	31	1	16	21	24	18
21	280	249	270	70	14	191	73	75	6	25	151	74	130	138	320	106
22	661	899	771	131	18	208	288	252	11	235	682	180	575	532	368	90
23	1614	2194	2588	227	48	322	473	386	111	334	1002	764	1121	772	1155	185
24	3966	5664	6511	822	188	721	1929	1238	515	1399	3162	1836	2523	1341	1787	410
25	8164	10930	13678	2844	1201	2742	3670	3940	1803	3843	7873	4419	3478	3842	3845	1823
26	13297	13998	17811	6376	5684	6319	8258	8499	4773	7875	13242	7910	6651	7285	9264	4362
27	17614	16094	22006	12010	9439	10891	12759	14173	7520	11079	14926	12869	9702	12566	14413	6905
28	18572	15350	21879	14647	13248	12640	15732	15390	8991	11920	13260	13788	14431	16617	14546	7753
29	16843	14808	18027	14591	12516	12890	13524	15340	9602	11120	13397	14560	13726	18269	17209	9186
30	17264	14143	15570	13690	12219	10726	13271	15736	8821	9636	10296	12662	13690	16596	16695	8812
31	13345	12353	12634	11814	10698	9772	10859	12749	8253	8393	9137	11051	12456	16820	12979	8307
32	11276	10322	9907	9694	9274	8845	9310	11366	6954	7414	7116	10354	12021	13096	12950	6417
33	8253	8020	7800	8421	7859	7436	7086	8851	6175	6069	5558	6509	9882	12519	7752	7079
34	6195	6298	6537	7112	6539	6425	5985	7140	5467	4505	4123	6657	7881	8416	7638	4991
35	4653	4673	5100	5135	6529	5366	4568	5852	4541	3507	2783	4961	6122	6809	5052	3676
36	3818	3308	3369	4104	4735	3867	3697	3626	4260	2649	1978	3264	5219	6474	4829	3537
37	3075	2875	2597	3196	3839	3121	2565	3024	3648	1976	1472	2682	4511	4785	2620	2263
38	2660	2098	2380	2662	2639	2398	1871	2247	3911	1563	998	1783	3311	3342	2005	1890
39	2174	1683	1650	1956	2245	2043	1491	1630	3472	1314	936	1844	2726	2850	2176	1775
40	1936	1555	1628	1599	1711	1633	1190	1280	3296	1103	518	843	2676	1976	1294	1232
41	1423	1188	1154	1171	1227	1190	878	966	2740	878	438	669	1635	1394	1020	652
42	1403	889	953	990	1111	1015	742	742	2497	635	351	412	1284	1185	779	329
43	1054	774	842	741	710	805	540	560	2157	558	320	343	883	749	585	388
44	810	707	640	633	746	706	473	509	1762	536	249	234	637	658	471	319
45	808	613	605	595	518	536	396	442	1177	478	177	206	467	708	442	296
46	535	485	415	479	373	405	307	305	1024	441	181	159	236	368	271	153
47	456	388	353	440	311	361	262	290	858	378	88	151	216	332	261	86
48	339	313	339	382	257	294	245	237	656	381	98	87	149	230	143	80
49	206	318	288	319	237	262	196	204	557	212	74	72	200	195	100	51
50	253	306	276	287	190	228	156	160	501	160	46	63	108	123	126	68
51	170	214	176	246	163	201	115	135	383	132	37	58	68	83	53	32
52	150	152	184	201	138	116	110	120	296	128	32	24	46	88	96	36
53	120	111	142	137	140	121	98	97	198	96	24	42	33	56	37	21
54	80	90	104	156	115	95	63	95	271	93	17	18	29	59	49	18
55	57	47	109	137	79	73	75	79	152	58	15	11	26	23	38	10
56	23	86	69	117	60	67	54	75	132	46	8	5	15	21	24	8
57	47	49	58	134	70	41	31	67	98	48	22	10	18	7	12	6
58	22	27	43	134	45	40	48	47	105	52	3	8	5	7	12	11
59	10	32	41	85	33	19	23	48	79	33	12	3	3	8	6	1
60	8	10	19	115	33	23	14	42	48	22	3	2	3	5	7	3
61	5	5	28	40	23	7	8	30	39	15	8	1	0	3	2	1
62	4	3	16	21	9	9	9	16	55	18	1	1	7	3	6	3
63	1	5	9	19	9	7	10	7	23	11	2	1	0	0	1	1
64	0	8	8	18	10	6	3	16	12	8	0	0	1	1	2	72
65	0	1	14	11	9	1	3	9	11	7	0	0	1	1	3	0
66	1	1	6	10	1	0	2	3	11	3	0	0	0	1	1	0
67	0	1	5	8	1	0	2	3	6	1	0	0	0	0	0	0
68	0	2	4	7	3	0	0	4	7	0	0	0	0	0	0	0
69	1	0	1	6	2	0	1	1	2	2	0	0	0	0	0	0
70	0	0	2	4	0	0	0	1	2	0	0	0	0	1	1	0
71	1	0	1	5	0	0	0	1	1	0	0	0	0	0	0	0
72	0	0	1	5	0	0	0	0	0	0	0	0	0	0	1	0
73	0	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0
74	0	0	0	4	0	0	0	0	1	0	0	1	0	0	1	0
75	0	0	1	4	0	0	0	0	0	1	0	0	0	2	5	0
Total	**163771**	**154405**	**179758**	**128777**	**117273**	**115274**	**123504**	**138120**	**108011**	**101424**	**114853**	**121594**	**138920**	**161371**	**143502**	**83463**
Weights	**3886**	**3571**	**3991**	**3447**	**3176**	**3030**	**2987**	**3398**	**3559**	**2520**	**2380**	**2807**	**3569**	**4091**	**3412**	**2125**

Table 11.6.c Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) discards length distributions in 1987-2002.

Total Discards																
CL mm/Y	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
10	0	1318	75	0	0	546	199	134	185	82	1325	0	93	186	950	1268
11	0	2152	152	0	114	807	313	208	279	125	1611	85	150	291	1341	1817
12	0	3508	308	0	0	1190	491	323	419	191	1952	128	240	455	1890	2597
13	0	5695	624	1	93	1749	768	501	627	291	2354	162	384	710	2654	3696
14	78	9194	1261	2	258	2556	1198	774	936	441	2823	660	613	1104	3713	5233
15	2074	14706	2539	7	1249	3708	1858	1189	1388	666	3364	1741	977	1710	5164	7354
16	3974	23183	5074	22	2240	5320	2854	1811	2040	999	3980	1861	1548	2631	7126	10227
17	13577	35760	9995	71	4638	7521	4326	2727	2961	1484	4671	3527	2433	4008	9732	14027
18	29288	53448	19148	235	10619	10421	6429	4034	4221	2171	5432	5003	3776	6016	13110	18895
19	28370	76547	34910	766	12852	14070	9295	5825	5877	3114	6254	5991	5753	8843	17354	24883
20	60253	230038	153497	2426	22797	18408	12961	8143	7938	4347	7125	12091	8534	12628	22483	31890
21	45446	129602	100993	31048	18043	23225	17283	10932	10337	5862	8028	9973	12205	17372	28397	39629
22	51268	61144	47652	26066	24289	17350	17709	13186	9925	7591	14964	23278	16667	25140	49505	24662
23	23074	25627	17991	11687	15611	20991	15746	11862	12053	6558	10661	21641	17635	22623	54819	48438
24	7213	10004	6496	3836	13741	20860	12123	10225	9074	6765	10758	19750	15698	21146	34491	39179
25	2686	3535	2479	1516	14722	13478	10054	7645	7037	6720	10252	20487	18666	20177	30416	22841
26	672	1008	694	570	7131	6137	5513	4390	4741	4030	4720	10676	8465	8496	11137	17386
27	270	335	240	181	1711	3200	2863	2452	2817	2088	2639	7502	4774	4780	6340	8069
28	0	117	70	78	999	1759	1449	1143	1117	874	1096	3019	2202	2630	2658	4129
29	0	32	20	25	138	654	517	434	415	431	584	1357	813	1245	1183	1494
30	0	10	7	7	291	256	268	208	249	263	287	686	695	679	665	876
31	0	3	2	2	97	94	84	69	84	89	64	129	208	273	226	214
32	0	1	1	1	0	39	40	34	42	45	30	481	115	112	114	119
33	0	0	0	0	0	14	18	11	11	13	10	231	38	40	47	44
34	0	0	0	0	0	6	6	5	6	5	4	151	20	17	20	21
35	0	0	0	0	0	2	2	2	2	2	2	88	10	8	7	7
36	0	0	0	0	0	1	1	1	1	1	0	48	5	3	4	4
37	0	0	0	0	0	0	0	0	0	0	0	74	2	2	1	1
38	0	0	0	0	0	0	0	0	0	0	0	44	1	1	1	1
39	0	0	0	0	0	0	0	0	0	0	0	36	0	0	1	0
40	0	0	0	0	0	0	0	0	0	0	0	57	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**268244**	**686969**	**404228**	**78546**	**151634**	**174362**	**124368**	**88267**	**84780**	**55250**	**104994**	**150995**	**122720**	**163330**	**305547**	**329002**
Weights	**1767**	**4123**	**2634**	**627**	**1213**	**1354**	**1007**	**741**	**706**	**495**	**805**	**1453**	**1148**	**1455**	**2537**	**2620**

Table 11.6.d Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) discards length distributions in 2003-2018.

Total Discards

CL mm/Y	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
10	28	0	0	0	22	0	82	0	0	0	0	0	0	0	26	0
11	0	0	94	0	171	38	135	2	0	0	0	0	0	0	0	23
12	70	363	413	70	202	98	79	0	237	0	0	0	75	76	54	0
13	294	1722	1085	234	122	235	177	97	596	532	0	28	184	76	111	47
14	636	3152	3190	1138	900	389	291	83	834	665	229	101	606	327	384	31
15	1198	5548	7287	3102	1288	189	1157	155	941	1425	870	281	1476	578	1228	533
16	3386	6784	13528	7810	2959	1027	2315	822	1230	4544	1313	1300	2354	569	1668	1025
17	5927	8836	15094	11655	3636	1832	3059	1333	2430	4737	4179	1647	3242	2717	3697	3498
18	8078	10161	19795	16139	4590	2626	4843	2309	3630	8066	3372	2808	5073	5207	4175	6526
19	11506	17361	19522	25891	5244	6473	6485	3532	4546	8024	8730	3822	8084	9685	8517	7525
20	12142	19250	22265	39742	8735	11444	12766	5692	7227	10125	9682	6457	9246	9420	13805	9528
21	18597	25898	32409	54220	11585	15630	16772	7699	10393	12145	15281	9195	10952	12022	16601	13519
22	21416	25210	35523	69870	17930	24730	18701	11689	15161	14034	20618	11284	11324	15704	16245	17587
23	28429	26756	40041	70094	24086	27560	21693	13672	13837	12904	26287	15130	14109	18312	20400	20543
24	26501	21343	36279	55408	30615	29638	24105	16963	15551	14889	21750	14000	16820	19435	21961	16751
25	23211	20085	30222	52660	32917	28007	20736	14670	16545	10873	17823	18051	18746	22159	21886	18939
26	17357	12006	19003	38812	27376	23127	14205	11852	10047	7747	10188	11947	15874	24994	21474	12592
27	9680	6436	8498	20124	20567	10129	9188	8558	8127	4304	5439	8155	11931	17139	13660	8534
28	6187	3487	4603	10263	10365	5893	5927	5986	3201	919	2824	5026	8056	11441	11298	5704
29	2537	2115	1201	4188	4464	3225	3163	3360	2086	588	2146	2316	5771	10887	5361	3148
30	1605	1901	1600	2578	2868	1923	3261	1876	2011	680	945	1672	4714	5283	5464	1475
31	1326	1115	1417	1109	1316	925	1824	1274	1246	125	922	1263	2033	4343	3766	1132
32	574	735	526	592	737	454	839	716	492	200	684	1482	1745	2458	2470	533
33	313	503	296	544	484	421	671	350	265	13	365	384	812	3193	814	1017
34	261	385	553	411	537	1025	830	274	272	145	494	433	1108	1071	1132	785
35	176	424	260	230	265	206	332	242	174	24	233	125	147	874	1540	342
36	113	108	46	73	336	78	197	55	59	3	260	391	243	774	503	140
37	83	74	246	25	299	153	188	162	149	146	130	45	298	573	681	58
38	93	31	116	99	40	93	269	16	97	68	81	71	246	576	320	66
39	15	139	147	0	3	369	55	33	24	0	33	230	65	598	409	78
40	37	73	37	169	47	0	66	38	25	3	0	122	175	72	235	42
41	34	60	20	0	40	0	8	4	0	0	0	7	46	148	126	127
42	4	12	31	0	20	53	0	4	157	0	0	0	508	186	139	71
43	14	13	0	0	11	0	38	0	4	4	0	152	199	0	202	30
44	0	13	0	0	0	0	14	6	0	0	0	0	12	0	164	29
45	13	0	0	36	0	0	0	0	5	0	0	0	56	0	38	13
46	0	0	0	0	0	0	0	6	0	0	0	0	44	77	0	57
47	0	0	0	0	0	0	0	0	6	0	0	7	0	0	23	25
48	0	0	0	0	0	0	8	0	0	0	36	0	0	0	0	3
49	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	23
50	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	6
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	69
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	31
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	39	0	0	0	0	0	0	0	0	0	28
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**201841**	**222102**	**315346**	**487288**	**214788**	**198031**	**174480**	**113530**	**121603**	**117935**	**154914**	**117930**	**156400**	**200973**	**200600**	**152342**
Weights	**1977**	**1932**	**2698**	**4544**	**2411**	**2123**	**1833**	**1275**	**1263**	**1012**	**1521**	**1326**	**1822**	**2531**	**2387**	**1627**

Table 11.6.e Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) catches length distributions in 1987-2002.

Total catches

CL mm/Y	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
10	0	1318	75	0	0	546	199	134	185	82	1325	0	93	186	950	1268
11	0	2152	152	0	114	807	313	208	279	125	1611	85	150	291	1341	1817
12	0	3508	308	0	0	1190	491	323	419	191	1952	128	240	455	1890	2597
13	0	5695	624	1	93	1749	768	501	627	291	2354	162	384	710	2654	3696
14	78	9194	1261	2	258	2556	1198	774	936	441	2823	660	613	1104	3713	5233
15	2074	14706	2539	7	1249	3708	1858	1189	1388	666	3378	1741	977	1710	5164	7354
16	3974	23341	5134	22	2240	5320	2854	1811	2040	999	3994	1861	1548	2631	7126	10227
17	13727	35990	10072	83	4673	7583	4326	2727	2961	1484	4671	3527	2433	4008	9732	14027
18	29620	54001	19279	299	10649	10421	6429	4065	4241	2171	5432	5003	3776	6031	13122	18895
19	29666	78433	35810	814	12931	14209	9295	5897	5938	3114	6254	5991	5753	8854	17392	24883
20	63382	234265	156289	2955	23271	18858	13425	8348	8279	4394	7573	12116	8605	12744	22767	31997
21	51922	138484	108031	32996	19615	24820	18569	11413	11910	6276	9341	10260	12424	17805	29040	40555
22	64770	77194	60622	31979	29023	21298	21587	16010	12320	8902	17764	24263	17516	26155	51621	25784
23	44411	51001	36064	22597	23464	30692	23143	17227	17576	9357	15299	24812	19523	25155	61081	53951
24	31551	43954	28456	17129	29262	41808	24072	19876	17805	12836	20763	26235	19730	26608	43406	49240
25	35162	39829	28130	17956	34469	41355	31065	22724	21385	19960	30089	34467	29383	31534	47522	35792
26	30342	30817	23441	18775	29237	32754	29245	22702	24510	20810	24100	24211	19056	18708	24882	38790
27	28357	28715	22331	16290	23611	31610	28907	23633	27943	20472	25462	24104	17498	16307	23438	27502
28	24925	26134	19157	19672	22213	33851	29028	21631	22031	16618	20563	17450	14261	15269	18493	26203
29	18703	20952	14247	16275	17276	25413	21145	16961	16324	16763	21463	13189	10261	12718	14962	18053
30	18407	17871	13696	12061	15053	20084	21682	16111	19413	20478	21774	17021	16882	14567	16833	18981
31	11419	13159	9038	11090	12505	14375	13535	11276	13418	14098	9856	8668	9417	10102	11542	10203
32	10185	12823	8410	8541	8635	12825	12751	11524	13710	14436	9652	9718	9860	9048	11448	10403
33	8528	8848	7128	10650	7273	9311	11387	7033	7128	8589	6344	6178	6038	6373	8297	7857
34	5926	7812	6967	10543	7987	7324	7361	6688	7590	6529	4820	6770	5930	5242	6204	5329
35	5763	5935	6214	7637	5425	5931	6309	5648	4678	6580	4739	6787	5277	4903	5220	4316
36	4033	5064	4532	6274	4979	4999	4609	4338	3709	4134	2568	5356	4295	3245	4041	3161
37	4024	3754	3545	4841	4541	4195	4089	3753	3496	4227	2135	4796	3232	2947	2903	2050
38	3131	3106	3193	4966	2993	3933	2991	2771	2879	2788	1142	3571	2589	2688	2370	2225
39	2151	2778	2154	3339	2869	2987	2290	1841	1746	1596	927	2205	2186	2027	2298	1560
40	2425	2159	2175	2766	2414	2574	2206	1738	2015	1956	982	3140	2353	1862	1908	1399
41	1375	1753	1461	1951	2076	1546	1452	1150	1123	1250	520	1558	1363	1020	941	764
42	1350	1542	1130	1668	1662	1599	1111	1118	1558	1142	508	1490	1124	797	863	632
43	1150	1209	1087	1908	1495	1348	1069	687	1039	610	370	1055	762	534	530	641
44	965	704	1192	1401	1089	1050	745	500	915	414	219	778	708	413	383	432
45	641	581	1194	955	1058	766	684	550	700	464	253	904	429	421	523	416
46	645	689	669	713	666	734	584	353	460	374	135	525	424	248	294	328
47	509	391	641	715	431	567	417	407	437	397	140	327	276	213	368	241
48	343	333	526	863	636	588	456	270	494	264	92	382	104	205	188	188
49	290	254	378	470	377	263	145	178	254	205	57	132	151	177	183	79
50	319	216	351	230	263	256	238	273	255	179	76	154	159	154	160	115
51	135	241	240	181	210	107	126	156	214	123	38	191	58	109	135	73
52	192	48	180	335	180	159	202	107	175	77	30	115	93	85	102	46
53	137	70	150	121	124	111	55	136	91	84	26	156	23	133	82	51
54	111	112	218	99	189	94	120	77	55	75	11	93	11	63	40	20
55	76	85	187	53	63	61	128	66	91	53	9	114	16	75	53	30
56	111	41	123	26	28	66	50	49	47	62	12	7	5	18	24	13
57	74	39	116	43	34	61	72	36	77	48	8	31	14	20	46	6
58	39	65	70	2	11	68	58	47	88	48	9	14	5	16	29	6
59	32	60	36	13	17	28	13	31	36	30	8	10	2	7	26	3
60	21	7	30	5	24	7	54	26	32	9	5	8	4	2	21	11
61	21	15	15	4	11	0	25	12	4	4	0	0	3	8	7	0
62	0	0	21	10	0	44	3	8	0	9	1	10	0	1	2	0
63	19	13	10	0	3	28	0	5	20	4	5	4	0	0	5	1
64	0	7	0	0	0	14	7	10	0	0	0	0	0	4	0	0
65	8	0	4	0	0	0	30	16	4	0	0	4	2	1	0	1
66	0	0	0	0	0	0	7	0	20	2	4	0	0	0	0	0
67	0	0	0	0	0	0	18	3	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
69	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**557218**	**1011467**	**649102**	**292325**	**368972**	**448648**	**365006**	**277146**	**287074**	**237291**	**293688**	**312544**	**258025**	**296713**	**478366**	**509443**
Weights	**7164**	**9997**	**7470**	**5599**	**5967**	**7034**	**6116**	**4833**	**5159**	**4614**	**4415**	**5318**	**4357**	**4523**	**6267**	**6299**

Table 11.6.f Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) catches length distributions in 2003-2018.

Total catches

CL mm/Y	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
10	28	0	0	0	22	0	82	0	0	0	0	0	0	0	26	0
11	0	0	94	0	171	38	135	2	0	0	0	0	0	0	0	23
12	70	363	413	70	202	98	79	0	237	0	0	0	75	76	54	0
13	294	1722	1085	234	122	235	177	97	596	532	0	28	184	76	111	47
14	636	3152	3190	1138	900	389	291	83	834	665	229	101	606	327	384	31
15	1198	5548	7287	3102	1289	189	1157	155	941	1425	870	281	1476	578	1228	533
16	3386	6784	13528	7810	2959	1027	2315	822	1230	4544	1313	1300	2354	569	1668	1025
17	5947	8843	15094	11655	3636	1832	3059	1333	2430	4737	4179	1647	3242	2717	3697	3498
18	8092	10161	19820	16144	4593	2638	4843	2309	3630	8066	3372	2808	5073	5207	4181	6526
19	11506	17376	19549	25891	5244	6473	6485	3532	4546	8024	8735	3822	8084	9685	8535	7525
20	12229	19297	22348	39747	8738	11521	12803	5706	7249	10160	9713	6458	9262	9441	13829	9546
21	18877	26146	32679	54289	11598	15820	16845	7775	10398	12170	15433	9269	11082	12160	16921	13625
22	22077	26109	36293	70001	17948	24938	18989	11941	15171	14269	21300	11464	11899	16237	16613	17677
23	30042	28950	42629	70322	24134	27882	22167	14058	13948	13238	27289	15894	15231	19084	21554	20728
24	30467	27006	42790	56230	30803	30359	26034	18202	16065	16288	24913	15836	19343	20775	23747	17161
25	31376	31015	43900	55504	34119	30750	24406	18610	18348	14716	25696	22470	22223	26001	25731	20762
26	30654	26004	36814	45189	33060	29446	22463	20352	14820	15622	23430	19857	22526	32279	30738	16955
27	27294	22530	30504	32134	30006	21020	21948	22730	15647	15383	20365	21024	21633	29705	28073	15439
28	24759	18837	26482	24909	23613	18533	21659	21375	12191	12838	16084	18814	22487	28058	25844	13457
29	19381	16923	19228	18779	16980	16115	16687	18700	11687	11708	15543	16876	19498	29156	22570	12333
30	18868	16044	17170	16268	15087	12649	16531	17612	10832	10315	11241	14334	18403	21879	22159	10287
31	14672	13469	14051	12923	12014	10697	12682	14024	9500	8518	10059	12314	14489	21163	16745	9440
32	11849	11057	10433	10286	10011	9299	10150	12082	7447	7614	7801	11836	13766	15554	15419	6950
33	8566	8523	8095	8965	8343	7857	7757	9201	6440	6082	5923	6892	10695	15712	8566	8096
34	6456	6684	7090	7524	7076	7449	6815	7414	5739	4649	4617	7091	8990	9487	8770	5776
35	4829	5097	5361	5366	6793	5573	4900	6094	4715	3531	3016	5087	6270	7683	6592	4019
36	3931	3416	3415	4177	5071	3945	3894	3681	4319	2652	2237	3654	5462	7247	5332	3677
37	3158	2949	2844	3221	4138	3273	2753	3186	3797	2122	1602	2727	4809	5358	3302	2321
38	2752	2129	2496	2760	2679	2491	2139	2263	4007	1632	1079	1854	3556	3918	2325	1957
39	2189	1822	1797	1956	2247	2412	1546	1662	3496	1314	968	2075	2791	3448	2585	1853
40	1973	1628	1665	1768	1758	1633	1257	1318	3321	1107	518	965	2851	2048	1529	1274
41	1457	1248	1174	1171	1267	1190	886	971	2740	878	438	676	1681	1542	1146	779
42	1407	901	984	990	1130	1069	742	746	2654	635	351	412	1792	1370	918	400
43	1068	787	842	741	722	805	578	560	2161	563	320	495	1082	749	787	418
44	810	719	640	633	746	706	487	515	1762	536	249	234	649	658	636	348
45	821	613	605	631	518	536	396	442	1182	478	177	206	523	708	480	309
46	535	485	415	479	373	405	307	312	1024	441	181	159	280	445	271	210
47	456	388	353	440	311	361	262	290	865	378	88	158	216	332	284	111
48	339	313	339	382	257	294	254	237	656	381	134	87	149	230	143	83
49	206	318	288	319	237	262	196	204	557	212	74	72	223	195	100	74
50	253	306	276	287	201	228	156	160	501	160	46	63	108	123	126	74
51	170	214	176	246	163	201	115	135	383	132	37	58	68	83	53	58
52	150	152	184	201	138	116	110	120	296	128	32	24	46	88	96	39
53	120	111	142	137	140	121	98	97	198	96	24	42	33	56	37	90
54	80	90	104	156	115	95	63	95	271	93	17	18	29	59	49	40
55	57	47	109	137	79	73	75	79	152	58	15	11	26	23	61	41
56	23	86	69	117	60	67	54	75	132	46	8	5	15	21	24	37
57	47	49	58	134	70	41	31	67	98	48	22	10	18	7	12	6
58	22	27	43	134	45	80	48	47	105	52	3	8	5	7	12	39
59	10	32	41	85	33	19	23	48	79	33	12	3	3	8	6	1
60	8	10	19	115	33	23	14	42	48	22	3	2	3	5	7	28
61	5	5	28	40	23	7	8	30	39	15	8	1	0	3	2	1
62	4	3	16	21	9	9	9	16	55	18	1	1	7	3	6	4
63	1	5	9	19	9	7	10	7	23	11	2	1	0	0	1	1
64	0	8	8	18	10	6	3	16	12	8	0	0	1	1	2	72
65	0	1	14	11	9	1	3	9	11	7	0	0	1	1	3	0
66	1	1	6	10	1	0	2	3	11	3	0	0	0	1	1	0
67	0	1	5	8	1	0	2	3	6	1	0	0	0	0	0	0
68	0	2	4	7	3	0	0	4	7	0	0	0	0	0	0	0
69	1	0	1	6	2	0	1	1	2	2	0	0	0	0	0	0
70	0	0	2	4	0	0	0	1	2	0	0	0	0	1	1	0
71	1	0	1	5	0	0	0	1	1	0	0	0	0	0	0	0
72	0	0	1	5	0	0	0	0	0	0	0	0	0	0	1	0
73	0	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0
74	0	0	0	4	0	0	0	0	1	0	0	1	0	0	1	0
75	0	0	1	4	0	0	0	0	0	1	0	0	0	2	5	0
Total	**365612**	**376507**	**495103**	**616065**	**332060**	**313305**	**297984**	**251649**	**229614**	**219358**	**269767**	**239523**	**295319**	**362344**	**344102**	**235806**
Weights	**5863**	**5503**	**6689**	**7990**	**5587**	**5154**	**4820**	**4673**	**4822**	**3532**	**3900**	**4133**	**5391**	**6622**	**5799**	**3752**

Table 11.6.g Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) removals length distributions in 1987-2002.

Removals=Landings+dead catches (discard survival rate : 30%)

CL mm/Y	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
10	0	922	52	0	0	382	139	94	130	57	928	0	65	130	665	888
11	0	1507	106	0	80	565	219	146	195	88	1128	60	105	204	939	1272
12	0	2455	216	0	0	833	344	226	293	134	1366	89	168	319	1323	1818
13	0	3987	437	0	65	1224	538	351	439	203	1648	114	269	497	1858	2587
14	55	6436	883	1	181	1789	839	542	655	309	1976	462	429	773	2599	3663
15	1452	10294	1777	5	875	2595	1301	832	972	466	2369	1219	684	1197	3615	5148
16	2782	16386	3611	15	1568	3724	1998	1268	1428	699	2800	1302	1084	1842	4988	7159
17	9654	25262	7074	62	3282	5326	3028	1909	2072	1039	3270	2469	1703	2806	6812	9819
18	20833	37967	13534	229	7464	7294	4500	2855	2974	1520	3802	3502	2643	4226	9190	13226
19	21155	55469	25338	584	9075	9987	6507	4150	4175	2180	4378	4194	4027	6201	12186	17418
20	45306	165254	110239	2228	16432	13336	9537	5906	5898	3090	5436	8489	6045	8956	16022	22430
21	38288	99604	77733	23681	14202	17852	13384	8134	8809	4518	6933	7269	8763	12593	20521	28666
22	49389	58851	46327	24159	21736	16093	16274	12054	9343	6624	13274	17280	12516	18613	36769	18385
23	37489	43313	30667	19090	18781	24395	18420	13669	13960	7390	12101	18320	14232	18368	44635	39420
24	29387	40953	26507	15979	25139	35550	20435	16808	15083	10807	17535	20310	15021	20264	33059	37486
25	34356	38768	27386	17501	30052	37311	28048	20431	19274	17944	27014	28321	23783	25481	38397	28940
26	30141	30514	23233	18604	27098	30913	27591	21385	23088	19601	22684	21008	16516	16159	21541	33574
27	28276	28615	22259	16236	23098	30650	28048	22897	27098	19846	24670	21853	16066	14873	21536	25081
28	24925	26099	19136	19649	21914	33323	28594	21288	21696	16356	20234	16545	13600	14480	17695	24964
29	18703	20942	14241	16268	17235	25217	20989	16831	16199	16633	21287	12782	10017	12345	14607	17605
30	18407	17868	13693	12059	14965	20008	21602	16049	19338	20399	21688	16815	16674	14363	16633	18718
31	11419	13158	9038	11089	12476	14347	13510	11255	13392	14072	9836	8629	9354	10020	11475	10138
32	10185	12823	8410	8541	8635	12813	12739	11514	13697	14423	9643	9574	9826	9014	11414	10367
33	8528	8848	7128	10649	7273	9306	11382	7030	7124	8585	6341	6109	6027	6361	8283	7844
34	5926	7812	6967	10543	7987	7322	7360	6687	7588	6527	4819	6725	5924	5237	6198	5323
35	5763	5935	6214	7637	5425	5930	6309	5647	4678	6580	4738	6761	5274	4901	5218	4314
36	4033	5064	4532	6274	4979	4999	4609	4338	3709	4133	2568	5341	4294	3244	4040	3160
37	4024	3754	3545	4841	4541	4195	4089	3753	3496	4226	2135	4774	3231	2947	2902	2050
38	3131	3106	3193	4966	2993	3933	2991	2771	2879	2788	1142	3558	2589	2688	2370	2225
39	2151	2778	2154	3339	2869	2987	2290	1841	1746	1596	927	2195	2186	2027	2298	1560
40	2425	2159	2175	2766	2414	2574	2206	1738	2015	1956	982	3123	2353	1862	1908	1399
41	1375	1753	1461	1951	2076	1546	1452	1150	1123	1250	520	1558	1363	1020	941	764
42	1350	1542	1130	1668	1662	1599	1111	1118	1558	1142	508	1490	1124	797	863	632
43	1150	1209	1087	1908	1495	1348	1069	687	1039	610	370	1053	761	534	530	641
44	965	704	1192	1401	1089	1050	745	500	915	414	219	769	708	413	383	432
45	641	581	1194	955	1058	766	684	550	700	464	253	904	429	421	523	416
46	645	689	669	713	666	734	584	353	460	374	135	525	424	248	294	328
47	509	391	641	715	431	567	417	407	437	397	140	327	276	213	368	241
48	343	333	526	863	636	588	456	270	494	264	92	382	104	205	188	188
49	290	254	378	470	377	263	145	178	254	205	57	132	151	177	183	79
50	319	216	351	230	263	256	238	273	255	179	76	154	159	154	160	115
51	135	241	240	181	210	107	126	156	214	123	38	191	58	109	135	73
52	192	48	180	335	180	159	202	107	175	77	30	115	93	85	102	46
53	137	70	150	121	124	111	55	136	91	84	26	156	23	133	82	51
54	111	112	218	99	189	94	120	77	55	75	11	93	11	63	40	20
55	76	85	187	53	63	61	128	66	91	53	9	114	16	75	53	30
56	111	41	123	26	28	66	50	49	47	62	12	7	5	18	24	13
57	74	39	116	43	34	61	72	36	77	48	8	31	14	20	46	6
58	39	65	70	2	11	68	58	47	88	48	9	14	5	16	29	6
59	32	60	36	13	17	28	13	31	36	30	8	10	2	7	26	3
60	21	7	30	5	24	7	54	26	32	9	5	8	4	2	21	11
61	21	15	15	4	11	0	25	12	4	4	0	0	3	8	7	0
62	0	0	21	10	0	44	3	8	0	9	1	10	0	1	2	0
63	19	13	10	0	3	28	0	5	20	4	5	4	0	0	5	1
64	0	7	0	0	0	14	7	10	0	0	0	0	0	4	0	0
65	8	0	4	0	0	0	30	16	4	0	0	4	2	1	0	1
66	0	0	0	0	0	0	7	0	20	2	4	0	0	0	0	0
67	0	0	0	0	0	0	18	3	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
69	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**476745**	**805376**	**527834**	**268762**	**323482**	**396340**	**327696**	**250666**	**261640**	**220716**	**262190**	**267245**	**221208**	**247714**	**386702**	**410743**
Weights	**6634**	**8760**	**6679**	**5411**	**5603**	**6628**	**5814**	**4610**	**4947**	**4465**	**4173**	**4882**	**4013**	**4087**	**5506**	**5513**

Table 11.6.h Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) removals length distributions in 2003-2018.

Removals=Landings+dead catches (discard survival rate : 30%)

CL mm/Y	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
10	19	0	0	0	16	0	58	0	0	0	0	0	0	0	18	0
11	0	0	66	0	119	27	94	1	0	0	0	0	0	0	0	16
12	49	254	289	49	142	69	56	0	166	0	0	0	53	53	38	0
13	206	1205	760	164	85	164	124	68	417	372	0	20	129	53	78	33
14	445	2206	2233	797	630	272	204	58	584	466	160	71	424	229	269	21
15	839	3883	5101	2171	902	132	810	108	658	998	609	196	1033	405	859	373
16	2370	4749	9469	5467	2072	719	1621	575	861	3181	919	910	1648	399	1168	717
17	4169	6193	10565	8158	2545	1282	2141	933	1701	3316	2925	1153	2270	1902	2588	2449
18	5669	7112	13882	11302	3216	1851	3390	1616	2541	5646	2360	1966	3551	3645	2929	4568
19	8055	12167	13692	18124	3671	4531	4540	2472	3183	5617	6116	2676	5659	6779	5980	5267
20	8586	13522	15668	27825	6118	8087	8973	3998	5081	7122	6809	4521	6488	6615	9688	6687
21	13298	18377	22957	38024	8123	11131	11813	5465	7281	8527	10848	6510	7797	8553	11941	9569
22	15653	18546	25636	49040	12569	17519	13379	8434	10623	10058	15114	8079	8502	11525	11739	12401
23	21514	20924	30617	49293	16909	19614	15659	9957	9797	9367	19403	11355	10998	13591	15434	14566
24	22517	20604	31906	39608	21619	21468	18803	13113	11400	11821	18387	11636	14297	14945	17159	12136
25	24412	24990	34834	39706	24243	22348	18185	14209	13385	11454	20349	17054	16600	19353	19165	15080
26	25447	22402	31113	33545	24847	22508	18202	16796	11806	13298	20373	16273	17763	24781	24296	13177
27	24390	20599	27955	26097	23835	17982	19191	20163	13209	14092	18733	18578	18053	24563	23975	12879
28	22903	17791	25101	21831	20503	16765	19881	19579	11231	12563	15237	17306	20070	24626	22455	11745
29	18619	16289	18868	17523	15641	15148	15738	17692	11061	11531	14899	16181	17766	25890	20962	11389
30	18387	15474	16690	15495	14227	12072	15553	17049	10229	10111	10957	13832	16989	20294	20519	9844
31	14274	13134	13626	12590	11619	10419	12135	13641	9126	8480	9783	11935	13879	19860	15615	9100
32	11677	10836	10276	10108	9790	9163	9898	11867	7299	7554	7595	11391	13242	14816	14678	6790
33	8472	8372	8007	8802	8197	7731	7556	9096	6361	6078	5814	6777	10451	14754	8322	7791
34	6377	6568	6924	7400	6915	7142	6566	7332	5657	4606	4469	6961	8657	9165	8430	5541
35	4776	4970	5282	5297	6714	5511	4801	6021	4663	3524	2946	5049	6225	7421	6130	3916
36	3897	3384	3401	4155	4971	3921	3835	3665	4301	2651	2159	3537	5389	7015	5181	3635
37	3133	2927	2770	3214	4048	3228	2696	3138	3753	2078	1563	2713	4720	5186	3097	2304
38	2725	2120	2461	2731	2667	2463	2059	2258	3978	1611	1055	1833	3483	3745	2229	1937
39	2184	1780	1753	1956	2246	2301	1529	1652	3489	1314	959	2006	2772	3268	2462	1830
40	1962	1606	1654	1717	1744	1633	1237	1306	3313	1106	518	929	2798	2026	1459	1262
41	1447	1230	1168	1171	1255	1190	884	969	2740	878	438	674	1667	1498	1108	741
42	1406	897	975	990	1125	1053	742	745	2607	635	351	412	1640	1315	876	379
43	1064	783	842	741	718	805	567	560	2160	561	320	449	1022	749	726	409
44	810	715	640	633	746	706	483	514	1762	536	249	234	645	658	586	339
45	817	613	605	620	518	536	396	442	1181	478	177	206	506	708	468	305
46	535	485	415	479	373	405	307	310	1024	441	181	159	267	422	271	193
47	456	388	353	440	311	361	262	290	863	378	88	156	216	332	277	104
48	339	313	339	382	257	294	251	237	656	381	124	87	149	230	143	82
49	206	318	288	319	237	262	196	204	557	212	74	72	217	195	100	67
50	253	306	276	287	198	228	156	160	501	160	46	63	108	123	126	72
51	170	214	176	246	163	201	115	135	383	132	37	58	68	83	53	50
52	150	152	184	201	138	116	110	120	296	128	32	24	46	88	96	38
53	120	111	142	137	140	121	98	97	198	96	24	42	33	56	37	69
54	80	90	104	156	115	95	63	95	271	93	17	18	29	59	49	33
55	57	47	109	137	79	73	75	79	152	58	15	11	26	23	54	32
56	23	86	69	117	60	67	54	75	132	46	8	5	15	21	24	28
57	47	49	58	134	70	41	31	67	98	48	22	10	18	7	12	6
58	22	27	43	134	45	68	48	47	105	52	3	8	5	7	12	31
59	10	32	41	85	33	19	23	48	79	33	12	3	3	8	6	1
60	8	10	19	115	33	23	14	42	48	22	3	2	3	5	7	20
61	5	5	28	40	23	7	8	30	39	15	8	1	0	3	2	1
62	4	3	16	21	9	9	9	16	55	18	1	1	7	3	6	4
63	1	5	9	19	9	7	10	7	23	11	2	1	0	0	1	1
64	0	8	8	18	10	6	3	16	12	8	0	0	1	1	2	72
65	0	1	14	11	9	1	3	9	11	7	0	0	1	1	3	0
66	1	1	6	10	1	0	2	3	11	3	0	0	0	1	1	0
67	0	1	5	8	1	0	2	3	6	1	0	0	0	0	0	0
68	0	2	4	7	3	0	0	4	7	0	0	0	0	0	0	0
69	1	0	1	6	2	0	1	1	2	2	0	0	0	0	0	0
70	0	0	2	4	0	0	0	1	2	0	0	0	0	1	1	0
71	1	0	1	5	0	0	0	1	1	0	0	0	0	0	0	0
72	0	0	1	5	0	0	0	0	0	0	0	0	0	0	1	0
73	0	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0
74	0	0	0	4	0	0	0	0	1	0	0	1	0	0	1	0
75	0	0	1	4	0	0	0	0	0	1	0	0	0	2	5	0
Total	**305060**	**309877**	**400500**	**469879**	**267624**	**253896**	**245640**	**217590**	**193133**	**183978**	**223293**	**204145**	**248399**	**302052**	**283922**	**190103**
Weights	**5270**	**4923**	**5880**	**6627**	**4864**	**4517**	**4270**	**4290**	**4443**	**3229**	**3444**	**3735**	**4844**	**5863**	**5083**	**3264**

Table 11.7. Total number of burrows (10^6), densities/m² and CVs by spatial stratum and for the Bay of Biscay. Years 2016-2018 after including rough sea bottom (noted RO) contained in the outline of the Central Mud Bank (16 164 km² instead of 11 676 km² for the five sedimentary strata *sensu stricto*). Rough numbers of burrows with no correction by cumulative bias factor (equal to 1.24; WKNEP, 2016).

	2016 (196 stations)				*2017 (124 stations)*				*2018 (184 stations)*				
	nb/m²	total burrows	CV (%)	% burrows	nb/m²	total burrows	CV (%)	% burrows	nb/m²	total burrows	CV (%)	% burrows	% surf
	0.320	**5167.67**	**7.84**		**0.259**	**4181.95**	**9.87**			**4696.84**	**8.30**		
CB	0.258	654.41	19.84	12.66%	0.152	384.49	20.10	9.19%	0.259	656.93	19.56	13.99%	15.69%
CL	0.237	272.72	20.87	5.28%	0.262	302.03	14.76	7.22%	0.517	595.61	23.64	12.68%	7.13%
LI	0.283	1319.12	13.86	25.53%	0.210	978.48	14.75	23.40%	0.228	1064.10	13.27	22.66%	28.85%
VS	0.839	531.18	17.92	10.28%	1.147	726.44	27.94	17.37%	0.841	532.43	23.30	11.34%	3.92%
VV	0.642	1728.09	14.52	33.44%	0.425	1142.76	19.82	27.33%	0.492	1323.75	17.30	28.18%	16.65%
RO	0.148	662.15	29.61	12.81%	0.144	647.75	34.23	15.49%	0.117	524.02	31.79	11.16%	27.76%

Table 11.8. Estimation of the abundance of *Nephrops* burrows (10^6) by UWTV. Example of years 2014 and 2015 (rough numbers of burrows with no correction by cumulative bias factor equal to 1.24; WKNEP, 2016).

Year	2014		2015	
Number of data	204	204	114	114
Method of estimate for average (A=arithmetic; KO=ordinary kriging)	A	KO	A	KO
Estimation	0.415930	0.425463	0.410321	0.414796
CV geo	0.052829	0.046598	0.180002	0.183475
CV iid	0.072647	-	0.082643	-
Surface (km²)	11 676	11 676	11 676	11 676
Abundance (Estimation * Surface)	4 856	4 968	4 791	4 843

Table 11.9. Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b). Effort and LPUE values of commercial fleets. Sub-area VIII a,b

	Le Guilvinec District Quarter 2		
Year	Landings(t)	Effort(100h)	LPUE(Kg/h)
1987	603	437	13.81
1988	777	471	16.52
1989	862	664	12.99
1990	801	708	11.31
1991	717	728	9.84
1992	841	757	11.12
1993	805	735	10.96
1994	690	671	10.30
1995	609	627	9.72
1996	715	598	11.97
1997	638	539	11.83
1998	622	489	12.72
1999	505	423	11.93
2000	438	405	10.82
2001	697	417	16.71
2002	527	371	14.20
2003	487	356	13.68
2004	410	321	12.74
2005	455	336	13.57
2006	414	306	13.50
2007	401	291	13.76
2008	410	271	15.15
2009	384	279	13.78
2010	471	253	18.61
2011	422	279	15.13
2012	348	229	15.17
2013	288	224	12.83
2014	252	198	12.73
2015	451	231	19.52
2016	475	241	19.74
2017	520	238	21.88
2018	374	220	16.98

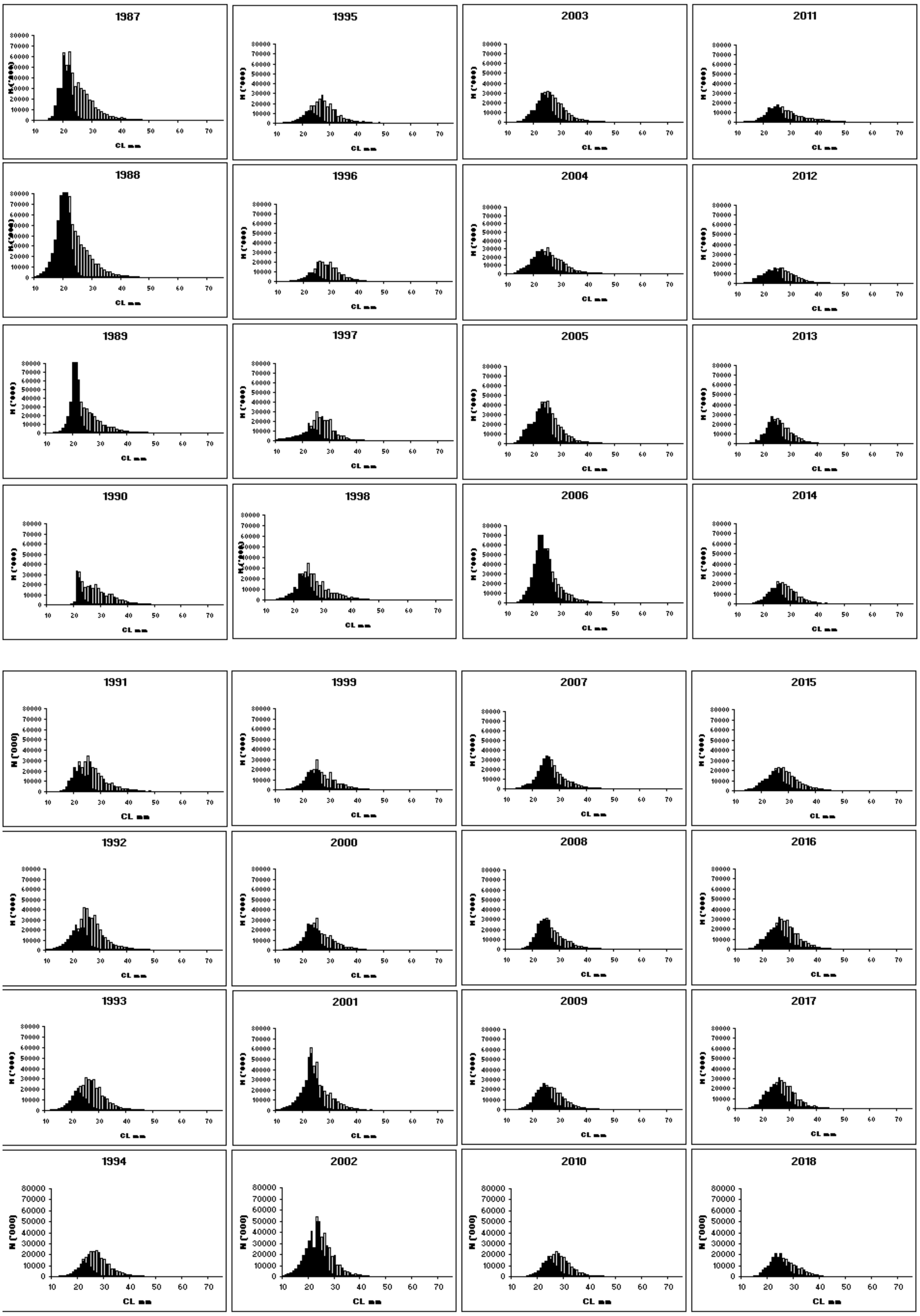
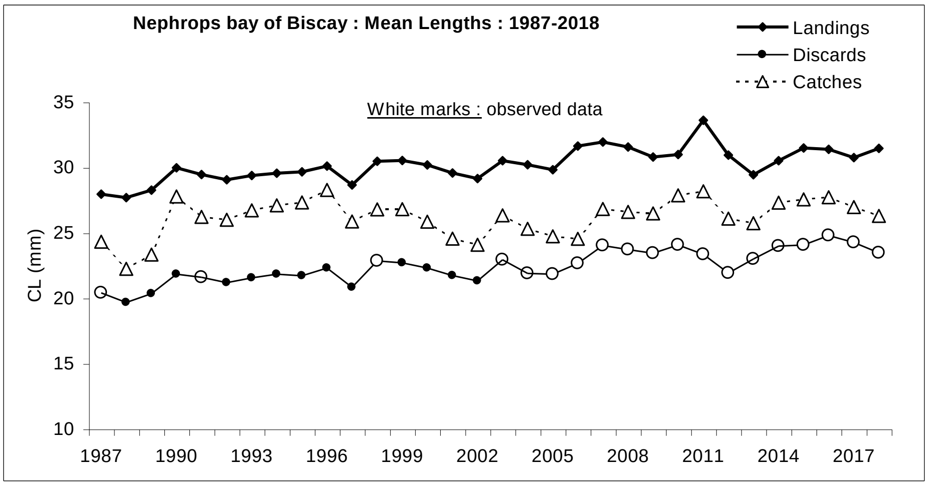
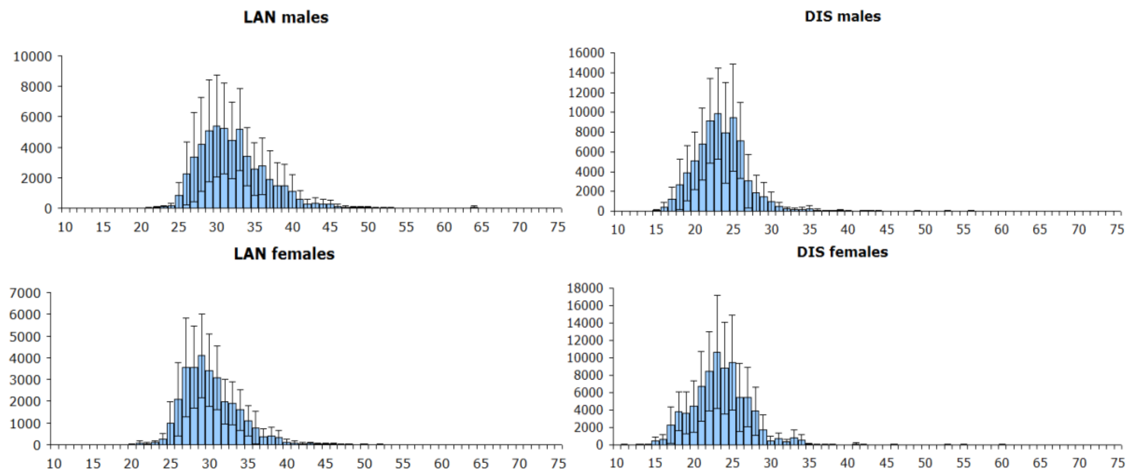


Figure 11.1. *Nephrops* in FU23-24 Bay of Biscay (8.ab) catches (landings in white, discards in dark). Years 1987-2018.

Figure 11.2. Nephrops in FUs 23-24 bay of Biscay (VIIIa,b) - mean length of landings, discards and catches





CV (%) by year and sex			
		males	females
2014	LAN	13.4	19.0
	DIS	28.4	35.0
2015	LAN	10.8	14.3
	DIS	15.9	15.9
2016	LAN	13.5	13.9
	DIS	25.2	25.0
2017	LAN	18.8	24.2
	DIS	25.5	19.4
2018	LAN	12.9	15.0
	DIS	19.8	20.3

Figure 11.3. *Nephrops* in FU23-24 Bay of Biscay (8.ab). LFDs and confidence intervals for landings and discards 2018 by sex.

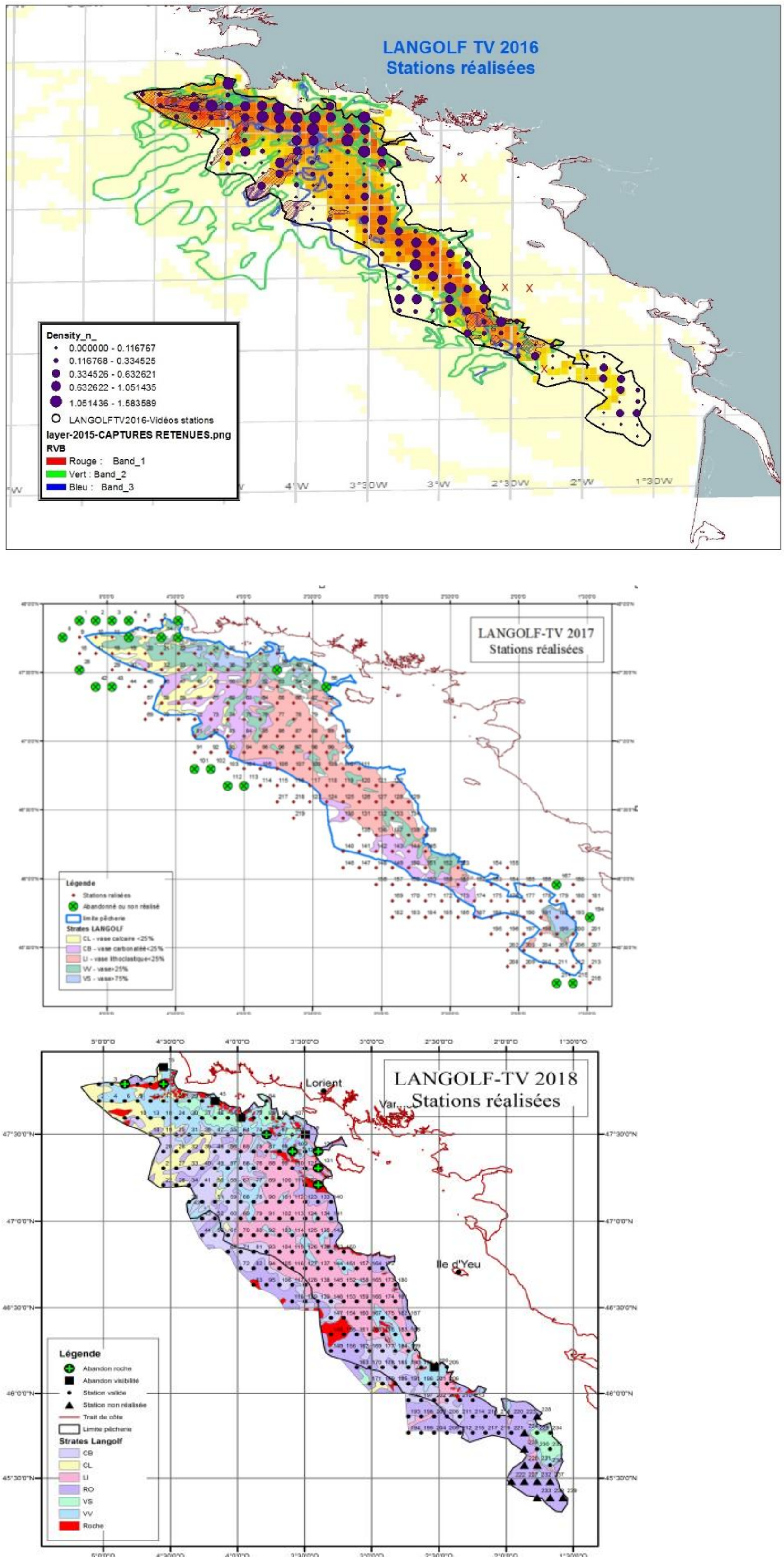


Figure 11.4. Above: systematic grid of the 2016's UWTV survey combined with VMS data (rectangles of 3 min*3 min; source: National Fisheries Direction; compilation: SIH Ifremer). Below: UWTV stations on a systematic grid for the 2017's (left) and 2018's (right) surveys.

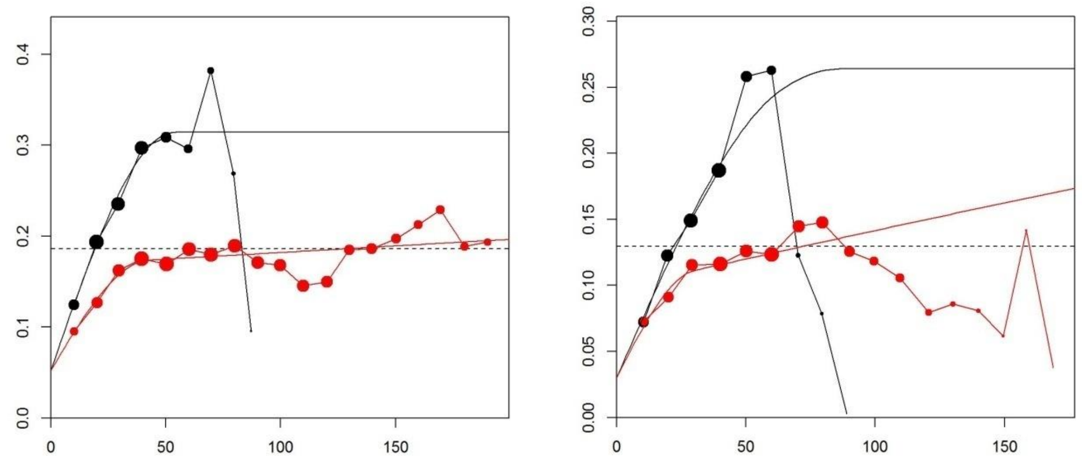


Figure 11.5. Experimental variograms (circles proportional to the number of pairs) and models (continuous curves) for the main anisotropic directions (red: NW->SE, black: SW->NE).

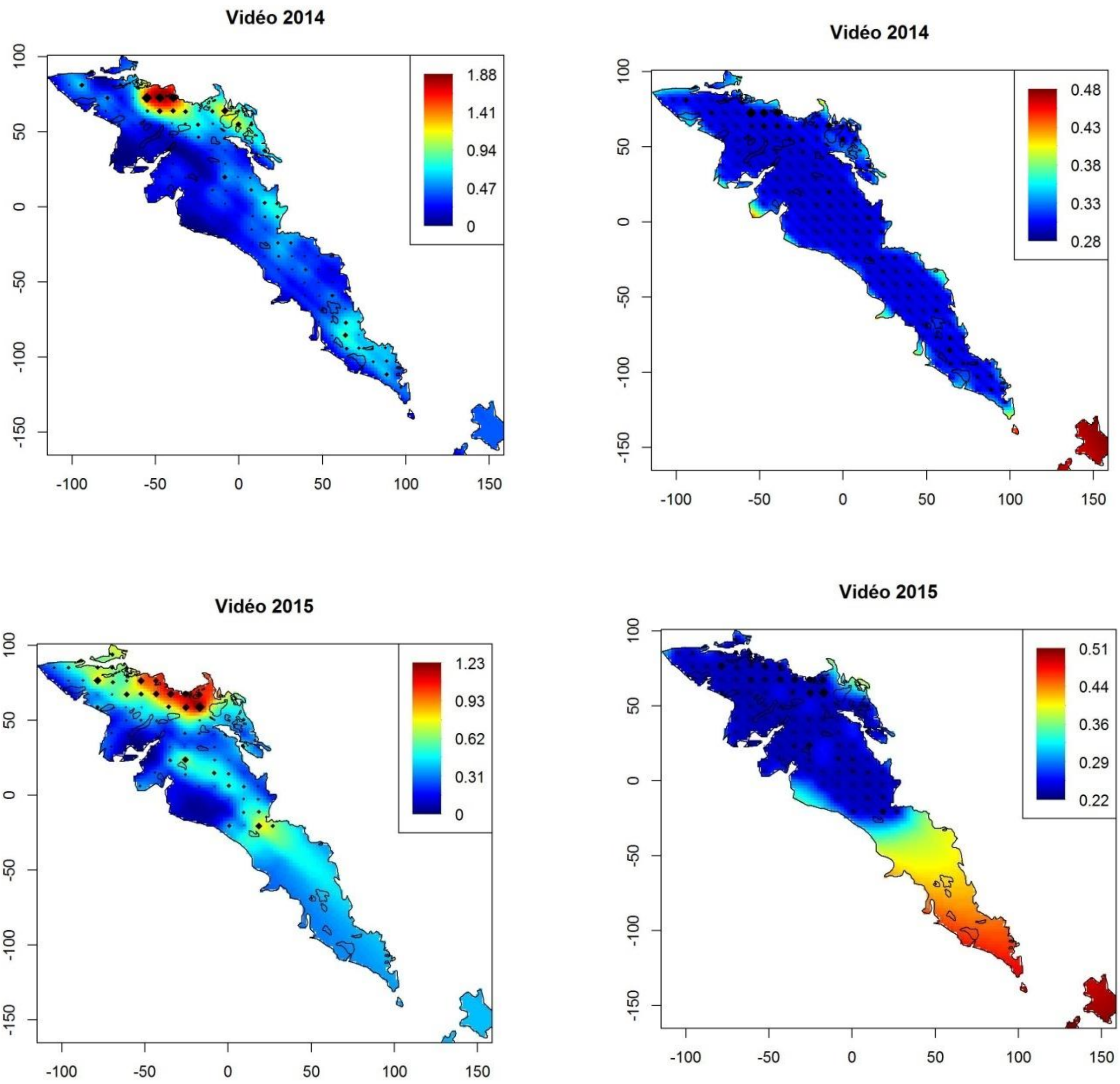


Figure 11.6. Years 2014 and 2015. Estimation of the burrows densities /m² using ordinary kriging (left column) error of kriging (right column).

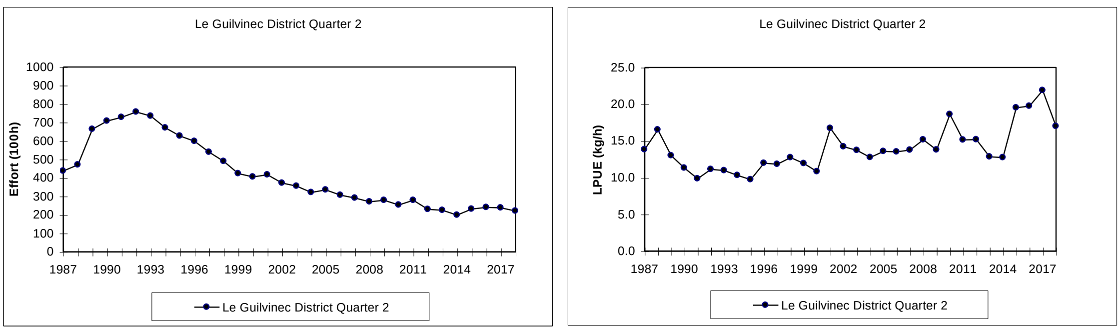


Figure 11.7. *Nephrops* in FUs 23-24 Bay of Biscay (8.a,b). Effort and LPUE values for standardised commercial fleets.

12 *Nephrops* in Division 8c

The ICES Division 8c includes two *Nephrops* Functional Units: FU 25, North Galicia, and FU 31, Cantabrian Sea. FU 25 provides the 63% of the Spanish *Nephrops* landings from 8c, FU 31 the 25% and other rectangles of 8c the 12% (logbooks 2003-2016) (Figure 12.1).

12.1 FU 25 (North Galicia) *Nephrops*

12.1.1 General

Till the date, the status of the FU 25 *Nephrops* stock was considered undesirable (ICES, 2016a) with extremely low biomass and zero catch advice (ICES, 2017).

12.1.1.1 Ecosystem aspects

See Stock annex in Annex K.

12.1.1.2 Fishery description

See Stock annex in Annex K.

12.1.1.3 Summary of ICES Advice for 2019 and management applicable to 2018 and 2019

ICES advice for 2019

The advice for this *Nephrops* stock is triennial and valid for 2017, 2018 and 2019.

ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2017, 2018, and 2019.

To protect the stock in these functional units, ICES advises that management should be implemented at the functional unit level.

Management applicable to 2018 and 2019

A recovery plan for 8c and 9a hake and *Nephrops* stocks (except FU 30, Gulf of Cádiz) has been in force since the end of January 2006 (Council Regulation (EC) No. 2166/2005) to March 2019 (Regulation EU 2019/472). This plan is based on precautionary reference points for 8c and 9a hake that are no longer appropriate.

A new Spanish regulation in 2011 established an Individual Transferable Quota system (ITQs) including *Nephrops* (ARM/3158/2011).

A zero TAC was set for *Nephrops* in the whole of Division 8c for 2017, 2018 and 2019.

Special quotas of 4.3 t in 2017, 2 t in 2018 and 2 t in 2019 were established for *Nephrops* in FU 25 in order to carry out an observers' programme supervised by the Spanish Oceanographic Institute (IEO) for obtaining a commercial *Nephrops* abundance index (Sentinel Fishery).

12.1.2 Data

12.1.2.1 Commercial catches and discards

Spanish landings are based on sales notes which are compiled and standardized by IEO. Since 2003, trips from sales notes are also combined with their respective logbooks, which allow georeferencing the catches. Data are available by statistical rectangle since 2003 and by metier since 2008 (EC, 2008).

The Spanish concurrent sampling is used to raise the FU 25 observed landings to total effort by metier since 2012. When the estimated landings exceed the official landings, the difference is provided to InterCatch as non-reported landings.

Landings were reported only by Spain. France had a small quota. The time series of the commercial landings (Table 12.1.1 and Figure 12.1.1) shows a clear declining trend. Since the early 90s landings declined from about 400 t to less than 100 t in 2003. In the period 2004–2014, landings show a continuous decreasing trend up to 9 t in 2014. Landings increase up to 14 t in 2015. In 2016, total landings estimated by the WG were 77 t representing an increase of more than five times the landings in previous year. This estimate is considered the best information available at this time. 88% of *Nephrops* landings of FU 25 comes from the statistical rectangle 16E1, 10% from 15E0 and 2% from 15E1 (logbooks 2003-2016).

In 2017 and 2018 *Nephrops* fishery was closed, but 2 t of *Nephrops* landings were obtained each year in the observer's programme Caracas Sentinel Survey 2017 and 2018. Details on the 2017 and 2018 surveys were documented in working documents presented to this WG in 2018 (WD Nº 10, Vila *et al*., 2018) and 2019 (WD Nº 02, González Herraiz *et al*., 2019).

Information on discards was sent to the WG through InterCatch. *Nephrops* discards are negligible in this fishery (estimates for 1994, 1997 and 1999 ranged from 0.4 to 2.4% of the catches by weight). In 2018, there were 179 kg of discards.

VMS information

2009-2018 VMS data of trawl fleet in FU 25 (baca OTB_DEF≥55, jurelera OTB_MPD≥55 and pair trawlers PTB_MPD≥55) provided some information about the spatial distribution of *Nephrops* landings in the FU when the *Nephrops* fishery was open (Figure 12.1.2, 2009-2016) and, after closure, when *Nephrops* was only caught in the restricted *Nephrops* sentinel fisheries in FU 25 (Figure 12.1.2, 2017-2018). VMS pings were allocated to logbooks by vessel, fishing day and statistical rectangle. 22% of VMS pings could not be identified in logbooks. 27% of 2009-2011 VMS pings reveal *Nephrops* presence.

The evolution of the spatial distribution of *Nephrops* landings in the FU while the fishery was open could suggest some contraction of the stock (Figure 12.1.2, 2009-2016).

Nephrops is a by-catch in the bottom trawl mix fishery directed at demersal fish. Fig. 12.1.2 maps reveal that the trawl fleet operates regularly in all the FU 25. Therefore, in the period when *Nephrops* fishery is closed, it would be possible to see the evolution of *Nephrops* catches from discard data recorded in logbooks, as already happens in FU 31 in 2018.

On the other hand, 2017 and 2018 maps show that the area covered by the *Nephrops* sentinel fishery within FU 25 is very small. This is a zone with high presence of *Nephrops* in the whole period (Figure 12.1.2, 2009-2016). Other areas of the FU with low or no presence of *Nephrops* in the last years of the fishery opened (Figure 12.1.2, 2009-2016) were not explored in the Sentinel fishery (Figure 12.1.2, 2017-2018).

12.1.2.2 Biological sampling

Length frequencies by sex of *Nephrops* landings were collected by the biological sampling programme. The sampling levels are showed in Table 1.4a.

Annual length compositions for males and females combined, mean size and mean weight in the landings in the time series are given in Tables 12.1.2a and 12.1.2b for the period 1982–2000 and 2001–2018, respectively. Length frequency distributions for the time series are also presented in two figures (Figure 12.1.3a for the period 1982–1999, Figure 12.1.3b for the period 2000–2016 and Figure 12.1.3c for 2017 and 2018).

Mean sizes in the landings show an increasing trend in the time series in both sexes. The maximum value was recorded in 2009. There were low mean sizes in 1983-1986, 1991 and 2013 that could suggest a recruitment failure from 1991 to 2013 (Figure 12.1.1). Mean carapace length in males was 42.1 mm CL while 40.3 mm CL for females in *Nephrops* sentinel survey 2018.

Low quantities of males in a *Nephrops* stock could be related with a high fishing pressure since ovigerous females are most of the year protected in the burrows (Fariña, 1996). In the worst cases low quantities of males could affect mating (ICES, 2013) and consequently recruitment in subsequent years. The percentage of males in landings in FU 25 since 1981 to 2010 fluctuates around 60% with the lowest values in 1987 and 1990 (Fig. 12.1.4).

12.1.2.3 Commercial catch-effort data

Fishing effort and lpue data were available for the bottom trawl fleet that sells in the harbour of A Coruña (SP-CORUTR8c) from 1975 (Table 12.1.3 and Figure 12.1.1). The method to estimate the effort has changed since 2009. Before this date the effort series (SP-CORUTR8c) was estimated using different fleet segments. Since the implementation of the current DCF sampling program (EC, 2008), the Northwestern Spanish OTB fleet was split into two different *metiers*: OTB_DEF_>55_0_0 ("baca", trips targeting demersal fish including *Nephrops*) and OTB_MPD_>55_0_0 ("jurelera", trips targeting pelagic and demersal fish). In 2015 it was presented a revision of the 2009–2014 effort and lpue series in FU 25 using only the demersal *métier* OTB_DEF_>55_0_0, renamed SP-LCGOTBDEF (Castro & Morlan, 2015). As a consequence, the method used to calculate the lpue is not consistent across the period as shown in Figure 12.1.1.

The available A Coruña time series of effort (Figure 12.1.1) shows a continuous decreasing trend up to 2011. The lowest effort was observed in that year, representing approximately 15% of fishing effort in the 70's. Effort increased from 2012 to 2014 but the overall trend since 2014 onwards is decreasing. SP-LCGOTBDEF effort was 1154 trips in 2018. In general, effort remained at very low level in the last decade. Effort of the bottom trawl in this fishery is primarily directed at a set of demersal species, with *Nephrops* making only a small contribution to the whole landings.

The overall trend of A Coruña LPUE is also declining (Figure 12.1.1). Since 1992 A Coruña LPUE had cycles of ten years, as in FU 16 catches since 1985 (ICES, 2018b). From 1975 to 1992, LPUE fluctuated around 70 kg/trip. Since 1992 LPUE sharply decreased until 6.6 kg/trip in 2016. In 2017 and 2018 the fishery was closed. In trips catching *Nephrops*, the CPUE (in kg/haul and in kg/hour) in rectangle 15E0 used to be half of the CPUE in rectangles 15E1 and 16E1 (logbooks 2006–2016).

In Portugal, CPUE in species with affinity for temperate waters (in opposition to tropical waters) decreased from 1992 to 2009, especially in long living species as *Nephrops* (Teixeira *et al*., 2014). CPUE time series of "temperate" species are directly correlated with rain and inversely with temperature (Teixeira *et al*., 2014). Similar processes could have affected FU 25 *Nephrops* from 1992 to 2009.

Figures 12.1.5 and 12.1.6 show two periods in FU 25 *Nephrops* CPUE (kg/haul) time series and spatial distribution from Spanish "Demersales" trawl survey (SP-NSGFS) (1983-2018): a first period with high abundances before 1996 and the other with low abundance since then. Moreover, Fig. 12.1.6 could indicate a very small increase in CPUE in the statistical rectangles 16E1 (inside FU 25) and 17E1 (outside FU 25) since 2008. This is a bottom trawl survey carried out in September to estimate hake recruitment and to collect information on the relative abundance of demersal species.

Although the fishery is closed in the period 2017-2019, FU 25 *Nephrops* general evolution could be followed through the Spanish "Demersales" trawl survey (SP-NSGFS) information and discards data registered in logbooks combined with VMSs.

In 2017, fishing industry presented CPUE information for this stock in 2015 and 2016 at WGBIE (Fernández *et al*., 2017) based on catches and effort data obtained from two trawl vessels based in the A Coruña port (Table 12.1.4).

An observers' program (CARACAS sentinel survey) was authorized in August and September in 2017 and 2018 in order to obtain a commercial *Nephrops* abundance index (see WD Nº 10, Vila *et al*., 2018, in 2018 WGBIE report, and WD Nº 02, González Herraiz *et al*., 2019, in this report). Table 12.1.5 shows the *Nephrops* abundance index (CPUE) estimated in 2017 and 2018 from this survey. *Nephrops* catch in 2018 Sentinel fishery was 2 t (2t of landings and zero discards). In order to introduce 2018 Sentinel *Nephrops* catch in InterCatch, a métier identification was made through a multivariate analysis (CLARA algorithm) of the catch profile by trip. So 1.5 t (75% of the 2018 Sentinel *Nephrops* catches) were allocated to the métier "baca" (OTB_DEF≥55) and 0.5 t (25%) to the métier "jurelera" (OTB_MPD≥55). This CPUE time series is still very short to identify trends in the abundance of *Nephrops*. It is also not clear if this information is representative of the whole FU 25 and its possible use in the future, since the sentinel fishery is carried out in a very small zone of FU 25 and *Nephrops* seemed to be almost absent in the rest of the FU (Figure 12.1.2).

12.1.3 Assessment

According to the ICES data-limited approach, this stock is considered as category 3.1.4, stock with extremely low biomass and zero catch advice (ICES, 2017). FU 25 is assessed by the analysis of the LPUE series trend (category 3 stock, ICES, 2017). Spanish "Demersales" trawl survey (SP-NSGFS) information, VMS data, landings proportion of males time series and mean length time series were also looked at. The perception of this stock has not changed and it continues showing an extremely low abundance level.

12.1.4 Biological reference points

Proxies of MSY reference points were defined using the methods developed in WKLIFE V and WKProxy 2015 (ICES, 2015, 2016b). $F_{0.1}$, taken as proxy of F_{MSY}, from length–based analysis for the period 1982–2014 was 0.17 for sexes combined stock (ICES, 2016b). MSY $B_{trigger}$ proxy is not available.

12.1.5 Stakeholders information

The fishing industry presented a working document to WGBIE 2017 with qualitative and quantitative information about *Nephrops*' fishery in FU25 (Fernández *et al*., 2017 in 2017 WGBIE report). The WG decided that the LPUE data provided could be examined as an abundance index of *Nephrops* in a future benchmark as long as the time series is continued and extended historically. Information on how these data were collected (*e.g.* area, season) was not provided.

12.1.6 Management Considerations

Nephrops is taken as by catch in the mixed bottom trawl fishery. In FU 25, 90% of the Spanish landings of *Nephrops* comes from the métier baca (OTB_DEF≥55), 10% from jurelera (OTB_MPD≥55) and 1% from pair trawlers (PTB_MPD≥55) (2008-2016).

The overall trend in landings of *Nephrops* from the North Galicia (FU25) is strongly declining. Landings have dramatically decreased since the beginning of the series (1975–2016), representing in 2016 11% of the 1975 landings. In 2017 and 2018, the *Nephrops* fishery was closed.

A recovery plan for 8c and 9a hake and *Nephrops* (except FU 30) stocks was implemented since 2006 (Council Regulation (EC) No 2166/2005) until March 2019 (EC, 2019), when this plan was repealed. The management objective was to rebuild the stock to safe biological limits within a period of 10 years. This recovery plan included a procedure for setting the TACs for *Nephrops* stocks, complemented by a system of fishing effort limitation. A Fishing Plan for the Northwest Cantabrian ground was established in 2011 (ARM/3158/2011). This new regulation established an Individual Transferable Quota system (ITQs) (including *Nephrops*).

An observer's programme in FU 25 supervised by the Spanish Oceanographic Institute (IEO) to obtain a commercial *Nephrops* abundance index (sentinel) was carried out in 2017. To do this, a special quota for *Nephrops* in FU 25 was authorized by EU.

Spain requested again a sentinel fishery for *Nephrops* in FU 25 for 2018. An ICES Special Request Advice about the characteristics of sentinel fishery in *Nephrops* FU 25 for 2018 was delivered in February 2018 (2018 WGBIE Annex 9). ICES advised that, if an UWTV survey cannot be conducted, collecting of sentinel fishery CPUE data would require ten trips and no more than 1.7 t (ICES, 2018). The observers' programme was repeated in 2018 (see WD Nº 02, González Herraiz *et al*., 2019, in this report). The quota for 2019 sentinel was also authorized.

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12.1.8 Tables and Figures

Table 12.1.1. *Nephrops* FU25, North Galicia. Landings and discards in tonnes.

Year	Landings		Discards	Catch
	Trawl	Non-reported		
1975	731			731
1976	559			559
1977	667			667
1978	690			690
1979	475			475
1980	412			412
1981	318			318
1982	431			431
1983	433			433
1984	515			515
1985	477			477
1986	364			364
1987	412			412
1988	445			445
1989	376			376
1990	285			285
1991	453			453
1992	428			428
1993	274			274
1994	245			245
1995	273			273
1996	209			209
1997	219			219
1998	103			103
1999	124			124
2000	81			81
2001	147			147
2002	143			143
2003	89			89
2004	75			75
2005	63			63
2006	62			62
2007	67			67
2008	39			39
2009	21			21
2010	34			34
2011	44			44
2012	10	11		21
2013	11	0		11
2014	9	0		9
2015	14	0		14
2016	13	65		77
2017	2*	0		2*
2018	2*	0	0.2	2*

* *Nephrops* fishery was closed in 8c (FU 25 & FU 31) in 2017 and 2018, but there were *Nephrops* Sentinel Fisheries in FU 25.

Table 12.1.2a. *Nephrops* FU25, North Galicia. Length compositions of landings, mean weight (Kg) and mean length (CL, mm) for the period 1982–2000.

Carapace length (mm)	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
15																			
16																			
17																			
18																			
19	1	8			6							5							
20	1	17		16	1				2			34			1			0	
21	7	31	10							1		49	1	0	2				0
22	10	99	22	8	50	0						32	1	7	5	5		0	
23	41	143	20	68	68	6	4		5	15		15	10	6	6	7	1	1	0
24	53	350	150	198	136	38	1		8	20	13	80	10	19	29	16	2	5	2
25	105	496	163	300	192	191	16		30	71	19	57	60	64	38	18	6	15	7
26	142	511	372	326	279	185	42	1	30	203	26	70	118	77	56	53	12	26	9
27	275	748	564	575	299	467	17	2	59	359	102	71	179	108	91	49	16	21	5
28	303	731	746	799	495	302	208	23	186	1038	331	105	281	213	179	186	47	67	32
29	382	761	1092	943	500	365	175	21	174	850	280	134	262	189	225	178	38	91	24
30	648	1068	1422	1253	470	505	535	84	278	1426	563	176	335	424	266	441	92	194	85
31	611	1004	1205	1215	602	446	504	95	329	1047	584	152	330	370	342	303	65	136	60
32	782	1009	1720	1045	779	618	613	248	535	1319	883	308	410	444	404	492	99	197	127
33	874	956	1439	817	812	526	906	369	547	946	831	472	471	433	454	387	69	100	95
34	906	782	1298	975	886	741	719	406	448	981	1114	533	507	480	520	695	152	300	219
35	927	777	1122	797	764	820	745	625	555	883	976	670	564	707	396	543	193	258	218
36	991	756	1057	823	682	945	820	414	563	709	809	549	547	480	360	500	139	241	158
37	728	610	700	637	694	845	989	618	447	738	923	563	462	462	341	323	192	208	144
38	582	667	496	484	600	453	799	757	429	641	656	546	454	459	329	407	178	211	113
39	553	513	392	593	341	491	438	433	315	404	528	362	330	315	257	299	123	138	82
40	480	438	481	494	416	478	582	477	348	449	517	336	301	507	233	326	203	202	134
41	368	348	351	307	329	283	461	507	304	279	365	230	178	239	166	141	101	110	64
42	347	286	448	230	251	226	673	375	235	295	386	243	222	300	145	166	106	106	73
43	250	194	203	301	283	312	314	417	244	230	296	175	113	219	122	98	81	58	30
44	193	124	220	239	108	286	236	280	181	146	214	173	99	116	82	57	65	61	48
45	238	125	223	104	102	125	219	236	157	170	138	158	99	142	74	84	82	72	40
46	111	87	105	223	64	302	123	209	93	109	138	124	52	74	55	31	35	42	20
47	100	56	86	65	80	136	104	156	78	97	104	43	38	56	55	37	41	23	10
48	81	44	197	85	31	108	106	163	71	79	34	69	25	30	37	26	31	26	17
49	48	23	97	52	42	93	44	90	36	32	45	23	29	12	21	16	16	16	11
50	48	17	61	48	25	41	30	71	26	34	31	25	18	16	21	28	28	41	13
51	32	16	70	41	17	9	23	49	22	10	16	17	8	8	12	3	5	6	8
52	16	6	4	4	20	19	20	41	24	9	33	26	11	6	6	5	9	9	8
53	12	9	7	34	8	21	5	41	18	13	14	20	10	6	11	4	4	4	2
54	9	6	27	33	8	1	7	26	8	4	5	2	7	4	7	3	3	5	5
55	8	6	27	7	4	3	5	13	9	1	12	10	7	3	5	5	3	7	7
56	3	3	27	5	0	10	3	9	2	3	2	2	4	2	3	0	2	4	2
57	4	1		6	0	7	4	8	5	3	0		5	1	2	1	0	2	3
58	1	3	1	0	11	8		5	1	3	0	0	2	1	5	0	1	2	4
59	3	2		2	1		10	2	2	1	0	0	1	1	5	0	1	0	0
60	2	2	1	1	0	3	2	8	1	0	1		0	1	3	1	1	0	2
61	0	2		1	0			4	2				1	1	2	0	0		2
62	3	2		1	0			2		1	1		0	1	3	0	0	0	0
63	1	1		1		1		1	0	0	0		1	1	1	2	0		0
64	2	0		3	0	1	2	3	1				0	1	1	0	0		0
65	1	0		0	0	1	12	1	0	2	1		0	0	4				0
66	0	1		1	0			1	1					0	1	1	0		0
67	1	2		0					1	1			0	0	0	1	0		0
68	0	1		1			2	0	1				0	0	1	0	0		0
69	1	0		1			2	1	1				0		1		0		0
70	0	1		1				0	0	0					1	0	1		1
71	1	1		0			2		1	0						0	0		0
72	1	0				1		0				0			0	0	0		0
73	0	1		1					1				0		0				
74	0	1		0	0			1		0			0	0	1	1	0		0
75	0	1		1					0	0			1		1		0		0
76	1	1		0									0		1	0	0		
77	0	0		0		1			0				1	0	0		0		
78	0	2		1				1		0			0	0	0		0		
79	0	0		0									0		0				
80	1	0		0				0								0	0		0
81																			
82																			
83																			
84																			
Total number (thousand)	11289	13847	16626	14167	10457	10418	10521	7296	6815	13623	10992	6661	6567	7003	5388	5939	2243	3004	1888
Total weight (tonnes)	431	432	515	477	363	411	444	376	281	452	427	274	246	273	209	219	103	124	81
Mean weight (kg)	0.038	0.031	0.031	0.034	0.035	0.039	0.042	0.052	0.041	0.033	0.039	0.041	0.037	0.039	0.039	0.037	0.046	0.041	0.043
Mean length (CL, mm)	35.5	33.0	34.0	33.9	34.4	35.8	36.8	39.4	36.6	33.9	35.9	36.4	35.3	35.8	35.5	35.3	37.8	36.5	36.9

Table 12.1.2b. *Nephrops* FU25, North Galicia. Length compositions of landings, mean weight (Kg) and mean length (CL, mm) for the period 2001–2018. * *Nephrops* fishery in 8c (FU 25 & FU 31) closed in 2017 and 2018. Length distributions of those years come from *Nephrops* Sentinel fishery in FU 25.

Carapace length (mm)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*	2018*
15													7					
16																		
17																		
18																		
19									0	0								
20							0		0	0			0					
21		1	0		0		0		0	0			0	0				
22				1	1	0	1		0	0			9	0			0	
23	10	2	0	1	1	1	1		0	0								0
24		2	1	2	2	1	1	0	0	0					1		0	0
25	10	2	0	7	5	2	1	1	0	0			9	1	2		0	0
26	19	5	2	7	8	3	5	1		0			9	0	1		0	0
27	20	14	3	12	13	9	4	3	0	2	0		0	1	1	0	0	0
28	79	30	2	26	25	15	8	4		2	1	4	10	1	3	0	0	0
29	125	43	5	28	25	18	11	6	0	2	2	3	2	1	2	10	0	0
30	112	105	14	46	43	25	19	10	1	9	2	4	13	3	18	37	0	0
31	129	102	26	45	56	39	36	10	1	9	3	5	2	2	11	31	0	0
32	288	198	36	60	66	55	44	15	1	18	3	7	3	2	14	49	1	0
33	319	181	51	71	87	69	69	13	3	20	5	6	5	5	25	73	1	0
34	302	272	66	70	83	62	75	16	4	27	13	4	6	7	26	97	2	1
35	265	308	85	91	98	85	90	25	5	34	25	9	20	12	47	183	2	1
36	243	259	110	98	102	88	101	31	6	30	21	7	9	16	26	153	3	2
37	285	236	123	101	88	87	105	37	9	34	23	10	10	13	22	137	3	3
38	238	185	147	98	92	80	101	35	10	26	63	7	7	13	22	193	3	3
39	192	129	130	81	69	67	86	37	10	23	45	3	16	11	12	121	3	2
40	212	186	129	96	81	64	90	47	12	20	78	16	12	13	16	180	3	2
41	115	99	81	78	61	59	73	44	12	23	61	7	8	9	11	96	3	2
42	150	117	79	63	52	49	63	38	11	23	50	7	6	8	12	59	3	3
43	103	67	65	57	47	44	59	35	12	24	52	3	16	8	10	58	2	2
44	98	109	52	39	36	32	46	29	14	22	34	6	7	7	10	38	2	2
45	68	78	46	44	34	30	42	23	13	21	24	6	8	4	6	36	1	1
46	35	65	57	35	26	26	37	22	11	22	17	3	8	5	5	18	1	1
47	22	34	42	26	20	18	30	20	14	22	13	1	2	4	5	17	1	1
48	24	35	37	23	14	17	22	16	9	17	15	1	5	2	3	13	1	1
49	18	23	27	16	13	11	16	14	8	14	17	3	3	2	3	11	1	1
50	18	24	27	19	11	14	18	10	8	13	12	1	2	2	2	13	0	0
51	16	34	20	13	7	9	11	11	6	11	7	3	2	1	2	8	0	0
52	10	18	16	12	8	8	8	9	6	8	7	1	2	1	2	6	0	1
53	15	13	11	9	6	7	7	8	7	9	4	2	2	2	2	5	0	0
54	4	4	9	7	5	4	4	6	5	7	7	1	2	1	1	4	0	0
55	7	9	6	6	5	4	3	6	6	7	6	2	1	1	1	3	0	0
56	5	6	5	5	3	9	3	4	4	4	5	1	1	1	1	2	0	0
57	0	5	7	4	3	4	2	5	3	5	4	1	1	0	0	2	0	0
58	1	9	4	4	3	2	2	4	3	3	4	1	1	1	0	1	0	0
59	1	4	5	3	2	1	1	3	3	2	1	0	1	0	0	1	0	0
60	1	2	2	2	2	1	1	2	3	3	3	0	0	0	0	1	0	0
61		1	1	3	1	1	1	2	1	1	3	3		0		0	0	0
62	0	3	3	2	1	7	1	1	2	1	6	1	1	0	0	0	0	0
63	0	10	0	2	1	1	1	1	2	1	1	0		0	0	0	0	0
64	0	0	1	2	1	6	0	1	1	0	2	0	0	0	0	0	0	0
65	0	4	1	2	1	1	0	1	1	1	1	0		0		0	0	0
66	0	1	2	1	1	0	0	1	1	1	1	0	0	0	0	0		0
67		2	1	1	1	1	0	1	1	0	2	0		0			0	0
68		0	1	1	1	0	0	1	1	1	2	0		0	0	0	0	0
69		0	2	1	1	0	0	1	1	0	0	0	0	0		0	0	0
70		2	1	1	1	0	0	0	1	0	0	0		0		0	0	0
71		0	1	2	0	6	0	0	1	0		0		0		0		0
72	0	0	1	1	0	6	0	0	1	0	0	0		0				0
73		0	1	1	1	0	0	0	1	0	0	0		0				0
74	0	1	0	1	0	0	0		0	0	0	0						0
75	0	0	1	0	0	0	0		0			0		0		0	0	0
76		0	0	0	0	0	0	0	0			0				0		
77	0		0	0	0	0			0			0						0
78	0	0	0	0		0	0		0	0		0		0				0
79				0	0				0	0		0						
80		0		0	0	0		0	0			0						
81									0	0								
82									0									
83																		
84									0									
Total number (thousand)	3562	3043	1543	1425	1314	1147	1298	612	236	528	650	139	229	163	327	1657	~~44~~ 38	32
Total weight (tonnes)	147	143	89	75	63	62	67	39	21	34	44	21	11	9	14	77	2	2
Mean weight (kg)	0.041	0.047	0.058	0.052	0.048	0.054	0.051	0.064	0.091	0.065	0.068	0.152	0.048	0.056	0.043	0.046	0.054	0.061
Mean length (CL, mm)	36.5	37.8	40.6	39.0	37.9	39.6	40	42.2	46.9	42.2	42.6	40.0	41.0	39.9	37.2	38.2	40.1	41.5

Table 12.1.3. Nephrops FU 25: North Galicia. Fishing effort and LPUE from the fleet selling in A Coruña port

		Effort (trips)		LPUE (kg/trip)	
Year	Landings (t)	SP-CORUTR8c	SP-LCOTBDEF	SP-CORUTR8c	SP-LCOTBDEF
1986	302	5017		60.1	
1987	356	4266		83.5	
1988	371	5246		70.7	
1989	297	5753		51.7	
1990	199	5710		34.9	
1991	334	5135		65.1	
1992	351	5127		68.5	
1993	229	5829		39.2	
1994	207	5216		39.6	
1995	233	5538		42.0	
1996	182	4911		37.0	
1997	187	4850		38.5	
1998	67	4560		14.7	
1999	121	4023		30.1	
2000	77	3547		21.7	
2001	145	3239		44.8	
2002	115	2333		49.5	
2003	65	1804		35.9	
2004	40	2091		18.9	
2005	32	2063		15.5	
2006	33	1699		19.4	
2007	37	2075		17.8	
2008	21	2128		9.9	
2009	11		1355		8.3
2010	22		1164		18.6
2011	35		906		38.4
2012	10		1460		6.8
2013	8		1582		5.3
2014	8		1869		4.5
2015	13		1358		9.3
2016	11		1589		6.6
2017	2*		1152		0
2018	2*		883		0

* *Nephrops* fishery in 8c (FU 25 and FU 31) was closed in 2017 and 2018, but there were *Nephrops* Sentinel fisheries in FU 25.

Table 12.1.4. FU 25 *Nephrops* CPUE (kg/hour) estimated by the fishing industry with data of two fishing vessels (2015 and 2016).

Source	year	period	directed CPUE (kg/hour)	Non-directed cpue (kg/hour)
Fishing Industry (Fernández *et al*., 2007 in 2017 WGBIE report)	2015	Year	6.46	0.18
	2016	Year	10.81	0.27

Table 12.1.5. FU 25 *Nephrops* CPUE (kg/hour) from Sentinel Fisheries (2017-2018).

Source	Year	Period	Directed CPUE (kg/hour)	s.d.	Non-directed* CPUE (Kg/hour)	s.d.
CARACAS Observers on board Sentinel survey	2017	Aug-Sep	7.22	1.57	0.59	0.56
	2018	Aug-Sep	5.2	2.94	0.9	1.3

*To avoid the effect of daily variations in the catchability of *Nephrops*, which is a consequence of the changes in their behaviour, the hauls that were carried out in more than 50% of time between dusk and dawn were considered non-directed to *Nephrops*.

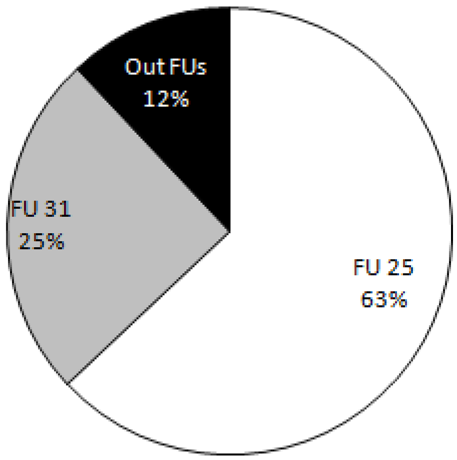

Figure 12.1. ICES Division 8c *Nephrops* landings by Functional Unit (FU) (2003-2016). 8c *Nephrops* fishery was closed in 2017 and 2018.

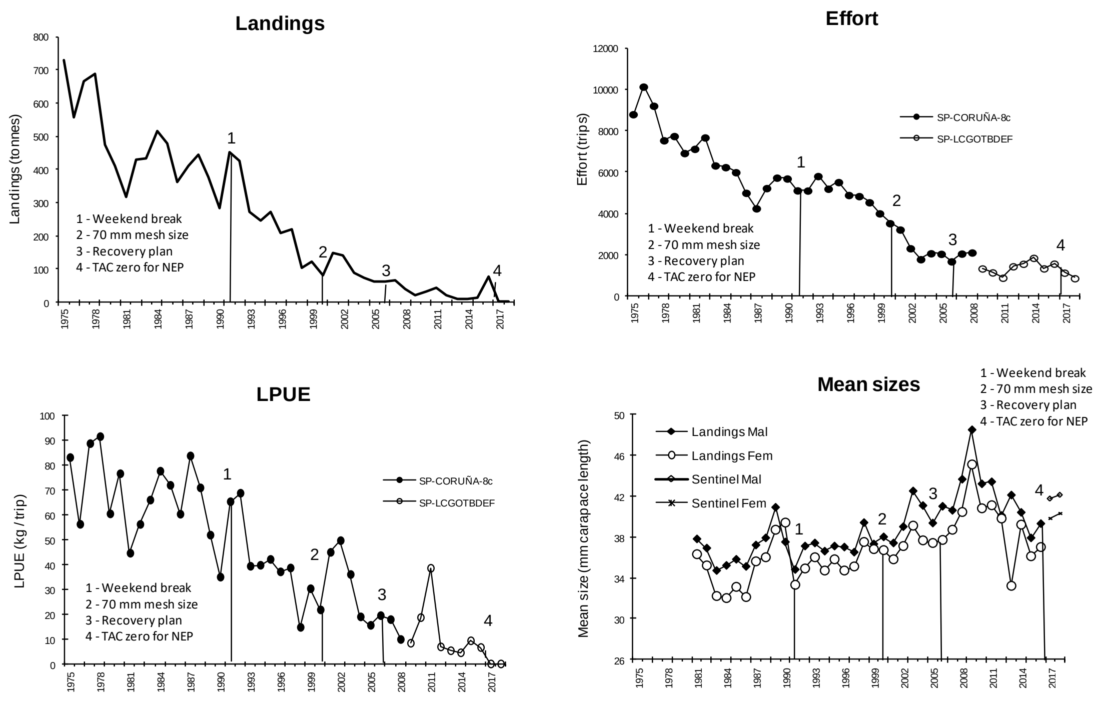

Figure 12.1.1. *Nephrops* FU25, North Galicia. Long-term trends in landings, effort, lpue and mean sizes. Effort and LPUE from the fleet selling in A Coruña port. 8c *Nephrops* fishery (FU 25 and 31) was closed in 2017 and 2018, mean sizes in those years from *Nephrops* Sentinel fisheries in FU 25.

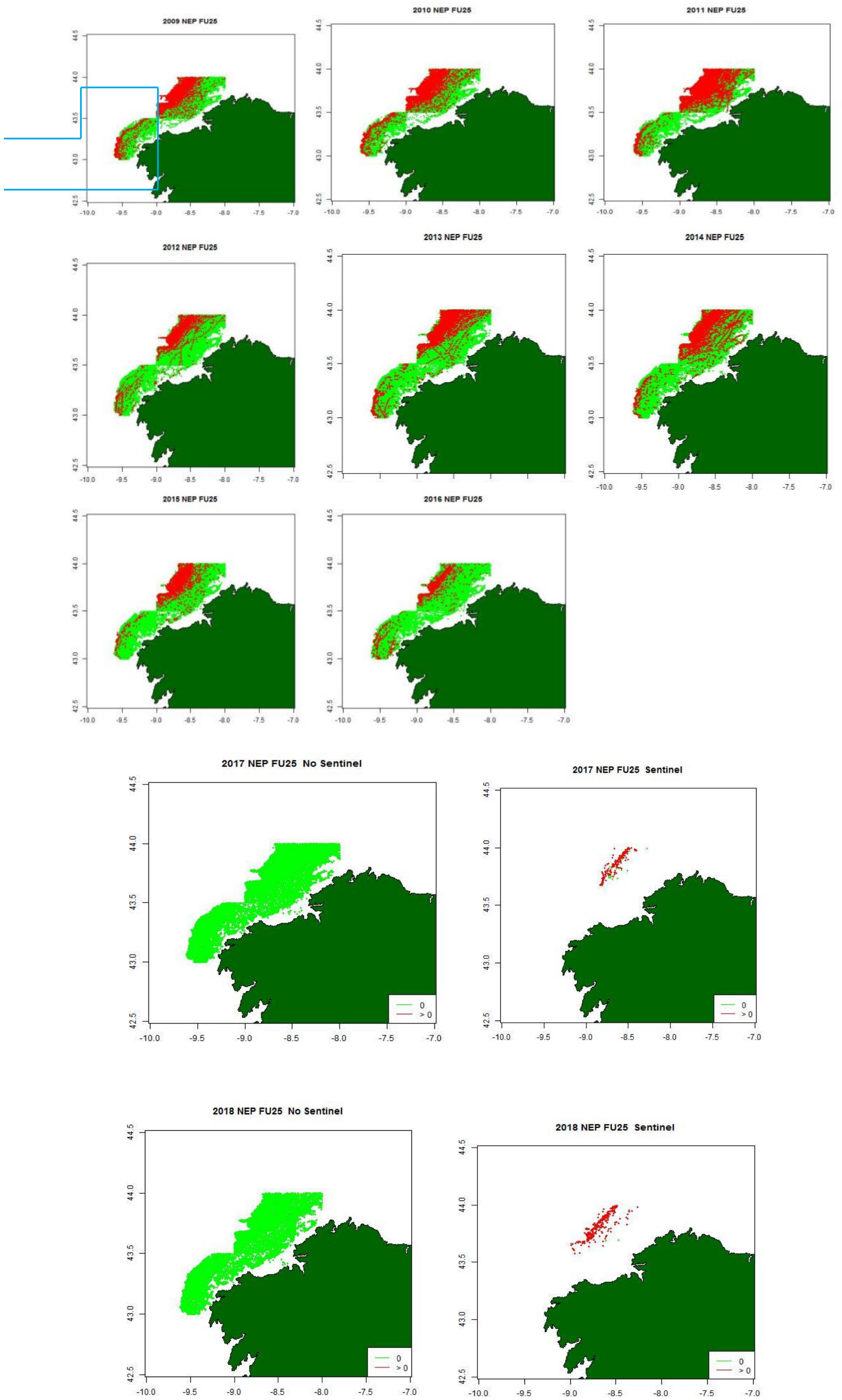

Figure 12.1.2. FU25 North Galicia *Nephrops*. Distribution of *Nephrops* LPUE (kg/fishing day). Metiers “baca” (OTB_DEF≥55), “jurelera” (OTB_MPD≥55) and pair trawlers (PTB_MPD≥55). Limits of the FU in blue in 2009 map. Red points: *Nephrops* LPUE > 0 kg/fd, green points: *Nephrops* LPUE = 0 kg/fd. *Nephrops* fishery in 8c (FU 25 and FU 31) was closed in 2017 and 2018; “No Sentinel”: ordinary trips. “Sentinel”: Sentinel trips.

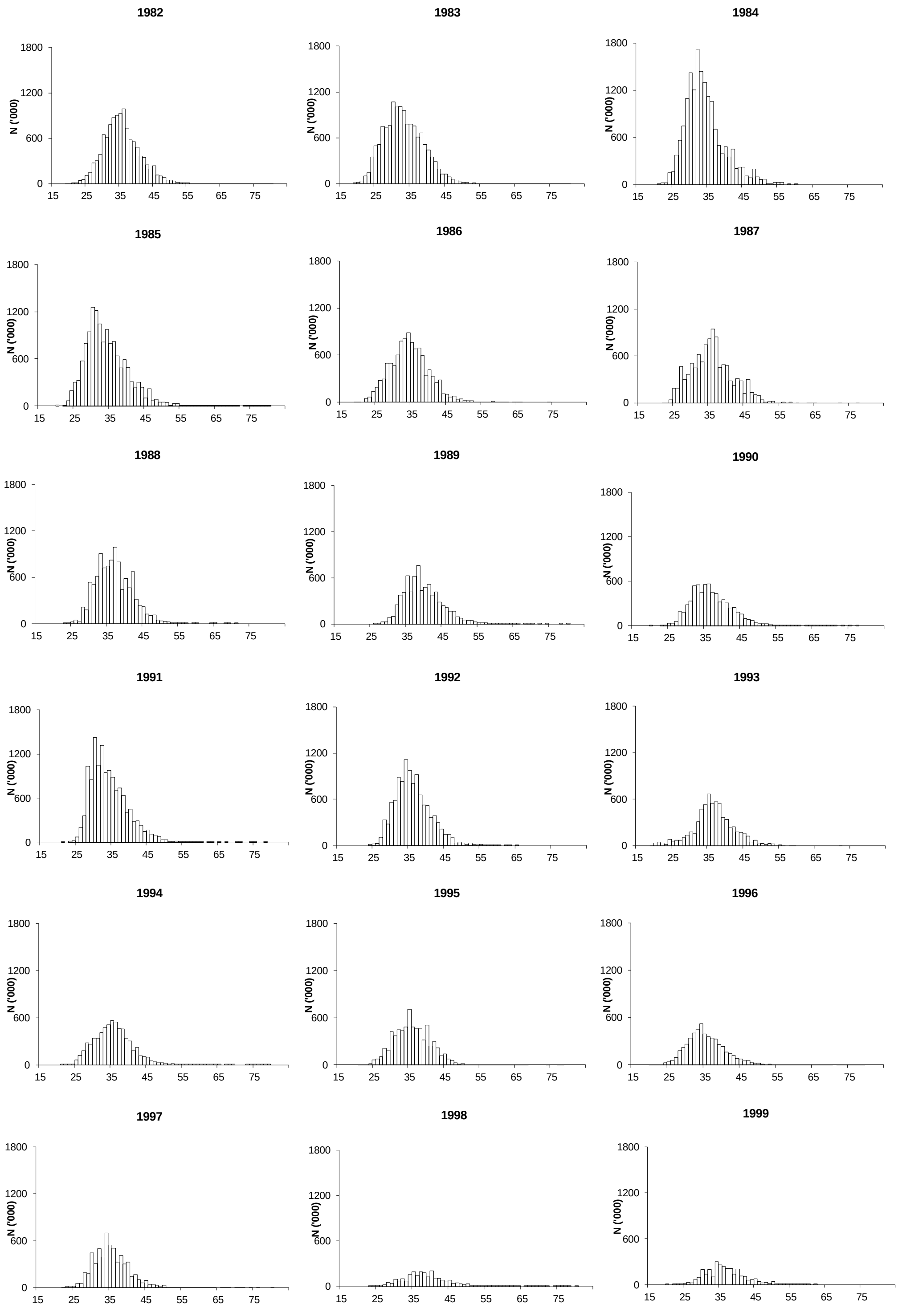

Figure 12.1.3a. *Nephrops* FU25, North Galicia. Length distributions in landings for 1982–1999. period. Maximum of Y-axis 1800 thousands. In X-axis Carapace length in mm.

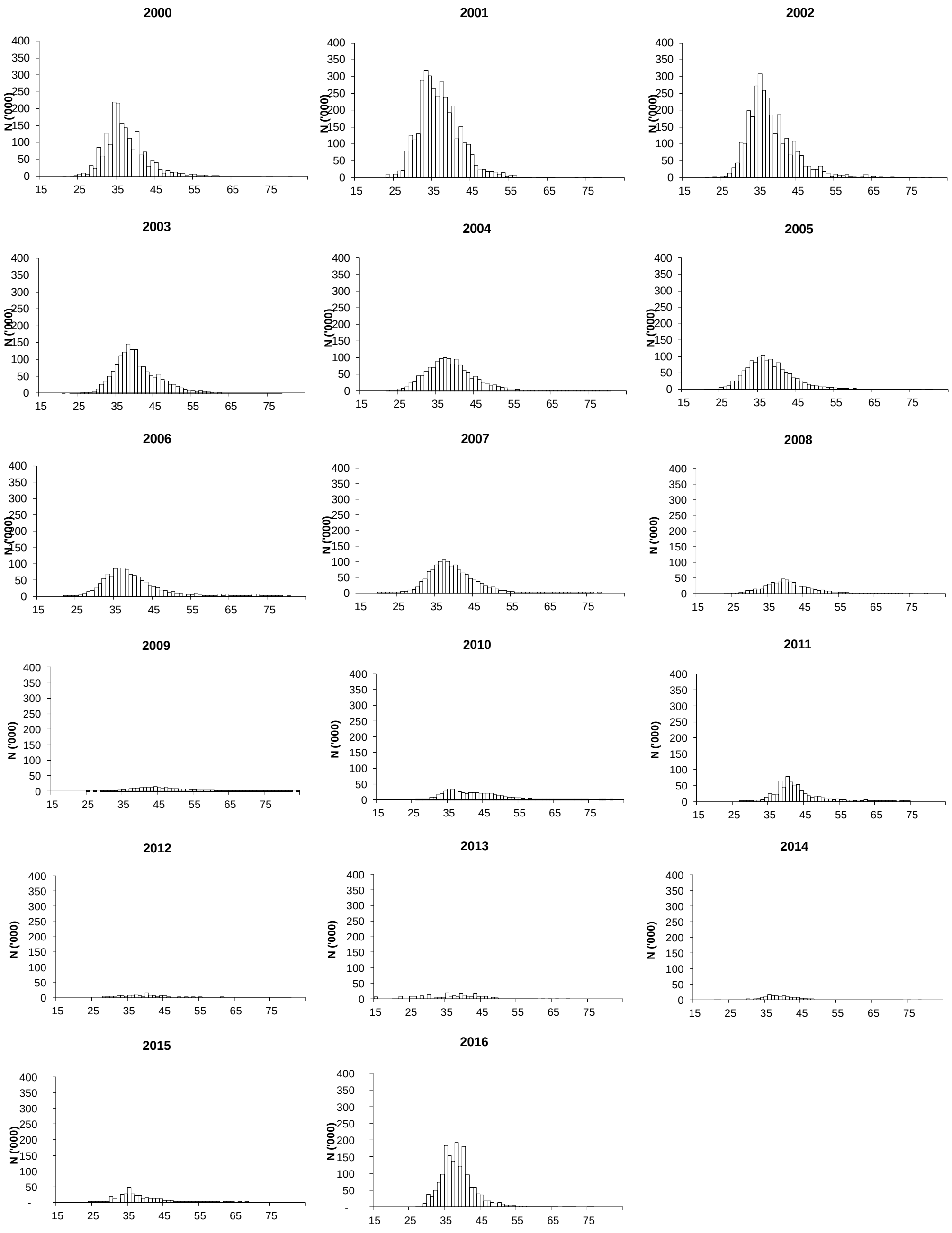

Figure 12.1.3b. *Nephrops* FU25, North Galicia. Length distributions in landings for the period 2000–2016. Maximum of Y-axis 400 thousands (2001-2016). In X-axis Carapace length in mm.

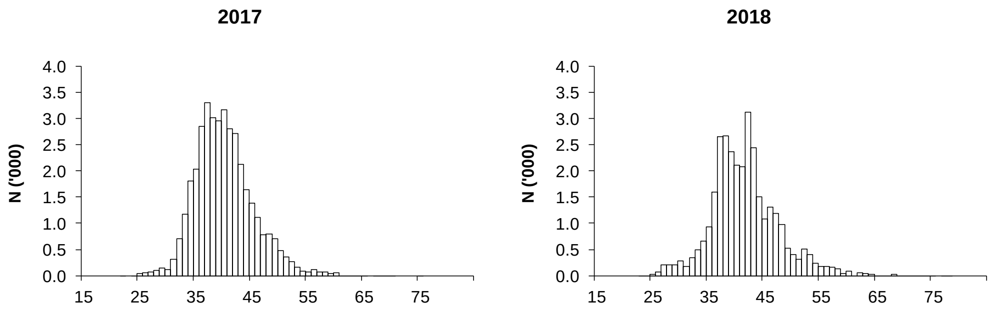

Figure 12.1.3c. *Nephrops* FU25, North Galicia. *Nephrops* fishery in 8c (FU 25 and FU 31) closed in 2017 and 2018. Length distributions in landings for those years from *Nephrops* Sentinel fishery in FU 25. Maximum of Y-axis 4 thousands. In X-axis Carapace length in mm. 7266 individuals were measured in 2017 and 8524 in 2018 (26% of the Sentinel *Nephrops* catch in 2018).

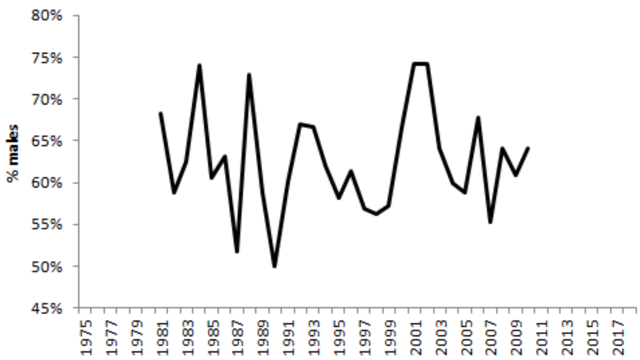

Figure 12.1.4. FU25 North Galicia *Nephrops*. Landings proportion of males (1981–2010).

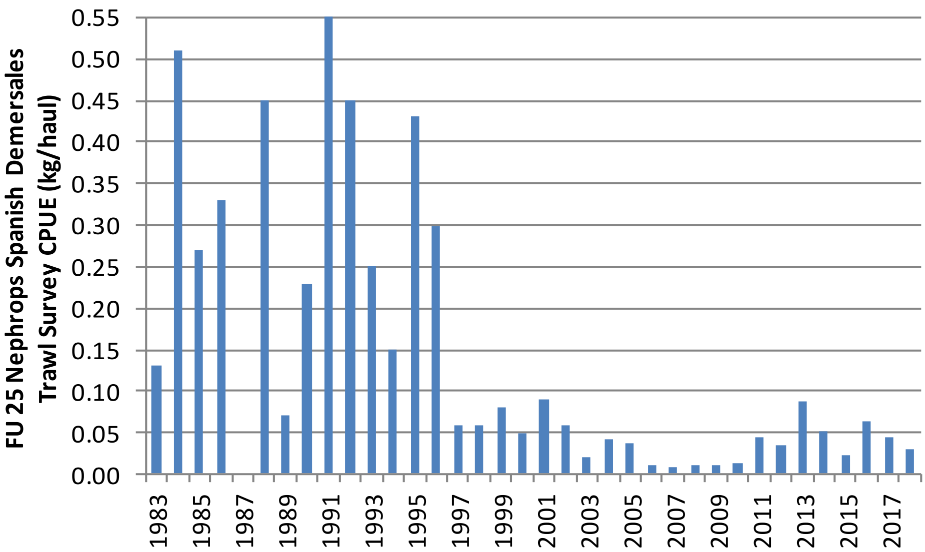

Figure 12.1.5. FU25 *Nephrops* CPUE (kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS) (1983-2018). No survey in 1987. Smaller gear in 1989. 1991 bar is not completely shown in the figure.

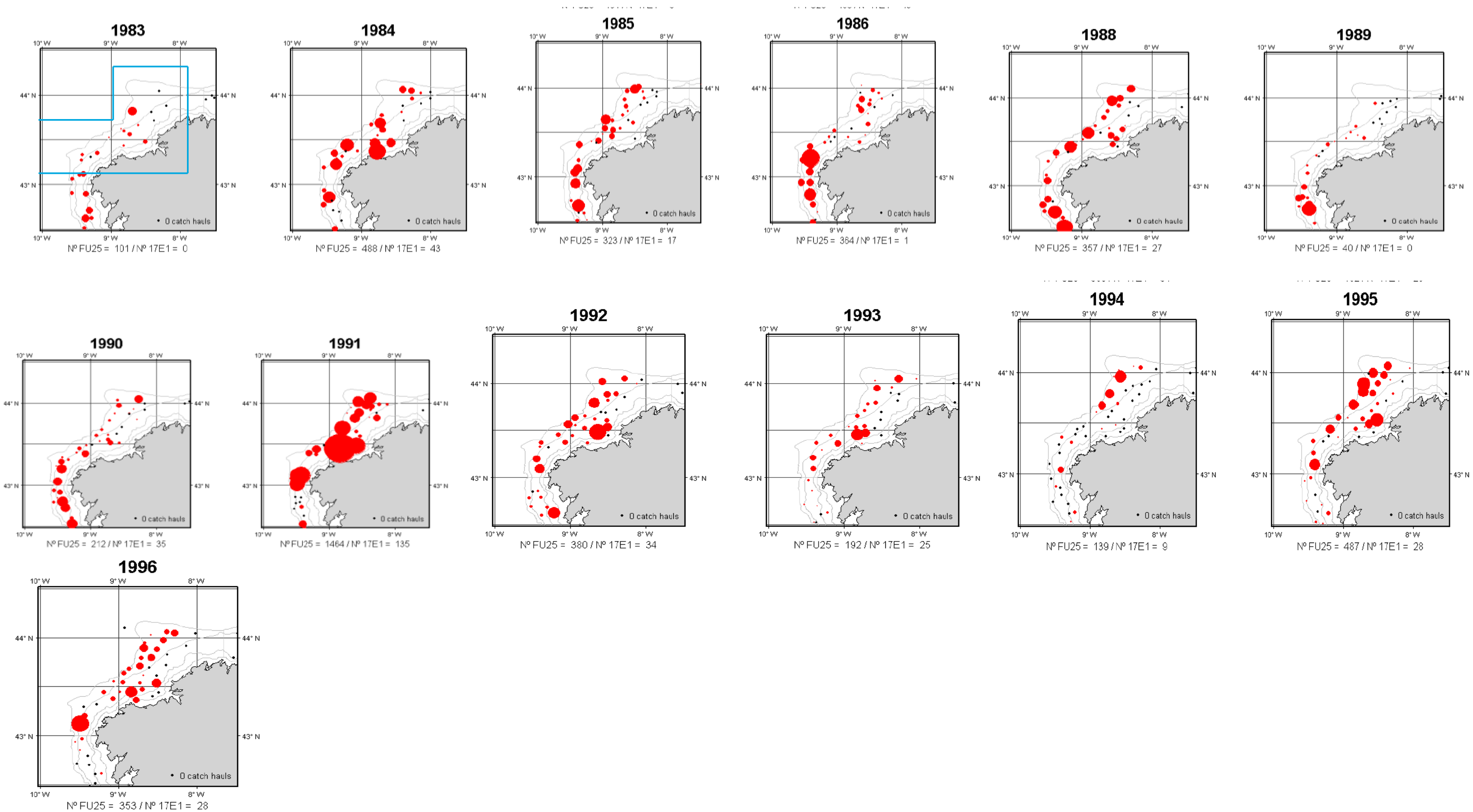

Figure 12.1.6a. FU25 *Nephrops* CPUE (kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero kg of *Nephrops* /haul. Limits of FU 25 in blue in 1983 map. No survey in 1987. Smaller gear in 1989. Period of high CPUEs (1983–1996).

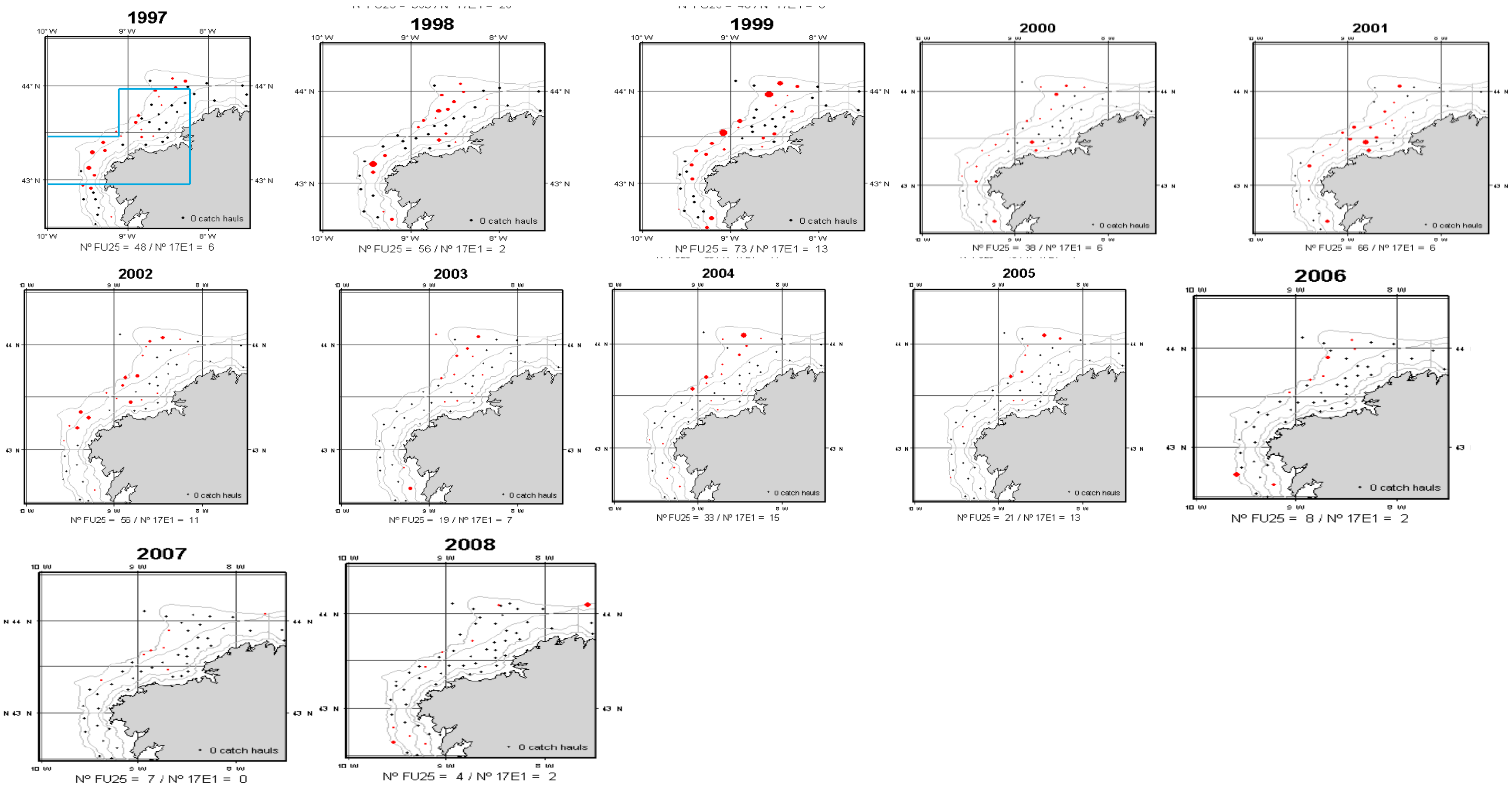

Figure 12.1.6b. FU25 *Nephrops* CPUE (kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero kg of *Nephrops* /haul. Limits of FU 25 in blue in 1997. Period of low CPUEs (1997–2008).

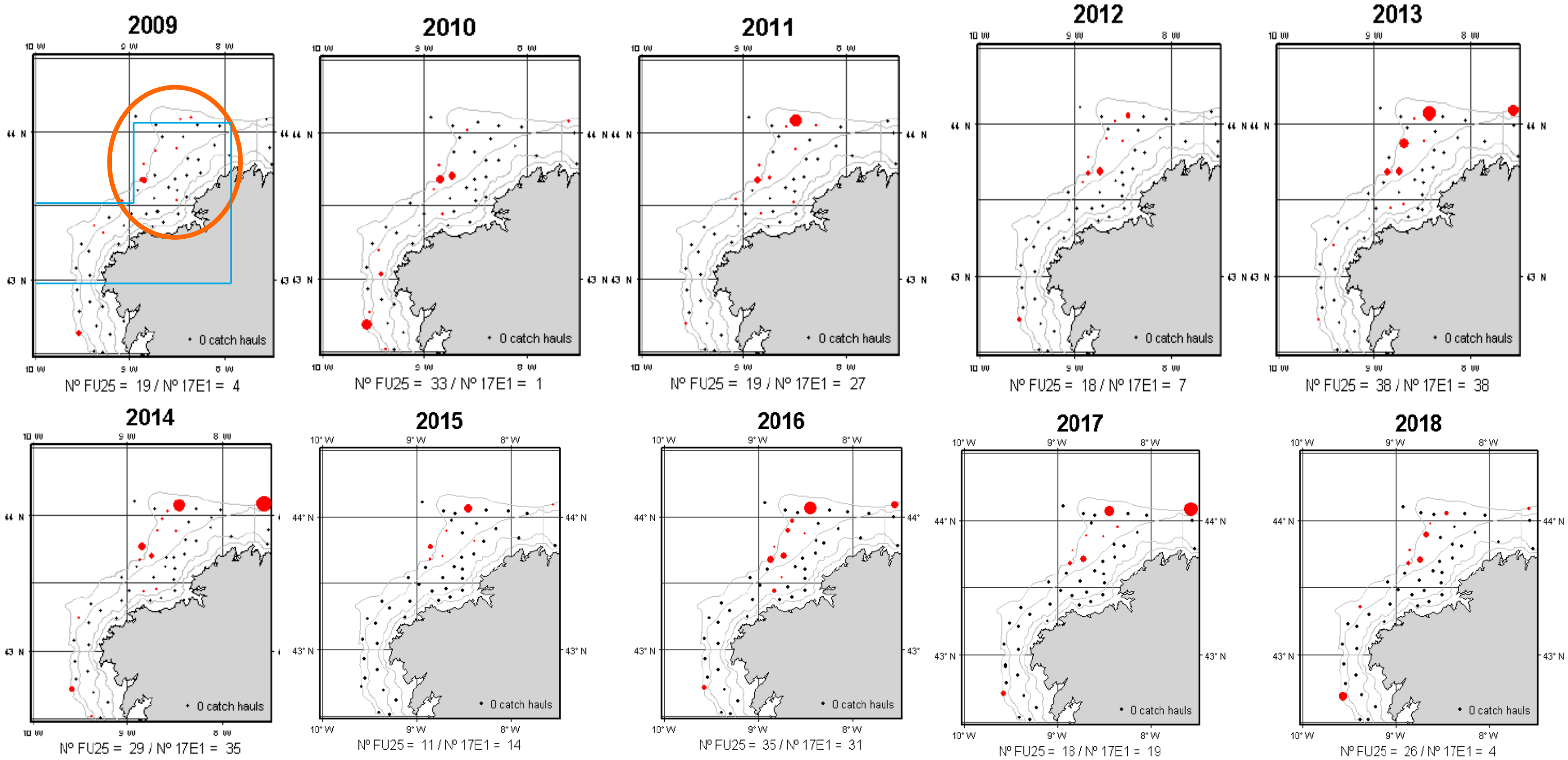

Figure 12.1.6c. FU25 *Nephrops* CPUE (kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero kg of *Nephrops* /haul. Limits of FU 25 in blue in 2009 map. Medium CPUEs in the rectangle 16E1 (inside FU 25) and 17E1 (outside FU) (2009–2018). Statistical rectangle 16E1 indicated with a orange circle. FU 31 (Cantabrian Sea) *Nephrops*

12.2 FU 31 (Cantabrian Sea) *Nephrops*

12.2.1 General

Till the date, the status of the FU 31 *Nephrops* stock was considered undesirable (ICES, 2016a) with extremely low biomass and zero catch advice (ICES, 2017).

12.2.1.1 Ecosystem aspects

See Stock annex in Annex K.

12.2.1.2 Fishery description

See Stock annex in Annex K.

12.2.1.3 Summary of ICES Advice for 2019 and management applicable to 2018 and 2019

ICES advice for 2019

The advice for this *Nephrops* stock is triennial and valid for 2017, 2018 and 2019.

ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2017, 2018, and 2019.

To protect the stock in this Functional Unit, ICES advices that management area should be consistent with the assessment area. Therefore, management should be implemented at the Functional Unit level.

Management applicable to 2018 and 2019

A recovery plan for 8c and 9a hake and *Nephrops* stocks (except FU 30, Gulf of Cádiz) has been in force since the end of January 2006 (CR (EC) No. 2166/2005) to March 2019 (Regulation EU 2019/472). This plan was based on precautionary reference points for 8c and 9a hake that are no longer appropriate.

A new Spanish regulation in 2011 established an Individual Transferable Quota system (ITQs) including *Nephrops* (ARM/3158/2011).

A zero TAC was set for *Nephrops* in the whole of Division 8c for 2017, 2018 and 2019.

12.2.2 Data

12.2.2.1 Commercial catches and discards

Spanish landings are based on sales notes which are compiled and standardized by IEO. Since 2003, trips from sales notes are also combined with their respective logbooks, which allow georeferencing the catches. Data are available by statistical rectangle since 2003 and by metier since 2008 (EC, 2008). A revision of the 2003-2009 FU 31 *Nephrops* landings was made based in logbooks data.

The Spanish concurrent sampling is used to raise the FU 31 observed landings to total effort by metier since 2013. When the estimated landings exceed the official landings, the difference is provided to InterCatch as non-reported landings.

Nephrops landings from FU 31 are reported by Spain (the only participant in the fishery, even though France had a small quota) (Table 12.2.1 and Figure 12.2.1) and are available for the period 1983–2018. The highest landings were recorded in 1989 and 1990, with 177 t and 174 t, respectively. Since 1996 landings have declined sharply from 129 t up to 4 t in 2016. In 2017 and 2018 the fishery was closed, landings were zero. 39% of *Nephrops* landings of FU 31 comes from the statistical rectangle 16E7 (Basque Country), 36% from 16E4 (Asturias region), 18% from 16E6 (Cantabria region) and 8% from 16E5 (logbooks 2003-2016).

Information on discards was sent to the WG through InterCatch. There have never been discards in this functional unit. Nevertheless, since the closure of the fishery there were 31.4 kg of discards in 2017 and 3.4 t in 2018.

VMS information

2009-2018 VMS data of trawl fleet in FU 31 (baca OTB_DEF≥55, jurelera OTB_MPD≥55 and pair trawlers PTB_MPD≥55) provided some information about the spatial distribution of *Nephrops* landings in the FU when the *Nephrops* fishery was open (Fig. 12.2.2, 2009-2016) and after closure (Fig. 12.2.2, 2017-2018). VMS pings were allocated to logbooks by vessel, fishing day and statistical rectangle. 28% of VMS pings could not be identify in logbooks. 9% of 2009-2011 VMS pings reveal *Nephrops* presence.

Nephrops is a by catch in the bottom trawl mix fishery directed to demersal fish. Fig. 12.2.2 maps reveal that trawl fleet operates regularly in all the FU 31. Therefore, in the period when *Nephrops* fishery is closed, it would be possible to see the evolution of *Nephrops* catches from discard data recorded in logbooks, as already happens in this FU in 2018 (see above). Biological sampling

The trend of the time series of mean size of males and females in the landings from 1988 to 2016 is increasing (Figure 12.2.1). The highest values were recorded in 2009 (males 55.8 mm and females 45.9 mm CL). There were decreases of mean sizes in 1991, 2002, 2011 and 2015. Mean sizes decreases could be related with recruitment. Mean size in 2016 was of 52.1 mm CL for males and 45.8 mm CL for females. No length frequency distributions for both sexes for FU 31 were available in 2017 and 2018 because the *Nephrops* fishery was closed. The number of *Nephrops* individuals in the Spanish "Demersales" trawl survey was insufficient in 2017 and 2018 to provide a reliable mean length.

12.2.2.2 Commercial catch-effort data

The fishing effort and CPUE data series includes three bottom trawl fleets operating in the Cantabrian Sea that sell in the harbours of Santander, Gijón and Avilés. In last years, the information of the different fleets is intermittent, although Santander data series is the largest (up to 2013). An effort series including the Santander, Avilés and Gijón effort together from 2009 onwards is presented. In order to standardize the effort units in Division 8c, the new effort series is expressed in trips. The available time series of effort show decreasing trends in the whole period (1983-2016) (Figure 12.2.1). The increase in the use of other gears (HVO and pair trawl) resulted in the reduction in effort by the baca trawl fleet, that fishes 85% of *Nephrops* from FU 31. After a slight increase in the Santander effort (in fishing days) in 2006 and 2007, fishing effort declined again and it has remained at low levels in the last five years. The new effort series (Santander +Gijón+Avilés) from 2009 to 2016 (expressed in trips) shows an increasing trend from 2010 to 2014, ranging between 850 trips to 1083 trips (Figure 12.2.1). Since 2014 effort has been decreasing up to 664 trips in 2018.

The Santander lpue series shows fluctuations around the general downward trend (Figure 12.2.1) until 2013 (2.3 kg/fishing days), last available data. The new lpue series (Santander +Gijón+Avilés) shows a decreasing trend until 2015. In 2016 the CPUE increased up to 4.3 kg/trip. In 2017 and 2018 *Nephrops* fishery was closed in 8c (FU 25 and FU 31).

In Portugal, CPUE in species with affinity for temperate waters (in opposition to tropical waters) decreased from 1992 to 2009, especially in long living species as *Nephrops* (Teixeira *et al*., 2014). CPUE time series of "temperate" species are directly correlated with rain and inversely with temperature (Teixeira *et al*., 2014). Similar processes could have affected FU 31 *Nephrops* from 1992 to 2009.

FU 31 *Nephrops* CPUE (kg/haul) time series from Spanish "Demersales" trawl survey (SP-NSGFS) (1983-2018) decreased from 1992-1994 to 2010, increased until 2015 and fell since then (Fig. 12.2.3). CPUE (kg/haul) spatial distribution shows a decreasing of the yields until 2000 and a slight prevalence of the eastern area since then (12.1.4). This is a bottom trawl survey carried out in September to estimate hake recruitment and to collect information on the relative abundance of demersal species.

Although the fishery is closed in the period 2017-2019, FU 31 *Nephrops* general evolution could be followed through the Spanish "Demersales" trawl survey (SP-NSGFS) information and discards data registered in logbooks combined with VMSs.

12.2.3 Assessment

According to the ICES data-limited approach, this stock is considered as category 3.1.4, stock with extremely low biomass and zero catch advice (ICES, 2017). FU 31 is assessed by the analysis of the LPUE series trend (category 3 stock, ICES, 2017). Spanish "Demersales" trawl survey (SP-NSGFS) information, VMSs data, mean length time series and discards data registered in logbooks were also looked at. The perception of this stock has not changed and it continues showing an extremely low abundance level.

12.2.4 Biological reference points

Proxies of MSY reference points were defined using the methods developed in WKLIFE V and WKProxy 2015 (ICES, 2015, 2016b). $F_{0.1}$, taken as proxy of $F_{MSY,}$ from length–based analysis for the period 2001–2014 was 0.28 for males and 0.47 for females (ICES, 2016b). MSY $B_{trigger}$ proxy is not available.

12.2.5 Management considerations

Nephrops is taken as bycatch in the mixed bottom trawl fishery. In FU 31, 85% of the Spanish landings of *Nephrops* comes from the métier baca (OTB_DEF≥55), 7% from crustacean pots (FPO_CRU), 3% from jurelera (OTB_MPD≥55), 3% from pair trawlers (PTB_MPD≥55) and 1% from other pots or traps (FPO_FIF) (logbooks 2008-2016).

The overall trend in landings of *Nephrops* from the Cantabrian Sea (FU 31) is strongly declining. Landings have dramatically decreased since the beginning of the series (1983–2016), representing in 2016 less than 2% of the 1989 maximum. In 2017 and 2018 the *Nephrops* fishery was closed.

A recovery plan for 8c and 9a hake and *Nephrops* stocks (except FU 30) including a fishing effort reduction was enforced in 2006 (Council Regulation (EC) No 2166/2005) until March 2019 (EC, 2019), when this plan was repealed.

A Fishing Plan for the Northwest Cantabrian ground was established in 2011 (ARM/3158/2011). This new regulation established an Individual Transferable Quota system (ITQs) (including *Nephrops*).

Spain requested a sentinel fishery for *Nephrops* in FU 31 for 2019 similar to those carried out in FU 25 in 2017 and 2018. An ICES Special Request Advice about a sentinel fishery for *Nephrops* in

FU 31 for 2019 was delivered in March 2019. ICES advised that, if an UWTV survey cannot be conducted, collecting of sentinel fishery CPUE data would require no more than 0.7 t (ICES, 2019).

12.2.6 References

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ICES, 2019. EU request for advice on a sentinel fishery for Norway lobster (*Nephrops*) in Functional Unit 31, Division 8c. ICES Special Request Advice Bay of Biscay and the Iberian Coast Ecoregion. Published 28 March 2019 - sr.2019.03 – https://doi.org/10.17895/ices.advice.4891Teixeira *et al*. 2014. Trends in landings of fish species potentially affected by climate changes in Portuguese fisheries. Reg Environ Change 14 (2), DOI 10.1007/s10113-013-0524-5.

12.2.7 Tables and Figures

Table 12.2.1. *Nephrops* FU31, Cantabrian Sea. Landings and discards in tonnes.

Year	Landings		Discards	Catch
	Trawl	Other gears		
1983	63			63
1984	100			100
1985	128			128
1986	127			127
1987	118			118
1988	151			151
1989	177			177
1990	174			174
1991	105	4		109
1992	92	2		94
1993	95	6		101
1994	146	2		148
1995	90	4		94
1996	120	9		129
1997	97	1		98
1998	69	3		72
1999	46	2		48
2000	33	1		34
2001	26	1		27
2002	25	1		26
2003	34	1		35
2004	29	0		29
2005	48	0		48
2006	37	0		37
2007	32	0		32
2008	19	1		20
2009	9	1		10
2010	8	0		9
2011	7	0		7
2012	10	0		10
2013	10	0		10
2014	4	0		4
2015	3	0		3
2016	3	0		3
2017	0*	0*		0*
2018	0*	0*	3*	3*

*Nephrops fishery was closed in 8c (FU 25 & FU 31) in 2017 and 2018

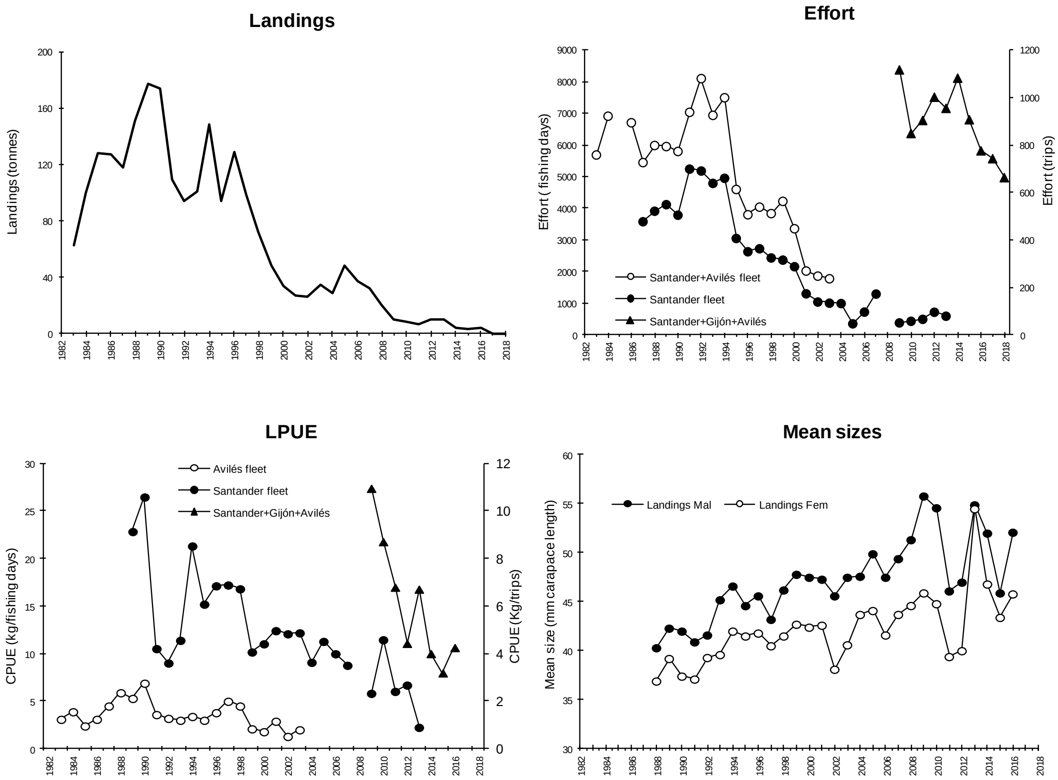


Figure 12.2.1. ***Nephrops*** **FU31, Cantabrian Sea. Long-term trends in landings, effort, lpue and mean sizes. Effort and LPUE for the "bacas" (metier OTB_DEF≥55) selling in the ports of Santander, Gijón and Avilés. 8c** ***Nephrops*** **fishery (FUs 25 & 31) was closed in 2017 and 2018.**

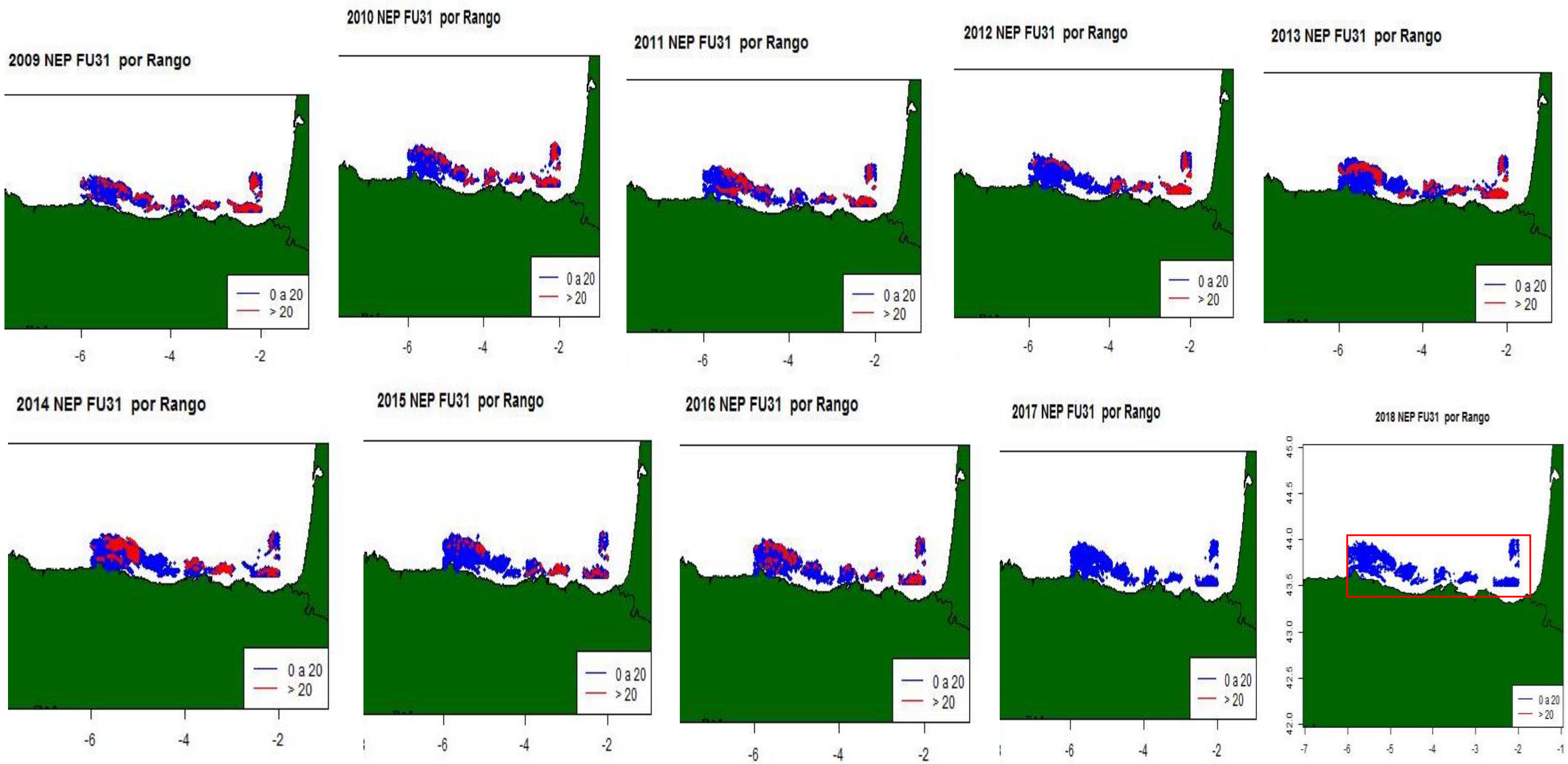


Figure 12.2.2. FU 31 Cantabrian Sea. Distribution of FU 31 *Nephrops* LPUE (kg/fishing day). Metiers "baca" (OTB_DEF≥55), "jurelera" (OTB_MPD≥55) and pair trawlers (PTB_MPD≥55). FU 31 limits indicated by red lines in 2018 map. Red points: *Nephrops* LPUE > 20 kg/fd, blue: *Nephrops* LPUE ≤20 kg/fd. *Nephrops* fishery in 8c (FUs 25 and 31) was closed in 2017 and 2018.

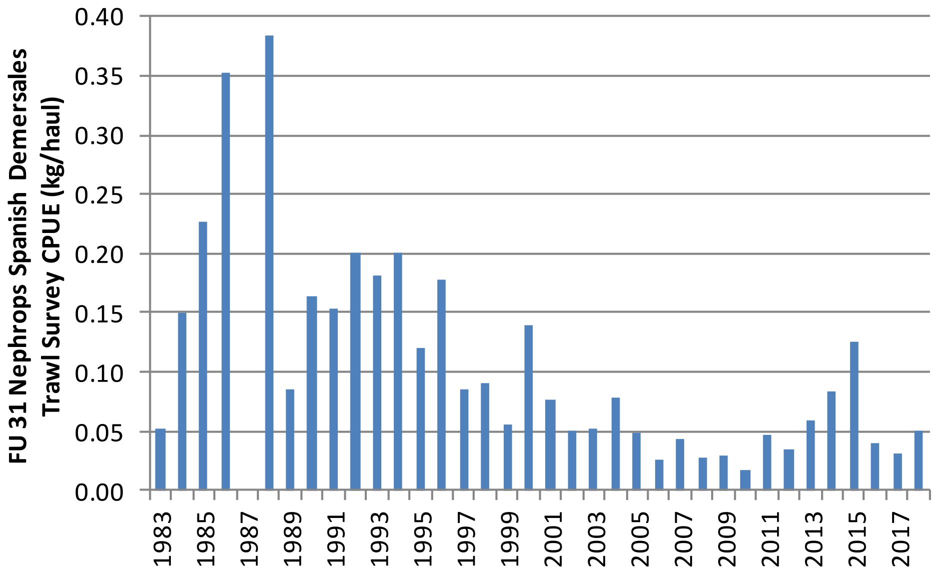


Figure 12.2.3. FU 31 *Nephrops* CPUE (kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS) (1983-2018). No survey in 1987. Smaller gear in 1989.

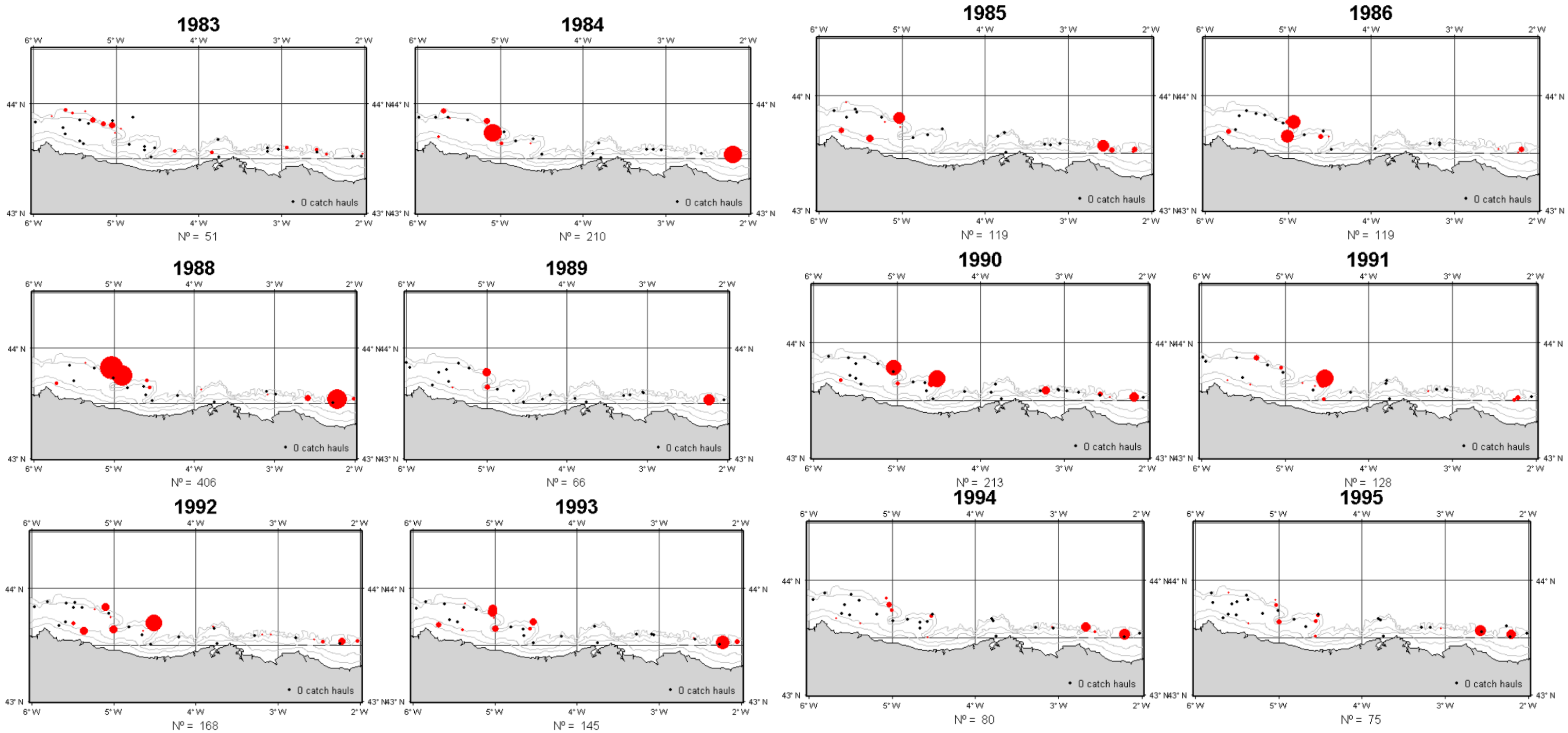


Figure 12.2.4a. FU 31 *Nephrops* CPUE (kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero kg of *Nephrops* by haul. Limits of FU 31 in black in 1983 map. No survey in 1987. Smaller gear in 1989. Higher CPUEs period (1983–1995).

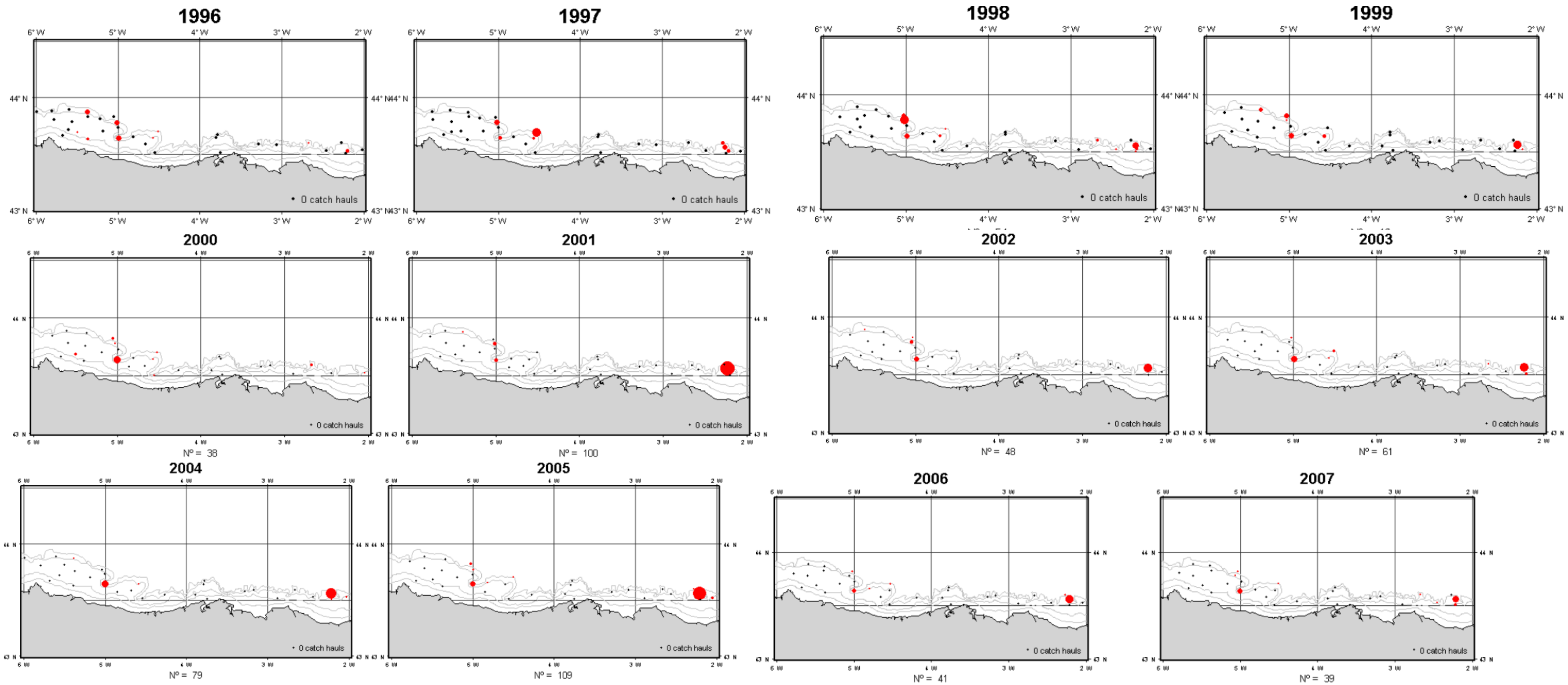


Figure 12.2.4b. FU 31 *Nephrops* CPUE (kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero kg of *Nephrops* by haul. Limits of FU 31 in black in 1983 map. Lesser CPUEs, eastern patch prevalence.

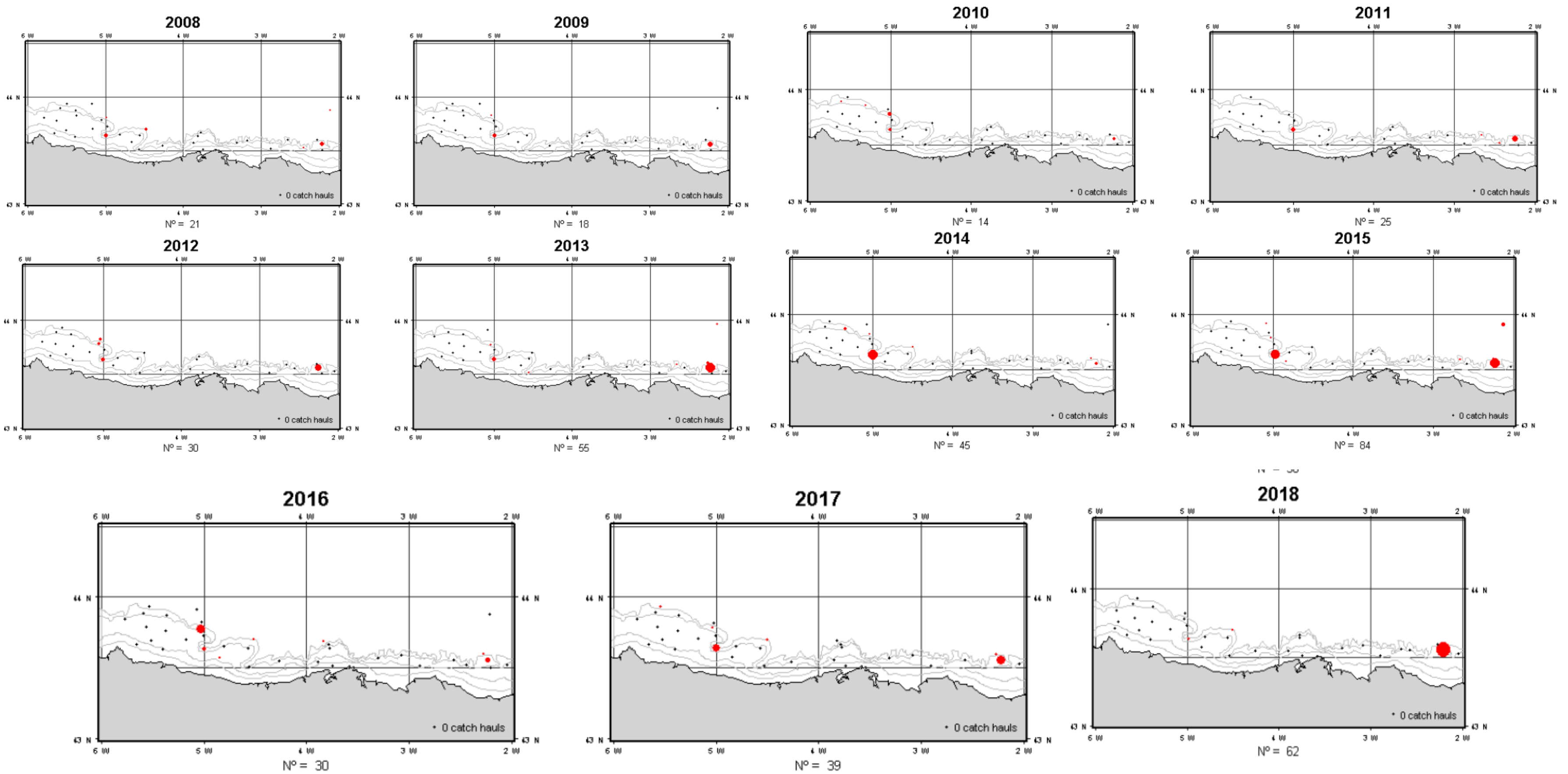


Figure 12.2.4c. FU 31 *Nephrops* CPUE (kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero kg of *Nephrops* by haul. Limits of FU 31 in black in 1983 map. Lesser CPUEs.

12.3 Summary for Division 8c

Atlantic *Nephrops* landings from the Iberian Peninsula (ICES divisions 8c and 9a) have decreasing a 93% since 1978 to 2014 (Figure 12.3.1). Separate 8c and 9a landings have different magnitude but offer the same evolution (Fig. 12.3.2).

8c division includes Functional Unit (FU) 25, North Galicia, and FU 31, Cantabrian Sea (Fig. 12.3.3). 9a division includes FU 26-27, FU 28-29 and FU 30 (see Division 9a *Nephrops* section).

Nephrops landings decreased until 1996 in all the Atlantic Iberian *Nephrops* stocks (Figs. 12.1.1, 12.2.1, 9a section). Since 1996 southern stocks (FU 28-29 and 30) landings increased during some years (9a section), while northern stocks (FUs 25, 31 and 26-27) landings continued decreasing so far (Figs. 12.1.1, 12.2.1, 9a section).

At the same time fishing effort (f) has been decreasing since the beginning of the time series in all of the Atlantic *Nephrops* stocks except in FU 30 (Gulf of Cádiz) between 1994 and 2005 (Figs. 12.1.1, 12.2.1, 9a section).

Nephrops CPUEs is decreasing since the beginning of the time series in the northern stocks (Figs. 12.1.1, 12.2.1, 9a section) and is quite stable in the southern stocks (9a section).

A recovery plan for 8c and 9a hake and *Nephrops* stocks except FU 30 (Gulf of Cádiz) was implemented since 2006 (Council Regulation (EC) No 2166/2005) to March 2019 (EC, 2019). This recovery plan included a procedure for setting the TACs for *Nephrops* stocks, complemented by a system of fishing effort limitation (a reduction of 10% in the fishing mortality rate in the year of its application as compared with the fishing mortality rate estimated for the preceding year, within the limits of ±15% of the preceding year TAC).

Regarding only Division 8c, FU 25 provides the 63% of the Spanish *Nephrops* landings, FU 31 the 25% and other rectangles of 8c the 12% (logbooks 2003-2016) (Table 12.3.1, Fig. 12.1).

In Division 8c, the 87% of *Nephrops* landings comes from the metier baca (OTB_DEF≥55), 7% from jurelera (OTB_MPD≥55), 2% from pair trawlers (PTB_MPD≥55) and 2% from pots (FPO_CRU) (logbooks 2008-2016).

The very low levels of landings from FU 25, FU 31 and rectangles outside the FUs and the decreasing LPUE trends indicate that both stocks are in very poor condition. TAC in FU 25 and FU 31 was zero catch for 2017, 2018 and 2019. However, a special quota was only authorized for FU25 in August and September 2017 and 2018 in order to get a commercial abundance index (sentinel fisheries).

Low quantities of males in a *Nephrops* stock could be related with a high fishing pressure since ovigerous females are most of the year protected in the burrows (Fariña, 1996). In the worst cases low quantities of males could affect mating (ICES, 2013) and consequently recruitment in subsequent years. The percentage of males in the Spanish "Demersales" trawl survey (SP-NSGFS) in Division 8c since 1983 to 2018 fluctuates around 55% with the lowest values in 1998 and 2004 (Fig. 12.3.4).

Decreases in mean length could be related with recruitment. 8c *Nephrops* mean length from SP-NSGFS has an increasing trend since 1983 to 2008 (Fig. 12.3.5). Atlantic Iberian Northern *Nephrops* stocks mean length has a increasing trend until 2009-2011 (Figs. 12.1.1, 12.2.1, 9a section) and southern stocks until 2012-2014 (9a section). The landings and CPUE decreases in fisheries with a decreasing fishing mortality (F) together with a mean size increase could be related with global processes (*e.g.* Teixeira *et al*., 2014). The resilience of the different stocks to those processes could be related with their different population/fishery characteristics (fishing pressure, density of the stock, stock size, etc.) and local/punctual events (*Nephrops* larvae mortality, etc.).

Table 12.3.1. *Nephrops* in Division 8c. Landings and discards (tonnes). *Nephrops* fishery in 8c was closed in 2017 and 2018.

Year	FU25			FU 31		8c Outside FUs		Total 8c
	Landings		Discards	Landings	Discards	Landings	Discards	
	Official	Non-reported						
1975	731							731
1976	559							559
1977	667							667
1978	690							690
1979	475							475
1980	412							412
1981	318							318
1982	431							431
1983	433			63				496
1984	515			100				615
1985	477			128				605
1986	364			127				491
1987	412			118				530
1988	445			151				596
1989	376			177				553
1990	285			174				459
1991	453			109				562
1992	428			94				522
1993	274			101				375
1994	245			148				393
1995	273			94				367
1996	209			129				338
1997	219			98				317
1998	103			72				175
1999	124			48				172
2000	81			34				115
2001	147			27				174
2002	143			26				169
2003	89			35		30		154
2004	75			29		10		114
2005	63			48		12		123
2006	62			37		11		110
2007	67			32		13		112
2008	39			20		10		69
2009	21			10		5		36
2010	34			9		5		47
2011	44			7		3		54
2012	10	11		10		5		36
2013	11	0		10		4		25
2014	9	0		4		2		15
2015	14	0		3		2		19
2016	13	65		3		4		85
2017*	2*	0		0		0		2
2018*	2*	0.0	0.2	0.0	3.4	0.1	4.0	9.7

* *Nephrops* fishery was closed in 8c (FU 25 & FU 31) in 2017 and 2018, but there were special Sentinel fisheries in FU 25.

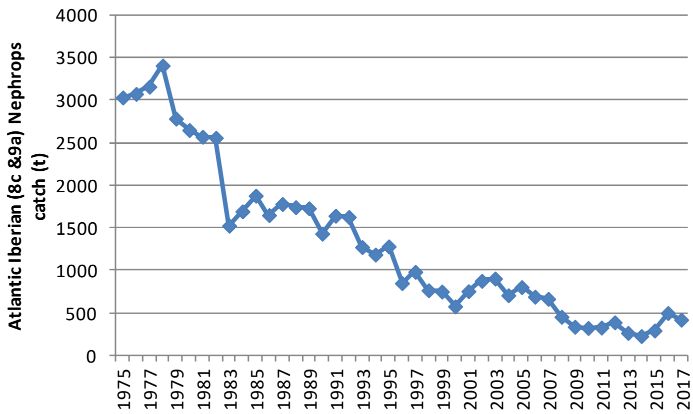


Figure 12.3.1 Atlantic Iberian (8c+9a) *Nephrops* landings (t), 1975–2017.

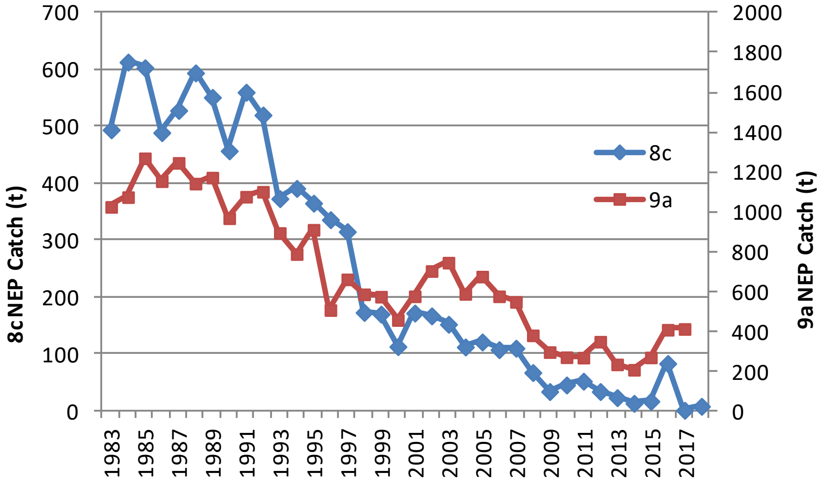


Figure 12.3.2 8c and 9a *Nephrops* landings (t), 1983–2018.

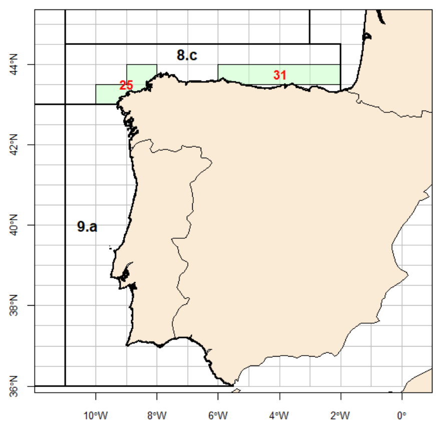


Figure 12.3.3 *Nephrops* in Division 8c: FU 25 (North Galicia) and FU 31 (Cantabrian Sea).

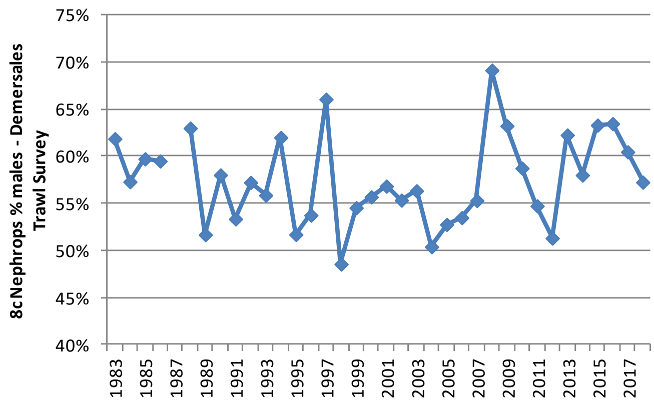


Fig. 12.3.4. *Nephrops* in Division 8c. Percentage of males from Spanish "Demersales" Trawl Survey (SP-NSGFS) (1983-2018).

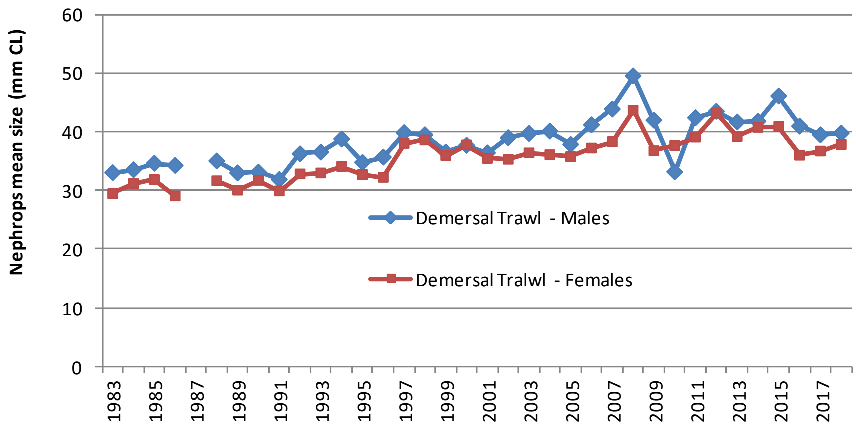


Fig. 12.3.5. *Nephrops* in Division 8c. Mean sizes from Spanish "Demersales" Trawl Survey (SP-NSGFS) (1983-2018)

Annex The elimination of *Nephrops* non-reported landings in Functional Unit 25 (North Galicia)

Since 2012 the Spanish landings are provided as official + non-reported landings. There is a scientific estimation of landings; if the estimation is higher than the official landings, the difference is provided as non-reported landings.

In FU 25 there were *Nephrops* non-reported landings in 2012 and in 2016 (Table 1).

Table 1. Nephrops FU 25, North Galicia. Landings in tonnes (2012–2016).

Year	Landings	
	Official	Non-reported
2012	10	11
2013	11	0
2014	9	0
2015	14	0
2016	13	65
2017	2	0
2018	2	0

The revision of the scientific estimation procedure has brought out that the procedure is correct, but it is designed for the target species. *Nephrops* is not caught in the majority of the bottom trips in FU 25. In most of the trips with *Nephrops* catch, is a by catch species. This results in a high level of uncertainty of the FU 25 *Nephrops* landings estimations. As a precaution, the WGBIE 2019 has decided stop using these estimations for FU 25 *Nephrops* and the FU 25 *Nephrops* non-reported landings will be deleted from Intercatch. Non-reported landings were never used in the calculation of FU 25 *Nephrops* CPUE. See below FU 25 *Nephrops* landings time series with and without non-reported landings (Figure 1).

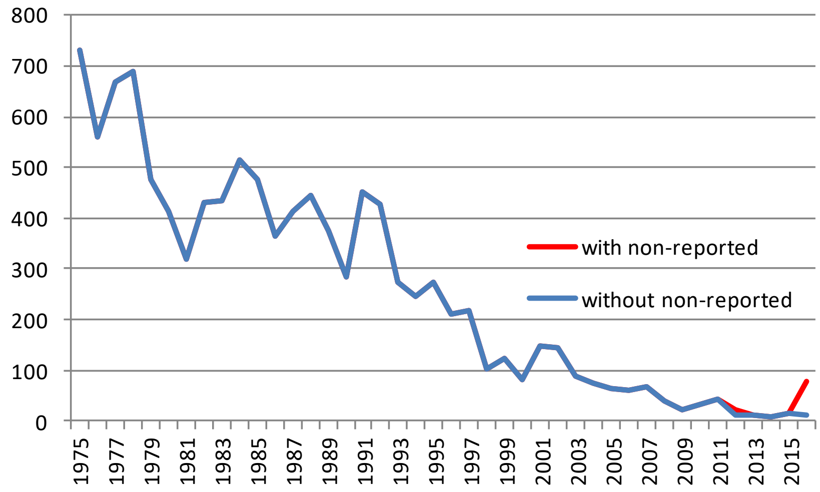


Figure 1. *Nephrops* FU 25, North Galicia. Landings in tonnes (1975–2016).

Taking into account this decision, some of the WGBIE 2019 tables and figures for FU 25 *Nephrops* have been changed:

Table 12.1.1. *Nephrops* FU 25, North Galicia. Landings and discards in tonnes.

Year	Landings	Discards	Catch
1975	731		731
1976	559		559
1977	667		667
1978	690		690
1979	475		475
1980	412		412
1981	318		318
1982	431		431
1983	433		433
1984	515		515
1985	477		477
1986	364		364
1987	412		412
1988	445		445
1989	376		376
1990	285		285
1991	453		453
1992	428		428
1993	274		274
1994	245		245
1995	273		273
1996	209		209
1997	219		219
1998	103		103
1999	124		124
2000	81		81
2001	147		147
2002	143		143
2003	89		89
2004	75		75
2005	63		63
2006	62		62
2007	67		67
2008	39		39
2009	21		21
2010	34		34
2011	44		44
2012	10		10
2013	11		11
2014	9		9
2015	14		14
2016	13		13
2017	2*		2
2018	2*	0.2	2

* *Nephrops* fishery was closed in 8c (FU 25 & FU 31) in 2017 and 2018, but there were *Nephrops* Sentinel Fisheries in FU 25.

Table 12.1.2b. *Nephrops* FU25, North Galicia. Length compositions of landings, mean weight (kg) and mean length (CL, mm) for the period 2001-2018. *Nephrops fishery in 8c (FU 25 and FU 31) was closed in 2017 and 2018. Length distributions of those years come from *Nephrops* Sentinels fisheries in FU 25.

Carapace length (mm)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*	2018*
15													7					
16																		
17																		
18																		
19									0	0								
20							0		0	0			0					
21		1	0		0		0		0	0			0	0				
22				1	1	0	1		0	0			9	0			0	
23	10	2	0	1	1	1	1		0	0								0
24		2	1	2	2	1	1	0	0	0					1		0	0
25	10	2	0	7	5	2	1	1	0	0			9	1	2		0	0
26	19	5	2	7	8	3	5	1		0			9	0	1		0	0
27	20	14	3	12	13	9	4	3	0	2	0		0	1	1	0	0	0
28	79	30	2	26	25	15	8	4		2	1	2	10	1	3	0	0	0
29	125	43	5	28	25	18	11	6	0	2	2	1	2	1	2	2	0	0
30	112	105	14	46	43	25	19	10	1	9	2	2	13	3	18	6	0	0
31	129	102	26	45	56	39	36	10	1	9	3	3	2	2	11	5	0	0
32	288	198	36	60	66	55	44	15	1	18	3	3	3	2	14	8	1	0
33	319	181	51	71	87	69	69	13	3	20	5	3	5	5	25	12	1	0
34	302	272	66	70	83	62	75	16	4	27	13	2	6	7	26	16	2	1
35	265	308	85	91	98	85	90	25	5	34	25	4	20	12	47	31	2	1
36	243	259	110	98	102	88	101	31	6	30	21	4	9	16	26	26	3	2
37	285	236	123	101	88	87	105	37	9	34	23	5	10	13	22	23	3	3
38	238	185	147	98	92	80	101	35	10	26	63	3	7	13	22	33	3	3
39	192	129	130	81	69	67	86	37	10	23	45	1	16	11	12	20	3	2
40	212	186	129	96	81	64	90	47	12	20	78	8	12	13	16	30	3	2
41	115	99	81	78	61	59	73	44	12	23	61	4	8	9	11	16	3	2
42	150	117	79	63	52	49	63	38	11	23	50	3	6	8	12	10	3	3
43	103	67	65	57	47	44	59	35	12	24	52	1	16	8	10	10	2	2
44	98	109	52	39	36	32	46	29	14	22	34	3	7	7	10	6	2	2
45	68	78	46	44	34	30	42	23	13	21	24	3	8	4	6	6	1	1
46	35	65	57	35	26	26	37	22	11	22	17	1	8	5	5	3	1	1
47	22	34	42	26	20	18	30	20	14	22	13	1	2	4	5	3	1	1
48	24	35	37	23	14	17	22	16	9	17	15	0	5	2	3	2	1	1
49	18	23	27	16	13	11	16	14	8	14	17	2	3	2	3	2	1	1
50	18	24	27	19	11	14	18	10	8	13	12	0	2	2	2	2	0	0
51	16	34	20	13	7	9	11	11	6	11	7	1	2	1	2	1	0	0
52	10	18	16	12	8	8	8	9	6	8	7	0	2	1	2	1	0	1
53	15	13	11	9	6	7	7	8	7	9	4	1	2	2	2	1	0	0
54	4	4	9	7	5	4	4	6	5	7	7	0	2	1	1	1	0	0
55	7	9	6	6	5	4	3	6	6	7	6	1	1	1	1	1	0	0
56	5	6	5	5	3	9	3	4	4	4	5	0	1	1	1	0	0	0
57	0	5	7	4	3	4	2	5	3	5	4	0	1	0	0	0	0	0
58	1	9	4	4	3	2	2	4	3	3	4	0	1	1	0	0	0	0
59	1	4	5	3	2	1	1	3	3	2	1	0	1	0	0	0	0	0
60	1	2	2	2	2	1	1	2	3	3	3	0	0	0	0	0	0	0
61		1	1	3	1	1	1	2	1	1	3	1		0		0	0	0
62	0	3	3	2	1	7	1	1	2	1	6	0	1	0	0	0	0	0
63	0	10	0	2	1	1	1	1	2	1	1	0		0	0	0	0	0
64	0	0	1	2	1	6	0	1	1	0	2	0	0	0	0	0	0	0
65	0	4	1	2	1	1	0	1	1	1	1	0		0		0	0	0
66	0	1	2	1	1	0	0	1	1	1	1	0	0	0	0	0		0
67		2	1	1	1	1	0	1	1	0	2	0		0			0	0
68		0	1	1	1	0	0	1	1	1	2	0		0	0	0	0	0
69		0	2	1	1	0	0	1	1	0	0	0	0	0		0	0	0
70		2	1	1	1	0	0	0	1	0	0	0		0		0	0	0
71		0	1	2	0	6	0	0	1	0		0		0		0		0
72	0	0	1	1	0	6	0	0	1	0	0	0		0				0
73		0	1	1	1	0	0	0	1	0	0	0		0				0
74	0	1	0	1	0	0	0		0	0	0	0						0
75	0	0	1	0	0	0	0		0			0		0		0	0	0
76		0	0	0	0	0	0	0	0			0				0		
77	0		0	0	0	0			0			0						0
78	0	0	0	0		0	0		0	0		0		0				0
79				0	0				0	0		0						
80		0		0	0	0		0	0			0						
81									0	0								
82									0									
83																		
84									0									
Total number (thousand)	3562	3043	1543	1425	1314	1147	1298	612	236	528	650	66	229	163	327	280	~~44~~ 38	32
Total weight (tonnes)	147	143	89	75	63	62	67	39	21	34	44	10	11	9	14	13	2	2
Mean weight (kg)	0.041	0.047	0.058	0.052	0.048	0.054	0.051	0.064	0.091	0.065	0.068	0.152	0.048	0.056	0.043	0.046	0.054	0.061
Mean length (CL, mm)	36.5	37.8	40.6	39.0	37.9	39.6	40	42.2	46.9	42.2	42.6	40.0	41.0	39.9	37.2	38.2	40.1	41.5

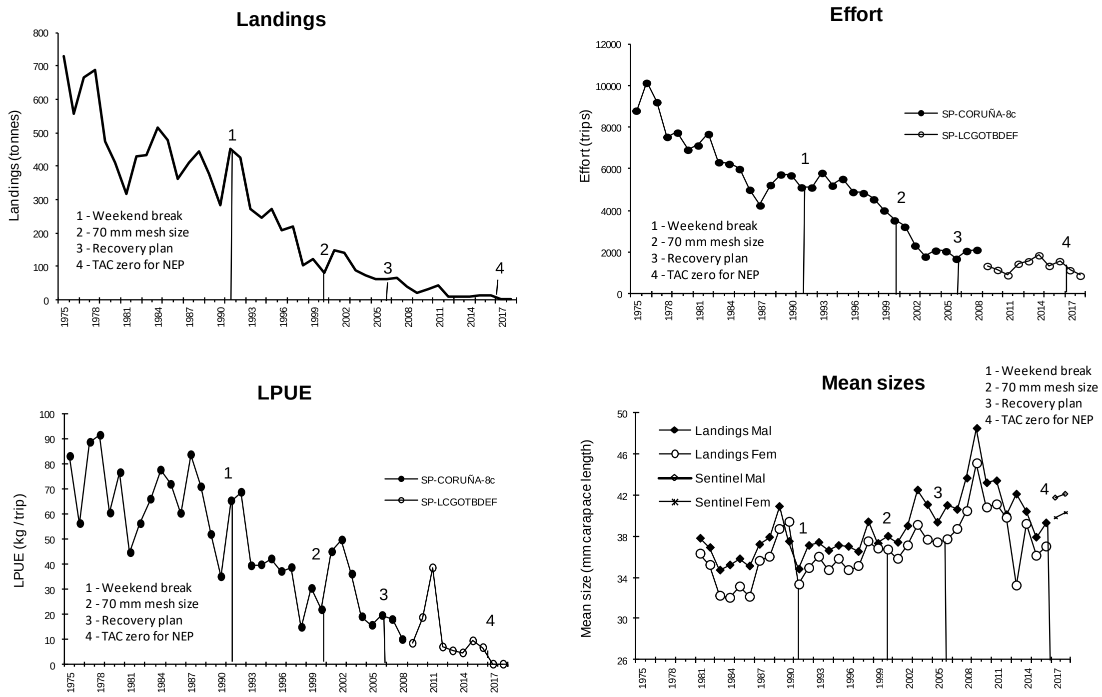


Figure 12.1.1. *Nephrops* FU25, North Galicia. Long-term trend in landings, effort, lpue and mean sizes. Effort and LPUE from the fleet selling in A Coruña harbor. 8c *Nephrops* fishery (FU 25 and 31) was closed in 2017 and 2018, mean sizes in those years from *Nephrops* Sentinel fisheries in FU 25.

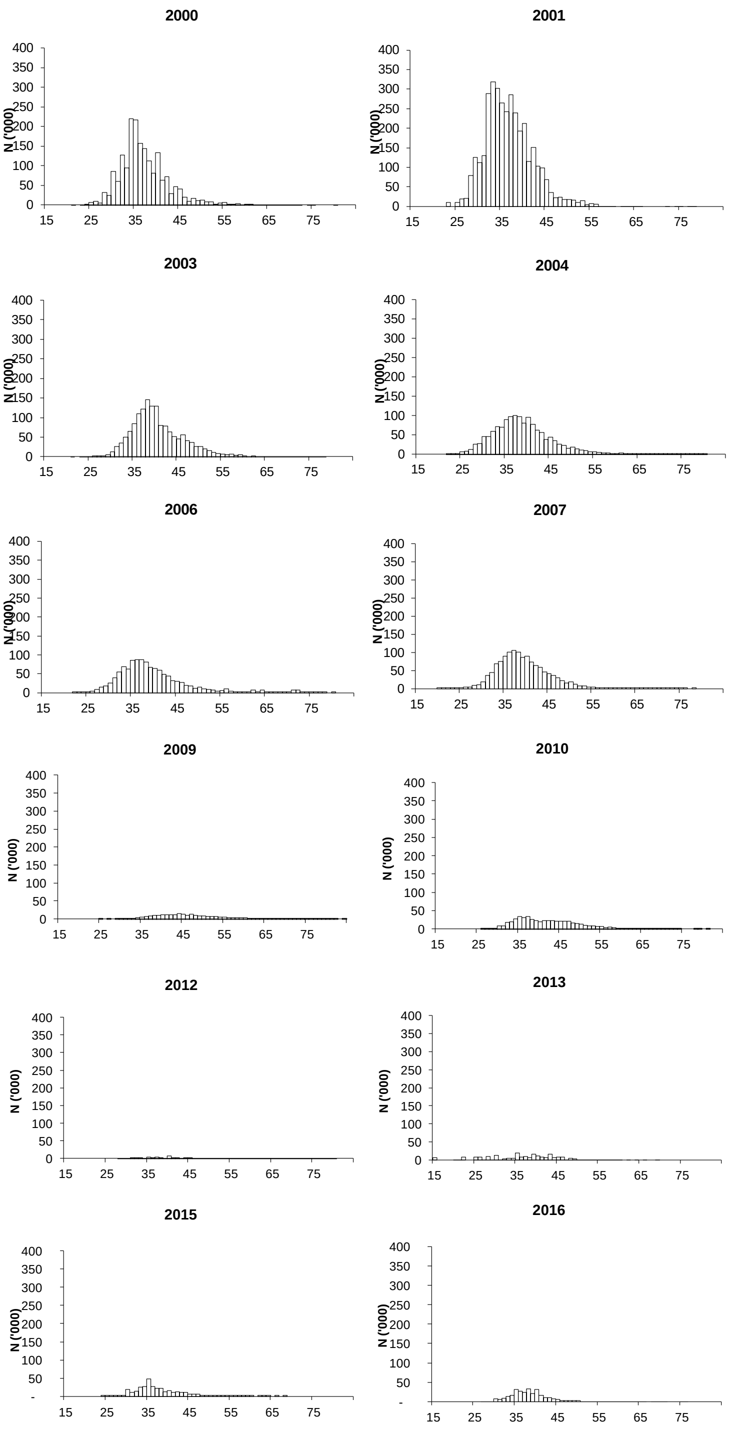


Figure 12.1.3b. *Nephrops* FU25, North Galicia. Length distributions in landings for the period 2000-2016. Maximum of Y-axis 400 thousands (2000–2016). In X-axis Carapace Length (CL) in mm.

Table 12.3.1. *Nephrops* in Division 8c. Landings and discards (tonnes). *Nephrops* fishery in 8c was closed in 2017 and 2018

.

Year	FU25		FU 31		8c Outside FUs		Total 8c
	Landings	Discards	Landings	Discards	Landings	Discards	
1975	731						731
1976	559						559
1977	667						667
1978	690						690
1979	475						475
1980	412						412
1981	318						318
1982	431						431
1983	433		63				496
1984	515		100				615
1985	477		128				605
1986	364		127				491
1987	412		118				530
1988	445		151				596
1989	376		177				553
1990	285		174				459
1991	453		109				562
1992	428		94				522
1993	274		101				375
1994	245		148				393
1995	273		94				367
1996	209		129				338
1997	219		98				317
1998	103		72				175
1999	124		48				172
2000	81		34				115
2001	147		27				174
2002	143		26				169
2003	89		35		30		154
2004	75		29		10		114
2005	63		48		12		123
2006	62		37		11		110
2007	67		32		13		112
2008	39		20		10		69
2009	21		10		5		36
2010	34		9		5		47
2011	44		7		3		54
2012	10		10		5		25
2013	11		10		4		25
2014	9		4		2		15
2015	14		3		2		19
2016	13		3		4		20
2017*	2*		0		0		2
2018*	2*	0.2	0.0	3.4	0.1	4.0	9.7

* *Nephrops* fishery was closed in 8c (FU 25 & FU 31) in 2017 and 2018, but there were special Sentinel fisheries in FU 25.

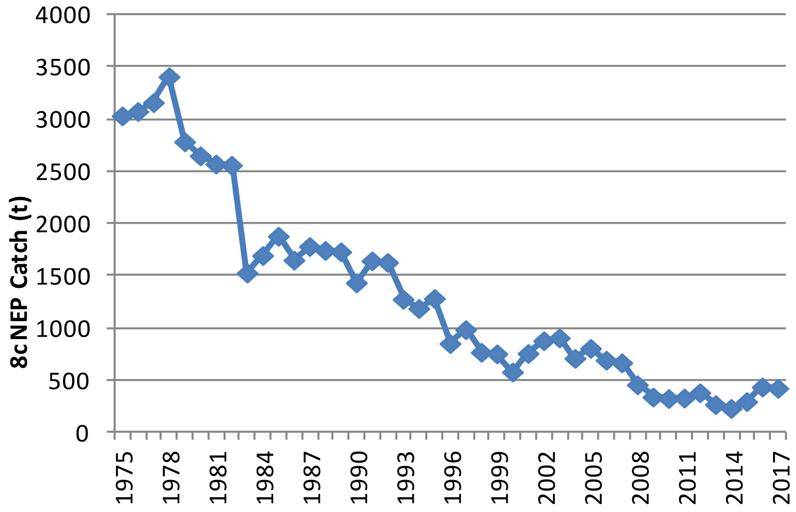


Fig. 12.3.2.- Atlantic Iberian (8c + 9a) *Nephrops* landings (t), 1983–2018.

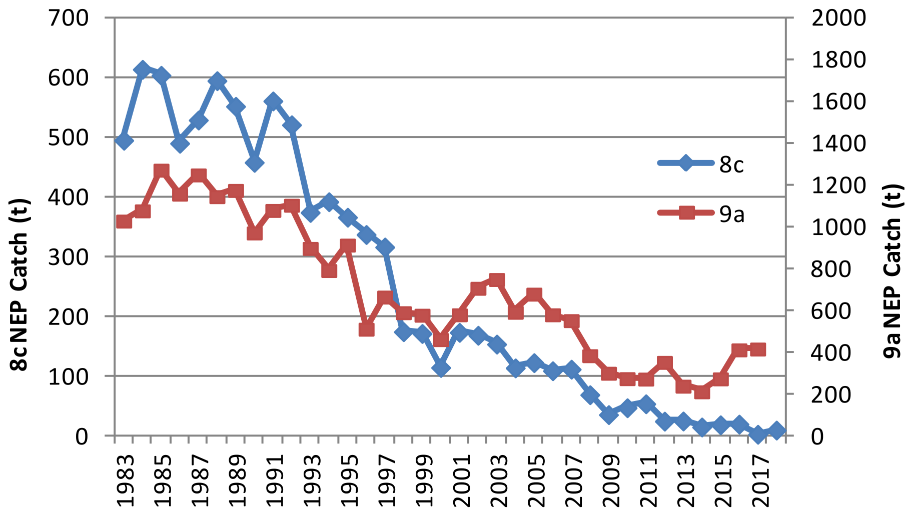


Fig. 12.3.2.- 8c & 9a *Nephrops* landings (t), 1983–2018.

13 *Nephrops* in Division 9a

The ICES Division 9a has five *Nephrops* Functional Units: FU 26, West Galicia; FU 27 North Portugal; FU 28, Alentejo, Southwest Portugal; FU 29, Algarve, South Portugal and FU 30, Gulf of Cadiz.

13.1 *Nephrops* FU 26-27, West Galicia and North Portugal (Division 9a)

13.1.1 General

13.1.1.1 Ecosystem aspects

See Stock Annex L

13.1.1.2 Fishery description

See Stock Annex L

13.1.2 ICES Advice for 2019 and management applicable to 2018 and 2019

ICES advice for 2019

The advice for these *Nephrops* stocks is triennial and valid for 2017, 2018 and 2019.

ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2017, 2018, and 2019.

To protect the stock in these functional units, ICES advises that management should be implemented at the functional unit level.

Management applicable to 2018 and 2019

A recovery plan for southern hake and Iberian *Nephrops* stocks has been in force since the end of January 2006. The aim of the recovery plan is to rebuild the stocks within 10 years, with a reduction of 10% in F relative to the previous year and the TAC set accordingly (Council Regulation (EC) No. 2166/2005). This plan is based on precautionary reference points for southern hake that are no longer appropriate.

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including *Nephrops* in FU 26-27 in ICES divisions 9a (Council Regulation (EU) 2019/472).

In order to reduce F on *Nephrops* stocks in this Division even further, a seasonal ban was introduced in the trawl and creel fishery for two boxes, located in FU 26 and 28, in the peak of the *Nephrops* fishing season. These boxes are closed for *Nephrops* fishing in June–August and in May–August, respectively.

The TAC set for the whole Division 9a was 381 t for 2018 and 401 t for 2019, respectively, of which no more than 6 % may be taken in FUs 26 and 27. The maximum number of fishing days per vessel was fixed at 129 days for Spanish vessels and at 113 days for Portuguese vessels for these two years (Annex II B and Annex II A of Council Regulations nos. 120/2018 and 124/2019, respectively). The number of fishing days included in these regulations is not applicable to the Gulf of Cadiz (FU 30), which has a different regime.

A Fishing Plan for the Northwest Cantabrian ground was established in 2013 (AAA/1307/2013). This new regulation establishes an assignation of the quotas by vessel including *Nephrops*.

13.1.3 Data

13.1.3.1 Commercial catches and discards

Spanish landings are based on sales notes which are compiled and standardized by IEO. Since 2013, trips from sales notes are also combined with their respective logbooks, which allow georeferencing the catches.

Since 2013, the Spanish concurrent sampling is used to raise the FU26-27 observed landings to total effort by *métier*. When the estimated landings exceed the official landings, the difference is provided to InterCatch as non-reported landings.

Landings in these FUs are reported by Spain and minor quantities by Portugal. The catches are taken by the Spanish fleets fishing on the West Galicia (FU 26) and North Portugal (FU 27) fishing grounds, and by the Portuguese fleet fishing on FU 27. *Nephrops* represents a minor percentage in the composition of total trawl landings and can be considered as by-catch although it is a very valuable species.

Along the time series, landings by the Spanish fleets are mostly from FU 26, together with smaller quantities taken from FU 27. However, since 2011 landings are very low in both FUs. Prior to 1996, no distinction was made between these two FUs, and therefore they are considered together.

Two periods can be distinguished in the time series of landings available 1975-2018 (Figure 13.1.1). During 1975-1989, the mean landing was 680 t, fluctuating between 575 and 800 t approximately. Since 1990 onwards there has been a marked downward trend in landings, being below 50 t from 2005 to 2011.Landings were minimal since 2012 (less than 10). In 2017 and 2018, landings were only 2 t.

Total Portuguese landings from FU 27 have decreased from almost 100 t in 1988 to just 1 t in 2012-2014 and less than 1 t in 2015. In 2016, landings increased lightly in FU 26 by the Spanish fleet and in FU 27 by the Portuguese fleet. So, estimated landings in 2016 were three times more than 2015 (6 t). In 2017 and 2018, estimated landings were only 2 t. Table 13.1.1 shows total landings in FU26-27 for the time series. Information on discards was sent to the WG through InterCatch although no discards are recorded in these FUs.

13.1.3.2 Biological sampling

Mean size for both sexes shows an increasing trend from 2001 to 2010 with the highest value recorded in 2010 (52.0 mm CL in males and 43.7 mm CL in females) (Figure 13.1.1). In contrast, mean carapace length declined in both sexes in 2011-2013 period. The mean size trend increased for males since 2014 onwards but it declined for females in 2016. In 2016 males achieved a mean carapace length of 45.1 mm and females 37.5 mm. Annual length compositions for males and females combined, mean size and mean weight in landings for the period 1988-2016 are given in Table 13.1.2 and Figure 13.1.2a and Figure 13.1.2b. No length frequency distributions for both sexes were available in 2017 and 2018.

13.1.3.3 Commercial catch-effort data

Fishing effort and LPUE estimates are available for Marin trawl fleet (SP-MATR) for the period 1990-2018 (Table 13.1.3; Figure 13.1.1). The overall trend for the effort and LPUE of SP-MATR time series is decreasing. Fishing effort remained stable at very low level since 2010 (means value 454 Kg/trip). LPUE series shows the same, so de index was very low since 2012 and lower than 1Kg/trip since 2014, indicating that the abundance of this FU is very poor.

Time series of fishing effort and LPUE of the bottom trawl fleets with the Spanish home ports of Muros (1984-2003), Riveira, (1984-2004), and Vigo, (1995-2008 and 2010) are also available. These data are plotted in Figure 13.1.1 for complementary information.

13.1.4 Biomass index from surveys

The SP-NSGFS covers the northern Spanish shelf comprised in ICES Division 8c and the northern part of 9a, including the Cantabrian Sea and off Galicia waters. This survey is not targeting to estimate *Nephrops* abundance but it could be used for an analysis of the trend. In the past, the abundance index survey was estimated for all area surveyed and not by FU, for this reason it never was explored by this WG. Now the *Nephrops* survey index is estimated for FU 26 (West Galicia) (Table 13.1.4). The survey index shows an increasing trend from 1985 to 1991, when the highest value was recorded (0.67 Kg/30min.). In 1997, the abundance decreased up to 0.05 Kg/30min. The abundance increased in 2001 (0.31 Kg/30min.) and afterwards the index remains at very low level, always below 0.04. A more detailed spatial analysis of this survey index by haul in FU 26 should be explored.

13.1.5 Assessment

According to the ICES data-limited approach, this stock is considered as category 3.1.4 (ICES, 2012). FU 26-27 is assessed by the analysis of the LPUE series trend. The perception of this stock has not changed and it continues with an extremely low abundance level.

13.1.6 Biological reference points

Proxies of MSY reference points were defined using the methods developed in WKLIFE and WKProxy (ICES, 2015, 2016d). $F_{0.1}$, taken as proxy of F_{MSY}, from length–based analysis was updated up to 2016 using the Mean-Length Z method. The period 1988-2016 was used and the proxy of F_{MSY} resulting was 0.16 for both sexes combined. Length frequency distribution for 2017 and 2018 is not available so F_{MSY} proxy could not be updated for this year. Table 13.1.5 and Figure 13.1.4 show the updated results. The value of MSY $B_{trigger}$ proxy is not available.

13.1.7 Management Considerations

Nephrops is taken as bycatch in a mixed bottom trawl fishery. Landings of *Nephrops* have substantially declined since 1995. Recent landings represent less than 1% of the average landings in the early period of the time series (1975-1992). Fishing effort in FU 26-27 has decreased throughout the time series.

There is a seasonal closure (June-August) for *Nephrops* in an area of the West Galicia (FU 26) fishing grounds, which was amended to the Council Regulation (EC) No 850/98.

A multiannual management plan (MAP) for the Western Waters has been published by the European Parliament and the Council (EU, 2019). This plan applies to demersal stocks including *Nephrops* in FU 26-27 in ICES divisions 9a.

A Fishing Plan for the Northwest Cantabrian ground was established in 2013 (AAA/1307/2013). This new regulation establishes an assignation of the quotas by vessel including *Nephrops*.

13.1.8 Tables and Figures

Table 13.1.1. *Nephrops* FU26-27, West Galicia and North Portugal. Landings in tonnes by Functional Units and country.

	Spain		Portugal	Unallocated/Nonreported		Total
Year	FU 26**	FU 27	FU 27	FU26	FU27	FU 26-27
1975	622					622
1976	603					603
1977	620					620
1978	575					575
1979	580					580
1980	599					599
1981	823					823
1982	736					736
1983	786					786
1984	604		14			618
1985	750		15			765
1986	657		37			694
1987	671		71			742
1988	631		96			727
1989	620		88			708
1990	401		48			449
1991	549		54			603
1992	584		52			636
1993	472		50			522
1994	426		22			448
1995	501		10			511
1996	264	50	17			331
1997	359	68	6			433
1998	295	42	8			345
1999	194	48	6			248
2000	102	21	9			132
2001	105	21	6			132
2002	59	24	4			87
2003	39	26	8			73
2004	38	24	9			71
2005	16	16	11			43
2006	15	17	12			44
2007	20	17	10			47
2008	17	12	13			42
2009	16	5	10			31
2010	3	14	4			21
2011	8	8	4		7	27
2012	3	4	1			8
2013	1	<1	1			3
2014	1	<1	1			4
2015	<1	<1	<1			2
2016	3	<1	3	1		6
2017	<1	0	2			2
2018	<1	1	0			2

**Prior 1996, landings of Spain recorded in FU 26 include catches in FU 27

Table 13.1.2. ***Nephrops*** **FU26-27, West Galicia and North Portugal. Length compositions, mean weight (Kg) and mean size (CL, mm) in landings for the 1988-2016 period. Data not available in 2017 and 2018.**

Lenght (mm)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
12	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
13	0	71	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
14	0	69	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
15	0	451	110	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
16	0	191	289	13	0	0	0	0	0	0	0	0	3	17	0	0	0	0	0	0	0	0	0	0	0	0			
17	0	128	518	17	0	0	7	0	0	0	0	0	3	11	0	0	0	0	0	0	0	0	0	0	0	0			
18	0	683	898	25	0	0	2	1	0	0	0	0	16	19	0	4	0	0	0	0	0	0	0	0	0	0			
19	0	679	1502	38	0	0	0	0	0	0	0	0	38	52	0	4	0	0	0	0	0	0	0	0	0	0			
20	27	1057	2044	97	6	5	10	7	25	3	0	0	86	151	3	29	0	0	0	0	0	0	0	0	0	0			
21	27	1260	2489	199	12	24	19	8	78	0	0	0	119	236	3	27	0	0	1	0	0	0	0	0	0	0			
22	39	1657	2642	398	48	99	84	47	202	12	1	0	129	348	11	11	1	0	1	0	0	0	0	0	0	1			
23	109	1901	3063	568	103	99	77	151	373	26	6	0	127	518	16	31	0	0	0	1	0	0	0	0	0	0			
24	198	1626	2736	1216	284	222	169	338	550	46	7	3	93	466	22	17	1	2	1	0	2	0	0	0	0	0	1		
25	290	2212	1802	1477	541	381	199	672	906	113	45	15	134	441	35	28	1	2	1	0	3	1	0	0	0	0	2	0	2
26	574	1675	1451	1516	829	542	289	709	960	184	40	43	145	365	56	22	7	2	2	1	2	1	0	0	0	0	1	0	0
27	854	1878	1333	1351	926	904	409	933	746	306	80	68	129	419	106	40	18	8	5	2	3	1	0	0	0	0	1	0	0
28	1272	1560	1319	1940	1079	1017	524	1298	842	402	138	109	123	274	74	46	23	12	8	6	9	4	0	0	0	0	2	0	1
29	1487	1716	913	1797	1023	987	613	1223	706	489	191	134	143	266	86	60	20	15	13	7	7	9	0	0	0	0	2	0	3
30	1615	1510	845	1501	1069	1140	767	1371	792	681	295	195	172	252	118	90	31	25	20	12	13	11	0	1	1	1	4	0	6
31	1960	1106	632	1450	1180	890	802	1378	609	719	359	239	182	209	105	102	27	21	21	13	16	9	1	1	0	1	1	0	0
32	1951	1472	772	1484	1197	912	847	1491	601	888	411	292	285	220	160	95	49	29	35	23	27	11	2	3	2	1	1	0	3
33	2288	1313	601	1126	1378	878	898	1444	517	780	525	377	176	201	167	84	56	26	40	47	23	11	2	2	2	1	0	1	3
34	1581	1299	572	1160	1001	849	853	1255	542	745	551	376	192	156	131	83	56	31	51	43	37	22	5	3	2	1	5	1	4
35	1487	952	518	1044	915	855	745	963	506	637	569	432	200	148	96	91	53	26	48	46	25	18	4	5	2	1	5	2	6
36	1161	634	407	879	776	901	611	744	433	527	484	360	176	120	110	85	56	21	42	36	22	15	4	5	1	1	2	1	2
37	838	545	284	651	627	736	546	580	348	484	417	321	175	143	106	111	70	31	51	49	31	17	7	5	2	1	3	1	2
38	1196	608	294	616	545	682	621	542	346	534	425	308	128	110	76	72	86	35	61	38	28	20	6	9	2	1	1	1	4
39	837	451	226	600	505	510	475	425	285	406	292	240	128	85	95	79	65	27	43	36	21	14	6	12	3	1	2	1	3
40	501	325	199	450	666	573	412	455	284	466	393	218	115	65	76	60	90	24	55	39	32	21	7	19	4	1	4	3	7
41	428	288	165	375	431	385	321	321	213	399	312	182	112	58	88	48	60	21	40	32	23	16	8	13	4	1	1	1	1
42	367	287	144	220	362	375	314	214	182	360	249	210	66	57	81	54	101	22	47	43	26	14	6	12	6	1	1	1	3
43	433	296	156	203	425	307	293	188	165	325	292	219	64	36	76	47	73	25	38	49	25	13	9	12	4	1	1	2	2
44	164	277	87	136	301	251	200	152	127	290	207	193	61	44	52	33	62	20	32	38	36	13	10	11	4	0	3	1	4
45	165	286	58	110	303	219	178	125	118	218	196	162	58	42	44	34	56	17	18	29	17	12	8	11	5	0	3	1	8
46	96	135	23	90	350	153	129	116	94	191	178	152	40	28	49	26	29	20	18	24	18	8	10	10	3	0	1	0	1
47	94	117	45	82	228	104	92	84	56	123	120	84	38	47	42	31	38	26	18	28	17	8	8	9	4	0	1	0	4
48	71	100	25	49	222	58	96	55	70	117	147	96	23	18	22	13	28	18	12	15	16	7	7	4	3	1	1	0	2
49	73	76	29	42	148	84	71	46	23	60	105	64	21	16	15	16	18	13	11	14	9	5	7	8	3	0	1	0	3
50	83	127	14	46	63	81	69	29	31	81	95	54	17	12	12	15	16	15	13	14	9	9	10	9	3	0	2	0	5
51	15	48	9	14	71	27	59	13	21	43	59	21	17	6	7	15	7	15	7	7	9	6	4	3	3	0	0	0	2
52	20	75	14	33	71	21	59	18	22	43	55	30	18	6	7	10	12	10	8	10	9	6	5	4	3	0	0	0	1
53	23	34	13	26	34	20	28	6	13	30	37	33	5	5	6	10	5	7	6	8	4	6	5	3	2	0	0	0	1
54	14	10	11	23	23	14	12	6	15	42	28	27	8	3	2	8	4	11	10	6	7	4	5	3	3	0	1	0	1
55	6	27	1	6	13	17	12	1	9	25	26	12	6	7	3	4	5	8	3	6	6	5	7	3	1	0	1	0	2
56	6	9	1	5	5	10	5	1	9	14	14	14	7	4	3	5	3	4	2	3	6	6	4	2	1	0	0	0	0
57	10	5	1	2	6	5	10	0	4	8	12	6	5	3	3	2	2	3	2	4	5	5	3	1	0	0	0	0	0
58	11	5	1	4	6	5	14	0	3	6	11	5	4	5	4	3	3	4	4	4	5	5	4	2	0	0	1	0	0
59	7	0	4	0	7	2	7	0	0	2	1	5	3	3	0	1	4	3	1	3	2	2	1	1	1	0	0	0	0
60	2	0	2	0	4	3	3	0	0	1	2	3	2	2	2	2	7	4	2	1	3	3	4	2	1	0	1	0	1
61	4	0	1	0	3	2	12	0	0	0	2	0	3	2	0	2	1	14	1	2	1	1	3	1	1	0	0	0	1
62	2	0	1	0	1	0	7	0	0	0	0	0	1	5	0	2	2	4	2	1	3	2	1	1	1	0	0	0	0
63	1	0	1	0	3	0	5	0	0	1	0	0	3	3	0	2	1	2	1	1	1	1	2	1	0	0	0	0	0
64	2	0	1	0	3	1	4	0	0	0	1	0	2	2	0	2	1	1	1	1	2	3	2	1	0	0	0	0	0
65	2	0	1	0	1	0	2	0	0	0	0	0	1	1	1	1	2	2	1	1	1	2	2	1	0	0	0	0	0
66	3	0	1	0	1	0	2	0	0	0	1	0	2	2	0	1	0	1	1	1	1	1	1	0	1	0	0	0	0
67	2	4	1	0	1	1	1	0	0	0	1	0	3	1	0	2	1	2	1	1	1	1	1	0	0	0	0	0	0
68	2	11	1	0	2	2	6	0	0	0	0	0	2	1	0	2	1	1	2	2	2	1	2	1	0	0	0	0	0
69	1	4	1	0	1	1	0	0	0	0	0	0	2	1	0	1	1	1	2	1	1	1	1	0	1	0	0	0	0
70	12	25	1	2	12	6	8	0	1	0	3	0	11	1	1	5	4	8	1	1	4	1	1	1	0	0	0	0	1
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	1	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Total number (thousand)	22409	31275	29319	23087	17811	15360	12003	17411	11828	10827	7383	5302	3822	5712	2169	1666	1257	638	800	752	569	355	191	201	81	20	60	23	92
Total weight (t)	727	708	450	603	636	522	448	511	331	432	344	246	132	132	87	72	70	42	44	46	36	25	19	16	7	2	4	1	6
Mean weight (kg)	0.032	0.023	0.015	0.026	0.036	0.034	0.037	0.029	0.028	0.040	0.047	0.046	0.035	0.023	0.040	0.043	0.056	0.066	0.057	0.061	0.063	0.071	0.099	0.080	0.086	0.081	0.059	0.057	0.069
CL Mean length (mm)	34.0	29.1	25.9	31.4	34.5	34.3	35.2	32.9	31.9	36.2	38.1	38.1	33.5	29.5	36.0	36.2	40.2	42.0	40.0	41.3	41.5	42.6	48.4	46.5	46.1	35.8	39.4	42.0	42.2

Table 13.1.3. *Nephrops* FU26-27, West Galicia and North Portugal. Fishing effort and LPUE for SP-MATR fleet.

		SP-MATR	
Year	Landings (t)	trips	LPUE (kg/trip)
1994	234	2692	113.9
1995	267	2859	93.3
1996	158	3191	49.5
1997	245	3702	66.3
1998	188	2857	66.0
1999	134	2714	49.5
2000	72	2479	28.9
2001	80	2374	33.6
2002	52	1671	31.2
2003	59	1597	24.0
2004	31	1980	19.3
2005	17	1629	10.3
2006	18	1547	11.9
2007	22	1196	18.0
2008	17	980	17.3
2009	15	854	17.4
2010	8	539	15.4
2011	4	543	6.4
2012	1	492	2.2
2013	<1	419	1.0
2014	<1	494	0.8
2015	<1	384	0.7
2016	<1	403	0.6
2017	<1	390	0.3
2018	<1	398	0.9

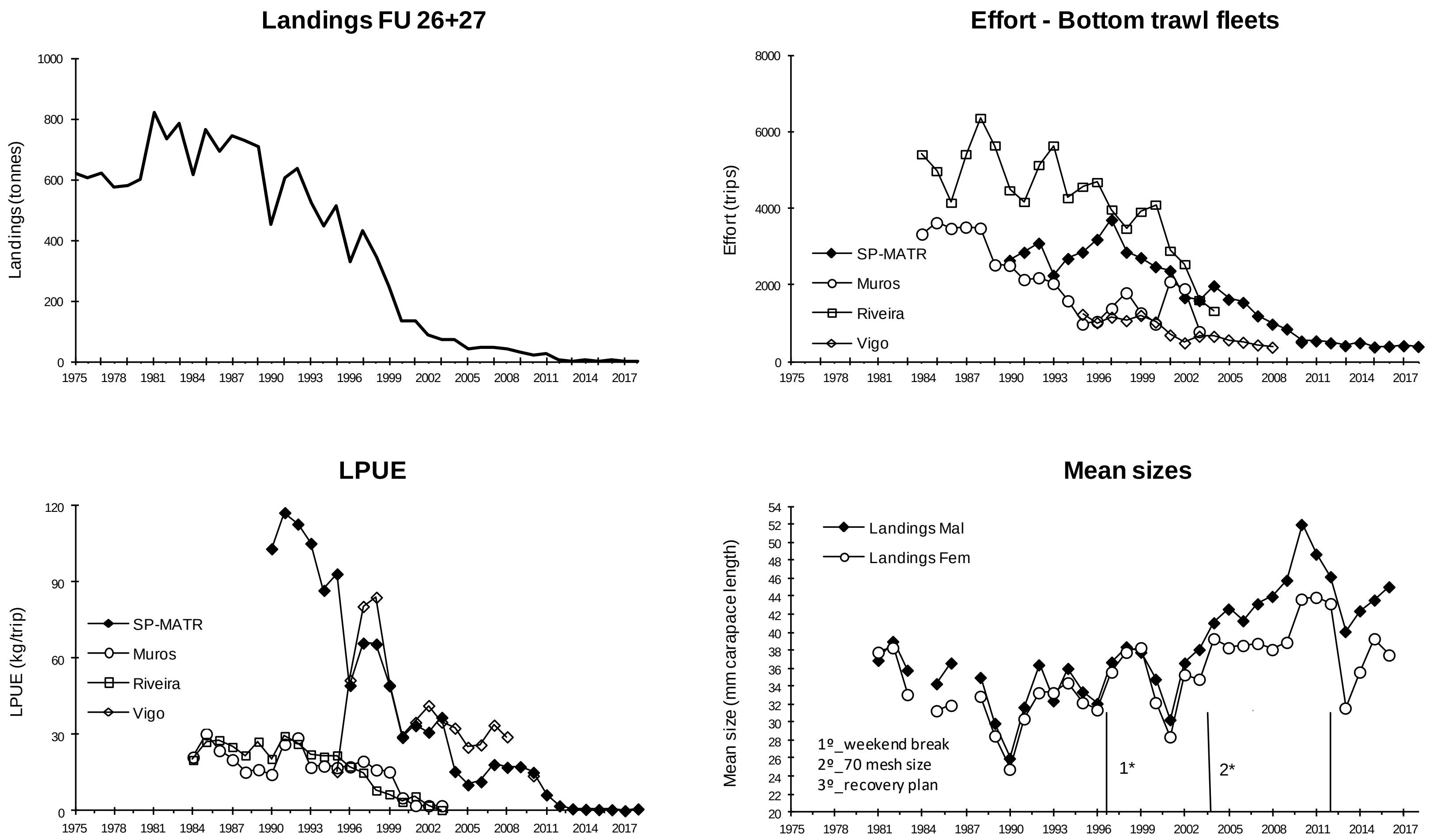
Table 13.1.4. *Nephrops* FU26–27, West Galicia and North Portugal: Biomass and Abundance index from Spanish bottom trawl survey (SP-NSGFS) in FU26.

Year	SP-NSGFS survey index in FU 26			
	Kg / haul		Nº / haul	
	Yst	SE	Yst	SE
1983	0.40	0.16	15.10	6.44
1984	0.24	0.09	9.90	3.72
1985	0.14	0.06	9.10	4.67
1986	0.49	0.19	21.90	8.60
1987	n.a	n.a	n.a	n.a
1988	0.60	0.27	25.00	10.34
1989	0.40	0.11	20.41	5.28
1990	0.55	0.21	20.80	7.41
1991	0.67	0.33	25.40	12.33
1992	0.38	0.16	15.20	5.85
1993	0.12	0.10	4.80	3.89
1994	0.06	0.02	1.50	0.61
1995	0.28	0.16	10.50	6.57
1996	0.08	0.05	4.20	2.48
1997	0.05	0.02	1.10	0.32
1998	0.13	0.09	1.80	1.22
1999	0.18	0.06	4.30	1.52
2000	0.08	0.04	1.50	0.70
2001	0.31	0.15	8.30	3.72
2002	0.02	0.01	0.40	0.15
2003	0.04	0.02	0.60	0.25
2004	0.02	0.01	0.45	0.12
2005	0.00	0.00	0.05	0.05
2006	0.02	0.02	0.48	0.25
2007	0.01	0.01	0.16	0.08
2008	0.02	0.01	0.27	0.10
2009	0.02	0.02	0.30	0.30
2010	0.04	0.02	0.87	0.45
2011	0.01	0.00	0.12	0.09
2012	0.01	0.01	0.07	0.07
2013	0.04	0.02	0.46	0.18
2014	0.01	0.01	0.12	0.08
2015	0.01	0.01	0.16	0.13
2016	0.02	0.02	0.24	0.15
2017	0.01	0.01	0.07	0.07
2018	0.00	0.00	0.05	0.05

Table 13.1.5. *Nephrops* FU26–27, West Galicia and North Portugal. Results from the application of the Mean Length Z approach.

		Combined sexes
	Input:	
	LFD period	1988-2016
	Effort series	1990-2018
	W~L relationship	
	a =	0.00043
	b =	3.16
	External M*	0.2

Method	Results	
Gedamke & Hoenig	Z =	0.3278722
	F* =	0.1278722
THoG	q estimate =	1.2588638
	q estimate* =	1.214027
	M estimate =	0.1901158
	F2016 estimate =	0.05073221
	F2016 estimate* =	0.0489253
Y/R	FMSY proxy: F0.1 =	0.16
	F/FMSY =	0.79920125



1* -weekend break in West Galicia, 2*- 70 mm mesh size, 3*-recovery plan

Figure 13.1.1. ***Nephrops*** **FU26–27, West Galicia and North Portugal. Long-term trends in landings, effort and mean sizes.**

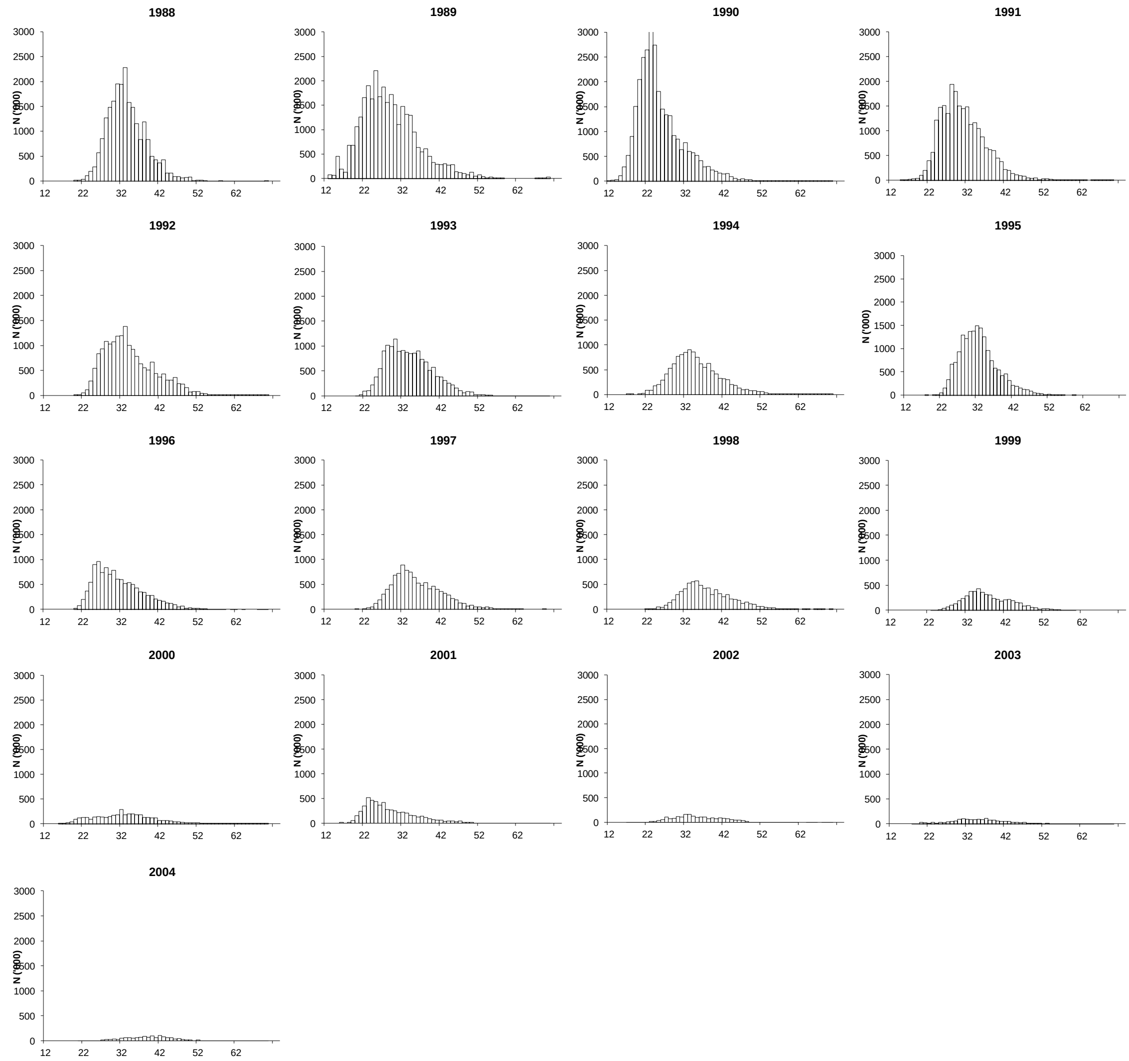


Figure 13.1.2a. *Nephrops* FU26–27. West Galicia and North Portugal. Length distributions in landings for the 1988–2004 period.

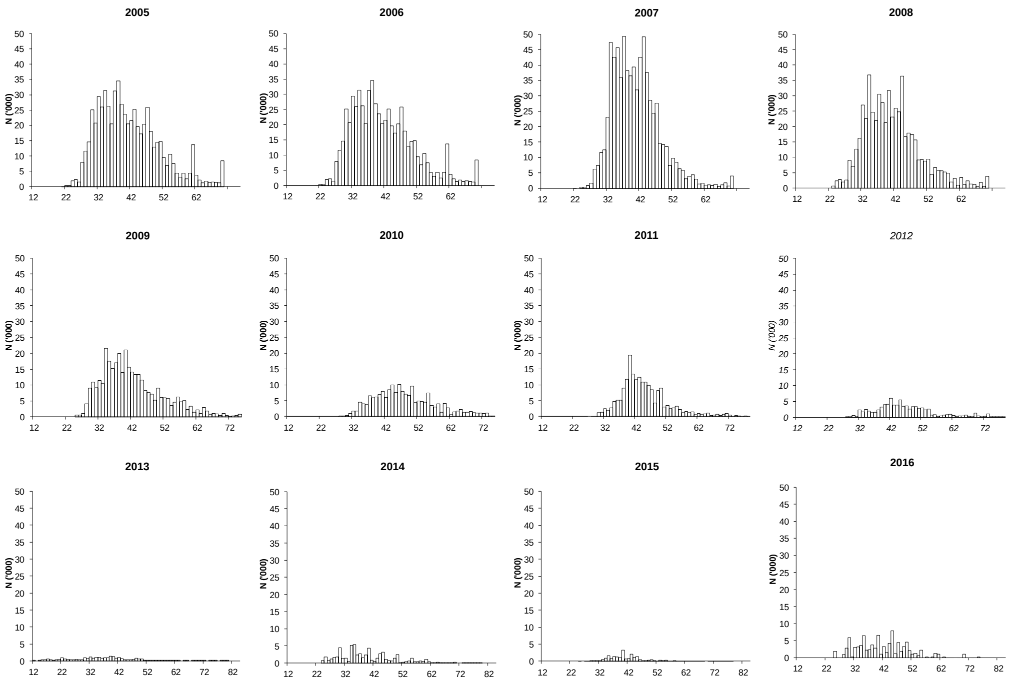


Figure 13.1.2b. ***Nephrops*** **FU26–27. West Galicia and North Portugal. Length distributions in landings for the 2005–2016 period. Data not available in 2017 and 2018.**

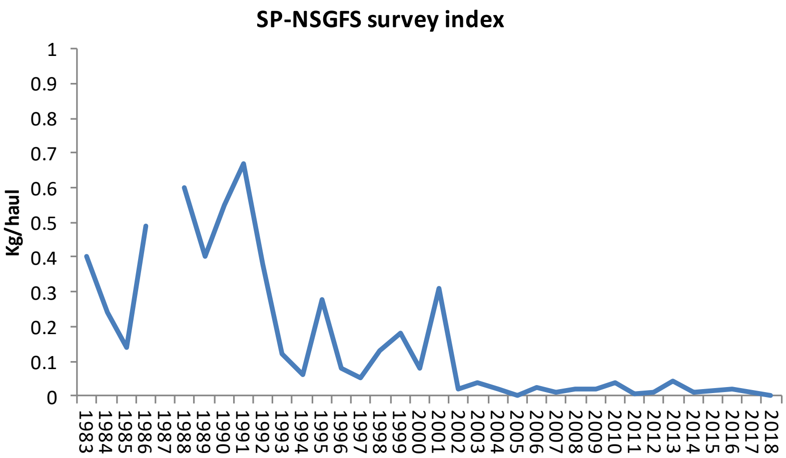


Figure 13.1.3. ***Nephrops*** **FU26–27. West Galicia and North Portugal. Abundance index from Spanish bottom trawl survey (SP-NSGFS) in FU26. Data no available in 1987.**

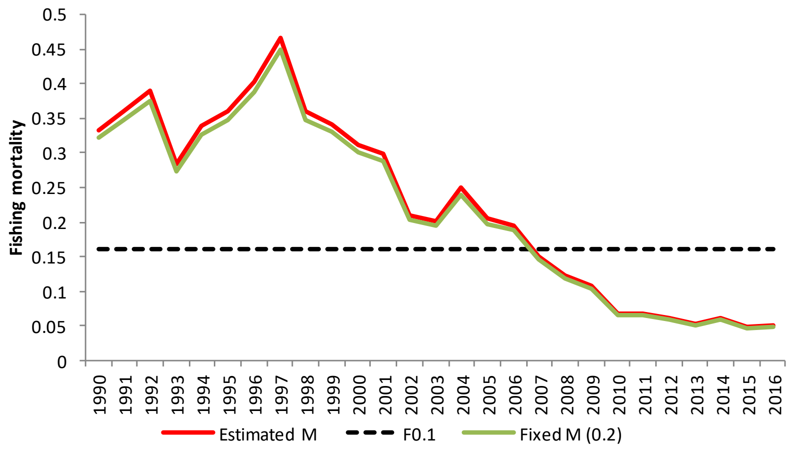


Figure 13.1.4. *Nephrops* FU26–27. West Galicia and North Portugal. Fishing mortality from THoG model using an external fixed M or an M estimated by the model.

13.2 FU 28 - 29 (SW and S Portugal)

13.2.1 General

13.2.1.1 Ecosystem aspects

See the Stock Annex (in Annex L of WG report)

13.2.1.2 Fishery description

See the Stock Annex (in Annex L of WG report)

13.2.1.3 ICES Advice and Management applicable for 2015 and 2016

ICES Advice for 2019

The advice for these stocks is biennial and valid for 2018-2019. Based on the ICES approach for data-limited stocks, ICES advised that catches in 2019 for FUs 28 and 29 should be no more than 281 tonnes.

To protect the stock in this Functional Unit, ICES advises that management area should be consistent with the assessment area. Therefore, management should be implemented at the Functional Unit level.

Management applicable for 2018 and 2019

A recovery plan for southern hake and Iberian *Nephrops* stocks has been in force since the end of January 2006. The aim of the recovery plan is to rebuild the stocks within 10 years, with a reduction of 10% in F relative to the previous year and the TAC set accordingly (Council Regulation (EC) No. 2166/2005). This plan is based on precautionary reference points for southern hake that are no longer appropriate.

In order to reduce F on *Nephrops* stocks in Subarea 9.a even further, seasonal restrictions were introduced in the trawl and creel fishery for two boxes (geographic areas) located in FU 26 and in FU 28, in the peak of the *Nephrops* fishing season. These restrictions are applied to *Nephrops* fishing in these boxes in June–August and May–August, respectively (amendment to Council Regulation (EC) 850/98).

ICES has not evaluated the recovery plan for *Nephrops* in relation to the precautionary approach. A new Management Plan for Western Waters was established in 2019 for demersal species including *Nephrops* in these FUs (Regulation (EU) 2019/472, of 19 March 2019).

The TAC set for the whole Subarea 9.a was 381 and 401 t for 2018 and 2019, respectively, of which no more than 6 % may be taken in FUs 26 and 27. The maximum number of fishing days for vessels operating under effort limitations was fixed at 129 days per vessel for Spanish vessels, 113 days for Portuguese vessels for these two years and 109 days for French vessels (Annex II B of Council Regulation 120/2018 and Annex II A of CR 124/2019). The number of fishing days included in these regulations is not applicable to the Gulf of Cadiz (FU 30), which has a different effort management regime.

13.2.2 Data

13.2.2.1 Commercial catches and discards

Table 13.2.1 and Figure 13.2.1 show the landings data series for these Functional Units (FUs). For the time period 1984 to 1992, the recorded landings from FUs 28 and 29 have fluctuated between 420 and 530 t, with a long-term average of about 480 t, falling drastically in the period 1990–1996, down to 132 t. From 1997 to 2005 landings have increased to levels observed during the early

1990s and decreased until 2009. The landings value was approximately at the same level (≈ 150 t) in 2009-2011, presenting an increasing trend in the last period of the series. In recent years, the reduced TAC has limited the fishing activity, and the fishery has been closed for 1 – 2 months in the 2nd semester from 2013 onwards.

Since 2011, landings include the Spanish official landings. Spanish vessels are licensed for crustaceans in these FUs under a bilateral agreement since 2004. No data from these vessels' operation is available prior to 2011.

Spanish official landings are derived from logbooks. This source of information allows landings disaggregation by ICES statistical rectangles. In 2012 and 2013, *Nephrops* catches recorded in statistical rectangles outside the FUs in Division 9.a were allocated to the closest rectangles in each FU. In 2014-2017, 100% of the caches were into FU 28-29 definition.

Males are the dominant component in most of the years in the time series with exception for 1995 and 1996 when total female landings exceeded male landings (ICES, 2006). The male:female ratio in 2017 and 2018 were 1:1 and 1.3:1, respectively.

Information on discards and on the sampling program was sent to the WG through ICES Accessions. The frequency of *Nephrops* occurrence in discards samples is very low. Discards are negligible in this fishery and mostly due to quality and not related to MLS (20 mm of carapace length). Only in 2013, the occurrence of *Nephrops* in discards samples was greater than 30% and a total amount of 3 t was estimated, with a high coefficient of variation (CV = 58%).

13.2.2.2 Biological sampling

Length distributions for both males and females for the Portuguese trawl landings are obtained from samples taken weekly at the main auction port, Vila Real de Sto. António. Sampling frequency in 2018 was at the same level as in previous years, in the months when the Norway lobster fishing was open. The sampling data are raised to the total landings by market size category, vessel and month.

The length compositions of the landings are presented in Tables 13.2.2a-b and Figures 13.2.2a-b. The number of samples and measured individuals are presented in Table 1.4a.

13.2.2.3 Biomass indices from surveys

Trawl surveys

Since 1997, groundfish (PtGFS-WIBTS-Q4) and crustacean trawl surveys (PT-CTS UWTV FU 28-29) were carried out every year, covering FUs 28 and 29. Table 13.2.4 and Figure 13.2.1 shows the average *Nephrops* CPUEs (kg/h trawling) from the crustacean trawl surveys, which can be used as an overall biomass index. As the surveys were performed with a smaller mesh size than the commercial fishery, this information provides a better estimation of the abundance for the smaller lengths of *Nephrops*. There was an increase in the overall biomass index in the period 2003-2005, and also of small individuals in a particular juvenile concentration area in 2005, which could be an indication of higher recruitment.

The R/V "NORUEGA" had some technical problems in 2010 and could not trawl in areas deeper than 600 m. The survey plan had to be adapted accordingly. The CPUE value estimated for 2010, the highest from the series, was probably affected by this change. In 2011, due to engine failure, the survey did not cover the whole area of *Nephrops* distribution. No CPUE index was presented for this year. Budgetary constraints of national scope turned unfeasible to repair the R/V NORUEGA and the chartering of another research vessel and therefore no survey was conducted in 2012.

The biomass index estimated from the 2013 survey is only comparable to the value of 2009, which covered the same area. Comparing the fraction of the area covered in 2011 and the same area in 2013, the biomass of *Nephrops* increased in the area of Alentejo (FU 28). The survey in 2011 did not cover the main area of concentration in Algarve (FU29).

The survey area was adapted in 2014 taking into account the information from the fishing grounds obtained from VMS data. Figure 13.2.3 shows the spatial distribution of the survey biomass index in the last 4 years.

UWTV experiments

In 2005 and 2007, some experiments to collect UWTV images from the *Nephrops* fishing grounds were made with a camera hanged from the trawl headline. In 2008, the images collected from 9 stations in FU 28 with the same procedure looked very promising. In 2009 survey, a two-beam laser pointer was attached to the camera and UWTV images were recorded from 58 of the 65 stations. The trawling speed and the turbidity were the main problems affecting the clarity of the image and the high variation of the height of the camera to the ground resulted in a variable field of view. It is not guaranteed that this method can be used for abundance estimation (information presented to SGNEPS 2012 – Study Group of *Nephrops* Surveys (ICES, 2012b).

13.2.2.4 Mean sizes

Mean carapace length (CL) data for males and females in the landings and surveys are presented for the period 1994-2018 (Table 13.2.5). Figure 13.2.1 shows the mean CL trends since 1984. The mean sizes of males and females have fluctuated along the period with no apparent trend.

13.2.2.5 Commercial catch-effort data

The effort in 2003–2004 corresponds to only eleven months of fleet operation for each year as the crustacean fishery was experimentally closed in January 2003 and 30 days for *Nephrops* in September–October 2004.

A Portuguese national regulation (Portaria no. 1142, 13th September 2004) closed the crustacean fishery in January-February 2005 and enforced a ban in *Nephrops* fishing for 30 days in September – October 2005. As a result, the effort in 2005 corresponds to nine months.

The recovery plan for southern hake and Iberian *Nephrops* stocks was approved in December 2005 and entered in force at the end of January 2006. This recovery plan includes a reduction of 10% in F relative to the previous year (Council Regulation (EC) No 2166/2005). As a result, the number of fishing days per vessel was progressively reduced. Additional days were allocated in 2010 to Spanish and Portuguese vessels on the basis of permanent cessation of vessels from each country (Commission Decisions nos. 2010/370/EU and 2010/415/EU).

Besides this effort reduction, the Council Regulation (EC) No 850/98 was amended with the introduction of two boxes in Division 9.a, one of them located in FU 28. In the period of higher catches (May-August), this box is closed for *Nephrops* fishing (Council Regulation (EC) No 2166/2005). By way of derogation, fishing with bottom trawls in these areas and periods is authorised provided that the by-catch of Norway lobster does not exceed 2 % of the total weight of the catch. The same applies to creels that do not catch *Nephrops*.

The effort reduction measures were combined with a national regulation closing the crustacean fishery every year in January (Portaria no. 43, 12th January 2006). In 2016, this period was extended for February. Besides the closed season, in 2013-2016, the Portuguese vessels had to stop fishing for 1.5 to 2 months, in October-November, due to quota limitations. In regard to the Spanish fleet, the number of fishing days was reduced, due to sanctions imposed by EC related to the catches over quota in 2012, affecting also the operation of this fleet in the Portuguese fishing grounds in the period 2013-2015.

Crustacean vessels target two main species, rose shrimp and Norway lobster, which have different market value. Depending on their abundance/availability, the effort is mostly directed at one species or the other (Figure 13.2.4). A standardized CPUE series for *Nephrops* (Figure 13.2.5) is used to estimate the fishing effort in standard hours. The model used to standardize the CPUE is described in the stock annex. An exploratory analysis was carried out aiming a better definition of the fishing areas and depths and to separate the Functional Units 28 and 29. Although not changing the model, this exploratory work was incorporated in the analysis, excluding the records in fishing areas and depths with no *Nephrops*. As a result, the variability explained by the model increased from 33% to 51% (Table 13.2.6).
In the period 2008-2018, the standardized fishing effort has fluctuated around an average of approximately 40 thousand hours (Table 13.2.3).

13.2.3 Assessment

The advice for this stock is biennial. The stock data were updated with the new information from 2017 and 2018.

The advice is based on the standardized commercial CPUE and effort trends. According the ICES data-limited approach, this stock is classified in the category 3.2.0 (ICES, 2012).

The standardized effort (Figure 13.2.1) shows a consistent declining trend since 2005 reaching a historic low in 2009–2010. Since then, the effort has fluctuated at a low level due to quota reduction derived from the application of the former recovery plan rules.

The standardized commercial CPUE (Figure 13.2.5), used as index of biomass, decreased in the period 2006–2011 reversing the downward trend in recent years. The crustacean survey biomass index also shows an increasing trend in 2014–2018 (Figure 13.2.3).

Length-based indicators were used to assess the status of the conservation of the stock. The ratios L_c/L_{mat} and $L_{25\%}/L_{mat}$ indicate that immature individuals are preserved. However, P_{mega}<30% indicates a truncated length distribution of the female catch, which may be explained by their reproductive behaviour, not leaving the burrows during the egg-bearing period (Table 13.2.7 and Figure 13.2.6).

Assuming a constant M of 0.3 for males and 0.2 for females, F was estimated using the Mean Length Z method, as defined in WKLIFE-V (ICES, 2015) and WKProxy (ICES, 2016). The input data and the output of Gedamke & Hoenig (G&H) and Then, Hoenig & Gedamke (THoG) models are summarized in (Table 13.2.8). Figures 13.2.7 and 13.2.8 show the model diagnostics for G&H model and the F series estimated by the THoG model.

G&H model with two periods gives the better fit and a lower AIC. For the last period, fishing mortality was estimated at 0.18 for males and 0.10 for females.

The results indicate that the stock is exploited at a level below the F_{MSY} proxy, either with the Gedamke & Hoenig model or with the THoG model, although the latter gives much lower F values. The M value estimated by the THoG model is also greater than the fixed M, historically assumed for *Nephrops* stocks. The results of the models were accepted using fixed values for M (0.3 for males and 0.2 for females) which give higher F values, although still below F_{MSY}.

13.2.4 Biological reference points

Proxies of MSY reference points were reviewed in WGBIE 2017 using the methods developed in WKLIFE and WKProxy (ICES, 2015, 2016). From length-based analysis of the period 1984-2016, $F_{0.1}$ was estimated at 0.23 for males and 0.24 for females, as proxies of F_{MSY}. No proxy for B_{MSY} was identified (ICES, 2017).

13.2.5 Management considerations

Nephrops is taken by a multi-species and mixed bottom trawl fishery.

A recovery plan for southern hake and Iberian *Nephrops* stocks was approved in December 2005 and in action since the end of January 2006. This recovery plan includes a reduction of 10% in the hake F relative to the previous year and TAC set accordingly, within the limits of ±15% of the previous year TAC (Council Regulation (EC) No 2166/2005). Although no clear targets were defined for Norway lobster stocks in the plan, the same 10% reduction has been applied to these stocks TAC. The number of allowed fishing days is set in each year EU regulation fixing the fishing opportunities for fish stocks, applicable in Union waters. The recovery plan target and rules have not been changed since it was implemented. Although not revoked, the enforcement of the plan has been relaxed in the last two years and, in March 2019, a new multiannual plan for stocks fished in the Western Waters (including the *Nephrops* stocks in these FUs) and adjacent waters was established, repealing the previous recovery plan.

Besides the recovery plan, the Council Regulation (EC) No 850/98 was amended with the introduction of two boxes in Division 9.a, one of them located in FU 28. In the period of higher catches (May-August), these boxes are closed for *Nephrops* fishing (Council Regulation (EC) No 2166/2005). By derogation, fishing with bottom trawls in these areas and periods are authorised provided that the by-catch of Norway lobster does not exceed 2 % of the total weight of the catch. The same applies to creels that do not catch *Nephrops*.

With the aim of reducing effort on crustacean stocks, a Portuguese national regulation (Portaria no. 1142, 13th September 2004) closed the crustacean fishery in January-February 2005 and enforced a ban in *Nephrops* fishing for 30 days in September–October 2005, in FUs 28-29. This regulation was revoked in January 2006, after the entry in force of the recovery plan and the amendment to the Council Regulation (EC) No 850/98, keeping only one month of closure of the crustacean fishery in January (Portaria no. 43/2006, of 12th January 2006). This period was extended for one more month in 2016 (Portaria no. 8-A/2016, of 28th January 2016), for this year only. The national regulations are only applicable to the Portuguese fleet.

Portugal and Spain have bilateral agreements for fishing in each other waters. The agreement for the period 2004-2013 was reviewed and extended for 2014-2016. Under this agreement a number of Spanish trawlers are licensed to fish crustaceans in Portuguese waters. No information from landings of these vessels is available for the years prior to 2011.

13.2.6 References

ICES. 2012c. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp.

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13.2.7 Tables and Figures

Table 13.2.1. ***Nephrops* in South-West and South Portugal (FU 28-29). Total landings per country (tonnes).**

Year	FU 28+29 SW+S Portugal					
	28***	29	28+29			Total
	Spain	Spain	Portugal			
	Trawl	Trawl	Artisanal	Trawl	Total	
1975	137	1510		34	34	1681
1976	132	1752		30	30	1914
1977	95	1764		15	15	1874
1978	120	1979		45	45	2144
1979	96	1532		102	102	1730
1980	193	1300		147	147	1640
1981	270	1033		128	128	1431
1982	130	1177		86	86	1393
1983				244	244	244
1984				461	461	461
1985				509	509	509
1986				465	465	465
1987			11	498	509	509
1988			15	405	420	420
1989			6	463	469	469
1990			4	520	524	524
1991			5	473	478	478
1992			1	469	470	470
1993			1	376	377	377
1994				237	237	237
1995			1	272	273	273
1996			4	128	132	132
1997			2	134	136	136
1998			2	159	161	161

Year	FU 28+29 SW+S Portugal					
	28***	29	28+29			Total
	Spain	Spain	Portugal			
	Trawl	Trawl	Artisanal	Trawl	Total	
1999			5	206	211	211
2000			4	197	201	201
2001			2	269	271	271
2002			1	358	359	359
2003			35	335	370	370
2004			31	345	375	375
2005			31	360	391	391
2006			17	274	291	291
2007			18	274	291	291
2008			35	188	223	223
2009			17	133	151	151
2010			16	131	147	147
2011		17	16	117	133	150
2012	0	14	3	211	214	229
2013		10	1	198	199	209
2014		8	3	183	186	193
2015		12	4	231	235	247
2016		21	8	254	262	283
2017		26	9	241	249	275
2018**		25	10	263	273	299
**	**Preliminary values**					
***	**Spanish landings from FU28 included in FU29**					

Table 13.2.2.a. FU 28-29 - Length Composition of *Nephrops* Males (1984-2018)

Landings	(thousands)													
Age/Year	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
17														
18														
19					4	21					0			
20			0	16	4			6	4					
21		17	9			84		16	37	9				
22	7	5	14	15		97	9	29	96	38	9			
23	24	7	7	8		143	5	19	55	34			8	4
24	14	40	121	209	51	272	27	53	202	42	18		17	9
25	109	83	115	81	97	229	116	69	181	149	34	3	23	6
26	250	170	137	446	128	205	182	111	263	72	68	0	36	43
27	282	326	170	718	208	269	149	94	185	95	77	0	54	95
28	374	500	289	871	399	280	337	139	506	272	157	0	56	78
29	439	559	341	727	456	283	415	159	462	382	95	28	38	88
30	412	742	328	584	442	317	695	239	725	548	187	11	68	104
31	277	670	389	742	457	230	813	325	755	548	231	24	92	172
32	373	784	680	806	446	367	866	260	670	674	383	108	151	283
33	339	531	213	236	428	265	702	133	345	365	149	83	70	90
34	389	635	609	721	656	328	785	239	451	655	270	215	159	251
35	478	525	590	245	664	291	755	171	296	475	224	169	147	169
36	378	463	519	342	572	295	449	138	399	639	221	147	78	154
37	528	346	322	406	424	356	465	77	351	391	107	262	172	149
38	496	383	606	355	571	302	479	120	378	344	179	134	113	58
39	353	309	361	240	326	332	611	126	348	306	95	151	62	46
40	447	337	323	156	366	316	829	200	248	174	144	232	83	82
41	247	230	316	335	164	314	797	141	243	158	93	247	78	37
42	371	246	507	264	215	360	628	174	246	170	168	293	85	33
43	199	156	198	62	102	364	335	121	242	107	127	65	31	21
44	194	233	422	215	128	481	553	125	371	179	150	88	42	28
45	165	144	233	206	93	339	324	90	220	150	87	27	22	21
46	148	178	189	170	72	231	228	128	167	55	79	58	21	33
47	129	161	140	74	76	191	202	122	191	96	68	31	38	20
48	176	212	149	79	85	193	121	62	178	102	78	25	15	9
49	89	138	104	58	43	73	92	78	111	47	47	16	20	4
50	91	142	50	34	53	94	58	67	69	30	50	12	9	3
51	66	120	63	27	34	114	59	44	50	38	29	4	6	7
52	64	135	66	44	38	77	33	40	35	15	46	11	16	7
53	45	99	32	37	23	40	19	16	29	18	22	5	6	6
54	73	101	35	45	22	35	27	29	50	23	18	5	8	16
55	20	67	25	31	22	37	30	26	29	19	9	3	4	10
56	20	35	14	20	16	20	30	19	5	5	11	2	4	3
57	10	33	5	15	12	22	7	10	6	5	11	3	7	16
58	13	14	8	14	11	17	14		11	4	6		5	3
59	7	10	3	9	4	16	5	2	9	3	10	0	5	2
60	3	6	3	4	3	13	2		10	8	1	1	1	4
61	3	1	4	4	1	5		1	3	2	1	0	1	9
62	3	1	2	1	2	3		1	7	5	1		2	7
63	1	1		1	1	4		5	0	1	0		2	3
64		2	0	2	1			1	3	1	2		0	4
65	0	0		2	2				3	1	1		0	4
66	0			0	1					1			0	4
67	0			0	0	0			6	5				6
68					0	2				0	1			0
69				0										0
70	0			1		0				2				0
71										0				
72				0		0				1				
73														0
74	0									1				
75														
76														
77														
78		0			0									
79														
80									0					
81														
82														
83														
Total	**8106**	**9897**	**8709**	**9679**	**7925**	**8329**	**12255**	**4023**	**9249**	**7463**	**3766**	**2466**	**1854**	**2200**
Landings (t)	**292**	**353**	**315**	**277**	**249**	**318**	**351**	**345**	**304**	**232**	**139**	**98**	**65**	**74**

Table 13.2.2.a. FU 28-29 - Length Composition of *Nephrops* Males (1984-2018) (continued)

Landings Age/Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
17														
18														
19						0				2	0			
20		4				0		4		3	1	0	0	
21		3	3	0	2	0	0	33		5	0	0	0	
22	2	0	16	1	2	13	4	51	10	20	8	2		0
23		5	8	3	1	3	15	32	22	31	10	4		1
24	8	9	20	5	2	11	20	107	53	53	26	29	8	0
25	16	39	13	6	3	40	45	120	46	65	28	30	10	1
26	32	33	58	8	11	56	126	153	75	121	32	38	8	3
27	81	49	85	24	24	87	187	206	94	111	52	63	22	6
28	65	68	44	24	48	62	205	286	144	141	60	89	14	4
29	65	109	148	53	60	147	246	330	220	189	62	83	33	5
30	160	133	87	74	139	248	300	533	290	297	60	129	44	5
31	129	272	111	92	123	188	277	573	270	256	93	116	75	22
32	289	88	161	274	233	325	475	757	378	295	129	135	116	32
33	95	182	92	139	281	248	352	437	247	246	108	80	78	21
34	269	152	160	224	257	264	352	574	311	327	150	94	104	52
35	118	175	100	173	274	275	347	333	194	252	121	76	83	31
36	166	143	158	163	265	195	224	263	168	256	83	59	77	34
37	167	128	162	167	247	234	167	293	172	224	109	57	78	64
38	85	75	106	99	254	197	147	226	164	265	73	58	125	69
39	47	180	81	109	229	174	93	175	100	173	75	61	71	39
40	83	83	96	159	254	215	165	152	100	188	77	63	84	44
41	53	184	102	130	163	163	108	129	125	163	102	53	55	49
42	167	58	91	195	163	168	177	152	190	198	128	105	75	68
43	43	102	47	181	167	172	113	118	95	82	76	38	51	45
44	69	63	86	173	122	121	122	176	144	90	61	51	65	43
45	34	111	61	140	113	103	131	140	96	83	60	25	39	19
46	38	67	85	144	106	76	103	117	118	71	38	25	26	15
47	34	59	88	120	111	75	97	113	61	60	48	25	43	18
48	24	40	55	80	104	83	90	66	54	65	48	23	35	12
49	13	50	37	79	86	59	58	52	41	38	34	24	23	12
50	33	32	65	93	103	94	82	69	28	42	36	20	25	11
51	14	32	34	71	72	65	41	40	30	37	27	17	20	15
52	31	8	53	88	94	73	65	45	37	48	29	32	30	24
53	11	13	18	41	69	58	31	22	22	21	24	13	16	9
54	19	15	31	54	53	57	50	24	33	27	23	19	21	24
55	8	9	19	34	28	46	26	12	15	10	20	12	14	15
56	6	13	19	29	43	29	57	14	11	8	15	13	8	25
57	8	8	19	37	37	25	16	9	6	6	17	11	9	25
58	5	4	13	23	26	21	12	9	7	7	20	7	11	45
59	3	4	10	15	16	13	15	8	9	5	11	4	6	19
60	1	1	8	15	25	16	24	12	6	3	9	7	5	13
61	1	2	14	9	11	8	11	8	8	4	8	4	5	7
62	1	3	6	10	11	15	16	8	8	3	15	8	6	22
63	0	2	1	4	11	11	7	7	7	1	8	4	6	7
64	0	1	1	9	11	8	10	10	7	1	10	6	5	17
65		0	4	6	5	4	3	10	7	1	9	2	3	9
66	0		1	5	8	3	7	3	4	2	11	1	3	5
67	0			4	3	5	2	2	6	1	6	1	3	3
68	0			1	6	6	2	3	4	0	8	0	4	3
69	0		0	3	3	2	2	2	4	1	4	1	0	2
70	0		0	6	2	4	3	4	5	0	4	1	0	1
71	0			2	2	4	1	1	3	1	2	0	0	0
72	0			2	2	4	1	3	4	0	3	1	0	1
73			0	0	1	1	1	2	2		1	0	0	1
74				0	1	1	1	3	1		1	1	0	1
75				0	1	0	0	1	1		1	1	2	0
76				0	0	0	0	0	1		1	0		0
77					0	0	0	0	1		1	0	0	0
78							0	1			0			0
79					0		0	1	0		0	0		
80								0			0			0
81									0		0	0		
82					0				0		0	0		
83											0			
Total	**2491**	**2811**	**2680**	**3602**	**4486**	**4575**	**5233**	**7036**	**4259**	**4598**	**2280**	**1822**	**1649**	**1018**
Landings (t)	**88**	**116**	**117**	**190**	**222**	**205**	**205**	**231**	**162**	**159**	**114**	**73**	**79**	**72**

Table 13.2.2.a. FU 28-29 - Length Composition of *Nephrops* Males (1984-2018) (continued)

Landings

Age/Year	2012	2013	2014	2015	2016	2017	2018
17							
18							
19				1			
20							
21			0				1
22	3		1				1
23	0	3	1	0		8	20
24	8		1	1		4	28
25	27	8	6	5		8	180
26	37	6	7	3		23	89
27	47	27	15	8		68	162
28	37	25	12	10		109	201
29	143	55	35	27	10	149	241
30	158	84	36	71	27	324	321
31	248	82	49	112	51	293	382
32	573	217	120	138	36	345	433
33	329	109	47	96	75	207	281
34	436	276	119	162	166	277	334
35	356	155	144	263	128	295	387
36	248	191	119	202	173	138	146
37	211	145	108	191	155	145	191
38	206	216	144	179	240	82	89
39	126	95	129	125	300	71	116
40	112	162	160	139	247	114	128
41	114	113	90	117	179	86	69
42	140	171	129	142	185	101	112
43	79	64	58	85	182	64	45
44	87	89	104	127	222	94	82
45	52	42	59	92	187	108	64
46	46	81	59	62	211	75	23
47	47	89	83	61	129	53	42
48	30	67	26	28	157	18	26
49	32	53	36	48	92	32	33
50	19	59	25	58	69	41	53
51	17	37	32	56	58	27	47
52	33	47	64	70	26	46	57
53	22	18	25	45	34	38	34
54	32	36	44	48	52	46	54
55	15	16	24	60	41	38	45
56	24	20	20	43	51	30	30
57	20	15	20	27	36	22	33
58	7	12	10	14	45	5	19
59	7	8	9	16	38	12	18
60	4	10	7	10	30	10	15
61	9	7	4	4	21	4	10
62	3	1	12	4	10	5	8
63	2	4	3	3	14	2	3
64	2	3	8	3	10	2	4
65	1	1	2	1	9	2	9
66	3	2	3	2	6	3	5
67	3	1	2	1	4	2	5
68	3	1	1	0	4	1	2
69	1		1	0	8	1	3
70	3	1	1	0	3	1	4
71	1		1	0	3	1	0
72	3	0	1		2	0	2
73	1		1		0	0	0
74	1		1		0	0	0
75	1		0		0	0	3
76	0			0			0
77	0				0		0
78					0	0	0
79	0				0		0
80							0
81							
82							
83							
Total	**4170**	**2928**	**2217**	**2959**	**3725**	**3632**	**4693**
Landings (t)	**149**	**132**	**114**	**147**	**166**	**139**	**169.42**

Table 13.2.2.b. FU 28-29 - Length Composition of *Nephrops* Females (1984-2018)

Landings (thousands)														
Age/Year	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
17														
18					4									
19		0				35					0			
20	3	1	7		8	21				18				
21	1	1	22	3	21	102		21	9	49				
22	8	21	30	78		88	19	11	102	63			0	13
23	66	21	7	31	28	135	15	69	38	21	2		0	0
24	79	102	118	270	153	258	38	173	164	41	22	2	11	20
25	228	205	104	357	163	197	138	198	203	191	73		13	20
26	272	284	186	684	220	282	140	436	361	111	92	1	35	102
27	345	491	359	902	429	326	247	418	448	235	134	0	37	77
28	431	523	322	1421	471	231	345	598	597	413	170	6	36	152
29	443	672	419	1253	516	285	491	590	514	523	269	31	45	178
30	422	588	381	928	499	317	575	771	599	775	326	104	50	199
31	487	593	418	948	482	501	639	414	736	752	427	182	95	394
32	485	653	700	946	766	306	859	807	617	824	558	322	198	502
33	613	415	406	227	527	314	596	375	430	449	283	251	53	163
34	618	467	654	774	813	511	734	310	369	359	353	641	209	278
35	562	563	447	447	460	435	519	284	287	194	246	674	184	150
36	469	329	316	386	489	274	243	130	267	203	237	811	142	135
37	505	353	400	223	206	318	189	108	333	154	147	692	267	129
38	383	284	330	269	265	285	207	135	251	100	128	348	151	39
39	274	142	211	146	288	148	216	74	176	150	66	194	67	35
40	171	119	80	119	132	131	230	131	147	110	114	344	120	21
41	58	106	55	65	128	149	73	39	68	108	77	361	63	31
42	50	36	133	54	43	127	210	62	69	95	73	165	111	18
43	30	27	21	40	28	109	58	82	26	43	23	64	29	2
44	17	13	47	147	27	91	77	6	46	42	43	88	90	18
45	14	11	27	84	19	27	41	21	40	34	13	54	36	8
46	7	6	5	40	14	38	31	45	25	37	11	13	15	4
47	5	3	3	26	9	24	16	7	12	29	7	18	23	3
48	4	1		71	11	29	7	15	18	15	4	15	8	2
49	1	0	3	17	4	9	1	17	17	23	4	1	6	7
50	1	0		2	6	3	1	2	32	8	17	1	2	1
51	0	0	3	4	3	7	2	4	4	5	0			1
52	1			5	5	8	1		5	6	1	1	0	1
53	2			2	3	1			9	6	0			0
54				4	1	1			1	1			1	0
55				0	1	1			6	2				
56				3	0	2		5	14	5				
57				0	0	1			4	1			0	
58				0		0			4	1				
59				1	0	0								
60					0				1	0				
61						1								
62														
63									4	1				
64														
65														
66														
67														
68									4	1				
69														
70														
71														
72														
73														
74														
75														
76														
77														
78														
79														
80														
81														
82														
83														
Total	**7052**	**7032**	**6218**	**10978**	**7243**	**6126**	**6962**	**6358**	**7059**	**6198**	**3920**	**5385**	**2095**	**2702**
Landings (t)	**169**	**156**	**150**	**232**	**171**	**151**	**174**	**134**	**165**	**145**	**97**	**174**	**67**	**62**

Table 13.2.2.b. FU 28-29 - Length Composition of *Nephrops* Females (1984–2018) (continued)

Landings

Age/Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
17						0								
18							0				0			
19						1				2	0			
20				0		0	0	8		4	1			
21			3	1	0	3	12	48	3	15	2	1		
22	2	5	18	0		3	10	88	14	26	12	1	0	
23	4	4	6	7	0	9	43	54	37	34	11	4	1	1
24	15	25	49	7	10	19	62	135	44	53	25	22	10	1
25	25	27	24	15	11	36	101	129	55	130	23	23	11	1
26	74	94	81	24	15	67	211	272	113	227	38	80	12	3
27	91	76	139	34	34	67	266	294	152	298	73	138	20	7
28	148	100	64	44	107	98	336	242	179	355	81	170	26	7
29	114	121	171	90	127	173	395	420	392	458	123	149	51	4
30	199	236	152	131	237	241	406	654	321	365	145	205	67	7
31	168	263	131	167	195	152	334	565	305	317	129	132	99	26
32	376	485	283	316	296	360	530	857	510	409	252	209	145	45
33	116	187	153	184	467	270	433	448	272	253	182	110	91	51
34	298	346	235	252	429	314	400	462	341	386	177	122	140	96
35	112	287	193	158	470	255	324	254	249	351	187	103	120	56
36	166	317	225	174	351	194	222	203	162	213	103	83	144	60
37	171	201	213	144	302	203	178	182	142	240	121	90	119	73
38	48	184	85	108	300	206	151	178	152	247	134	83	106	151
39	59	151	92	112	213	160	113	89	173	138	123	86	95	113
40	89	111	79	133	186	284	136	84	114	109	125	62	80	68
41	64	81	66	79	110	170	82	73	129	73	95	83	65	65
42	84	73	67	91	80	192	122	116	112	56	75	94	52	80
43	34	38	41	55	87	132	70	70	44	16	30	25	28	80
44	71	34	49	56	57	75	66	61	46	21	24	43	40	41
45	22	18	23	29	51	68	66	50	35	18	28	17	25	21
46	28	18	38	33	40	37	51	39	54	19	14	22	19	11
47	23	7	52	26	25	25	44	35	23	9	26	16	18	15
48	6	9	25	12	24	28	37	18	11	8	20	7	12	9
49	6	4	21	15	19	18	24	24	7	7	13	6	7	7
50	6	5	10	15	26	24	20	23	7	3	13	8	7	2
51	2	2	10	9	22	14	13	17	11	5	11	3	6	5
52	1	3	16	6	19	21	13	17	7	3	7	3	4	4
53	0		6	6	10	13	8	10	2	1	8	3	2	3
54	1		5	2	2	14	7	6	9	1	8	1	2	5
55			1	2	3	10	4	5	1	1	3	4	0	5
56	0		3	1	3	7	6	2	1	0	3	0	0	2
57	0		1	0	2	4	2	3	1		1	0	0	1
58				1	1	1	2	0	1	0	1	1	0	4
59			0	1	0	0	1	1	1			0	0	2
60				0		0		2			1		0	2
61			3	1		0	1					0	0	1
62					0	0	0	1	0				0	0
63				0	0			0				0	0	2
64							1	0		0	0	0		
65							0	0						0
66			0	0				0						
67														0
68														
69														
70							0					0		
71														
72														
73														
74														
75														
76														
77														
78														
79														
80														
81														
82														
83														
Total	**2621**	**3509**	**2829**	**2540**	**4332**	**3969**	**5304**	**6240**	**4229**	**4871**	**2449**	**2211**	**1628**	**1138**
Landings (t)	**72**	**95**	**84**	**79**	**135**	**130**	**140**	**151**	**112**	**114**	**74**	**60**	**52**	**45**

Table 13.2.2.b. FU 28-29 - Length Composition of *Nephrops* Females (1984–2018) (continued)

Landings Age/Year	2012	2013	2014	2015	2016	2017	2018
17							
18							
19				0			
20							
21	7				4		
22		3	1		4		19
23		7	1	0	1		4
24	5	7	3		2	13	66
25	8	18	10	5	19	91	150
26	17	7	10	7	19	23	87
27	40	36	17	13	46	100	110
28	51	33	23	23	44	134	125
29	130	59	60	39	57	169	203
30	164	119	80	85	219	464	351
31	330	129	99	143	149	290	260
32	397	290	203	208	307	462	327
33	195	194	105	146	214	290	247
34	297	278	202	167	325	353	235
35	165	232	188	303	362	365	381
36	138	166	153	203	193	196	138
37	98	199	151	162	203	142	149
38	76	206	148	171	125	81	78
39	46	61	121	136	112	105	75
40	46	67	145	134	130	108	89
41	37	41	66	104	82	56	51
42	35	65	90	87	112	72	94
43	33	9	27	54	59	55	33
44	27	13	40	58	48	53	35
45	10	9	17	56	25	45	38
46	10	11	17	36	28	36	15
47	11	13	18	16	14	21	22
48	5	7	5	8	3	14	9
49	6	5	7	8	5	7	14
50	6	5	4	8	14	7	16
51	6	1	3	7	4	7	12
52	9	5	4	9	8	6	13
53	5	1	3	6	0	5	7
54	5	3	8	12	2	4	6
55	2	1	3	12	2	3	4
56	1	1	6	10	1	1	6
57	3	2	2	4	0	1	5
58	2	0		1	0	0	5
59	0	1	1	3	0	0	2
60	0		2	3	1	1	3
61	0					0	1
62	0	0	0	0			0
63	0						0
64	0			0			2
65				0		0	
66				0		0	0
67				0			
68							0
69				0			
70				0			
71							
72							
73							
74							
75							
76							
77							
78							
79							
80							
81							
82							
83							
Total	**2424**	**2306**	**2044**	**2446**	**2946**	**3782**	**3487**
Landings (t)	**65**	**66**	**66**	**85**	**88**	**102**	**94**

Table 13.2.3. - SW and S Portugal (FUs 28-29): Effort and CPUE of Portuguese trawlers, 1994–2017.

Year	No. of trawlers	CPUE (t/boat)	Estimated hours	CPUE** (kg/hour)
1994	31	7.6		
1995	30	9.1		
1996	25	5.3		
1997	25	5.5		
1998	25	6.4	94,568	1.7
1999	26	8.1	89,044	2.4
2000	27	7.4	119,703	1.7
2001	33	8.2	87,344	3.1
2002	31	11.5	72,373	5.0
2003	32	10.5	56,519	6.5
2004	23	15.0	82,852	4.5
2005	25	15.3	66,572	5.9
2006	25	11.0	49,691	5.8
2007	26	10.5	54,013	5.4
2008	27	7.0	43,970	5.1
2009	27	4.9	33,620	4.5
2010	25	5.2	32,179	4.6
2011	26	4.5	37,712	4.0
2012	21	10.2	48,219	4.7
2013	24	8.2	40,090	5.2
2014	24	7.5	35,640	5.2
2015	22	10.5	30,263	5.1
2016	22	11.5	42,006	6.2
2017	22	11.0	49,048	5.6
2018*	24	11.0	42,354	6.5
* provisional; ** standardized CPUE				

Table 13.2.4. - SW and S Portugal (FUs 28-29): *Nephrops* CPUEs (kg/hour) in research trawl surveys, 1994–2017.

Year	Demersal surveys			Crustacean surveys	
	CPUE (kg/hour)			Month and year of survey	CPUE (kg/hour)
	Summer	Autumn	Winter		
1994	ns	0.40	ns	May-94	2.3
1995	1.3	0.26	ns	No surveys 1995-96	
1996	ns	0.03	ns		
1997	0.7	0.06	ns	Jun-97	2.7
1998	0.7	0.02	ns	Jun-98	1.4
1999	0.3	0.02	ns	Jun-99	2.5
2000	1.0	0.92	ns	Jun-00	1.6
2001	0.6	0.35	ns	Jun-01	0.8
2002	ns	0.02	ns	Jun-02	2.8
2003	ns	0.19	ns	Jun-03	2.9
2004	ns	0.51	ns	Jun-04	nr
2005	ns	0.09	0.16	Jun-05	5.3
2006	ns	0.19	0.06	Jun-06	2.8
2007	ns	0.04	0.73	Jun-07	2.9
2008	ns	0.13	0.25	Jun-08	5.4
2009	ns	0.13	ns	Jun-09	2.8
2010	ns	0.34	ns	Jun-10	8.1
2011	ns	0.11	ns	Jun-11	nc
2012	ns	ns	ns	ns	ns
2013	ns	0.64	ns	Jun-13	2.5
2014	ns	0.06	ns	Jul-14	1.0
2015	ns	0.21	ns	Jul-15	3.2
2016	ns	0.69	ns	Jun-16	4.9
2017	ns	1.21	ns	Jul-17	5.0
2018	ns	0.46	ns	Aug-18	5.0
ns = no survey nr = not reliable nc = whole area not covered					

Table 13.2.5. - SW and S Portugal (FUs 28-29): Mean sizes (mm CL) of male and female *Nephrops* in Portuguese landings and surveys, 1994–2017.

Year	Landings		Demersal surveys						Crustacean surveys	
	Males	Females	Summer		Autumn		Winter		Males	Females
			Males	Females	Males	Females	Males	Females		
1994	37.4	33.6	ns	ns	39.0	33.6	ns	ns	ns	ns
1995	39.3	37.0	42.1	35.6	42.0	34.9	ns	ns	ns	ns
1996	36.9	36.6	ns	ns	38.6	32.2	ns	ns	ns	ns
1997	35.9	32.8	40.4	36.9	39.1	31.7	ns	ns	43.7	41.9
1998	36.8	34.5	36.0	33.9	40.6	35.9	ns	ns	39.5	36.7
1999	38.7	34.6	45.1	40.4	43.8	32.8	ns	ns	39.7	37.5
2000	38.9	35.2	40.8	37.1	39.0	35.1	ns	ns	41.7	40.2
2001	41.6	36.1	40.5	34.5	47.2	41.6	ns	ns	44.5	39.9
2002	40.7	36.2	na	na	35.0	39.0	ns	ns	44.8	40.7
2003	39.1	36.4	ns	ns	37.5	32.3	ns	ns	39.7	36.7
2004	37.3	33.8	ns	ns	36.7	31.3	ns	ns	39.0	37.0
2005	35.6	33.0	ns	ns	40.6	39.1	40.6	40.9	37.3	35.7
2006	37.2	34.1	ns	ns	36.1	32.8	31.7	35.0	37.7	35.2
2007	36.5	32.8	ns	ns	42.0	38.5	39.0	36.2	38.3	35.0
2008	40.1	35.5	ns	ns	43.2	41.4	46.7	40.6	40.1	36.7
2009	37.4	34.2	ns	ns	45.3	39.8	ns	ns	41.4	36.6
2010	40.1	36.5	ns	ns	39.7	33.7	ns	ns	37.7	36.6
2011	45.0	39.2	ns	ns	43.1	40.0	ns	ns	nc	nc
2012	36.9	34.4	ns	ns	ns	ns	ns	ns	ns	ns
2013	39.7	35.3	ns	ns	42.6	37.3	ns	ns	39.1	39.5
2014	41.3	36.7	ns	ns	46.5	39.2	ns	ns	37.8	35.2
2015	40.9	37.4	ns	ns	42.4	35.2	ns	ns	39.2	37.3
2016	39.5	35.8	ns	ns	43.7	41.6	ns	ns	38.7	36.1
2017	37.4	34.3	ns	ns	45.2	45.3	ns	ns	40.6	34.5
2018	36.2	34.0	ns	ns	43.5	37.9	ns	ns	37.7	34.0

ns = no survey nr = not reliable nc = whole area not covered

Table 13.2.6 Analysis of deviance for the Gamma-based GLM model fitted to the positive *Nephrops* CPUE in the catches.

Source of variation	Df	Deviance	Resid. Df	Resid. Dev	Pr(>F)	% explained
NULL			111922	146369		
year	20	26331	111902	120038	< 2.2e-16	18.0%
month	11	3606	111891	116432	< 2.2e-16	2.5%
depth.class2	2	2990	111889	113442	< 2.2e-16	2.0%
catdps	1	2057	111888	111385	< 2.2e-16	1.4%
cat_pnep	1	38433	111887	72952	< 2.2e-16	26.3%
catPRT2	2	1720	111885	71232	< 2.2e-16	1.2%
Total	**37**	**75137**				**51.3%**

AIC: 421746

Table 13.2.7. Length-based indicators for *Nephrops* Males and females in FU 28-29

		Conservation				Optimizing Yield	MSY
		L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{max5\%}/L_{inf}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
	Ref	>1	>1	>0.8	>30%	~1 (>0.9)	≥1
2016	M	1.02	1.11	0.82	0.08	0.81	0.97
	F	0.97	1.02	0.73	0.02	0.81	0.92
2017	M	1.02	1.21	0.83	0.09	0.86	1.02
	F	0.97	1.08	0.73	0.01	0.84	0.95
2018	M	0.95	1.07	0.85	0.09	0.79	0.98
	F	0.90	1.02	0.78	0.03	0.81	0.96

Table 13.2.8 Results from the application of the Mean Length Z approach.

		Males	Females
	Input:		
	LFD period	1984-2018	1984-2018
	Effort series	1998-2018	1998-2018
	Growth		
	Linf =	70	65
	K =	0.2	0.065
	t0 =	-0.15	-0.15
	W~L relationship		
	a =	0.00028	0.00056
	b =	3.2229	3.0288
	External M	0.3	0.2
Method	**Results**		
Gedamke & Hoenig	Z =	0.48	0.30
	F* =	0.18	0.10
THoG	q estimate =	0.004	0.001
	q estimate* =	0.025	0.011
	M estimate =	0.45	0.27
	F_{2018} estimate =	0.02	0.01
	F_{2018} estimate* =	0.11	0.05
Y/R	F_{MSY} proxy: $F_{0.1}$ =	0.23	0.24

* indicates estimates with external fixed M

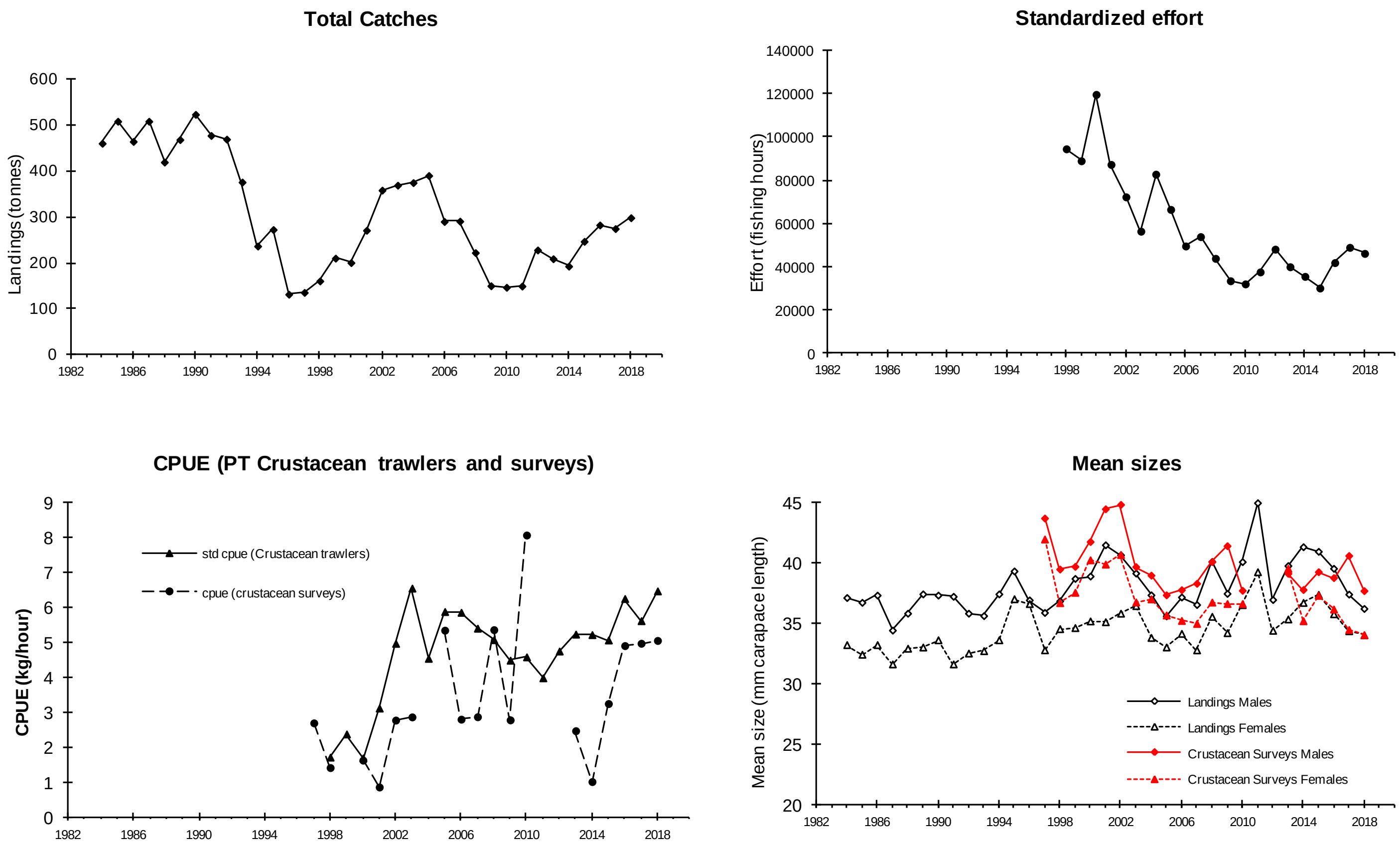


Figure 13.2.1. SW and S Portugal (FU 28+29): landings, effort, biomass indices and mean sizes of *Nephrops* in Portuguese landings and surveys. Note: Values of CPUEs and effort updated with the new CPUE standardization.

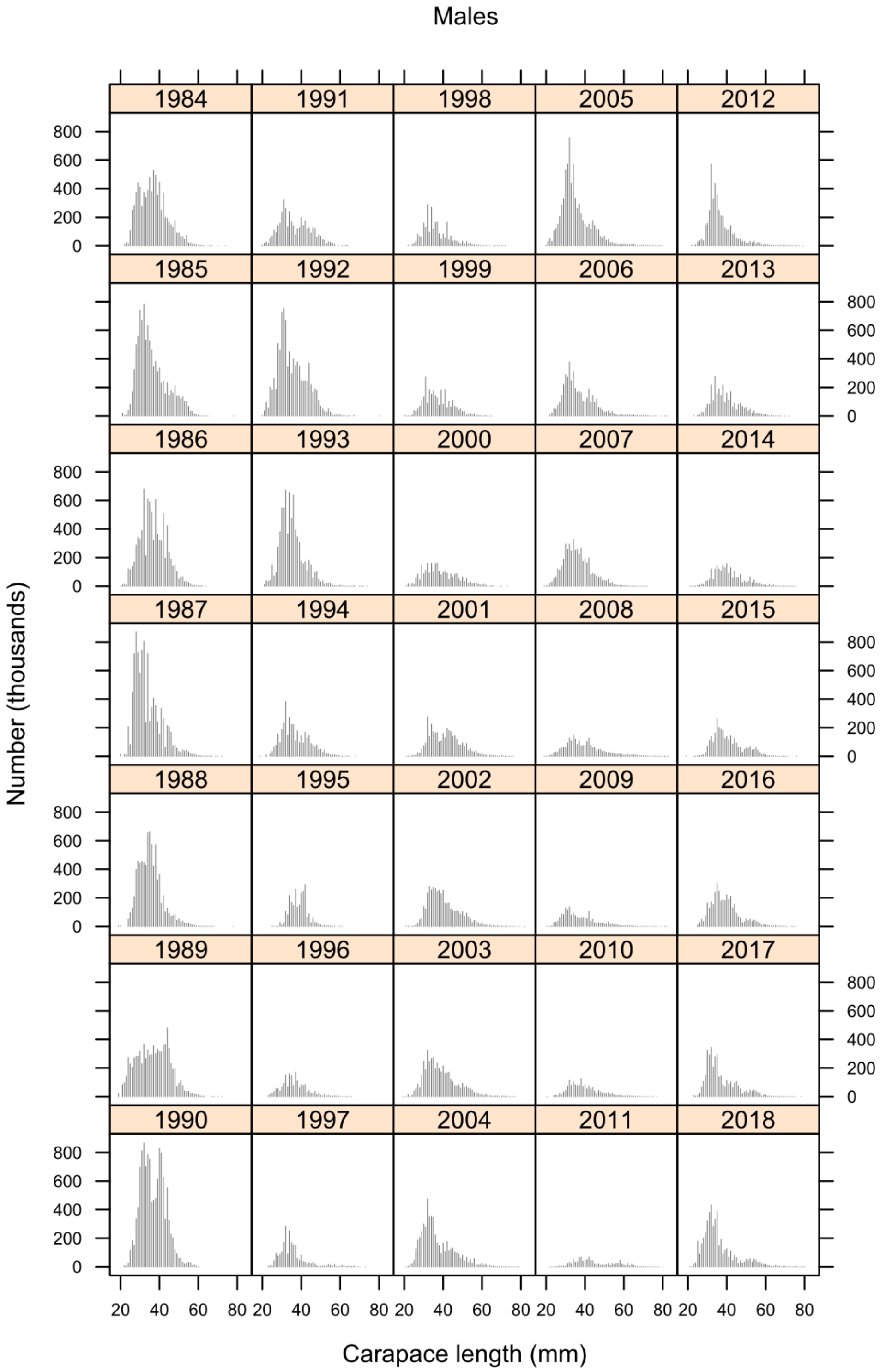


Figure 13.2.2.a. SW and S Portugal (FU 28-29) male length distributions for the period 1984–2018.

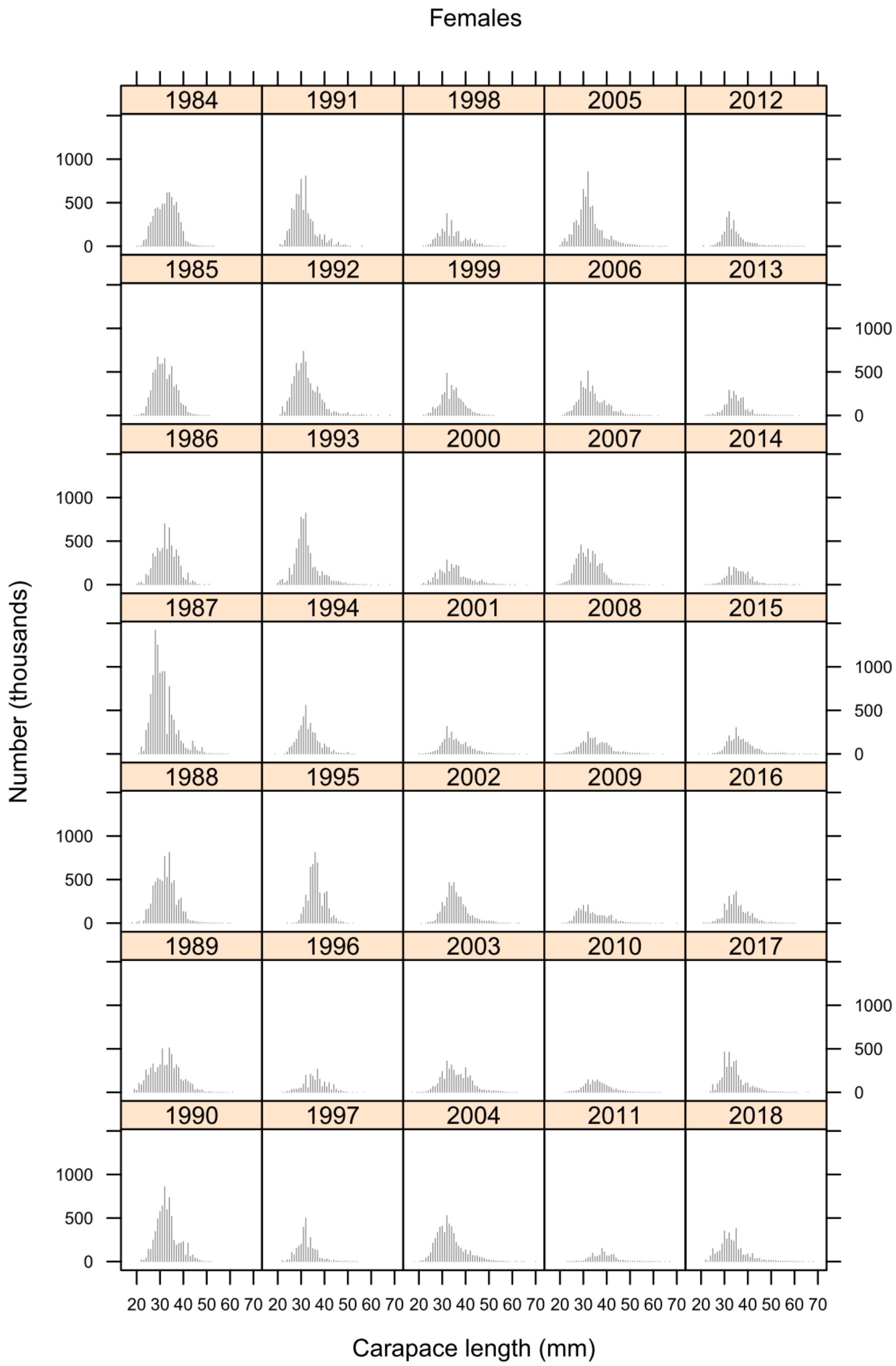
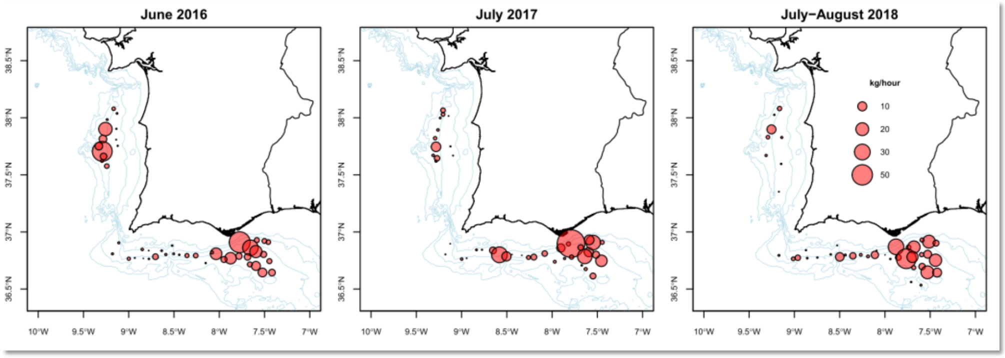


Figure 13.2.2.b. SW and S Portugal (FU 28-29) female length distributions for the period 1984–2017.



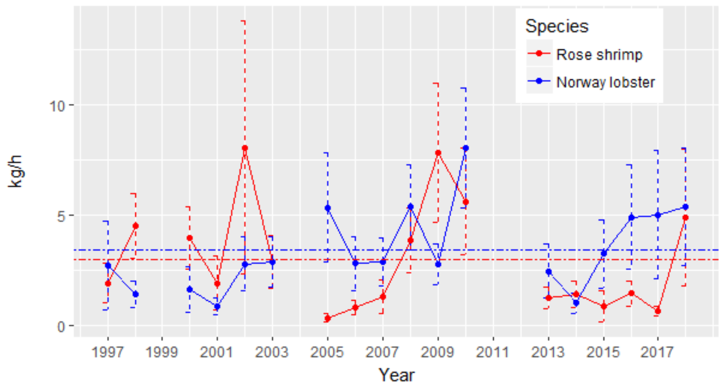


Figure 13.2.3. Spatial distribution of Norway lobster biomass survey index in the period 2016–2018 (upper panel) and stratified mean biomass time series with 95% confidence interval of Norway lobster and deepwater rose shrimp (lower panel).

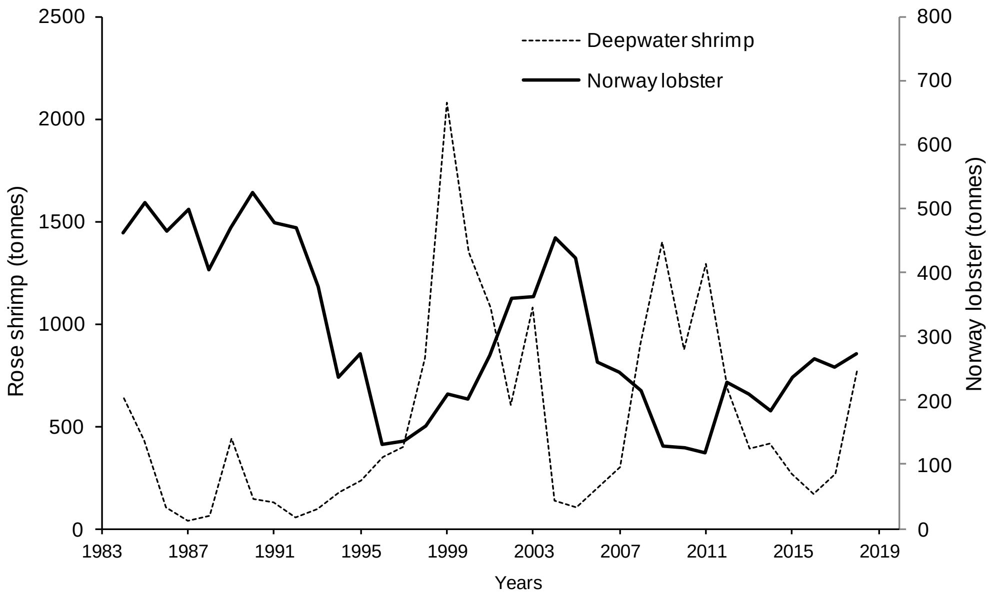


Figure 13.2.4 FUs 28-29: Landings of the two main target species of the Crustacean Fishery in the period 1984–2018.

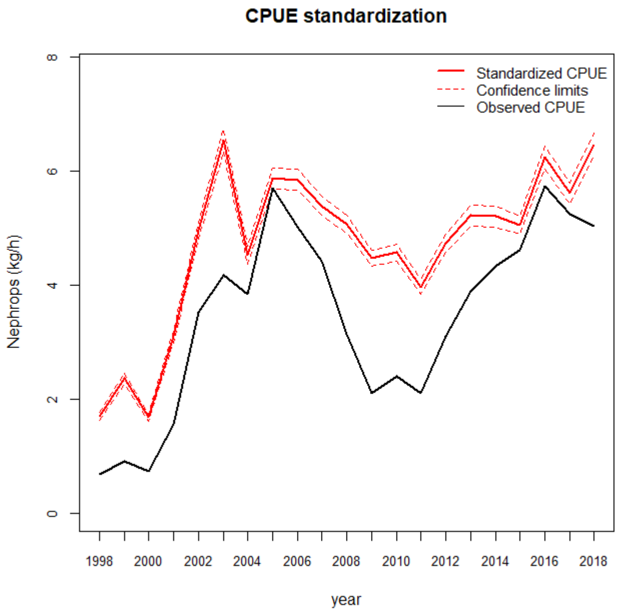


Figure 13.2.5. Comparison of standardized and observed *Nephrops* CPUE.

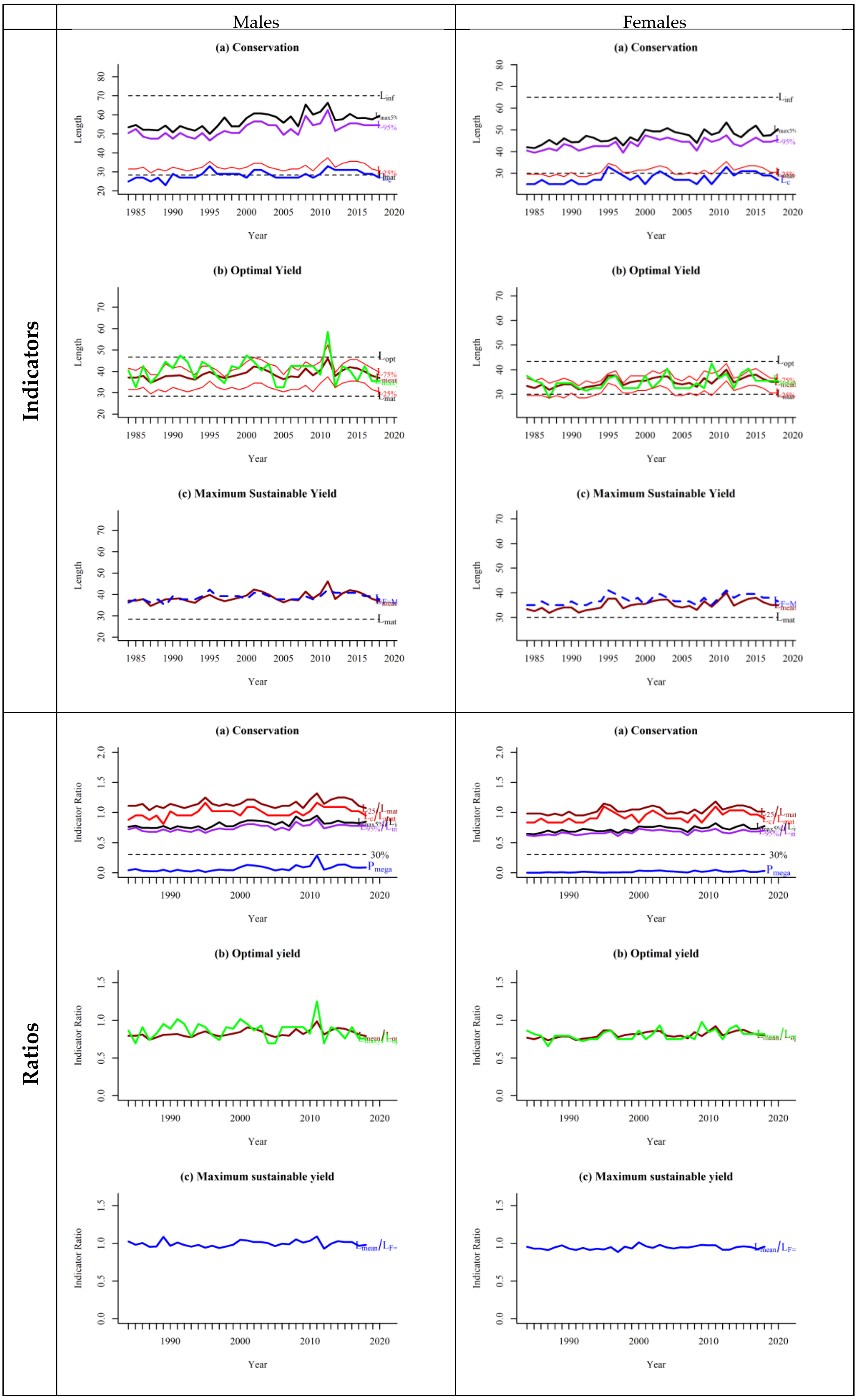


Figure 13.2.6. Length-based indicators (upper panel) and ratios (lower panel) for *Nephrops* Males (left) and Females (right) in FUs 28-29.

Figure 13.2.7. ***Nephrops*** **FU 28-29. Mean Length Z (Gedamke & Hoenig) model diagnostics.**

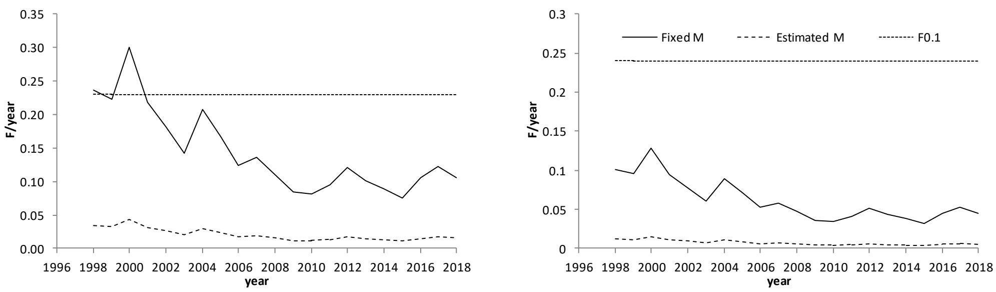


Figure 13.2.8. ***Nephrops*** **FU 28-29. Fishing mortality from THoG model using an external fixed M or an M estimated by the model. Left panel: males, right panel: females.**

13.3 *Nephrops* in FU 30 (Gulf of Cadiz)

Nephrops FU 30 was benchmarked by WKNEP 2016. UWTV Surveys based Approach was considered appropriated for providing scientific advice on the abundance of this FU but stock specific MSY harvest rate could not be derived. The basis of advice for this stock follows a category 4 approach for *Nephrops* lobster stocks. When the stock specific MSY reference points can be estimated, *Nephrops* FU 30 will meet the requirements for category 1 assessment.

13.3.1 General

13.3.1.1 Ecosystem aspects

See Annex L

13.3.1.2 Fishery description

See Annex L

13.3.1.3 ICES Advice for 2019 and Management applicable for 2018 and 2019

ICES Advice for 2019

ICES advises that when the precautionary approach is applied, catches should be no more than 120 tonnes in 2019. All catches are assumed to be landed.

To protect the stock in the functional unit (FU) 30 and to ensure that this stock is exploited sustainably, ICES advises that management should be implemented at the functional unit level.

Management applicable for 2018 and 2019

A recovery plan for southern hake and Iberian *Nephrops* stocks has been in force since the end of January 2006. The aim of the recovery plan is to rebuild the stocks within 10 years, with a reduction of 10% in F relative to the previous year and the TAC set accordingly (Council Regulation (EC) No. 2166/2005). This recovery plan does not apply to FU 30.

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including *Nephrops* in FU 30 in ICES divisions 9a (Council Regulation (EU) 2019/472).

An increase of mesh size to 55 mm was established since September of 2009 (Orden ARM/2515/2009) for the bottom trawl fleet.

The TAC set for the whole Division 9a was 381 t for 2018 and 401 t for 2019, respectively, of which no more than 6 % may be taken in FUs 26 and 27 and no more than 120 t in FU30. The maximum number of fishing days per vessel was fixed at 129 days for Spanish vessels and at 113 days for Portuguese vessels for these two years (Annex II B and Annex II A of Council Regulations nos. 120/2018 and 124/2019, respectively). The number of fishing days included in these regulations is not applicable to the Gulf of Cadiz (FU 30), which has a different regime.

A modification of the Fishing Plan for the Gulf of Cadiz was established in 2014 (AAA/1710/2014). This new regulation establishes an assignation of the *Nephrops* quotas by vessel. A close season in autumn for the bottom trawl fleet of the Gulf of Cadiz is implemented since 2004. In 2018, this close season is from 16 September to 31 October (APM/453/2018).

13.3.2 Data

13.3.2.1 Commercial catch and discard

Landings in this FU are reported by Spain and also minor quantities by Portugal. Spanish landings are based on sales notes which are compiled and standardized by IEO. Since 2013, trips from sales notes are also combined with their respective logbooks, which allow georeferencing the catches.

The total landings were estimated by this WG since 2016 when the concurrent sampling was satisfactory implemented. The Spanish concurrent sampling is used to raise the FU 30 observed landings to total effort by *métier*. When the estimated landings exceed the official landings, the difference is provided to InterCatch as non-reported landings.

Since WGHMM in 2010, *Nephrops* landings in Ayamonte port were incorporated in the Gulf of Cadiz time series of landings, as well as directed effort and LPUE from 2002 (Tables 13.3.1 and 13.3.5). *Nephrops* total landings in FU 30 decreased from 108 t in 1994 to 49 t in 1996. After that, there has been an increasing trend, reaching 307 t in 2003, dropping to 246 t in 2005-2006 (with the exception for the year 2004 when a decrease of more than 50% was observed). In the 2008-2012 periods, landings remained relatively stable around 100 t. Landings drop during the 2013-2015 period up to a mean value of 22 t since the quota in 2012 was exceeded and the European Commission applied a sanction to be paid in 3 years (2013-2015 period) (Figure 13.3.1). TAC was limiting the fishery during this period. Moreover, the *Nephrops* fishery was closed in 2013 and vessels could only go fishing *Nephrops* a few days in summer and winter. Total estimated landings increased in 2016 and 2017 (124 t and 140 t, respectively), representing almost six times landings in 2013-2015period. In 2018, landings estimations were 75 t, representing 46% less than the previous year (Figure 13.3.1). Estimates since 2016 are considered the best information available at this time. A modification of the regulation implemented for the Spanish Administration for the Gulf of Cadiz grounds in 2014 (Orden AAA/1710/2014) establishes the assignment of *Nephrops* quotas by vessel. These facts may have caused unreported *Nephrops* landings in the last years, as well as landings below the ICES catch in this FU for 2018.

Information on discards was sent to the WG through InterCatch. The discarding rate of *Nephrops* in this fishery fluctuates annually but is always very low or zero and the discards are considered negligible (Table 13.3.2). In 2018, the percentage discarded was 3.3%, very slightly higher than the previous year (2.5%). Figure 13.3.2 shows the estimated length frequency distributions of the discarded and retained *Nephrops* by trip for the annual discarding program (2005-2018).

13.3.2.2 Biological sampling

The sampling level for the species is given in Table 1.3. The sampling effort has been increased with an additional number of *Nephrops* directed sampling since summer 2016 in order to improve the quality of the commercial length distributions.

Figure 13.3.3 shows the annual landings length distribution for males, females and both sexes combined during the period 2001-2018. The length composition of landings is biased for the period 2001 to 2005 since the sampling of landings was not stratified by commercial categories (Silva *et al*., 2006). A new sampling scheme was applied from 2006 to 2008 and the information was more reliable. The mean sizes for both sexes remained relatively stable after the sampling scheme was changed, around 29 mm CL for sexes combined.

Since 2009, onboard concurrent sampling is carried out, as required by the DCF (Reg. EC 1343/2007). Outside of the *Nephrops* fishing season, a higher proportion of observer trips are likely to not cover *Nephrops* catches whereas when the directed *Nephrops* sampling were carried out in harbours in the past, the length distribution of landings were covered in all months. This fact could reduce the consistency of the length distribution of the catches. The number of sampling between 2013 and 2015 was influenced by the EU sanction in this period and the closure of *Nephrops* fishery in 2013.

Mean size of males and females in *Nephrops* landings in the period 2001-2018 are shown in Figure 13.3.1. The mean sizes show a slight increasing trend from 2006 to 2013 (35.3 mm CL in males and 31.9 mm CL in females). In 2014 and 2015, the mean size in females was highest than males the opposite of what it should be expected. It could be due problems in the sampling. This fact was investigated in collaboration with the observed. The number of sampling and the number of individuals sampled was low in both years and they could distort the sex-ratio and the mean size in both sexes. The length frequency distribution in both sexes improved since 2016, when additional directed *Nephrops* sampling were implemented. The mean sizes remained relatively stable in the three last years. In 2018, the mean size was 32.5 mm CL in males and 30.2 mm in females. Length frequency distribution shows an increase of smaller sizes in 2017 and 2018 (see Figure 13.3.3).

The sex-ratio as proportion of males in landings is shown in Figure 13.3.4. The proportion of males remained stable around 50% since 2009 although an increase of males was observed in 2017, representing 60% of landings.

13.3.2.3 . Mean weight in landings

The mean weights in landings are shown for the all time series in Figure 13.3.5. Since 2009 an increasing trend of the mean weight was observed but declined in 2013 remaining stable (about 31 g). In 2016, a decreasing of the mean weight in landings was observed up to 23.2 g. No changes were observed in mean weight in 2017 and 2018 landings. The mean weight average for the three last years was 23.4 g.

13.3.2.4 Abundance indices from surveys

Trawl surveys

The biomass and the abundance indices of *Nephrops* by depth strata, estimated from the Spanish bottom trawl spring surveys (SP-GCGFS-Q1) (1993-2019 time series) are shown in Table 13.3.3.

The overall abundance index trend was decreasing from 1993 to 1998, while from 1998 to 2009 the index has remained stable although fluctuating widely in some years. The lowest value in the time series was recorded in 2004 and 2012. In 2010 the deeper strata (500-700 m) were not sampled due to a reduction in number of the days, as a consequence of adverse weather conditions. Therefore, only the abundance index for the strata 200-500 m is available for 2010 (Table 13.3.3) and its value is similar to the corresponding strata in previous year. The abundance index increased strongly in 2013 and 2014 (Table 13.3.3). The survey index has fluctuated since 2015 and it declined in 2017 and 2018. Recent results in 2019, show an increase of the abundance survey index. This survey is not specifically directed to *Nephrops* and is not carried out during the main *Nephrops* fishing season but the overall abundance index shows an increasing trend since 2013 onwards (Figure 13.3.6), suggesting that the *Nephrops* abundance stock is not in bad conditions.

The length distributions of *Nephrops* obtained in the Spanish bottom trawl spring surveys (SP-GCGFS-Q1) during the period 2001-2019 are presented in Figure 13.3.7. In 2015 and 2016, an increase of the smaller individuals was observed but in the mean size in both sexes increased in 2017, remaining relatively stable in 2018 and 2019 for males (~36 mm CL) and slightly decreasing for females (30.5 mm CL). The time series of *Nephrops* mean sizes for males, females and combined sexes obtained in these surveys are shown in Figure 13.3.8. No apparent trends are observed. The mean size ranged between 28.3 and 34.9 mm CL for females and 32.2 and 42.9 mm CL for males.

UWTV surveys

An exploratory *Nephrops* UWTV survey on the Gulf of Cadiz fishing grounds was carried out in 2014 within the framework of a project supported by Biodiversity Foundation (Spanish Ministry of Agriculture, Food and Environment) and European Fisheries Fund (EFF) (Vila *et al.*, 2014). Survey in 2014 was considered exploratory but four UWTV surveys are available (2015 and 2018) and the next survey will be carried out in June 2019.

The surveys are based on a randomized isometric grid design with stations spaced 4 nm. The method used during the surveys are according to WKNEPHTV (ICES, 2007), WKNEPHBID (ICES, 2008), and SGNEPS and WGNEPS. A description of UWTV surveys carried out in FU 30 since 2014 is documented in the stock annex.

UWTV surveys results were evaluated in the Benchmark Workshop on *Nephrops* Stocks (WKNEP) in 2016 (ICES, 2016). WKNEP 2016 concluded that the UWTV survey in FU 30 is appropriate for providing scientific advice on the abundance of this stock.

The mean burrow density (adjusted to the cumulative bias) in last two years (2017 and 2018) was higher than in the previous years (2015 and 2016) (Table 13.3.4). The lowest value was recorded in 2016 (0,078 burrows/m^2) while the highest value was recorded in 2017 (0.13 burrows/m^2). The mean burrow density was 0.12 burrows/m^2) in 2018. In general, the range of the observations was relatively high in all years (0.00–0.34 burrows/m^2 in 2015, 0.00-0.33 burrows/m^2 in 2016, 0.00-0.53 burrows/m^2 in 2017 and 0.00-0.49 burrows/m^2).

The final modelled density surfaces for the time series (2015–2018) are shown as a heat maps and bubble plots in Figure 13.3.9. The abundance estimate derived from the krigged burrow surface (and adjusted for the cumulative bias) increased from 298 million burrows in 2015 to 371 million burrows in 2017 with a lower value recorded in 2016 of 232 million burrows. The coefficient of variation was about 7% in 2015 and 2016 but it was higher in 2017 (CV=8.7%). In 2018, geostatistic abundance estimated was slightly lower than the previous year (329 millions burrows) with a CV of 6%. However, the heat map of the abundance estimates in the main patch within the *Nephrops* area distribution, where the commercial bottom trawl fish, shows an increase in relation to 2017. The spatial pattern of burrow density is consistent in last two years. Detailed results about the ISUNEPCA UWTV survey in FU 30 in 2018 are documented in a WD presented in this WG (WD NºXX, Vila *et al.*, 2019).

In UWTV survey carried out in 2015, the number of stations and the space between them was increased in relation to 2014 (exploratory survey). However, the border was under sampled mainly in the shallower limit. In addition, an overestimation of the number of burrows may have happened. Many participants in the survey were not experienced in the quantification of *Nephrops* burrows. In 2016, the area was better covered, with more stations in the border. Moreover, the identification of the *Nephrops* burrows was carried out for three scientist who participated in the two previous surveys and therefore with more experience.

The total number of TV stations was increased up to 65 in 2017 and 70 in 2018. However, the stations used in the geostatistic abundance estimate resulted in 62 and 60, respectively in two last years because of the bad visibility for recent fishing activity in some stations. These stations were revisited again but some of them were considered definitely null after the videos were reviewed due the uncertainty generated for the presence of burrows of others crustacean and the low visibility (Table 13.3.4).

A more realistic result was obtained in 2016, 2017 and 2018 UWTV survey (Figure 13.3.9) according to the VMS information (ICES, 2016).

13.3.2.5 Commercial catch- Effort data

Figure 13.3.1 and Table 13.3.5 show directed *Nephrops* effort estimates and LPUE series modified after the incorporation of data from Ayamonte port since 2002. Directed effort is estimated from trips with landings at least 10% *Nephrops*.

The directed fishing effort trend is clearly increasing from 1994 to 2005, where the highest value of the time series was recorded (4336 fishing days). After that, the effort declined to 2008 (73%) remaining relatively stable during the 2009–2012 period. As a consequence of the sanction in 2012, the effort drop in the 2013-2015 period (mean value 283 fishing days) (Figure 13.3.1). Fishing effort increased since 2016 up to 658 fishing days in last year.

LPUE obtained from the directed effort shows a gradual decrease from 1994 to 1998. After 1998, the trend slightly increases until 2003. In 2004, the LPUE decreases to the lowest value recorded (44.3 Kg/fishing day). LPUE then increased until 2008 around 60%. Since 2008 LPUE have declined to 50 Kg/fishing day in 2009 and 45.5 Kg/fishing day in 2010 (about 30% less with respect to 2008). The increased abundance of rose shrimp in 2008 is believed to have led to a change in the objectives of the fishery, as rose shrimp achieves a higher market value and its fishing grounds, shallower (90-380 m) and closer to the coast. Since 2010, LPUE shows an increasing trend with a high rise in 2013. After a drop of the LPUE in 2014, commercial abundance index trend shows an increasing trend up to 2016. The commercial index declined in 2017 and remained relatively stable in 2018 regarding to the previous year(Figure 13.3.1). LPUE in 2013-2015 period must be taken with caution as in this period was applied the penalty for exceeding the quota in 2012, which increases the uncertainty associated with the LPUE index. Moreover, the assignment of *Nephrops* quotas by vessel implemented in 2014 might have caused unreported landings and to contribute to the increases the uncertainty of the commercial index since this date. On the other hand, LPUE since 2016 is estimated using official landings and not the total landings estimated by the WG.

13.3.3 Assessment

This stock was benchmarked in October 2016 (ICES, 2016). The assessment is based on UWTV approach according to category 4 for *Nephrops* stocks outlined in WKNEP 2016 and using parameters in the stock annex.

13.3.4 Catch options

Table 13.3.6 shows the UWTV abundance, estimates of mean weight and HR for 2015 - 2018 period. A decreasing trend of the harvest rate is observed since 2016.

Inputs table to the catch options are given below.

Variable	Value	Source	Notes
Stock abundance	Available in October 2019	ICES (2018)	UWTV survey 2019
Mean weight in landings	23.4 g	ICES (2018)	Average 2016-2018
Mean weight in discards		ICES (2018)	Not relevant
Discard proportion	0%	ICES (2018)	Negligible
Discard survival rate		ICES (2018)	Not relevant
Dead discard rate	0%	ICES (2018)	Negligible

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A prediction of landings for the FU 30 using approach agreed procedure proposed at WKNEP 2016 and outlined in the stock annex will be made on the basis of the 2019 UWTV survey.

13.3.5 Biological reference points

F_{MSY} proxy ($F_{0.1}$) derived from the SCA (Separable Cohort Analysis) model during WKNEP 2016 (ICES, 2016), corresponds to a harvest rate of 9.5% but this resulted in recommended catches much higher than experienced historically. WKNEP 2016 decided to derive the harvest rate (HR) from historical experience in this stock and from experience with similar stocks as an interim solution, until a firmer basis for generating advice from UWTV survey abundance estimates can be developed (ICES, 2016). Taken into account the *Nephrops* FU 30 fishery history, HR was estimated ranging between 1.5% in recent year (2010-2012) and 4% when landings achieved the highest value (2003). The last period (2013–2015) was not considered because TAC was limiting the fishery as a consequence of the penalty applied for exceeding the TAC in 2012. So WKNEP 2016 recommended setting an initial F_{MSY} proxy to 4% and moving gradually towards this level although with no current definition of the transition scheme. As the UWTV survey approach is recently initiated for the FU 30, this should be taken with caution for the definition of the transition scheme towards F_{MSY} proxy.

WKNEP 2016 recommended a new EG on reference points that will examine the methodology for all *Nephrops* reference points with focus on M and growth.

ADGNEP agreed in October 2017 that in absence of stock specific MSY harvest rate in *Nephrops* FU 30 because of the poor fits in length-frequency model, normally used for calculating F_{MSY} for category 1 in *Nephrops* stocks, the basis of advice for this stock should follow the category 4 approach for Norway lobster stocks and not category 1. ADGNEP recommended that if stock specific MSY reference points can be estimated, *Nephrops* FU 30 will meet the requirements for category 1 assessment.

The WGBIE 2017 supports the proposal of a specific workshop before the 2018 assessment WGs but this was not possible. This WK will be carry out in November 2019.

Several trials with the mean-length Z method developed in WKLIFE V and WKProxy 2016 (ICES, 2015, 2016) were performed using the data for the period 2006–2017 and 2009–2017 during last WG. Results of the model application are inconsistent and could not be used.

13.3.6 Management considerations

Nephrops fishery is taken in mixed bottom trawl fisheries; therefore HCRs applied to other species will affect this stock.

In 2013 and 2014, *Nephrops* fishery was closed the most part of the year because the quota in 2012 was exceeded and a sanction for the European Commission to be paid in 3 years was applied.

A Recovery Plan for the Iberian stocks of hake and *Nephrops* was approved in December 2005 (CE 2166/2005). This recovery plan was based on precautionary reference point for southern hake that are not longer appropriated. By derogation, a different method of effort management method is applied to the Gulf of Cadiz. A multiannual management plan (MAP) for the Western Waters has been published by the European Parliament and the Council (EU, 2019). This plan applies to demersal stocks including *Nephrops* in FU 30 in ICES divisions 9a.

Different Fishing Plans for the Gulf of Cadiz have been established by the Spanish Administration since 2004 in order to reduce the fishing effort of the bottom trawl fleet (ORDENES APA/3423/2004, APA/2858/2005, APA/2883/2006, APA/2801/2007, ARM/2515/2009, ARM/58/2010, ARM/2457/2010; AAA/627/2013). These plans establishes a closed fishing season to 45 days, between September and November, plus 5 additional days to be selected by the ship owner during the duration of this Plan. The potential effect of the closed seasons on the *Nephrops* population has not been evaluated. Additionally, an increase of mesh size to 55 mm or more was implemented at the end of 2009 in order to reduce discards of individuals below the minimum landing size. In 2014, a modification of last Fishing Plan for the Gulf of Cadiz was established (AAA/1710/2014,modified by AAA/1406/2016). This new regulation establishes an assignation of the *Nephrops* quotas by vessel. Fishing Plan for the Gulf of Cadiz establishes a modification of the close season for the bottom trawl fleet from 16 September to 31 October (APM/453/2018).

Regulations were established by the Regional Administration with the aim of distributing the fishing effort throughout the year (Resolutions: 13th February 2008, BOJA nº 40; 16th February 2009, BOJA nº 36; 23th November 2009, BOJA nº 235; 15th October 2010, BOJA nº 209). These regional regulations controlled the days and time when the Gulf of Cadiz bottom trawl fleet can enter or leave fishing ports. Although the regulations varied among them, they generally allowed a large flexibility during late spring and summer months (*e.g.* the 2010 Regulation established a continuous period from Monday 3 am to Thursday 9 pm during May-August, that was implemented in 2011), which is the main *Nephrops* fishing season, with more restricted time period in other months. This flexibility in summer months might have induced fleets from the ports closer to *Nephrops* grounds, such as Ayamonte or Isla Cristina, to direct their fishing effort to this species between 2008 and 2011. Currently, this regulation is not implemented.

13.3.7 References

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13.3.8 Tables and Figures

Table 13.3.1. *Nephrops* FU30, Gulf of Cadiz: Landings in tonnes.

Year	Spain**	Portugal	Non-reported	Total
1994	108			108
1995	131			131
1996	49			49
1997	97			97
1998	85			85
1999	120			120
2000	129			129
2001	178			178
2002	262			262
2003	303	4		307
2004	143	4		147
2005	243	3		246
2006	242	4		246
2007	211	4		215
2008	117	3		120
2009	117	2		119
2010	106	1		107
2011	93	3		96
2012	115	1		116
2013	26	<1		27
2014	14	<1		15
2015	25	<1		25
2016	35	<1	89	124
2017	38	<1	101	140
2018	49	<1	27	75

** Ayamonte landings are included since 2002

Table 13.3.2. *Nephrops* FU30, Gulf of Cadiz: Mean carapace length of the discarded and retained fraction of *Nephrops*, and percentage of discarded (2005-2018) for the annual discarding program.

	MEAN CARAPACE LENGTH (mm)		% DISCARDED	
	Discarded fraction	Retained fraction	Weight	Number
2005	23.4	33.5	5.2	15.2
2006	20.5	29.4	4.6	11.8
2007	23.2	33.7	0.5	1.4
2008	20.8	35.2	2.5	7.7
2009	21.2	30.2	2.7	4.0
2010	21.9	31.7	1.3	4.5
2011	-	32.7	0.0	0.0
2012	-	32.6	0.0	0.0
2013	23.9	32.7	3.7	10.9
2014	-	34.5	0.0	0.0
2015	21.2	33.6	2.0	5.4
2016	20.5	31.0	0.0	0.1
2017	24.2	29.8	2.5	3.0
2018	23.5	32.0	3.3	7.6

Table 13.3.3. *Nephrops* FU30, Gulf of Cadiz. Abundance index from Spanish bottom trawl spring surveys (SP-GCGFS-Q1).

Spanish bottom trawl spring surveys						
	200-500 meters		500-700 meters		200-700 meters	
Year	Kg/60'	Nb/60'	Kg/60'	Nb/60'	Kg/60'	Nb/60'
1993	0.77	19	1.16	34	0.95	26
1994	1.23	31	0.60	8	0.94	21
1995	0.55	8	**	**	na	na
1996	0.56	10	1.33	29	0.93	19
1997	0.08	2	0.70	23	0.38	12
1998	0.40	16	0.23	7	0.30	11
1999	0.50	15	0.28	7	0.41	12
2000	0.22	7	0.57	15	0.37	10
2001	0.32	8	0.61	14	0.44	11
2002	0.49	17	0.45	11	0.47	14
2003	ns	ns	ns	ns	ns	ns
2004	0.15	5	0.15	4	0.15	5
2005	0.54	18	0.76	25	0.64	21
2006	0.24	6	0.66	20	0.42	12
2007	0.44	16	0.23	9	0.35	13
2008	0.88	26	0.81	14	0.85	20
2009	0.64	18	0.30	4	0.37	9
2010	0.63	20	**	**	na	na
2011	0.35	11	0.08	2	0.23	7
2012	0.15	4	0.22	4	0.18	4
2013	0.36	13	1.39	51	0.79	29
2014	2.97	84	0.50	9	1.92	52
2015	1.04	45	1.58	52	1.27	48
2016	4.38	194	0.5	15	2.73	118
2017	2.27	79	0.86	20	1.67	54
2018	0.49	15	0.23	5	0.38	11
2019	1.49	46	1.14	27	1.34	38

ns = no survey

**= no sampled

Table 13.3.4. ***Nephrops*** **FU 30, Gulf of Cadiz. Results summary table for geostatistical analysis for ISUNEPCA UWTV survey.**

Year	Nª stations	Mean density adjusted	Area Surveyed	Domine area	Geoestatistical Abundance estimate adjusted	CV on burrow estimate
		Burrow/m2	Km2	Km2	Millions burrows	
2015	58	0.0905	3000	3000	298	7.6
2016	58	0.0776	3000	3000	233	7.3
2017	62	0.1336	3000	3000	371	8.7
2018	60	0.1197	3000	3000	329	6.0

Table 13.3.5. ***Nephrops*** **FU30, Gulf of Cadiz. Total landings and landings, LPUE and effort at the bottom trawl fleet making fishing trips with at least 10%** ***Nephrops*** **catches.**

Year	**Total landings (t)	*Landings (t)	*LPUE (kg/day)	*Effort (Fishing days)
1994	108	90	98.6	915
1995	131	107	99.4	1079
1996	49	40	88.2	458
1997	97	75	79.2	943
1998	85	51	62.3	811
1999	120	83	66.2	1259
2000	129	90	60.6	1484
2001	178	130	67.7	1924
2002	262	196	69.4	2827
2003	307	214	75.4	2840
2004	147	98	44.3	2206
2005	246	228	52.7	4336
2006	246	227	64.0	3555
2007	215	198	63.7	3105
2008	120	84	72.9	1150
2009	119	83	50.0	1653
2010	107	73	45.5	1603
2011	97	62	54.6	1135
2012	116	80	58.0	1380
2013	27	24	92.1	262
2014	15	12	40.1	293
2015	25	17	58.8	294
2016***	124	29	64.6	443
2017	140	24	45.5	535
2018				

*Landings, LPUE and fishing effort from fishing trips with at least 10% *Nephrops*.
** Ayamonte landings are included since 2002
*** Since 2016 Total landings were estimated by the WG. Official landings are used for LPUE estimation.

Table 13.3.6. *Nephrops* FU30, Gulf of Cadiz. Summary for the assessment.

Year	Landing in number	Total discard in number*	Removals in number	UWTV Abundance estimates	95% conf. intervals	Harvest Rate	Mean weight in landings	Mean weight in discard	Discard rate	Dead discard rate
	millions	millions	millions	millions	millions	%	g	g	%	%
2014**	0.48	0	0.48	282		0.2	31.2	NA	0	0
2015	0.80	0	0.80	298	45	0.3	30.8	NA	0	0
2016	5.35	0	5.35	233	34	2.3	23.2	NA	0	0
2017	5.95	0	5.95	370	63	1.6	23.3	NA	0	0
2018	3.21	0	3.21	329	39	1.0	23.4	NA	0	0

* Discards are considered negligible and are not included in the assessmet

** UWTV survey in 2014 is considered exploratory. UWTV abundance estimate is not adjusted by the cummulative bias

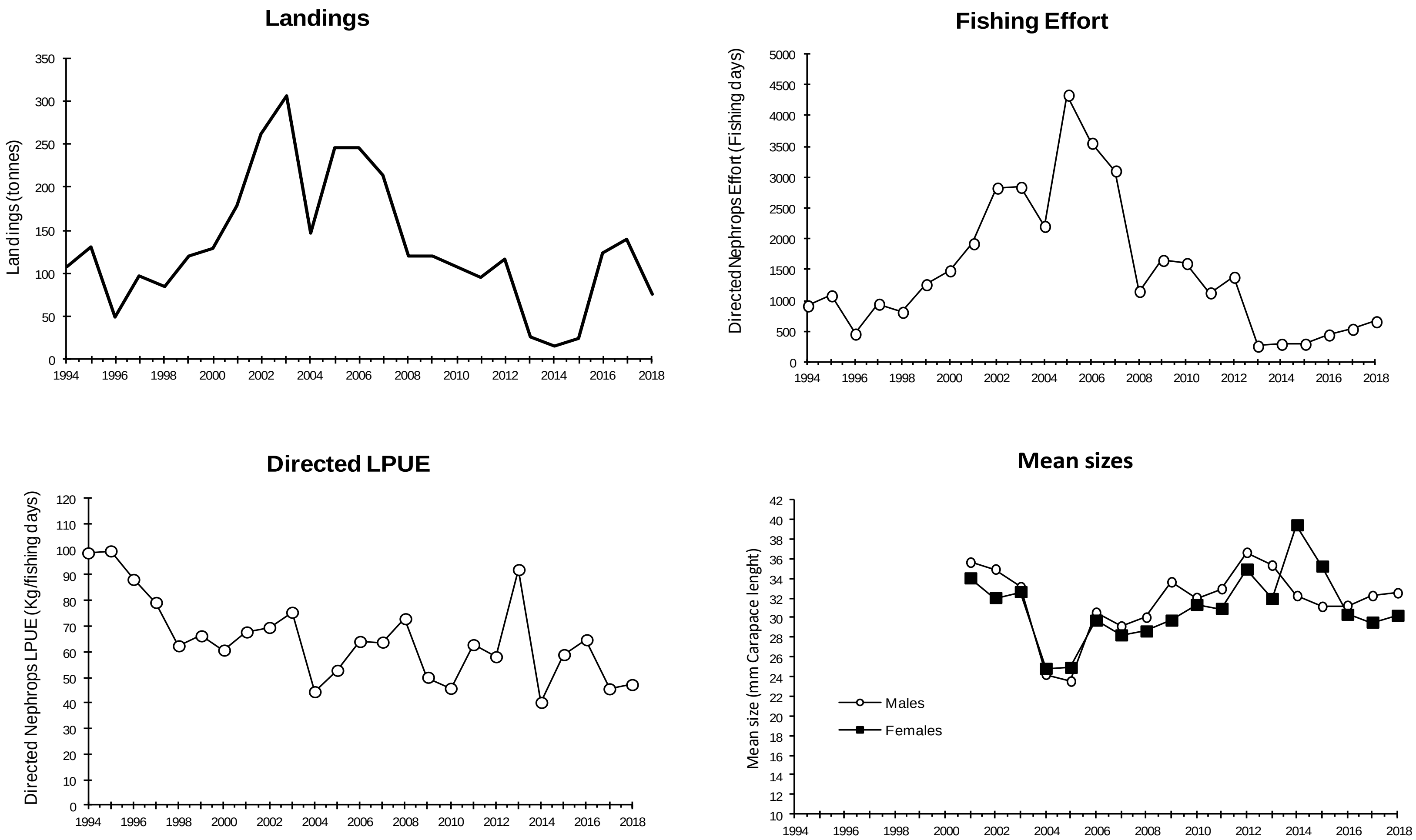


Figure 13.3.1. ***Nephrops*** **FU 30, Gulf of Cadiz. Long term trends in landings,** ***Nephrops*** **directed effort and LPUE and mean sizes.**

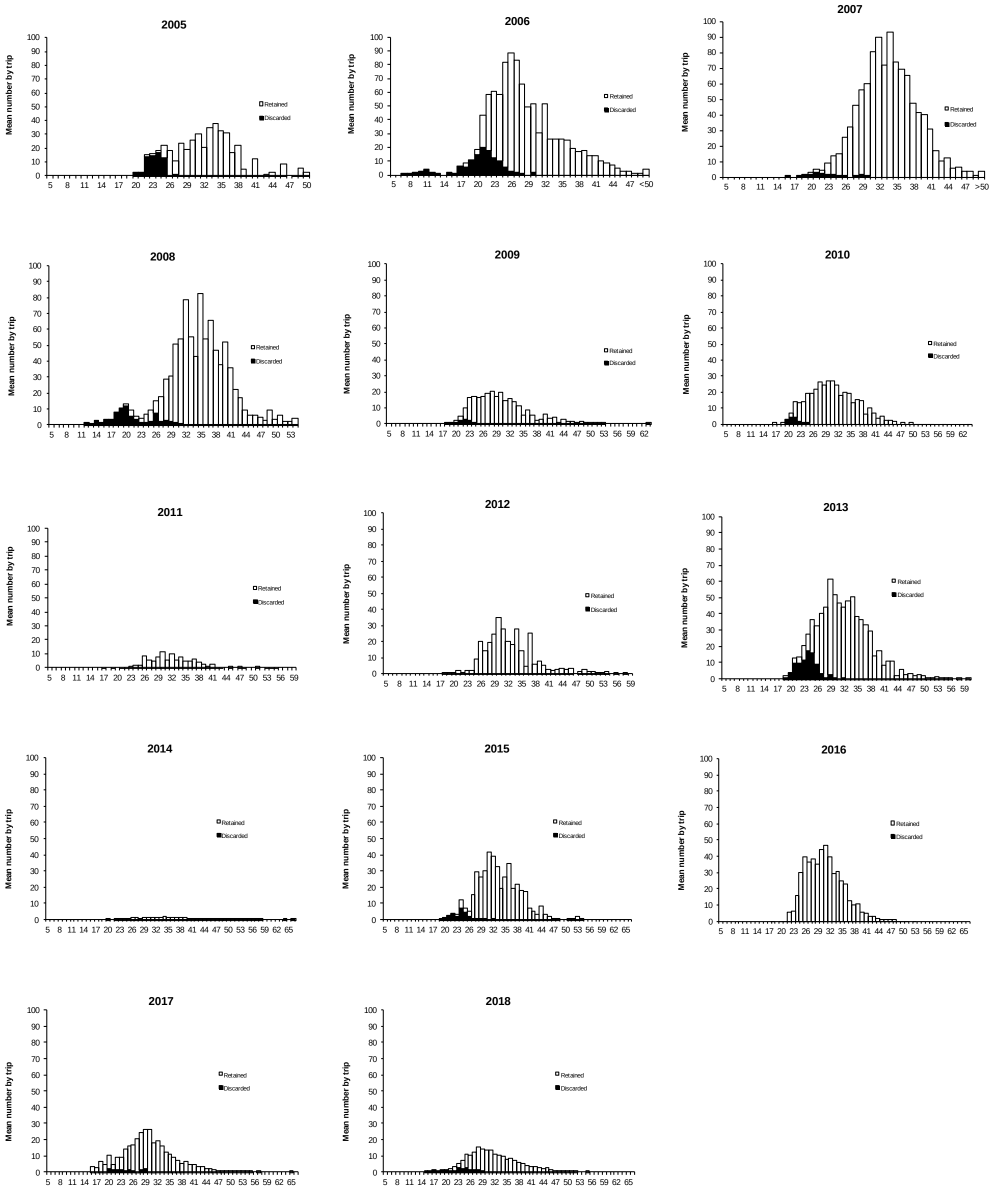


Figure 13.3.2. ***Nephrops*** **FU 30, Gulf of Cadiz. Length distribution of retained and discarded fractions** ***Nephrops*** **from discards program (2005–2018 period).**

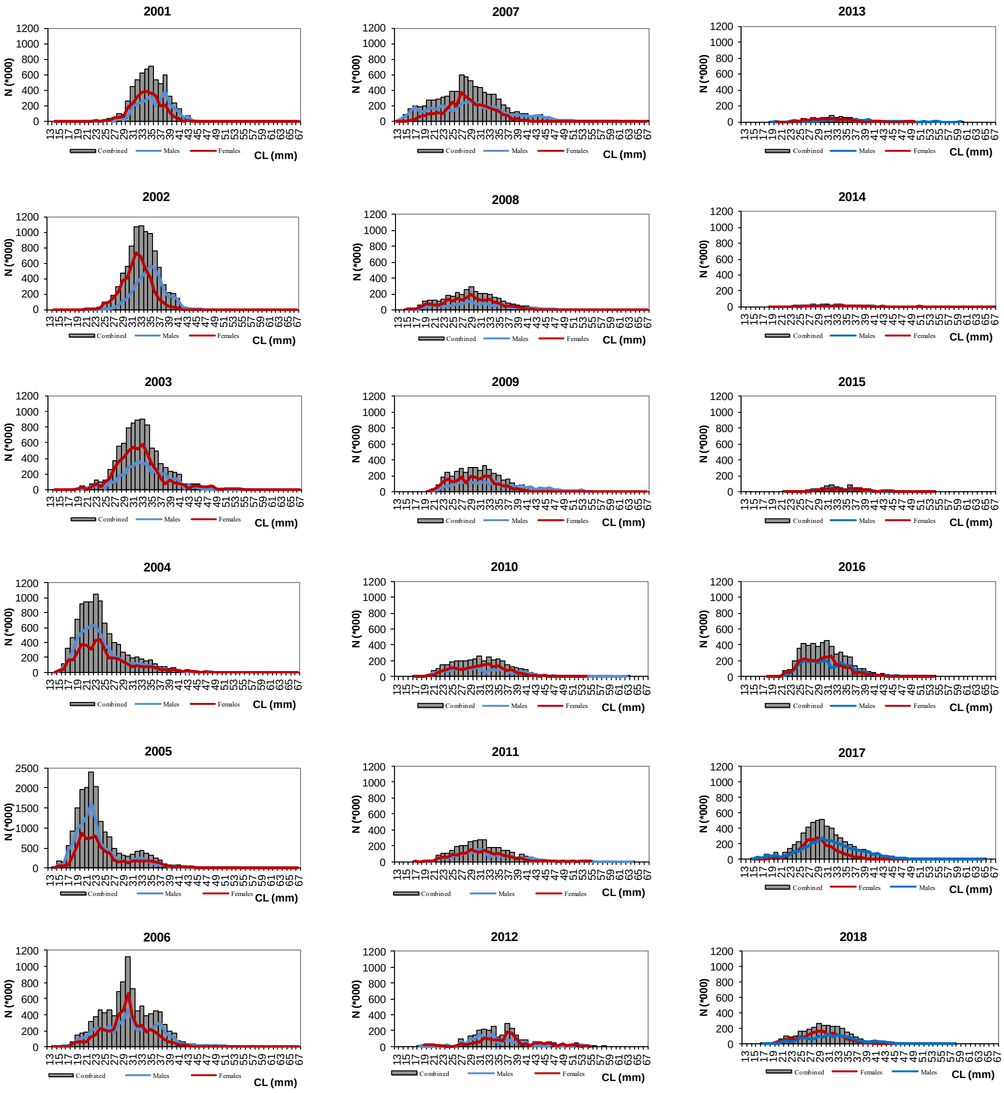


Figure 13.3.3. ***Nephrops*** **FU30, Gulf of Cadiz. Length distributions of landings for the period 2001–2018**

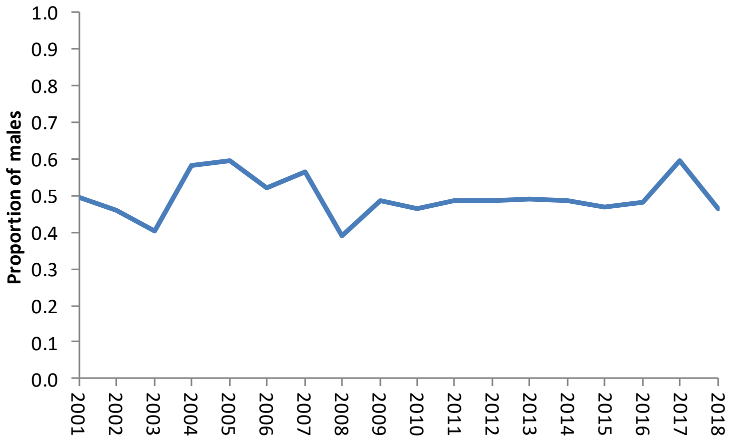


Figure 13.3.4. *Nephrops* in FU 30, Gulf of Cadiz. Proportion of males in landings for the time series.

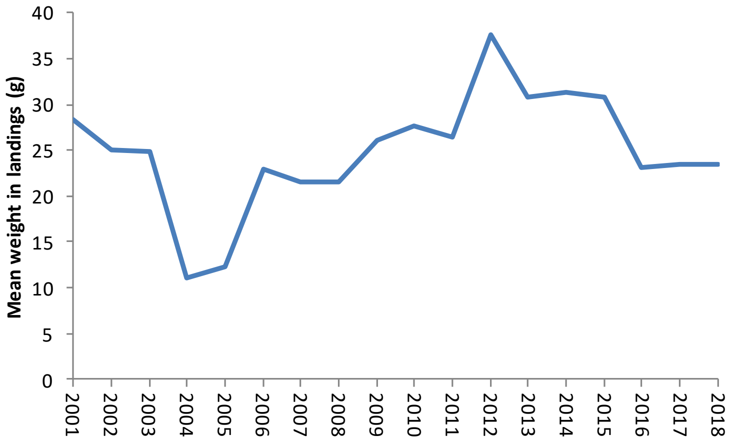
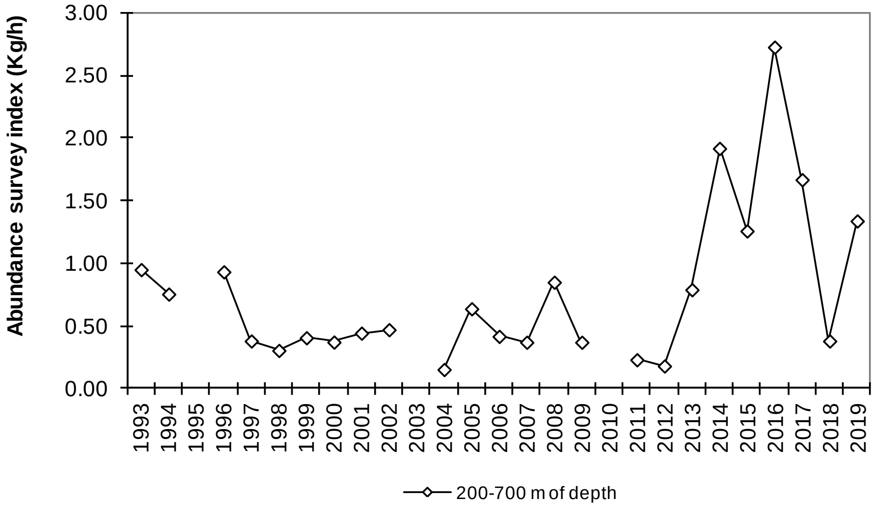


Figure 13.3.5. *Nephrops* in FU 30, Gulf of Cadiz. Mean weight trend in commercial landings for the time series.



* 1995 and 2010: strata 500-700 m no sampled

** 2003: no survey

Figure 13.3.6. *Nephrops* FU30, Gulf of Cadiz, Abundance index from Spanish bottom trawl spring surveys (SP-GCGFS-Q1).

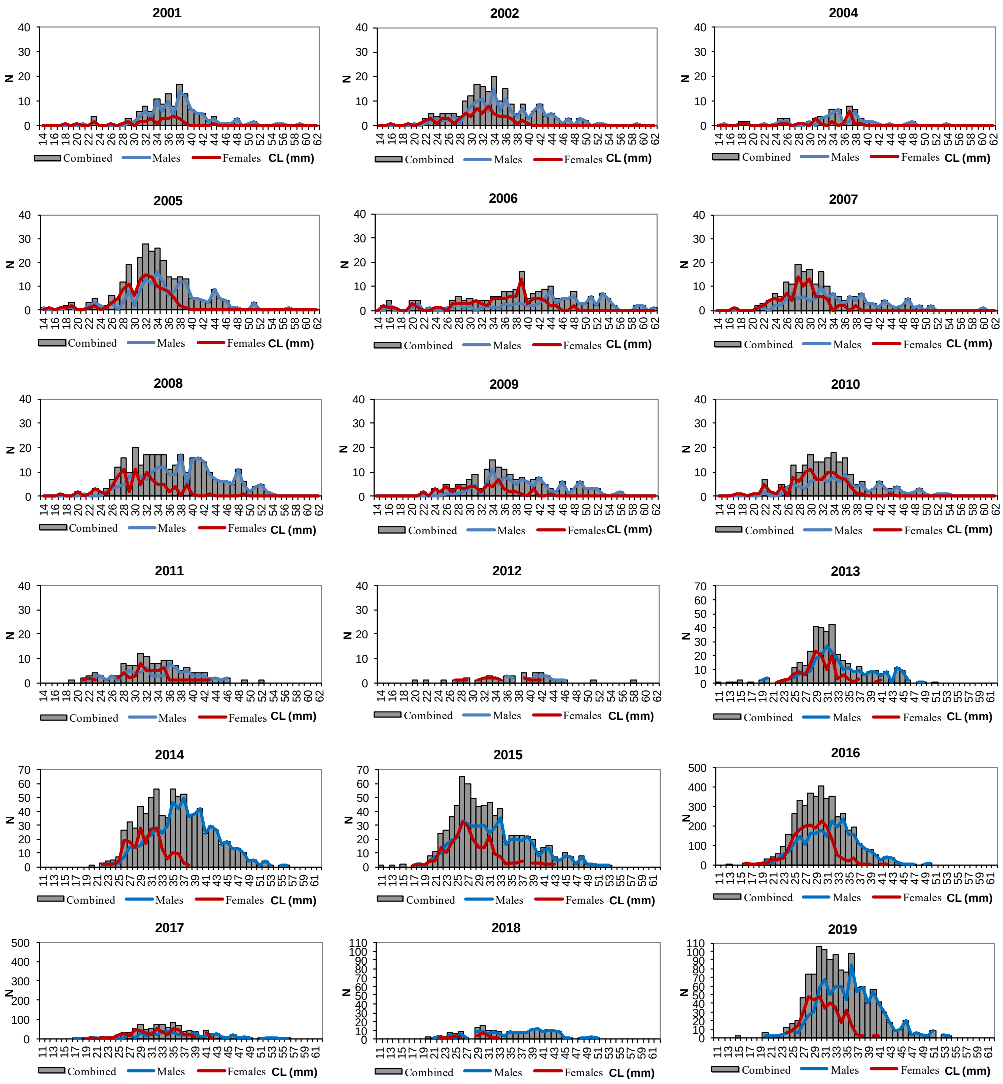


Figure 13.3.7. *Nephrops* FU30, Gulf of Cadiz. Length distributions from Spanish bottom trawl surveys (SP-SPNGFS-Q1) for 2001–2019 period.

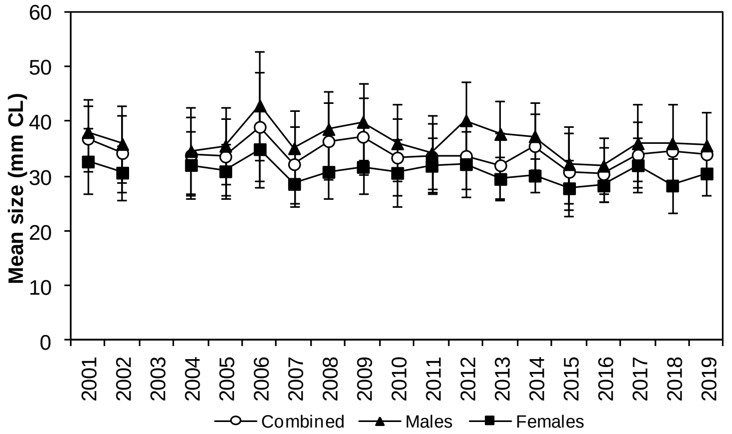


Figure 13.3.8. ***Nephrops*** **FU30, Gulf of Cadiz. Mean size in spring bottom trawl surveys (SP-GCGFS-Q1) for the period 2001–2019.**

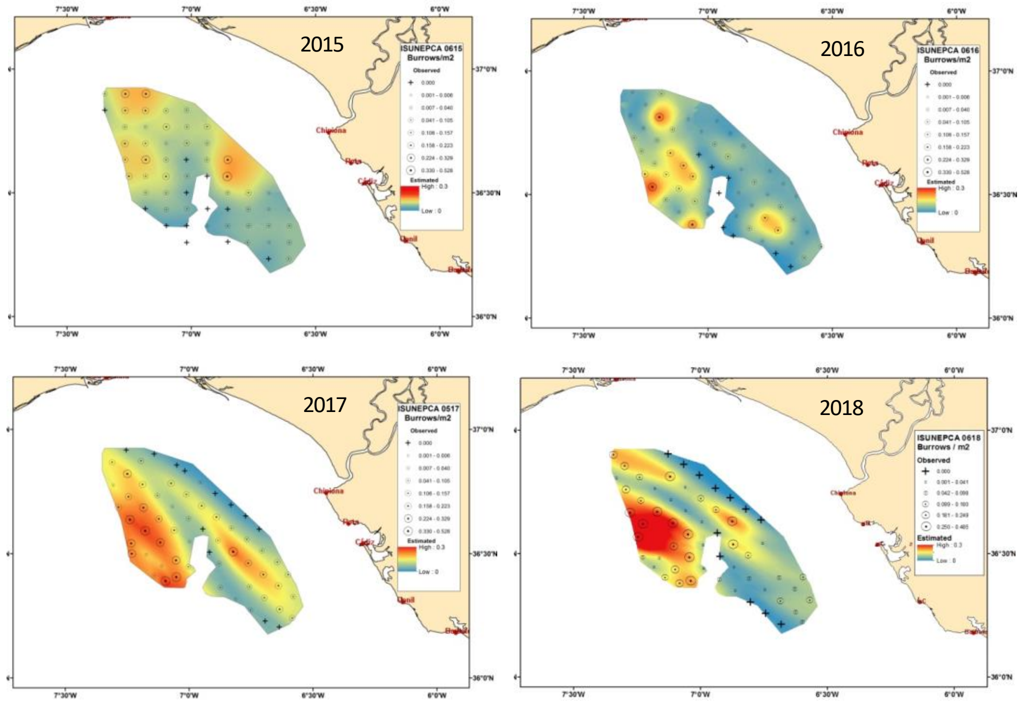


Figure 13.3.9. ***Nephrops*** **FU 30, Gulf of Cadiz. Contour plots of the krigged density estimates for the ISUNEPCA UWTV surveys time series (2015–2018).**

Annex The elimination of *Nephrops* non-reported landings in Functional Units 26-27(West Galicia and North Portugal)

Since 2012 the Spanish landings are provided as official and non-reported landings. There is a scientific estimation of landings; if the estimation is higher than the official landings, the difference is provided as non-reported landings.

In FU 26-27 there were *Nephrops* non-reported landings in 2011 and in 2016 (Table 1).

Table 1. *Nephrops* FU 26-27, West Galicia and North Portugal. Landings in tonnes (2011–2018).

	Spain		Portugal	Unallocated/Nonreported		Total
Year	FU 26	FU 27	FU 27	FU26	FU27	FU 26-27
2011	8	8	4		7	27
2012	3	4	1			8
2013	1	<1	1			3
2014	1	<1	1			4
2015	<1	<1	<1			2
2016	3	<1	2	1		6
2017	<1	0	2			3
2018	<1	1	0			2

The revision of the scientific estimation procedure has brought out that the procedure is correct, but it is designed for the target species. However, *Nephrops* is considered a by catch in the most of the bottom trips in FU 26-27. This results in a high level of uncertainty of these FUs *Nephrops* landings estimations. WGBIE 2019 has decided do not use these estimations for FU 26-27. *Nephrops* non-reported landings will be deleted from Intercatch. Non-reported landings were never used in the calculation of FU 26-27 *Nephrops* CPUE.

Taking into account this decision, some of the WGBIE 2019 tables and figures for FU 26-27 *Nephrops* have been changed:

Table 13.1.1. *Nephrops* FU 26-27, West Galicia and North Portugal. Landings in tonnes.

	Spain		Portugal	Total
Year	FU 26**	FU 27	FU 27	FU 26-27
1975	622			622
1976	603			603
1977	620			620
1978	575			575
1979	580			580
1980	599			599
1981	823			823
1982	736			736
1983	786			786
1984	604		14	618
1985	750		15	765
1986	657		37	694
1987	671		71	742
1988	631		96	727
1989	620		88	708
1990	401		48	449
1991	549		54	603
1992	584		52	636
1993	472		50	522
1994	426		22	448
1995	501		10	511
1996	264	50	17	331
1997	359	68	6	433
1998	295	42	8	345
1999	194	48	6	248
2000	102	21	9	132
2001	105	21	6	132
2002	59	24	4	87
2003	39	26	8	73
2004	38	24	9	71
2005	16	16	11	43
2006	15	17	12	44
2007	20	17	10	47
2008	17	12	13	42
2009	16	5	10	31
2010	3	14	4	21
2011	8	8	4	20
2012	3	4	1	8
2013	1	<1	1	3
2014	1	<1	1	4
2015	<1	<1	<1	2
2016	3	<1	2	5
2017	<1	0	2	3
2018	<1	1	0	2

**Prior 1996, landings of Spain recorded in FU 26 include catches in FU 27

Table 13.1.2. Nephrops FU 26-27, West Galicia and North Portugal. Length compositions of landings, mean weight (kg) and mean length (CL, mm) for the period 1988–2018.

Lenght (mm)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
12	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
13	0	71	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
14	0	69	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
15	0	451	110	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
16	0	191	289	13	0	0	0	0	0	0	0	0	3	17	0	0	0	0	0	0	0	0	0	0	0	0					
17	0	128	518	17	0	0	7	0	0	0	0	0	3	11	0	0	0	0	0	0	0	0	0	0	0	0					
18	0	683	898	25	0	0	2	1	0	0	0	0	16	19	0	4	0	0	0	0	0	0	0	0	0	0					
19	0	679	1502	38	0	0	0	0	0	0	0	0	38	52	0	4	0	0	0	0	0	0	0	0	0	0					
20	27	1057	2044	97	6	5	10	7	25	3	0	0	86	151	3	29	0	0	0	0	0	0	0	0	0	0					
21	27	1260	2489	199	12	24	19	8	78	0	0	0	119	236	3	27	0	0	1	0	0	0	0	0	0	0					
22	39	1657	2642	398	48	99	84	47	202	12	1	0	129	348	11	11	1	0	1	0	0	0	0	0	0	1					
23	109	1901	3063	568	103	99	77	151	373	26	6	0	127	518	16	31	0	0	0	0	1	0	0	0	0	0					
24	198	1626	2736	1216	284	222	169	338	550	46	7	3	93	466	22	17	1	2	1	0	2	0	0	0	0	0	1				
25	290	2212	1802	1477	541	381	199	672	906	113	45	15	134	441	35	28	1	2	1	0	3	1	0	0	0	0	2	0	1		
26	574	1675	1451	1516	829	542	289	709	960	184	40	43	145	365	56	22	7	2	2	1	2	1	0	0	0	0	1	0	0		
27	854	1878	1333	1351	926	904	409	933	746	306	80	68	129	419	106	40	18	8	5	2	3	1	0	0	0	0	1	0	0		
28	1272	1560	1319	1940	1079	1017	524	1298	842	402	138	109	123	274	74	46	23	12	8	6	9	4	0	0	0	0	2	0	1		
29	1487	1716	913	1797	1023	987	613	1223	706	489	191	134	143	266	86	60	20	15	13	7	7	9	0	0	0	0	2	0	2		
30	1615	1510	845	1501	1069	1140	767	1371	792	681	295	195	172	252	118	90	31	25	20	12	13	11	0	2	1	1	4	0	4		
31	1960	1106	632	1450	1180	890	802	1378	609	719	359	239	182	209	105	102	27	21	21	13	16	9	1	2	0	1	1	0	0		
32	1951	1472	772	1484	1197	912	847	1491	601	888	411	292	285	220	160	95	49	29	35	23	27	11	2	5	2	1	1	0	2		
33	2288	1313	601	1126	1378	878	898	1444	517	780	525	377	176	201	167	84	56	26	40	47	23	11	2	3	2	1	0	1	2		
34	1581	1299	572	1160	1001	849	853	1255	542	745	551	376	192	156	131	83	56	31	51	43	37	22	5	3	2	1	5	1	3		
35	1487	952	518	1044	915	855	745	963	506	637	569	432	200	148	96	91	53	26	48	46	25	18	4	5	2	1	5	2	5		
36	1161	634	407	879	776	901	611	744	433	527	484	360	176	120	110	85	56	21	42	36	22	15	4	4	1	1	2	1	2		
37	838	545	284	651	627	736	546	580	348	484	417	321	175	143	106	111	70	31	51	49	31	17	7	2	2	1	3	1	2		
38	1196	608	294	616	545	682	621	542	346	534	425	308	128	110	76	72	86	35	61	38	28	20	6	2	2	1	1	1	3		
39	837	451	226	600	505	510	475	425	285	406	292	240	128	85	95	79	65	27	43	36	21	14	6	8	3	1	2	1	2		
40	501	325	199	450	666	573	412	455	284	466	393	218	115	65	76	60	90	24	55	39	32	21	7	7	4	1	4	3	5		
41	428	288	165	375	431	385	321	321	213	399	312	182	112	58	88	48	60	21	40	32	23	16	8	6	4	1	1	1	1		
42	367	287	144	220	362	375	314	214	182	360	249	210	66	57	81	54	101	22	47	43	26	14	6	7	6	1	1	1	2		
43	433	296	156	203	425	307	293	188	165	325	292	219	64	36	76	47	73	25	38	49	25	13	9	7	4	1	1	2	1		
44	164	277	87	136	301	251	200	152	127	290	207	193	61	44	52	33	62	20	32	38	36	13	10	7	4	0	3	1	3		
45	165	286	58	110	303	219	178	125	118	218	196	162	58	42	44	34	56	17	18	29	17	12	8	10	5	0	3	1	6		
46	96	135	23	90	350	153	129	116	94	191	178	152	40	28	49	26	29	20	18	24	18	8	10	11	3	0	1	0	1		
47	94	117	45	82	228	104	92	84	56	123	120	84	38	47	42	31	38	26	18	28	17	8	8	9	4	0	1	0	3		
48	71	100	25	49	222	58	96	55	70	117	147	96	23	18	22	13	28	18	12	15	16	7	7	7	3	1	1	0	2		
49	73	76	29	42	148	84	71	46	23	60	105	64	21	16	15	16	18	13	11	14	9	5	7	7	3	0	1	0	2		
50	83	127	14	46	63	81	69	29	31	81	95	54	17	12	12	15	16	15	13	14	9	9	10	14	3	0	2	0	3		
51	15	48	9	14	71	27	59	13	21	43	59	21	17	6	7	15	7	15	7	7	9	6	4	5	3	0	0	0	1		
52	20	75	14	33	71	21	59	18	22	43	55	30	18	6	7	10	12	10	8	10	9	6	5	5	3	0	0	0	1		
53	23	34	13	26	34	20	28	6	13	30	37	33	5	5	6	10	5	7	6	8	4	6	5	6	2	0	0	0	1		
54	14	10	11	23	23	14	12	6	15	42	28	27	8	3	2	8	4	11	10	6	7	4	5	4	3	0	1	0	1		
55	6	27	1	6	13	17	12	1	9	25	26	12	6	7	3	4	5	8	3	6	6	5	7	5	1	0	1	0	2		
56	6	9	1	5	5	10	5	1	9	14	14	14	7	4	3	5	3	4	2	3	6	6	4	5	1	0	0	0	0		
57	10	5	1	2	6	5	10	0	4	8	12	6	5	3	3	2	2	3	2	4	5	5	3	2	0	0	0	0	0		
58	11	5	1	4	6	5	14	0	3	6	11	5	4	5	4	3	3	4	4	4	5	5	4	2	0	0	1	0	0		
59	7	0	4	0	7	2	7	0	0	2	1	5	3	3	0	1	4	3	1	3	2	2	1	3	1	0	0	0	0		
60	2	0	2	0	4	3	3	0	0	1	2	3	2	2	2	2	7	4	2	1	3	3	4	3	1	0	1	0	1		
61	4	0	1	0	3	2	12	0	0	0	2	0	3	2	0	2	1	14	1	2	1	1	3	2	1	0	0	0	1		
62	2	0	1	0	1	0	7	0	0	0	0	0	1	5	0	2	2	4	2	1	3	2	1	1	1	0	0	0	0		
63	1	0	1	0	3	0	5	0	0	1	0	0	3	3	0	2	1	2	1	1	1	1	2	2	0	0	0	0	0		
64	2	0	1	0	3	1	4	0	0	0	1	0	2	2	0	2	1	1	1	1	2	3	2	2	0	0	0	0	0		
65	2	0	1	0	1	0	2	0	0	0	0	0	1	1	1	1	2	2	1	1	1	2	2	2	0	0	0	0	0		
66	3	0	1	0	1	0	2	0	0	0	1	0	2	2	0	1	0	1	1	1	1	1	1	1	1	0	0	0	0		
67	2	4	1	0	1	1	1	0	0	0	1	0	3	1	0	2	1	2	1	1	1	1	1	1	0	0	0	0	0		
68	2	11	1	0	2	2	6	0	0	0	0	0	2	1	0	2	1	1	2	2	2	1	2	2	0	0	0	0	0		
69	1	4	1	0	1	1	0	0	0	0	0	0	2	1	0	1	1	1	2	1	1	1	1	1	1	0	0	0	0		
70	12	25	1	2	12	6	8	0	1	0	3	0	11	1	1	5	4	8	1	1	4	1	1	1	0	0	0	0	1		
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	2	0	0	0	0	0		
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0		
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0		
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0		
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0		
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0			
78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Total number (thousand)	22409	31275	29319	23087	17811	15360	12003	17411	11828	10827	7383	5302	3822	5712	2169	1666	1257	638	800	752	569	355	191	191	81	20	60	23	69		
Total weight (t)	727	708	450	603	636	522	448	511	331	432	344	246	132	132	87	72	70	42	44	46	36	25	19	20	8	3	4	2	5		
Mean weight (kg)	0.032	0.023	0.015	0.026	0.036	0.034	0.037	0.029	0.028	0.040	0.047	0.046	0.035	0.023	0.040	0.043	0.056	0.066	0.057	0.061	0.063	0.071	0.099	0.105	0.098	0.081	0.059	0.087	0.077		
CL Mean length (mm)	34.0	29.1	25.9	31.4	34.5	34.3	35.2	32.9	31.9	36.2	38.1	38.1	33.5	29.5	36.0	36.2	40.2	42.0	40.0	41.3	41.5	42.6	48.4	46.5	46.1	35.8	39.4	42.0	42.2		

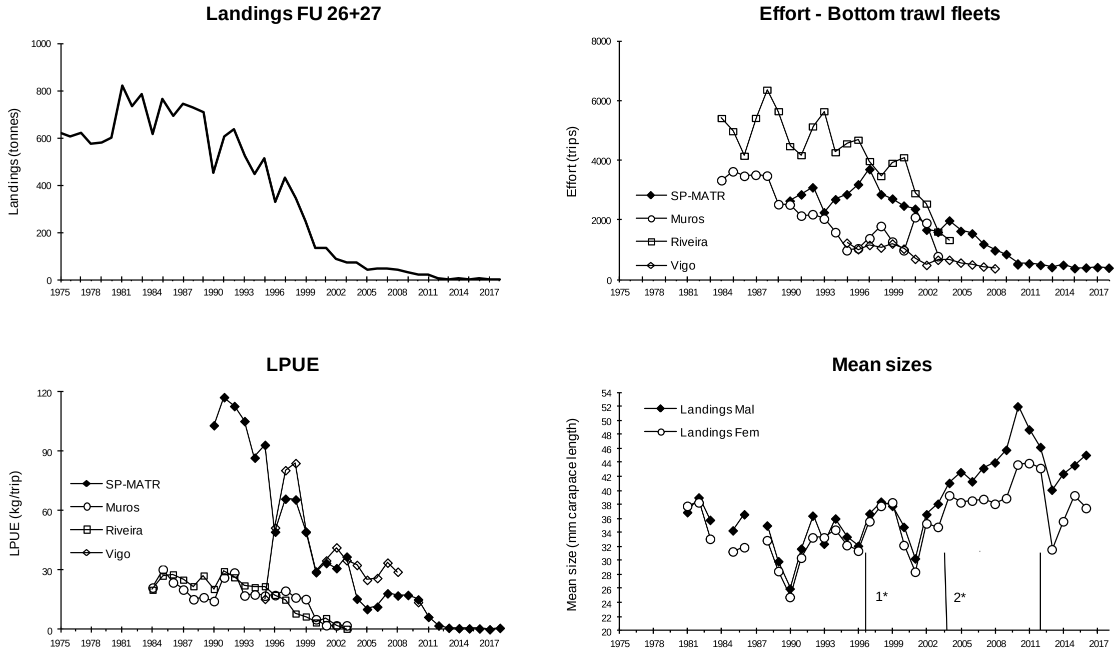


Figure 13.1.1. ***Nephrops*** **FU 26-27, West Galicia and North Portugal. Long-term trend in landings, effort, lpue and mean sizes.**

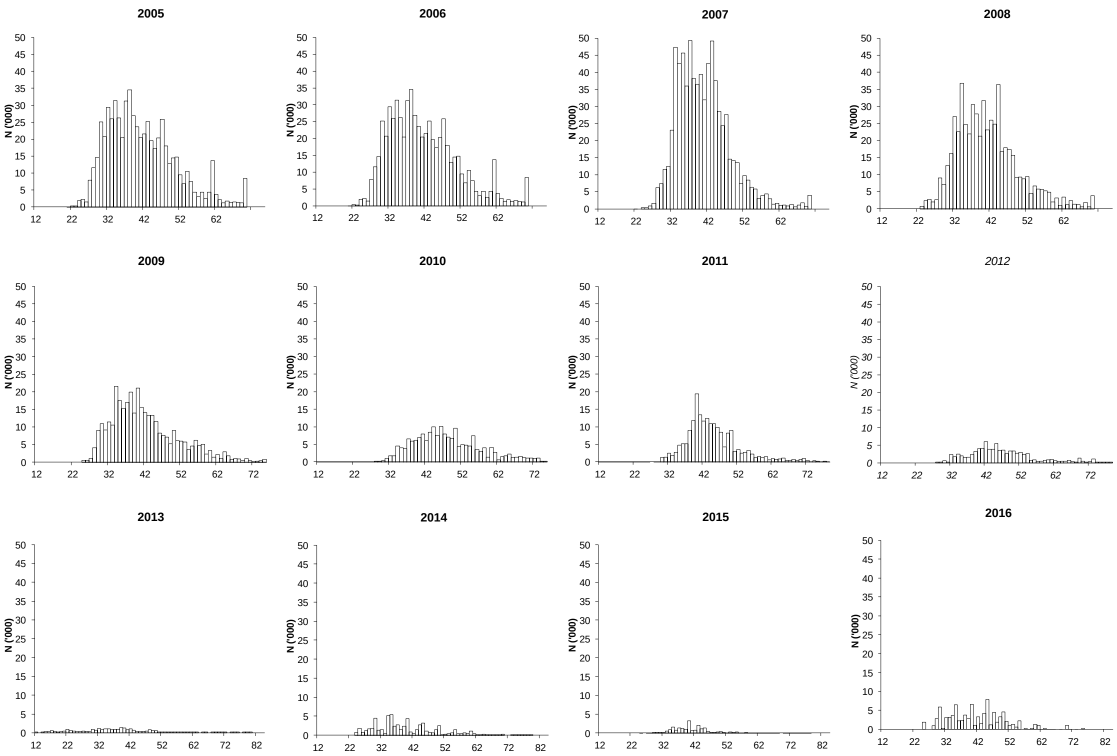


Figure 13.1.3b. ***Nephrops*** **FU 26-27, West Galicia and North Portugal. Length distributions in landings for the period 2000-2016.**

14 Seabass (*Dicentrarchus labrax*) in Divisions 8.a-b (Bay of Biscay North and Central)

Type of assessment: SS3 runs/update (stock benchmarked in WKBASS 2017, WKBASS 2018, and IBPbass 2018).

Data revisions: None.

Working Group issues: None.

14.1 General

14.1.1 Stock definition and ecosystem aspects

This section is described in the Stock Annex.

14.1.2 Fishery description

Seabass in the Bay of Biscay are targeted by France with more than 96% of international landings in 2018 (Table 14-1). Spain is responsible for 4% of the catches essentially in the area 8.b in 2018 (mainly bottom trawlers). A more detailed description of the fishery can be found in the Stock Annex.

Table 14-1: Summary of official and ICES commercial landings data. UK includes England, Wales, Northern Ireland and Scotland.

Year	Belgium	France	Netherlands	Spain	UK	Total Official	Total ICES
1985	0	2477	0	0	0	2477	3420
1986	0	2606	0	0	0	2606	3549
1987	0	2474	0	0	5	2479	3417
1988	0	2274	0	0	15	2289	3217
1989	0	2201	0	0	0	2201	3144
1990	0	1678	0	0	0	1678	2621
1991	0	1774	0	17	0	1791	2734
1992	0	1752	0	14	0	1766	2709
1993	0	1595	0	14	0	1609	2552
1994	0	1708	0	17	0	1725	2668
1995	0	1549	0	0	0	1549	2492
1996	0	1459	0	0	0	1459	2402
1997	0	1415	0	0	0	1415	2358

Year	Belgium	France	Netherlands	Spain	UK	Total Official	Total ICES
1998	0	1261	0	27	0	1288	2231
1999	0	2081	0	11	0	11	2091
2000	0	2080	0	67	0	2147	2362
2001	0	2020	3	68	0	2091	2306
2002	0	1937	0	176	0	2113	2392
2003	0	2812	0	119	0	2931	2616
2004	0	2561	0	96	0	2657	2380
2005	0	3184	0	74	0	3258	2796
2006	0	3318	0	168	2	3488	2875
2007	1	2984	0	74	1	3060	2751
2008	0	1508	0	145	0	1653	2745
2009	1	2339	0	194	0	2534	2278
2010	0	2322	0	165	2	2489	2229
2011	1	2295	0	311	0	2607	2575
2012	0	2325				2325	2549
2013	0	2532	0		0	2532	2685
2014	0	2900	0	91	0	2991	2991
2015	0	2193	0	71	0	2264	2264
2016	0	2160	0	93	0	2253	2253
2017	0	2223	0	72	0	2295	2295
2018	0	2222	0	94	0	2316	2317

For France, lines fishery (handlines and longlines) takes place all year round (especially during quarters 3 and 4), while nets, pelagic and bottom trawls fisheries take place from November to April on pre-spawning and spawning seabass when they aggregate to reproduce. In 2018, nets represent 36% of the landings of the area, lines 28%, bottom trawl 23%, and pelagic trawl 8%. In 2018, total landings are stable compared to 2017. An increase is observed for netters and bottom trawlers while a decrease for liners and pelagic trawlers (Figure 14–1). Note that netters are very dependent on weather conditions (2014 was exceptional).

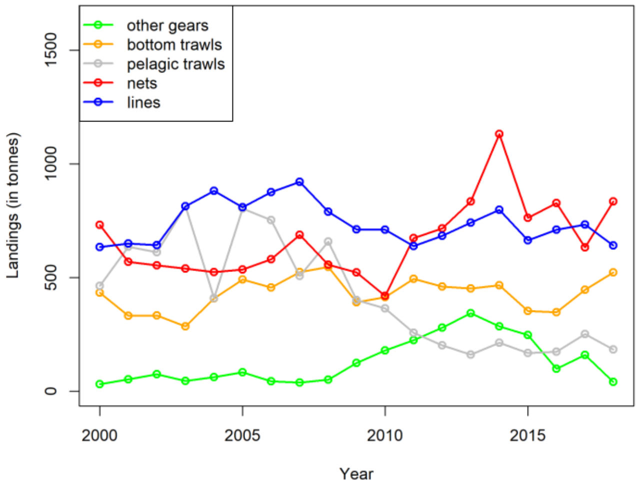


Figure 14-1: French landings per gear.

14.1.3 Summary of ICES advice for 2019 and management

14.1.3.1 ICES advice for 2019

This was the first time that ICES has provided advice for this stock based on a category 1 assessment. ICES advises that when the MSY approach is applied, total catch (commercial and recreational removals) in 2019 should be no more than 2 495 t (1924 t and 571 t, respectively).

14.1.3.2 Management

14.1.3.2.1 Commercial fishery

Seabass in the Bay of Biscay is subject neither to EU TACs and quotas, nor to a management plan in 2018. Only French national regulation is applied. From 2012 onwards, a national license, defined and implemented by the Committees for Maritime Fisheries and Fish Farming (CNPMEM), supervises French professional seabass landings on both the Bay of Biscay stock (ICES divisions 8abd) and the Northern stock (ICES divisions 4bc, 7a and 7d-h). Regarding the Bay of Biscay (ICES divisions 8abd), since 2017, a minimum landing size of 38 cm has been implemented. Moreover, all French professional fishing activities in the area have been subjected to an annual overall catch limit. It has been implemented in 2017, 2018 and 2019 and set respectively to 2 490 t, 2 241 t and 2 150 t. Note that during 2018, given the level of consumption of the overall catch limit estimated during mid-November and projections to the end of the year, individual fishing opportunities have been reduced from 27 November 2018, to 50 kg per vessel at the initiative of the fishermen and a closure of the fishery occurred on December 27, 2018 (the overall 2018 catch limit being consumed at 100%). To manage the overall catch limit, annual and periodic individual limitations of fishing opportunities occurred (Table 14-2 and Table 14-3). In addition, a voluntary closed season from February to mid-March for longline and handline seabass fisheries occurred in Brittany, France.

Table 14-2: Annual limits in 2018 for seabass landings in the Bay of Biscay for holders and non-holders of the national license.

Individual annual limits (tonnes/year)	**Lines and handlines**	**Nets**	**Bottom trawlers and seiners**	**Pelagic trawlers**
Non holder 2018	1	1	3	4
License holder 2018 – accessory fishing	6	6	6	--
License holder 2018 – targeted fishing	20	20	15	15

NB: Purse seiners have been allowed to land 41 tonnes in 2018 (all vessels combined). Others gears than those mentioned above have been allowed to land individually 1 tonne maximum in 2018.

Table 14-3: Individual periodic limits in 2018 for seabass in the Bay of Biscay for holders and non-holders of the national license.

<table>
<tr><th colspan="2">Individual periodic limits (tonnes/calendar fortnight)</th><th>Lines and handlines</th><th>Nets</th><th>Bottom trawlers and seiners</th><th>Pelagic trawlers</th></tr>
<tr><td colspan="2">Non holder 2018</td><td>0,2</td><td>0,2</td><td>0,5</td><td>0,5</td></tr>
<tr><td rowspan="2">License holder 2018 – accessory fishing</td><td>April to October</td><td rowspan="2">1</td><td>0,5</td><td rowspan="2">1</td><td rowspan="2">--</td></tr>
<tr><td>November and December</td><td>2</td></tr>
<tr><td rowspan="2">License holder 2018 – targeted fishing</td><td>April to October</td><td>3</td><td>1</td><td>2</td><td>2</td></tr>
<tr><td>November and December</td><td>2</td><td>5</td><td>5</td><td>5</td></tr>
<tr><td colspan="6">NB: Fishing opportunities for license holder using different gear prohibit the possibility of cumulating the annual or periodic limits.</td></tr>
</table>

14.1.3.2.2 Management applicable to 2019

European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including seabass in ICES divisions 8a and 8b.

14.1.3.2.3 Recreational fishery

A series of management measures have been taken by the French recreational fishery:

- A minimum conservation size of 42 cm has been implemented in 2013.
- A 5 fish bag limit has been implemented in 2017.
- A 3 fish bag limit has been implemented in 2018.

14.2 Data

14.2.1 Commercial landings and discards

A detailed description of the commercial landings can be found in the Stock Annex.

Landings series were reconstructed using the three main sources available (Figure 14-2):

1. Official statistics recorded in the Fishstat database since around the mid-1980s (total landings).
2. French landings for 2000-2018 from a separate analysis by Ifremer of logbook, auction data and VMS (SACROIS methodology; Demaneche *et al.*, 2010). Landings are available per metier.
3. Spanish landings for 2007-2011 from sale notes and for 2012-2018 from InterCatch statistics.

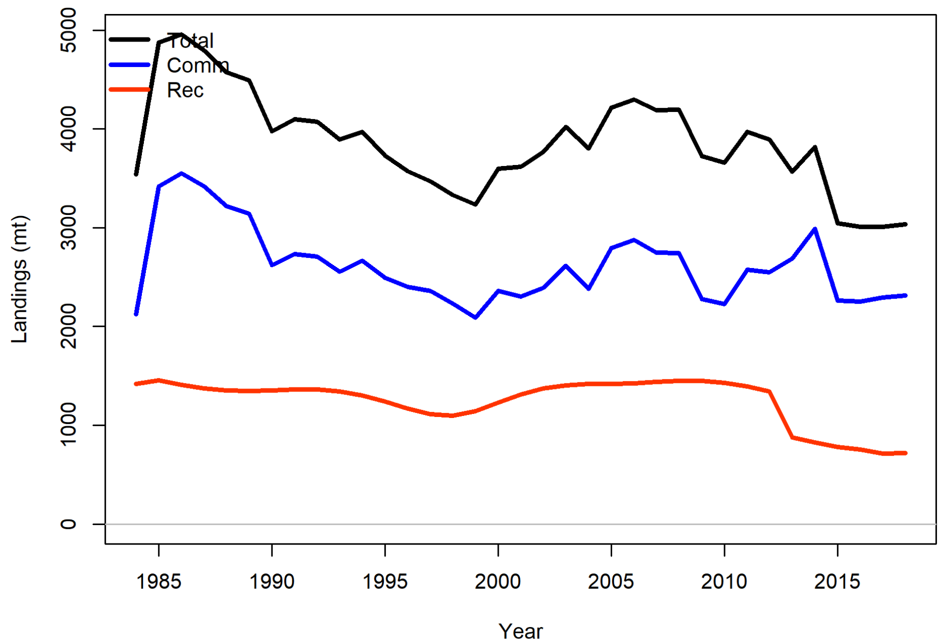


Figure 14-2: Commercial landings, recreational removals and total. Weights are in tonnes.

Discarding of seabass by commercial fisheries can occur where fishing takes place in areas with seabass smaller than the minimum landing size (i.e. < 38 cm). For France, discards rates are low (Table 14-4). In 2018, total discards percentage is estimated at 4.55% of the French commercial catches with an amount of 106 t. For Spain, observer data from Spanish vessels fishing in area 8, have shown that there was no seabass discards from 2003 (no information in 2018 were available on discards for this working group). So, for 2018, this correspond to 3.37% of the total catches (discards 106 t + commercial catch 2316 t + recreational removals 720 t, see hereafter). Discards are considered negligible and are not included in the stock assessment.

Table 14-4: Estimated seabass discards of French vessels in the Bay of Biscay. Weights are in tonnes.

Year	Commercial discards	Commercial landings	% discards
2015	69	2264	2.96
2016	62	2253	2.68
2017	74	2295	3.12
2018	106	2222	4.55

14.2.2 Length and age sampling

The full description of the biological sampling is available in the Stock Annex.

14.2.2.1 French commercial fishery

The French sampling programme for length compositions of seabass landings covers sampling at sea and on shore. Data are available from 2000 onwards. French length composition for 8.a-b, across time, all gear combined are presented in Figure 14-3.

14.2.2.1.1 Length compositions

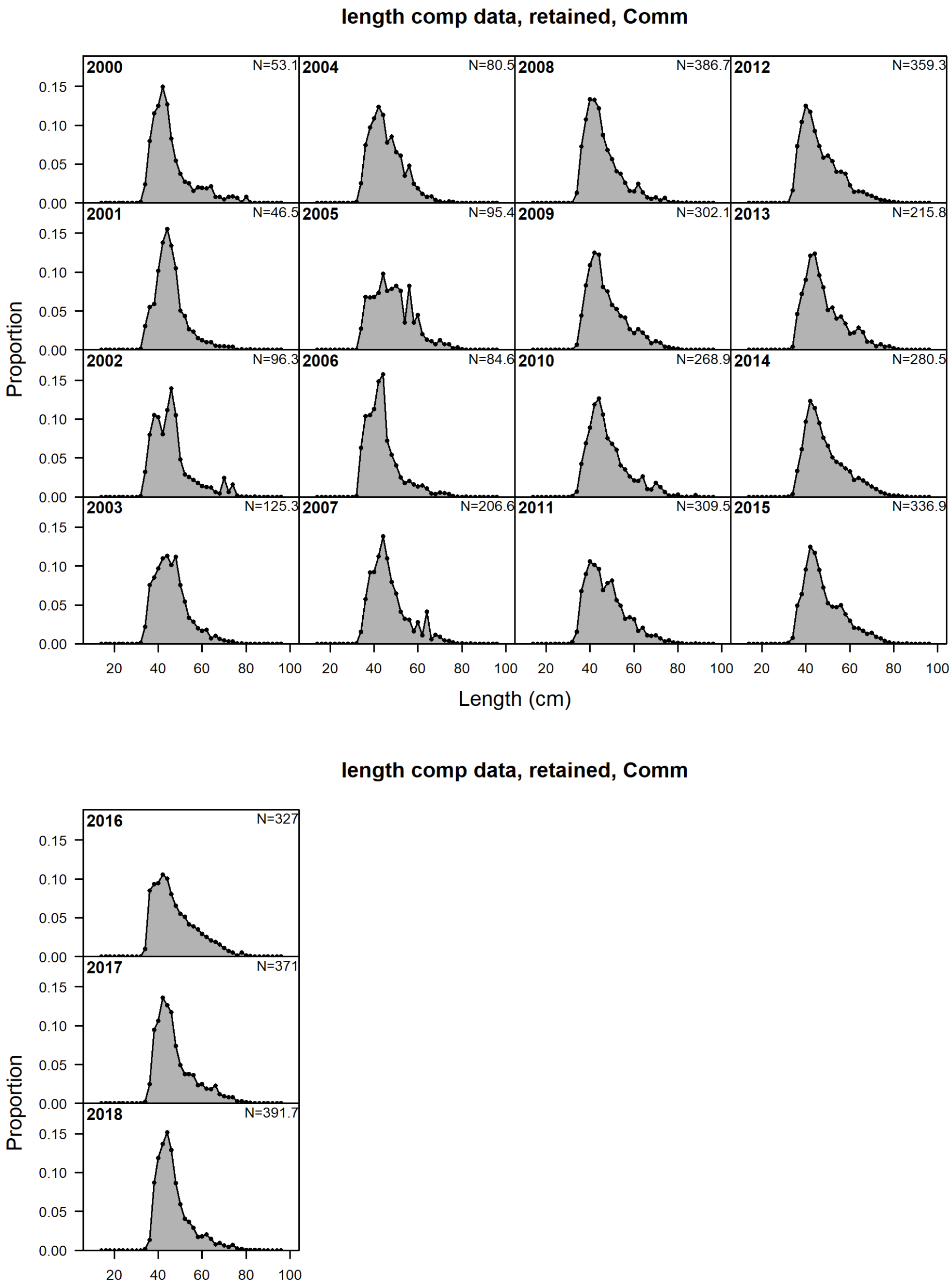


Figure 14-3: Length composition all French fleet combined from 2000 onwards.

Note that last year, WGBIE 2018 were made aware of an issue with the sampling level in Q1 and Q2 of 2017 from France (working document Quemar *et al.*, 2018). Because of the lack of market sampling for length (biological and on-board sampling was unaffected), efforts were made to try and fill the deficiency in the number of samples by the use of simulation techniques. Both simulated data and actual data were uploaded to InterCatch combined making it impossible to distinguish true samples from simulated ones. The simulation was based on commercial landings market categories (Figure 14-4).

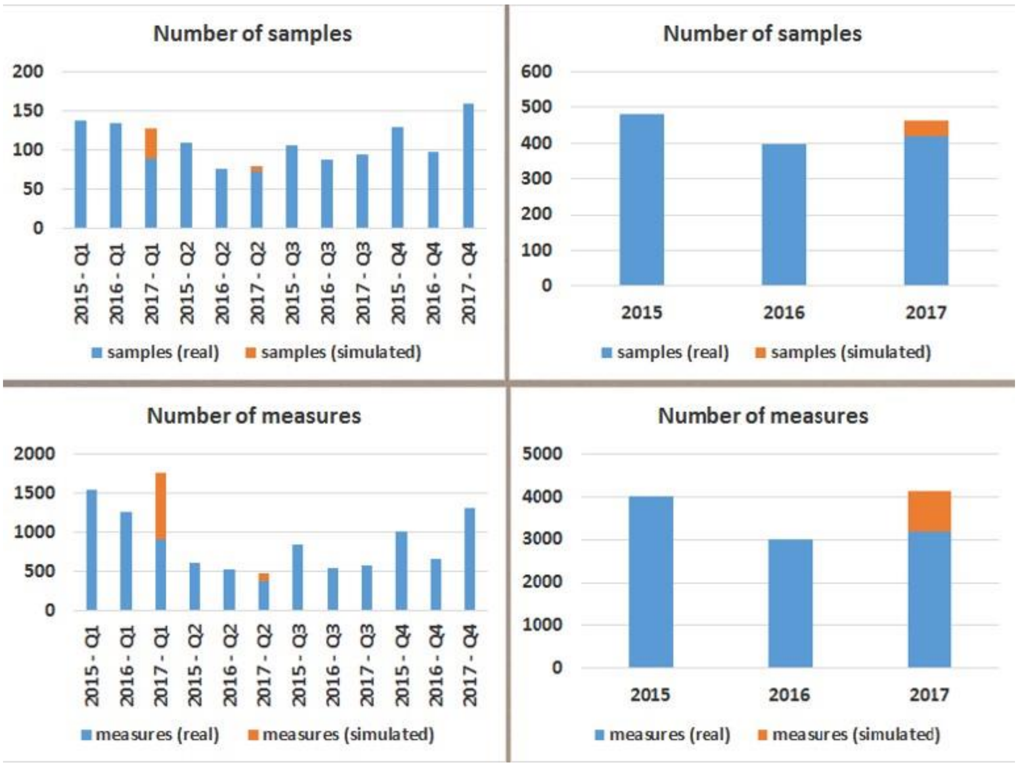


Figure 14-4: Numbers of seabass samples (trips) and measures (fish) simulated or not in the French sampling scheme in 2017 compared to the previous years.

14.2.2.1.2 Age compositions

The French sampling programme for age compositions of seabass is based on age-length keys with fixed allocation. For the 8.a-b area, the information is available only from 2008. This year, it was observed that 2018 age-at-length key (and in a lesser extent 2015) showed a pattern inconsistent with the historical data (Figure 14-5). This is likely related to an age reader change (Table 14-5). The group decided not to include those age-at-length data, as the retrospective analysis showed that year 2018 was offset compared to the other retrospective runs (see hereafter).

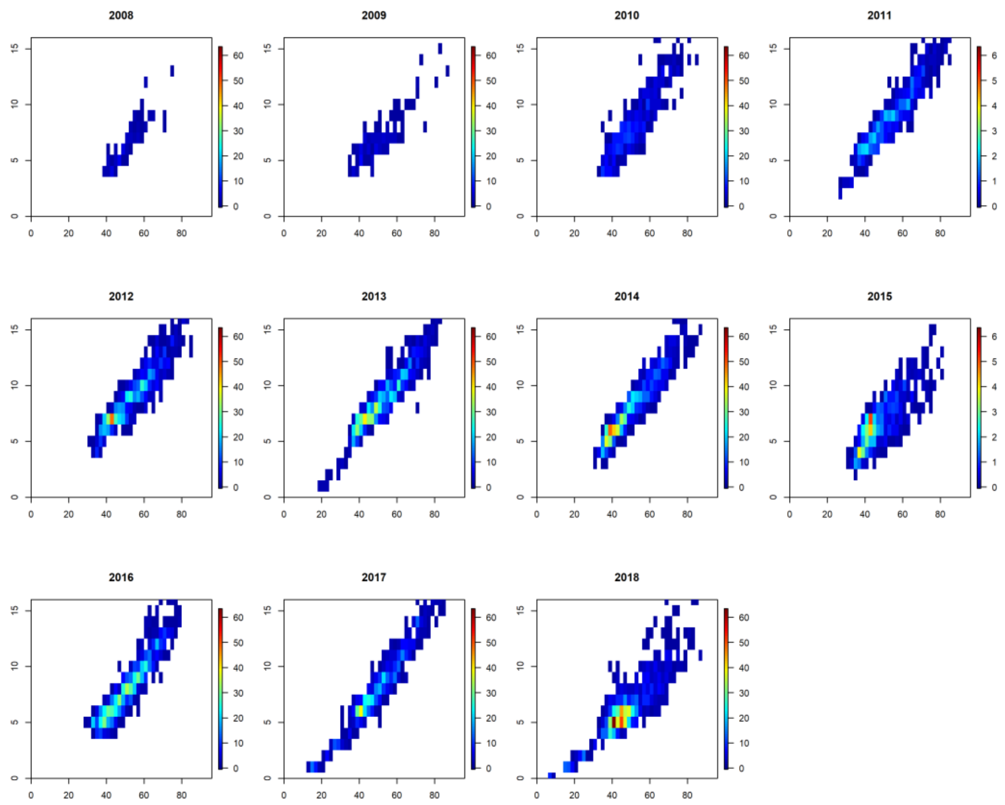


Figure 14-5: Age-at-length keys over years 2008-2018.

Table 14-5: Age readers proportion over years 2008-2018

Year	Age readers			
	JH	KS	RE	SM
2008			100	
2009			100	
2010		71	29	
2011		100		
2012		100		
2013		100		
2014	13	78	9	
2015		31	69	
2016		89	5	6
2017		88	12	
2018			100	
2019			100	

14.2.2.2 Recreational fishery

The full description of the recreational catches is presented in the Stock Annex.

14.2.2.2.1 Recreational fishery catches reconstructed for the whole time series

In previous reports (ICES, 2016b), partitioning French recreational data between the Biscay and Northern stock was only possible for the 2009–2011 study (Rocklin et al., 2014). There are no historical estimates of the recreational catch over the entire time series. IBP Bass (ICES, 2014) considered more plausible to treat recreational fishing as having a more stable participation and effort over time than the commercial fishery. A decision was made during the WKBASS 2018 assessment meeting to apply a constant recreational fishing mortality over time considering the same approach used for the Northern stock (ICES, 2018). Total retained recreational catches were iteratively adjusted to obtain a constant recreational F over all years, which was derived using the catch of 1 430 t estimated in 2010. The implementation of new management measures should have led to a reduction in fishing mortality as more and larger fish are released (Hyder *et al.*, 2018). This means that it is not appropriate to assume constant recreational fishing mortality in the last years and, thus, it is necessary to re-estimate the recreational catches. This has been done using the estimated reductions generated from the assessment of the impact of different levels of bag limits and minimum landing sizes (Armstrong *et al.*, 2014) in order to derive changes in recreational fishing mortality. Also, the application of different management measures, gave a recreational mortality multiplier for 2010–2012 of 1 and of 0.684 for 2013–2016 (related to an increase in MCRS to 42 cm). In 2017, with a 5 fish bag limit implementation, the multiplier was estimated to be unchanged. However, for 2018 with a 3 fish bag limit implementation, it was estimated to be 0.647. This was taken into account when preforming the short-term forecast. Table 14-6 compiled figures used in the assessment for the recreational fishery.

Table 14-6: Time series used in SS3 as commercial landings and recreational removals. Numbers are in tonnes.

Year	Recreational removals	Commercial landings
1985	1455	3420
1986	1408	3549
1987	1374	3417
1988	1355	3217
1989	1347	3144
1990	1355	2621
1991	1366	2734
1992	1362	2709
1993	1341	2552
1994	1301	2668
1995	1239	2492
1996	1171	2402
1997	1113	2358
1998	1099	2231

Year	Recreational removals	Commercial landings
1999	1142	2091
2000	1233	2362
2001	1313	2306
2002	1372	2392
2003	1404	2616
2004	1419	2380
2005	1422	2796
2006	1425	2875
2007	1440	2751
2008	1451	2745
2009	1449	2278
2010	1430	2229
2011	1394	2575
2012	1345	2549
2013	879	2685
2014	825	2991
2015	783	2264
2016	757	2252
2017	713	2295
2018	720	2316

14.2.2.2.2 Recreational post released mortality (PRM)

Based on the information provided by Hyder *et al*. (2018), WKBASS 2018 agreed on a figure of 5% for PRM in recreational fisheries on the Northern and the Bay of Biscay seabass stocks. This estimate is based on a published German study (Lewin *et al.*, 2018)

14.2.2.2.3 Recreational length compositions

The estimate of removals were recalculated for the 2010 reference year as the sum of retained and released fish with a PRM of 5%. A length composition for recreational removals for the 2010 reference year was estimated as described in working document from Hyder *et al*. (2018) and illustrated in Figure 14-6.

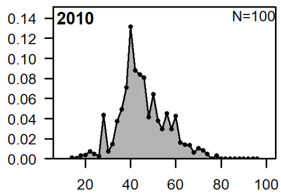


Figure 14-6: Length composition for the recreational fishery. Only one year of data available in 2010.

14.2.3 Abundance indices from surveys

Currently, there is no survey providing relative indices of adult or juvenile seabass abundance over time. However one pre recruit survey began on the coast of France from 2014. At this stage, the methodology has been set and give good results in term of gear used, catchability of seabass group 0,1,2,3 and understanding of nurseries dynamics. In the Bay of Biscay, the survey takes place in the Loire estuary and preliminary indices are available from 2016. The survey will be conduct until 2021 under an European Maritime and Fisheries Fund (EMFF) program (NOURDEM). The program includes also the Gironde estuary in order to get two abundance index for the stock bss.27.8ab (the first survey in the Gironde is planned for September 2019). The ultimate objective would be to make it sustainable through DCF from 2022 onwards.

14.2.4 Commercial landing-effort data

The full description of the LPUE is presented in the Stock Annex and in the working document from Laurec and Drogou (2017). The absence of a relative index of abundance covering adult seabass has been identified as a major issue for the assessment of the seabass stock in the Bay of Biscay. There are no scientific surveys providing sufficient data on adult seabass to develop an index of abundance for the area. Therefore, Ifremer investigated the potential for deriving an index from commercial fishery landings and effort data available since 2000. This allows the possibility to derive from French logbooks data (vessels with length > or < 10m) a LPUE index at the resolution of ICES rectangle and gear strata. A new LPUE index was presented at WKBASS 2018. This index is obtained by modelling the zeros and non-zeros values using a delta-GLM approach. A review of the study has been done by an external expert (M. Christman) before WKBASS 2018. The reviewer recommended the new LPUE index to be used in the assessment of Bay of Biscay seabass stock. The new LPUE index has been incorporated in the Northern and the Bay of Biscay stocks assessment models. Results updated with 2018 data are presented in Figure 14-7. The LPUE abundance index computed for the WGBIE 2019 compared well with the LPUE abundance index computed for the WGBIE 2018.

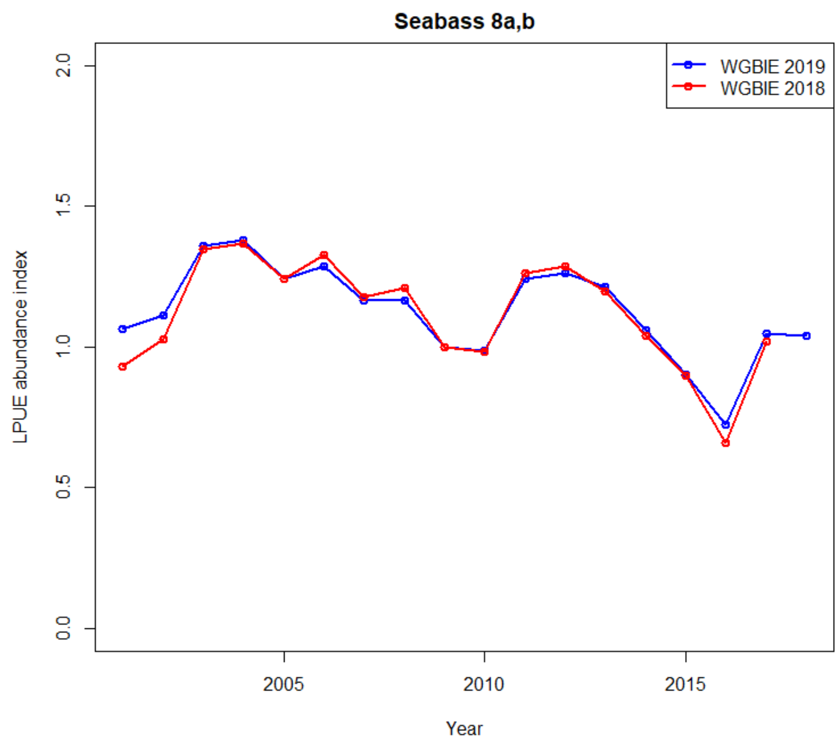


Figure 14-7: 2017 and 2018 LPUE abundance indices derived from the French commercial fishery.

14.2.5 Biological parameters

The full description of the biological parameters is presented in the Stock Annex.

14.2.5.1 Growth

In the Bay of Biscay, studies on seabass growth exist and have been published by Dorel (1986) and Bertignac (1987). To update these studies, seabass was sampled by Ifremer along the coasts of France in area 8.a-b. A Von Bertalanffy model parameters estimated using an absolute error model minimising $\sum(\text{obs-exp})^2$ in lengths-at-age has been used. L_{inf} was fixed to 80.4 cm (Bertignac, 1987). The standard deviation could be described by the linear model: SD = 0.1861 * age + 2.6955 (samples used from age 0 to age 15). The standard deviation of length-at-age increased with length as expected. K was estimated (see stock annex), but it is not used in the assessment model (K is re-estimated).

14.2.5.2 Maturity

Seabass maturity has been studied with samples collected by France in the Bay of Biscay. Samples were derived from French fisheries around the Bay of Biscay coast. The size at which 50% of the females are mature is 42.14 cm (low limit 41.31cm and upper limit 43.08 cm). The Pearson test (p-value = 0.597) identifies a good fit from the model to the data (Figure 14-8)

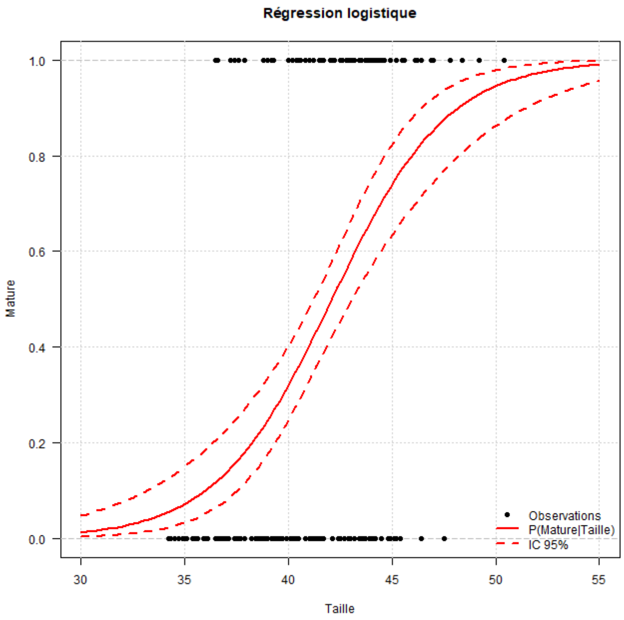


Figure 14-8: Maturity ogive for the Bay of Biscay sea-bass stock.

14.2.5.3 Natural mortality

WKBASS 2017 and WKBASS 2018 proposed to use the same value for both the Northern and the Bay of Biscay seabass stock (ICES, 2018): Then et al. (2014) tmax method, as being more robust than inferences from any single study, set the natural mortality for seabass to M = 0.24.

14.3 Assessment

This is an update assessment including the new data available for year 2018 from WKBASS assessment.

14.3.1 Input data

Input data are described in the Stock Annex (see under section "Input data for SS3").

14.3.2 Data Revisions

There were no data revisions for this update assessment.

14.3.3 Model

The Stock Synthesis 3 (SS3) assessment model (Methot and Wetzel, 2013) was selected for use in this assessment. Model description and settings are presented in the Stock Annex (under "Current assessment" for model description and "SS3 settings (input data and control files)" for model settings).

14.3.4 Assessment results

The assessment model includes estimation of size-based selectivity functions (selection pattern at length) for commercial and recreational fleets and for LPUE abundance index. Figure 14-9 presents selectivity functions by fleet estimated by the model. The inclusion of 2018 data did not change the selectivity pattern and its modelling.

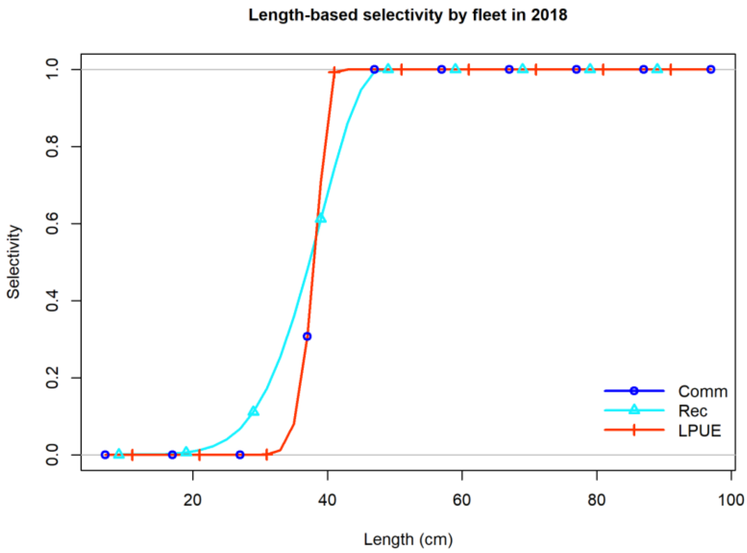


Figure 14-9: Selection patterns at length by commercial and recreational fleets estimated by SS3. Selection pattern for the LPUE abundance index was assumed to follow the one from the commercial fleet.

The selection curve is assumed constant over the whole period for all the fleets. The selection curve for the LPUE abundance index was assumed identical to that of the commercial fleet. The assessment currently assumes that commercial fleets do not discard fish (discards negligible less than 5% of the total landings).

Model fit for the LPUE abundance index was good (Figure 14-10). The index was useful to help the model to get the correct trend over time.

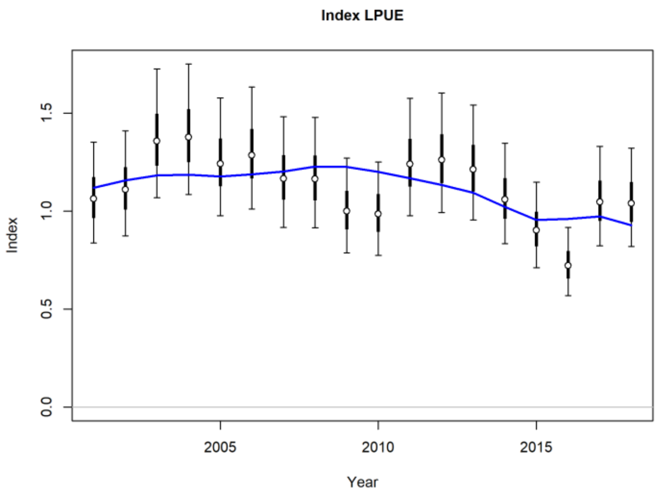
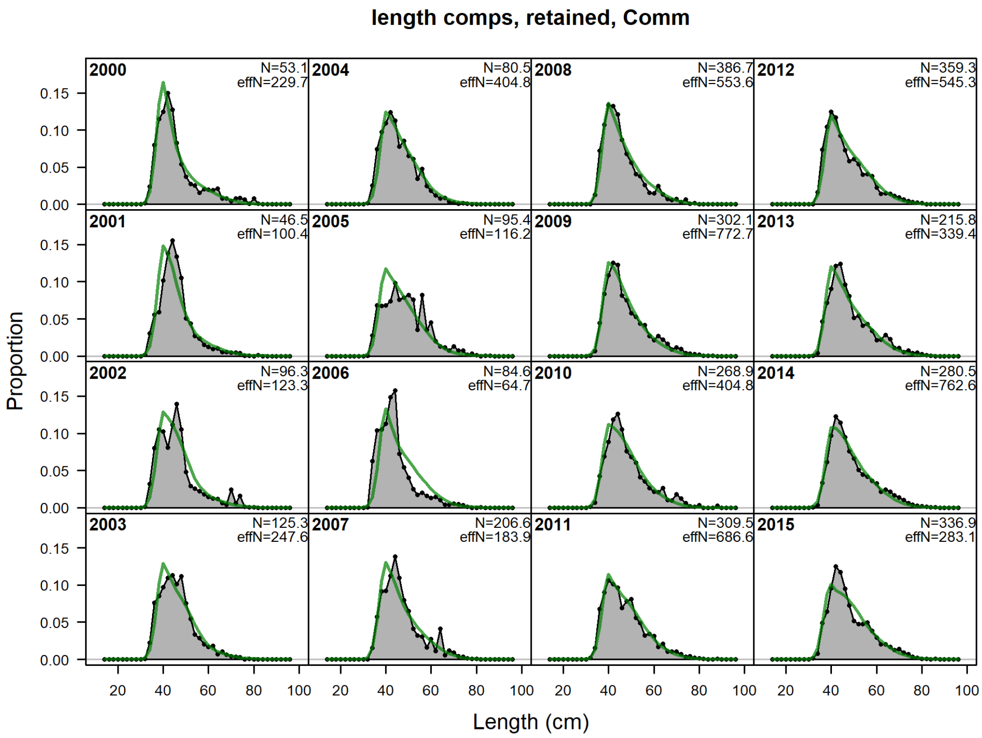


Figure 14-10: Fit to the LPUE abundance index.

Model fit for the commercial and recreational length composition data was good (Figure 14-11 and Figure 14-12)



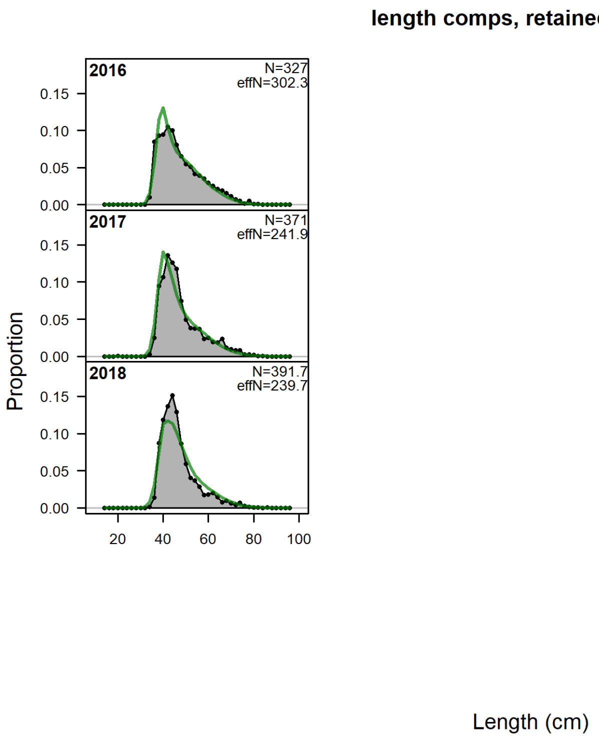


Figure 14-11: Fit to commercial fishery length composition data.

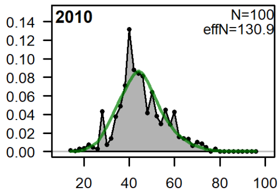
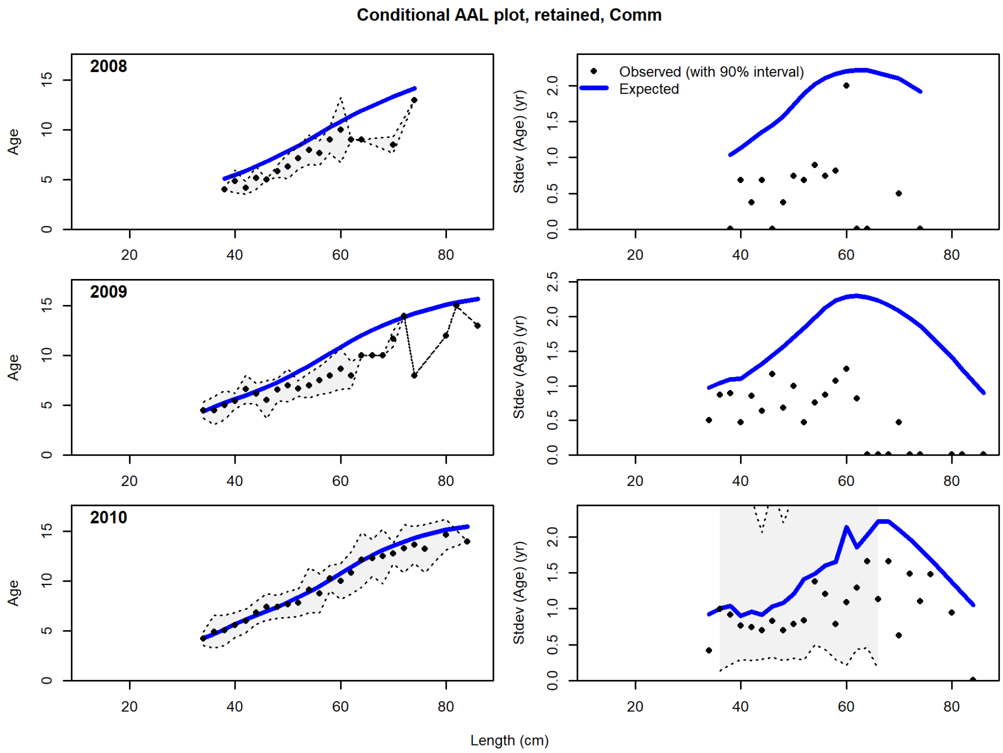


Figure 14-12: Fit to recreational fishery length composition data.

Model fit for the aggregated fishery age-at-length composition data were good in average, but poor in standard deviation (Figure 14-13 and Figure 14-14). The 2018 age-at-length data were not included in the assessment as they show a pattern incoherent with the historical data. The retrospective analysis (see below) was poor when these data were included.



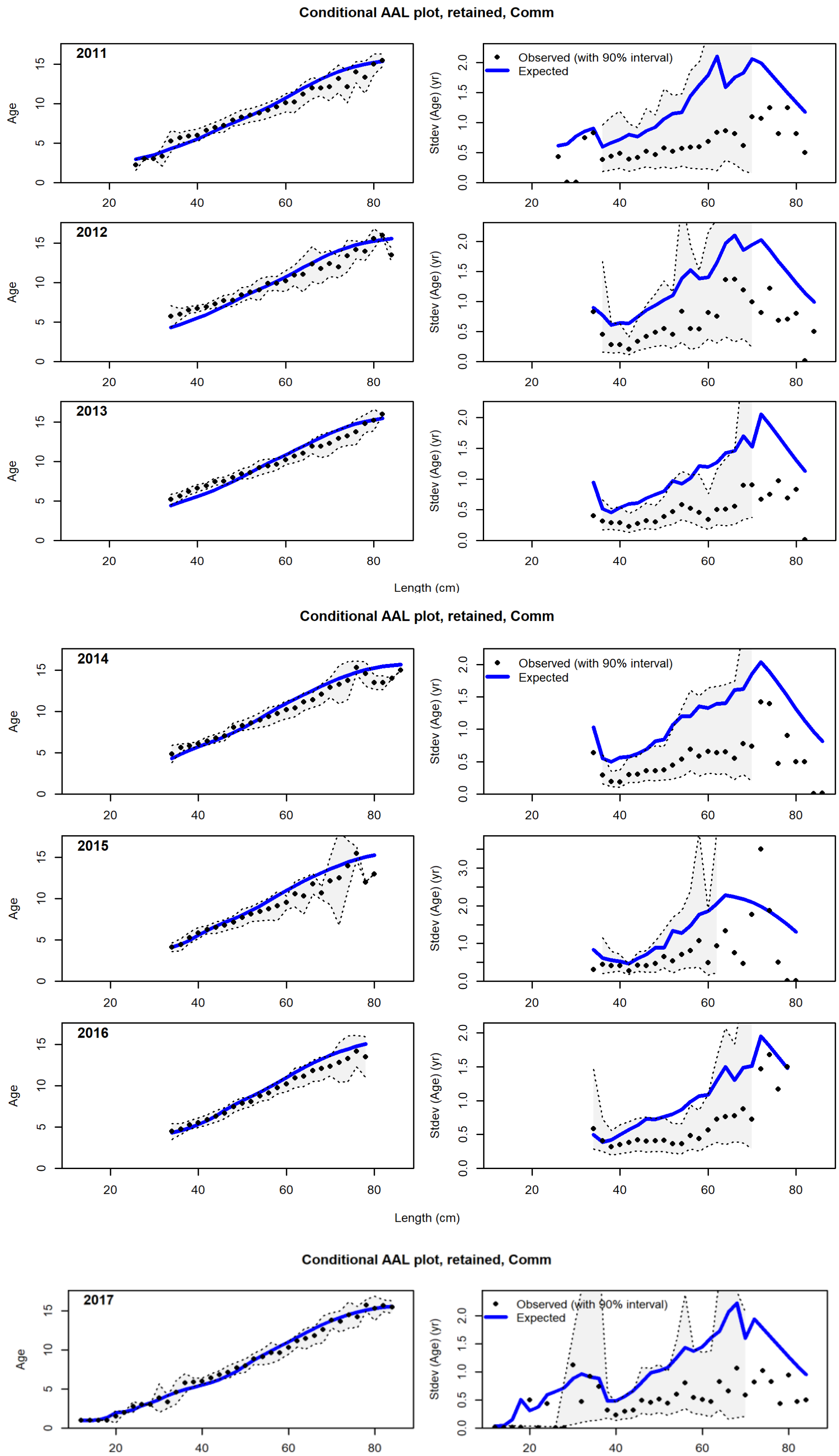


Figure 14-13: Fit to conditional age-at-length for commercial fishery.

The fit was poor for the first 2 age-at-length keys (years 2008 and 2009). However, for these years the sampling size was low.

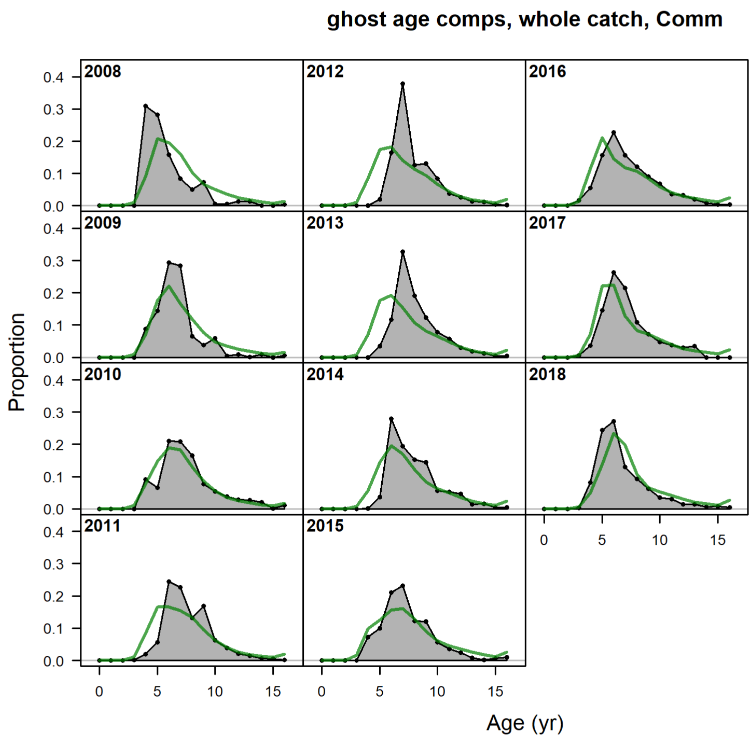


Figure 14-14: Observations and model predictions for age composition.

Age compositions data were included in the base model as “ghost”, meaning that they were not used for estimating the model likelihood. The purpose was to illustrate what the model estimated in terms of age composition data (Figure 14-14). Model and observations compared well, even though a discrepancies for some years was evident. For instance, in years 2011-2014, the model overestimated the proportion of age ≤ 5 compared to observations, or vice versa. Uncertainty in age reading or sampling bias may be considered as a potential explanation.

Two retrospective analysis were conducted (Figure 14-15 and Figure 14-17). When excluding 2018 age-at-length key (Figure 14-14), recruitment, SSB and F series showed some variability, however the stock trend is rather robust. In the last 5 years, the SSB is stable around 20 000 t showing a decreasing trend, while the F is below 0.15 and fluctuating without a trend. Recruitment was poorly estimated in recent years and showed high variability.

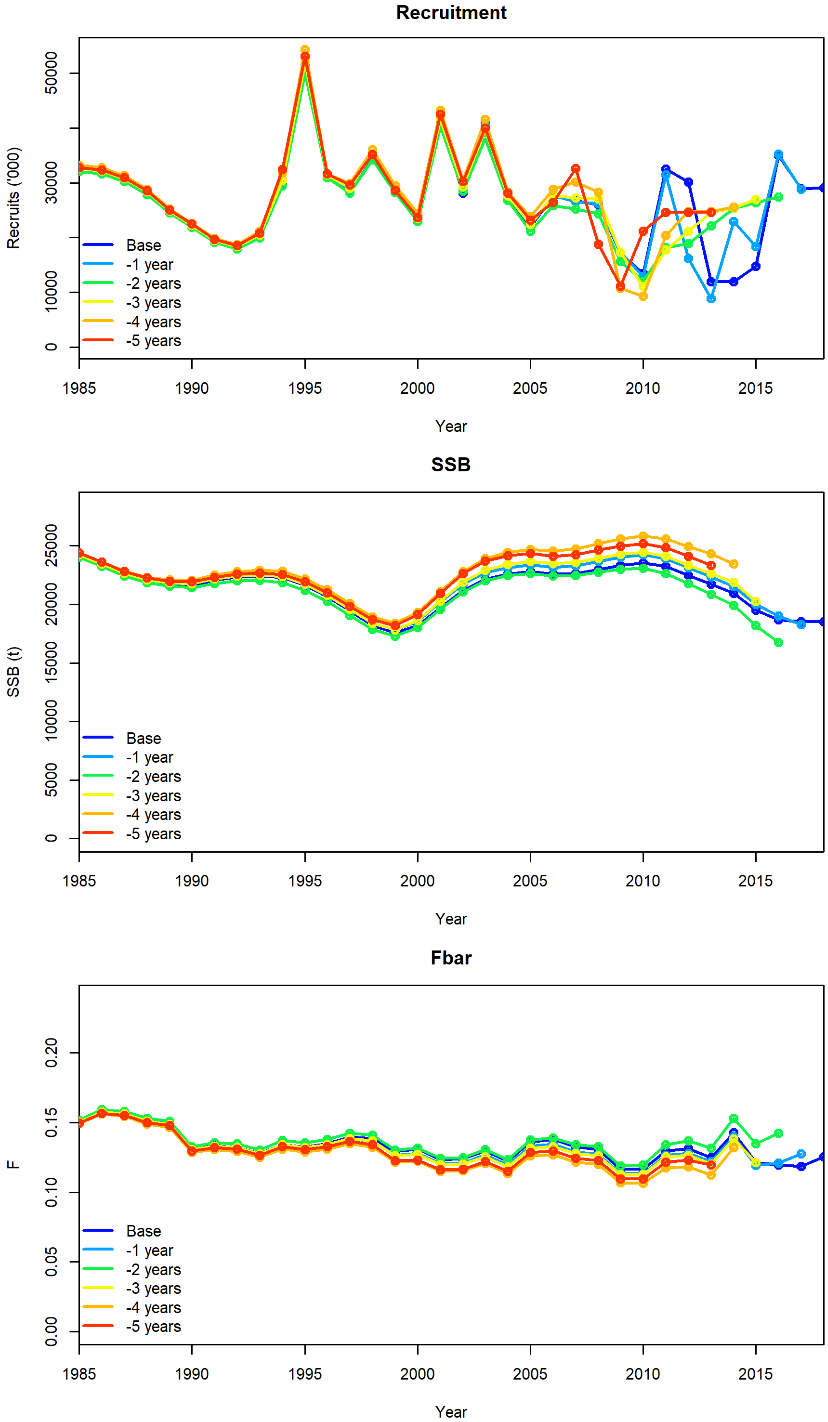


Figure 14-15: Retrospective plot without 2018 age-at-length key (i.e. with the model used for the assessment).

When including 2018 age-at-length key (Figure 14-14), recruitment, SSB and F series showed the same pattern as before, except that in the current assessment SSB is shifted down and F is shifted up. The shifts is quantified by the poor values of mohn's rho (see Table 14-7). Assessment including 2018 age-at-length key may not be in adequaction with the current biological reference points. Consequently 2018 age-at-length key were not included in the assessment model.

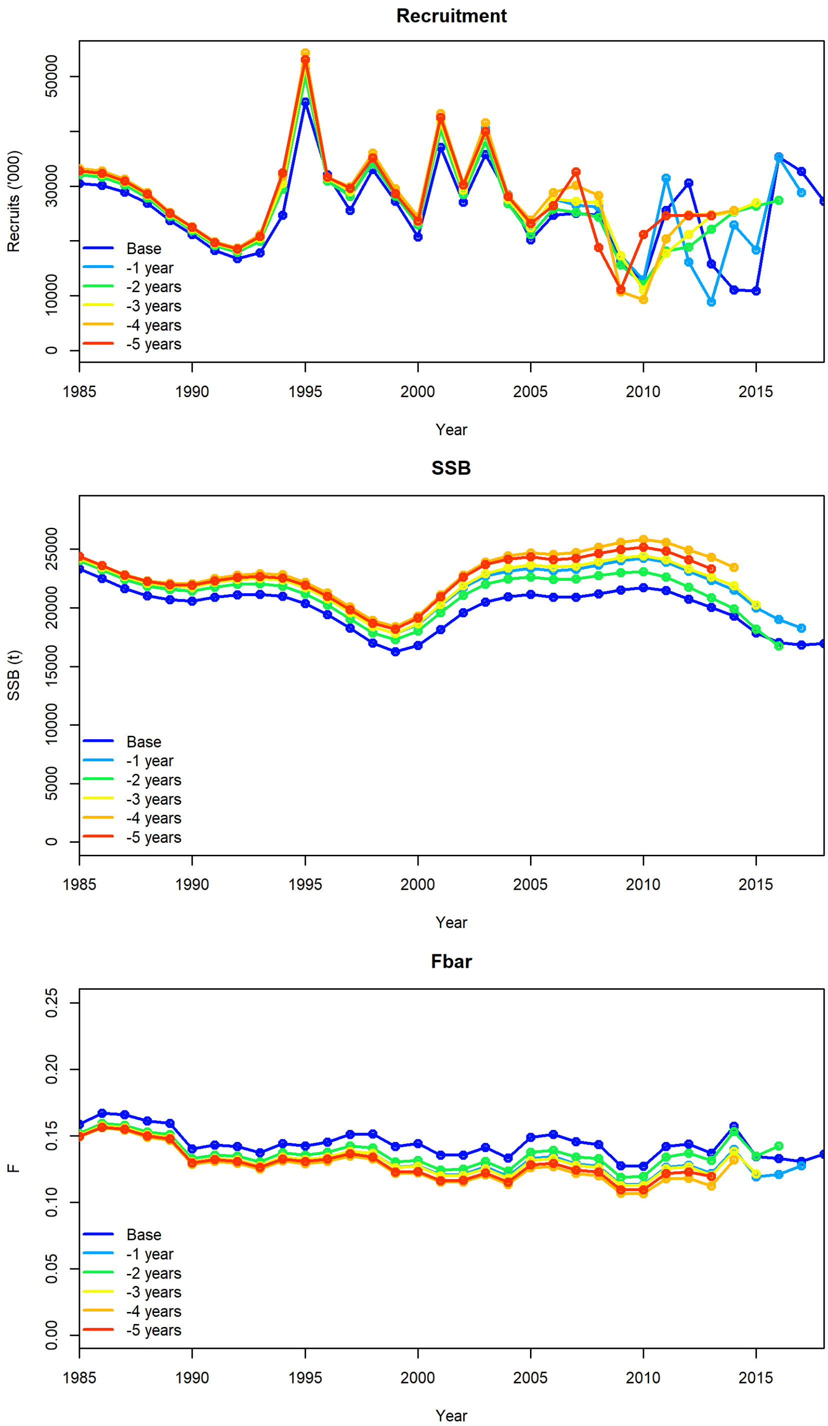


Figure 14-16: Retrospective plot with 2018 age-at-length key (i.e. with a model not used for the assessment).

Table 14-7: Mohn's rho values for both retrospective analysis.

without 2018 aal key			**with 2018 aal key**		
ssb	recr	fbar	ssb	recr	fbar
0.023	0.562	0.029	0.116	0.602	-0.068

14.4 Historic trends in biomass, fishing mortality and recruitment

Assessment summary from SS3 are given in Figure 14-17. The recruitment series was variable around ~30,000,000 individuals per year. Recruitment below average was observed for years 2009-2014. The SSB fluctuated around 20 000 t. A low SSB was observed just before the 2000s, and high SSB was observed around year 2010. Since then, a decreasing trend is observed. Average F computed for ages 4–15 showed a stable trend over the whole time series.

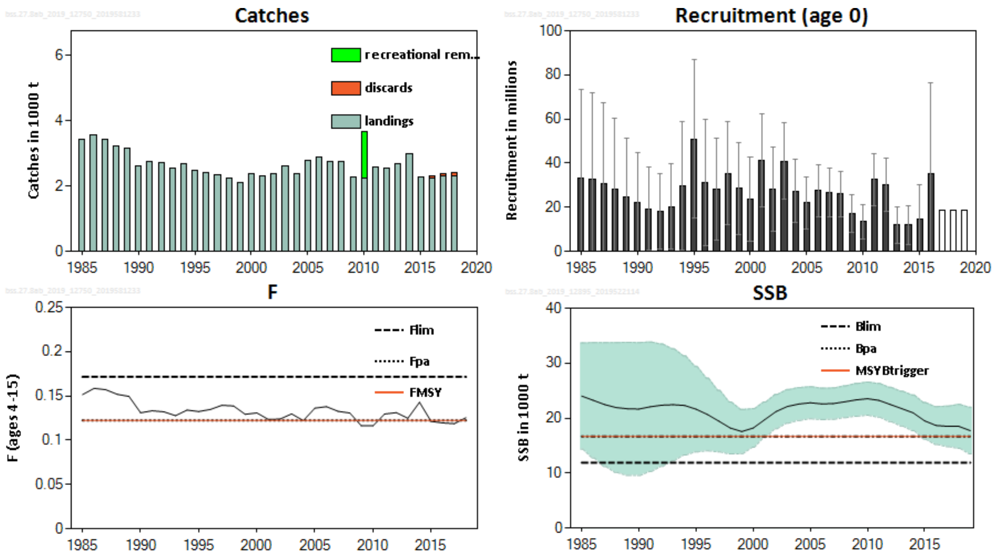


Figure 14-17: Summary of the stock assessment (weights in thousand tonnes). Commercial landings (with discards only included in 2016, 2017 and 2018), and recreational removals (only presented for 2010, where the data are available), including 5% mortality of released fish. Fishing mortality is shown for the combined commercial and recreational fisheries. Assumed recruitment values are not shaded. Recruitment and SSB are shown with 95% confidence intervals.

In 2018, F is above F_{MSY} (Table 14-8). SSB is above trigger and the stock is at full reproductive capacity.

Table 14-8: State of the stock and fishery relative to reference points.

		Fishing pressure				Stock size			
		2016	2017	2018			2017	2018	2019
Maximum sustainable yield	F_{MSY}	✔	✔	✖ Above		MSY $B_{trigger}$	✔	✔	✔ Above trigger
Precautionary approach	F_{pa},F_{lim}	✔	✔	o Increased risk		B_{pa},B_{lim}	✔	✔	✔ Full reproductive capacity
Management plan	F_{MGT}	–	–	– Not applicable		B_{MGT}	–	–	– Not applicable

Table 14-9: Assessment summary. All weights are in tonnes.

Year	Recruitment Age 0 thousands	High	Low	SSB tonnes	High	Low	Commercial landings tonnes	Recreational removals tonnes	F Ages 4–15
1985	32984	73465	0	24019	33676	14362	3420	1455	0.152
1986	32477	71715	0	23248	33737	12759	3549	1408	0.159
1987	30912	67216	0	22474	33731	11216	3417	1374	0.157
1988	28400	60459	0	21936	33751	10120	3217	1355	0.152
1989	24755	51258	0	21703	33806	9599	3144	1347	0.150
1990	22083	44638	0	21656	33748	9564	2621	1355	0.131
1991	19312	38102	523	22073	33855	10291	2734	1366	0.133
1992	18178	35369	988	22351	33477	11226	2709	1362	0.132
1993	20317	39689	945	22441	32610	12271	2552	1341	0.128
1994	29655	58832	479	22301	31318	13284	2668	1301	0.134
1995	50986	86812	15161	21625	29408	13842	2492	1239	0.132
1996	31227	59963	2491	20659	27267	14051	2402	1171	0.135
1997	28113	51329	4898	19444	25025	13863	2358	1113	0.140
1998	35297	58585	12008	18205	22929	13481	2231	1099	0.139
1999	28427	49014	7841	17557	21578	13537	2091	1142	0.129
2000	23690	42926	4454	18203	21722	14684	2362	1233	0.131
2001	41150	62334	19965	19711	22948	16474	2306	1313	0.124
2002	28083	47070	9096	21196	24307	18085	2392	1372	0.124
2003	40826	58219	23433	22137	25180	19094	2616	1404	0.130
2004	27397	41639	13156	22569	25555	19584	2380	1419	0.122
2005	21962	33920	10005	22802	25726	19878	2796	1422	0.136
2006	27548	39416	15680	22599	25461	19737	2875	1425	0.138
2007	26690	37857	15524	22645	25489	19801	2751	1440	0.133
2008	26029	36282	15775	22974	25868	20079	2745	1451	0.131
2009	17141	25550	8732	23319	26287	20351	2278	1449	0.116
2010	13432	21111	5752	23535	26561	20508	2229	1430	0.116

Year	Recruitment Age 0 thousands	High	Low	SSB tonnes	High	Low	Commercial landings tonnes	Recreational removals tonnes	F Ages 4–15
2011	32501	44221	20780	23232	26303	20162	2575	1394	0.130
2012	30177	42288	18067	22478	25593	19364	2549	1345	0.131
2013	11949	20132	3765	21727	24895	18558	2685	879	0.125
2014	11940	20639	3241	20963	24206	17720	2991	825	0.143
2015	14746	29940	0	19505	22827	16182	2264	783	0.121
2016	35004	76160	0	18666	22107	15225	2252	757	0.120
2017	18827			18513	22194	14832	2295	713	0.119
2018	18827			18498	22492	14504	2316	720	0.126
2019	18827			17730	21967	13493			
Average	26282	47692	7274	21277	27074	15479	2625	1241	0.133

14.5 Biological reference points

IBPbass (ICES, 2019) set the biological reference points to be used for this stock. Table 14-10 compiles the biological reference points computed under type 6 stock-recruitment relationship as agreed during the inter-benchmark IBPbass.

Table 14-10: Biological reference points agreed by IBPbass 2018 for use in the ICES advice. All weights are in tonnes.

Framework	Reference Point	Value	Basis
MSY approach	MSY $B_{trigger}$	16688 t	Bpa
	FMSY	0.123	F that maximizes median long-term yield in stochastic simulations under constant F exploitation; constrained by the requirement that FMSY = Fpa
Precautionary approach	Blim	11920 t	Bpa / exp(CV * 1.645)
	Bpa	16688 t	Lowest observed SSB
	Flim	0.172	F that, In equilibrium gives a 50% probability of SSB>Blim
	Fpa	0.123	Fpa = Flim / exp(CV * 1.645)
Management plan	SSBmgt	Not defined	
	Fmgt	Not defined	

14.6 Catch options and prognosis

14.6.1 Short-Term projection

Forecast inputs used for projections are compiled in Table 14-11. The recruitment used for projections is the geometric mean (GM) calculated from 2008 to 2014. For the short-term projection, F-at-age averaged over the last 3 years (2016-2018) and scaled to 2018 value were used for commercial and recreational fleets (Table 14-11).

Table 14-11: Forecast inputs table.

Ages	N@age	Weight@age	Prop.mature@age	Commercial F	Commercial mean weight	Recreational F	Recreational mean weight	Natural mortality
0	18827	0.004	0.000	0.000	0.009	0.000	0.009	0.24
1	14810	0.020	0.000	0.000	0.044	0.000	0.051	0.24
2	11649	0.077	0.000	0.000	0.285	0.001	0.150	0.24
3	17024	0.181	0.003	0.000	0.454	0.004	0.298	0.24
4	5617	0.328	0.030	0.016	0.592	0.011	0.482	0.24
5	3480	0.514	0.161	0.061	0.727	0.019	0.685	0.24
6	2525	0.729	0.421	0.091	0.897	0.026	0.899	0.24
7	4459	0.967	0.675	0.101	1.112	0.030	1.125	0.24
8	3315	1.219	0.836	0.104	1.356	0.032	1.367	0.24
9	937	1.479	0.920	0.105	1.613	0.032	1.619	0.24
10	810	1.741	0.960	0.105	1.872	0.033	1.876	0.24
11	833	2.000	0.980	0.105	2.128	0.033	2.130	0.24
12	579	2.253	0.989	0.105	2.376	0.033	2.377	0.24
13	407	2.496	0.994	0.105	2.614	0.033	2.615	0.24
14	223	2.729	0.996	0.105	2.840	0.033	2.841	0.24
15	191	2.949	0.998	0.105	3.054	0.033	3.054	0.24

Ages	N@age	Weight@age	Prop.mature@age	Commercial F	Commercial mean weight	Recreational F	Recreational mean weight	Natural mortality
16	505	3.481	0.998	0.105	3.602	0.033	3.602	0.24

Age 0,1,2 over-written as follows:

2019 yc -> 2019 age 0 replaced by 2008–2014 LTGM (18827 thousand);

2018 yc -> 2019 age 1 from SS3 survivor estimate at-age 1, 2019 * LTGM / SS3 estimate of age 0 in 2017;

2017 yc -> 2019 age 2 from SS3 survivor estimate at-age 2, 2019 * LTGM / SS3 estimate of age 0 in 2016.

Total landings forecasted for 2019 are 2 723 t, with 2 065 t for the commercial fishery and 658 t for the recreational fishery. SSB 2020 is forecasted to be at 15 937 t, i.e. below MSY Btrigger, and between Bpa and Blim (Table 14-12).

Table 14-12: The basis for the catch scenarios.

Variable	Value
F ages 4-15 (2019)	Commercial fishery F = 0.092, Recreational fishery F = 0.029 Total F = 0.121
SSB (2020)	15937 t
Rage0 (2017,2018,2019)	18827 thousands
Total catch (2019)	2723 t
Wanted commercial catch (2019)	2065 t
Unwanted commercial catch (2019)	NA
Recreational Catch (2019)	658 t

ICES advises that when the EU multiannual plan (MAP) is applied, catches in 2020 that correspond to the F ranges are between 2 417 t and 3 075 t. According to the MAP, catches higher than those corresponding to F_{MSY} (2 533 t) can only be taken under conditions specified in the MAP, whilst the entire range is considered precautionary when applying the ICES advice rule. (Table 14-13).

Table 14-13: Catch options table.

Basis	Total landings	Commercial landings	Recreational removals	Total Fbar	Commercial Fbar	Recreational Fbar	SSB 2021	SSB change	Advice change
F=(SSB_2020/MSY_Btrigger)*F_{MSY}	2533	1914	619	0.117	0.089	0.028	15308	-3.9	1.5
F=(SSB_2020/MSY_Btrigger)*F_{MSY}_lower	2417	1827	590	0.111	0.085	0.026	15397	-3.4	-3.1
F=(SSB_2020/MSY_Btrigger)*F_{MSY}_upper	3075	2323	752	0.144	0.110	0.034	14891	-6.6	23.2
F=F_{MSY}	2645	1999	646	0.123	0.093	0.029	15221	-4.5	6.0
F=0	0	0	0	0.000	0.000	0.000	17274	8.4	-100.0
F=Fpa	2645	1999	646	0.123	0.093	0.029	15221	-4.5	6.0
F=Flim	3619	2734	885	0.172	0.131	0.041	14473	-9.2	45.0
SSB_2021 = Blim	6994	5279	1715	0.362	0.276	0.086	11920	-25.2	180.3
SSB_2021 = Bpa	751	567	183	0.033	0.025	0.008	16688	4.7	-69.9
SSB_2021 = MSY Btrigger	751	567	183	0.033	0.025	0.008	16688	4.7	-69.9
F=F_2018	2620	1980	640	0.121	0.092	0.029	15241	-4.4	5.0
F=F_{MSY}_lower	2525	1908	617	0.117	0.089	0.028	15314	-3.9	1.2
F=F_{MSY}_lower differing by 0.01	2728	2062	667	0.127	0.097	0.030	15157	-4.9	9.4
F=F_{MSY}_lower differing by 0.02	2930	2214	716	0.137	0.104	0.032	15002	-5.9	17.4

Basis	Total landings	Commercial landings	Recreational removals	Total Fbar	Commercial Fbar	Recreational Fbar	SSB 2021	SSB change	Advice change
$F=F_{MSY}$_lower differing by 0.03	3130	2365	765	0.147	0.112	0.035	14849	-6.8	25.4
$F=F_{MSY}$_upper	3210	2425	785	0.151	0.115	0.036	14787	-7.2	28.6

14.7 Comments on the assessment

The assessment for the Bay of Biscay seabass stock shows that since 2000, the spawning stock biomass (SSB) fluctuated around 20 000 t and is currently just above MSY $B_{trigger}$. A low SSB was observed just before the 2000s, and high SSB was observed around year 2010. Since then, a decreasing trend is observed. The fishing mortality (F) showed a stable trend over the whole time series and has fluctuated around F_{MSY} during the period. The recruitment is variable over time, and it was observed below average for years 2009-2014. Landings are stable over time around 2 600 t. Thus, extreme situations have not been explored to fully understand the dynamics of this stock. This implies that the estimation of the biological reference points is uncertain.

Otherwise, this assessment relies on short data time-series: length composition time series start in 2000; age-at-length time series start only in 2008 (with a proper sampling after 2010); recreational data were surveyed for only one year, 2010. In addition, there is no scientific survey for adult seabass to scale the model to an appropriate level of abundance. There is no survey on recruits either. All those elements make this assessment uncertain. In order to improve future assessments and advice for this stock, several important limitations and deficiencies in data for the Bay of Biscay seabass stock should be addressed.

1. Recruitment indices are needed for the Bay of Biscay area. Estimation of recruitment is only based on commercial landings, and it may be smooth because of ageing errors (Laurec and Drogou, 2012). A French study has been undertaken in 2014 to explore the possibility of creating recruitment indices in estuarine waters. The survey delivered good results. Abundance indices have been calculated for year 2016, 2017 and 2018 in the Loire estuary and are planned for year 2019. The survey will be conduct until 2021 under an European Maritime and Fisheries Fund (EMFF) program (NOURDEM). This includes also the Gironde estuary in order to get two abundance index for the stock bss.27.8ab. The final objective would be to make it sustainable through DCF from 2022 after having implemented in the assessment and discussed it during a benchmark.
2. Robust relative fishery-independent abundance indices are needed for adult seabass in the Bay of Biscay. The establishment of dedicated surveys on the spawning grounds could provide valuable information on trends in abundance and population structure of adult seabass as well as information on stock structure and linkages between spawning and recruitment grounds using drift model.
3. Further research is needed to better understand the spatial dynamics of seabass (mixing between stock areas; effects of site fidelity on fishery catch rates; spawning site–recruitment ground linkages; environmental influences on recruitment).
4. Assessment model should be revised according to the results of undergoing tagging and genetic programs.
5. Studies are needed to investigate the accuracy/bias in ageing and errors due to historically age sampling schemes.
6. Continued estimation of recreational catches and size compositions is needed across the stock range and information to evaluate historical trends in recreational effort and catches would be beneficial for interpreting changes in age–length compositions over time.
7. Historical catches data (1985-2000) need to be revised following the methodology used for the recent years (2000 onwards). Historical catches data need also to be disaggregated into several fishing fleets (e.g. midwater trawls, bottom trawls, nets, lines).
8. Discard rates are considered negligible in the current assessment. Nonetheless, a time-series of discards-at-length or -age may be needed for all fleets, if the impact of technical

measures to improve selectivity is to be evaluated as part of any future seabass management.

9. The absence of length composition data for French fisheries prior to 2000 is a serious deficiency in the model preventing any evaluation of changes in selectivity that may have occurred, for example due to changes in the proportion of different gear types (especially with the large decrease in numbers of pair trawlers after 1995).

14.8 Management considerations

Seabass is characterized by slow growth, late maturity and low natural mortality on adults, which imply the need for comparatively low rates of fishing mortality to avoid depletion of spawning potential in each year class. In the well-known northern stock (4.b-c, 7.a,d-h) productivity of the stock is affected by extended periods of enhanced or reduced recruitment which appear to be related to changes in sea temperature (ICES, 2016a). Warm conditions facilitate northward penetration of seabass in the Northeast Atlantic, and enhance the growth and survival of young fish in estuarine and other coastal nursery habitats. In the Bay of Biscay there is no reason to observe different dynamics. In terms of numbers of recruits, the Bay of Biscay area looks more productive than in the North. If no management is put in place, and if a combination of increasing fishing mortality and environmental conditions causing relative successive poor recruitments occur, it could lead in the long term to the same situation than in the North part with a large decline of biomass.

The behaviour of seabass, forming predictable aggregations for spawning in winter and moving inshore to feed at other times of year, increase their vulnerability to exploitation by offshore and inshore fisheries. The effects of targeting offshore spawning aggregations of seabass are poorly understood, particularly how the fishing effort is distributed in relation to the mixing of fish from different nursery grounds or summer feeding grounds, given the strong site fidelity of seabass. Fisheries targeting offshore aggregation are mainly netters and to a lesser extent pelagic trawlers operating from December to March. Note that a high increase in the French landings for the nets fishery is observed from 2011: indeed, as seabass is currently a non-TAC species, there is potential for displacement of fishing effort from other species with limiting quotas as observed with netters in Bay of Biscay reporting their catches from sole to seabass. With no effective control on the fishery to limit the increase of the landings as observed in 2014, risks are taken. Many small-scale artisanal fisheries, especially line fishing have developed a high seasonal dependency on seabass. There is also a significant recreational fishing mortality in inshore waters. The importance of seabass to recreational fisheries, artisanal and other inshore commercial fisheries and large-scale offshore fisheries in different regions means that resource sharing is an important management consideration.

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14 Seabass (*Dicentrarchus labrax*) in Divisions 8.a-b (Bay of Biscay North and Central)

Type of assessment: SS3 runs/update (stock benchmarked in WKBASS 2017, WKBASS 2018, and IBPbass 2018).

Data revisions: None.

Working Group issues: None.

14.1 General

14.1.1 Stock definition and ecosystem aspects

This section is described in the Stock Annex.

14.1.2 Fishery description

Seabass in the Bay of Biscay are targeted by France with more than 96% of international landings in 2018 (Table 14-1). Spain is responsible for 4% of the catches essentially in the area 8.b in 2018 (mainly bottom trawlers). A more detailed description of the fishery can be found in the Stock Annex.

Table 14-1: Summary of official and ICES commercial landings data. UK includes England, Wales, Northern Ireland and Scotland.

Year	Belgium	France	Netherlands	Spain	UK	Total Official	Total ICES
1985	0	2477	0	0	0	2477	3420
1986	0	2606	0	0	0	2606	3549
1987	0	2474	0	0	5	2479	3417
1988	0	2274	0	0	15	2289	3217
1989	0	2201	0	0	0	2201	3144
1990	0	1678	0	0	0	1678	2621
1991	0	1774	0	17	0	1791	2734
1992	0	1752	0	14	0	1766	2709
1993	0	1595	0	14	0	1609	2552
1994	0	1708	0	17	0	1725	2668
1995	0	1549	0	0	0	1549	2492
1996	0	1459	0	0	0	1459	2402
1997	0	1415	0	0	0	1415	2358

Year	Belgium	France	Netherlands	Spain	UK	Total Official	Total ICES
1998	0	1261	0	27	0	1288	2231
1999	0	2081	0	11	0	11	2091
2000	0	2080	0	67	0	2147	2362
2001	0	2020	3	68	0	2091	2306
2002	0	1937	0	176	0	2113	2392
2003	0	2812	0	119	0	2931	2616
2004	0	2561	0	96	0	2657	2380
2005	0	3184	0	74	0	3258	2796
2006	0	3318	0	168	2	3488	2875
2007	1	2984	0	74	1	3060	2751
2008	0	1508	0	145	0	1653	2745
2009	1	2339	0	194	0	2534	2278
2010	0	2322	0	165	2	2489	2229
2011	1	2295	0	311	0	2607	2575
2012	0	2325				2325	2549
2013	0	2532	0		0	2532	2685
2014	0	2900	0	91	0	2991	2991
2015	0	2193	0	71	0	2264	2264
2016	0	2160	0	93	0	2253	2253
2017	0	2223	0	72	0	2295	2295
2018	0	2222	0	94	0	2316	2317

For France, lines fishery (handlines and longlines) takes place all year round (especially during quarters 3 and 4), while nets, pelagic and bottom trawls fisheries take place from November to April on pre-spawning and spawning seabass when they aggregate to reproduce. In 2018, nets represent 36% of the landings of the area, lines 28%, bottom trawl 23%, and pelagic trawl 8%. In 2018, total landings are stable compared to 2017. An increase is observed for netters and bottom trawlers while a decrease for liners and pelagic trawlers (Figure 14–1). Note that netters are very dependent on weather conditions (2014 was exceptional).

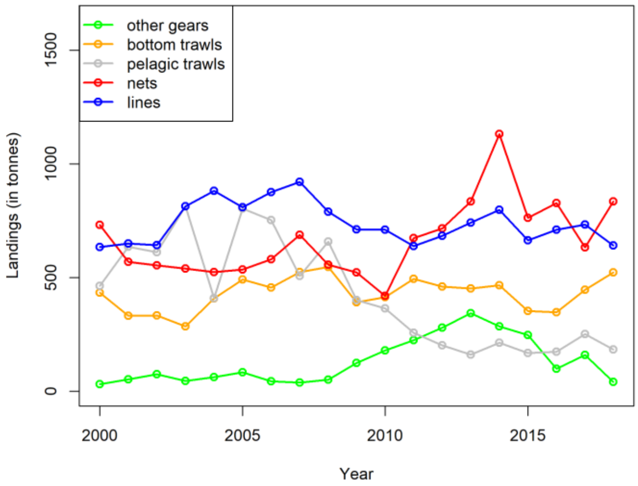


Figure 14-1: French landings per gear.

14.1.3 Summary of ICES advice for 2019 and management

14.1.3.1 ICES advice for 2019

This was the first time that ICES has provided advice for this stock based on a category 1 assessment. ICES advises that when the MSY approach is applied, total catch (commercial and recreational removals) in 2019 should be no more than 2 495 t (1924 t and 571 t, respectively).

14.1.3.2 Management

14.1.3.2.1 Commercial fishery

Seabass in the Bay of Biscay is subject neither to EU TACs and quotas, nor to a management plan in 2018. Only French national regulation is applied. From 2012 onwards, a national license, defined and implemented by the Committees for Maritime Fisheries and Fish Farming (CNPMEM), supervises French professional seabass landings on both the Bay of Biscay stock (ICES divisions 8abd) and the Northern stock (ICES divisions 4bc, 7a and 7d-h). Regarding the Bay of Biscay (ICES divisions 8abd), since 2017, a minimum landing size of 38 cm has been implemented. Moreover, all French professional fishing activities in the area have been subjected to an annual overall catch limit. It has been implemented in 2017, 2018 and 2019 and set respectively to 2 490 t, 2 241 t and 2 150 t. Note that during 2018, given the level of consumption of the overall catch limit estimated during mid-November and projections to the end of the year, individual fishing opportunities have been reduced from 27 November 2018, to 50 kg per vessel at the initiative of the fishermen and a closure of the fishery occurred on December 27, 2018 (the overall 2018 catch limit being consumed at 100%). To manage the overall catch limit, annual and periodic individual limitations of fishing opportunities occurred (Table 14-2 and Table 14-3). In addition, a voluntary closed season from February to mid-March for longline and handline seabass fisheries occurred in Brittany, France.

Table 14-2: Annual limits in 2018 for seabass landings in the Bay of Biscay for holders and non-holders of the national license.

Individual annual limits (tonnes/year)	Lines and handlines	Nets	Bottom trawlers and seiners	Pelagic trawlers
Non holder 2018	1	1	3	4
License holder 2018 – accessory fishing	6	6	6	--
License holder 2018 – targeted fishing	20	20	15	15
NB: Purse seiners have been allowed to land 41 tonnes in 2018 (all vessels combined). Others gears than those mentioned above have been allowed to land individually 1 tonne maximum in 2018.				

Table 14-3: Individual periodic limits in 2018 for seabass in the Bay of Biscay for holders and non-holders of the national license.

<table>
<tr><th colspan="2">Individual periodic limits (tonnes/calendar fortnight)</th><th>Lines and handlines</th><th>Nets</th><th>Bottom trawlers and seiners</th><th>Pelagic trawlers</th></tr>
<tr><td colspan="2">Non holder 2018</td><td>0,2</td><td>0,2</td><td>0,5</td><td>0,5</td></tr>
<tr><td rowspan="2">License holder 2018 – accessory fishing</td><td>April to October</td><td rowspan="2">1</td><td>0,5</td><td rowspan="2">1</td><td rowspan="2">--</td></tr>
<tr><td>November and December</td><td>2</td></tr>
<tr><td rowspan="2">License holder 2018 – targeted fishing</td><td>April to October</td><td>3</td><td>1</td><td>2</td><td>2</td></tr>
<tr><td>November and December</td><td>2</td><td>5</td><td>5</td><td>5</td></tr>
<tr><td colspan="6">NB: Fishing opportunities for license holder using different gear prohibit the possibility of cumulating the annual or periodic limits.</td></tr>
</table>

14.1.3.2.2 Management applicable to 2019

European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including seabass in ICES divisions 8a and 8b.

14.1.3.2.3 Recreational fishery

A series of management measures have been taken by the French recreational fishery:

- A minimum conservation size of 42 cm has been implemented in 2013.
- A 5 fish bag limit has been implemented in 2017.
- A 3 fish bag limit has been implemented in 2018.

14.2 Data

14.2.1 Commercial landings and discards

A detailed description of the commercial landings can be found in the Stock Annex.

Landings series were reconstructed using the three main sources available (Figure 14-2):

1. Official statistics recorded in the Fishstat database since around the mid-1980s (total landings).
2. French landings for 2000-2018 from a separate analysis by Ifremer of logbook, auction data and VMS (SACROIS methodology; Demaneche *et al.*, 2010). Landings are available per metier.
3. Spanish landings for 2007-2011 from sale notes and for 2012-2018 from InterCatch statistics.

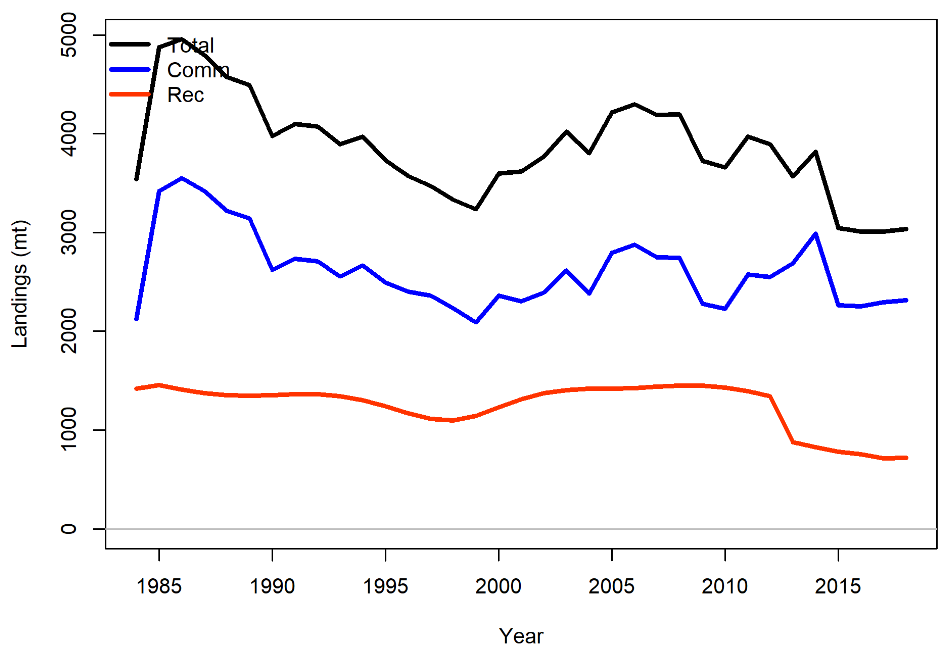


Figure 14-2: Commercial landings, recreational removals and total. Weights are in tonnes.

Discarding of seabass by commercial fisheries can occur where fishing takes place in areas with seabass smaller than the minimum landing size (i.e. < 38 cm). For France, discards rates are low (Table 14-4). In 2018, total discards percentage is estimated at 4.55% of the French commercial catches with an amount of 106 t. For Spain, observer data from Spanish vessels fishing in area 8, have shown that there was no seabass discards from 2003 (no information in 2018 were available on discards for this working group). So, for 2018, this correspond to 3.37% of the total catches (discards 106 t + commercial catch 2316 t + recreational removals 720 t, see hereafter). Discards are considered negligible and are not included in the stock assessment.

Table 14-4: Estimated seabass discards of French vessels in the Bay of Biscay. Weights are in tonnes.

Year	Commercial discards	Commercial landings	% discards
2015	69	2264	2.96
2016	62	2253	2.68
2017	74	2295	3.12
2018	106	2222	4.55

14.2.2 Length and age sampling

The full description of the biological sampling is available in the Stock Annex.

14.2.2.1 French commercial fishery

The French sampling programme for length compositions of seabass landings covers sampling at sea and on shore. Data are available from 2000 onwards. French length composition for 8.a-b, across time, all gear combined are presented in Figure 14-3.

14.2.2.1.1 Length compositions

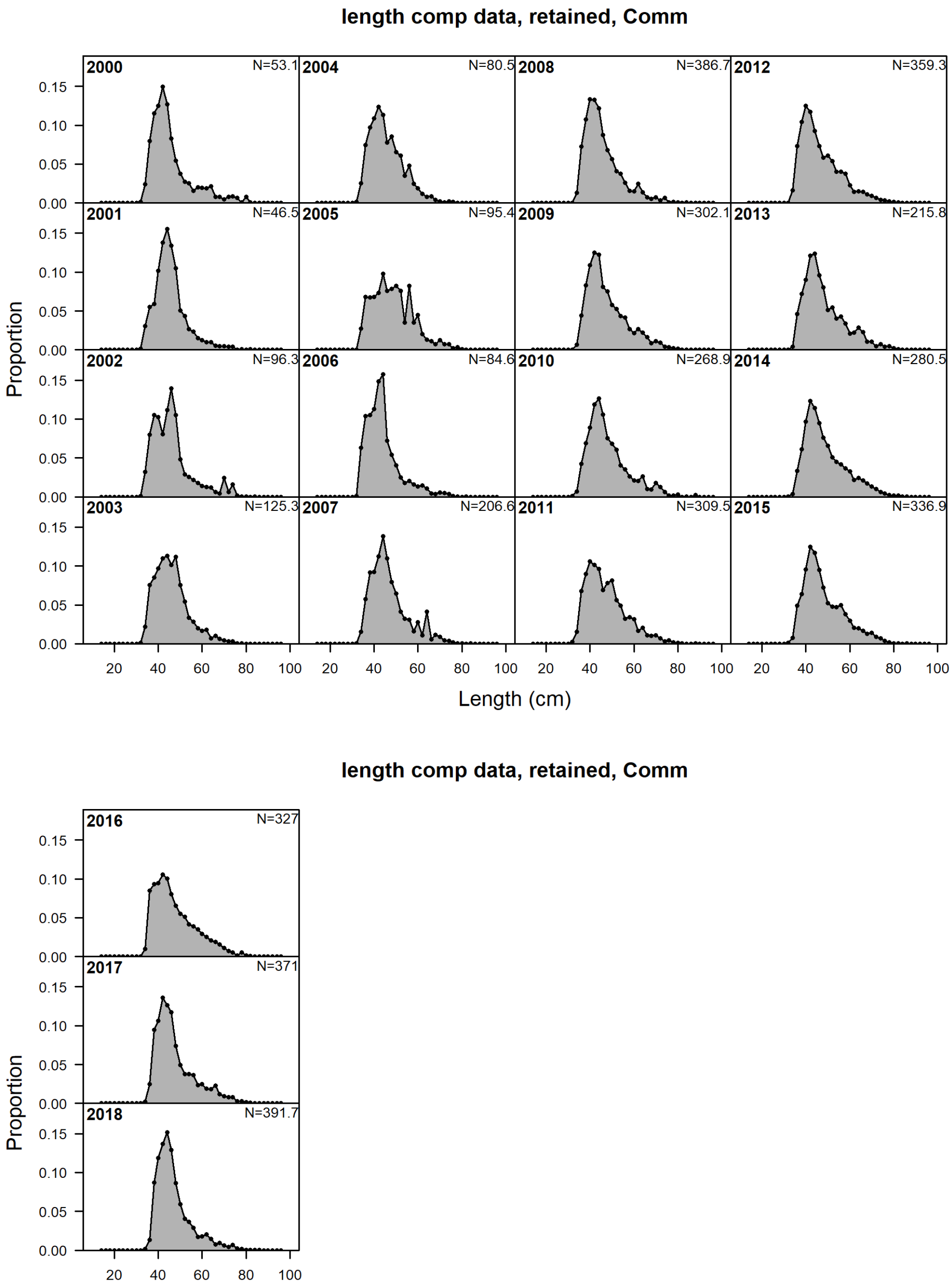


Figure 14-3: Length composition all French fleet combined from 2000 onwards.

Note that last year, WGBIE 2018 were made aware of an issue with the sampling level in Q1 and Q2 of 2017 from France (working document Quemar *et al.*, 2018). Because of the lack of market sampling for length (biological and on-board sampling was unaffected), efforts were made to try and fill the deficiency in the number of samples by the use of simulation techniques. Both simulated data and actual data were uploaded to InterCatch combined making it impossible to distinguish true samples from simulated ones. The simulation was based on commercial landings market categories (Figure 14-4).

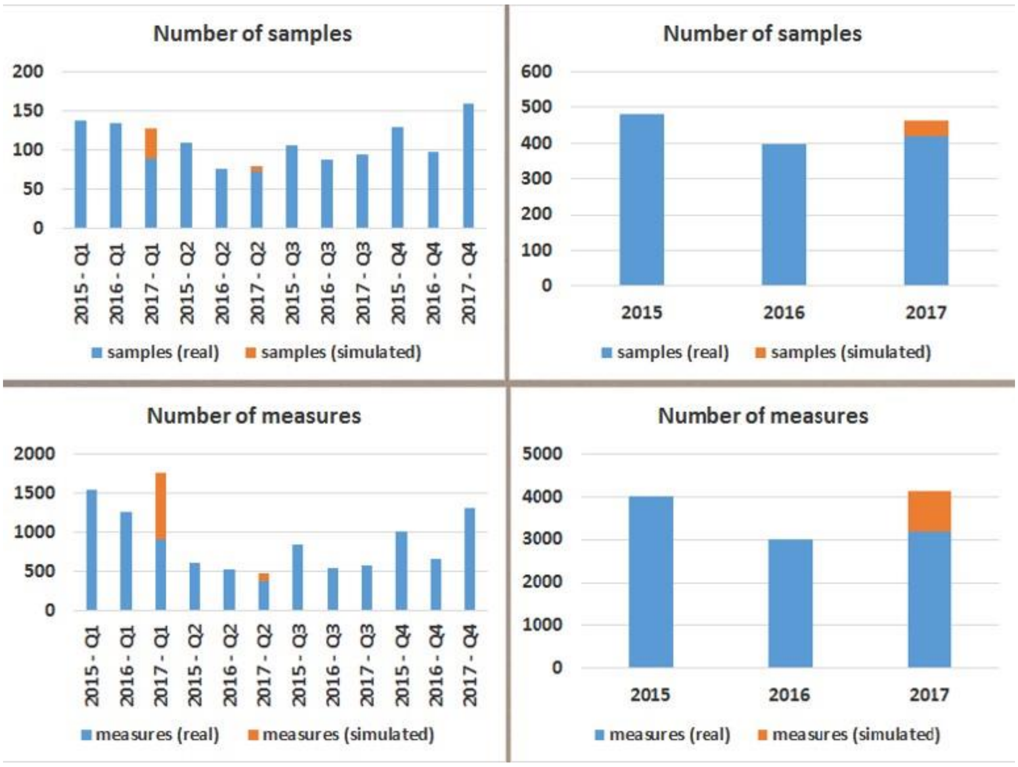


Figure 14-4: Numbers of seabass samples (trips) and measures (fish) simulated or not in the French sampling scheme in 2017 compared to the previous years.

14.2.2.1.2 Age compositions

The French sampling programme for age compositions of seabass is based on age-length keys with fixed allocation. For the 8.a-b area, the information is available only from 2008. This year, it was observed that 2018 age-at-length key (and in a lesser extent 2015) showed a pattern inconsistent with the historical data (Figure 14-5). This is likely related to an age reader change (Table 14-5). The group decided not to include those age-at-length data, as the retrospective analysis showed that year 2018 was offset compared to the other retrospective runs (see hereafter).

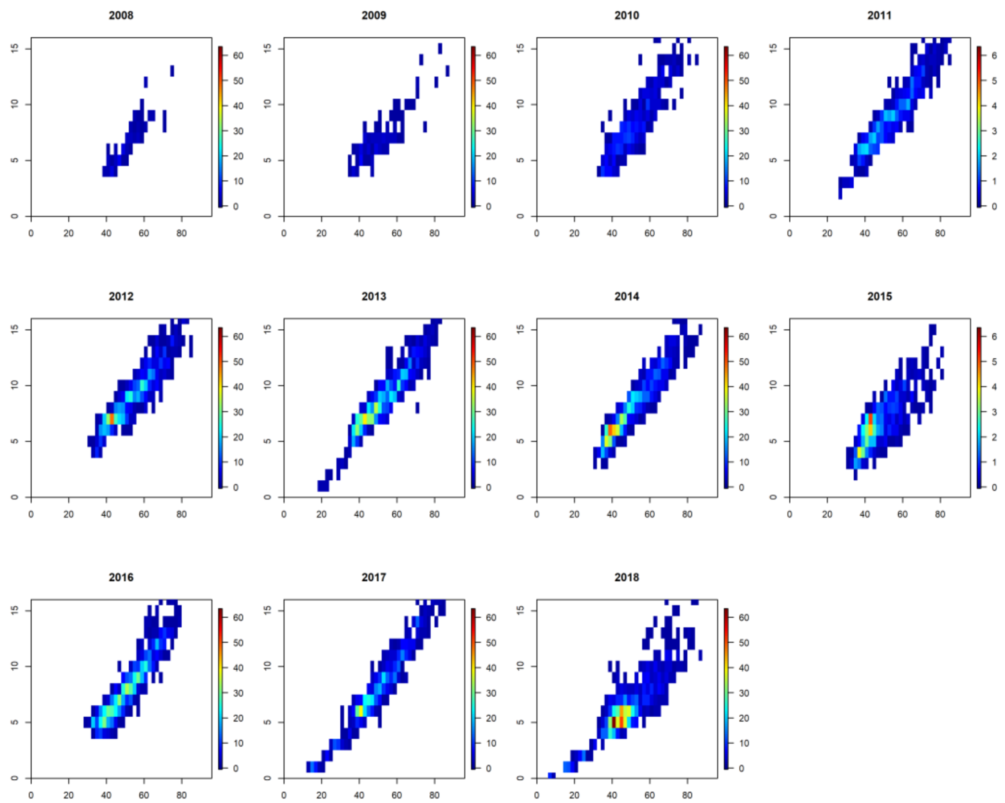


Figure 14-5: Age-at-length keys over years 2008-2018.

Table 14-5: Age readers proportion over years 2008-2018

Year	Age readers			
	JH	KS	RE	SM
2008			100	
2009			100	
2010		71	29	
2011		100		
2012		100		
2013		100		
2014	13	78	9	
2015		31	69	
2016		89	5	6
2017		88	12	
2018			100	
2019			100	

14.2.2.2 Recreational fishery

The full description of the recreational catches is presented in the Stock Annex.

14.2.2.2.1 Recreational fishery catches reconstructed for the whole time series

In previous reports (ICES, 2016b), partitioning French recreational data between the Biscay and Northern stock was only possible for the 2009–2011 study (Rocklin et al., 2014). There are no historical estimates of the recreational catch over the entire time series. IBP Bass (ICES, 2014) considered more plausible to treat recreational fishing as having a more stable participation and effort over time than the commercial fishery. A decision was made during the WKBASS 2018 assessment meeting to apply a constant recreational fishing mortality over time considering the same approach used for the Northern stock (ICES, 2018). Total retained recreational catches were iteratively adjusted to obtain a constant recreational F over all years, which was derived using the catch of 1 430 t estimated in 2010. The implementation of new management measures should have led to a reduction in fishing mortality as more and larger fish are released (Hyder *et al.*, 2018). This means that it is not appropriate to assume constant recreational fishing mortality in the last years and, thus, it is necessary to re-estimate the recreational catches. This has been done using the estimated reductions generated from the assessment of the impact of different levels of bag limits and minimum landing sizes (Armstrong *et al.*, 2014) in order to derive changes in recreational fishing mortality. Also, the application of different management measures, gave a recreational mortality multiplier for 2010–2012 of 1 and of 0.684 for 2013–2016 (related to an increase in MCRS to 42 cm). In 2017, with a 5 fish bag limit implementation, the multiplier was estimated to be unchanged. However, for 2018 with a 3 fish bag limit implementation, it was estimated to be 0.647. This was taken into account when preforming the short-term forecast. Table 14-6 compiled figures used in the assessment for the recreational fishery.

Table 14-6: Time series used in SS3 as commercial landings and recreational removals. Numbers are in tonnes.

Year	Recreational removals	Commercial landings
1985	1455	3420
1986	1408	3549
1987	1374	3417
1988	1355	3217
1989	1347	3144
1990	1355	2621
1991	1366	2734
1992	1362	2709
1993	1341	2552
1994	1301	2668
1995	1239	2492
1996	1171	2402
1997	1113	2358
1998	1099	2231

Year	Recreational removals	Commercial landings
1999	1142	2091
2000	1233	2362
2001	1313	2306
2002	1372	2392
2003	1404	2616
2004	1419	2380
2005	1422	2796
2006	1425	2875
2007	1440	2751
2008	1451	2745
2009	1449	2278
2010	1430	2229
2011	1394	2575
2012	1345	2549
2013	879	2685
2014	825	2991
2015	783	2264
2016	757	2252
2017	713	2295
2018	720	2316

14.2.2.2.2 Recreational post released mortality (PRM)

Based on the information provided by Hyder *et al*. (2018), WKBASS 2018 agreed on a figure of 5% for PRM in recreational fisheries on the Northern and the Bay of Biscay seabass stocks. This estimate is based on a published German study (Lewin *et al*., 2018)

14.2.2.2.3 Recreational length compositions

The estimate of removals were recalculated for the 2010 reference year as the sum of retained and released fish with a PRM of 5%. A length composition for recreational removals for the 2010 reference year was estimated as described in working document from Hyder *et al*. (2018) and illustrated in Figure 14-6.

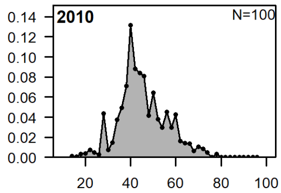


Figure 14-6: Length composition for the recreational fishery. Only one year of data available in 2010.

14.2.3 Abundance indices from surveys

Currently, there is no survey providing relative indices of adult or juvenile seabass abundance over time. However one pre recruit survey began on the coast of France from 2014. At this stage, the methodology has been set and give good results in term of gear used, catchability of seabass group 0,1,2,3 and understanding of nurseries dynamics. In the Bay of Biscay, the survey takes place in the Loire estuary and preliminary indices are available from 2016. The survey will be conduct until 2021 under an European Maritime and Fisheries Fund (EMFF) program (NOURDEM). The program includes also the Gironde estuary in order to get two abundance index for the stock bss.27.8ab (the first survey in the Gironde is planned for September 2019). The ultimate objective would be to make it sustainable through DCF from 2022 onwards.

14.2.4 Commercial landing-effort data

The full description of the LPUE is presented in the Stock Annex and in the working document from Laurec and Drogou (2017). The absence of a relative index of abundance covering adult seabass has been identified as a major issue for the assessment of the seabass stock in the Bay of Biscay. There are no scientific surveys providing sufficient data on adult seabass to develop an index of abundance for the area. Therefore, Ifremer investigated the potential for deriving an index from commercial fishery landings and effort data available since 2000. This allows the possibility to derive from French logbooks data (vessels with length > or < 10m) a LPUE index at the resolution of ICES rectangle and gear strata. A new LPUE index was presented at WKBASS 2018. This index is obtained by modelling the zeros and non-zeros values using a delta-GLM approach. A review of the study has been done by an external expert (M. Christman) before WKBASS 2018. The reviewer recommended the new LPUE index to be used in the assessment of Bay of Biscay seabass stock. The new LPUE index has been incorporated in the Northern and the Bay of Biscay stocks assessment models. Results updated with 2018 data are presented in Figure 14-7. The LPUE abundance index computed for the WGBIE 2019 compared well with the LPUE abundance index computed for the WGBIE 2018.

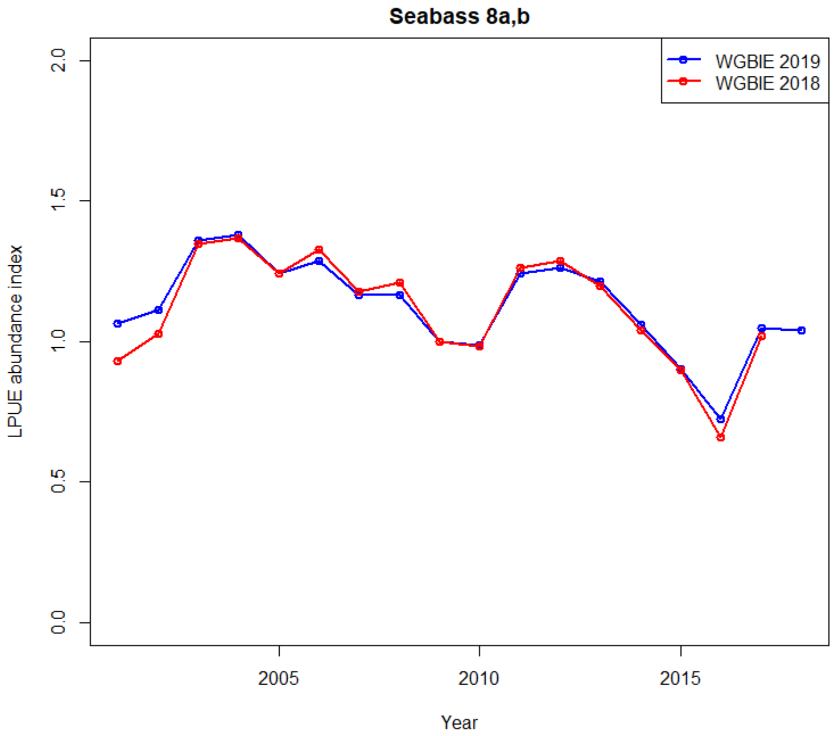


Figure 14-7: 2017 and 2018 LPUE abundance indices derived from the French commercial fishery.

14.2.5 Biological parameters

The full description of the biological parameters is presented in the Stock Annex.

14.2.5.1 Growth

In the Bay of Biscay, studies on seabass growth exist and have been published by Dorel (1986) and Bertignac (1987). To update these studies, seabass was sampled by Ifremer along the coasts of France in area 8.a-b. A Von Bertalanffy model parameters estimated using an absolute error model minimising $\sum(\text{obs-exp})^2$ in lengths-at-age has been used. L_{inf} was fixed to 80.4 cm (Bertignac, 1987). The standard deviation could be described by the linear model: SD = 0.1861 * age + 2.6955 (samples used from age 0 to age 15). The standard deviation of length-at-age increased with length as expected. K was estimated (see stock annex), but it is not used in the assessment model (K is re-estimated).

14.2.5.2 Maturity

Seabass maturity has been studied with samples collected by France in the Bay of Biscay. Samples were derived from French fisheries around the Bay of Biscay coast. The size at which 50% of the females are mature is 42.14 cm (low limit 41.31cm and upper limit 43.08 cm). The Pearson test (p-value = 0.597) identifies a good fit from the model to the data (Figure 14-8)

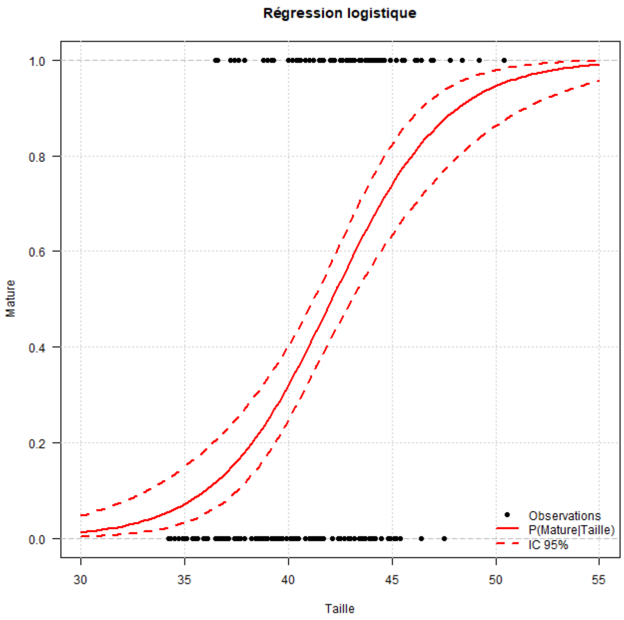


Figure 14-8: Maturity ogive for the Bay of Biscay sea-bass stock.

14.2.5.3 Natural mortality

WKBASS 2017 and WKBASS 2018 proposed to use the same value for both the Northern and the Bay of Biscay seabass stock (ICES, 2018): Then et al. (2014) tmax method, as being more robust than inferences from any single study, set the natural mortality for seabass to M = 0.24.

14.3 Assessment

This is an update assessment including the new data available for year 2018 from WKBASS assessment.

14.3.1 Input data

Input data are described in the Stock Annex (see under section "Input data for SS3").

14.3.2 Data Revisions

There were no data revisions for this update assessment.

14.3.3 Model

The Stock Synthesis 3 (SS3) assessment model (Methot and Wetzel, 2013) was selected for use in this assessment. Model description and settings are presented in the Stock Annex (under "Current assessment" for model description and "SS3 settings (input data and control files)" for model settings).

14.3.4 Assessment results

The assessment model includes estimation of size-based selectivity functions (selection pattern at length) for commercial and recreational fleets and for LPUE abundance index. Figure 14-9 presents selectivity functions by fleet estimated by the model. The inclusion of 2018 data did not change the selectivity pattern and its modelling.

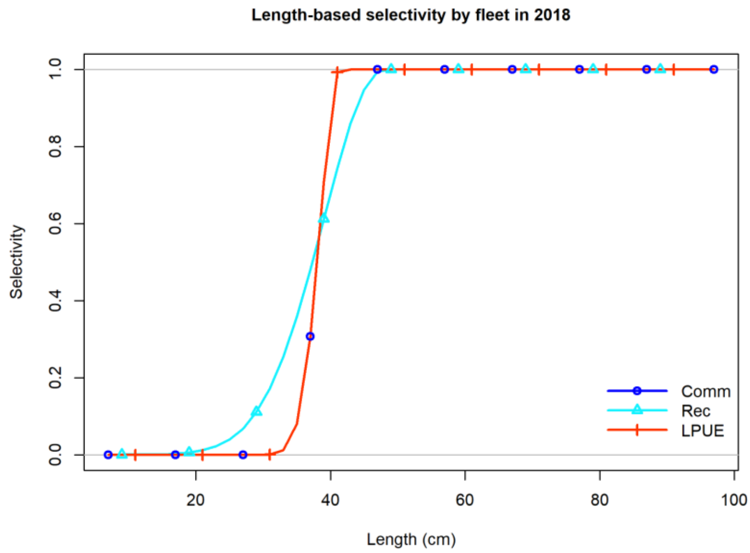


Figure 14-9: Selection patterns at length by commercial and recreational fleets estimated by SS3. Selection pattern for the LPUE abundance index was assumed to follow the one from the commercial fleet.

The selection curve is assumed constant over the whole period for all the fleets. The selection curve for the LPUE abundance index was assumed identical to that of the commercial fleet. The assessment currently assumes that commercial fleets do not discard fish (discards negligible less than 5% of the total landings).

Model fit for the LPUE abundance index was good (Figure 14-10). The index was useful to help the model to get the correct trend over time.

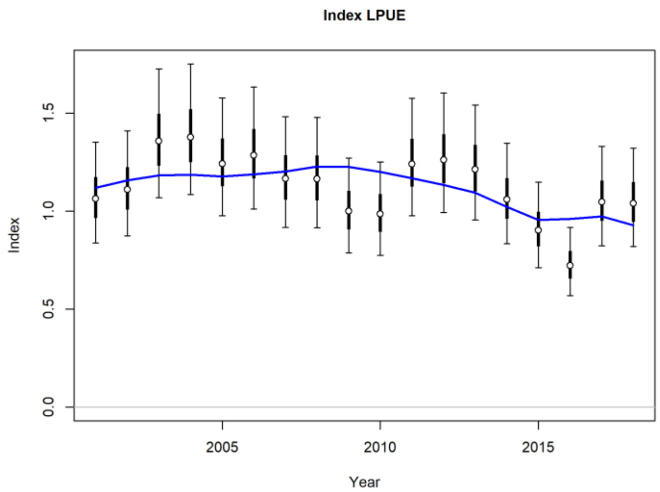
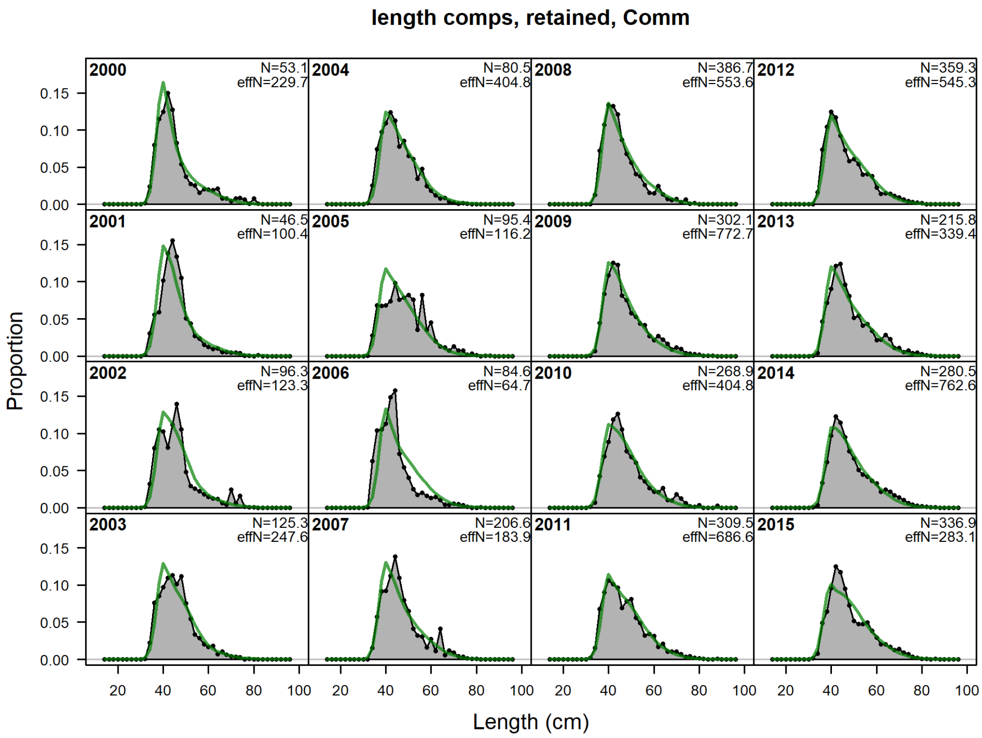


Figure 14-10: Fit to the LPUE abundance index.

Model fit for the commercial and recreational length composition data was good (Figure 14-11 and Figure 14-12)



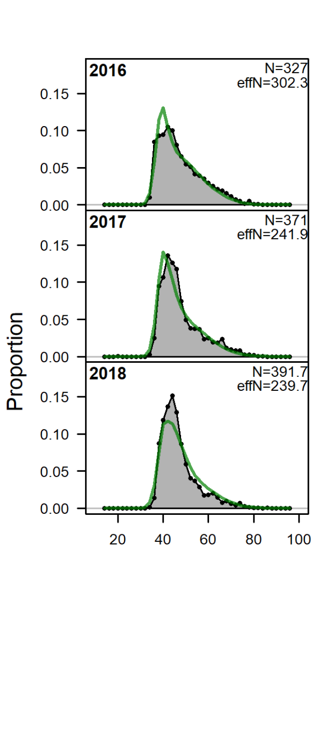


Figure 14-11: Fit to commercial fishery length composition data.

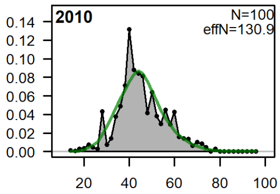
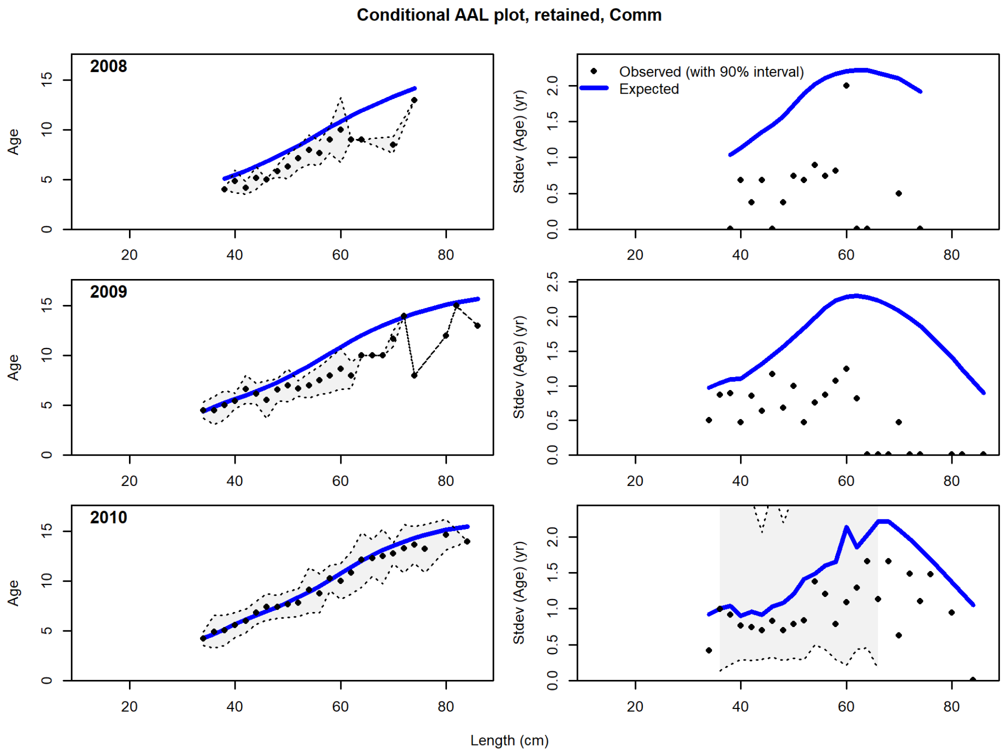


Figure 14-12: Fit to recreational fishery length composition data.

Model fit for the aggregated fishery age-at-length composition data were good in average, but poor in standard deviation (Figure 14-13 and Figure 14-14). The 2018 age-at-length data were not included in the assessment as they show a pattern incoherent with the historical data. The retrospective analysis (see below) was poor when these data were included.



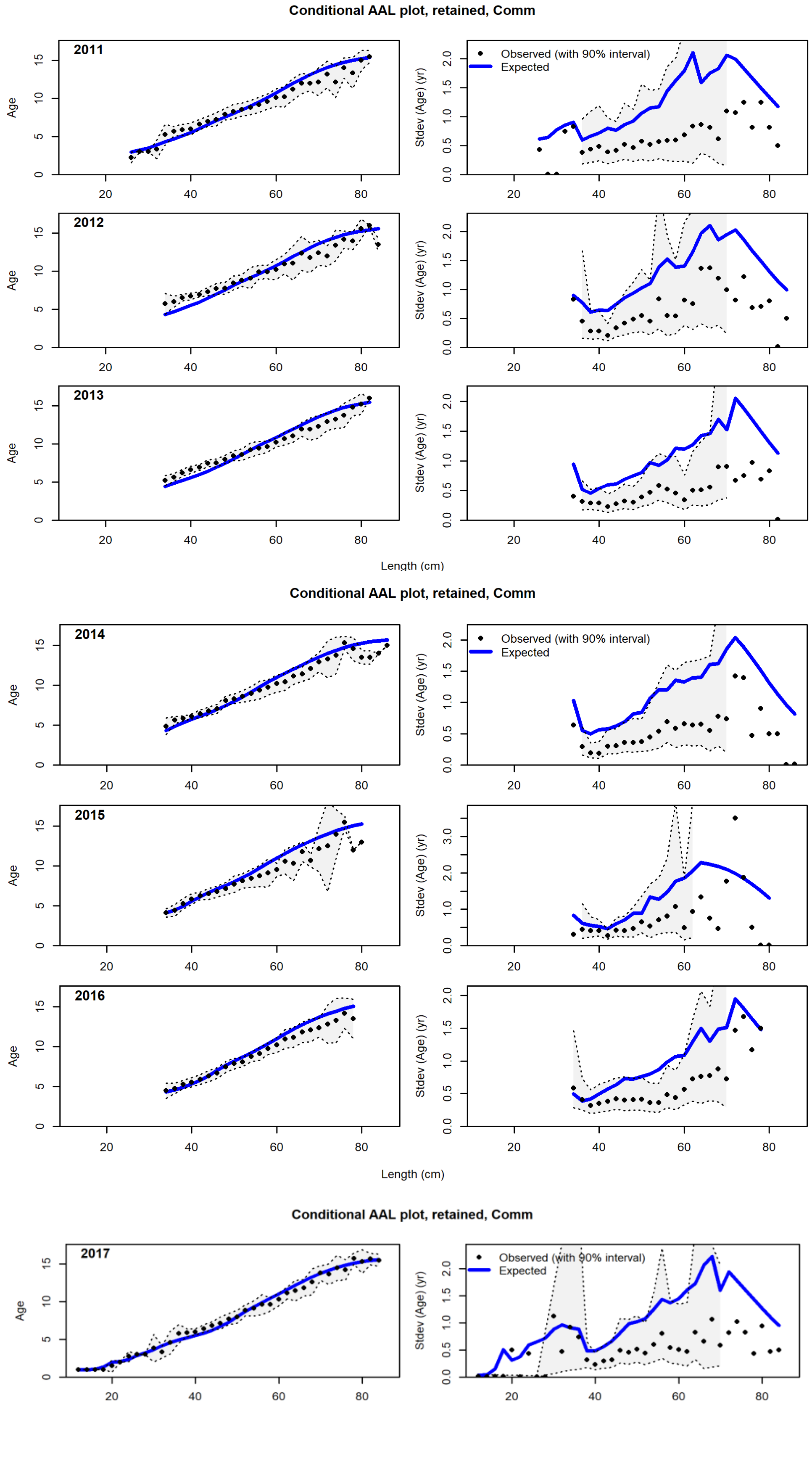


Figure 14-13: Fit to conditional age-at-length for commercial fishery.

The fit was poor for the first 2 age-at-length keys (years 2008 and 2009). However, for these years the sampling size was low.

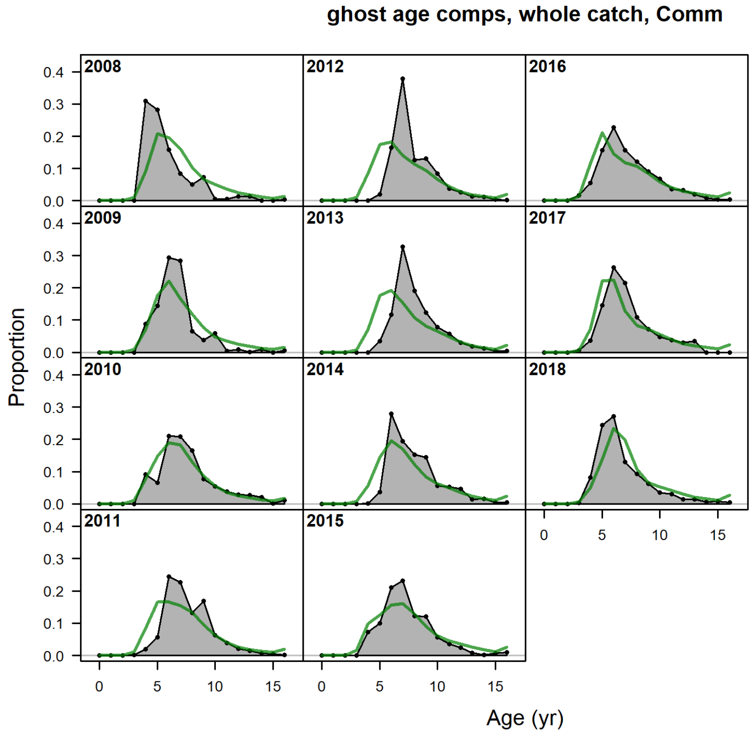


Figure 14-14: Observations and model predictions for age composition.

Age compositions data were included in the base model as “ghost”, meaning that they were not used for estimating the model likelihood. The purpose was to illustrate what the model estimated in terms of age composition data (Figure 14-14). Model and observations compared well, even though a discrepancies for some years was evident. For instance, in years 2011-2014, the model overestimated the proportion of age ≤ 5 compared to observations, or vice versa. Uncertainty in age reading or sampling bias may be considered as a potential explanation.

Two retrospective analysis were conducted (Figure 14-15 and Figure 14-17). When excluding 2018 age-at-length key (Figure 14-14), recruitment, SSB and F series showed some variability, however the stock trend is rather robust. In the last 5 years, the SSB is stable around 20 000 t showing a decreasing trend, while the F is below 0.15 and fluctuating without a trend. Recruitment was poorly estimated in recent years and showed high variability.

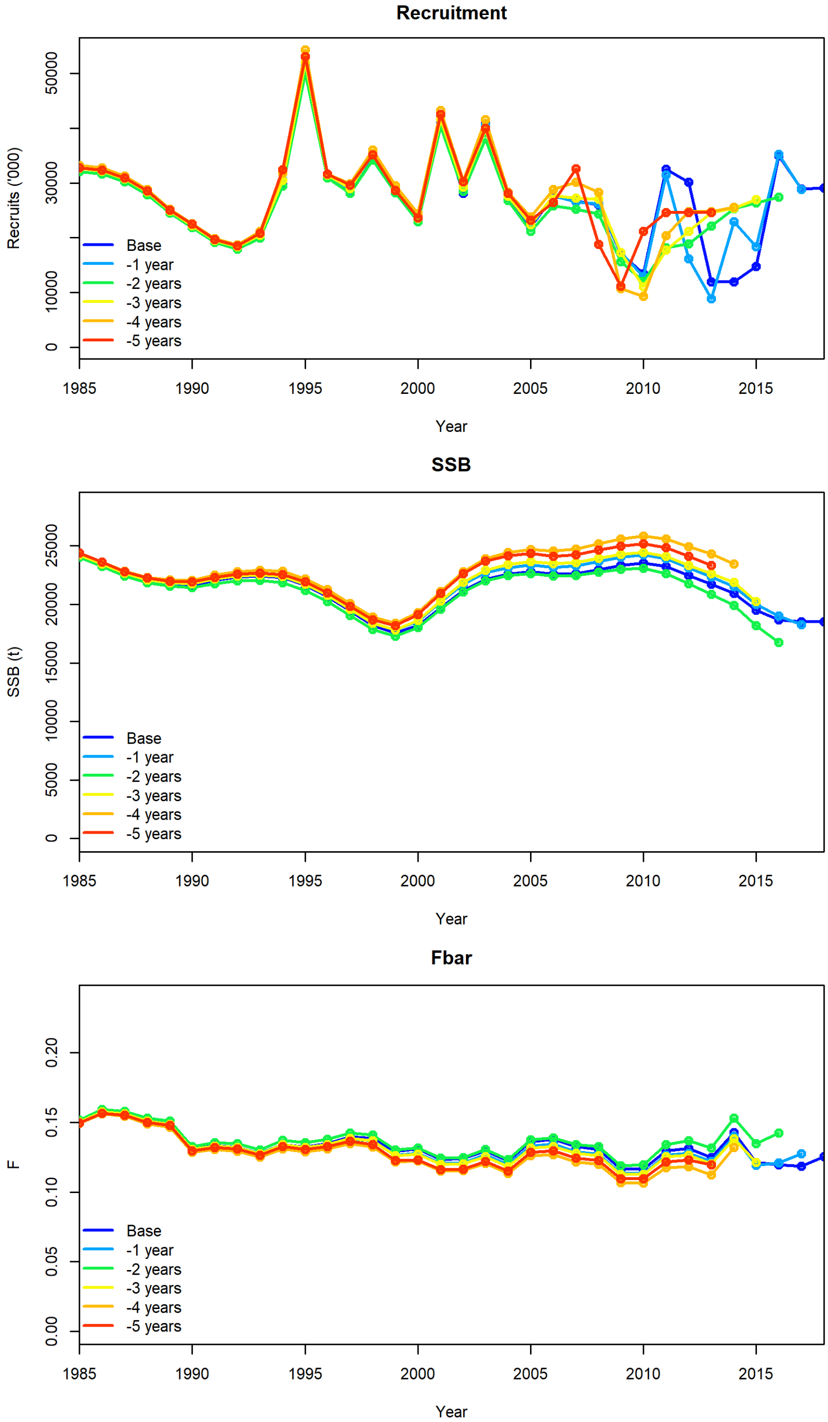


Figure 14-15: Retrospective plot without 2018 age-at-length key (i.e. with the model used for the assessment).

When including 2018 age-at-length key (Figure 14-14), recruitment, SSB and F series showed the same pattern as before, except that in the current assessment SSB is shifted down and F is shifted up. The shifts is quantified by the poor values of mohn's rho (see Table 14-7). Assessment including 2018 age-at-length key may not be in adequaction with the current biological reference points. Consequently 2018 age-at-length key were not included in the assessment model.

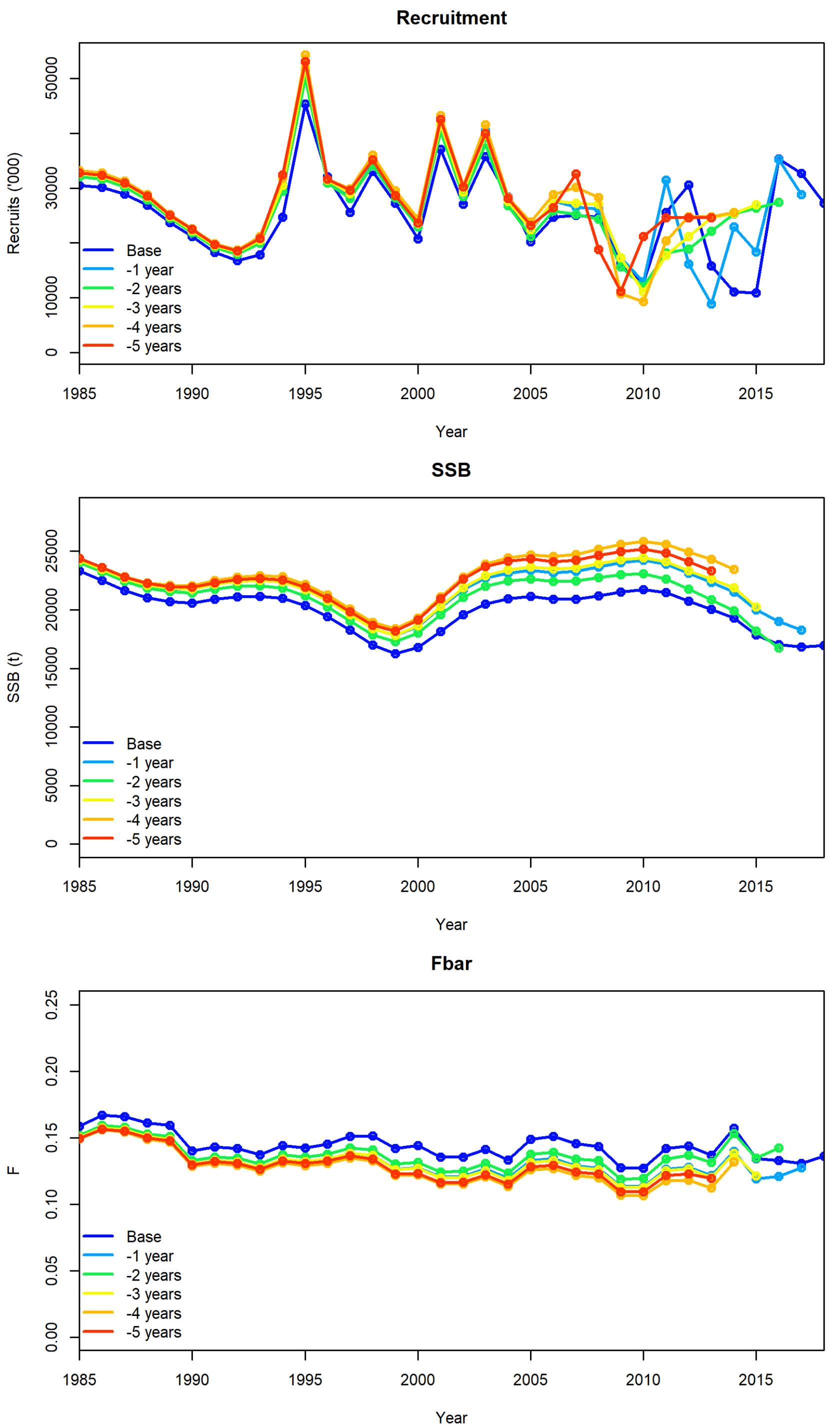


Figure 14-16: Retrospective plot with 2018 age-at-length key (i.e. with a model not used for the assessment).

Table 14-7: Mohn's rho values for both retrospective analysis.

without 2018 aal key			**with 2018 aal key**		
ssb	recr	fbar	ssb	recr	fbar
0.023	0.562	0.029	0.116	0.602	-0.068

14.4 Historic trends in biomass, fishing mortality and recruitment

Assessment summary from SS3 are given in Figure 14-17. The recruitment series was variable around ~30,000,000 individuals per year. Recruitment below average was observed for years 2009-2014. The SSB fluctuated around 20 000 t. A low SSB was observed just before the 2000s, and high SSB was observed around year 2010. Since then, a decreasing trend is observed. Average F computed for ages 4–15 showed a stable trend over the whole time series.

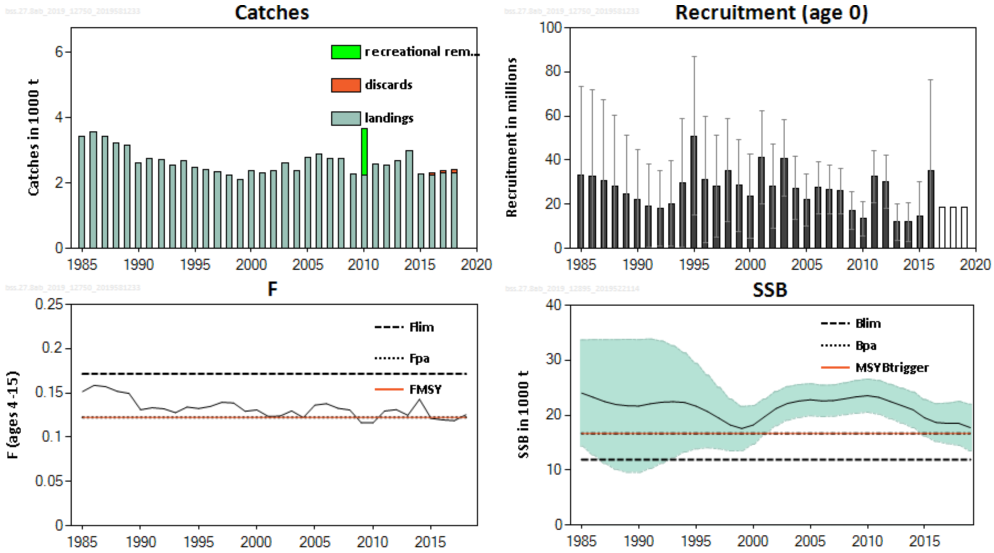


Figure 14-17: Summary of the stock assessment (weights in thousand tonnes). Commercial landings (with discards only included in 2016, 2017 and 2018), and recreational removals (only presented for 2010, where the data are available), including 5% mortality of released fish. Fishing mortality is shown for the combined commercial and recreational fisheries. Assumed recruitment values are not shaded. Recruitment and SSB are shown with 95% confidence intervals.

In 2018, F is above F_{MSY} (Table 14-8). SSB is above trigger and the stock is at full reproductive capacity.

Table 14-8: State of the stock and fishery relative to reference points.

	Fishing pressure					Stock size				
		2016	2017	2018			2017	2018	2019	
Maximum sustainable yield	F_{MSY}	✓	✓	✗	Above	MSY $B_{trigger}$	✓	✓	✓	Above trigger
Precautionary approach	F_{pa},F_{lim}	✓	✓	O	Increased risk	B_{pa},B_{lim}	✓	✓	✓	Full reproductive capacity
Management plan	F_{MGT}	–	–	–	Not applicable	B_{MGT}	–	–	–	Not applicable

Table 14-9: Assessment summary. All weights are in tonnes.

Year	Recruitment Age 0 thousands	High	Low	SSB tonnes	High	Low	Commercial landings tonnes	Recreational removals tonnes	F Ages 4–15
1985	32984	73465	0	24019	33676	14362	3420	1455	0.152
1986	32477	71715	0	23248	33737	12759	3549	1408	0.159
1987	30912	67216	0	22474	33731	11216	3417	1374	0.157
1988	28400	60459	0	21936	33751	10120	3217	1355	0.152
1989	24755	51258	0	21703	33806	9599	3144	1347	0.150
1990	22083	44638	0	21656	33748	9564	2621	1355	0.131
1991	19312	38102	523	22073	33855	10291	2734	1366	0.133
1992	18178	35369	988	22351	33477	11226	2709	1362	0.132
1993	20317	39689	945	22441	32610	12271	2552	1341	0.128
1994	29655	58832	479	22301	31318	13284	2668	1301	0.134
1995	50986	86812	15161	21625	29408	13842	2492	1239	0.132
1996	31227	59963	2491	20659	27267	14051	2402	1171	0.135
1997	28113	51329	4898	19444	25025	13863	2358	1113	0.140
1998	35297	58585	12008	18205	22929	13481	2231	1099	0.139
1999	28427	49014	7841	17557	21578	13537	2091	1142	0.129
2000	23690	42926	4454	18203	21722	14684	2362	1233	0.131
2001	41150	62334	19965	19711	22948	16474	2306	1313	0.124
2002	28083	47070	9096	21196	24307	18085	2392	1372	0.124
2003	40826	58219	23433	22137	25180	19094	2616	1404	0.130
2004	27397	41639	13156	22569	25555	19584	2380	1419	0.122
2005	21962	33920	10005	22802	25726	19878	2796	1422	0.136
2006	27548	39416	15680	22599	25461	19737	2875	1425	0.138
2007	26690	37857	15524	22645	25489	19801	2751	1440	0.133
2008	26029	36282	15775	22974	25868	20079	2745	1451	0.131
2009	17141	25550	8732	23319	26287	20351	2278	1449	0.116
2010	13432	21111	5752	23535	26561	20508	2229	1430	0.116

Year	Recruitment Age 0 thousands	High	Low	SSB tonnes	High	Low	Commercial landings tonnes	Recreational removals tonnes	F Ages 4–15
2011	32501	44221	20780	23232	26303	20162	2575	1394	0.130
2012	30177	42288	18067	22478	25593	19364	2549	1345	0.131
2013	11949	20132	3765	21727	24895	18558	2685	879	0.125
2014	11940	20639	3241	20963	24206	17720	2991	825	0.143
2015	14746	29940	0	19505	22827	16182	2264	783	0.121
2016	35004	76160	0	18666	22107	15225	2252	757	0.120
2017	18827			18513	22194	14832	2295	713	0.119
2018	18827			18498	22492	14504	2316	720	0.126
2019	18827			17730	21967	13493			
Average	26282	47692	7274	21277	27074	15479	2625	1241	0.133

14.5 Biological reference points

IBPbass (ICES, 2019) set the biological reference points to be used for this stock. Table 14-10 compiles the biological reference points computed under type 6 stock-recruitment relationship as agreed during the inter-benchmark IBPbass.

Table 14-10: Biological reference points agreed by IBPbass 2018 for use in the ICES advice. All weights are in tonnes.

Framework	Reference Point	Value	Basis
MSY approach	MSY $B_{trigger}$	16688 t	Bpa
	FMSY	0.123	F that maximizes median long-term yield in stochastic simulations under constant F exploitation; constrained by the requirement that FMSY = Fpa
Precautionary approach	Blim	11920 t	Bpa / exp(CV * 1.645)
	Bpa	16688 t	Lowest observed SSB
	Flim	0.172	F that, In equilibrium gives a 50% probability of SSB>Blim
	Fpa	0.123	Fpa = Flim / exp(CV * 1.645)
Management plan	SSBmgt	Not defined	
	Fmgt	Not defined	

14.6 Catch options and prognosis

14.6.1 Short-Term projection

Forecast inputs used for projections are compiled in Table 14-11. The recruitment used for projections is the geometric mean (GM) calculated from 2008 to 2014. For the short-term projection, F-at-age averaged over the last 3 years (2016-2018) and scaled to 2018 value were used for commercial and recreational fleets (Table 14-11).

Table 14-11: Forecast inputs table.

Ages	N@age	Weight@age	Prop.mature@age	Commercial F	Commercial mean weight	Recreational F	Recreational mean weight	Natural mortality
0	18827	0.004	0.000	0.000	0.009	0.000	0.009	0.24
1	14810	0.020	0.000	0.000	0.044	0.000	0.051	0.24
2	11649	0.077	0.000	0.000	0.285	0.001	0.150	0.24
3	17024	0.181	0.003	0.000	0.454	0.004	0.298	0.24
4	5617	0.328	0.030	0.016	0.592	0.011	0.482	0.24
5	3480	0.514	0.161	0.061	0.727	0.019	0.685	0.24
6	2525	0.729	0.421	0.091	0.897	0.026	0.899	0.24
7	4459	0.967	0.675	0.101	1.112	0.030	1.125	0.24
8	3315	1.219	0.836	0.104	1.356	0.032	1.367	0.24
9	937	1.479	0.920	0.105	1.613	0.032	1.619	0.24
10	810	1.741	0.960	0.105	1.872	0.033	1.876	0.24
11	833	2.000	0.980	0.105	2.128	0.033	2.130	0.24
12	579	2.253	0.989	0.105	2.376	0.033	2.377	0.24
13	407	2.496	0.994	0.105	2.614	0.033	2.615	0.24
14	223	2.729	0.996	0.105	2.840	0.033	2.841	0.24
15	191	2.949	0.998	0.105	3.054	0.033	3.054	0.24

Ages	N@age	Weight@age	Prop.mature@age	Commercial F	Commercial mean weight	Recreational F	Recreational mean weight	Natural mortality
16	505	3.481	0.998	0.105	3.602	0.033	3.602	0.24

Age 0,1,2 over-written as follows:

2019 yc -> 2019 age 0 replaced by 2008–2014 LTGM (18827 thousand);

2018 yc -> 2019 age 1 from SS3 survivor estimate at-age 1, 2019 * LTGM / SS3 estimate of age 0 in 2017;

2017 yc -> 2019 age 2 from SS3 survivor estimate at-age 2, 2019 * LTGM / SS3 estimate of age 0 in 2016.

Total landings forecasted for 2019 are 2 723 t, with 2 065 t for the commercial fishery and 658 t for the recreational fishery. SSB 2020 is forecasted to be at 15 937 t, i.e. below MSY Btrigger, and between Bpa and Blim (Table 14-12).

Table 14-12: The basis for the catch scenarios.

Variable	Value
F ages 4-15 (2019)	Commercial fishery F = 0.092, Recreational fishery F = 0.029 Total F = 0.121
SSB (2020)	15937 t
Rage0 (2017,2018,2019)	18827 thousands
Total catch (2019)	2723 t
Wanted commercial catch (2019)	2065 t
Unwanted commercial catch (2019)	NA
Recreational Catch (2019)	658 t

ICES advises that when the EU multiannual plan (MAP) is applied, catches in 2020 that correspond to the F ranges are between 2 417 t and 3 075 t. According to the MAP, catches higher than those corresponding to F_{MSY} (2 533 t) can only be taken under conditions specified in the MAP, whilst the entire range is considered precautionary when applying the ICES advice rule. (Table 14-13).

Table 14-13: Catch options table.

Basis	Total landings	Commercial landings	Recreational removals	Total Fbar	Commercial Fbar	Recreational Fbar	SSB 2021	SSB change	Advice change
F=(SSB_2020/MSY_Btrigger)*F_{MSY}	2533	1914	619	0.117	0.089	0.028	15308	-3.9	1.5
F=(SSB_2020/MSY_Btrigger)*F_{MSY}_lower	2417	1827	590	0.111	0.085	0.026	15397	-3.4	-3.1
F=(SSB_2020/MSY_Btrigger)*F_{MSY}_upper	3075	2323	752	0.144	0.110	0.034	14891	-6.6	23.2
F=F_{MSY}	2645	1999	646	0.123	0.093	0.029	15221	-4.5	6.0
F=0	0	0	0	0.000	0.000	0.000	17274	8.4	-100.0
F=Fpa	2645	1999	646	0.123	0.093	0.029	15221	-4.5	6.0
F=Flim	3619	2734	885	0.172	0.131	0.041	14473	-9.2	45.0
SSB_2021 = Blim	6994	5279	1715	0.362	0.276	0.086	11920	-25.2	180.3
SSB_2021 = Bpa	751	567	183	0.033	0.025	0.008	16688	4.7	-69.9
SSB_2021 = MSY Btrigger	751	567	183	0.033	0.025	0.008	16688	4.7	-69.9
F=F_2018	2620	1980	640	0.121	0.092	0.029	15241	-4.4	5.0
F=F_{MSY}_lower	2525	1908	617	0.117	0.089	0.028	15314	-3.9	1.2
F=F_{MSY}_lower differing by 0.01	2728	2062	667	0.127	0.097	0.030	15157	-4.9	9.4
F=F_{MSY}_lower differing by 0.02	2930	2214	716	0.137	0.104	0.032	15002	-5.9	17.4

Basis	Total landings	Commercial landings	Recreational removals	Total Fbar	Commercial Fbar	Recreational Fbar	SSB 2021	SSB change	Advice change
$F=F_{MSY}$_lower differing by 0.03	3130	2365	765	0.147	0.112	0.035	14849	-6.8	25.4
$F=F_{MSY}$_upper	3210	2425	785	0.151	0.115	0.036	14787	-7.2	28.6

14.7 Comments on the assessment

The assessment for the Bay of Biscay seabass stock shows that since 2000, the spawning stock biomass (SSB) fluctuated around 20 000 t and is currently just above MSY $B_{trigger}$. A low SSB was observed just before the 2000s, and high SSB was observed around year 2010. Since then, a decreasing trend is observed. The fishing mortality (F) showed a stable trend over the whole time series and has fluctuated around F_{MSY} during the period. The recruitment is variable over time, and it was observed below average for years 2009-2014. Landings are stable over time around 2 600 t. Thus, extreme situations have not been explored to fully understand the dynamics of this stock. This implies that the estimation of the biological reference points is uncertain.

Otherwise, this assessment relies on short data time-series: length composition time series start in 2000; age-at-length time series start only in 2008 (with a proper sampling after 2010); recreational data were surveyed for only one year, 2010. In addition, there is no scientific survey for adult seabass to scale the model to an appropriate level of abundance. There is no survey on recruits either. All those elements make this assessment uncertain. In order to improve future assessments and advice for this stock, several important limitations and deficiencies in data for the Bay of Biscay seabass stock should be addressed.

1. Recruitment indices are needed for the Bay of Biscay area. Estimation of recruitment is only based on commercial landings, and it may be smooth because of ageing errors (Laurec and Drogou, 2012). A French study has been undertaken in 2014 to explore the possibility of creating recruitment indices in estuarine waters. The survey delivered good results. Abundance indices have been calculated for year 2016, 2017 and 2018 in the Loire estuary and are planned for year 2019. The survey will be conduct until 2021 under an European Maritime and Fisheries Fund (EMFF) program (NOURDEM). This includes also the Gironde estuary in order to get two abundance index for the stock bss.27.8ab. The final objective would be to make it sustainable through DCF from 2022 after having implemented in the assessment and discussed it during a benchmark.
2. Robust relative fishery-independent abundance indices are needed for adult seabass in the Bay of Biscay. The establishment of dedicated surveys on the spawning grounds could provide valuable information on trends in abundance and population structure of adult seabass as well as information on stock structure and linkages between spawning and recruitment grounds using drift model.
3. Further research is needed to better understand the spatial dynamics of seabass (mixing between stock areas; effects of site fidelity on fishery catch rates; spawning site–recruitment ground linkages; environmental influences on recruitment).
4. Assessment model should be revised according to the results of undergoing tagging and genetic programs.
5. Studies are needed to investigate the accuracy/bias in ageing and errors due to historically age sampling schemes.
6. Continued estimation of recreational catches and size compositions is needed across the stock range and information to evaluate historical trends in recreational effort and catches would be beneficial for interpreting changes in age–length compositions over time.
7. Historical catches data (1985-2000) need to be revised following the methodology used for the recent years (2000 onwards). Historical catches data need also to be disaggregated into several fishing fleets (e.g. midwater trawls, bottom trawls, nets, lines).
8. Discard rates are considered negligible in the current assessment. Nonetheless, a time-series of discards-at-length or -age may be needed for all fleets, if the impact of technical

measures to improve selectivity is to be evaluated as part of any future seabass management.

9. The absence of length composition data for French fisheries prior to 2000 is a serious deficiency in the model preventing any evaluation of changes in selectivity that may have occurred, for example due to changes in the proportion of different gear types (especially with the large decrease in numbers of pair trawlers after 1995).

14.8 Management considerations

Seabass is characterized by slow growth, late maturity and low natural mortality on adults, which imply the need for comparatively low rates of fishing mortality to avoid depletion of spawning potential in each year class. In the well-known northern stock (4.b-c, 7.a,d-h) productivity of the stock is affected by extended periods of enhanced or reduced recruitment which appear to be related to changes in sea temperature (ICES, 2016a). Warm conditions facilitate northward penetration of seabass in the Northeast Atlantic, and enhance the growth and survival of young fish in estuarine and other coastal nursery habitats. In the Bay of Biscay there is no reason to observe different dynamics. In terms of numbers of recruits, the Bay of Biscay area looks more productive than in the North. If no management is put in place, and if a combination of increasing fishing mortality and environmental conditions causing relative successive poor recruitments occur, it could lead in the long term to the same situation than in the North part with a large decline of biomass.

The behaviour of seabass, forming predictable aggregations for spawning in winter and moving inshore to feed at other times of year, increase their vulnerability to exploitation by offshore and inshore fisheries. The effects of targeting offshore spawning aggregations of seabass are poorly understood, particularly how the fishing effort is distributed in relation to the mixing of fish from different nursery grounds or summer feeding grounds, given the strong site fidelity of seabass. Fisheries targeting offshore aggregation are mainly netters and to a lesser extent pelagic trawlers operating from December to March. Note that a high increase in the French landings for the nets fishery is observed from 2011: indeed, as seabass is currently a non-TAC species, there is potential for displacement of fishing effort from other species with limiting quotas as observed with netters in Bay of Biscay reporting their catches from sole to seabass. With no effective control on the fishery to limit the increase of the landings as observed in 2014, risks are taken. Many small-scale artisanal fisheries, especially line fishing have developed a high seasonal dependency on seabass. There is also a significant recreational fishing mortality in inshore waters. The importance of seabass to recreational fisheries, artisanal and other inshore commercial fisheries and large-scale offshore fisheries in different regions means that resource sharing is an important management consideration.

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15 European Seabass in Division 8c, 9a

15.1 ICES advice applicable

"ICES advises that when the precautionary approach is applied, commercial catches in each of the years 2018 and 2019 should be no more than 478 t. All commercial catches are assumed to be landed. Recreational catches cannot be quantified; therefore, total catches cannot be calculated."

15.2 General

15.2.1 Stock ID and sub-stock structure

Seabass *Dicentrarchus labrax* is a widely distributed species in Northeast Atlantic shelf waters with a range from southern Norway, through the North Sea, the Irish Sea, the Bay of Biscay, the Mediterranean and the Black Sea to North-west Africa. The species is at the northern limits of its range around the British Isles and southern Scandinavia. Further studies are needed on seabass stock identity, using conventional and electronic tagging, genetics and other individual and population markers (e.g. otolith microchemistry and shape), together with data on spawning distribution, larval transport and VMS data for vessels tracking migrating seabass shoals, to confirm and quantify the exchange rate of seabass between areas that could form management units for this stock (ICES, 2012abc).

The stock identity was assumed to be: Northern (ICES areas 4b-c, 7a,d-h); Southern Ireland and Western Scotland (ICES areas 6a, 7b and 7j); Biscay (ICES areas 8a-b); Portugal & Northern Spain (ICES areas 8c & 9a) (Figure 15.1). Since then, stock identity has not changed (ICES, 2017a), but research on population structure are under progress.

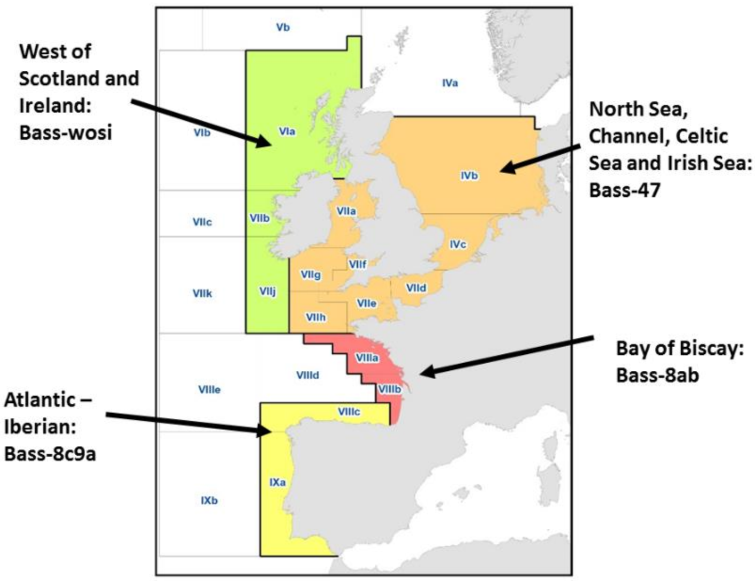

Figure 15.1. Current stock definitions for sea bass.

15.2.2 Management applicable to 2017

Seabass is not subject to EU TACs and quotas. Under EU regulation, the minimum landing size (MLS) of bass in the Northeast Atlantic is 36 cm total length. A variety of national restrictions on commercial bass fishing are also in place.

- The measures affecting recreational fisheries in Portugal include gear restrictions, a minimum landing size equal to the commercial fishery MLS (36 cm), the total catch of fish and cephalopods by each fisher must be less than 10 kg per day, and prohibition on the sale of catch.

15.2.3 Management applicable to 2018

No new management plan is known at present in 8c, 9a.

15.2.4 Management applicable to 2019

European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including seabass in ICES divisions 8c and 9a.

15.3 Fisheries data

15.3.1 Commercial landings data

Landings series are given in **Error! Reference source not found.** and are derived from:

i. Official statistics recorded in the Fishstat database since around the mid-1970s.
ii. Spanish landings for 2007-2011 from sale notes.
iii. Portuguese estimated landings from 1986 to 2011 including distinction between *Dicentrarchus labrax* and *D. punctatus*.
iv. Official landings from recent years (reviewed from 2012 onwards).

Spanish and Portuguese vessels represent almost all of the total annual landings in the area 8c and 9a. Commercial landings represent 716 t in 2018. A peak of landings was observed in the early 90's and in 2013, reaching more than 1000 t, and lowest landings (637 t) have been observed in 2004. Artisanal fisheries are mainly observed in this area. A decrease is observed in 2018, due to the Portuguese fleets which saw its landings decreasing from 598 t in 2017 to 366 t in 2018. Compared to 2017, in 2018, Spanish landings are stable (354 t and 350 t respectively). Landings from Portugal are only from the 9a area, while the Spanish landings are distributed between the two zones 8c and 9a (182 t and 168 t in 2018 respectively). Landings per country are given in Figure 15.1, and landings split by country, gear and area are given in Table 15.2 : commercial landings in Iberian waters per country, gear and subareaTable 15.2.

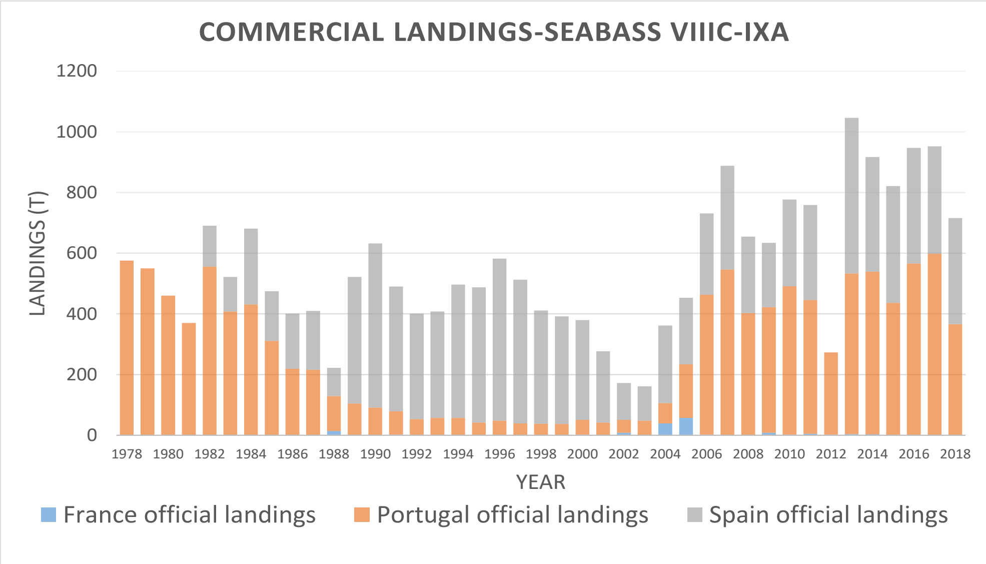

Figure 15.1: commercial landings per country in area 27.7.9a and 27.7.8c (source: InterCatch).

15.3.2 Commercial length composition data

Quarterly length composition is available in the 9a area (source InterCatch) for Portuguese fleet (MIS_MIS_0_0_0) in 2016-2018 and presented yearly in Figure 15.2 and for Spanish fleet in 2017-2018 presented in Figure 15.3.

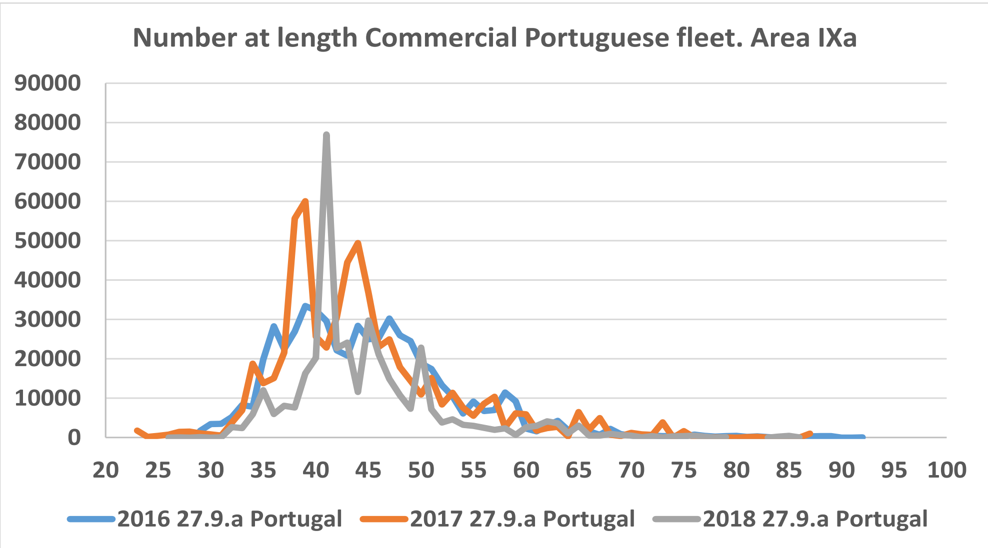

Figure 15.2 : commercial length composition in 2016-2018 for Portuguese fleet landings (source: InterCatch).

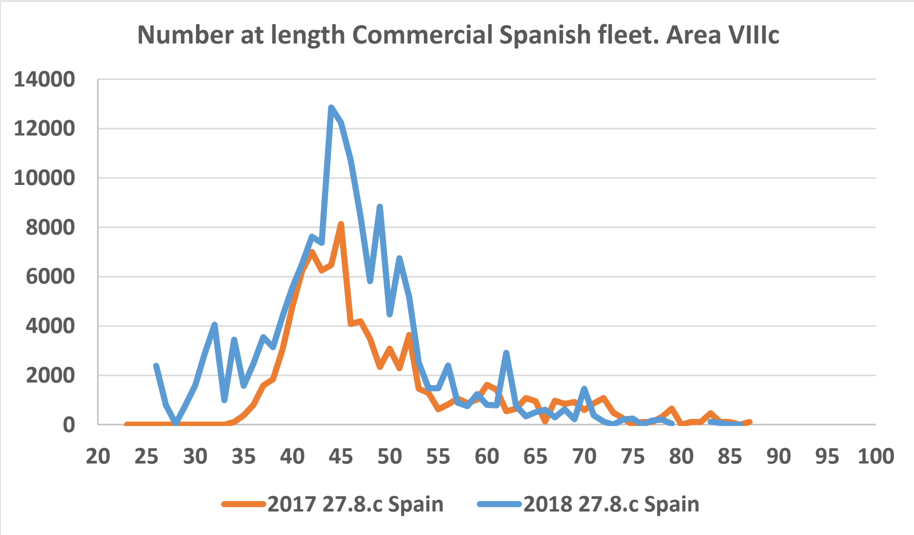

Figure 15.3: commercial length composition in 2017-2018 for Spanish fleet landings (source: InterCatch)

15.3.3 Commercial discards

Portugal: Seabass discards are recorded by the DCF on-board sampling program. The Portuguese on-board sampling is not covering the Seabass fishing area. No discards are observed.

Spain: No bass discards were observed for any métier in the 2003–2018 periods.

15.3.4 Effort

Some effort data were available (source InterCatch) for Spanish fleet from 2013 and for Portuguese fleet from 2015, showing a global decrease over time (Figure 15.4).

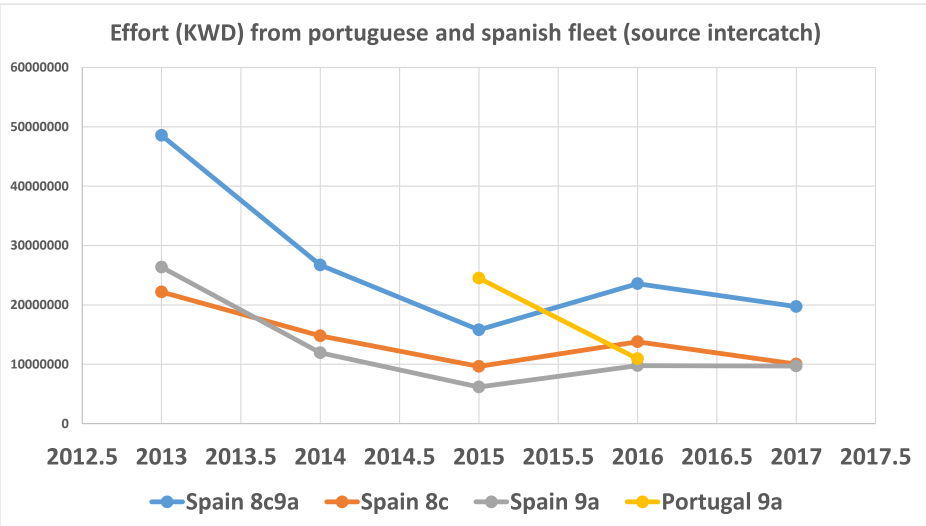

Figure 15.4: Effort (KWD) for Spanish and Portuguese fleet in 8c 9a area (source: InterCatch).

15.3.5 Recreational catches

In 2015, a study has been conducted in Spain "*Comparing different survey methods to estimate European seabass recreational catches in the Basque Country*" (Zarauz *et al*., 2015). This is the first study that estimates seabass recreational catches in the Basque Country including fishers from shore, boat, and spearfishing. Three different offsite survey methods were used (e-mail, phone, and post) and their performance was compared. Estimates were different depending on the survey method used. Total catch estimates for shore fishing were 129, 156, and 351 t for e-mail, phone, and post surveys, respectively. For boat fishing, estimates varied from 5 t (phone) to 13 t (e-mail and post). For spearfishing, only e-mail surveys were performed and total catch was estimated in 13 t. Potential representation and measurement bias of each survey method were analysed. It was concluded that post surveys assured a full coverage of the target population, but showed very low response rates. Telephone surveys presented the highest response rates, but lower coverage of the target population. E-mail surveys had a low coverage and a low response rate, but it was the cheapest method, and allowed the largest sample size. All surveys methods were affected by recall bias. Recommendations are made about how to improve the surveys (increasing coverage, reducing non-response, and recall bias) to set up a routine cost-effective monitoring program for Basque recreational fisheries. Results show that estimated seabass recreational catches are comparable to commercial catches, which emphasize the relevance of sampling recreational fishing on a routine basis and including this information into the stock assessment and management processes.

In 2016, data for the seabass capture estimation in recreational fisheries provided by AZTI correspond only to the landings in the Basque Country, and that despite being mostly in division 27.8.c, (it could be part from 27.8.b) are 117 t. (Source: AZTIs estimation under Data Collection Framework). Further details can be found in the WGRFS 2017 report (ICES, 2017b).

15.4 Assessment model, diagnostics and retrospectives

15.4.1 Previous assessment

Advice for 2014: Based on ICES approach to data-limited stocks, ICES advised that commercial catches should be no more than 598 t in 2014 (0.8*average landings 2009–2011). All commercial catches are assumed to be landed. Recreational catches cannot be quantified; therefore, total catches cannot be calculated.

Advice for 2015: There are no new data available and the perception of the stock has not changed. Therefore, the advice for this fishery in 2015 is the same as the advice for 2014: based on ICES approach to data-limited stocks, ICES advises that commercial catches should be no more than 598 t. All commercial catches are assumed to be landed. Recreational catches cannot be quantified; therefore, total catches cannot be calculated.

Advice for 2016 and 2017: the ICES framework for category 5 stocks was applied (ICES, 2012a). For stocks without information on abundance or exploitation, ICES considered that a precautionary reduction of catches should be implemented unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was applied in 2013 (for the 2014 advice). ICES advises than when the precautionary approach is applied, commercial catches should be no more than 598 t in each of the years 2016 and 2017.

Advice for 2018 and 2019:

The ICES framework for category 5 stocks was applied (ICES, 2012a). For stocks without information on abundance or exploitation, ICES considered that a precautionary reduction of catches should be implemented unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was applied in 2013 for the 2014 advice. ICES advises than when the precautionary approach is applied, commercial catches should be no more than 478 t in each of the years 2018 and 2019.

Note of the working group during WGBIE 2018 (ICES 2018a): a precautionary approach (PA) has been adopted on this stock in 2013 (-20%) on the average of 2009-2011 years catches. The new buffer of 20% applied this year to the latest advice doesn't make sense for the WGBIE 2018 group, due to the very old period for calculation, the relatively stability in landings over time, the presence of very large individuals (up to 92cm) in length composition of commercial landings and because seabass is not a targeted species in this area (contrary to the other northern stock). The mean of the three last years' catches (2014-2016) applying the buffer (20% less), resulting in a catch advice of 716 t would have been probably more appropriate.

15.4.2 Current assessment

According to ICES Guidance for preparing single stock advice, if the PA buffer has been applied in 2017 or later (assessment conducted in 2017 providing advice for 2018), then it should not be applied in 2019. Also, ICES advises than when the precautionary approach is applied, commercial catches should be no more than 478 t in each of the years 2020 and 2021.

15.5 Recommendations for next benchmark assessment

ICES WGBIE 2019 encouraged documentation of the quality of the seabass data for the Iberian waters, and studies to better understand the stock dynamics and movements between the current stock areas. Seabass in Iberian waters is considered as a 5.2.0 category at present. The ICES framework for category 5 stocks is applied (ICES, 2012a) for catch advice. No information is available at present indicating the level of the stock. A parallel can be done with the 27.7.8ab seabass stock assessed with the same methodology until 2014. In 2015 ICES using a French LPUE index based on log book of French commercial vessels (>10m and <10m), allowed to assess this stock using the ICES framework for category 3 stocks (ICES, 2012a). The French LPUE was applied as the index of stock biomass. The advice was based on a comparison of the two latest index values (index A) with the three preceding values (index B), multiplied by the recent average landings. A data call has also been written at WGBIE 2017 in order to get material from Spain and Portugal in order to assess the 8c9a stock using an LPUE index calculated with the French methodology. The analysed data set would correspond to Spanish and Portuguese logbooks from commercial vessels catching seabass (<10m if possible, and >10m).

15.6 Management plans

European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including seabass in ICES divisions 8c and 9a.

15.7 References

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.

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ICES. 2012a. Report of the Inter-Benchmark Protocol on New Species (Turbot and Seabass; IBPNew 2012). ICES CM. 2012/ACOM: 45.

ICES. 2012c. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2012/ACOM: 23. 55 pp.

ICES. 2014b. Report of the Inter-Benchmark Protocol for Seabass in the Irish Sea, Celtic Sea, English Channel, and Southern North Sea (IBPBass). By correspondence. ICES CM 2014/ ACOM: 46.

ICES. 2014c. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 13–22 May 2014, Copenhagen, Denmark. ICES CM 2014/ACOM: 12.

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ICES. 2018a. 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 CM/ACOM: 12, 642 pp.

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ICES. 2018c. Report of the Benchmark Workshop on Seabass (WKBASS) 20-24 February 2017 and 21-23 February 2018, ICES HQ, Copenhagen, Denmark. ICES CM/ACOM: 44.

Van der Hammen, T. and de Graaf, M. 2015. Recreational fisheries in the Netherlands: analyses of the 2012–2013 logbook survey, 2013 online screening survey and 2013 random digit dialing survey. IMARES C042/15, pp 55.Zarauz, L., Ruiz, J., Urtizberea, A., Andonegi, E., Mugerza, E., and Artetxe, I. Comparing different survey methods to estimate European seabass recreational catches in the Basque Country. – ICES Journal of Marine Science, doi: 10.1093/icesjms/fsv054.

Zarauz L., Ruiz J., Urtizberea A., Andonegi E., Mugerza E., Artetxe I. 2015. Comparing different survey methods to estimate European seabass recreational catches in the Basque Country, *ICES Journal of Marine Science*,Volume 72(4): 1181–1191, https://doi.org/10.1093/icesjms/fsv054

15.8 Tables

Table 15.1: Seabass in the 9 and 8c areas. ICES and official landings (tons).

Year	France** official landings	Portugal** official landings	Spain** official landings	Total official** landings	Total ICES estimates***
1978	0	576	0	576	576
1979	0	550	0	550	550
1980	0	460	0	460	460
1981	0	370	0	370	370
1982	0	556	135	691	691
1983	0	408	114	522	522
1984	0	431	250	681	681
1985	0	311	164	475	475
1986	0	219	182	401	580
1987	0	216	194	410	542
1988	14	115	93	222	586
1989	0	105	417	522	1029
1990	1	90	541	632	1042
1991	2	77	411	490	867
1992	0	53	348	401	743
1993	0	57	351	408	694
1994	0	57	440	497	863
1995	0	42	446	488	798
1996	0	48	534	582	956
1997	0	39	474	513	742
1998	0	38	373	411	683
1999	0	37	355	392	720
2000	2	49	329	380	775
2001	0	42	235	277	635
2002	8	43	121	172	518
2003	1	47	113	161	466
2004	39	67	256	362	676

Year	France** official landings	Portugal** official landings	Spain** official landings	Total official** landings	Total ICES estimates***
2005	57	177	219	453	753
2006	2	461	268	731	905
2007	1	545	342	888	910
2008	0	403	252	655	614
2009	8	414	212	634	652
2010	2	489	286	777	814
2011	5	441	313	759	777
2012	2	368	316	686	701
2013	4	502	495	1001	1046
2014	3	661	365	1026	917
2015	0	437	381	818	821
2016*	0	546	377	923	947
2017	2	596	159	757	952
2018	0	500	332	832	716

*** Preliminary**

***-Official landings have been extracted from the ICES Official Catch Statistics Web page (04 May 2015) for "BSS" and area 8c, 9a and 9 (9 has been retained for Portuguese statistics because reported as 9a prior 2007).**

*****Difference between Ices Statistics and official Statistics are mainly due prior 2006 to Portugal statistics: before 2006 most of the seabass catches were registered under the code BSE, i.e. (*Dicentrarchus* sp.). After the DCF implementation there was a progressive increase in the correct identification of species in the official statistics (BSS increase, BSE decrease) who consider *Dicentrarchus* sp. landings minus 2.3% of *Dicentrarchus punctatus* based on DCF market and on-board sampling between 2008 and 2012)**

NB : Official landings reviewed from 2012 onwards in 2019

Table 15.2 : commercial landings in Iberian waters per country, gear and subarea.

		landings 2016	landings 2017	landings 2018
Portugal	total IXa	565	598	366
	MIS_MIS_0_0_0	565	598	366
	total VIIIc	0	0	366
	Total Portugal	565	598	366
Spain	total IXa	165	171	168
	GNS_DEF_60-79_0_0	8	8	12.1
	GNS_DEF_80-99_0_0	0	0	0.04
	GTR_DEF_60-79_0_0	50	45	33.7
	LHM_DEF_0_0_0	3	3	3.38
	LLS_DEF_0_0_0	86	85	76.61
	MIS_MIS_0_0_0_HC	12	3	2.2
	OTB_DEF_>=55_0_0	0	0	0.08
	OTB_MCD_>=55_0_0	0	0	0.33
	PS_SPF_0_0_0	6	25.03	39.38
	total VIIIc	215	183	182
	GNS_DEF_>=100_0_0	0	0	0.04
	GNS_DEF_60-79_0_0	7	11	12.82048
	GNS_DEF_80-99_0_0	3	1	3.81
	GTR_DEF_60-79_0_0	38	26	26.76525
	LHM_DEF_0_0_0	2	0	1.02
	LHM_SPF_0_0_0			0.18
	LLS_DEF_0_0_0	139	130	115.19584
	MIS_MIS_0_0_0	0	3	
	MIS_MIS_0_0_0_HC	3		1.85
	OTB_DEF_>=55_0_0	0	0.29	0.343
	OTB_MPD_>=55_0_0	1	0.25	0.49
	PS_SPF_0_0_0	21	12.81	19.5689
	PTB_MPD_>=55_0_0	0		0.3763

16 Plaice in Subarea 8 and Division 9a

Plaice (*Pleuronectes platessa*) are caught as a bycatch by various fleets and gear types covering small-scale artisanal and trawl fisheries. Portugal and France are the main participants in this fishery with Spain playing a minor role. Landings may contain misidentified flounder (*Platichthys flesus*) as they are often confounded at sales auctions in Portugal. The official landings are given in table 16.1 and the catches submitted to the WG are given in table 16.2. The quantity of discarding is uncertain. France submitted discard estimates for the 2015, 2016, 2017 and 2018 catches, which were in the order of 11%, 2%, 5% and 2% of the French catches in these years. Portugal stated that the discards in the trawl fleet were 0% but no estimates are available for other gears. It is likely that discards are relatively minor but the WG cannot conclude that discarding is less than 5% of the catch.

Plaice were not present in sufficient numbers to provide survey abundance indices; the only survey that covers the stock area, EVHOE, only caught 43 plaice in division 8 during its entire time series (1997-present). The same survey did catch considerable numbers of plaice in the Celtic Sea. No commercial indices are currently available; however the advice might benefit from commercial LPUE data if this was made available to the working group.

Biological information needs to be compiled. However, issues concerning the quality of landings statistics in addition to the lack of survey or commercial abundance indices need to be resolved before an assessment is developed. As this species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula (Figure 16.1) perhaps merging of the northern and southern stocks would provide the best opportunity to improve the assessment.

This stock is under the EU landing obligation since 2016.

16.1 Assessment model, diagnostics and retrospectives

16.1.1 Previous assessments

ICES 2016 Advice (Published 30 June 2015): ICES advises that when the precautionary approach is applied, wanted catches should be no more than 194 tonnes in each of the years 2016 and 2017. ICES cannot quantify the corresponding total catches. The ICES framework for category 5 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. Given that this is the first time that ICES is providing a quantitative advice, the precautionary buffer was applied.

ICES 2018 Advice (Published 30 June 2017): ICES advises that when the precautionary approach is applied, wanted catches[1] in each of the years 2018 and 2019 should be no more than 194 tonnes. ICES cannot quantify the corresponding total catches. The ICES framework for category 5 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the

[1] The term "wanted catch" is used to describe the fish that would be landed in the absence of the EU landing obligation.

stock. The stock status relative to reference points remains unknown. The precautionary buffer was applied in 2015 (for the 2016 advice) and is therefore not applied again this year.

16.1.2 Current assessment

According to the ICES Guidance for preparing a single stock advice, if the PA buffer has not been applied in 2016 or later, the following guidelines for applying the PA buffer (-20%) should be used. ICES also advises that when the precautionary approach is applied, wanted catches[2] in each of the years 2020 and 2021 should be no more than 155 tonnes (194*0.8). ICES cannot quantify the corresponding total catches.

16.2 References

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp.

[2] The term "wanted catch" is used to describe the fish that would be landed in the absence of the EU landing obligation.

16.3 Tables and Figures

Table 16.1: Plaice in Subarea 8 and Division 9.a: official landings by country in tonnes

Year	Belgium	France	Portugal	Spain	Total
1994		365	33	1	399
1995		319		12	331
1996		248		14	262
1997		255		3	258
1998		219		6	225
1999	1			3	4
2000	15	193		22	230
2001		201		22	223
2002	1	167		11	179
2003	1	217	1	4	223
2004		229	163	7	399
2005	4	186	1	33	224
2006	2	248	1	5	256
2007	5	214	41	4	263
2008	2	98	89	4	193
2009	2	133	101	8	244
2010	2	200	112	12	325
2011	2	208	65	9	283
2012	3	183	63	4	252
2013	0	147	45	5	197
2014	1	164	51	6	222
2015	2	142	45	5	194
2016	1	121	49	4	175
2017	1	98	33	2	134
2018*	0	90	39	3	133

**** provisional**

Table 16.2: Plaice in Subarea 8 and Division 9a: Catches submitted to InterCatch (tonnes).

Catch category	Country	Gear	2014	2015	2016	2017	2018
Discards	France	Nets	-	10	3	4	2
		Other	-	2	0	0	0
		Trawl	-	4	0	1	1
	Spain	Nets	0	-	-	-	0
		Trawl	0	-	-	-	0
	Portugal	Trawl		0*	0*	0*	0
Discards Total			0	15	3	5	3
Landings	Belgium	Other	1	2	1	1	-
	France	Nets	42	46	48	42	41
		Other	38	21	12	24	6
		Trawl	82	74	62	33	44
	Portugal	Other	47	44	47	33	39
	Spain	Nets	4	3	3	1	2
		Other	1	1	1	0	0
		Trawl	1	1	1	1	1
Landings Total			217	193	174	135	133
Catch Total			217	208	177	140	136
Official Landings			220	193	173	134	133**

*** not in IC, submitted to AC**

**** official provisional statistic from Ices website http://data.ices.dk/rec12/downloadData.aspx**

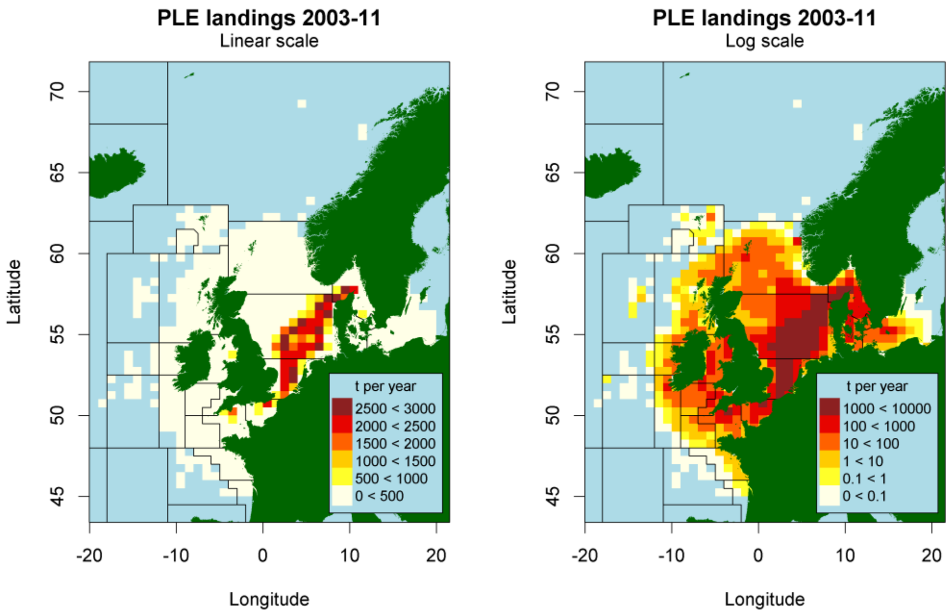

Figure 16.1: International landings of Plaice by statistical rectangle from 2003–2011.

17 Pollack in Subarea 8 and Division 9.a

Type of assessment

The Bay of Biscay and Atlantic Iberian Waters pollack stock is considered as data-limited stock and it is classified as category 5.2 stock (ICES, 2012). There is no assessment for pollack in this area.

Data revision

French landings for the period 2000-2014 were updated with the information provided by ROMELIGO Project. French discard estimates for the period 2003–2014, calculated by ROMELIGO Project, were included in the discards time-series.

17.1 General

17.1.1 Stock identity

See Stock Annex.

17.1.2 Fishery description

See Stock Annex.

17.1.3 Summary of ICES advice for 2018 and 2019 and management for 2018 and 2019

ICES advice for 2018 and 2019:

In 2017, ICES advised that when the precautionary approach is applied, commercial catches should be no more than 1131 tonnes in each of the years 2018 and 2019.

Management applicable for 2018 and 2019:

Pollack is managed under a TAC that was set at 1955 t for 2018 and at 1995 t for 2019. The TAC for pol.27.89a is set separately for ICES divisions 8abde, ICES division 8c, and subareas 9 and 10 (and Union waters of CECAF 34.1.1), and for 2019 were as follows:

Species:	Pollack *Pollachius pollachius*	Zone:	8a, 8b, 8d and 8e (POL/8ABDE.)
Spain	252		
France	1 230		
Union	1 482		
TAC	1 482		Precautionary TAC

Species:	Pollack *Pollachius pollachius*	Zone:	8c (POL/08C.)
Spain	208		
France	23		
Union	231		
TAC	231		Precautionary TAC

Species:	Pollack *Pollachius pollachius*	Zone:	9 and 10; Union waters of CECAF 34.1.1 (POL/9/3411)
Spain	273 (1)		
Portugal	9 (1) (2)		
Union	282 (1)		
TAC	282 (2)		Precautionary TAC

The reported landings of pol.27.89a in 2018 were 76% of the established TAC. The Minimum Landing Size for pollack is set at 30 cm in European Member States (Council Regulation (EU) 850/1998).

17.2 Fisheries data

17.2.1 Commercial landings

Pollack, *Pollachius pollachius,* is mainly exploited by France and Spain, with minor contribution to landings from UK and Portugal. In the last 10 years, France was responsible for 77% of the commercial landings of the stock and Spain for 18%. The commercial landing statistics are given in table 17.1. A more detailed description of the fisheries and biology of the species is provided in the Stock Annex. There is some mixing in Portuguese markets with whiting (*Merlangius merlangus*) due to use of common names. This resulted in most pollack landings being recorded as whiting from 2004 onwards. Sampling data since 2012 indicates that Portuguese landings of whiting and pollack from 9a consisted of 2% whiting and 98% pollack (*personal communication*). The updated estimates of landings are presented in Table 17.1.

The landings by gear submitted to the Working Group are given in Table 17.2. Note that these are not the landings figures used in the advice issued in 2015 and 2017 because there were many gaps in the data. A new series of French landings by metier from 2000 to 2014 is available from ROMELIGO Project (WD 05; ICES, 2018), and this data were used to update pollack landings for these years. Data from this Project have been used to complete the official information available for this stock.

Annual commercial landings have fluctuated between 1479 t and 2313 t since 2000, without a clear trend. Pollack landings increased from 1481 t in 2017 to 1512 t in 2018, which is an increase of 2%. The TAC for 2018 was 1995 t, which means that commercial landings have not exceeded the total allowable catches.

Recreational catches may be considerable and have not been quantified.

17.2.2 Commercial Discards

Discard estimates are available since 2003 for French fleets and for the last 4 years for all relevant fleets (Table 17.3). Discard information from 2003 to 2014 was compiled from data provided by ROMELIGO Project to the Working Group (*personal communication*). Most fleets did not report pollack in discards and, for Spanish netters, discards are considered negligible (less than 0.5% of catch). French netters discarded 3% and 2% of their catches in 2017and 2018, respectively which represented less than 2% of the commercial catches of the stock.

17.2.3 Commercial landing-effort data

A commercial abundance index for pollack is available for the French gillnet fleet in division 8a. The index includes information for fishing sequences performed with gillnets of mesh size > 90 mm and acting during the 2nd semester of the year (FR-GNS >90mm-8a-2s). This index was identified as a task of the ROMELIGO Project and it is described by Léauté *et al*. (2018) (WD 5 in WGBIE2018). The time-series of landings and effort have been provided to the Working Group this year (Table 17.4). The FR-GNS >90mm-8a-2s index is available since 2005 and it represents an average of 7.5% of the total landings of the stock. Landings of this fleet have fluctuated between 54 t and 178 t recorded in 2008 and 2014, respectively (Figure 17.2). Since 2014, there is a decreasing trend in landings. The effort unit is the fishing sequence, a combination of vessel, gear, statistical rectangle, and day. After an increasing period, between 2011 and 2016, effort of FR-GNS>90mm-8a-2s has decreased in the last two years. The LPUE showed a decreasing trend in the last 7 years, declining from 197 kg/Fs in 2011 to 112 kg/Fs in 2018.

17.3 Current assessment

In 2015, ICES advised that commercial landings should be no more than 1414 tonnes in each of the years 2016 and 2017. In 2017, ICES advised that commercial landings should be no more than 1131 tonnes in each of the years 2018 and 2019.

The landings statistics for pollack do not show any remarkable changes. The available scientific data for the stock are not sufficient to evaluate its abundance and exploitation status. Following the Draft of ICES Guidance for preparing single-stock advice (2019), as the Precautionary Approach buffer was applied in 2017, then it is not applied in 2019. The advice for 2020 and 2021 should be the latest ICES advised catch: 1131 t.

17.4 Management plans

No management plan is known for pol.27.89a.

17.5 References

ICES, 2012. Report of The Workshop to Finalize the ICES Data-limited Stock (DLS) Methodologies Documentation in an Operational Form for the 2013 Advice Season and to make Recommendations on Target Categories for Data-limited Stocks (WKLIFE2). 20–22 November 2012, Copenhagen, Denmark. ICES CM 2012/ACOM: 79, 46 pp.

ICES, 2018. Report of the Working Group for the Bay of Biscay and Iberian Waters Ecoregion (WGBIE2018). 3–10 May 2018, Copenhagen, Denmark. ICES CM 2018/ACOM: 12, 544 pp.

Léauté, J.-P., Caill-Milly, N., and M. Lissardy. 2018. ROMELIGO: Improvement of the fishery knowledge of striped red mullet, whiting and pollack of the Bay of Biscay. Pollack part. Working Document number 5 in the Working Group for the Bay of Biscay and Iberian Waters Ecoregion (WGBIE2018).

17.6 Tables and Figures

Table 17.1. Pollack in Subarea 8 and Division 9a: Commercial landings by country in tonnes as estimated by the Working Group. The ICES estimate is based on a correction of mixed species (whiting and pollack) landings records in the Portuguese landings from 9a. Shaded values come from ICES/FAO historical data base and ROMELIGO Project. No-shaded figures, from 2015 to 2018, were derived from the InterCatch data base.

	Bay of Biscay (Subarea 8)				Atlantic Iberian waters (Division 9a)				ICES
Year	Belgium	Spain	France	UK	Spain	Portugal	**Total**	**Unallocated**	**estimates**
1985	0	2304	2769	23	636	0	5732	0	5732
1986	0	437	2127	5	237	0	2806	0	2806
1987	0	584	2022	1	308	3	2918	0	2918
1988	3	476	1761	6	329	7	2582	0	2582
1989	13	214	1682	4	57	3	1973	0	1973
1990	14	194	1662	2	27	1	1900	0	1900
1991	1	221	1867	1	76	2	2168	0	2168
1992	2	154	1735	0	65	2	1958	0	1958
1993	3	135	1327	0	47	1	1513	0	1513
1994	3	157	1764	0	28	3	1955	0	1955
1995	6	153	1457	2	59	2	1679	0	1679
1996	8	137	1164	0	43	2	1354	0	1354
1997	2	152	1167	1	54	2	1378	0	1378
1998	1	152	956	0	55	1	1165	0	1165
1999	0	120	n/a	0	36	1	157	0	157
2000	0	121	1294	0	49	15	1479	0	1479
2001	0	346	1278	0	81	41	1746	0	1746
2002	0	170	1722	0	35	45	1972	0	1972
2003	0	142	1450	1	39	31	1663	0	1663
2004	0	211	1343	0	90	12	1656	70	1726
2005	0	306	1552	0	132	0	1990	-4	1986
2006	0	251	1596	171	102	0	2120	6	2126
2007	0	198	1375	62	103	5	1743	104	1847
2008	0	265	1732	64	128	31	2220	93	2313
2009	0	218	1371	41	68	3	1701	111	1812
2010	0	265	1170	44	91	2	1572	110	1682
2011	0	322	1475	27	104	2	1930	102	2032
2012	0	159	1131	2	139	2	1433	87	1520
2013	0	251	1346	8	110	3	1718	93	1811
2014	0	185	1612	19	93	1	1910	49	1959
2015	0	195	1244	37	78	18	1573	37	1610
2016	0	186	1292	25	111	28	1642	19	1661
2017	0	128	1219	0	95	38	1480	1	1481
2018	0	135	1220	0	124	33	1512	0	1512

Table 17.2. Pollack in Subarea 8 and Division 9a. Landings (tonnes) from France, Spain and Portugal by country and gear as submitted to the Working Group. Shaded values come from ICES/FAO historical data base and ROMELIGO Project. No-shaded figures, from 2015 to 2018, were derived from the InterCatch data base.

	France				Spain			Portugal	
Year	Nets	Trawl	Lines	Others	Lines	Nets	Others	Others	Trawl
2000	671	353	176	94	-	-	-	-	-
2001	794	271	133	80	31	53	169	-	-
2002	1151	321	170	79	26	28	134	-	-
2003	990	215	182	64	31	35	146	-	-
2004	679	298	292	73	47	36	222	16.5	0.1
2005	801	364	326	62	90	36	161	7.8	0.6
2006	882	395	245	74	48	29	243	6.7	0.3
2007	797	301	228	49	72	51	210	4.5	0.4
2008	1055	267	351	59	147	95	163	33.3	0
2009	829	185	328	30	101	76	97	2.4	0.5
2010	719	128	249	74	167	162	93	1.7	0.1
2011	850	180	357	88	207	199	20	1.2	0.3
2012	631	148	305	46	123	122	53	-	-
2013	756	210	327	52	-	-	-	-	-
2014	925	288	345	55	110	147	103	1	0
2015	766	178	258	42	145	114	14	18	0.2
2016	735	128	399	30	185	87	26	28	0
2017	596	100	486	37	123	91	9	38	0
2018	685	92	403	40	134	120	6	32.3	0.8

Table 17.3. Pollack in Subarea 8 and Division 9a. Discards estimates (tonnes) from France, Spain and Portugal by country and gear as submitted to the Working Group. Shaded values come from ROMELIGO Project. No-shaded figures, from 2015 to 2018, were derived from the InterCatch data base.

	France			Spain		Portugal
Year	Nets	Trawl	Lines	Lines	Nets	Trawl
2003	0	0	-	-	-	-
2004	0	0.2	-	-	-	-
2005	11	0	-	-	-	-
2006	1.4	13.9	-	-	-	-
2007	5.7	0	-	-	-	-
2008	35.5	0	0	-	-	-
2009	3.2	0	1.5	-	-	-
2010	9	0	0	-	-	-
2011	2.9	0	6.2	-	-	-
2012	13	0	1.2	-	-	-
2013	19.4	0.3	6.8	-	-	-
2014	63.6	0	1.1	-	-	-
2015	28.1	0	0	0	3.5	0
2016	83.1	5.4	4.3	0	0.4	0
2017	18.6	0	0	0	0	0
2018	16	9.3	3.2	0	0	0

Table 17.4. Pollack in Subarea 8 and Division 9a. Data for commercial index FR-GNS>90mm-8a-2s as submitted to the Working Group. Last column indicates the representativeness of the index related to the total annual stock landings.

Year	Landings (kg)	Effort (Fishing sequence)	LPUE (kg/Fs)	% Stock
2005	105638	918	115,1	5,3
2006	52672	794	66,3	2,5
2007	124141	961	129,2	6,7
2008	144019	1117	128,9	6,2
2009	112862	907	124,4	6,2
2010	92146	854	107,9	5,5
2011	157098	799	196,6	7,7
2012	163350	937	174,3	10,7
2013	161663	1033	156,5	8,9
2014	178039	1187	150,0	9,1
2015	167710	1166	143,8	10,4
2016	149680	1242	120,5	9,0
2017	136618	1118	122,2	9,2
2018	111191	995	111,7	7,4

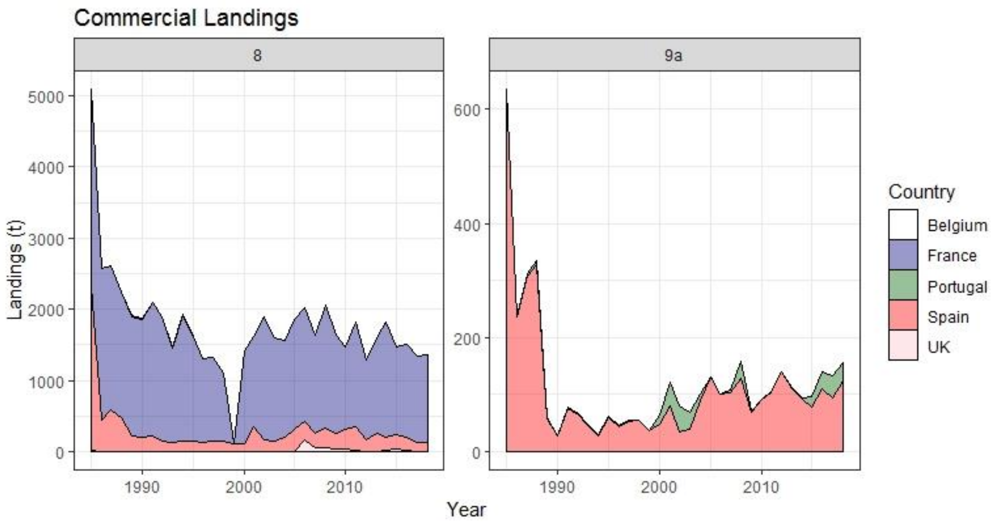

Figure 17.1. Pollack in Subarea 8 and Division 9a. Commercial landings by country in Subarea 8 and Division 9a. French data is missing for 1999.

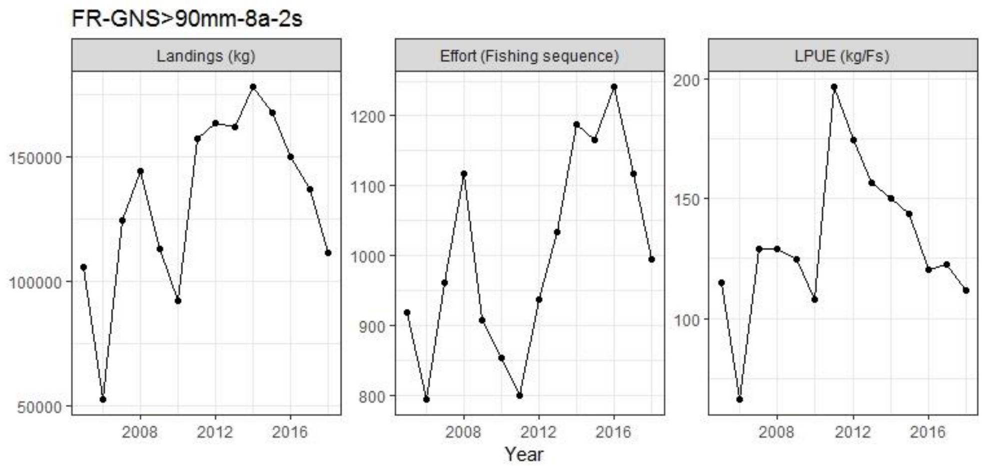

Figure 17.2. Pollack in Subarea 8 and Division 9a. Landings, effort and LPUE for commercial fleet FR-GNS>90mm-8a-2s.

18 Whiting in Subarea 8 and Division 9a

Type of assessment in 2019: LBI

Data revision in 2019: InterCatch data were compiled from 2016 to 2018 to compute discards

18.1 General

18.1.1 Summary of ICES advice for 2019

2017 ICES advice for 2019 catch advice for whiting in divisions 8 and 9a was elaborated following the precautionary approach.

ICES advises that when the precautionary approach is applied, wanted catches1 in each of the years 2018 and 2019 should be no more than 1613 tonnes. ICES cannot quantify the corresponding total catches.

The rational for catch option were the following:

The ICES framework for category 5 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock.

The precautionary buffer was applied in 2015 (for the 2016 advice) and will therefore not be applied this year. Discarding is known to be substantial but cannot be quantified.

ICES considers that the available information is not sufficient to provide a reliable discard estimate.

18.2 Data

18.2.1 Commercial catches and discards

Whiting (*Merlangius merlangus*) are caught in mixed demersal fisheries primarily by France and Spain (Table 19.1 and figure 19.1). There are concerns about the reliability of the French data from 2008-09, which appear to be incomplete. There is some mixing in Portuguese markets with pollack due to use of common names. This resulted in most pollack landings being recorded as whiting from 2004 onwards. Sampling data since 2012 indicates that Portuguese landings of whiting and pollack from 9.a consisted of 2% whiting and 98% Pollack; whiting landed by Portuguese vessels makes up an insignificant amount of the total whiting landings in this area.

18.2.1.1 Commercial catches and discards

InterCatch data from 2016-2018 were processed in 2019 to compute discards estimates

The standard procedure to estimate discards is to use the discard data provided for the different combinations of countries/gears/seasons/areas ("strata"), and to raise the available discard data to the total landings for the strata with limited available data. As shown in table 19.2.1, landings with associated data (same strata) represent respectively 70, 72 and 88% for 2018, 2017 and 2016. This discards rate are very variable among season/area and gears (figure 19.2.1.1). Discards data were provided for areas 27.8.a and 27.8.b but not for area 27.8.c and 27.9.a but very few whiting landings are recorded in 27.8.c and 27.9.a.

Despite the high discard rates variability observed the relatively high level of coverage for discards allowed discard raising.
The strata with and without discards associated to the landings are displayed in figures 19.2.1.2-19.2.1.4.

Raised and total discards between 2016 and 2018 are presented in table 19.2.2.

18.2.1.2 Length structure of commercial catches

For landings, respectively 46, 44 and 63% of the landings (in volume) had a length structure associated in 2018, 2017 and 2016.

For discards, the percentage of the total discards (after raising) with a length distribution provided are respectively 44, 43 and 60% in 2018, 2017 and 2016 see tables 19.2.3-5 for details and figures 19.2.1.5–19.2.1.10

Length distribution of landings and discards before and after raising are show in figures 19.2.11-3. Final distributions (pink dots) are similar to the sampled (provided) distribution, showing the limited impact of the raising procedures on length compositions.

The landings distributions of the landings are truncated below 27cm due to the Minimum Conservation Reference Size set at 27 cm in this area.

18.2.2 Survey data

Whiting are present in the French EVHOE-WIBTS-Q4 survey from the Bay of Biscay. The ICES WGBIE 2017 working group investigated if this survey can provide an index of recruitment and/or biomass. The survey regularly catches whiting on inshore stations but the catch rates are highly variable, resulting in very wide confidence limits. The recruitment and biomass indices are given in Figure 19.2.2.1 for information only. WGBIE does not propose to use these as a basis for the advice.

A Commercial abundance index is available from the Basque pair trawl fleet in 8.abd (Figure 19.2.2.2; Very High Vertical Opening gear, VHVO). Traditionally, this fleet obtains the most important whiting Basque catches and its fishing effort can be quantified with accuracy along all the period. However it has to be noted that the whiting is not the main target for this metier - focused at present on hake. The VHVO index has not been updated since WGHMM 2012.

This species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula (Figure 19.2.2.3). It is not clear whether this is a separate stock from a biological point of view.

18.2.3 Length based indicators

Whiting length samples (sex combined) from commercial catches were provided in InterCatch format for the years 2016-2018. Length structures of the catches were estimated from these samples and were used for the analyses of MSY proxies applying the Length Based Indicator method (LBI; ICES 2017). The length distributions were binned to 40mm length classes (figure 19.2.3.1). The method also requires growth parameters, which were taken from fishbase (Table 19.2.3.1).

The results of the LBI method showed that most of the indicators are above the reference points (Table 19.2.3.2. and figures 19.2.3.2-4). From these results it was concluded that whiting is currently exploited below F_{MSY} as $L_{mean}/L_{F=M}$ is above 1 for 2016, 2017 and 2018. Only LC/L_{mat} ratio in 2017 is below the reference point.

18.3 Issues List

- No discard information provided for the areas 8c and 9a
- Very little information is available about stock distribution
- Surveys should be investigated further to check for data availability

18.4 Tables and Figures

Table 19.1: Whiting in Subarea 8 and Division 9a: official landings in tonnes (*2015/16 provisional). The ICES estimate is based on a correction of mixed species (whiting and pollack) landings records in the Portuguese landings from 9a.

Year	Belgium	France	Portugal	Spain	Total	Unalloc	ICES est
1994		3496	15	136	3647	0	3647
1995		2645	2	1	2648	0	2648
1996		1544	4	13	1561	0	1561
1997		1895	3	47	1945	0	1945
1998		1750	3	105	1858	0	1858
1999			1	211	212	0	212
2000	2	1106	2	338	1448	0	1448
2001	3	1989	1	288	2281	0	2281
2002	3	1970	1	230	2204	0	2204
2003	1	2275	4	171	2451	0	2451
2004		1965	77	249	2291	-70	2221
2005	3	1662	2	416	2083	-2	2081
2006	2	1420	7	433	1862	-6	1856
2007	4	1617	107	296	2024	-104	1920
2008	1	772	98	187	1058	-93	965
2009	2	1303	114	54	1473	-111	1362
2010	3	2234	114	101	2452	-110	2342
2011	1	2029	105	108	2243	-102	2141
2012	3	1791	90	110	1994	-87	1907
2013	1	1943	95	55	2094	-93	2001
2014	1	1579	65	55	1700	-49	1651
2015*	2	2138	38	56	2234	-35	2199
2016	1	2441	20	40	2502	23	2525
2017*	0	1 887	17	20	1 925		1 925
2018*	2	1 523	14	26	1 565		1 565

*** preliminary**

Table 19.2.1 Whiting landings with associated discards (same strata) submitted to InterCatch (percentages).

Year	Percentage of landings with associated discards (same combinations of countries/gears/seasons/areas
2016	88%
2017	72%
2018	70%

Table 19.2.2 Whiting landings and discards after raising procedures (in tonnes).

Year	Landings (Imported)	Discards (Imported)	Discards (raised)	Total Discards	Overall DR
2016	2525	828.4	98.38	926.78	0.268
2017	1925	617.6	320.2	937.8	0.328
2018	1565	376	279.5	655.5	0.295

Table 19.2.3 Whiting, Summary of the structures provided in 2018 (Imported_Data refer to data imported to IC, Raised_Discards refers to discard raised based on observed data for other stratas, Sampled_Distribution refer to landings or discards with length structures provided, Estimated_Distribution refer to length distribution estimated from the provided stratas).

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Estimated_Distribution	846.2	54
Landings	Imported_Data	Sampled_Distribution	718.6	46
Discards	Imported_Data	Sampled_Distribution	290.5	44
Discards	Raised_Discards	Estimated_Distribution	279.5	43
Discards	Imported_Data	Estimated_Distribution	85.51	13

Table 19.2.3 Whiting, Summary of the structures provided in 2017 (Imported_Data refer to data imported to IC, Raised_Discards refers to discard raised based on observed data for other stratas, Sampled_Distribution refer to landings or discards with length structures provided, Estimated_Distribution refer to length distribution estimated from the provided stratas).

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Estimated_Distribution	1080	56
Landings	Imported_Data	Sampled_Distribution	844.4	44
Discards	Imported_Data	Sampled_Distribution	404.7	43
Discards	Raised_Discards	Estimated_Distribution	320.2	34
Discards	Imported_Data	Estimated_Distribution	212.9	23

Table 19.2.3 Whiting, Summary of the structures provided in 2016 (Imported_Data refer to data imported to IC, Raised_Discards refers to discard raised based on observed data for other stratas, Sampled_Distribution refer to landings or discards with length structures provided, Estimated_Distribution refer to length distribution estimated from the provided stratas).

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	1585	63
Landings	Imported_Data	Estimated_Distribution	939.9	37
Discards	Imported_Data	Sampled_Distribution	553.1	60
Discards	Imported_Data	Estimated_Distribution	275.2	30
Discards	Raised_Discards	Estimated_Distribution	98.38	11

Table 19.2.3.1. Whiting in Subarea 8 and Division 9.a. Parameters used as input for the LBI method.

Table 1: Table continues below

Data Type	Value/Year
Length at maturit	261 261 261
von Bertalanffy growth parameter	443 443 443
Catch at length by year	2014 2018
Length-weight relationship parameters for landings and discards	2014 2018

Source
https://www.fishbase.in/Reproduction/MaturityList.php?ID=29
https://www.fishbase.in/Reproduction/MaturityList.php?ID=29
Length data from IC
Mean weight at length from IC

Table 19.2.3.2. Whiting in Subarea 8 and Division 9.a. Results from LBI method.

Year	Lc_Lmat	L25_Lmat	Lmax5_Linf	Pmega	Lmean_Lopt	Lmean_LFeM
2016	1	**1.07**	**1.18**	0.48	**1.18**	**1.14**
2017	0.84	**1.03**	**1.17**	0.49	**1.13**	**1.21**
2018	**1.15**	**1.15**	**1.11**	0.53	**1.2**	**1.05**

Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/Lf=m
>1	>1	>0.8	>30%	~1 (>0.9)	>=1

Table 19.2 Whiting in Subarea 8 and Division 9a: landings submitted to InterCatch (tonnes).

Catch cat	Country	Gear	2014	2015	2016	2017	2018
Landings	France	Lines	0*	539	807	675	468
		Nets	113*	234	419	281	284
		Other	561*	412	491	182	248
		Trawl	465*	955	736	748	521
	Portugal	Other	0	31**	0	15	13
		Trawl	0	2**	0	1	2
	Spain	Other	1	0	1	1	1
		Trawl;	53	55	71	20	26
	Other	Other	1	2	1	2	2
	Total	land	1194	2231**	2525	1925	1565
ICES best estimate of the landings			1651	2199	2525	1925	1565
Discards	Total	dis	-	1060	828	618	376

*** probably incomplete (official landings: 1579)**

**** no correction for whiting/pollack species mis-identification**

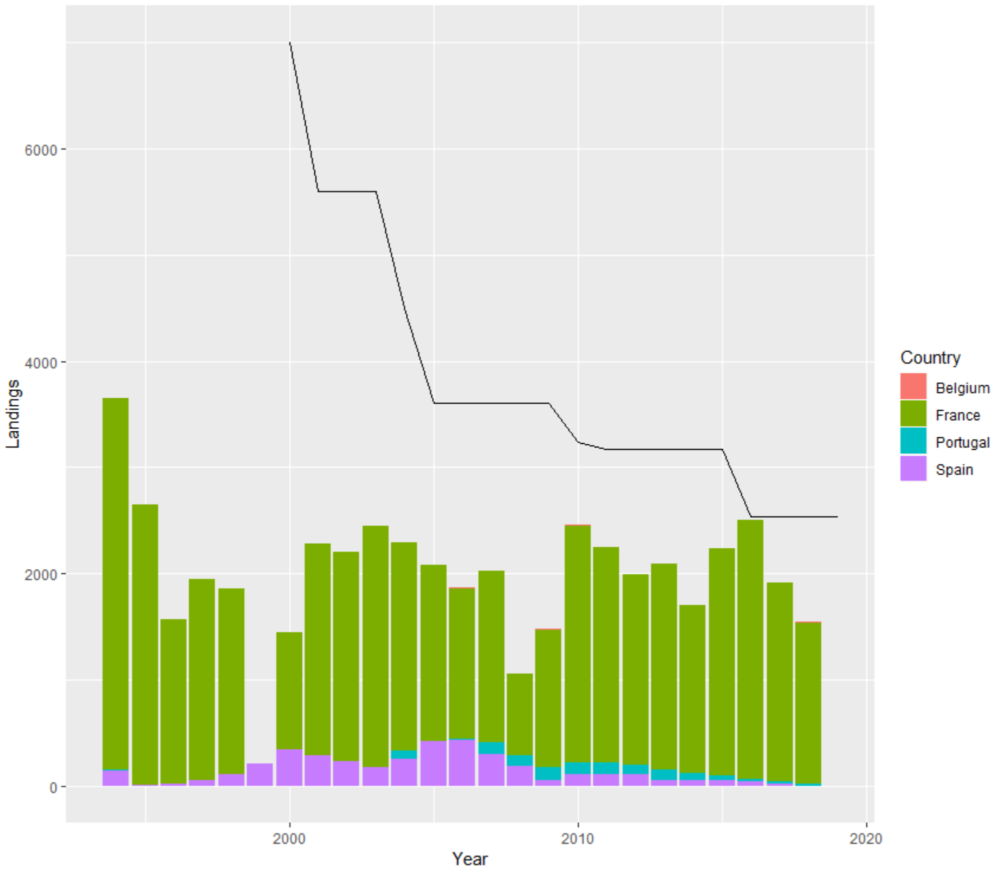

Figure 19.1: Landings by country and TAC (black line)

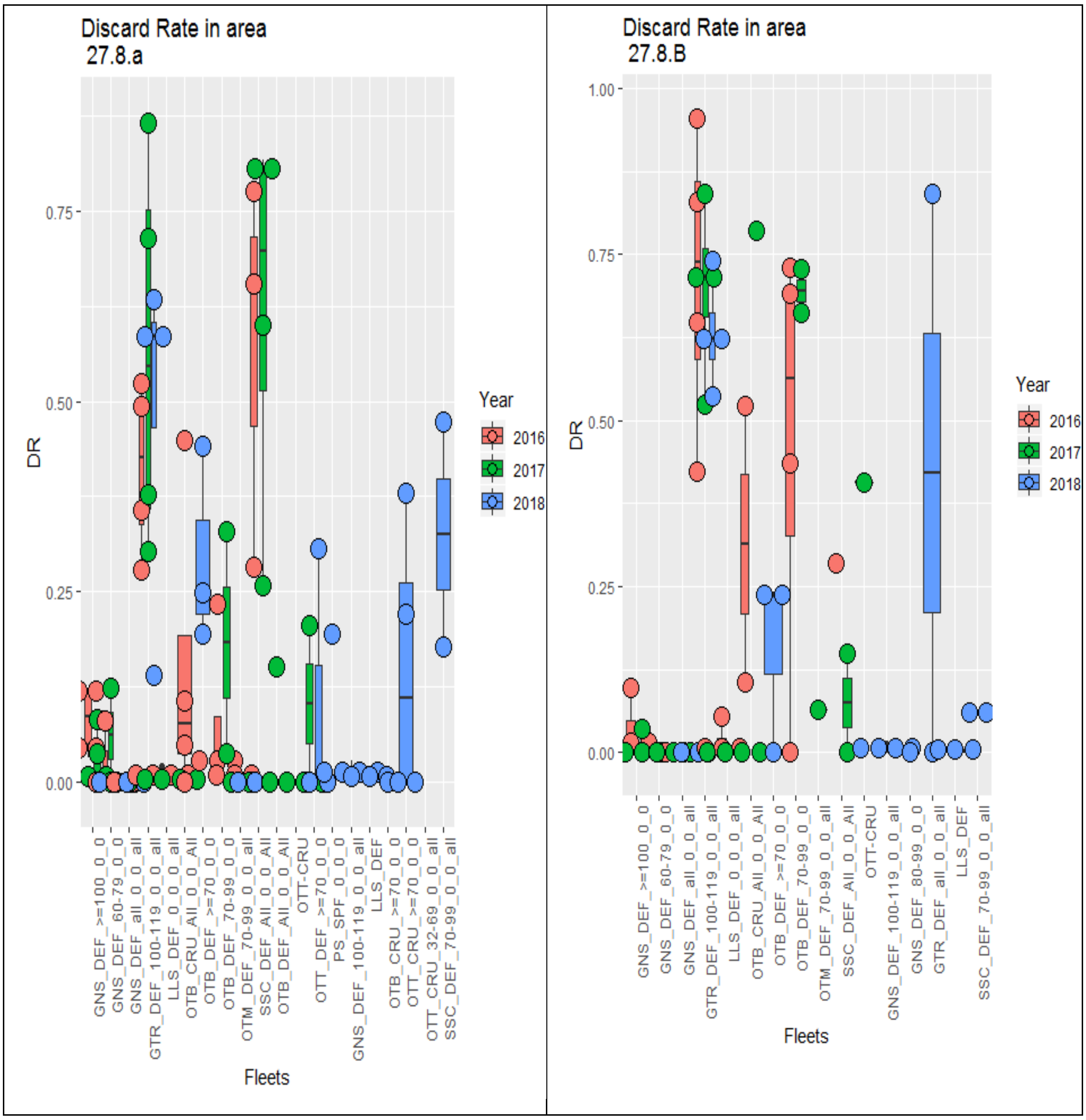

Figure 29.2.1.1: Provided discards rates by metier from InterCatch for area 27.8.a (left) and area 27.8.b (right). Points are representing quarters. No discards were provided for areas 27.8.c and 27.9.a

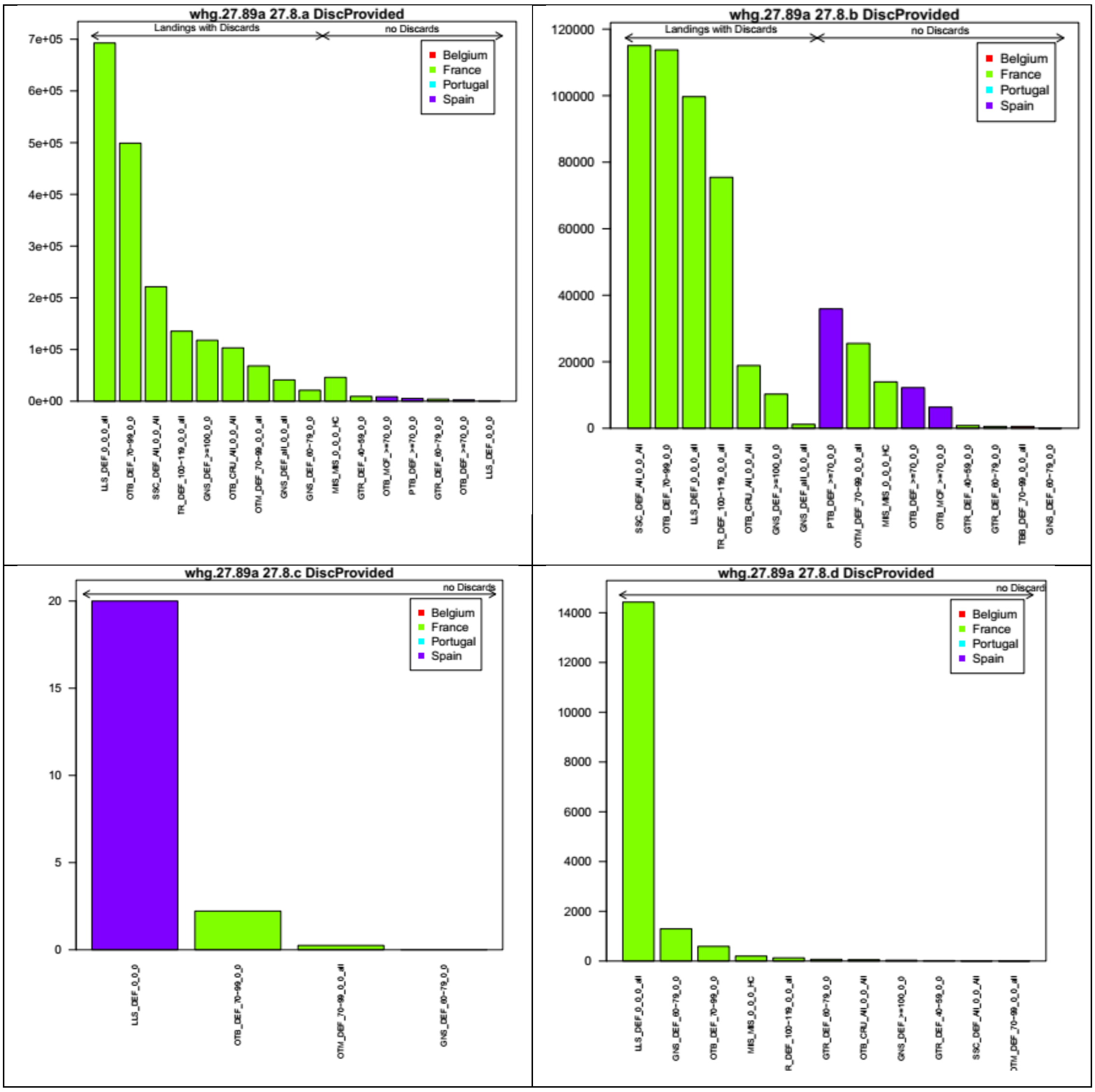

Figure 39.2.1.2: Strata with or without discards associated by country and area for 2016 (no landings provided in 27.9.a) (landings are in kg)

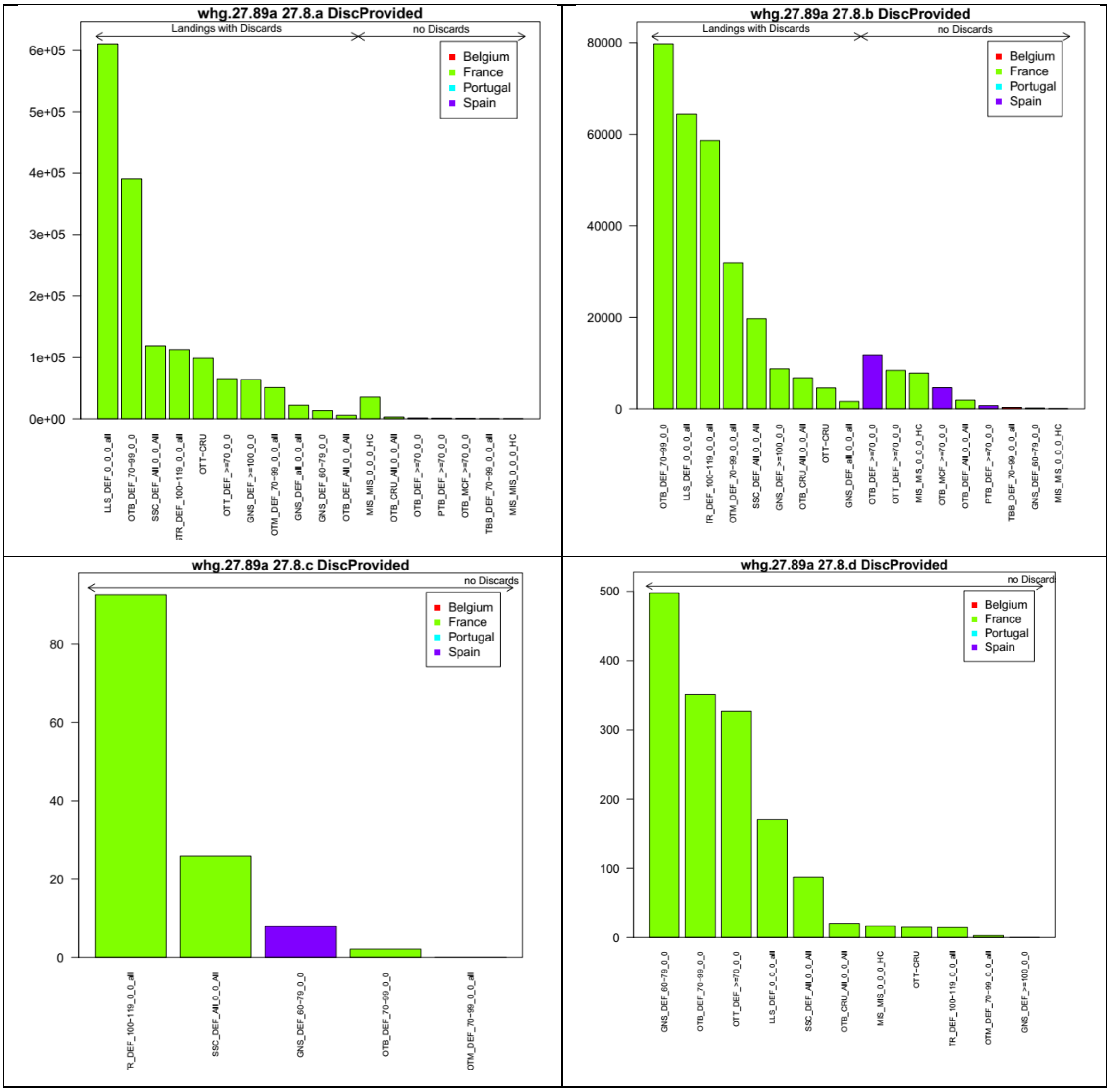

Figure 49.2.1.3: Strata with or without discards associated by country and area for 2017 (no landings provided in 27.9.a) (landings are in kg)

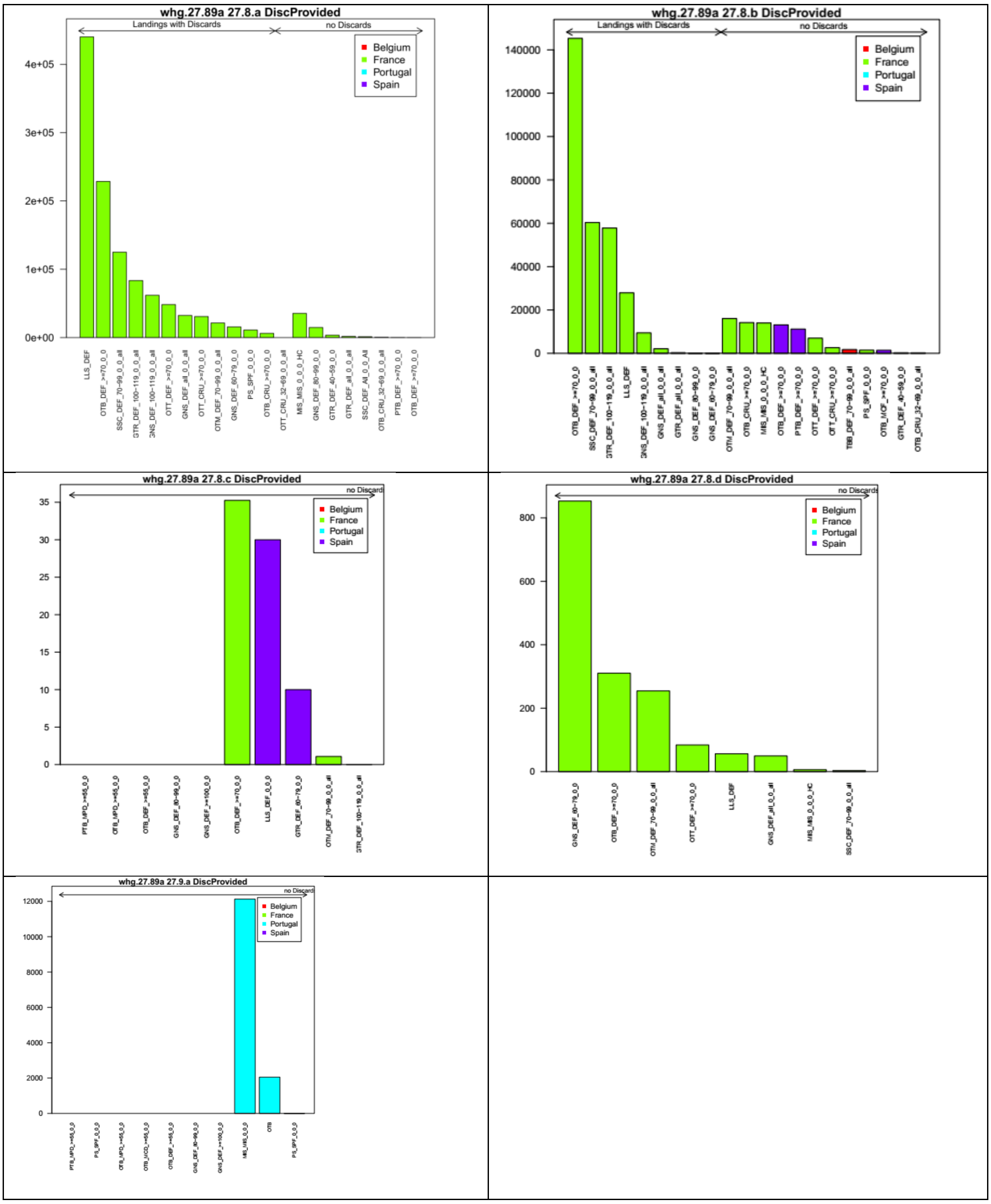

Figure 59.2.1.4: Strata with or without discards associated by country and area for 2018 (landings are in kg)

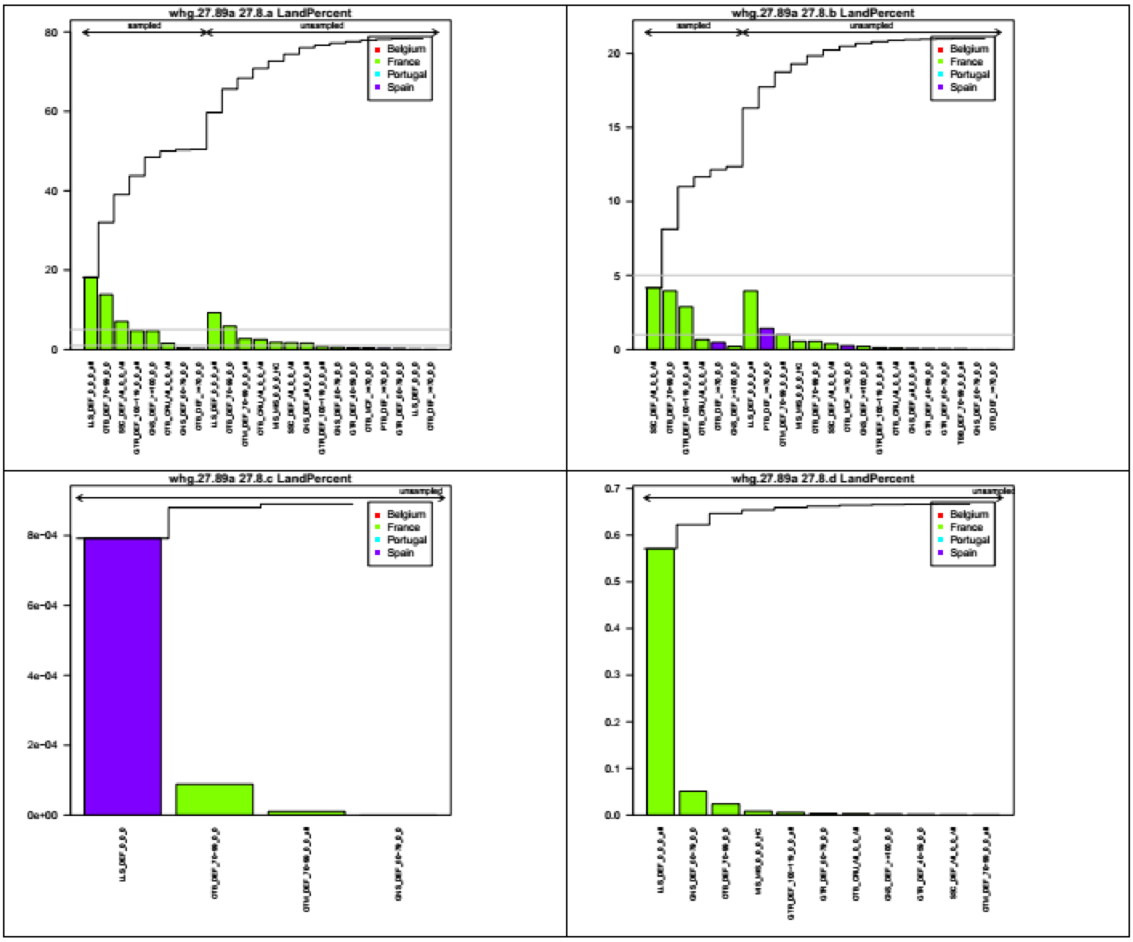

Figure 69.2.1.5: Strata with or without length structure associated by country and area for 2016 for the landing fraction

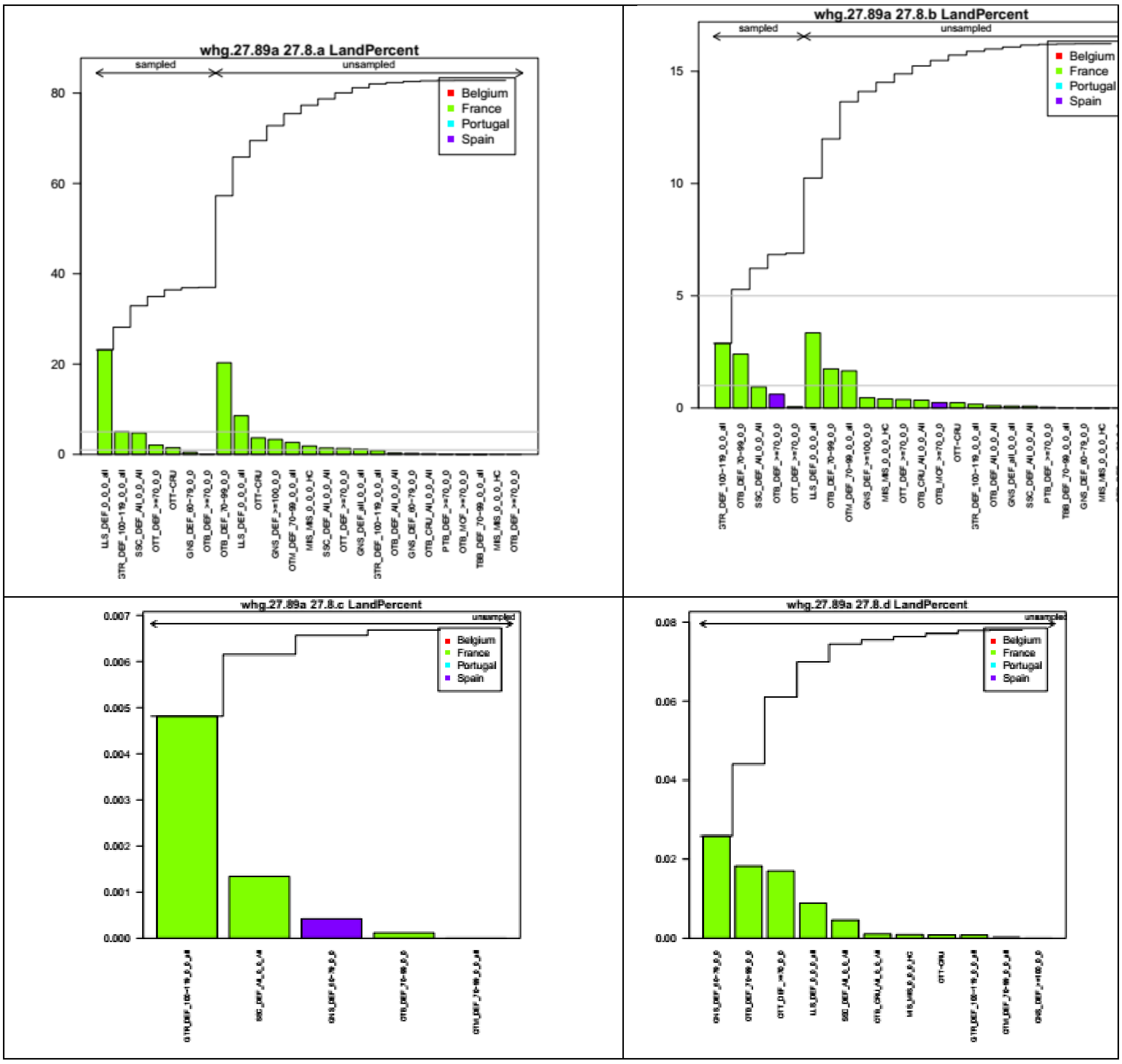

Figure 79.2.1.6: Strata with or without length structure associated by country and area for 2017 for the landing fraction

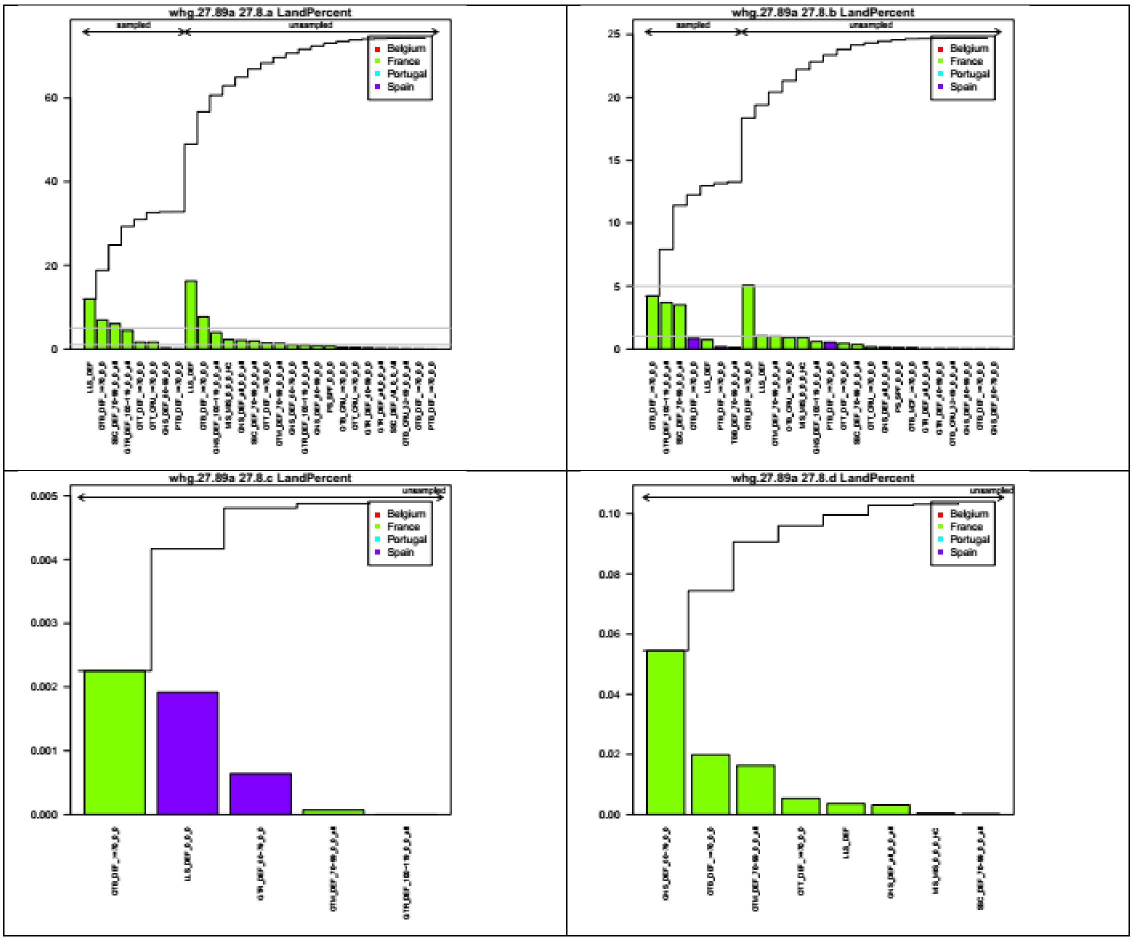

Figure 89.2.1.7: Strata with or without length structure associated by country and area for 2018 for the landing fraction

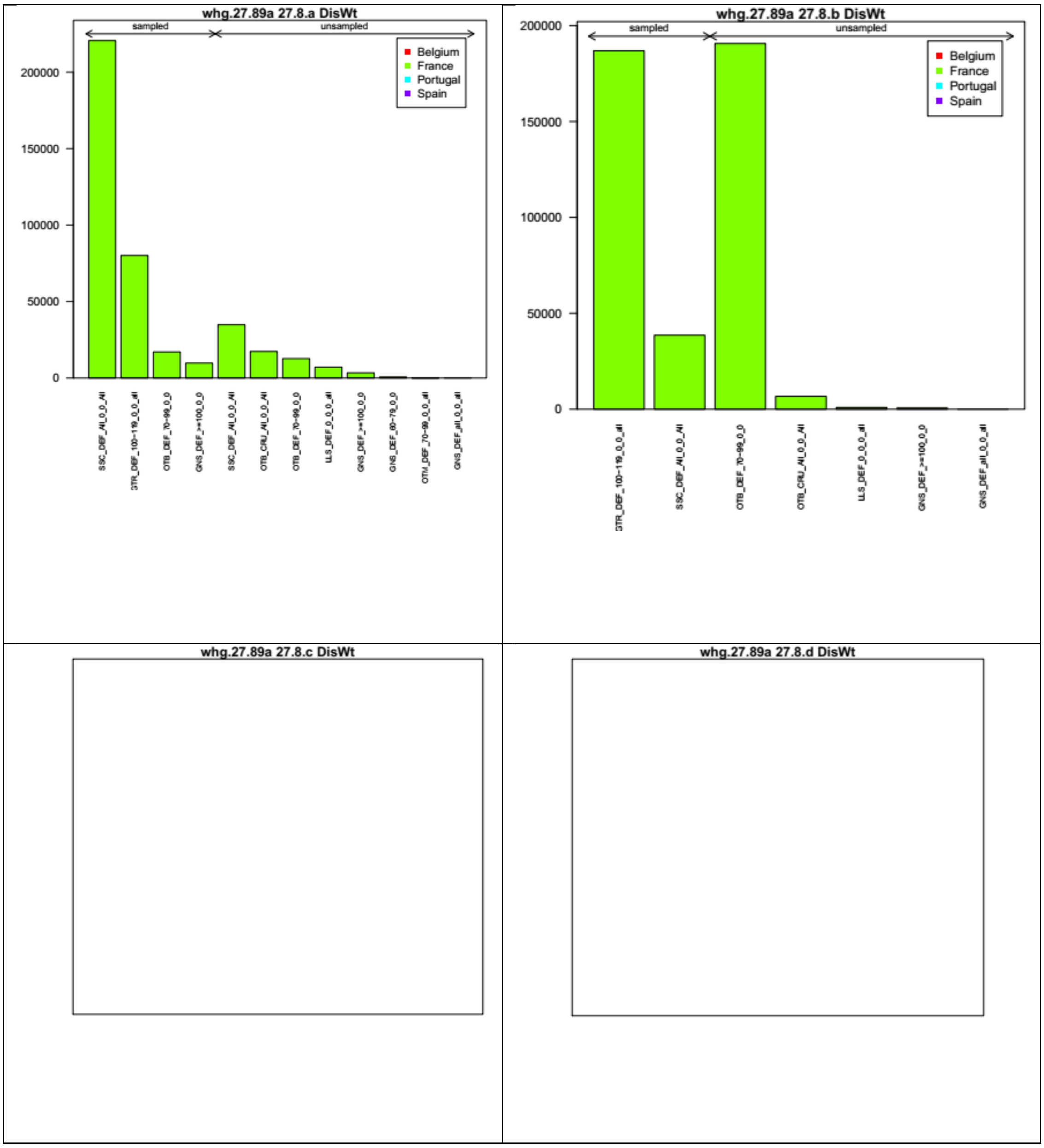

Figure 99.2.1.8: Strata with or without length structure associated by country and area for 2016 for the discard fraction

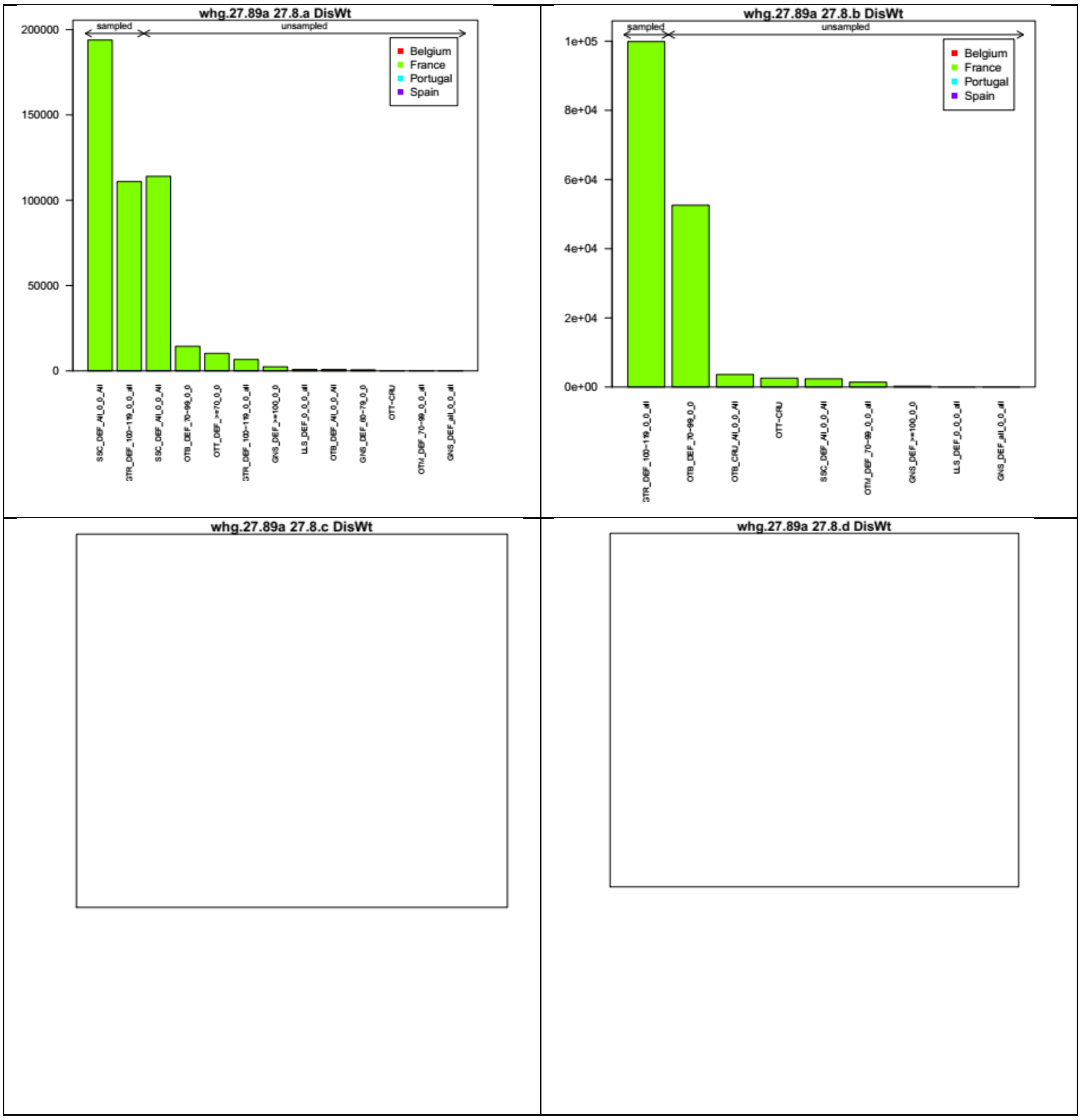

Figure 109.2.1.9: Strata with or without length structure associated by country and area for 2017 for the discard fraction

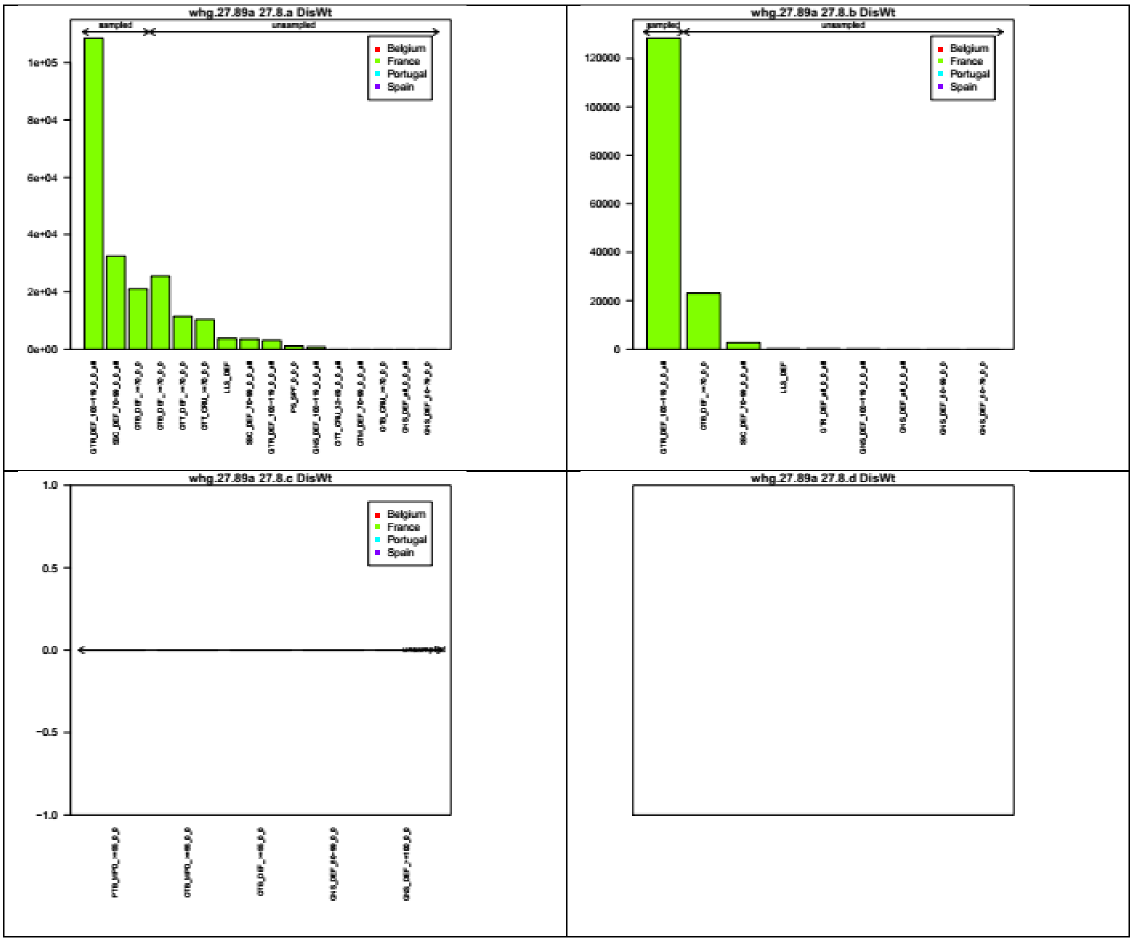

Figure 119.2.1.10: Strata with or without length structure associated by country and area for 2018 for the discard fraction

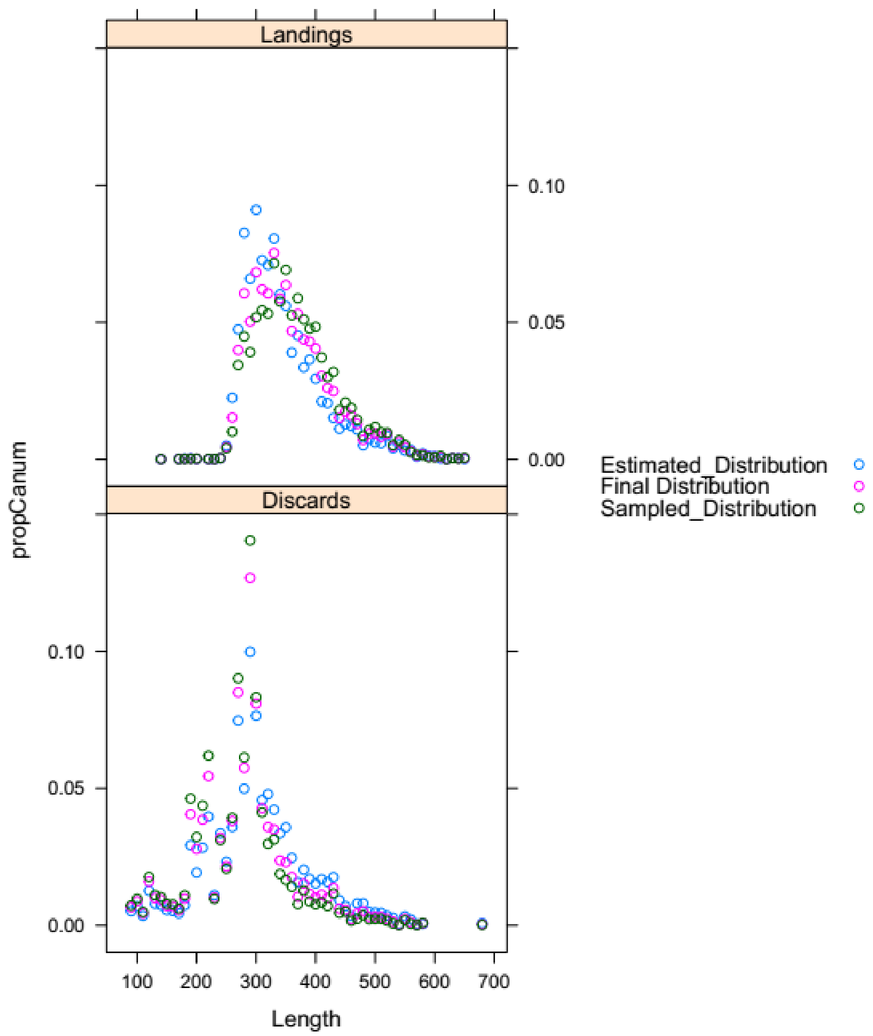

Figure 129.2.1.11: Length distribution of landings (top) and discards for 2016

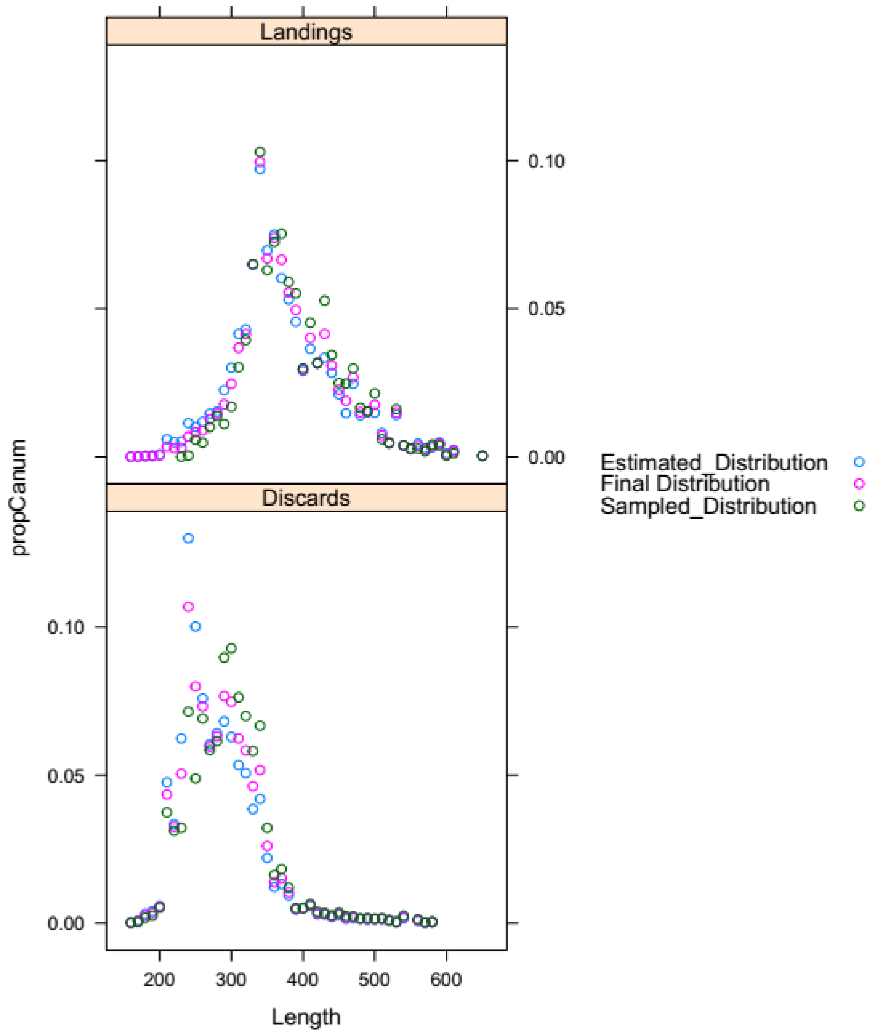

Figure 139.2.1.11: Length distribution of landings (top) and discards for 2017

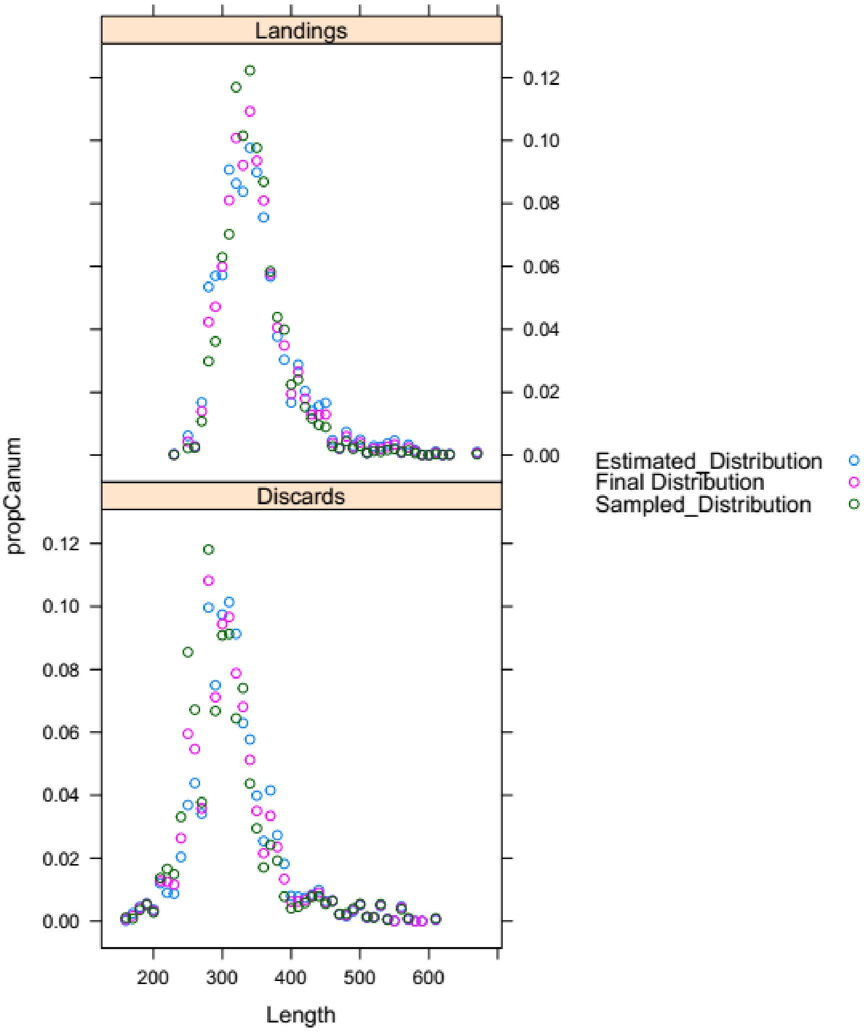

Figure 149.2.1.11: Length distribution of landings (top) and discards for 2018

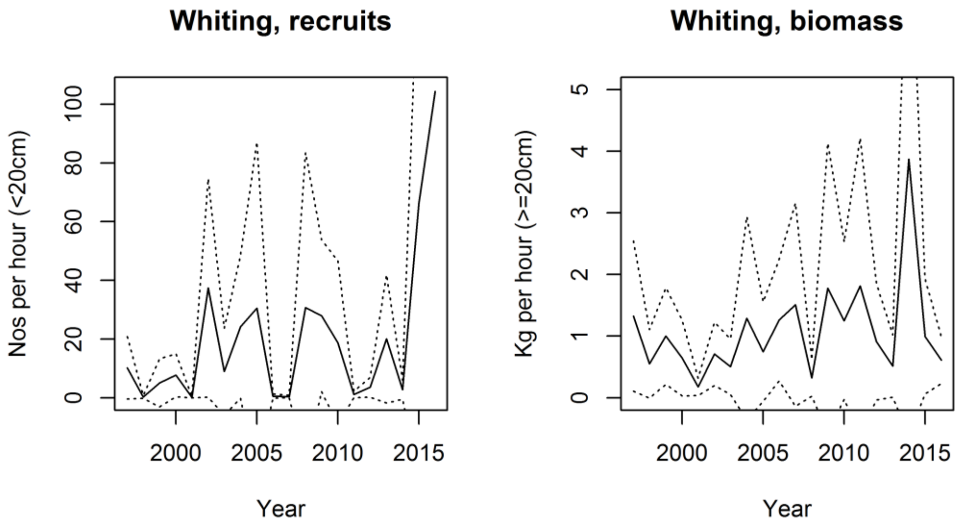

Figure 19.2.2.1. EVHOE-WIBTS-Q4 survey indices of recruitment (left) and biomass (right).

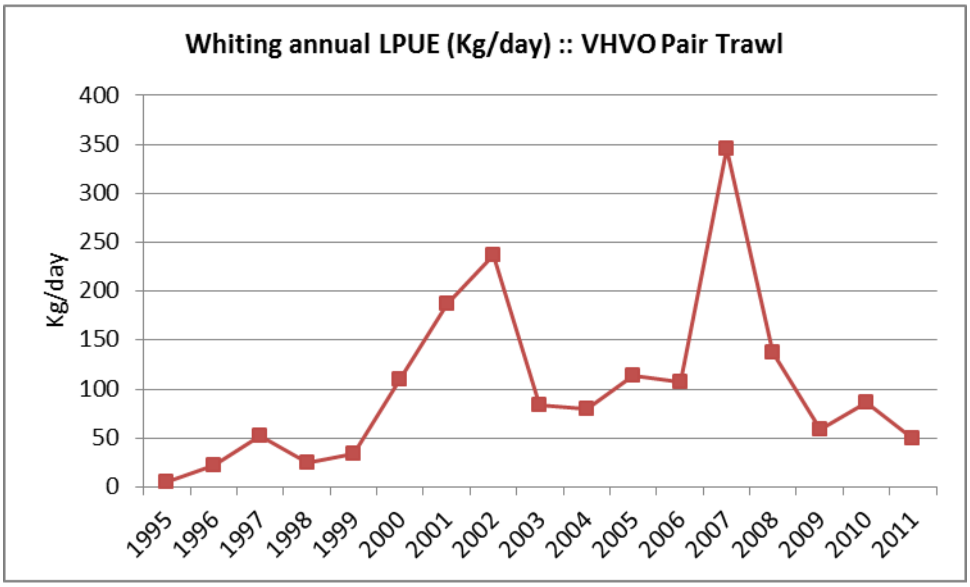

Figure 19.2.2.2 Whiting landings per unit effort (LPUEs in kg/day), by year, for Basque pair bottom trawl fleet fishing in Divisions 8.a,b,d, in the period 1995–2011.

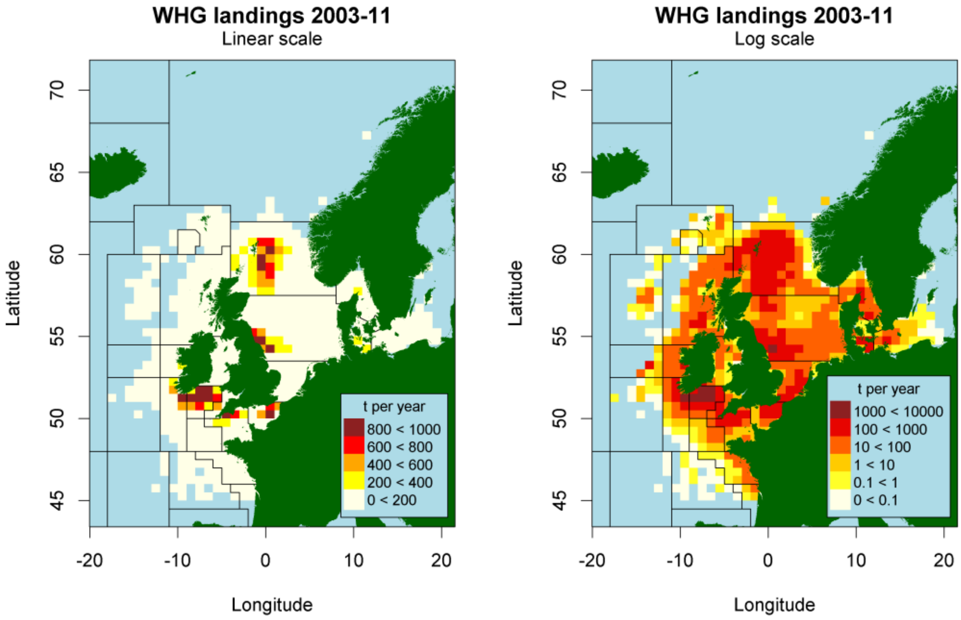

Figure 19.2.2.3: International landings of Whiting by statistical rectangle from 2003–2011

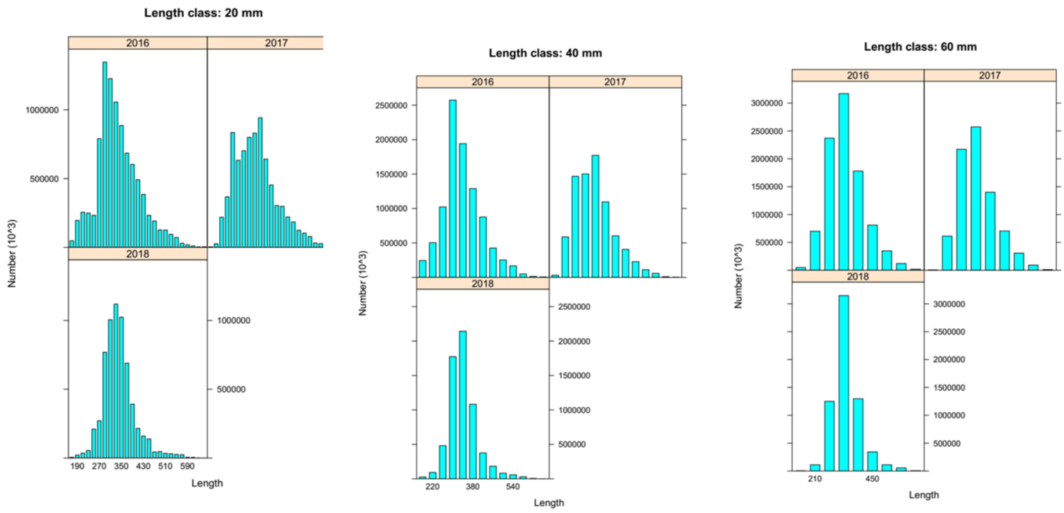

Figure 19.2.3.1: Length composition of the catches binned at 20, 40 and 60 mm

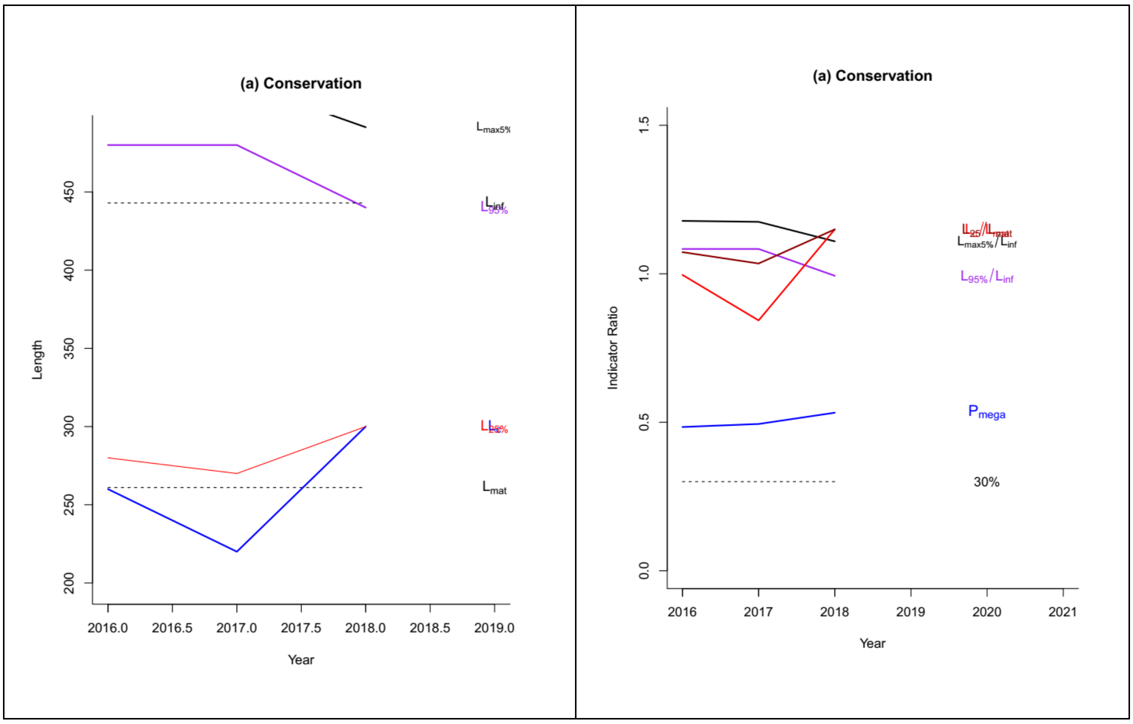

Figure 19.2.3.2: results from LBI analyses, conservation

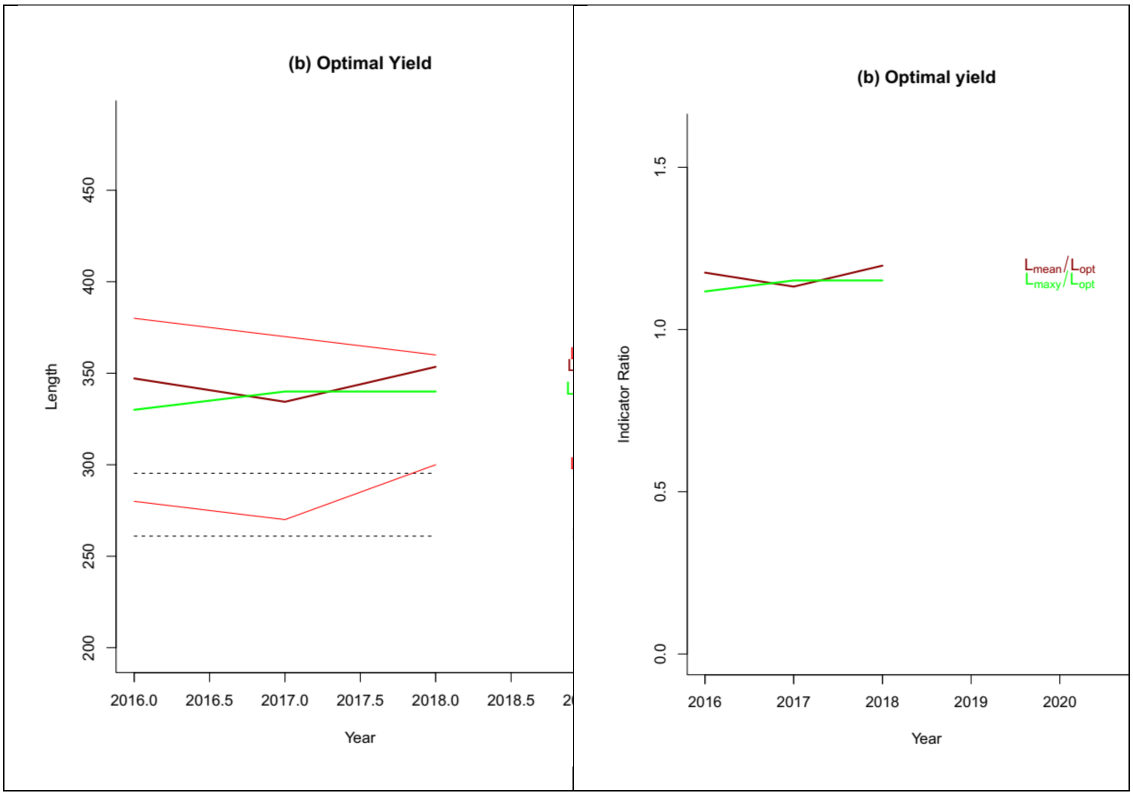

Figure 19.2.3.3: results from LBI analyses, Optimal Yield

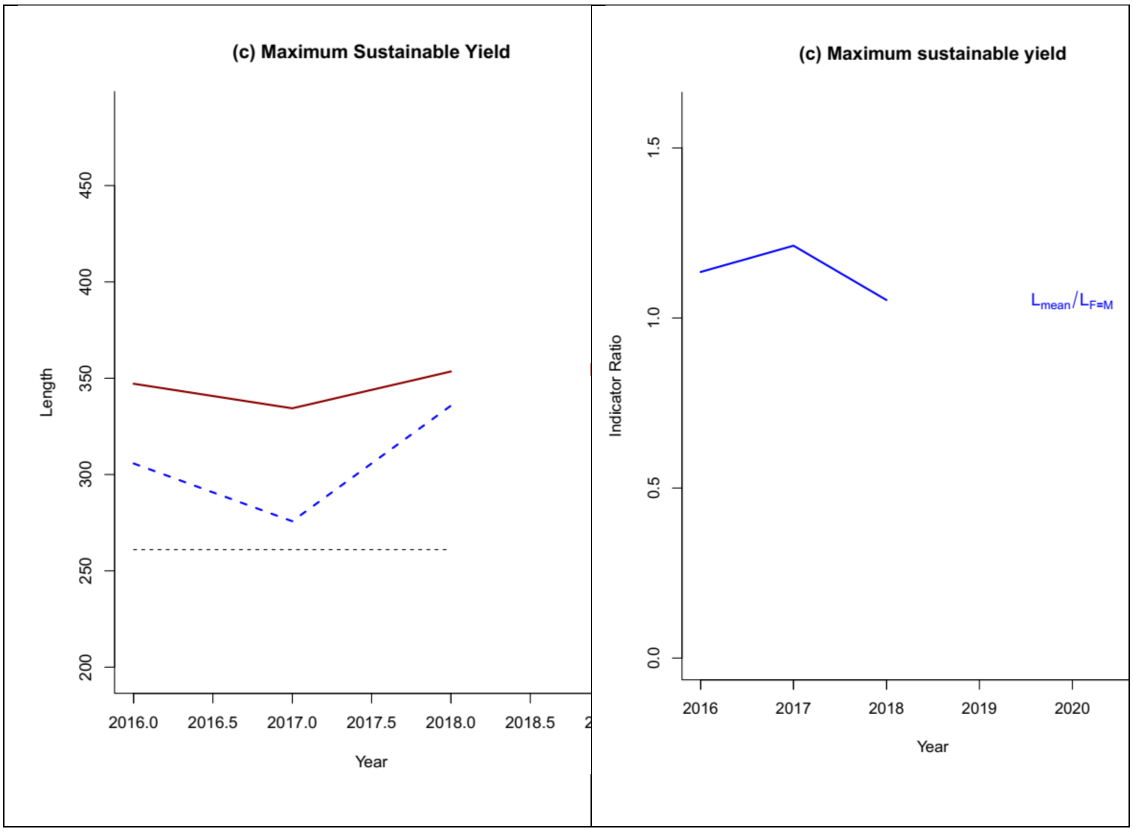

Figure 19.2.3.4: results from LBI analyses, Maximum Yield

18.5 WGBIE – Whiting in 8.9a – LBI reference points Review

Reviewed by Cassidy Peterson

General Comments

1. **Assessment method(s)**: Length Based Indicators (LBI)
2. **Evaluating Uncertainties**
   - Natural mortality and implications on LBI proxies (e.g., Lopt M/K = 1.5? LF=M, FMSY = M?)
   - Fishbase: estimated M/K = 0.35/0.29 = 1.2; M=0.34
   - Misidentification in landings—though specific to Portuguese landings, which comprise an insignificant component of landings. Therefore, this concern is negligible
   - Unreliable/incomplete landings data from France between 2008-2009; not analyzed in the current assessment
   - Missing discard information for areas 27.8.c & 27.9.a; though few landings recorded from these areas
   - Note uncertainties regarding life history parameters; taken from fishbase, where estimates of length at median maturity doesn't appear to be taken from the same locality. Thus, consider the possibility of regional/latitudinal variability in length parameters.
     - "This species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula. It is not clear whether this is a separate stock from a biological point of view."
     - Linf (443mmTL) estimates vary widely on fishbase (291/351mmTL – 947mm TL)
     - Lmat (261mmTL) estimates range on fishbase from 202mm TL – 304mmTL (284mm TL)
3. **Consistency:**
   - The stock has been assessed previously without consideration of discards.
4. **Proxy reference points & stock status:**
   - Method tried: Length Based Indicator (LBI)
   - Proxy reference points:
   - LBI: Lc/Lmat; L25%/Lmat; Lmax 5% / Linf; ; Pmega; Lmean / Lopt ; Lmean / LF=M
   - EG's conclusions: Overfished/ Overfishing occurring?
   - The EG concludes that based on LBI, overfishing is not occurring
   - Reviewer's conclusions: methods and stock status
   - Agree that overfishing is not occurring based on the available information. Best available information was utilized to assess this stock.
5. **Comments & Suggestions:**
   - Consider uncertainty in life history parameters. Linf and Lmat were taken from fishbase, which contains multiple different estimates of Linf and Lmat. Consider the effect that a different estimate of Linf and Lmat would have on estimated stock status.
     - L_{inf} (assumed 443mmTL in the current assessment) estimates vary between 291mmTL – 947mm TL on fishbase
     - L_{mat} (assumed 261mmTL in the current assessment) estimates range from 202mm TL – 304mmTL on fishbase

- Life history parameters taken from fishbase doesn't appear to be taken from the same locality. Thus, consider the possibility of regional/latitudinal variability in length parameters. As quoted from the assessment: "This species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula. It is not clear whether this is a separate stock from a biological point of view." Further, the presence of stock structure could lead to regional differences in life history parameters.
- Note that fishbase estimates M/K=1.2, not M/K=1.5 as assumed under LBI framework (see appendix of Jardim *et al.*2015 for further details).
- Though a recruitment survey is available, it was deemed unreliable for management advice. Recruitment appears to be increasing since 2014 (with very high uncertainty). Large estimated recruitment is suggestive that current harvest limits may continue to be precautionary with respect to conservation in the future.
- High discarding rate may justify investigation into (area and gear-specific) post-release mortality in the future. Consider the variable effects of discarding under post-release M = 1 versus post-release M = 0 scenarios.
- Lc is below Lmat in 2017. Based on information provided, it appears that including discards in the current LBI analysis would result in a decrease in estimated Lc. If it is reasonable to assume that post-release mortality is less than 1, then one year of Lc/Lmat<1 is not concerning.
- Reference points for all years (excepting Lc in 2017), based on the current available information, are indicative of a stock that is not experiencing overfishing.

Annex 1: List of participants

Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE)

1–9 May 2019

Name	Institute	Country of Institute	Email
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Annex 2: Resolutions

2019 Terms of Reference

WGBIE– Working Group for the Bay of Biscay and Iberian waters Ecoregion
2018/2/ACOM12 The **Working Group for the Bay of Biscay and Iberian waters Ecoregion** (WGBIE), chaired by Ching Villanueva*, France and Lisa Readdy, UK, will meet in Lisbon, Portugal, 2–9 May 2019 to:

a) Address generic ToRs for Regional and Species Working Groups;
b) Review and evaluate the potential for assessing FU29 and FU30 as one stock;
c) Review and assess the progress on the benchmark preparation of hake stocks;

The assessments will be carried out on the basis of the stock annex. The assessments must be available for audit on the first day of the meeting. Material and data relevant for the meeting must be available to the group on the dates specified in the 2019 ICES data call.

WGBIE will report by 23 May 2019 for the attention of ACOM

Fish Stock	Stock Name	Stock Coordinator	Assess. Coord. 1	Assess. Coord. 2	Advice
mon.27.78abd	Anglerfish (*Lophius piscatorius*) in Subarea 7 and Divisions 8.a,b.d	Ireland	Spain	none	Update
ank.27.78abd	Anglerfish (*L. budegassa*) in Divisions 7.b-k and 8.a,b,d	Spain	Ireland	none	Update
ank.27.8c9a	Anglerfish (*L. budegassa*) in Divisions 8.c and 9.a	Portugal	Portugal	Spain	Update
mon.27,8c9a	Anglerfish (*L. piscatorius*) in Divisions 8.c and 9.a	Spain	Spain	Portugal	Update
bss.27.8ab	Seabass in Divisions 8.a,b	France	France	none	Update
bss.27.8c9a	Seabass in Divisions 8.c and 9.a	France	France	none	Update
hke.27.3a46-8abd	Hake in Division 3.a, Subareas 4, 6 and 7 and Divisions 8.a,b,d (Northern stock);	Spain	Spain	none	Update
hke.27.8c9a	Hake in Division 8.c and 9.a (Southern stock);	Spain	Spain	Portugal	Update
ldb.27.8c9a	Megrim (*Lepidorhombus boscii*) in Divisions 8.c and 9.a	Spain	Spain	none	Update
meg,27.8c9a	Megrim (*Lepidorhombus whiffiagonis*) in Divisions 8.c and 9.a	Spain	Spain	none	Update
ldb.27.7b-k8abd	Megrim (*L. boscii*) in Divions 7.b-k & 8.a,b,d	Ireland	Ireland	None	Update
meg.27.7b-k8abd	Megrim (*L. whiffiagonis*) in Divisons 7.b-k & 8.a,b,d	Spain	Spain	none	Update

Fish Stock	Stock Name	Stock Coordinator	Assess. Coord. 1	Assess. Coord. 2	Advice
sol.27.8ab	Sole in Divisions 8.a,b,d (Bay of Biscay)	France	France	none	Update
ple.27.89a	Plaice in Subarea 8. and Division 9.a	none	none	none	Update
whg.27.89a	Whiting in Subarea 8. and Division 9.a	none	none	none	Update
pol.27.89a	Pollack in Subarea 8. and Division 9.a	Spain	Spain	none	Update
sol.27.8c9a	Sole in Divisions 8.c and 9.a	Spain	Spain	none	Update
nep.fu.2324	*Nephrops* in Divisions 8.a,b (Bay of Biscay, FU 23, 24)	France	France	none	Update[1]
nep.fu.25	*Nephrops* in North Galicia (FU 25)	Spain	Spain	none	Update
nep.fu.31	*Nephrops* in the Cantabrian Sea (FU 31)	Spain	Spain	none	Update
nep.fu.2627	*Nephrops* in West Galicia and North Portugal (FU 26-27)	Spain	Spain	Portugal	Update
nep.fu.2829	*Nephrops* in Southwest and South Portugal (FU 28-29)	Portugal	Portugal	Spain	Update
nep.fu.30	*Nephrops* in Gulf of Cadiz (FU 30)	Spain	Spain	Portugal	Update[1]

[1] Update assessment due in October 2019.

2020 Terms of Reference

WGBIE– Working Group for the Bay of Biscay and Iberian waters Ecoregion

2019/2/FRSGxx

The **Working Group for the Bay of Biscay and Iberian waters Ecoregion** [WGBIE], chaired by Ching Villanueva (France), will meet at ICES headquarters, Copenhagen, Denmark, 6–13 May 2020 (tbc) to:

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

b) Review and evaluate the potential for assessing FU29 and FU30 as one stock;

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

Material and data relevant for the meeting must be available to the group no later than 30 March 2020 (tbc) according to the Data Call 2020.

WGBIE will report by XX May (tbc) for the attention of ACOM.

Annex 3: List of Stock Annexes

The table below provides an overview of the WGBIE Stock Annexes. Stock Annexes for other stocks are available on the ICES website Library under the Publication Type "Stock Annexes". Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year*, *ecoregion, species,* and *acronym* of the relevant ICES expert group.

Stock ID	Stock name	Last up-dated
ank.27.8c9a_SA	Anglerfish (*Lophius budegassa*) in Divisions 8.c, 9.a	May 2019
ank.27.78abd_SA	Anglerfish *(L. budegassa*) in Divisions 7.b–k and 8.a,b,d	May 2018
bss.27.8ab_SA	European sea bass (*Dicentrarchus labrax*) in subarea 8.a,b,d (Bay of Biscay)	April 2018
bss-8c9a_SA	European sea bass (*Dicentrarchus labrax*) in subarea 8.c, 9.a	May 2013
gug-89a_SA	Grey gurnard in Subarea 8 and Division 9a	May 2014
hke-nrth_SA	Hake in Division 3.a, Subareas 4, 6 and 7 and Divisions 8.a,b,d (Northern Stock of Hake)	May 2019
hke-soth_SA	Hake in Divisions 8.c and 9.a (South Stock of Hake)	May 2016
ldb.27.7b-k8abd_SA	Megrim (*Lepidorhombus boscii*) in Divisions 7.b-k and 8.a,b,d	May 2017
ldb.27.8c9a_SA	Megrims (*L. boscii*), Division 8.c, 9.a	May 2016
meg.27.7b-k8abd78_SA	Megrim (*Lepidorhombus whiffiagonis*) in Divisions 7.b-k and 8.a,b,d	May 2017
meg.27.8c9a_SA	Megrim (L. whiffiagonis), Division 8.c, 9.a	May 2016
mon.27.78abd_SA	Anglerfish *(L.ophius piscatorius*) in Subarea 7 and Divisions 8.a,b,d	May 2019
mon.27.8c9a_SA	Southern white anglerfish (*L. piscatorius*) (Divisions 8.c, 9.a)	May 2019
nep-2324_SA	*Nephrops* in Division 8.a,b, FU 23-24-	May 2019
nep-25_SA	*Nephrops* Division 8.c, FU 25 (North Galicia)	May 2019
nep-2627_SA	*Nephrops* Division 9.a, FUs 26, 27 (West Galician and North Portugal)	May 2016

Stock ID	Stock name	Last up-dated
nep-2829_SA	*Nephrops* in Division 9.a, FU 28-29 (Southwest and South Portugal)	May 2016
nep-30_SA	*Nephrops* in Division 9.a, FU 30 (Gulf of Cadiz)	November 2017
nep-31_SA	*Nephrops* in Division 8.c, FU 31 (Cantabrian Sea)	May 2019
ple.27.89a_SA	Plaice (*Pleuronectes platessa*) in Subarea 8 and Division 9.a	May 2014
pol.27.89a_SA	Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a	May 2019
sol.27.8ab_SA	Sole in Division 8.a,b	May 2016
sol.27.8c9a_SA	Sole in subdivisions 8.c and 9.a	May 2018
whg-89a_SA	Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9.a	May 2016

Annex 4: Working documents

List of Working Documents

WD01: Filling in missing EVHOE Survey data for Black anglerfish in 7,8abd using the Vector Autoregressive Spatio-Temporal (VAST) model, Hans Gerritsen, Cóilín Minto

WD 02: Abundance indices data collection for *Nephrops* FU 25 (North Galicia) in 2018, González Herraiz, Vila, Sampedro, Fariña, Gómez Suárez

WD 03: Maturity-at-age estimates for Irish Demersal Stocks in 6.a, 7.a and 7.bgj between 2004–2018, Sara-Jane Moore and Hans Gerritsen

WD 06: Biological Reference points for Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock (Greater North Sea, Celtic Seas, and the northern Bay of Biscay), Dorleta Garcia

WD07: Reference points for black anglerfish in areas 27.78abd, Hans Gerritsen

WD08: GULF OF CADIZ *Nephrops* Grounds (FU 30) ISUNEPCA 2018 UWTV Survey and catch options for 2019, Vila, Y., Burgos, C., Farias, C., Soriano, M., Rueda, J., Gallardo-Núñez, M.

WD04: Changes in the length-weight relationship in Northern 2 Stock of European hake (*Merluccius merluccius),* Dorleta Garcia, Maria Grazia Pennino

WD05: Ecological basis to embrace temporal assessment and 2 spatial management of the European hake (*Merluccius merluccius)* in the northern Iberian Peninsula, Francisco Izquierdo, Iosu Paradinas, Francisco Velasco, Maria Grazia Pennino, Santiago Cervi˜no

WD09: Applying catch-only-model with sampling-importance re-sampling (COM-SIR) to common sole (*Solea solea*) species in 8c9a areas, Maria Grazia Pennino

Filling in missing EVHOE Survey data for Black anglerfish in 7,8abd using the Vector Autoregressive Spatio-Temporal (VAST) model

Working document to the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion

WGBIE – Lisbon 2-9 May 2019

Hans Gerritsen (Marine Institute, Ireland) and Cóilín Minto (GMIT, Ireland)

Introduction

In 2017 the French survey vessel Thalassa suffered major mechanical issues and the majority of the IBTS EVHOE bottom trawl survey could not be completed (Figure 1 shows the distribution of the sampling stations for the time series since 2003).

For black anglerfish (*Lophius budegassa*) in areas 7,8abd the combined Irish IGFS and French EVHOE survey index forms the basis for the category 3 advice (2/3 rule).

During WGBIE 2018 it was decided to base the advice for 2019 on the five-year period 2012-2016. WGBIE 2019 now needs to decide how to provide advice for 2020.

This document describes an approach to model the distribution of black anglerfish in the survey area in order to fill the gap in the survey coverage for 2017 (and any smaller gaps in coverage due to weather or operational issues).

The VAST (Vector Autoregressive Spatio-Temporal) model (www.github.com/james-thorson/VAST) provides a tool to do this. VAST is a spatially explicit model that predicts population density for all locations within a spatial domain, and then predicts derived quantities (e.g. biomass, abundance) by aggregating population density across the spatial domain while weighting density estimates by the area associated with each estimate. VAST imputes biomass or abundance in unsampled areas using spatially correlated random effects.

Methods

Raw survey data were extracted from DATRAS and quality checked (specifically, the estimated weights of the catch numbers-at-length were checked against the reported catch weights). For each valid haul, the catch weight, tow duration, tow position (midpoint), survey series and year were used as input values for the VAST model.

The model first estimates the likelihood of occurrence and then the biomass using a gamma error distribution or the abundance using a lognormal error distribution. The model was specified to have spatial autocorrelation but no temporal autocorrelation (i.e. years are independent). VAST can optionally estimate, and correct for, differences in catchability between the two survey series as there is a significant spatial overlap between the two surveys.

Results

The historic approach of estimating the combined-survey index was simply to weight the indices of the IGFS and EVHOE by the surface area covered by each survey (45% IGFS and 55% EVHOE). This method gives nearly identical trends to the indices estimated by VAST without a catchability correction (Figure 2). However, for biomass, there is an apparent difference in the catchability of the two survey series and when this is accounted for, the overall index is higher (but shows the same trend). The recruitment index does not seem to be sensitive to the catchability correction, suggesting that catchability for young fish is similar in the EVHOE and IGFS surveys.

The VAST model estimates the strong 2003 cohort to be slightly lower than the traditional index. This may be explained by the fact that the highest observations for recruitment in that year were in the area where the two surveys overlap. The traditional method essentially “double counts” this as it does not correct for this overlap.

Figure 3a shows the observed and predicted distribution of the biomass. In most years there is a ‘hotspot’ of biomass to the west and south-west of Ireland and in the central Bay of Biscay. Biomass is generally low to the west of the English Channel and in the southern Bay of Biscay. Biomass in the eastern Celtic Sea, western approaches and onshore Biscay are low.

Figure 3b shows the observed and predicted distribution of recruits. In most years recruitment mainly takes place in the western Celtic Sea, in some years also in Biscay.

In order to investigate how well the model can predict the biomass index when data are missing, the EVHOE survey data were removed for one year at a time and the index was re-calculated with the missing data (Figure 4). The figure shows that in many years, omitting the EVHOE data did not significantly affect the index. However in years where the EVHOE survey observed relatively high or low biomass compared to the IGFS survey, omitting the EVHOE data resulted in a considerable difference in the index for that year.

Fortunately, not all EVHOE data was missing in 2017; the EVHOE survey managed to complete 26 valid tows in the central Biscay area. Additionally, the Irish survey completed an extra 22 stations in the area normally covered by EVHOE. A final set of models were fitted by removing, for one year at a time, only the data in the regions that were not sampled during 2017 (shown as yellow polygons in Figure 1). This simulates, for each year, coverage similar to 2017 and tests how well the index would have been estimated in each year if only the 2017 survey coverage would have been available. Figure 5 shows that removing the data from the two polygons resulted only in minor differences in the estimate of the biomass index, suggesting that the survey coverage in 2017 was sufficient to accurately estimate the index.

Discussion

The IGFS and EVHOE surveys sometimes give conflicting signals. This may be due to migration or it could be year-effects in the surveys (e.g. differences in catchability due to weather etc.). WKANGLER 2018 concluded that a combined index was more likely to provide an appropriate biomass trend than the two separate surveys.

The VAST model provides almost identical indices to the traditional way of calculating them if the catchability is not taken into account. Scientifically it would be better to account for this difference in catchability but the purpose of this exercise is to deal with the missing 2017 data. Therefore it is recommended that the VAST model is configured as close to the traditional way of estimating the indices (i.e. without catchability correction).

Omitting an entire year of EVHOE data did result in a very different biomass index in years when the surveys show conflicting signals. However, omitting only the stations in the area that was not surveyed in 2017 affected the estimated biomass index very little. Therefore, the VAST model appears to be able to provide a robust estimate of the biomass index in 2017 and it is proposed that the VAST estimate is used as the basis for the advice.

The model can be further explored to include temporal auto-correlation, an option that was not explored here as it was the intention to deviate from the tradition index as little as possible.

VAST offers a number of advantages over more traditional ways of estimating indices and may be appropriate to estimate indices for other stocks as well. Advantages include:

- The ability to deal with gaps in survey coverage
- The ability to account for differences in catchability between surveys or vessels, providing an objective way to combine multiple indices, even when the gear is not standardised.
- The ability to reduce inter-annual noise by accounting for temporal auto-correlation
- The ability to specify appropriate error structure should result in a more realistic estimate of uncertainty.

ACOM leadership expressed some concerns about the use of a modelled survey index. The concerns are listed below, with responses from WGBIE 2019:

- Concern: *Survey design-based calculation is the default for survey indices for most stocks and model-based estimates are generally not used. This provides transparency as to how the indices are derived and allows for easy verification of results using DATRAS for example.*

> Response:

1. To a certain extent the VAST model ignores the survey design (i.e. the spatial stratification). However, because the model is spatially explicit, it achieves almost the same outcome. Additionally, the station density in either survey does not actually vary much between stations, so the design effect is minimal.
2. While design-based calculations may be preferable for single survey, the combined survey index is simply a weighed average of the single survey indices, this ignores the area of overlap and is therefore potentially biased. The VAST model provides a convenient and statistically robust method of combining the two surveys.
3. The working group will continue to monitor the outcomes of the VAST model against the original index as well as the raw data from DATRAS. This approach allows continued verification of the data and estimates.

- Concern: *Using a model will result in differences for past values of indices. While differences are likely to be small, we may end up having requests to provide revised advice for the current year using the updated model as it may imply small changes in the ratio.*

> Response:

1. Category 1 models all suffer from some sort of retrospective pattern, yet it is very unusual to provide revised advice in the current year for these stocks, based on small retrospective revisions.
2. Historic survey data are regularly revised as mistakes are discovered or improved estimation methods are proposed. Therefore it is incorrect to suggest that the historic index values do not change.
3. There are a number of category 3 stocks for which the biomass trend is not a survey index but an assessment model (e.g. an XSA that is accepted for trends only). These models will be likely to have much larger retrospective patterns than the VAST model, which will only use data from other years to estimate areas without survey coverage.

Figures

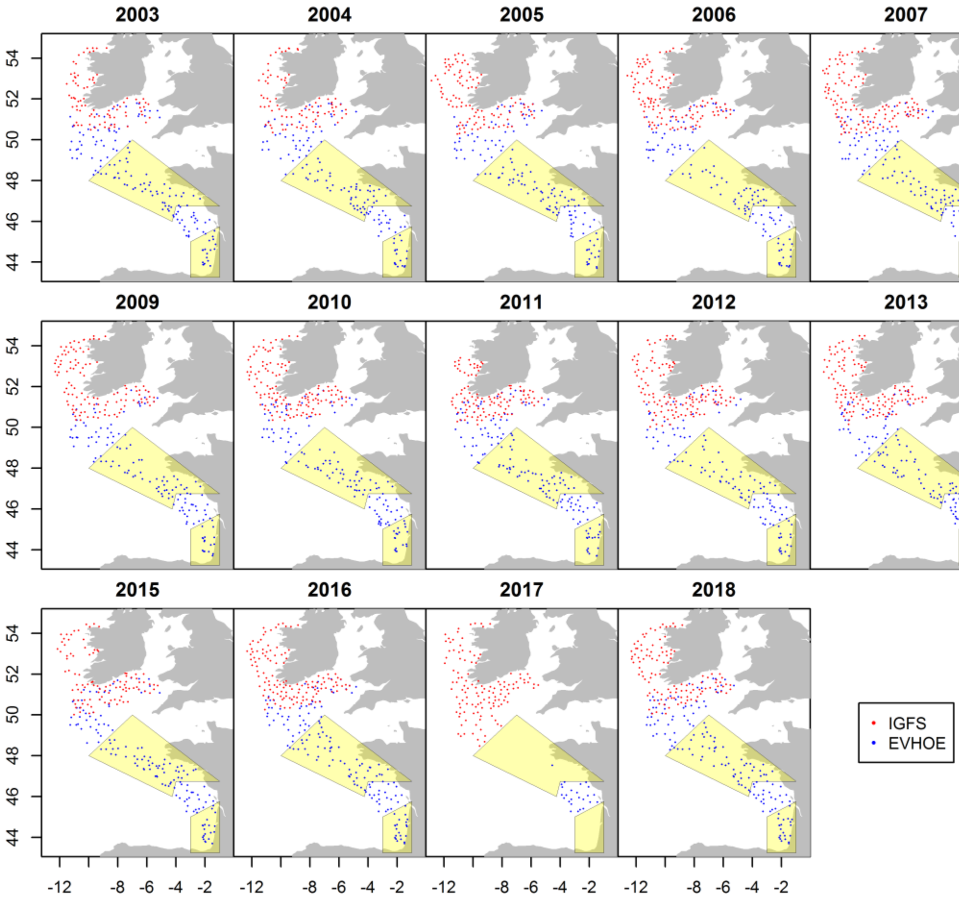

Figure 1. Haul locations of the Irish IGFS (red) and French EVHOE surveys(blue). Note the large gap in survey coverage during 2017. The IGFS survey completed 22 additional stations in the EVHOE area during that year and the EVHOE survey completed 26 stations in the Central Biscay area but the area indicated by the two polygons was not covered. The yellow polygons indicate the area not sampled in 2017.

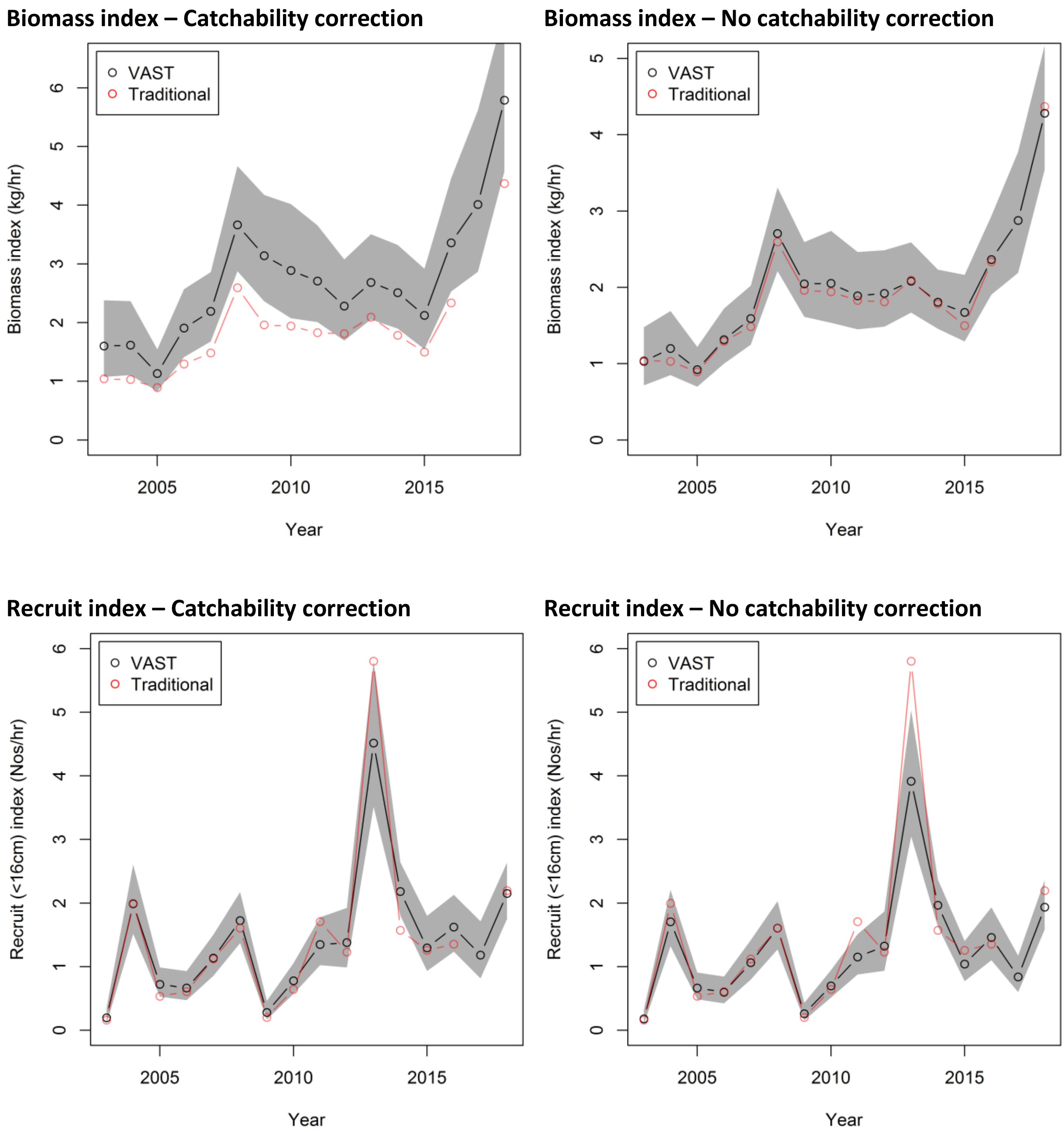

Figure 2. Comparison between the VAST model biomass (top) and recruit (bottom) index and the 'traditional' indices calculated according to the stock annex. The left-hand plots show the indices estimated with a catchability correction, the right-hand side plots show the indices without the catchability correction.

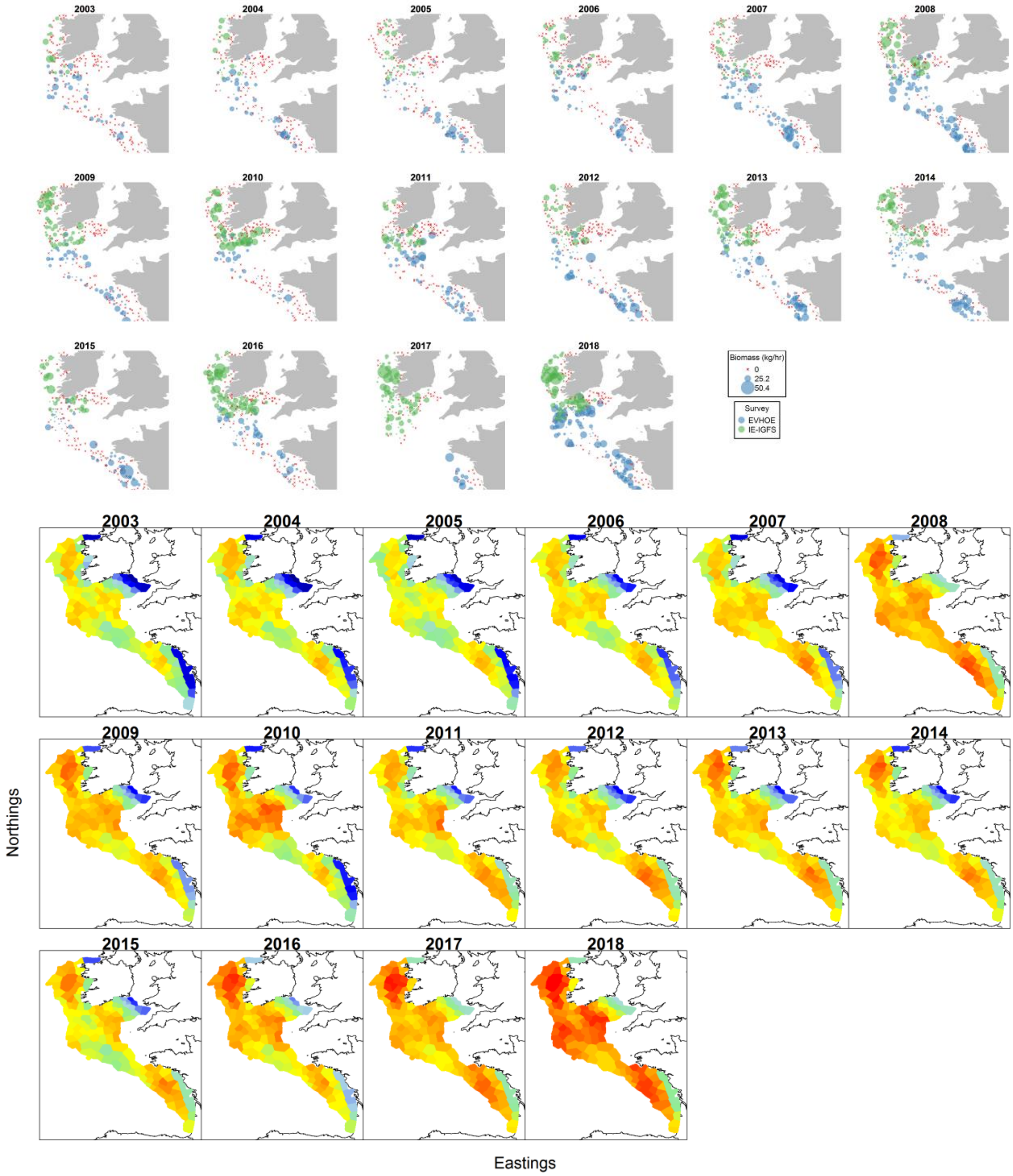

Figure 3a. Observed (top) and modelled (bottom) biomass densities in each of the survey years.

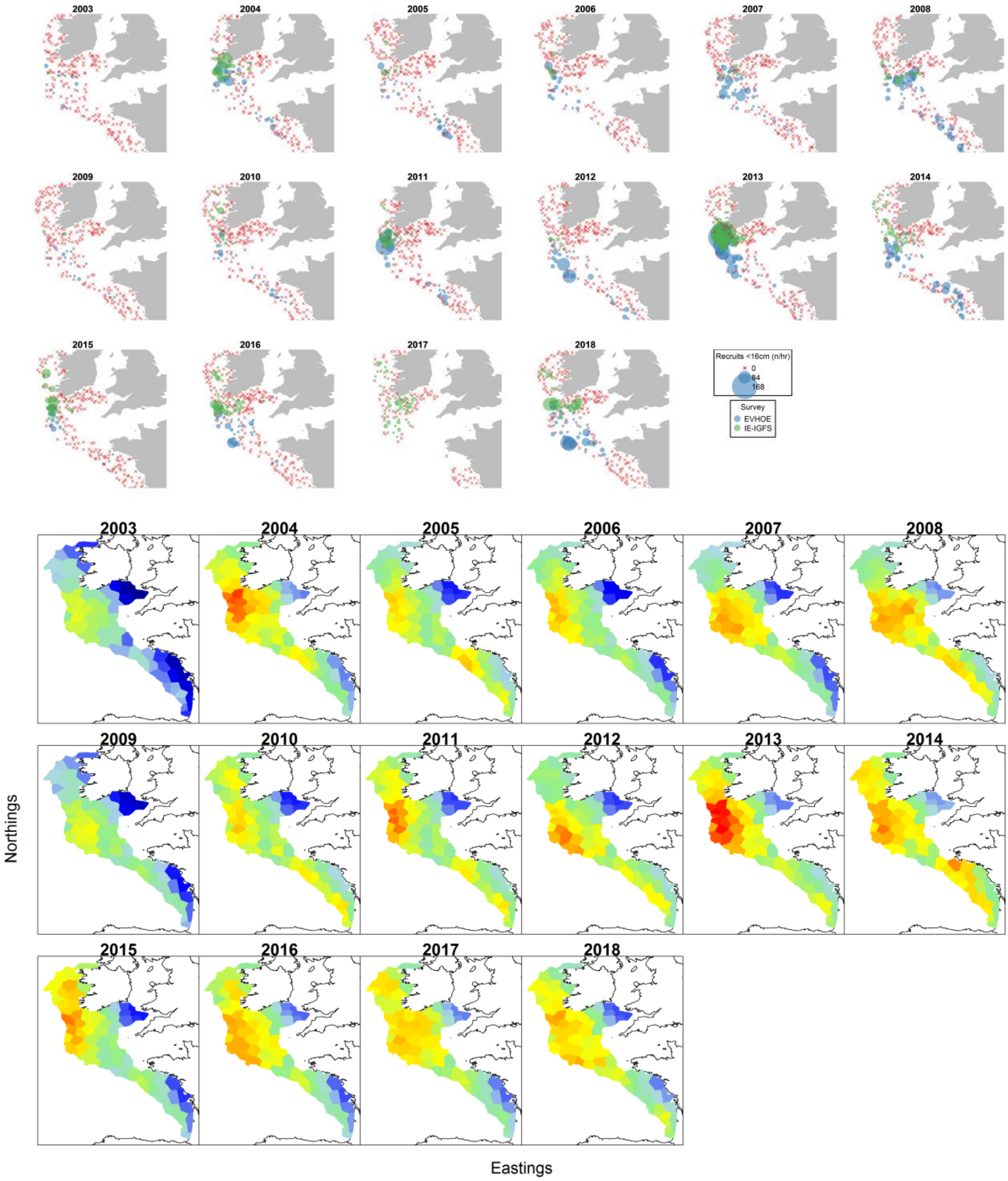

Figure 3b. Observed (top) and modelled (bottom) recruitment (<16cm) densities in each of the survey years.

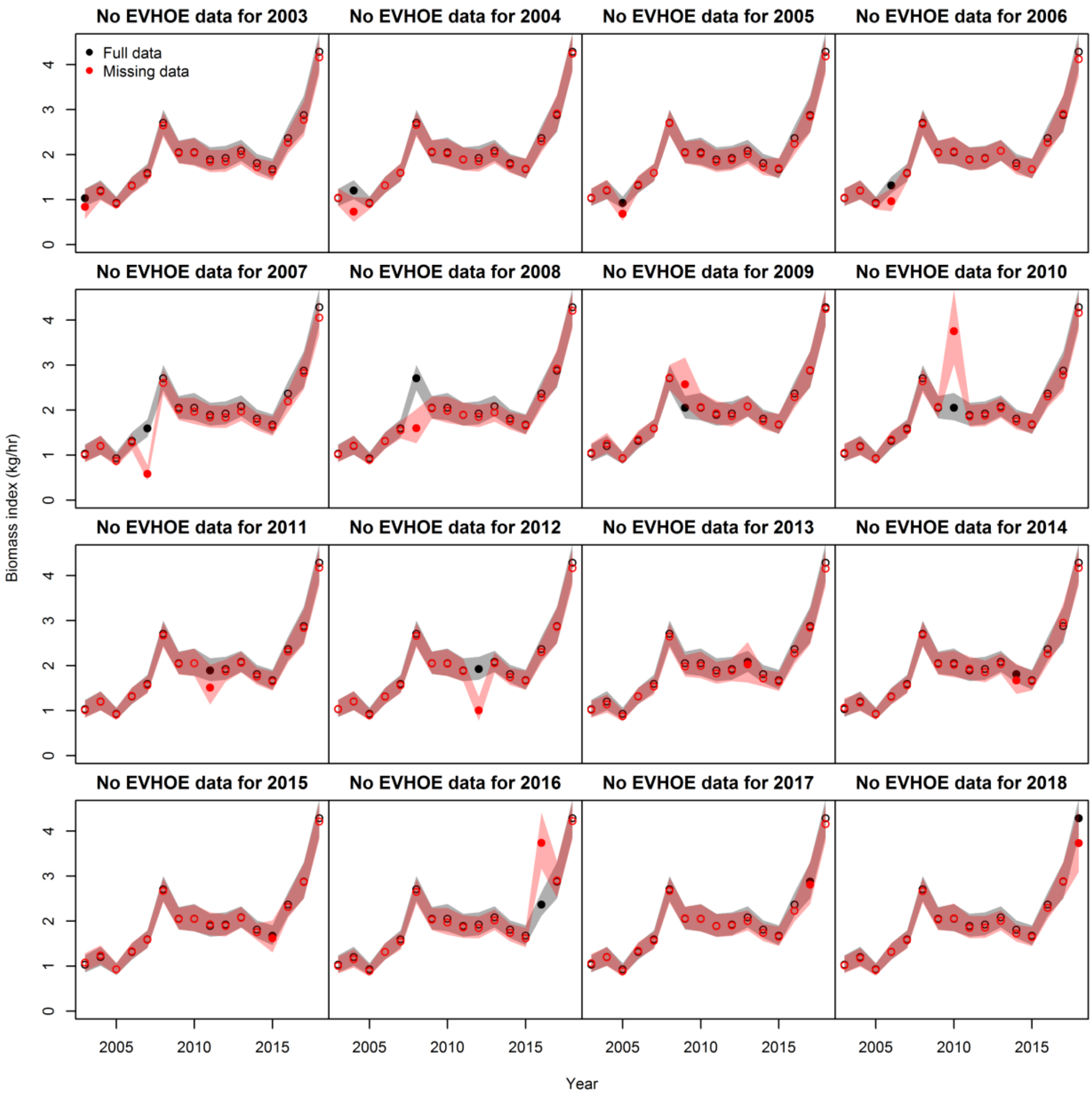

Figure 4. The impact of missing data was investigated by sequentially removing an entire year of EVHOE data (red) and comparing the resulting biomass index with that estimated from the full data set (grey). In years where the EVHOE recorded above-average biomass, removing this data resulted in under-estimates (e.g. 2007, 2008) and removing years with below-average EVHOE biomass resulted in over-estimates (e.g. 2009, 2010, 2016, 2018).The error bands are a single standard error from the mean.

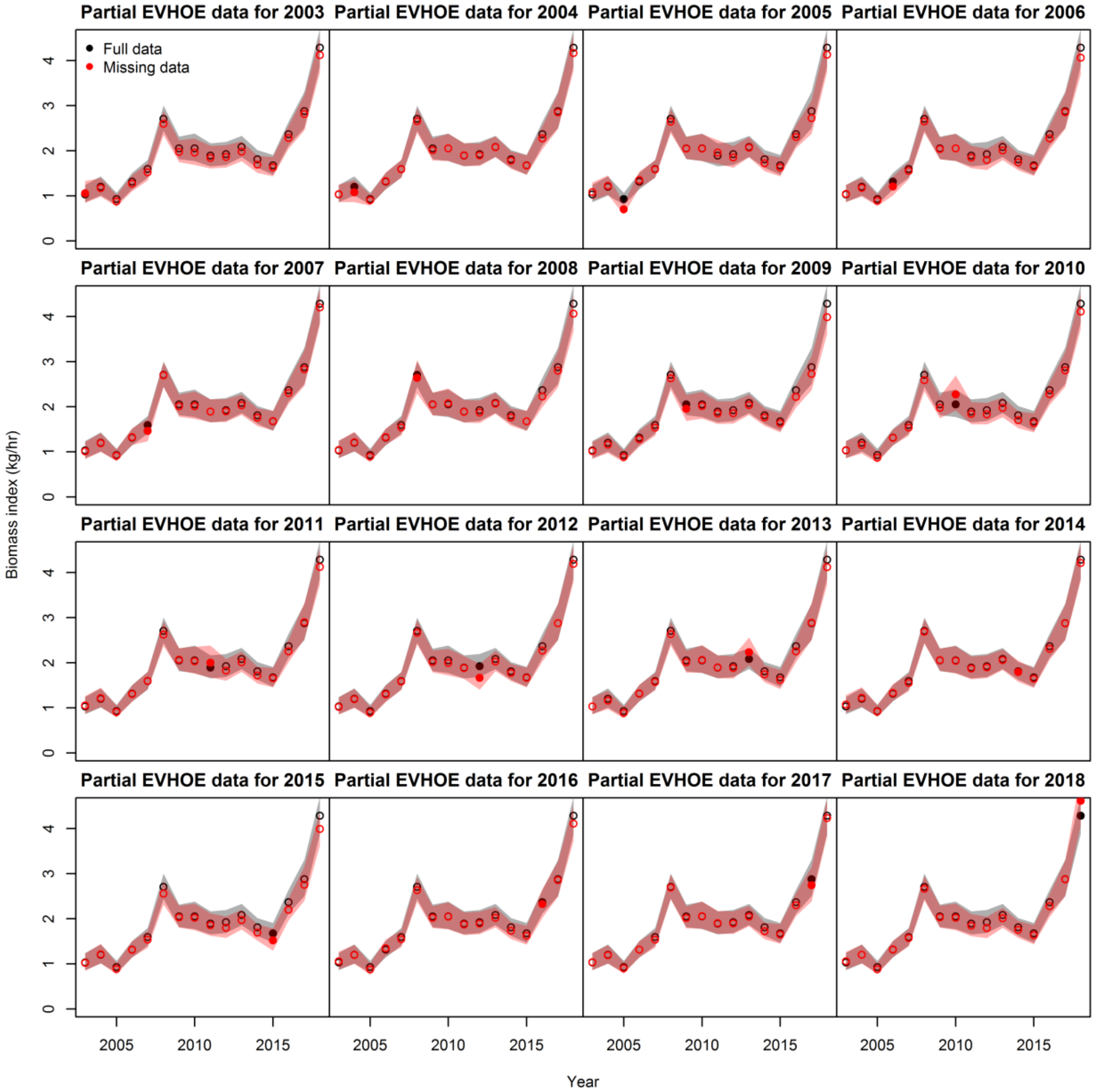

Figure 5. The impact of missing data was further investigated by sequentially removing only the EVHOE data inside the polygons shown in Figure 1 to mimic the actual missing data (red) and comparing the resulting biomass index with that estimated from the full data set (grey). The VAST model produced very similar biomass estimates for the full dataset and the partial data, suggesting that the survey coverage in 2017 was sufficient to accurately estimate the index.

Table 1. Biomass index (Kg/hr) and recruit (numbers<16cm/hr) with lower and upper 95% confidence intervals

Year	Biomass	Lower CI	Upper CI	Recruits	Lower CI	Upper CI
2003	0.18	0.33	0.10	1.03	1.48	0.72
2004	1.71	2.21	1.32	1.20	1.69	0.85
2005	0.66	0.91	0.49	0.92	1.22	0.70
2006	0.60	0.84	0.42	1.31	1.72	1.00
2007	1.06	1.42	0.80	1.59	2.02	1.25
2008	1.61	2.03	1.27	2.71	3.31	2.22
2009	0.26	0.43	0.16	2.05	2.59	1.62
2010	0.70	0.95	0.51	2.05	2.74	1.54
2011	1.15	1.51	0.88	1.89	2.46	1.45
2012	1.32	1.87	0.94	1.92	2.49	1.48
2013	3.92	5.03	3.05	2.08	2.59	1.67
2014	1.97	2.37	1.63	1.81	2.23	1.46
2015	1.04	1.40	0.77	1.67	2.16	1.29
2016	1.46	1.93	1.10	2.37	2.94	1.91
2017	0.84	1.17	0.60	2.88	3.78	2.19
2018	1.94	2.36	1.59	4.28	5.17	3.55

Abundance indices data collection for *Nephrops* FU 25 (North Galicia) in 2018

González Herraiz, I.[1], Vila, Y.[2], Sampedro, P.[1], Fariña, C.[1] and Gómez Suárez, F.J.[1]

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INTRODUCTION

Nephrops landings in FU 25 (ICES Division 8c, North Galicia) have decreased an 89% from 1975 to 2016. ICES advice for this stock is on the basis of a data-limited approach since 2006, meaning that no analytical stock assessment is conducted in this FU. According to this approach, FU 25 is considered as category 3.1.4 (ICES, 2012) and it is assessed mainly by the analysis of the LPUE series trend. ICES recommendation for this FU has been zero catch since 2002. Results of the last assessments in 2016 indicated an extremely low abundance level and a zero TAC was also recommended for 2017, 2018 and 2019. This recommendation was established in the rule-power of EU (EU, 2017) in 2017 and as consequence the *Nephrops* fishery in FU 25 was closed for that triennium.

Fishing industry presented abundance data of this stock for 2015 and 2016 in WGBIE 2017 (ICES, 2017) based on catches and effort information obtained from two trawler vessels based in the A Coruña port (Fernández et al., 2017). Part of each one of their trips are directed to *Nephrops* in FU 25. There are no *Nephrops* discards in this FU, therefore catches are equivalent to landings (ICES, 2018a). ICES 2017 WGBIE considered that “the LPUE data provided […] could be used as an abundance index in a future Benchmark as long as the time series is continued and extended historically”.

Get new fishery data and commercial abundance indices is impossible with the closed FU 25 *Nephrops* fishery. Moreover, there are not appropriate abundance indices from scientific survey. Therefore, any new approach of analysis and assessment of the stock trends in the next few years cannot be achieved. So, the fishing industry asked the Spanish General Secretariat of Fisheries (SGP) the possibility of carrying out a survey in 2017 to still providing a a *Nephrops* abundance index. This survey would be restricted to the two vessels used for the calculation of abundance indices submitted to WGBIE 2017 (Fernández et al., 2017). Spain requested a special quota for *Nephrops* in FU 25 to EU in order to carry out an observer’s programme in 2017 supervised by the Spanish Oceanographic Institute (IEO). EU conceded 4.2 tonnes for *Nephrops* in FU25 and a sentinel fishery for *Nephrops* was carried out in August and September of 2017. A permission to carry out a 2018 sentinel fishery was solicited later to DG-MARE by Spain. EU requested to ICES for advice on the level of catch and characteristics needed for the 2018 sentinel fishery, what was answered by ICES in February 2018 (ICES, 2018b). In June 2018 EU provided a special quota of 2 t for the Sentinel fishery 2018 (EU, 2018, Annex I), that was carried out in August and September of 2018. In November of 2018 EU provided a special quota of 2 t for the Sentinel fishery 2019 (EU, 2019).

In this working document the results of the Sentinel fisheries of 2018 are analyzed.

SURVEY OBJECTIVES

The main objective of this survey was to obtain an abundance index for *Nephrops* FU 25 in 2018 to continue the time series of commercial CPUEs initiated by the fishing industry in 2015 and followed by the first Sentinel fishery of 2017 (Vila et al., 2018). Other objectives were obtain the size composition and the proportion of sexes in catches.

METHODS

The survey was conducted between 1st August to 21st September 2018 by two commercial vessels on the fishing grounds at the Northwest of A Coruña (FU 25, NW of Spain) (Figure 1). The survey was designed and coordinated by IEO (C.O. A Coruña), the Association of owners of fishing vessels of Galicia, "Pescagalicia-Arpega-O Barco", and the shipowners of "Ana Isabel" and "Burelés". Conditions of the authorization of the 2018 observers survey in Annex I.

Study area

Figure 1 shows the fishing area covered in this survey (in green), ranging between 200 and 500 m depth. This area is where the *Nephrops* densities are highest and represents a part of the geographical area where *Nephrops* used to be in this FU (ICES statistical rectangles 15E0-E1 and 16E1, in red).

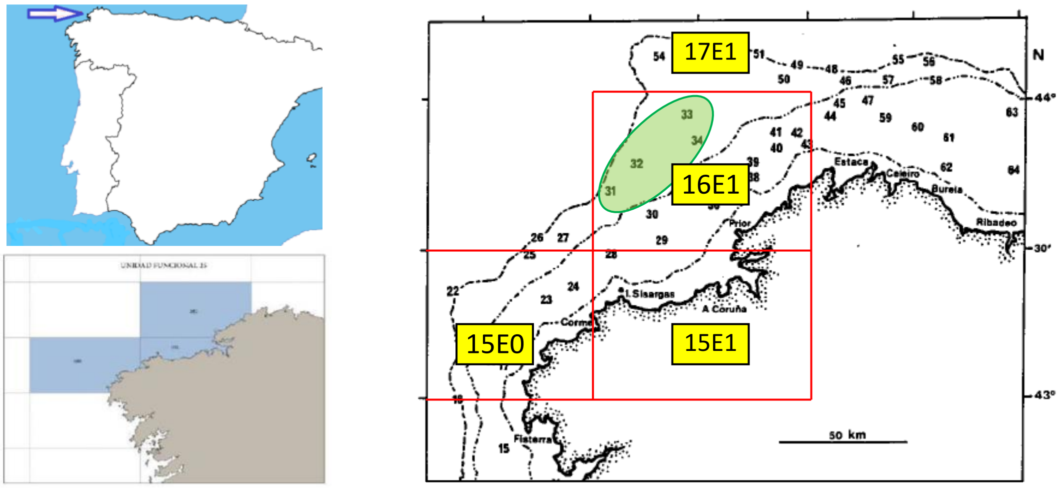

Figure 1. Statistical rectangles of *Nephrops* Functional Unit 25 (North of Galicia) in red, rectangles names in yellow. Study area in the CARACAS survey in green.

Observation and data collection methodology

A total of 33 fishing days targeting to *Nephrops* were made in the 2018 survey, a 38% more than in the 2017 survey. The observers were on board all of the days. Table 1 shows the specifications of the vessels that participated in this programme and Table 2 shows the fishing calendar. The development of trips, schedules, and sets followed the normal commercial schemes in the bottom trawl fishery and there was not interference in the usual procedure of commercial fishing in order to commercial indices were comparable with the previously provided by the industry. Trips usually take two days because of the distance of the fishing grounds to the base port. The gear used was the usual with the regulatory 70 mm mesh size.

Table 1. Technical specifications of vessels participating in the survey.

	BURELÉS	**ANA ISABEL**
REGISTER	FE-2-1-97	VI-5-8-00
CATEGORY - FLEET CENSUS	Bottom-Trawl Cantábrico NW	Bottom-Trawl Cantábrico NW
GROSS TONNAGE (GT)	223.61	219.02
TOTAL LENGTH	28 m	28 m
POWER	625 cv	320 cv
GEAR	Otter Trawl (OTB)	Otter Trawl (OTB)
MESH SIZE	70 mm	70 mm

Table 2. Calendar of the fishing days by vessel of the survey.

Vessel	August	September	Total fishing days
Ana Isabel	1, 9, 10, 14, 15, 23, 24, 28 and 29	4, 5, 10, 13, 14, 18 and 19	16
Burelés	2, 3, 7, 8, 16, 17, 21, 22, 30 and 31	6, 7, 11, 12, 17, 20 and 21	17

Nephrops shows daily and seasonal variations in its catchability, due to their behaviour (Aguzzi and Sardá, 2008). Individuals at more than 200 m of depth are inside their burrows during hours of low-light (Chapman, 1980). To avoid the effect of daily variations in the catchability of *Nephrops* according to Aguzzi et al. (2003), the hauls that were carried out in more than 50% of time between dusk and dawn were considered non-directed to *Nephrops*. 66 hauls were directed to *Nephrops* and 37 hauls were not (22% and 48% more than the previous year, respectively). The duration of each haul was calculated as the elapsed time in hours between the moments in which the gear makes firm in the bottom to the beginning of the turned. Effort unit was trawling hour. A weekly CPUE for *Nephrops* was calculated for each vessel and for both vessels together to analyse the temporal evolution during the survey. *Nephrops* CPUE was estimated as the average of the weekly values of CPUE.

The observers followed the working protocol established, which consisted in:

1. General data collection of the trips and hauls, including latitude, longitude, depth and duration of the haul in hours.
2. For each haul, quantitative data of the total catch by specie, both landed and discarded.
3. Random sampling of *Nephrops* length (mm Carapace Length) by sex in each haul. Proportion of sex.
4. Size sampling of catch of other commercial species (hake, megrims, anglerfishes, and blue whiting).

All the information obtained by the observers was recorded in the IEO fishing database (SIRENO).

Nephrops size composition by haul was obtained rising the sampling carried out on board using the length-weight relationship for males and females according to Fariña (1984).

RESULTS

Trips

18 trips (9 for each vessel) targeting *Nephrops* were undertaken during this survey, 29% more than in the previous year. 15 trips were two-days long, 50% more than in the previous year, and 3 trips were one-day long, 25% less than the previous year. In 2018 survey, 105 hauls ranging to 188 and 526 m of depth were carried out, 33% more than in the previous year. Information by haul (date, hour, duration, depths, total catch, retained catch and *Nephrops* catch) in Annex II.

Total and Nephrops *catches*

A total catch of 22 22 kg of different species was caught, a 59% less than in the previous year, because in the 2017 survey a huge quantity of Henslow's swimming crab (*Polybius henslowii)* and squat lobsters (*Munida spp.*) was caught (and discarded). That is the reason why in the percentage of catch discarded in the 2017 survey was 69% (38 046 kg) and in 2018 only 19% (4 399 kg). Retained catch in 2018 was 18 424 kg, 8% more than in 2017.

The total *Nephrops* catch obtained by the two vessels was 1 982 kg, 4% less than in 2017. *Nephrops* discard was zero, in 2017 only one individual with CL under 25 mm had been discarded.

Nephrops CPUE

The average yield was 110 kg/trip, 60 kg/fishing day, 19 kg/haul and 3.7 kg/hour, 26-33% less than in 2017. Nevertheless, it is necessary to take into account the time of the year (ICES, 2018b) and if the haul is directed to *Nephrops* or not when *Nephrops* CPUE is analysed.

Figure 2 shows weekly trend of *Nephrops* CPUE data in the hauls directed to Nephrops. Maximum yield was observed in the first week of the survey (10 Kg/hour). Yield decreased since then up to 3.2 kg/hour in the week of September 3rd-9th. In hauls non directed to *Nephrops* CPUE varied between zero and 1.9 kg/hour without trend. The mean CPUE during the survey was 3.1 kg/hour. In the hauls directed to *Nephrops* the vessel Ana Isabel obtained higher CPUEs in the three first weeks than Burelés (Figure 3). The Ana Isabel overall catch trend was declining from early August to the the week of September 3rd-9th and Burelés CPUE varied around 4 kg/hour along the whole period. *Nephrops* CPUE in hauls directed to this specie for the whole period were 6.6 kg/hour for "Ana Isabel" and 4.1 kg/hour for "Burelés", 10 and 45% less than in 2017 survey, respectively. The *Nephrops* CPUE of the whole survey in the hauls directed to the species descended from 7.2 in 2017 to 5.2 in 2018 (Table 3). This decline could be related to bad weather conditions.

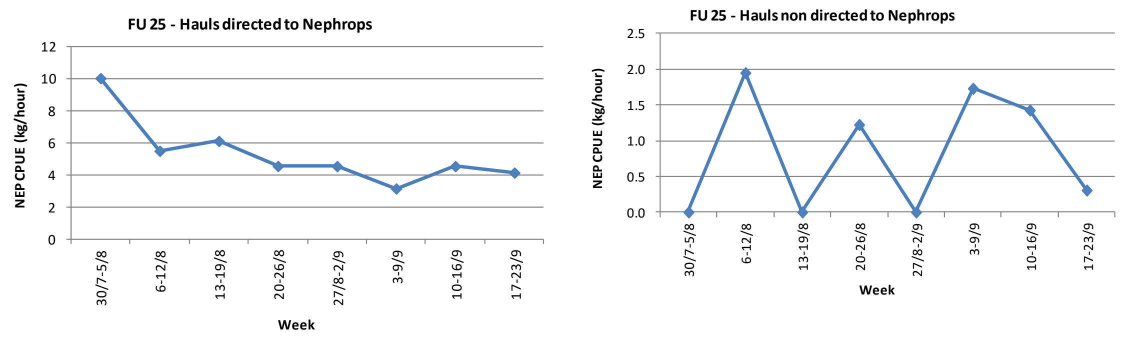

Figure 2. Weekly trend of CPUE in weight for *Nephrops* in hauls directed (left) and hauls non-directed (right).

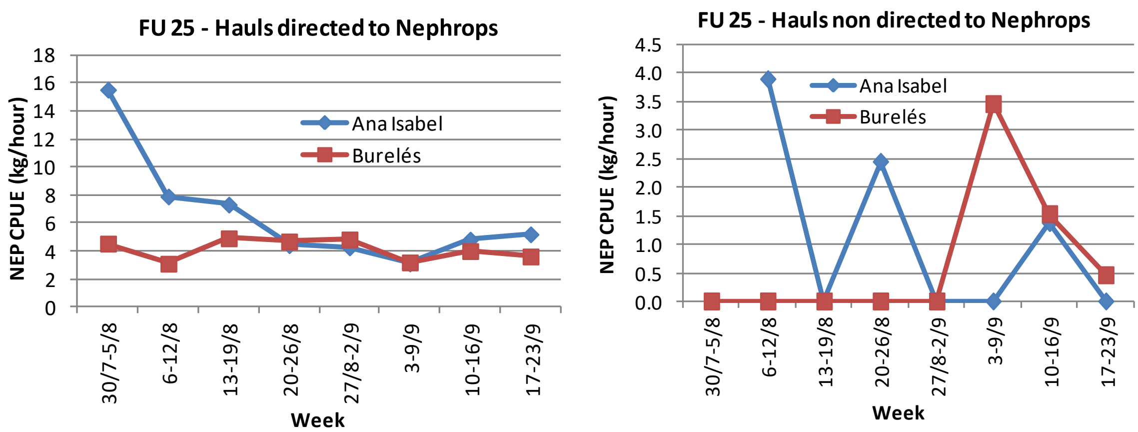

Figure 3. Weekly trend of CPUE for *Nephrops* by vessel in hauls directed (left) and hauls non-directed (right).

Table 3. Mean *Nephrops* CPUE, in kg per hour, and standard deviation for the 2017 and 2018 surveys.

Survey	Hauls directed to Nephrops		Hauls Non directed to Nephrops	
	CPUE (kg/hour)	s.d	CPUE (kg/hour)	s.d
August-September 2017	7.2	1.6	0.6	0.6
August-September 2018	5.2	2.9	0.9	1.3

Size composition and sex-ratio of the Nephrops *catch*

A total of 8 524 individuals were measured, 17% more than in the previous year, 5 406 males and 3 118 females. The percentage of females were the 37%. Carapace length fluctuated from 23 mm to 78 mm CL for males and from 24 mm to 68 mm CL for females (Figure 4). Mean sizes increased from 2017 to 2018 (Table 4).

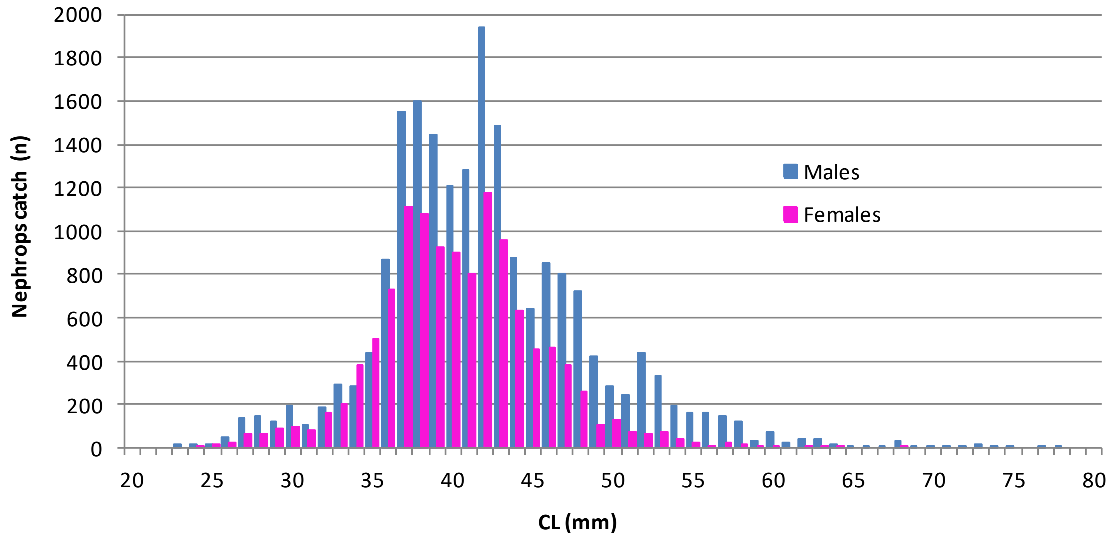

Figure 4. Length frequency distribution for the total catch for males (blue) and females (pink).

Table 4. *Nephrops* mean sizes for males and females in surveys 2017 and 2018.

	Mean size	
	2017	2018
Males	41.7	42.1
Females	39.8	40.3

Nephrops weight in catch

The percentage of *Nephrops* in the catch in weight is shown in Table 5. In the survey, *Nephrops* catch represents 13% in the directed hauls, 15% less than in 2017, and 2% in the non directed hauls.

Nephrops represents between 9% and 20% of the weight in hauls directed to this species. The highest values were recorded in the first week of the survey in August, while the lowest values were recorded in September. Results are consistent with the seasonal cycle of *Nephrops* in the area, which is very pronounced between May and August, with an abundance peak in July (ICES, 2018b). In August-September, starting the incubation season (González Herraiz et al., 2011) and females with eggs are confined in their burrows, resulting less accessible to the fishing gear.

Table 5. Percentage of *Nephrops* weight in total catch.

Week	Directed hauls	Non-directed hauls
30/07-05/08/2018	20.3	0.0
06-12/08/2018	11.8	3.7
13-19/08/2018	14.4	0.0
20-26/08/2018	13.7	3.2
27/08-02/09/2018	10.7	0.0
03-09/09/2018	8.9	4.1
10-16/09/2018	10.7	2.2
17-23/09/2018	10.4	1.1
Total Survey	12.6	1.8

CPUE associated species

Data concerning other associated species were collected, although *Nephrops* was the target species in the survey. For all hauls carried out in the survey, both night and day, catch retained per effort unit (RPUE) and catch discarded per effort unit (DPUE) were estimated (Table 6). The species with the highest yields in the survey were blue whiting (*Micromessistius poutassou*), hake (*Merluccius merluccius*), megrims (*Lepidorhombus spp*.) and Norway lobster (*Nephrops norvegicus*) with 9.8, 7.5, 6.1, and 3.7 Kg/hour, respectively. Therefore, in this fishing ground, *Nephrops* was the fourth species in relative importance in weight. The main discarded species was squat lobster (*Munida spp*.) with 5 kg/hour.

Table 6. Retained and discarded catch per effort unit (RPUE and DPUE) for the main species catches for all hauls carried out in the survey (day and night). *Nephrops* appears shaded.

Common name	Scientific name	RPUE (kg/hour)
Blue whiting	*Micromesistius poutassou*	9.8
Hake	*Merluccius merluccius*	7.5
Megrim	*Lepidorhombus spp*	6.1
Norway lobster	*Nephrops norvegicus*	3.7
Anglerfish	*Lophius spp*	3.1
Small-spotted catshark	*Scyliorhinus canicula*	1.3
Greater forkbeard	*Phycis blennoides*	0.7
Shortfin squid	*Illex coindetii*	0.7
Blackbelly rosefish	*Helicolenus dactylopterus*	0.5
White anglerfish	*Lophius piscatorius*	0.2
Horned octopus	*Eledone cirrhosa*	0.1
Gurnards	*Triglidae*	0.1
Conger	*Conger conger*	0.1

Common name	Scientific name	DPUE (kg/hour)
Squat lobster	*Munida spp*	4.9
Deania dogfishes nei	*Deania spp*	0.6
Fishes	*Pisces*	0.6
Crustaceans	*Crustacea*	0.5
Catsharks	*Galeus spp*	0.3
Deep-sea lantern shark	*Etmopterus spinax*	0.3
Gastropods	*Gastropoda*	0.2
Anemone	*Actinauge richardi*	0.2
Sevenstar flying squid	*Martialia hyadesi*	0.1
Rabbit fish	*Chimaera monstrosa*	0.1
Sea cucumber	*Holothuria spp*	0.1

FINAL CONSIDERATIONS

Results of the two observers surveys (2017 and 2018) provided relevant information about *Nephrops* in FU 25 (abundance index, sex-ratio, size composition, etc). Table 7 shows the *Nephrops* abundance index (CPUE) estimated in 2017 and 2018 from these surveys in FU 25, as well as the previous CPUE series estimated from the fishing industry in 2015 and 2016.

Table 7. Commercial CPUE time series available for *Nephrops* in FU25.

Source	Year	Period	Directed CPUE (kg/hour)	s.d.	Non-directed CPUE (kg/hour)	s.d.
Fishing Industry	2015	Year	6.46		0.18	
Fishing Industry	2016	Year	10.81		0.27	
2017 survey	2017	Aug-Sep	7.22	1.57	0.59	0.56
2018 survey	2018	Aug-Sep	5.21	2.94	0.88	1.30

This CPUE time series is still very short to describe the trend of the abundance index of *Nephrops* in FU 25.

Together with a CPUE decrease, a contraction of FU 25 *Nephrops* stock could have been occurred since 2009 (Figs. 5 and 6), with less presence of the species in the west part of the FU (statistical rectangle 15E0). 15E0 landings decreased an 87 between from 2007 to 2016. In 2016 Sentinel area was almost the only part of the FU 25 with *Nephrops* presence (Fig. 6).

According to this, yields provided by the Sentinel fisheries (Fig. 6) could not be representatives of the rest of the FU. High differences in population characteristics (CPUE, growth, etc.) in adyacent patches of the same population are not strange in *Nephrops* (Tuck et al., 1997) since is a species with a capacity of dispersion almost null (Chapman y Rice, 1971).

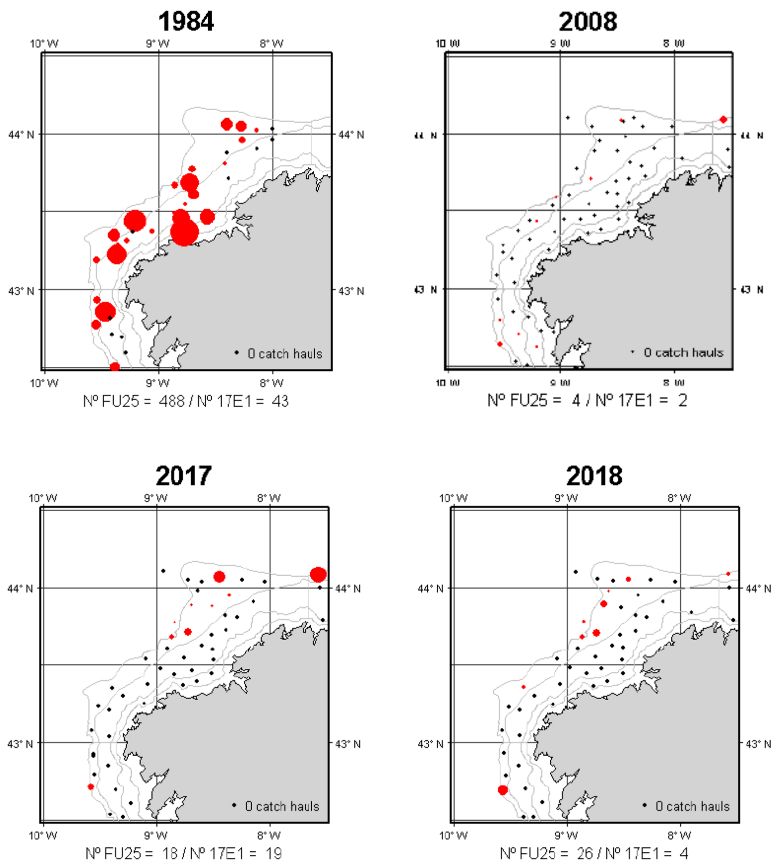

Fig. 5. *Nephrops* yield (n/haul) in IEO “Demersal” trawl survey. Year 1984, example of high CPUEs (1983-1996). Year 2008, example of low CPUEs (1997-2008). Years 2017 and 2018, example of *Nephrops* almost only present in sentinel area (2009-2018). Black points: zero catch of *Nephrops*.

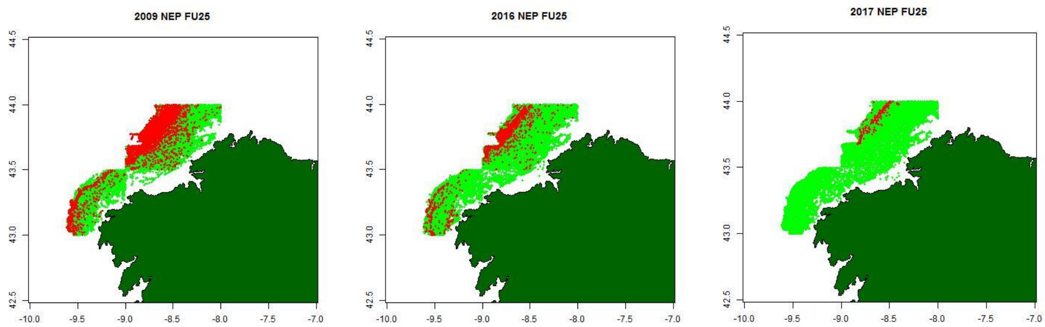

Fig. 6. *Nephrops* presence (red) and absence (green) in the commercial trips of trawl (OTB_DEF, OTB_MPD and PTB_DEF) in FU 25 (2009, 2016) and in the 2017 Sentinel fishery.

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Annex I

Observers Survey framework authorized by the General Secretariat of Fisheries (SGP).

MINISTERIO
DE AGRICULTURA, PESCA
Y ALIMENTACIÓN

SECRETARIA GENERAL DE PESCA

DIRECCION GENERAL DE ORDENACION PESQUERA Y ACUICULTURA
SUBDIRECCION GENERAL DE CONTROL INSPECCION

F A X

DE:	SUBDIRECCION GENERAL DE CONTROL E INSPECCIÓN
A:	IEO – CENTRO OCEANOGRÁFICO DE A CORUÑA (fax: 981 229 077) DIRECCIÓN ÁREA FUNCIONAL DE AGRICULTURA Y PESCA DE A CORUÑA SUB. GRAL. DE PROTECCIÓN DE LOS RECURSOS PESQUEROS SUB. GRAL. DE CALADERO NACIONAL Y AGUAS COMUNITARIAS
ASUNTO:	CAMPAÑA IEO – CENTINELA – CIGALA UF-25
S/REF:	N/REF: JAM/JAF
FECHA:	27 de julio de 2018
NUMERO PAGINAS INCLUYENDO PORTADA: 2	

En el marco del estudio del IEO en relación a una campaña sobre el índice de población de cigala en la Unidad Funcional (FU) 25, se autoriza a los buques pesqueros **"BURELES", "FE-2-1-97", Código U.E.: ESP000023450** y **"ANA ISABEL", "VI-5-8-00", Código U.E.: ESP000024668** a realizar, esta campaña.

La presente autorización queda subordinada a las siguientes condiciones:

- **Arte de pesca autorizado**: Arrastre de fondo, según Anexo I del Reglamento (CE) nº 850/98 del Consejo de 30 de marzo de 1998.
- **Periodo de validez de la autorización**: 5 mareas por buque/mes del día 1 de agosto al 30 de septiembre de lunes a viernes. Total de mareas 20 (10 por buque).
- **Zona de actividad**: Unidad funcional 25, correspondiente al Caladero Nacional del CNW (CIEM VIIIc).
- **Especies objetivo:** Cigala. Con posibilidad de estudio de otras especies secundarias (gallo, rape, merluza, etc). El **tope** de capturas de **cigala** será de **2.000 kg** para la totalidad de la campaña.
- Será obligatorio por parte del patrón del pesquero, reseñar en el diario de a bordo que la marea se encuentra bajo campaña científica, para ello tendrá que cumplimentar en el DEA en "Salida de Puerto" el campo "Actividad prevista" con la opción "Investigación científica".

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- Las cantidades de capturas serán contabilizadas a parte de la cuota general asignada a España hasta el máximo del 2% sobre dicha cuota.

- Las capturas se deberán desembarcar en el puerto de A Coruña, puerto habitual de descarga de estos pesqueros, permitiendo su comercialización, excepto ejemplares de tamaño inferior al reglamentario.

- El pesquero deberá disponer de un equipo de localización de buques vía satélite (caja azul) que se encuentre activo y operativo durante su permanencia en la mar.

- Deberá encontrarse a bordo personal del IEO los días efectivos de investigación y solo se considerarán esos días dentro de la presente autorización.

- Se deberá cumplir con todo lo establecido por el Reglamento (CE) nº 1224/2009 del Consejo, de 20 de noviembre de 2009, por el que se establece un régimen comunitario de control.

- A fin de poder conocer los días concretos de actividad, será necesario comunicar a esta Subdirección General (inspecpm@mapama.es) con al menos 24h de antelación el día o días a llevar a cabo dicha actividad.

Esta autorización es complementaria a la licencia comunitaria y a las respectivas autorizaciones de pesca que disponga cada pesquero y por tanto deberá llevarse a bordo.

La presente autorización se concede exclusivamente para el ámbito de la actividad pesquera y, por tanto, está condicionado al cumplimiento de la normativa en materia de seguridad y demás aspectos de la navegación que exige la Dirección General de la Marina Mercante.

EL Subdirector Adjunto Control e Inspección

Juan Antonio Agüero Monedero

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Annex II

Characteristics of hauls carried out during observers survey, total catch retained catch and *Nephrops* catch by haul.

HAUL	STARTING DATE	STARTING HOUR	DURATION (hh : min)	STARTING DEPTH (m)	ENDING DEPTH (m)	TOTAL CATCH (kg)	RETAINED CATCH (kg)	NEPHROPS CATCH (kg)
1	01-ago-18	6:35	6:55	529	384	294	279	85
2	01-ago-18	14:15	2:15	457	421	83	83	40
3	01-ago-18	18:23	4:40	466	439	602	597	77
4	02-ago-18	7:30	4:45	457	390	263	208	40
5	02-ago-18	13:15	5:00	413	567	159	124	21
6	02-ago-18	19:15	4:46	576	428	91	70	8
7	03-ago-18	0:45	5:20	433	238	134	120	0
8	03-ago-18	8:30	4:00	313	329	169	119	24
9	03-ago-18	13:30	5:00	380	377	413	403	13
10	07-ago-18	7:32	3:58	368	318	96	62	9
11	07-ago-18	11:58	4:32	322	302	160	110	22
12	07-ago-18	17:17	4:42	349	355	195	157	17
13	07-ago-18	23:00	3:30	285	289	143	131	0
14	08-ago-18	3:20	3:10	285	287	178	162	0
15	08-ago-18	7:30	5:01	408	380	201	179	24
16	08-ago-18	13:25	5:08	375	415	161	138	7
17	08-ago-18	19:25	3:59	304	311	129	106	7
18	09-ago-18	7:22	5:09	437	373	242	193	27
19	09-ago-18	13:20	5:22	393	422	266	220	57
20	09-ago-18	19:30	4:58	433	452	303	275	30
21	10-ago-18	1:39	4:36	468	499	160	140	8
22	10-ago-18	7:28	5:09	441	371	271	236	30
23	10-ago-18	13:20	5:09	391	463	333	288	51
24	14-ago-18	7:06	5:37	433	388	207	150	30
25	14-ago-18	13:10	5:20	393	424	241	201	35
26	14-ago-18	19:15	5:35	402	470	159	133	0
27	15-ago-18	2:15	3:45	426	333	159	139	0
28	15-ago-18	7:35	4:26	313	406	246	192	40
29	15-ago-18	12:45	6:50	402	406	363	247	57
30	15-ago-18	20:30	3:28	278	177	149	149	0
31	16-ago-18	7:35	6:18	395	377	265	180	34
32	16-ago-18	14:48	6:47	390	358	245	150	29
33	16-ago-18	22:35	3:25	307	187	120	120	0
34	17-ago-18	2:40	3:50	190	331	302	302	0
35	17-ago-18	7:25	5:05	406	316	123	80	23
36	17-ago-18	13:20	4:56	320	320	248	205	27
37	21-ago-18	7:35	4:32	333	313	137	94	24
38	21-ago-18	12:55	8:09	320	358	310	223	37
39	21-ago-18	21:55	4:05	265	197	161	161	0
40	22-ago-18	2:45	3:59	212	289	152	152	0
41	22-ago-18	7:33	6:34	382	375	237	158	37
42	22-ago-18	15:02	8:29	382	481	167	157	29
43	23-ago-18	7:39	6:51	368	382	180	114	21
44	23-ago-18	15:26	7:04	358	335	165	108	25
45	23-ago-18	23:30	6:33	494	497	249	184	16
46	24-ago-18	7:05	5:53	499	485	202	161	28
47	24-ago-18	13:45	4:45	496	497	420	379	30
48	28-ago-18	7:30	6:07	384	406	235	193	12
49	28-ago-18	14:21	5:04	402	318	201	134	20
50	28-ago-18	20:10	4:20	322	340	170	156	0
51	29-ago-18	2:30	4:00	234	219	105	90	0
52	29-ago-18	7:30	6:07	307	401	248	172	35
53	29-ago-18	14:32	4:59	395	384	303	215	27
54	29-ago-18	20:15	4:00	307	197	126	126	0
55	30-ago-18	7:45	5:18	368	382	190	123	25
56	30-ago-18	14:00	7:12	353	315	237	163	29
57	30-ago-18	22:15	3:45	302	203	97	97	0
58	31-ago-18	2:45	4:05	210	276	88	88	0
59	31-ago-18	8:00	5:02	384	357	207	133	29
60	31-ago-18	14:00	4:45	373	395	294	230	23
61	04-sep-18	7:35	5:35	439	393	198	137	14
62	04-sep-18	13:55	6:05	384	302	192	128	15
63	04-sep-18	20:50	4:40	247	241	191	191	0
64	05-sep-18	2:20	4:40	228	232	122	122	0
65	05-sep-18	8:00	6:09	312	391	283	212	20
66	05-sep-18	15:10	4:58	404	342	181	135	21
67	05-sep-18	21:05	3:25	274	190	140	140	0
68	06-sep-18	7:30	5:30	395	351	209	148	21
69	06-sep-18	14:00	7:00	371	333	207	154	18

Annex II *cont*

HAUL	STARTING DATE	STARTING HOUR	DURATION (hh : min)	STARTING DEPTH (m)	ENDING DEPTH (m)	TOTAL CATCH (kg)	RETAINED CATCH (kg)	NEPHROPS CATCH (kg)
70	06-sep-18	22:10	5:40	417	490	134	134	0
71	07-sep-18	4:40	4:05	576	475	173	154	28
72	07-sep-18	10:00	8:47	408	395	311	268	20
73	10-sep-18	4:04	4:16	475	461	210	139	0
74	10-sep-18	9:00	5:00	421	391	277	202	32
75	10-sep-18	14:54	4:55	379	455	277	199	32
76	10-sep-18	20:40	4:05	465	459	509	464	13
77	11-sep-18	7:55	5:50	415	375	229	138	30
78	11-sep-18	14:40	6:05	384	415	208	125	21
79	11-sep-18	21:50	4:35	481	527	608	456	14
80	12-sep-18	3:35	4:25	485	286	515	448	7
81	12-sep-18	8:58	5:17	439	395	143	112	19
82	12-sep-18	15:15	5:18	399	386	113	73	13
83	12-sep-18	21:32	3:58	223	152	146	146	0
84	13-sep-18	8:07	5:53	428	404	261	216	22
85	13-sep-18	14:50	5:42	430	408	186	141	22
86	13-sep-18	21:20	5:55	475	470	200	200	0
87	14-sep-18	4:10	6:05	477	375	289	225	14
88	14-sep-18	11:00	7:05	475	335	265	211	16
89	17-sep-18	3:27	4:38	441	430	133	71	9
90	17-ago-18	8:50	5:10	397	384	158	99	12
91	17-sep-18	15:00	5:00	366	358	168	94	14
92	17-sep-18	21:00	3:10	236	236	179	179	0
93	18-sep-18	7:35	5:55	315	390	220	206	16
94	18-sep-18	14:20	6:15	380	315	316	221	30
95	18-sep-18	21:40	3:50	430	430	118	118	0
96	19-sep-18	2:35	4:40	391	314	172	172	0
97	19-sep-18	8:00	5:03	313	316	260	172	34
98	19-sep-18	13:50	6:43	347	324	308	224	44
99	19-sep-18	21:15	4:00	247	165	76	76	0
100	20-sep-18	8:00	5:00	320	313	156	98	21
101	20-sep-18	14:00	6:34	335	335	261	187	27
102	20-sep-18	21:25	3:05	274	207	88	88	0
103	21-sep-18	1:25	5:55	207	322	291	291	0
104	21-sep-18	8:10	4:45	331	315	146	93	19
105	21-sep-18	13:43	4:47	313	327	244	162	31

Working document X

ICES Working Group for the Celtic Seas Ecoregion
8–17 May 2019
Ghent, Belgium

ICES Working Group for the Assessment of the Bay of Biscay and the Iberic waters Ecoregion
2–9 May 2019
Lisbon, Portugal

Maturity-at-age estimates for Irish Demersal Stocks in 6.a, 7.a and 7.bgj between 2004-2018

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Introduction

This document provides maturity-at-age estimates for stocks assessed by the WGCSE and WGBIE. All data are obtained on surveys and commercial sampling carried out by the Marine Institute.

Methods

Data was used from the Marine Institute Q1 Biological sampling programme (2010-2018), At-Sea Observer programme (2010-2018), Irish Anglerfish and megrim survey (2016-2018), the Irish beam trawl Ecosystem survey (2016-2018) and the MI Biological sampling survey (2004-2009). Proportions mature-at-age were estimated by constructing a matrix containing the sample numbers by age, sex and maturity state (mature/immature) at each length class. Unsexed individuals (usually small fish with undeveloped gonads) were assigned in equal numbers to both sexes. This Age-Sex-Maturity-Length Key (ASMLK) was applied to the length-frequency data to estimate the proportions mature-at-age for either sex and both sexes combined. Any gaps in the ASMLK were filled in using a multinomial model (Gerritsen et al., 2006).

Results

Figure 1 shows that for most stocks there are no clear trends in the L50 over time. Estimates for cod in area 7 (cod 7) varied from around 40cm to 60cm, however the sample sizes for this stock were generally very low at the start of the time-series; in recent years the estimates are were quite variable (around 40cm). Sole in 7 also exhibited variable estimates in recent years. Plaice in area 7 (ple 7) had an outlying estimate for 2013 but this was estimated with low precision. Because overall there was no clear evidence of trends in maturity over time for any stock, data from all years (2004-2018) were combined. Table 1. Shows the estimated proportions mature-at-age. For the cod stocks, the proportion of mature 2-year-olds is somewhat higher than that the proportions used by the working group. For other ages the estimates are very similar. For haddock in 7.b-k the Irish estimates are slightly lower for 2-year-olds and in agreement for the other ages. For haddock in 7.a the Irish estimates are similar to those used by WGCSE, 2018 for all ages. For haddock in 6.a the Irish estimates for age 2 were higher than the proportions used by the WGNSSK working group. For megrim, the Irish estimates were very close for females of ages 2 to 4, for ages 5 to 8 the Irish estimates were somewhat lower than those used by the WGBIE working group. Estimated proportions mature for plaice and sole were also slightly lower than those used by the working group. For whiting in 7.b-k, the Irish maturity estimates are broadly in agreement with the ogives used by the working group, for the other whiting stocks the Irish estimates are considerably higher for the 0-group and similar for older fish.

Discussion

Some (relatively minor) differences were found between the ogives used by the working groups and the current findings. Because Irish sampling generally does not cover the full extent of the stocks, it is difficult to determine whether the Irish estimates are unbiased. It is possible that the lack of full spatial coverage can explain some of the differences.

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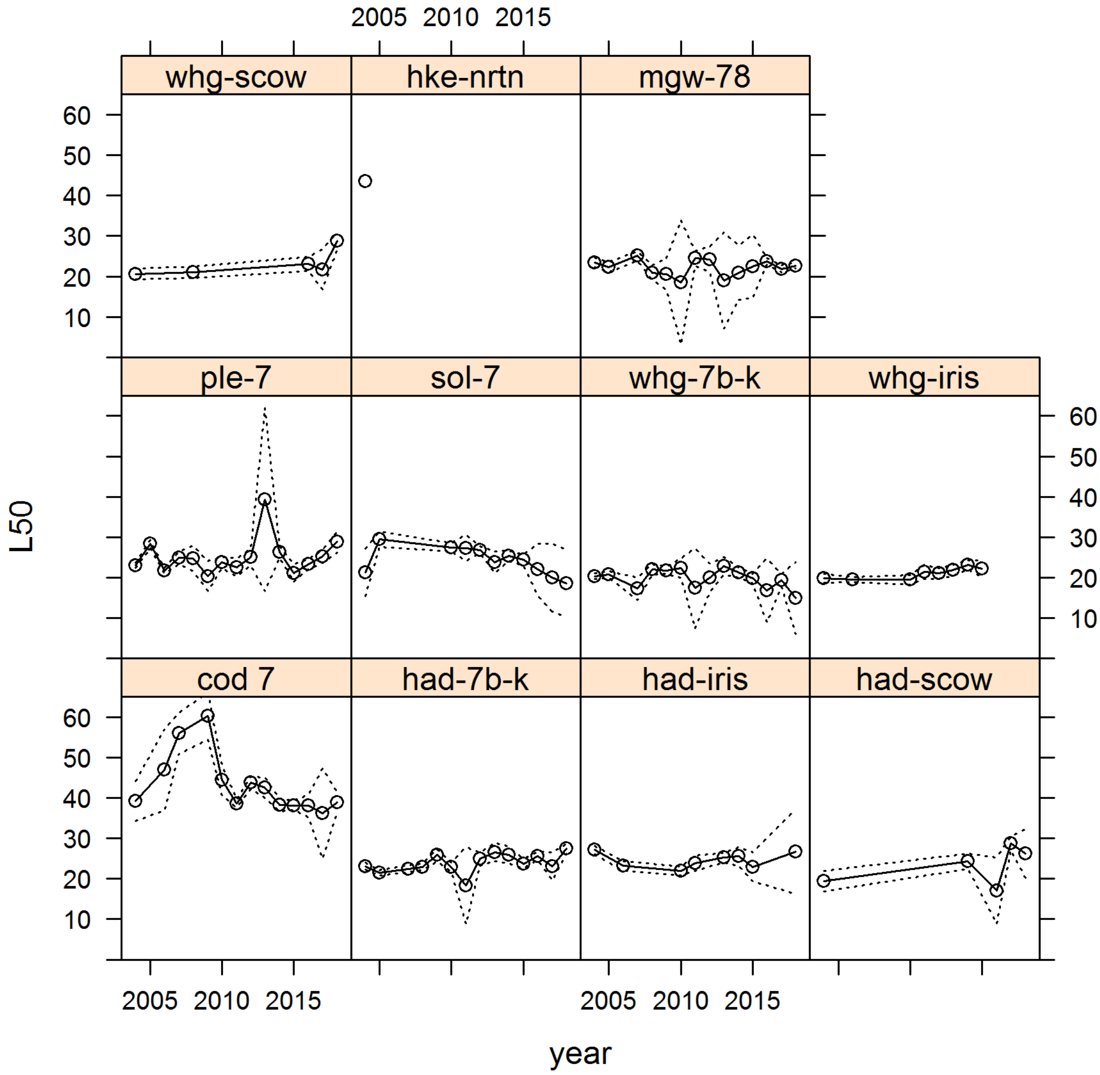

Figure 1. Length at 50% maturity (L50; cm) for females by stock and year.

Table 1. Estimated proportions mature (sample numbers in brackets) by stock, sex and age. Maturity ogives used by the WG are also given.

Stock	Sex/WG	1	2	3	4	5	6	7	8	9	10+
cod 7	**F**	0.02 (760)	0.60 (942)	0.95 (120)	1.00 (20)	1.00 (3)	1.00 (3)	1.00 (2)			
	M	0.01 (922)	0.75 (1494)	0.98 (133)	1.00 (14)	1.00 (2)					
cod 7.a	**WGCSE**	0	0.64	1	1	1	1	1	1	1	1
cod 7.e-k	**WGCSE**	0	0.39	0.87	0.93	1	1	1	1	1	1
had 7.b-k	**F**	0.01 (384)	0.89 (888)	0.98 (714)	0.98 (247)	1.00 (107)	1.00 (58)	1.00 (47)	1.00 (21)	1.00 (10)	1.00 (3)
	M	0.27 (493)	0.79 (726)	0.89 (482)	0.89 (172)	1.00 (81)	1.00 (30)	0.96 (19)	1.00 (15)	1.00 (4)	1.00 (1)
	WGCSE	0	1	1	1	1	1	1	1	1	1
had 7.a	**F**	0.02 (154)	0.78 (198)	0.96 (129)	1.00 (5)	1.00 (5)					
	M	0.14 (112)	0.72 (183)	0.87 (125)	1.00 (3)	1.00 (1)					
	WGCSE	0	0.72	0.99	1	1	1	1	1	1	1
had 6.a	**F**	0.05 (17)	0.91 (192)	0.82 (204)	0.83 (168)	0.94 (31)	0.96 (64)	0.98 (49)	1.00 (35)	0.91 (24)	1.00 (5)
	M	0.05 (35)	0.75 (150)	0.67 (132)	0.72 (80)	0.94 (12)	0.71 (18)	0.65 (12)	0.34 (11)	0.43 (7)	
	WGNSSK	0	0	1	1	1	1	1	1	1	1
mgw 78	**F**	0.10 (14)	0.25 (534)	0.67 (1096)	0.87 (840)	0.88 (539)	0.88 (372)	0.84 (192)	0.85 (141)	0.92 (125)	1.00 (1)
	M	0.66 (15)	0.35 (580)	0.54 (699)	0.69 (387)	0.71 (234)	0.75 (176)	0.85 (139)	0.90 (74)	0.94 (31)	
	WGHMM	0.04	0.21	0.6	0.9	0.98	1	1	1	1	1
ple 7	**F**	0.00 (13)	0.14 (222)	0.45 (720)	0.65 (547)	0.78 (406)	0.94 (164)	0.92 (98)	0.86 (50)	0.93 (18)	0.98 (28)
	M	0.00 (14)	0.31 (249)	0.57 (518)	0.72 (380)	0.81 (208)	0.87 (108)	0.87 (52)	0.91 (39)	0.83 (14)	1.00 (9)
ple 7.a	**WGCSE**	0	0.24	0.57	0.74	0.93	1	1	1	1	1
ple 7.fg	**WGCSE**	0	0.26	0.52	0.86	1	1	1	1	1	1
sol 7	**F**	0.00 (2)	0.17 (40)	0.47 (402)	0.65 (698)	0.87 (473)	0.93 (274)	0.96 (174)	0.98 (100)	0.95 (82)	0.96 (139)
	M		0.22 (22)	0.45 (81)	0.51 (127)	0.59 (96)	0.71 (132)	0.70 (118)	0.76 (113)	0.69 (73)	0.78 (164)
sol 7.fg	**WGCSE**	0	0.14	0.45	0.88	0.98	1	1	1	1	1
whg 7.b-k	**F**	0.29 (564)	0.96 (661)	0.98 (392)	0.99 (172)	1.00 (56)	1.00 (10)	1.00 (2)	1.00 (1)		
	M	0.49 (618)	0.82 (516)	0.95 (347)	0.85 (159)	0.80 (54)	1.00 (16)	1.00 (2)	1.00 (1)		
	WGCSE	0	1	1	1	1	1	1	1	1	1
whg 7.a	**F**	0.11 (295)	0.92 (281)	0.99 (144)	1.00 (22)	1.00 (4)					
	M	0.23 (239)	0.77 (148)	0.74 (48)	1.00 (9)	1.00 (5)					
	WGCSE	0	1	1	1	1	1	1	1	1	1
whg 6.a	**F**	0.44 (63)	0.90 (166)	0.93 (167)	0.92 (109)	0.96 (43)	1.00 (13)	1.00 (4)	1.00 (2)		0.00 (1)
	M	0.54 (77)	0.68 (136)	0.48 (119)	0.66 (54)	0.79 (13)	0.64 (12)	0.72 (6)	1.00 (1)		
	WGCSE	0	1	1	1	1	1	1	1	1	1

Changes in the length-weight relationship in Northern Stock of European hake (*Merluccius merluccius*).

Working document to the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion WGBIE – Lisbon 2-9 May 2019.

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May 6, 2019

Contents

Background

Information on length-weight relationships (LWR) for commercially exploited species is essential for the assessment of marine resources. However, commonly the analyses of LWR do not consider the intrinsic differences that could have individuals caught from different areas or years. The variability in the LWR could affect their estimations and the utility of this data in computing fisheries biomass.

In addition, for the northern stock of the European hake, (*Merluccius merluccius*), fishers in the ICES areas VI and VII warned that the mean LWR of individuals has decreased in the recent years. Biological data is not reported to the group and a fixed LWR is used in the assessment.

Within this context, we investigated the LWR for the European hake, northern stock, from 2003 to 2018 assessing difference among areas and years.

Sampling

Sampling length-weight measurements of European hake individuals collected from the Atlantic waters were taken from historical records collected during 2003-2018. Total length (TL) was measured to the nearest 0.1 cm and total weight (Wt) was measured to the nearest 1 g. AZTI provided 30990 samples from the commercial fleet, while the IEO provided 15213 from both fisheries and research surveys. In all cases, fish were processed fresh and sexed. Frozen samples were not considered in this study. However, it worth to be mentioned, that most of the data of the weight measurements provided by the IEO of commercial fisheries was gutted and for this reason excluded by most of the analysis.

Length-weight relationships

All analyses were conducted using the R statistical software R Core Team (2018) and in particular, the length-weight relationship parameters were computed using the Fisheries Stock Assessment (FSA) package Ogle (2017). First, a linear regression was performed (model 1) as presented in equation 2, where Wt is total weight, TL is total length, α is the regression intercept, and β is the regression slope.

$$\log_{10}(Wt) = \log_{10}(\alpha) + \beta \log_{10}(TL) \tag{1}$$

As mentioned before, several factors could influence the LWR. For this reason an error term e_i normally distributed was included in the equation 2. This error could be associated to annual (model 2) or spatial (model 3) variations at the level of fish individuals population. In order to account for differences with respect to length, temporal and spatial effects and interaction terms were added to the basic model (model 1). This allowed us to model LWR, including factors separately or as interactions to test if the relationship between length and weight (i.e. slopes) was statistically different across areas, seasons and years.

Models were fitted using the following terms as fixed factors: log10TL (continuous), divisions (VI, VII, VIII, Unknown) and year (2003-2018).

Model selection was performed using the Akaike Information Criterion (AIC). The final selected model was the one with the lowest AIC value.

Results and discussion

Descriptive results

From 2003, 2200 individuals on average were collected each year. Only in the 2014 a lower number of fishes was available (1636). The ICES divisions where fishes were caught were the VI, VIIbchjk,VIIIabd. These were grouped in three zones such as VI, VII and VIII.

In particular, the VIII was the area with more caught individuals (29010), followed by the VII with 8346, the VI with only 103 individuals and all sampled in the 2011 (Figure 1). It worth to be mentioned that, for 8744 individuals, the sampling area was unknown.

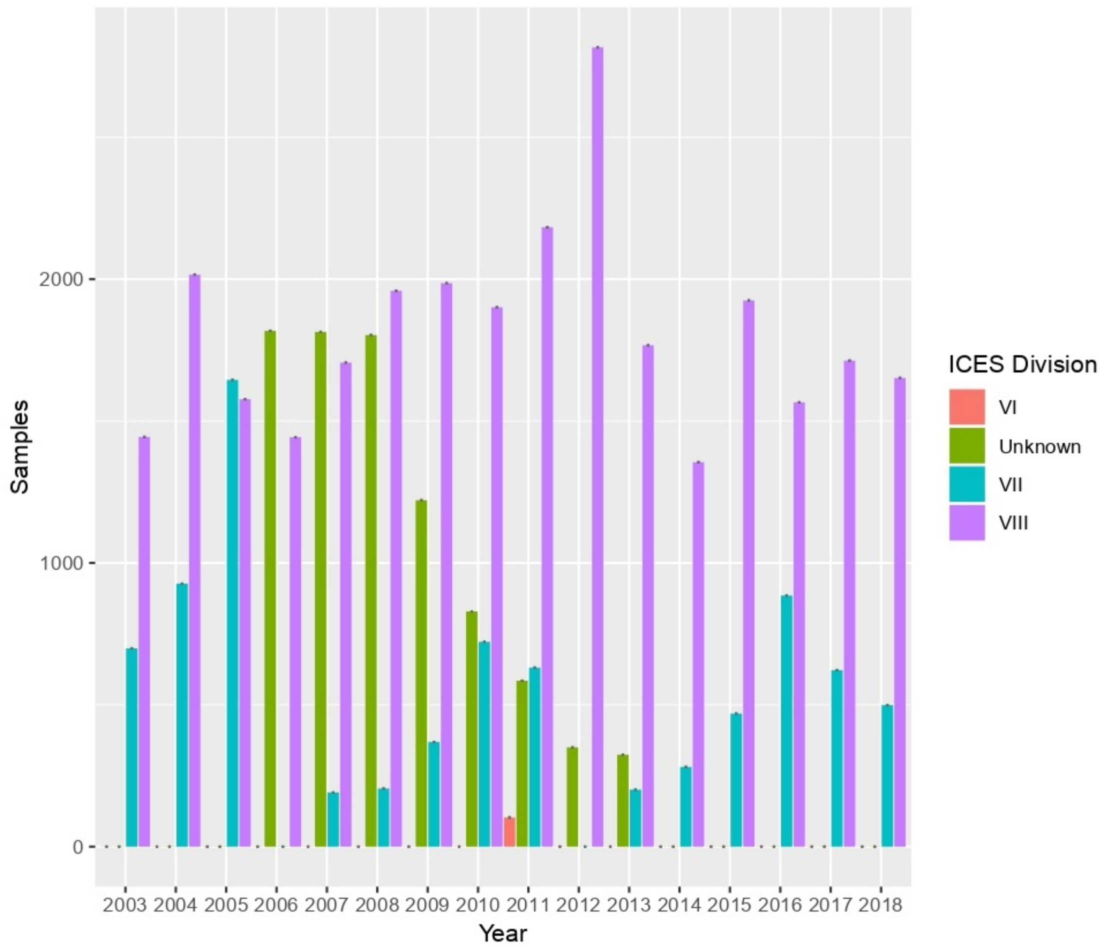

Figure 1: Samples by year and ICES Division.

If we examine the length frequency (with a length interval data of 10 cm) we can see that both, in number of individuals and in proportion, the majority of the population is between 30-40 cm (Figure 2).

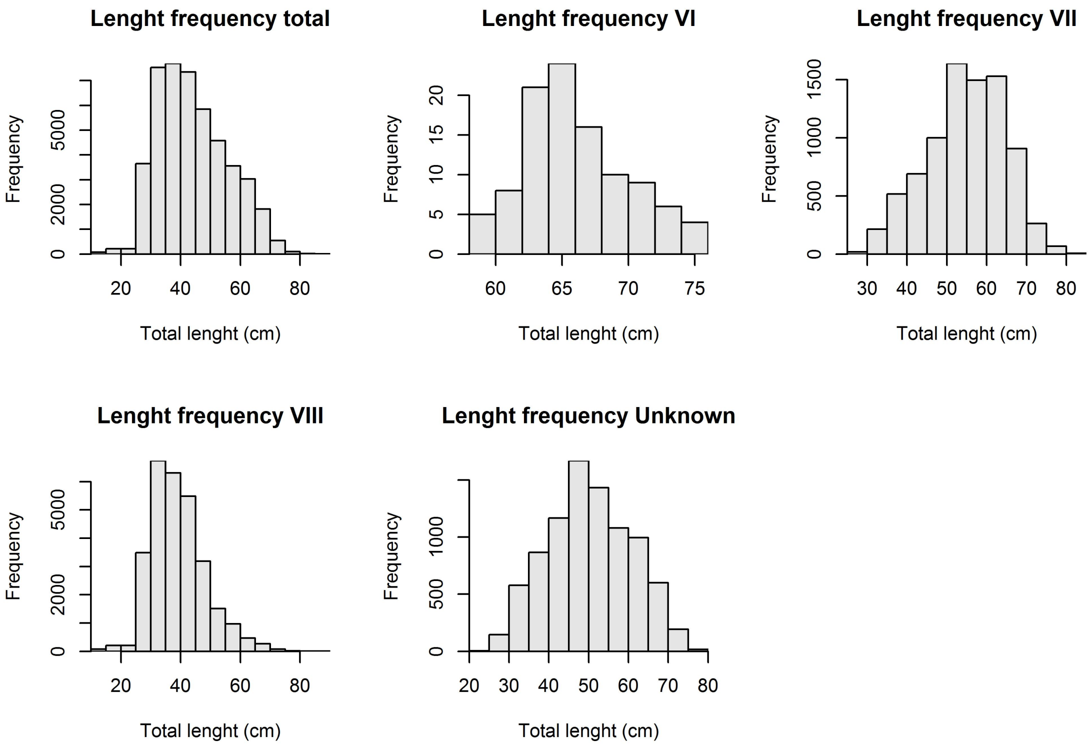

Figure 2: Histograms length frequency for all data and by ICES Division.

Length-weight relationships.

Log10 transformed weight (gutted weights) significantly predicted lengths. The model exhibits a good fit to the transformed data (R^2 0.99) with the possible exception of few individuals (Figure 3). The estimates for α and β for the basic model was:

$$\log_{10}(Wt) = \log_{10} -2.13 + +2.95 \log_{10}(TL) \tag{2}$$

with a variation of α between -2.15 (2.5 %) and -2.15 (97.5 %), and β between 2.95 (2.5 %) and 2.96 (97.5 %) (all on the transformed scale).

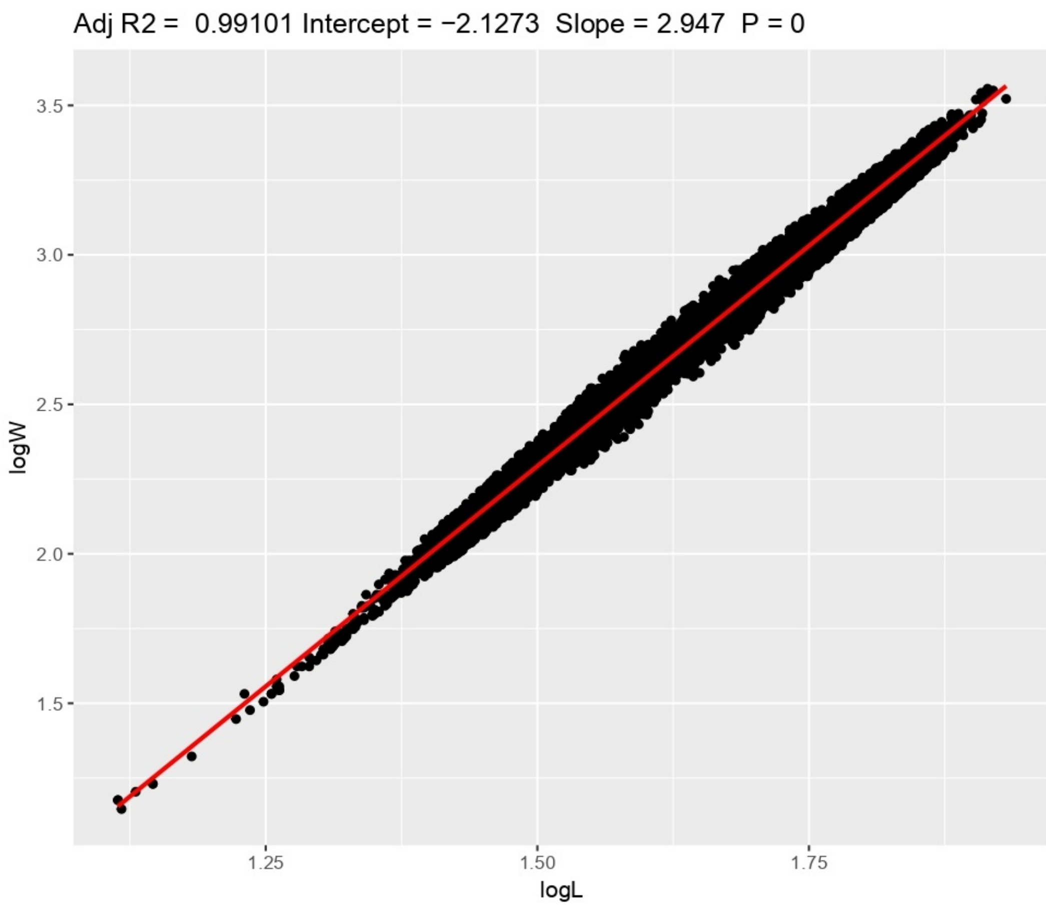

Figure 3: Length-weight relationship of the European hake from 2003-2018 with all data (gutted weights).

Testing spatio-temporal variations.

The model with the inclusion of the year as factor reveled that the year had a significant effect on the LWR. Because the studied years have statistically different slopes and intercepts, there is a variable difference between the log-transformed weights of the collected individuals in 2003-2018 regardless of the log-transformed lengths (Figure 4).

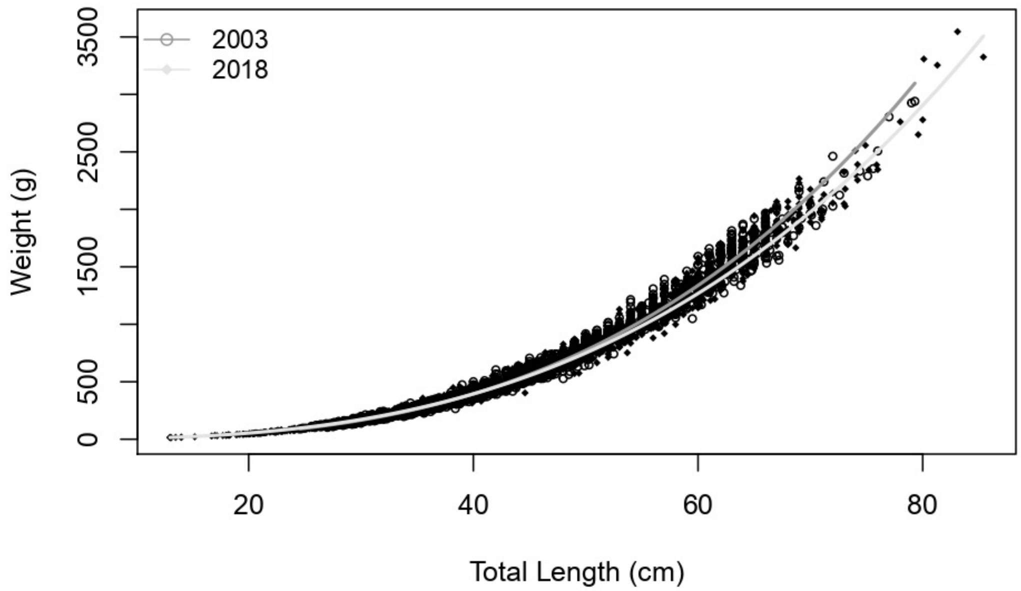

Figure 4: Length-weight relationship (gutted weights) of the European hake from 2003-2018 with the year factor.

Also the area showed a significant effect on the LWR, but particularly the difference was between the VI and the VII and VIII (Figure 5). However, it worth to be mentioned that data from the VI were present only for one year of the time series. The AIC of this model was -187230.5, while the one of the model with only the year was -188100.3. The model with the year is better.

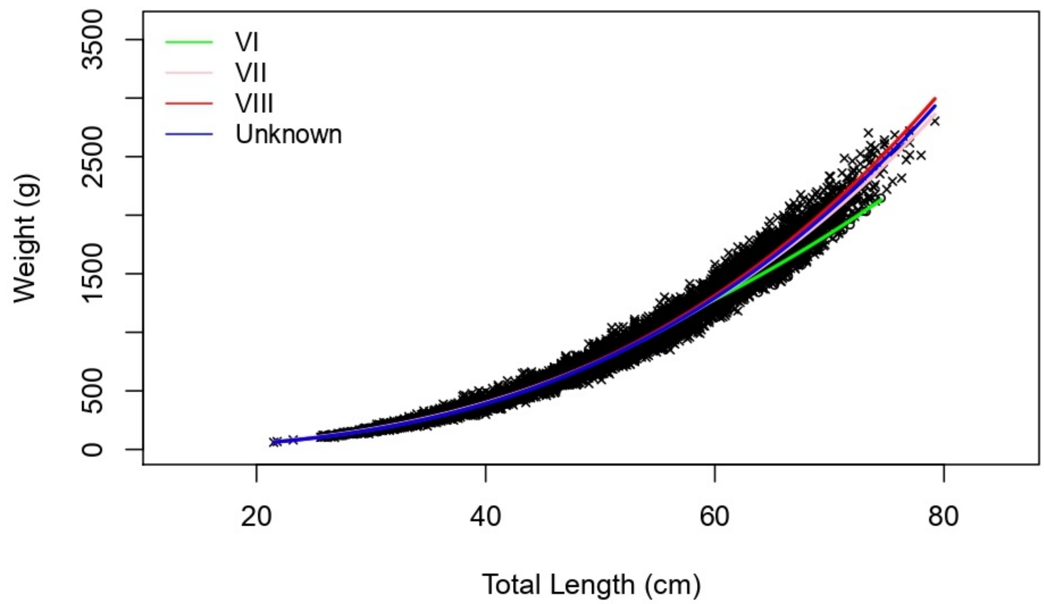

Figure 5: Length-weight relationship (gutted weights) of the European hake from 2003-2018 with the ICES division factor.

Assessment Results Comparison

As the difference between areas VII and VIII was not too big, and the input data for the stock assessment model require the use of total weights (not gutted), we run a separated analysis using only AZTI data that has total weights for the VIII area.

The model with the AZTI data (total weights) used for compute yearly LW parameters showed that there was a change in 2011 (Figures 6 and 7).

Year	a	b
2003	0.0086	2.93
2004	0.0038	3.16
2005	0.0053	3.06
2006	0.0056	3.05
2007	0.0071	2.99
2008	0.0046	3.10
2009	0.0068	3.00
2010	0.0057	3.04
2011	0.0078	2.96
2012	0.0081	2.95
2013	0.0099	2.89
2014	0.0072	2.98
2015	0.0079	2.95
2016	0.0117	2.85
2017	0.0078	2.95
2018	0.0095	2.91

Figure 6: Length-weight parameters computed with 2003-2018 data for VIII ICES area.

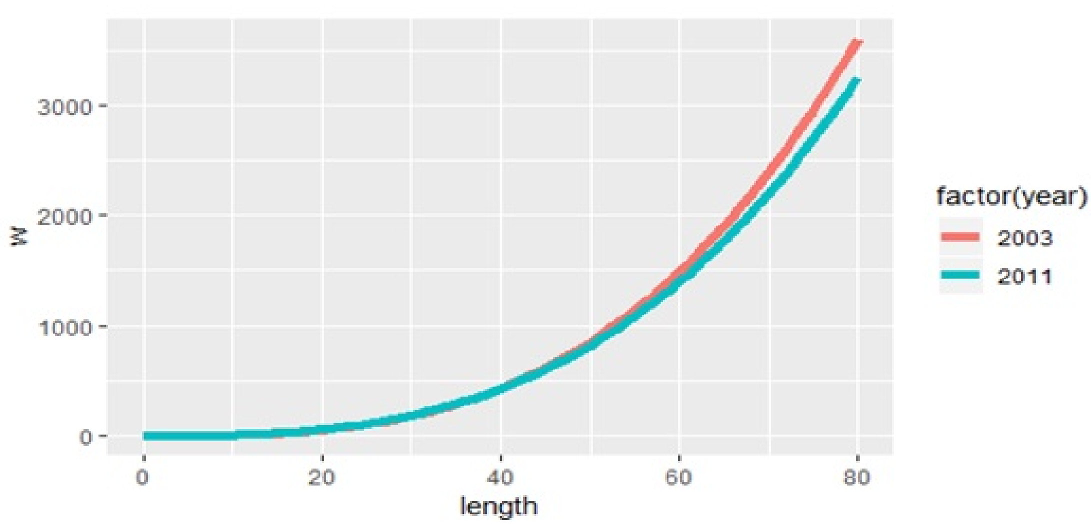

Figure 7: Length-weight parameters computed with 2003-2018 data for VIII ICES area.

The LW parameters commonly used in the SS3 until now was equal to α and 0.00513 and β 3.074.

As SS3 allows to add these parameters in temporal groups we used two different blocks:
(1) 1978-2010 α 0.00512 and β 3.07
(2) 2011:2017 α 0.00840 and β 2.94

Using the new computed LW parameters there was a decrease of the 7% in the SSB with respect to the assessment in 2017 performed with traditional parameters, and an increase in 8% in the F (Figure 8).

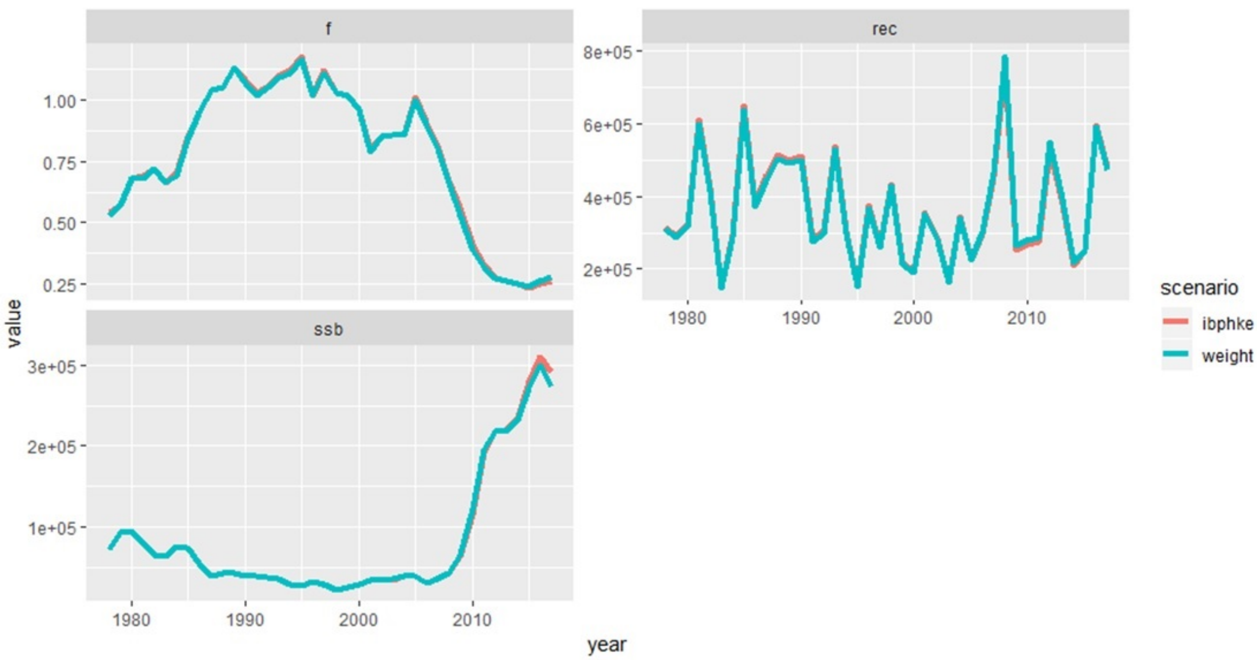

Figure 8: SS3 results using the new LW parameters.

For biological reference points there was slight changes (Figure 9).

Fishing mortality	wg19		Variation in weight	
	With Btrigger	No Btrigger	With Btrigger	No Btrigger
Fmsy	0.28	0.27	0.28	0.28
Flow	0.17	0.17	0.17	0.18
Fupp	0.41	0.39	0.43	0.42

Figure 9: Biological reference points comparison between the assessment of 2017 performed with traditional LW parameters and the new one.

Conclusions

Based on this preliminary analysis the introduction of the new LW parameters could vary the final assessment and advice. Further analysis need to be performed to explore additional data and specifically to apply the computed LWR to compile raw data that are used in the assessment.

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Ecological basis to embrace temporal assessment and spatial management of the European hake (*Merluccius merluccius*) in the northern Iberian Peninsula.

Working document to the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion WGBIE – Lisbon 2-9 May 2019.

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Contents

Background

Spatial management of commercial resources is becoming an effective measure to be broadly implemented in the European Seas. However, it is currently unconnected from the population dynamics and the official assessment. Indeed, it is known that species abundance can be influenced by the environmental features of its own habitat and/or by biotic process that are spatially structured (e.g. reproduction, predation, among others). Usually, this variability is assumed to be implicitly in the abundance trends used as inputs of the stock assessment models and it is not explicitly taken into account. Within this context, in this study we propose a novel methodological approach for an effective implementation of spatial and ecological knowledge that could help to embrace species spatial management in an operational way, providing a more holistic and ecosystem-based approach. As case study we used the European hake (*Merluccius merluccius*) in the northern continental shelf of the Iberian Peninsula. Hake data by length category collected during the scientific survey series "DEMERSALES" by the "Instituto Español de Oceanografía" (IEO) from 1992-to 2017 were analyzed using hierarchical Bayesian spatial-temporal models (H-BSTMs), considering as environmental variables Sea Bottom Temperature, Sea Bottom Salinity, bathymetry and rugosity of the seabed. H-BSTMs link spatially information on hake abundance to environmental variables to estimate and predict where (and how much of) this species is likely to be present in the studied area in a specific year.

Indices of abundance obtained as outputs from H-BSTMs, performed with the innovative integrated nested Laplace approximation (INLA) methodology and software, are then used as inputs for the GADGET (Globally applicable Area Disaggregated General Ecosystem Toolbox) stock assessment model (Figure 1). Finally, a comparative analysis of the results obtained with the GADGET model using the H-BSTMs abundance indexes and the ones commonly used in stock assessment evaluations is performed.

We argue that the analytical framework proposed in this study allowed to (1) assess which environmental factors influence the different life stages of the hake in the northern continental shelf of the Iberian Peninsula, (2) identity the areas in which the different life stages are more aggregated and their spatial-temporal fluctuations, and (3) could be a decisive step to improve habitat-based standardization abundance indexes and stocks' management in European Seas.

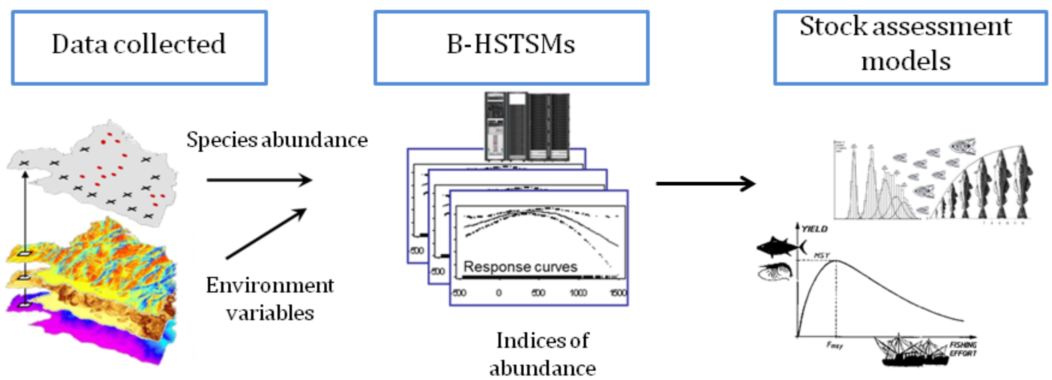

Figure 1: Working path representing how hierarchical Bayesian spatial-temporal models (H-BSTMs) will inform stock assessment models.

Material and methods

Data

The data used in this study were collected during the scientific survey series "DEMERSALES" by the "Instituto Español de Oceanografía" (IEO) carried out in autumn (September to October) from 1992 to 2017. The DEMERSALES survey makes use of a stratified sampling design based on depth with three bathymetric strata: 70–120 m, 121–200 m and 201–500 m. Sampling stations consisted of 30 min trawling hauls located randomly within each stratum at the beginning of the design. However, as a result of weather conditions or other external factors, station location varied slightly in some years and hauls were therefore not always performed at exactly the same latitude and longitude (Pennino et al., 2019). Approximately 128 hauls (minimum 119 and maximum 141) divided between the three bathymetric strata were performed every year in this zone (Figure 2), using the baka 44/60 gear (Sánchez and Gil, 2000).

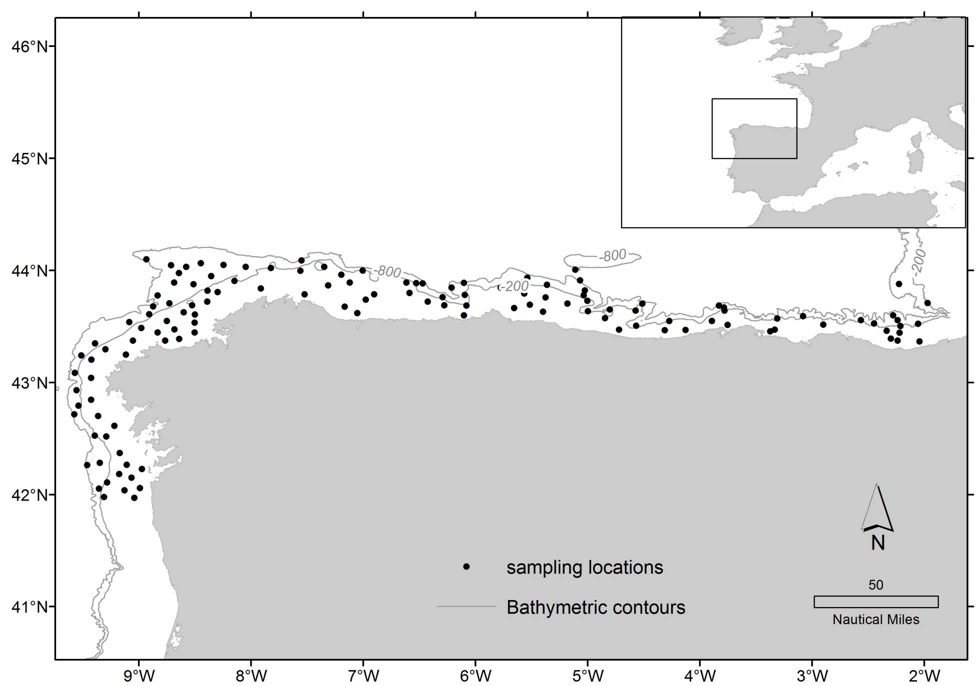

Figure 2: Study area and sampling locations (black dots) of the DEMERSALES surveys (1997-2016). Bathymetric contours indicate the 200 and 800 m isobatas.

With the European hake length distribution accessible to this gear three groups were created: recruits, which include all specimens with a length <21 cm; adults, individuals between 12 and 35 cm; and individuals larger than 35 were aggregated in a separated category.

For each one of this group two different variables were analyzed in order to describe the spatio-temporal behaviour of the European hake species. First, we considered the presence/absence variable to measure the occurrence of the species in each life stage. Secondly, we used a discrete variable, the total number of individuals per 30 minutes of trawling (i.e.

number per unit effort, NPUE), as an indicator of the conditional-to-presence abundance of the species.

Environmental variables

Three environmental variables were considered as potential or known predictors of the European hake life-stage distribution which may influence the habitat selection of this species. These include two oceanographic variables: Sea Bottom Temperature (SBT in C) and Sea Bottom Salinity (SBS in PSU), and the bathymetry (in metres).

SBT and SBS were added to the analysis as they are strongly related to marine system productivity, affecting nutrient availability and water stratification (Pennino et al., 2013). SBT and SBS values were collected during the survey with a sounding CTD (conductivity, temperature and depth) in different random sampling points of the study area. Monthly SBT and SBS maps of the entire area were obtained for each year of the studied period with the Radial basis functions (RBF) tool in ArcGIS 10.1.

The bathymetry map was retrieved from the European Marine Observation and Data Network (EMODnet, http://www.emodnet.eu/) with a spatial resolution of 0.02 x 0.02 decimal degrees.

In order to ensure the same spatial resolution, all environmental data were aggregated to the lower spatial resolutions using the *raster* package (Hijmans, 2018) in the R software (R Core Team, 2018). All covariates were explored for collinearity, outliers, and missing values before their use in the models following the approach of Zuur et al. (2010). In particular correlation among variables was tested using the Pearson's correlation, while the collinearity computing the Generalized variance-inflation factors (GVIF) (Fox and Weisberg, 2011).

Finally, to facilitate visualization and interpretation, the explanatory variables were standardized (difference from the mean divided by the corresponding standard deviation) (Gelman, 2008).

Characterizing the spatio-temporal behaviour of the European hake

This study used the spatio-temporal model structure comparison proposed by Paradinas et al. (2017) to categorize the spatio-temporal behaviour of the European hake in either opportunistic, persistent or progressive (see Table 1 and Figure 5). In particular, opportunistic structures indicate that species change their spatial pattern every year without following any specific pattern. Persistent structures imply that species have a spatial distribution that is common every year, while the progressive ones indicate that the spatial pattern of the process change from one year to another. The progressive structure contains a ρ_t parameter (see Table 1) that controls the degree of autocorrelation between consecutive years. This ρ_t parameter is bounded to $[0, 1]$, where parameter values close to 0 represent more opportunistic behaviors and parameter values close to 1 represent more persistent distributions.

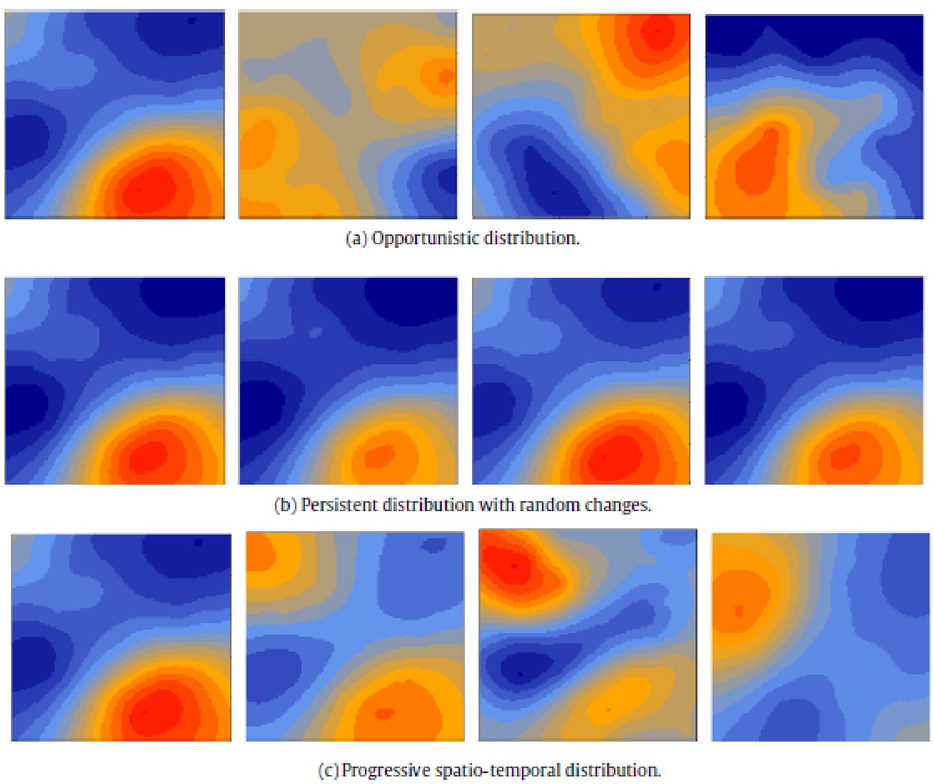

Figure 3: Simulated types of spatio-temporal scenarios. From Paradinas et al., (2017).

Modelling European hake occurrence and abundance distribution

Spatio-temporally fishery abundance data often result in observing large proportions of zeros, i.e. zero inflated data. These data are generally tackled using independent two-part models, also known as delta models. In these models, the occurrence and the conditional-to-presence abundances (NPUE) are modeled independently. However, abundance and detection probability are often related (Kéry et al., 2005), which violates the independence assumption of common delta models. This study incorporated the fact that both processes could be related by fitting shared environmental effects and/or spatio-temporal structures as described in Paradinas et al. (2017). In this way we combined information on the presence/absence of the species under study and its abundance.

In particular, Y_{st} and Z_{st} denote, respectively, the spatio-temporally distributed occurrence and the conditional-to-presence abundance (NPUE), where $s = 1, ..., n_t$ is the spatial location and $t = 1, ..., T$ the temporal index, being $i = 1, ..., I$ the environmental variable in location s. Then, as usual with this kind of variables, we modeled the occurrence, Y_{st}, using a Bernoulli distribution. In the case of the NPUE, Z_{st}, our selection to model it was a negative binomial distribution, a probability distribution that captures the overdispersion of the data. The mean of both variables was then related via the usual link functions (logit and log, respectively) to the bathymetric and spatio-temporal effects:

$$
\begin{aligned}
Y_{st} &\sim \mathrm{Ber}(\pi_{st}) \\
Z_{st} &\sim \mathrm{NB}(\mu_{st}, \sigma_{st}) \\
\mathrm{logit}(\pi_{st}) &= \alpha^{(Y)} + d_i + U_{st}^{(Y)} \\
\log(\mu_{st}) &= \alpha^{(Z)} + \theta_i d_i + U_{st}^{(Z)} \\
\Delta 2 d_i &= d_i - 2d_{i+1} + d_{i+2} \sim N(0, \rho_d)
\end{aligned}
\tag{1}
$$

where π_{st} represents the probability of occurrence at location s at time t and μ_{st} and σ_{st} are the mean and variance of the conditional-to-presence abundance. The linear predictors containing the effects to which these parameters π_{st} and μ_{st} are linked are formed with: $\alpha^{(Y)}$ and $\alpha^{(Z)}$, the terms representing the intercepts for each variable; d_i which stands for a second order Random Walk model that allows us to fit any possible non-linear relationship of the environmental variables (Fahrmeir and Lang, 2001); the final terms $U_{st}^{(Y)}$ and $U_{st}^{(Z)}$ refer to the spatio-temporal structure of the occurrence and conditional-to-presence abundance respectively and may follow any of the three spatio-temporal structures described in the previous section.

The spatial field (W_s) was modelled as a multivariate normal distribution with zero mean and a Matérn covariance function that depend on its range (r_w) and variance (σ_w). The temporal trend $f(t)$ could follow any suitable function, either a linear effect, a smooth effect, an unstructured random term, etc.

Vague prior distributions with a zero-mean and a standard deviation of 100 were implemented for all the fixed effects, the variance of the abundance process, and the scaling parameter of the shared effects. For the geostatistical terms and the ρ parameters of the second order Random Walks (RW2) PC priors (Simpson et al., 2017) were assigned fixing the probability of the range of the spatial effect at 0.15, the probability of the variance of the spatial effect at 0.20 and the probability that the precision of the RW2 effects at 0.01. A sensitivity analysis of the choice of priors was performed by verifying that the posterior distributions concentrated well within the support of the priors.

Model selection was performed testing all possible combinations among the possible spatio-temporal structures and variables and using the Watanabe Akaike Information Criterion (WAIC)(Watanabe, 2010) as criteria of the goodness of fit and the Log-Conditional Predictive Ordinates (LCPO) (Roos et al., 2011) as predictive quality measures. For both measures, the smaller the score the better the model. All these models and comparisons were fitted for all the European hake length groups.

Models were fitted using the integrated nested Laplace approximation (INLA) package (Rue et al., 2009) in the R environment.

Results and Discussion

Do the computational time at the moment we run these type of models only for the recruits group. The future steps will be do the same analysis for the others groups and use the derived abundance indices in the GADGET model to assess which kind of changes could have on the stock assessment of the European hake in this area.

European hake recruits

For the European hake recruits the best spatio-temporal structure was the progressive without shared spatio-temporal effects (Table 2). Concerning the spatio-temporal structures, shared components did not improve the progressive fitted model (Table 2), as also occurred in (Paradinas et al., 2017). This result could suggest that hake recruitment data is generated through two different processes; the probability of observing hake recruits and, if present, their abundance. However, the nature of the process under study induces to believe that this apparent independence is a consequence of the high sampling effort of the survey relative to the abundance of hake recruits, rather than being two different processes. The DEMERSALES survey trawls a relatively big areas, therefore the probability of observing at least one individual of an abundant fish species, such as hake, is quite high at environmentally not-too-challenging areas. Similarly, if effort was diminished, the detection probability would decrease proportionally and thus record a lot more zeros in our dataset.

No high correlation (Pearson's correlation lower than 0.60) and collinearity (Variance Inflation Factor, GVIF: values lower than 3) were found among the environmental variables. Consequently all variables were used in the models.

Bathymetry was the most important variable to define the occurrence and NPUE distribution of the hake recruits in the studies areas (Table 3). Indeed, although the best models, in terms of WAIC, were the one with the bathymetry and the SBS or SBS, the difference is negligible with the model that include only the bathymetry (i.e. lower than 5 units). For this reason, and following a parsimony principle, the selected model was the one with the bathymetry, fitted as shared smoothed effect between the two processes (i.e. occurrence and NPUE).

The selection of an autoregressive temporal term in the model suggests the presence of a certain degree of temporal continuity in the spatial distribution of hake recruits in the study area. These results were supported by the high temporal correlation parameters of the progressive spatio-temporal structures (0.99 and 0.96 for the occurrence and conditional-to-presence abundances respectively).

The smoothed bathymetric effect highlighted that abundance of hake recruits decreases gradually after the optimum 150–200 metre strata (Figure 4).

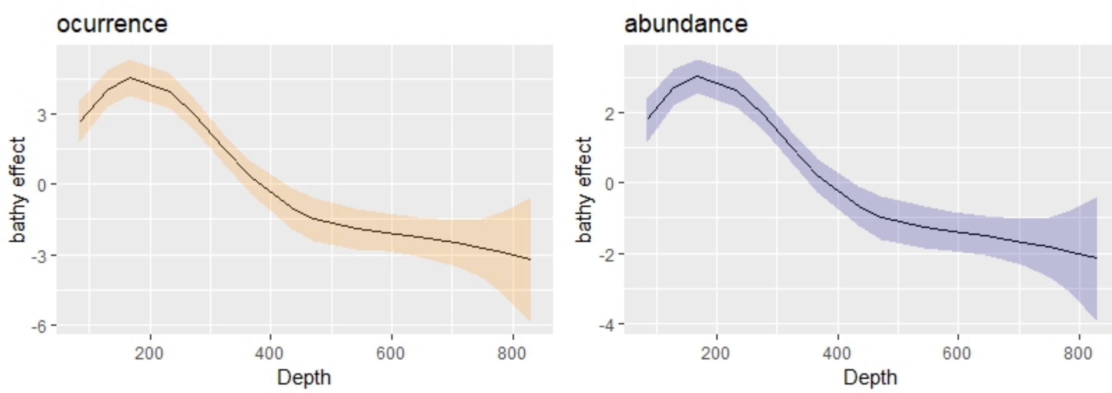

Figure 4: Bathymetric smoothed effect for both occurrence and abundance variables.

In addition, the posterior mean of the spatial effect maps in Figures 5 and 6 show a main persistent hot-spot along the continental shelf of the Artabrian gulf (off La Coruña). Although the recruitment of hake is mainly concentrated in this specific areas there have been smooth changes in the relative abundance and the spatial location from year to year.

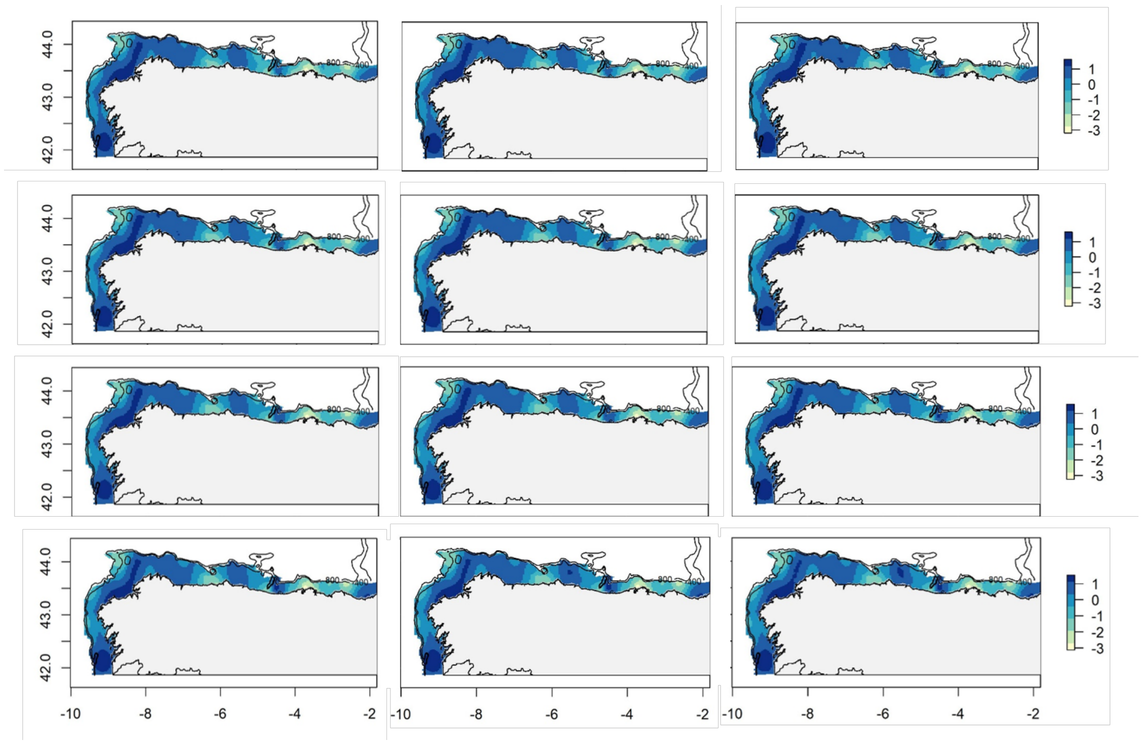

Figure 5: Posterior means of the spatial effect for the progressive model with the shared bathymetric smoothed effect for the occurrence pattern.

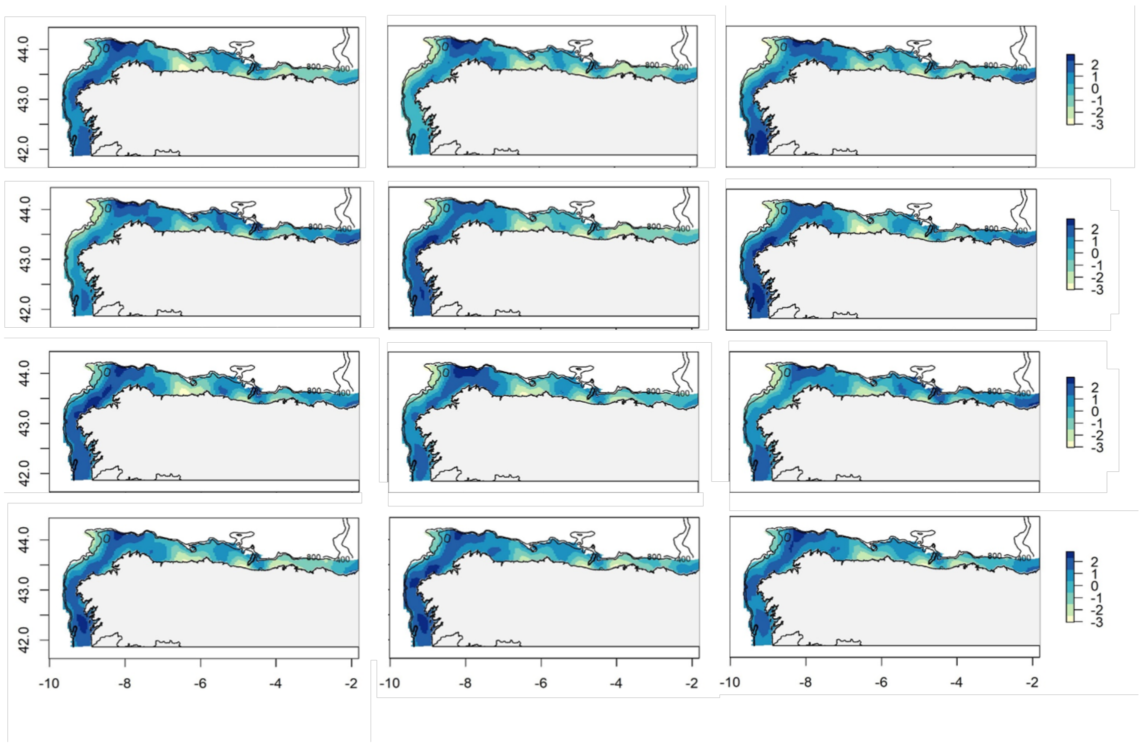

Figure 6: Posterior means of the spatial effect for the progressive model with the shared bathymetric smoothed effect for the abundance pattern.

Acknowledgments

The authors express their gratitude to all the people that work in the DEMERSALES surveys. DEMERSALES surveys were co-funded by the EU within the Spanish national program for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy.

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Tables

Model	Notation	Description
Opportunistic	$U_{st} = W_{s_t}$	Different and uncorrelated realizations of the spatial field every year.
Persistent	$U_{st} = W_s + f(t)$	A common realization of the spatial field for all years and an additive temporal trend
Progressive	$U_{st} = W_{st} + \rho_t U_{st-1}$	Spatial realizations change over time using a first order autoregressive model

Table 1: Explanation of the three different spatio-temporal structures compared in the models.

Model	WAIC	LCPO	Time (sec.)
Persistent Shared Effects	15879.45	2.90	80.91
Persistent Not Shared Effects	16001.28	2.92	118.08
Opportunistic Shared Effects	16095.17	2.95	59.82
Opportunistic Not Shared Effects	16231.99	2.95	79.56
Progressive Shared Effects	16774.70	3.05	401.62
Progressive Not Shared Effects	**15846.09**	**3.11**	**7138.10**

Table 2: Spatio-temporal structures comparison for the conditional-to-presence abundance distribution European hake recruits' model based on WAIC and LCPO scores. Time scores refer only to the estimation process of the model. The best model is highlighted in bold.

Model	WAIC	LCPO	Time
Progressive Bathymetry Shared Effects	**15659.88**	**3.02**	**13667.78**
Progressive SBS Shared Effects	15848.98	3.11	7168.39
Progressive SBT Shared Effects	15800.53	3.15	11032.17
Progressive Bathymetry SBS Shared Effects	15655.22	3.05	16488.46
Progressive Bathymetry SBT Shared Effects	15657.85	3.07	17097.45
Progressive SBS SBT Shared Effects	15804.95	3.16	11683.53
Progressive Bathymetry Not Shared Effects	15668.76	3.03	10143.00
Progressive SBS Not Shared Effects	15852.73	3.11	10662.15
Progressive SBT Not Shared Effects	15798.90	3.14	9416.98
Progressive Bathymetry SBS Not Shared Effects	15672.92	3.03	14104.07
Progressive Bathymetry SBT Not Shared Effects	15672.60	3.06	15135.95
Progressive SBS SBT Not Shared Effects	15805.43	3.14	11152.92

Table 3: Environmental effects comparison for the conditional-to-presence abundance distribution European hake recruits' model based on WAIC and LCPO scores. Time scores refer only to the estimation process of the model. The best model is highlighted in bold.

Biological Reference points for Hake (Merluccius merluccius) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock (Greater North Sea, Celtic Seas, and the northern Bay of Biscay)

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1. Introduction

In 2019 the stock was benchmarked in an interbenchmark workshop. The historical time series of discards of two of the fleets considered in the assessment model were introduced in the model. Now, all the discards estimates available in Intercatch and included in the assessment model. This change, lead to a change the perception of the stock status and the overall selection pattern of the fleet. Hence, it was necessary to recalculate the reference points. The biomass reference points are now higher than before and the fishing mortality ones lower.

2. Material and Methods

a. Data

The output of the assessment model selected as final in the interbechmark workshop held in February 2019 (ICES, 2019) was used to calculate the reference points.

b. Methods

The same software used in 2015 (ICES, 2015) was used to calculate the reference points. It consist on a series of R scripts specifically developed to be consistent with the stock dynamics used to describe the stock in SS3, the assessment model used to assess the stock, (Methot and Wetzel, 2013). The R code integrate the SS3 dynamics with the procedure to run long term projections in eqSim software. Basically, the difference is in the stock recruitment fit and the seasonal cohorts. With the software used here, the stock recruitment relationship is fitted using Bayesian statistics, so a join posterior distribution is obtained for the stock-recruitment paratemeters. Moreover, while eqSim uses annual dynamics, the R functions used here uses seasonal dynamics with one cohort per season.

Stock-recruitment relationship

First the stock recruitment relationship was adjusted to historical data using three different stock recruitment relationship, beverton and holt, ricker and segmented regression. The model was run for 10000 iterations and in each one, the stock-recruitment model that resulted in a better fit was selected.

Biomass-reference points

Once the stock recruitment relationship was fitted the biomass reference points were defined according to the categories and guidelines defined by ICES.

Fishing mortality reference points

Finally, the fishing mortality reference points were calculated. In the long term projections two different scenarios were run which depended on the harvest control rule used:

1. Constant fishing mortality harvest control rule.
2. The harvest control rule used by ICES in category 1 stocks. In this harvest control rule there is a target fishing mortality that is used for advice whenever the spawning biomass is above a reference level. If the spawning biomass is below that level, the fishing mortality used for advice is decreased linearly.

However, the fishing mortality reference points (Fmsy, Flower, Fupper, Fpa and Flim) were defined based on the scenario with constant fishing mortality.

c. Settings

Table 1 Model and data selection settings

DATA AND PARAMETERS	SETTING	COMMENTS
SSB-recruitment data	Full data series (years classes 1978-2014)	
Exclusion of extreme values (option extreme.trim)	No	
Trimming of R values	No	
Mean weights and proportion mature; natural mortality	These parameters are constant in SS·, the same values used.	
Exploitation pattern	2005-2014	
Assessment error in the advisory year. CV of F	0.212	Default value calculated from 5 stocks in WKMSYREF3
Autocorrelation in assessment error in the advisory year	0.423	Default value calculated from 5 stocks in WKMSYREF3

3. Results

Stock Recruitment relationship

The stock recruitment model fits obtained are presented in Figure 1. Ricker stock recruitment relationship was selected only once, Beverton and Holt in the 14% of the cases and Segmented Regression in the 86%. Hence, following the same rationale followed in 2015 it was decided to use only the Segmented Regression relationship to run the long-term projections.

Biological Reference Points

The stock recruitment relationship was considered to be of type 2 "Stocks with a wide dynamic range of SSB, and evidence that recruitment is or has been impaired". In this case Blim is defined as que breakpoint of the stock-recruitment relationship. As the stock recruitment relationship in this case was adjusted using the Bayesian approach the Blim was defined as the median of the breakpoints obtained in the fit. The median was equal to 39821 and it was rounded to 40 000 tons.

Bpa was defined as Blim × 1.4 because the σ estimated from the assessment uncertainty in SSB in the terminal year is considered to be under-estimated and the default value was used (σ = 0.20 which leads to the 1.4 multiplier).

The 5% percentile of the SSB at Fmsy, 215 000 tonnes, was considered too high to be used as MSY Brigger. Hence, MSY Btrigger was set equal to Bpa, i.e MSY Btrigger = 56 000 t.

Fishing mortality reference points

For the base run, yield includes discards, with FMSY being taken as the peak of the median landings yield curve. The FMSY range is calculated as those F values associated with median yield that is 95% of the peak of the median yield curve (Figure 2). Estimated ranges [0.18–0.4] are presented in all the plots (red and green dashed lines). Left plot shows a clear separation between Flim (0.84) and the upper bound of FMSY (0.4) suggesting that this bound could be precautionary. The SSB at equilibrium when FMSY is applied is around 330 000 tones that is close to the 2016 level of biomass. In the whole fishing mortality range the mean recruitment is expected to be around the stock-recruitment model asymptote and it is expected to start decreasing when Flim is applied in the long term. The equilibrium yield at Fmsy is equal to 120 000 tonnes, close to the catch observed in 2016. The probability of being below Blim and Bpa started increasing when F was above 0.6 and for F = 1, the probability for both reference points was already higher than 50%.

The target and upper bound of the range obtained using the harvest control rule that used Btrigger was higher and the lower range lower (Figure 3 and Figure 4).

4. Selected reference points

The selected reference points were based on the scenario where fishing mortality was maintained constant independently of the biomass.

Table 6.1.3 Summary table of proposed stock reference points for method

STOCK		
MSY Reference point	Value	Rational
Blim	40 000	The median of the segmented regression breakpoint. (Type 2 stock recruitment type REF)
Bpa	56 000	$Blim*e^{0.2*1.645}$ REF
Flim	0.84	
Fpa	0.6	Flim/1.4
FMSY without Btrigger	0.28	
FMSY lower without Btrigger	0.18	
FMSY upper without Btrigger	0.40	
$F_{P.05}$ (5% risk to Blim without Btrigger)	0.84	
MSY Btrigger	56 000 (Bpa)	
$F_{P.05}$ (5% risk to Blim with Btrigger)	1.02	
FMSY with Btrigger	0.27	
FMSY lower with Btrigger	0.17	
FMSY upper with Btrigger	0.42	
MSY	119 000 t	
Median SSB at FMSY	200 000 t	
Median SSB lower (median at FMSY upper)	178 000 t	
Median SSB upper (median at FMSY lower)	452 686t	

5. Figures.

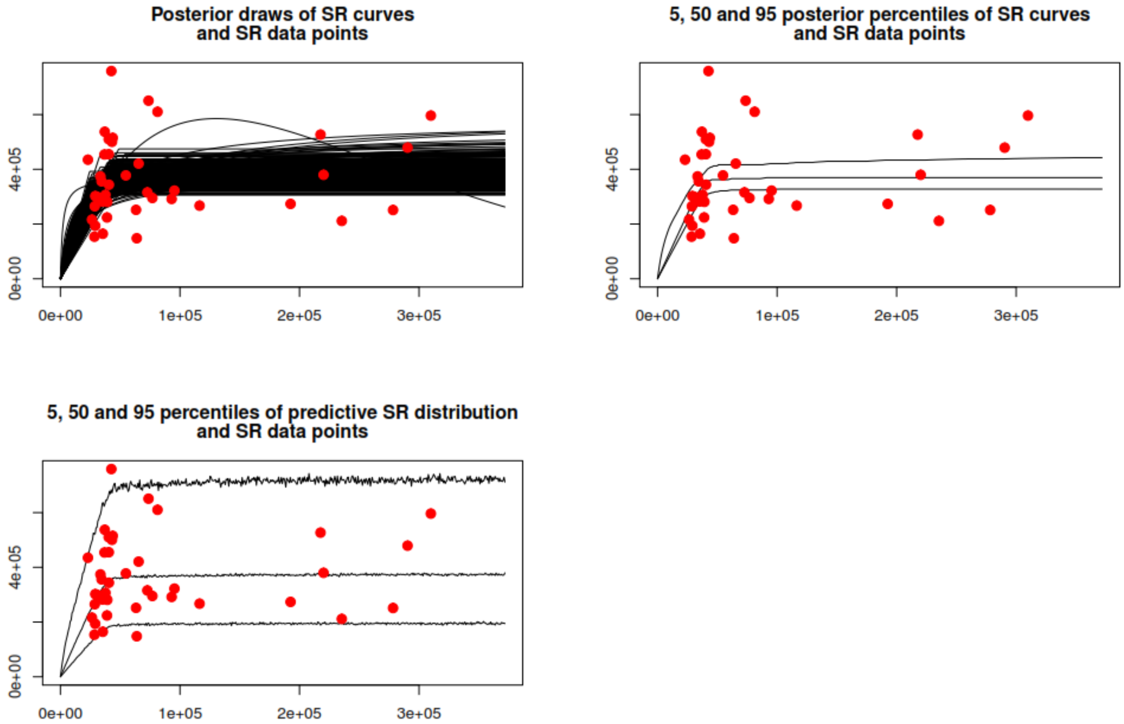

Figure 1. Stock recruitment model fit. The x-axis corresponds with stock spawning biomass and the y-axis with recruitment. The lines in the top-left graph correspond with the model fit in each iteration of the Bayesian model. The lines in the ther two plost correspond with the percentiles of the distribution. The red points correspond with the observed stock-recruitment values.

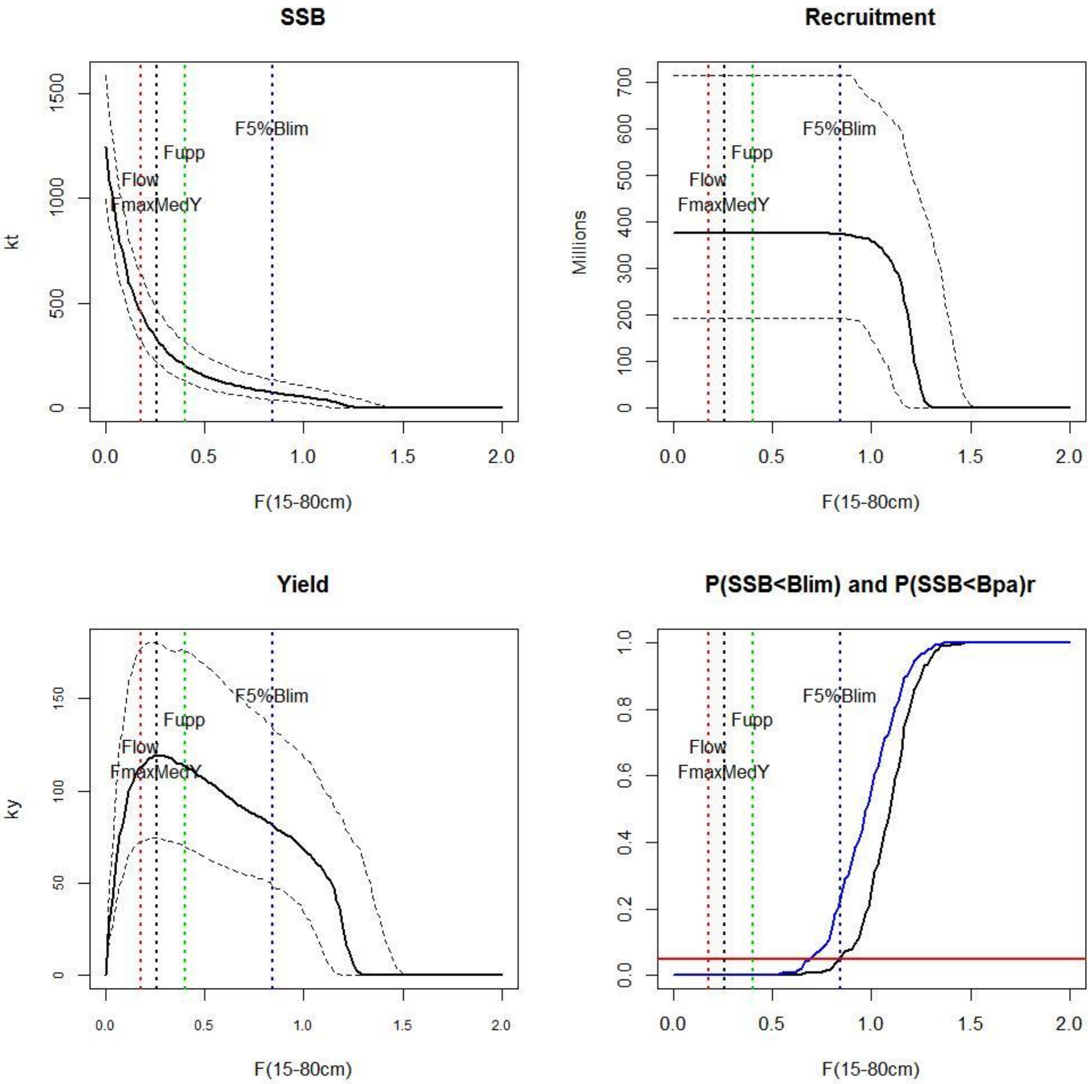

Figure 2 SSB, Recruitment, Yield and p(SSB < Blim), p(SSB<Bpa) versus Fbar. The solid line in the first three plots correspond with the median and the dashed lines with the 5% and 95% quantiles. The solid black line in bottom-right panel correspond with p(SSB < Blim) and the blue one with p(SSB<Bpa). The vertical lines correspond with lower limit of fishing mortality range (red), Fmax of Median Yield curve (black), upper limit of fishing mortality range (blue) and the fishing mortality which results in a 5% probability of being below Blim.

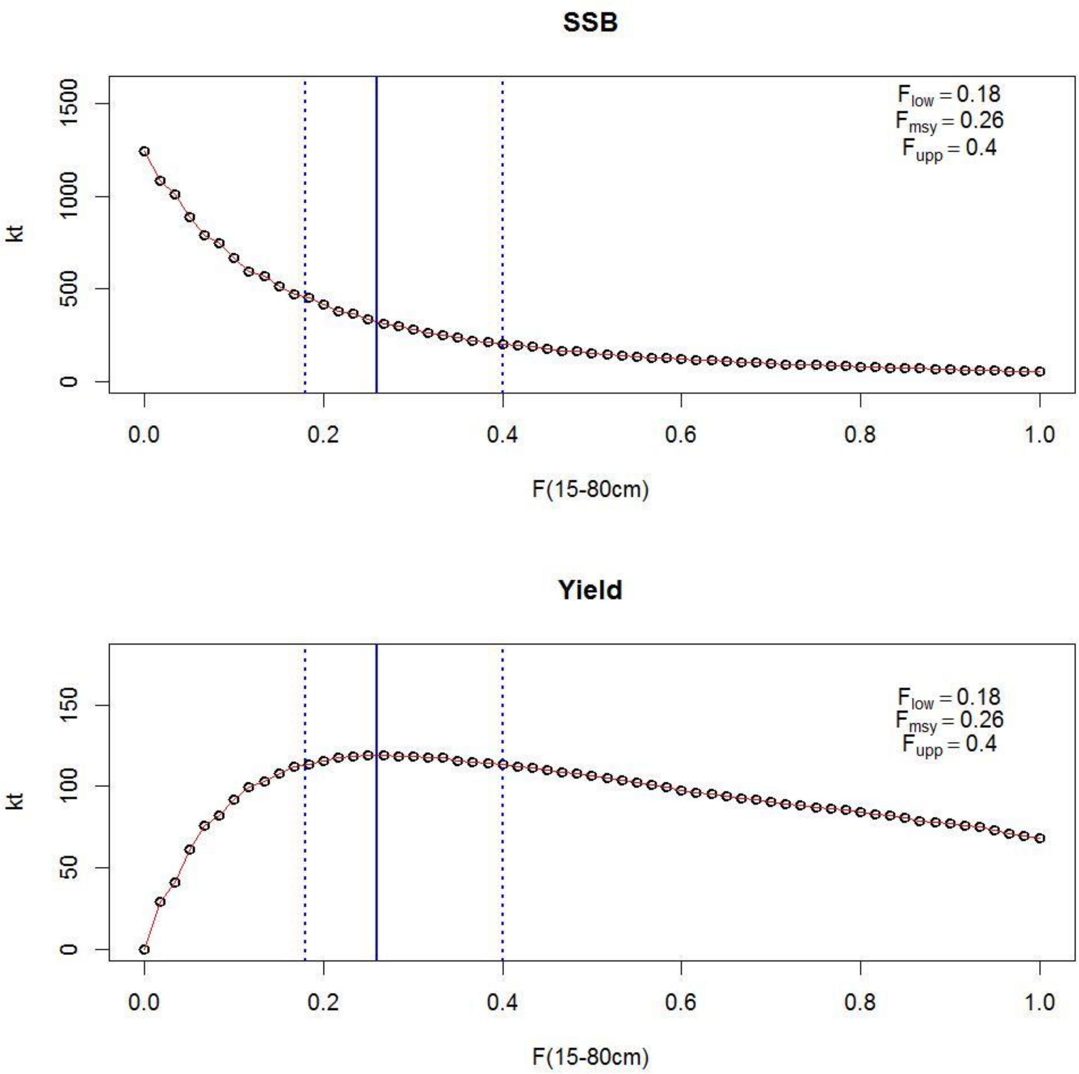

Figure 3 Median SSB (top) and landings yield (bottom) curve with estimated reference points for Northern stock of Hake with fixed F exploitation. Vertical solid line correspond with the median and dotted ones with the upper and lower limits of the fishing mortality ranges.

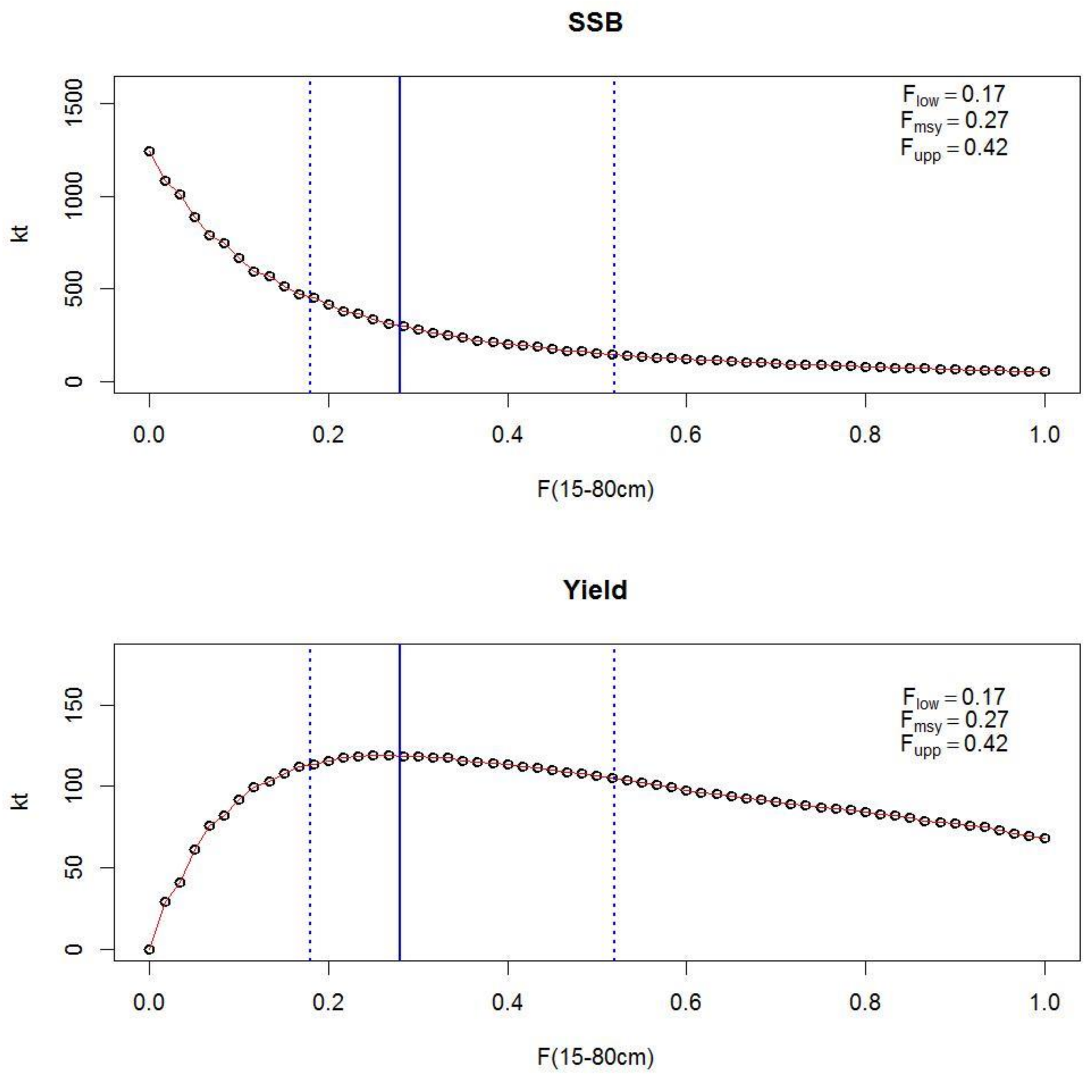

Figure 4 Median SSB (top) and landings yield (bottom) curve with estimated reference points for Northern stock of Hake with fixed F exploitation when applying the ICES MSY harvest control rule with $B_{trigger}$ at 56 000 t. Vertical solid line correspond with the median and dotted ones with the upper and lower limits of the fishing mortality ranges.

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Reference points for black anglerfish in areas 27.78abd

Working document to WGBIE 2019

Hans Gerritsen, Marine Institute, Ireland

Introduction

This document follows the ICES Technical Guidelines for setting reference points for stocks in category 3 and 4 (2018). Black anglerfish were benchmarked at WKAnglerfish in 2018 but no new assessment method or reference points could be agreed.

Input parameters

The input parameter that were used were estimated by WKAnglerfish 2018.

Parameter	Value	Comments
Linf	112.5	90% of largest observed individual
K	0.125	Linf and mean lengths of first two cohorts from survey length-frequency
T0	0	
M	0.3	WKAngler 2018
a	0.0195	WKAngler 2018
b	2.93	WKAngler 2018
maxage	10	WKAngler 2018

Length Based Indicators

The technical guidelines suggest that Length Based Indicators (LBI) should be used for screening; even if the assumption of equilibrium conditions are not met. In the case of black anglerfish there are strong pulses of recruitment which clearly violate those assumptions. The LBI indicators are presented therefore only for screening purposes (Figure 1).

Discard data are only available since 2003, which affects most of the indicators; therefore the indicators before 2003 should be considered separately.

Some of the indicators show a moderate increasing trend in recent years (e.g. the mean length of the largest 5%; the 95%ile; the mean length above Lc)

Mean length Z

The technical guidelines suggest exploring the mean length-based mortality estimator if sufficient length data and possibly effort data are available.

Catch length data are available from 2003 onwards. Landings data are available from 1986 onwards. Because the mean length Z method applies only to fully selected fish, the missing discard data should not affect the analysis.

No direct effort time-series is available. The guidelines provide an option to estimate effort from the total catch divided by the catch rate in one metier or in a survey (EffortTrend=Catch/CPUE). An approach analogous to this was applied, but using the while anglerfish assessment instead. This stock has a full analytical assessment and the two species are caught in the same fishery. WGBIE therefore considers that Catch/TSB of white anglerfish provides an adequate proxy for the fishing effort for black anglerfish.

Figure 2 shows the length frequency distribution of the catches for all years combined. The guidelines state that Lc, the length at full selectivity, should be chosen from the mode of the length distribution unless a bimodal distribution is found. The fish in the first mode are mainly 0-group and are not fully selected. The second mode is at 36cm at which length the fish are likely to be fully vulnerable to the fishery. This value was chosen for Lc but to test the sensitivity to this parameter, values of 16cm and 25cm were also explored.

The length at full selection (Lc) can then be used in an equilibrium yield-per-recruit analysis, together with the parameters listed above. Figure 3 shows the yield curve and F01 is estimated at 0.23.

The mean-length Z analysis was then performed using the mlen_effort() function in the code from https://github.com/ices-tools-dev/ICES_MSY. Figure 4 shows the outputs of the run with the default growth parameters.

A number of sensitivity runs were performed with higher and slower growth, estimated (rather than fixed) M and Lc = 16 and Lc = 25. Each of these runs resulted in F<F0.1 in the last year.

Other data-limited approaches

WKAnglerfish explored SPICT and found that the catch data did not respond to the changes in production. Although the model converged, the error bars were so large that no conclusions about the state of the stock could be drawn.

Length-based indicators and LB-SPR both require the assumption of equilibrium and cannot cope with strongly variable recruitment pulses that are a feature of this stock. These methods were therefore not further explored.

Biomass reference points

The mean-length-Z approach does not offer a way to estimate biomass reference points. However, the document ICES Implementation of Advice for Datalimited Stocks in 2012 in its 2012 Advice states: "*A survey-based proxy for MSY Btrigger should be estimated to represent a survey index below which more conservative catch advice is needed to avoid impaired productivity (e.g. lowest observed survey index or 25th percentile of survey indices). Ideally this would be an index of exploitable biomass*"

The combined EVHOE-IGFS index used for the advice indicates that during the time period for which the index is available the stock has not shown evidence of impaired reproductive capacity. The lowest observed (relative) biomass (Bloss), would therefore be a suitable proxy for Blim.

Following the guidelines for reference points for category 1 and 2 stocks, Bpa would then be:

Brigger = Bpa = Blim × exp(1.645 × σ) = Blim * 1.4. (If σ is unknown 1.4 can be used as default)

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger_{proxy}}$	1.29	B_{pa}	ICES 2019
	$F_{MSY_{proxy}}$	1	Relative value (F/F_{MSY}) from YPR and mean length-based Z.	ICES (2018c)
Precautionary approach	B_{lim}	0.92	B_{loss} in 2005 from the 2018 assessment	ICES 2019
	B_{pa}	1.29	B_{lim} * 1.4	ICES 2019
	F_{lim}			
	F_{pa}			

Conclusion

The input parameters are expected to be reasonably accurate; WKAnglerfish thoroughly explored the available data. The F reference point was somewhat sensitive to changes in the growth parameters and Lc, as was the estimated fishing mortality. However in all sensitivity runs the final year F was below F01.

It can therefore be concluded that F in 2018 was likely to be below F01. SSB was the highest observed and therefore above MSY Btrigger.

Figures and tables

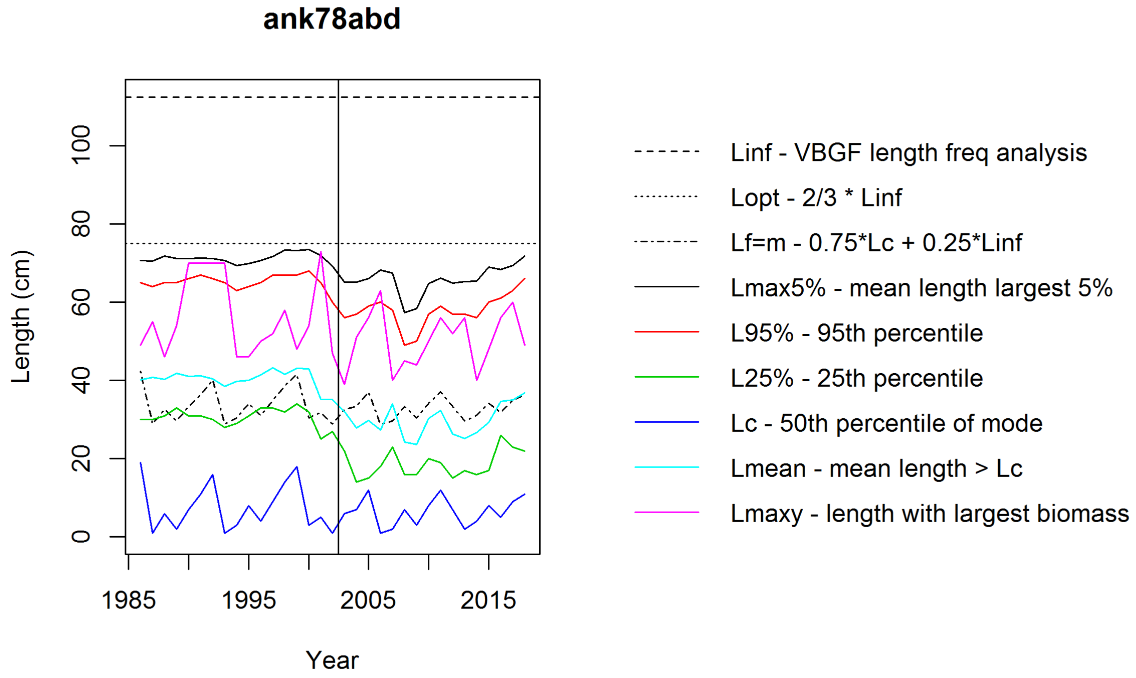


Figure 1. Length-based indicators. See Table 1 below for explanation. Discard data were not available before 2003 (vertical line)

Table 1. Selected indicators; table from technical guidelines.

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above L_{opt} + 10%. (L_{opt} is estimated from L_{inf}).	0.3 – 0.4	Pmega	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	> 1	Conservation (immatures)
L_c	Length at 50% of modal abundance	L_{mat}	L_c/L_{mat}	> 1	
L_{mean}	Mean length of individuals > L_c	$L_{opt} = {}^2/_3 L_{inf}$	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{max_y}	Length class with maximum biomass in catch	Lopt = ${}^2/_3 L_{inf}$	L_{maxy} / L_{opt}	≈ 1	
L_{mean}	Mean length of individuals > L_c	$L_{F=M} = (0.75L_c + 0.25L_{inf})$	L_{mean} / $L_{F=M}$	≥ 1	MSY

*Note this definition is different from the L_c used for the Mean-length Z estimator.

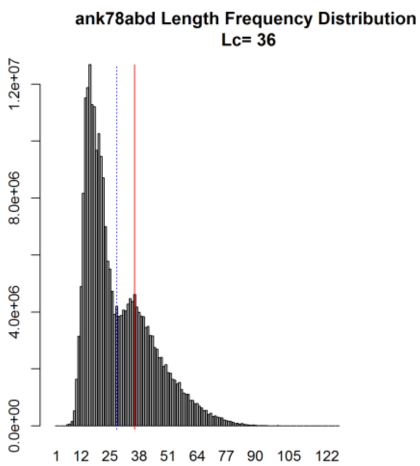


Figure 3.Total length distribution. The fish in the first mode are mainly 0-group and are not fully selected. The second mode is at 36cm at which length the fish are likely to be fully vulnerable to the fishery.

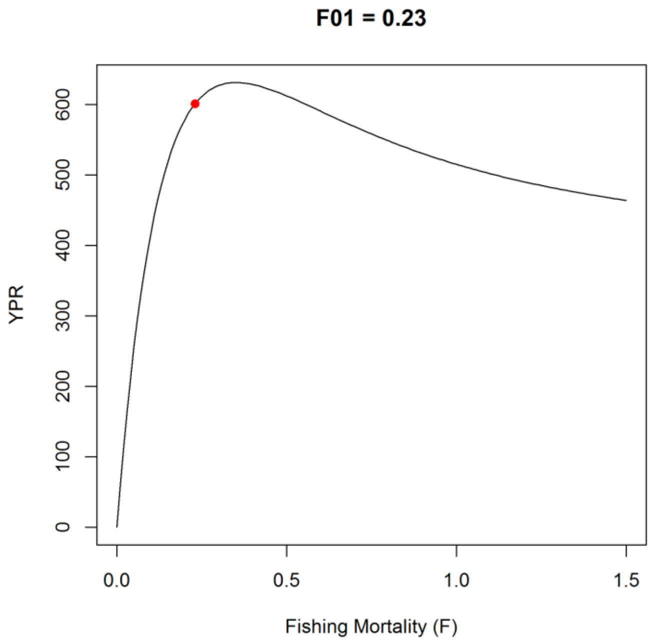


Figure 3. YPR curve.

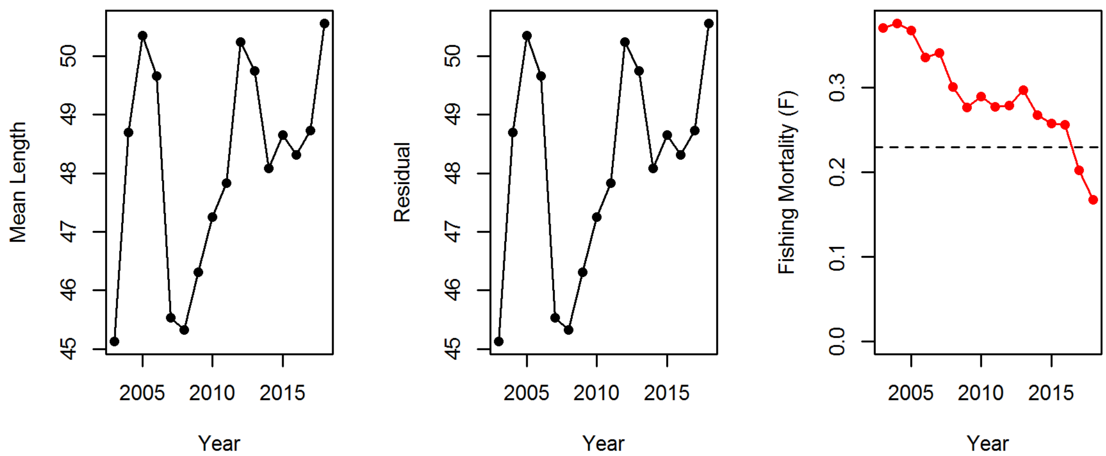
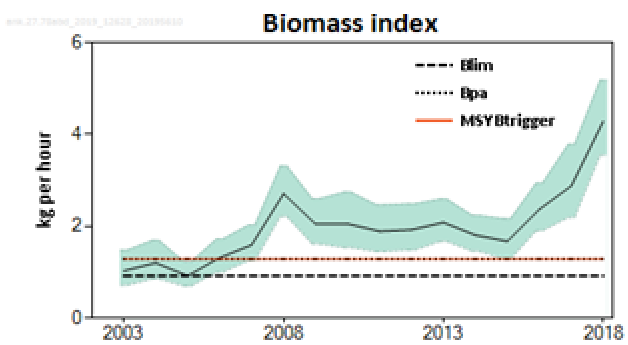


Figure 4. Mean-length Z analysis using the default growth parameters (Linf=175; k=0.078) and Lc=36. The dashed line is the F reference point F01 from the YPR analysis.



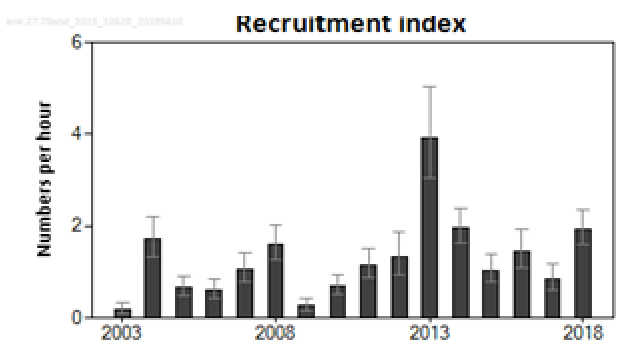


Figure 5. The biomass and recruitment indices of the combined IE-IGFS and FR-EVHOE surveys.

GULF OF CADIZ *Nephrops* Grounds (FU 30) ISUNEPCA 2018 UWTV Survey and catch options for 2019

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NTRODUCTION

The Norway lobster, *Nephrops norvegicus,* is one of the main commercial crustaceans exploited by a unique and highly multispecific bottom trawl fleet in the Gulf of Cadiz (Silva et al., 2007). Despite annual catches of *Nephrops* are small compared with other Atlantic *Nephrops* stocks (>100 t annually 2017 - 2019), this species gives valuable revenues for the trawl fleet. In the Gulf of Cádiz, *Nephrops* occurs in sandy-muddy bottoms mainly from 200 m to 700 m depth (Sobrino, 1994), where sediment is suitable for them to construct their burrows. It is well documented that this decapod spends a large part of the time in their burrows and their emergence behavior is influenced by several factors such as time of the year, light intensity, sex, size or reproductive stage (Froglia and Gramito, 1986; Chapman, 1980; Tuck et al., 2000; Aguzzi and Sardá, 2008).

Underwater television (UWTV) surveys for monitoring the abundance of *Nephrops* populations were pioneered in Scotland in early 90's. The estimation of Norway lobster abundances using UWTV systems involves identification and quantification of burrow density over the known area of *Nephrops* distribution (ICES, 2007). This can be used to produce a raised abundance estimate for the stock. Thus, UWTV surveys and assessment methodologies have been developed for providing a fishery independent estimate of stock size, explotation status and catch advice for several NE Atlantic *Nephrops* stocks (Campbell et al., 2008; ICES, 2009).

Up to 2016, the ICES advice for the *Nephrops* stock in the Gulf of Cadiz (FU 30) was on the basis of a data-limited approach. According to this approach, FU 30 was considered as category 3.1.4 (ICES, 2012a) and it was assessed mainly by the analysis of the LPUE series trend. This stock was benchmarked in October 2016 (ICES, 2016a). The approach based on UWTV survey to generate catch options was proposed for this FU. WKNEP 2016 considered in detail: the technology of the survey, including correction for edge effects, discovery rate, species identification, etc., the distribution area and coverage and the derivation of a recommended harvest rate (ICES, 2016a).

Regarding the first two points, WKNEP concluded that the UWTV survey based assessment as described before is appropriated for this stock. However, some difficulties were found for the derivation of the reference points. The common length based yield per recruit method was not appropriated for this stock. Reference points were derived from the perception of the stock and historical experience from similar previously assessed stocks as an interim solution. However, ADGNeph 2017 agreed that the poor fits in the length-frequency model, normally used for calculating F_{MSY} for category 1 *Nephrops* stocks, prevented its application to FU 30 (ICES, 2017a). In absence of stock specific MSY harvest rates the basis of the advice for this stock will follow the category 4 approach for *Nephrops* as is recorded in the stock annex.

The Spanish Oceanographic Institute (IEO) carried out the fifth *Nephrops* UWTV survey on the Gulf of Cadiz fishing grounds in 2018, although UWTV survey in 2014 was considerate only exploratory. This survey was multidisciplinary in nature and the specific objectives were:

1. To obtain estimates of *Nephrops* burrows densities

2. To confirm the boundaries of the *Nephrops* area distribution

2. To obtain estimates of macrobenthic species and the occurrence of trawl marks and litter on the seabed

3. To collect oceanographic data using a sledge mounted CTD

This working document details the results of FU 30 UWTV survey in 2018 which were used in the last advice carried out in October 2018.

MATERIAL AND METHODS

The ISUNEPCA TV survey was carried out from 2^{sd} and 14th June 2018 in Spanish waters of the Gulf of Cadiz (FU 30) onboard RV Angeles Alvariño. The UWTV designs followed a randomized isometric grid of stations at 4 nm spacing. A total of 70 stations were planned covering the *Nephrops* area distribution established in the last benchmarck (ICES, 2016a) (Figure 1). The *Nephrops* ground boundary was established using a combination of VMS and logbook data, *Nephrops* abundance data obtained in the IBTS surveys series carried out in this area and bathymetric information (Vila et al., 2014). The *Nephrops* area corresponds to 3000 Km^2. Stations ranged from 90 to 650 m depth. A couple of stations were planned beyond the deeper *Nephrops* limit and considerate as exploratory (black stars in the Figure 1). As last year, a number of hauls from beam-trawl were planned in order to know the presence of other burrowing fauna which co-occurring with *Nephrops* and that could be source of confusion in the identification of *Nephrops* burrows. A total 7 beam trawl was carried out, mainly in the shallowest border (Figure 1).

The UWTV sledge is equipped with a UHD 4K camera (angle of 45°) giving a field of view (FOV) of 0.75 m, which is confirmed by two lasers. The protocols used were those reviewed by WKNEPHTV (ICES, 2007) and annually by Expert Group on *Nephrops* surveys (SGNEPS/WGNEPS) (ICES, 2009b, 2010, 2012b). At each station, the sledge was deployed and once stable on the seabed a 10 minute tow was recorded. The sledge was towed at between 0.6-0.7 knots in order to obtain the best possible conditions for counting burrows. Video footage corresponds to 200 m swept, approximately. Vessel position (dGPS) and position of sledge, using a HiPAP, were recorded every 1 to 2 seconds. The distance over ground (DOG) was estimated from the position of sledge in all stations.

According to the SGNEPS recommendations all scientists were trained and familiarized with the identification of *Nephrops* burrows (ICES, 2009b) using training material and validated using FU 30 reference footages prior to recounting at sea. In 2018 survey, all recounts were conducted by three trained "burrow identifying" scientists independent of each other. Lin's CCC R script was implemented and applied to all recounts to identify those stations which required additional counts. Only stations with a threshold lower than 0.5 were reviewed again by consensus among the three counters.

Footages were also used for quantification of other megafauna species by a different team of scientists than the "burrow identification" team. The abundance was estimated using a rank-system composed by 6 categories from absent (0 indiv.) to extremely abundant (>100 indiv.). Trawl marks and litter were recorded as presence/absence.

Estimates of density at each station were calculated from standardized *Nephrops* burrows recounts divided by the area observed. This area was calculated multiplying the DOG by the FOV. Then, *Nephrops* burrows density was raised to the total area surveyed. The spatial co-variance and other spatial structuring Geo-statistical analysis were conducted using ARCGIS software. Geostatistic analysis was carried out applying an ordinary kriging. The result of kriging was used to obtain the *Nephrops* burrows abundance estimate, dividing the area in polygons with the some density range and raising this density to the surface of the each polygon. The summary of the method used in the geostatistic analysis is shown in Table 1. Krigged estimation variance or CV was carried out using the EVA: Estimation VAriance software (Petitgas and Lafont, 1997).

A number of factors are suspected to contribute as bias to UWTV surveys. In order to use the survey abundance estimate as absolute it is necessary to correct for these potential biases. The main bias is the “edge effect” which is a moderate source of overestimation when deriving *Nephrops population* size from underwater TV surveys. This bias is related to the counting of burrow complexes which lie mainly outside the viewed track. Other bias identifies are the “burrow detection” and “burrow identification regarding to visibility quality and the presence of other burrowing macro benthic species. The cumulative correction factor for the Gulf of Cadiz was 1.28 (Table 2).

At each station, CTD profile was logged for the duration of the tow using an AML Oceanographic Minos-X mounted on the sledge.

RESULTS

All planned UWTV stations were completed but the stations considered as exploratory could not be carried out within the time window of the survey. A few stations were re-do due to problems with the visibility from the recent fishing activity as well as technical problems (4 stations). However, 8 stations were considered definitely null after to be reviewed the videos due the low visibility. So, 60 of 70 stations were used in the geo-statistical analysis.

Figure 2 shows the *Nephrops* density (adjusted to account for bias factors=1.28) for 2018 in this FU. The density ranged between 0 and 0.35 burrows/m^2 and the average burrow density was 0.12 burrows/m^2. The highest densities were observed in the western part of the area (Figure 2). In the shallowest edge the visibility is very poor and the *Nephrops* density is low according to the VMS data and IBTS surveys series generating a high uncertainty in the *Nephrops* burrows identification. Additional information obtained from the beam trawl hauls carried out in 2017 and 2018 indicated absence of *Nephrops* in hauls carried out at depth lower than 200 m (Figure 2). Therefore, the stations located in this edge of the area surveyed were considerate stations with zero *Nephrops* density in the geostatistic analysis, as the previous year.

The final modeled density surfaces in the UWTV surveys time series (2015-2018) are shown as a heat maps and bubble plots in Figure 3. Table 1 shows the summary statistics from the geo-statistical analysis using ArcGis (Ordinary Kriging and positive anisotropy). This year the number of stations used in the geostatistic analysis was a little lower than the previous years (60 instead 62) since a higher number of stations were considered null. The abundance estimate derived from the krigged burrow surface (and adjusted for the cumulative bias) was 329 million burrows with a CV of 6% in 2018 (Table 3). Stock abundance has shown a small decrease in 2018 but the spatial pattern of burrow density is consistent in last two years.

Other burrowing species detected in the beam trawl hauls that co-occur with *Nephrops* were mainly *Munida* sp., *Goneplax rhomboides*, *Monodaeus couchii* and *Macropipus tuberculatus* being the squat lobster burrows the ones that created the highest confusion in the identification and quantification of *Nephrops* burrows.

Megafauna analyses from underwater image footages are still under processing. Table 4 shows some preliminary results in terms of presence of different species during the survey. A total of 36 footages where visibility was good enough to ensure a proper identification of the species were used for this analysis. The species with the highest frequency of occurrence in the footages were mainly the sedentary cerianthid *Cerianthus* sp. (63.7%), the sea-pen *Kophobelemnon stelliferum* (63.9%), *Funiculina quadrangularis* (58.3%) and *Pennatula aculeata* (38.9%). In less proportion (less than 25%), the crinoid *Leptometra phalangium*, the sea anemone *Actinauge richardii* and the small soft bottom sponge *Thenea muricata* were observed. Regarding to the burrowing megafauna highlight the squat lobster *Munida* sp. (44.4%), *Monodaeus couchii* (30.6%) and *Goneplax rhomboids* (16.7%). Species of commercial interest were also detected, being the most frequent ones the deep-water rose shrimp *Parapenaeus longirostris* and the Atlantic horse mackerel *Trachurus trachurus* with an occurrence of 22% and 14%, respectively.

The near-bottom temperature and salinity data collected during the survey are shown in Figure 4.

CATCH OPTIONS FOR 2018

The UWTV abundance data together with data from the fishery (landings in number and mean weight in landings) are used to provide the scientific advice for *Nephrops* FU 30 in 2018. Discards are considered negligible so all catches are assumed to be landed (ICES, 2017b). The ICES framework for Category 4 Norway lobster stocks (ICES, 2012a) was applied for *Nephrops* FU 30. Table 5 shows the basis for the catch options for this stock. The mean weight values used in order to convert the abundance in biomass were only the last two years instead the three last years (Figure 5). 2017 and 2018 corresponds to years just after the sanction applied for the period (2013-2015) due the exceeding the TAC in 2012.

Poor fits in the length frequency model (CSA, Cohort Separable Analysis) (ICES, 2016a), normally used for the calculating F_{MSY} for category 1 *Nephrops* stocks prevented its application to FU 30. In absence of stock specific MSY harvest rate, the advice was carried out on the basis of ICES precautionary approach (ICES, 2018). Catch options for 2019 are shown in Table 6. As the stock appears to be very lightly exploited, the advice could be increased to a level corresponding to an acceptable harvest rate (HR), applying an uncertainty cap to restrict annual change to no more than 20%. The same advice as given in 2017 plus a 20% corresponds to a potential HR of 1.57%. This is well below the range of maximum sustainable yield (MSY) harvest rates in almost all other FUs, which was considered conservative. Therefore the precautionary buffer was not applied. Fishing at precautionary approach in 2018 implies catches of 120 t. Table 7 shows the assessment summary for *Nephrops* FU 30 in 2018.

DISCUSSION

The Spanish Oceanographic Institute (IEO) carried out an exploratory *Nephrops* UWTV survey on the Gulf of Cadiz fishing grounds in 2014 within the framework of a project supported by Fundación Biodiversidad (Spanish Ministry of Agriculture, Food and Environment) and European Fisheries Funds (EFF). Nowadays, IEO carries out yearly UWTV survey in the Gulf of Cadiz (FU 30) since 2015. This survey has been included within Data Collection in the fisheries and aquaculture for its funding.

The surveyed area and the number of TV stations have increased since the first UWTV surveys in the Gulf of Cadiz (FU 30) that started in 2014. Currently, the TV stations cover well the entire distribution of the *Nephrops* ground established in the Benchmark Workshop on *Nephrops* (WKNEPS) (Vila et al., 2016, ICES, 2016a). Nevertheless, the shallowest edge of this area should be analyzed in detail for confirming this limit in the *Nephrops* distribution. VMS information does not show significant fishing activity targeting *Nephrops* below 200 m. Nevertheless, the bottom trawl survey series carried out in the Gulf of Cadiz since 1994 indicates small quantities of *Nephrops* at depths between 90 to 120m. Visibility at those depths is very poor and the presence of other species with a burrowing behavior could generate a high uncertainty in the *Nephrops* burrows identification. Therefore, the stations located at this edge of the surveyed area were considered to have no *Nephrops* in the geostatistic analysis.

Beam trawl was used during the UWTV survey in 2017 and 2018 for validating the information obtained in the videos and confirming the shallowest *Nephrops* boundary. The hauls carried out below 200 m depth showed the presence of the burrowing crab *Goneplax rhomboides* but no *Nephrops* was detected in them. Unfortunately, few hauls could be done because of the short time available after to achieve the main objective of the UWTV survey. WGNEPS recommended that beam trawl activity should be continued in future surveys for validating the video observations and confirming the limits of the *Nephrops* distribution (ICES, 2017b). A reduction of the *Nephrops* area in the shallowest limit should be evaluated in a future benchmark.

The burrow abundance estimates have decreased slightly in 2018 regarding the previous year (370 millions burrows in 2017 and 329 millions burrows in 2018). However, the traditional zone with the annual highest *Nephrops* density shows higher density in 2018. The spatial distribution is consistent in 2016-2018 periods and it is in accordance to the VMS and the IBTS survey information.

The approach based on UWTV survey to generate catch options was proposed for this FU in the framework of WKNEPS in October 2016 (ICES, 2016, a). WKNEPS agreed the UWTV survey in FU 30 is appropriated for give scientific advices for this stock. Nevertheless, specific MSY reference points could not be estimated. The large differences found between the abundance estimate derived from SCA model and the abundance estimated from the UWTV lead high harvest rates and as consequences recommends catches much higher than the obtained historically in the fishery. The problems could be amended to a variable extent in numerous ways, but in particular by increasing the natural mortality in the SCA model, which again would have an impact on the reference points and subsequently on the harvest rate to be recommended.

In absence of MSY reference points, the ICES framework for Category 4 Norway lobster stocks (ICES, 2012a) was applied for *Nephrops* FU 30 since the advice 2017. In the future if stock specific FMSY reference points can be estimated then the stock will meet the requirements for category 1 assessment (ICES, 2017a). In this sense, a workshop on *Nephrops* reference points has been recommended in order to evaluate reference point estimation methods for stocks with recent TV surveys. This workshop has been delaying for some time but finally, this will be carried out in November 2019.

UWTV surveys are an excellent platform for collecting additional multidisciplinary information that is highly relevant for several researchers and advisory applications. The monitoring of benthic macro fauna of circalitoral and bathyal sedimentary areas, such as the sea-pen communities with burrowing megafauna that have been included in the OSPAR List (OSPAR, 2010), the analysis of the impact of fishing activity on the bottom, the presence of litter as well as information of environmental variables are very valuable. CTD data collected, over time will augment the knowledge base on habitat and oceanographic regime on the bottom. This information could also be useful in the context of the Marine Strategy Framework Directive (MFSD) as well as on the management of the recently declared Site of Community Importance “Volcanes de fango del golfo de Cádiz”.

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Table 1. Geostatistic method summary

Method	Kriging
Type	Ordinary
Variogram	Semivariogram
Number of lags	12
Lag size	0.03143125
Nugget	0.00495596
Anisotropy	Yes
Range (Major)	0.37717501
Range (Minor)	0.13223257
Partial sill	0.01455035
Direction (angle)	118.476

Table 2. The bias associated with the estimates of *Nephrops* abundance in FU 30.

	Edge efect	**Detection rate**	**Species identification**	**Occupancy**	**Cumulative bias**
FU30: Gulf of Cadiz	1.24	0.90	1.15	1	1.28

Table 3. Results summary table for geostatistical analysis of UWTV surveys series in FU30.

Year	Nª stations	Mean density adjusted	Area Surveyed	Domine area	Geoestatistical Abundance estimate adjusted	CV on burrow estimate
		Burrow/m2	Km2	Km2	Millions burrows	
2015	58	0.0905	3000	3000	298	7.6
2016	58	0.0776	3000	3000	233	7.3
2017	62	0.1336	3000	3000	371	8.7
2018	60	0.1197	3000	3000	329	6.0

Table 4. Main mega benthic species observed during UWTV survey with indications of their frequency of occurrence (expressed as %) in the footages.

Species	**Frequency occurrence (%)**
Cerianthus sp.	67
Kophobelemnon stelliferum	64
Funiculina quadrangularis	58
Munida sp.	44
Pennatula aculeata	39
Scyliorhinus canicula	31
Gadiculus argenteus	31
Monodaeus couchii	31
Decapoda natantia	25
Actinauge richardii	25
Anthozoa	25
Parapenaeus longirostris	22
Thenea muricata	22
Maurolicus muelleri	17
Goneplax rhomboides	17
Leptometra phalangium	17
Salmacina sp.	17
Trachurus trachurus	14
Coelorinchus caelorhincus	11
Plesionika heterocarpus	11
Polybiidae	11

Table 5. Basis for catch options for 2019 for *Nephrops* FU 30.

Variable	Value	Notes
Stock abundance (2019)	329 millions	UWTV survey 2018 (number of individuals)
Mean weight in wanted catch	23.29 g	Average 2016-2017
Mean weight in unwanted catch	-	Not relevant
Unwanted catch	0%	Negligible
Discard survival	-	Not relevant
Dead unwanted catch	0%	Negligible

Table 6. Annual catch options for 2019. All weights are in tones

Basis	Total catch	Wanted catch*	Unwanted catch^ *	Harvest rate	% Advice change **
ICES advice basis					
Precautionary approach (advice for 2018 + 20%)	120	120	0	1.57	20
Other scenarios					
F_{2017}	123	123	0	1.61	23

^ Based on negligible discarding during observer trips.
* "Wanted" and "unwanted" catch are used to describe Norway lobster that would be landed and discarded in the absence of the EU landing obligation.
** Advice value for 2019 relative to advice value for 2018.

Table 7. Assessment summary for *Nephrops* FU 30 in 2018.

Year	Stock Abundance	High	Low	Total catch	Harvest rate	Landings mean weight	Discard* mean weight	Discard* rate	Dead discard* rate
	(Millions of individuals)			(Tonnes)	(%)	(kg)	(kg)	(%)	(%)
2015	298	343	253	25	0.30	0.031	NA	0	0
2016	233	267	199	124	2.3	0.023	NA	0	0
2017	370	433	307	140	1.60	0.023	NA	0	0
2018	329	368	290						

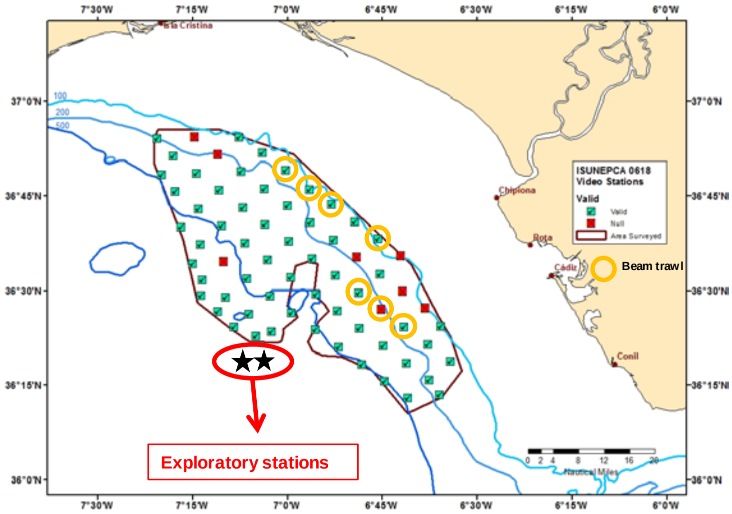
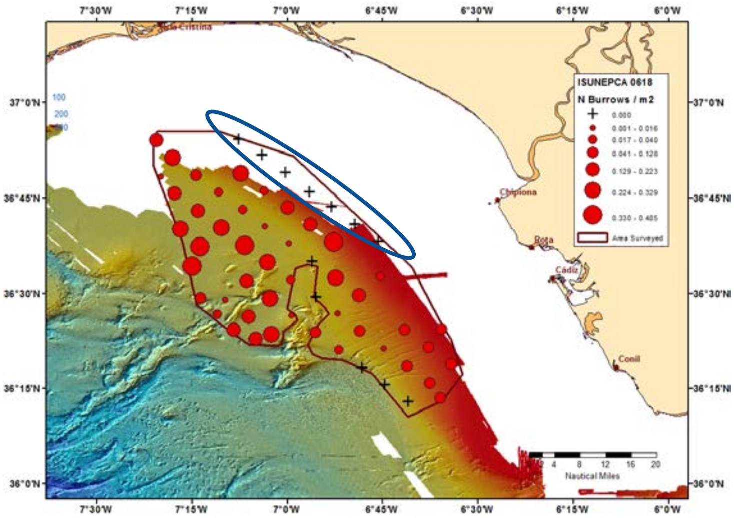


Figure 1. TV stations grid planned and hauls using beam trawl carried out in 2018 ISUNEPCA UWTV survey.



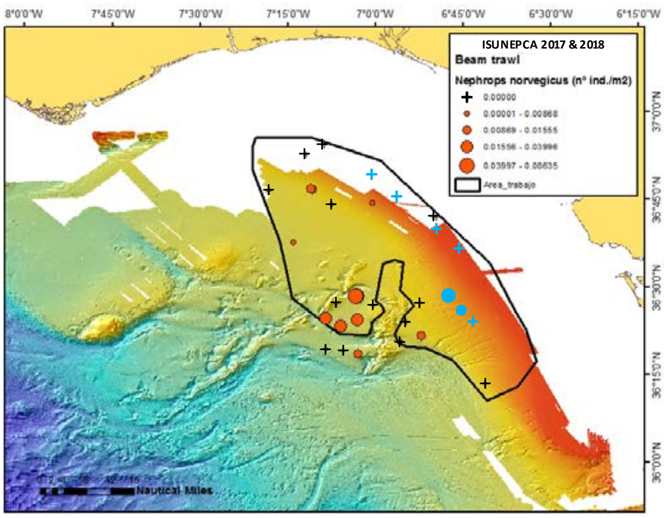


Figure 2. *Nephrops* density adjusted to account for bias factors for 2018 UWTV survey (above), blue ellipse shows stations where zero *Nephrops* is assumed; *Nephrops* density from beam trawl (below) (blue symbols represents survey in 2018 and + indicates station positions with zero density.

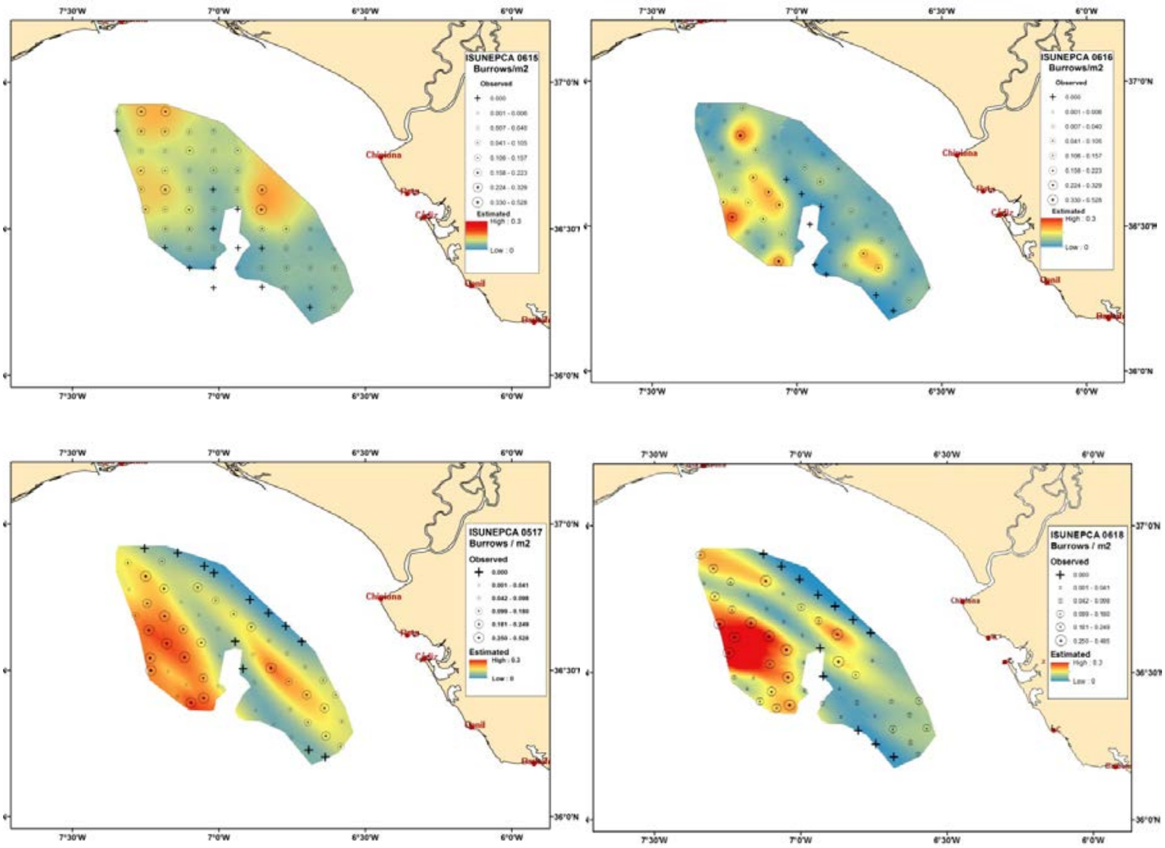


Figure 3. Bubble plot of the burrow density observations overlaid on a head map of the krigged burrow density surface for UWTV survey series (2015-2017). Station positions with zero density are indicated using a +.

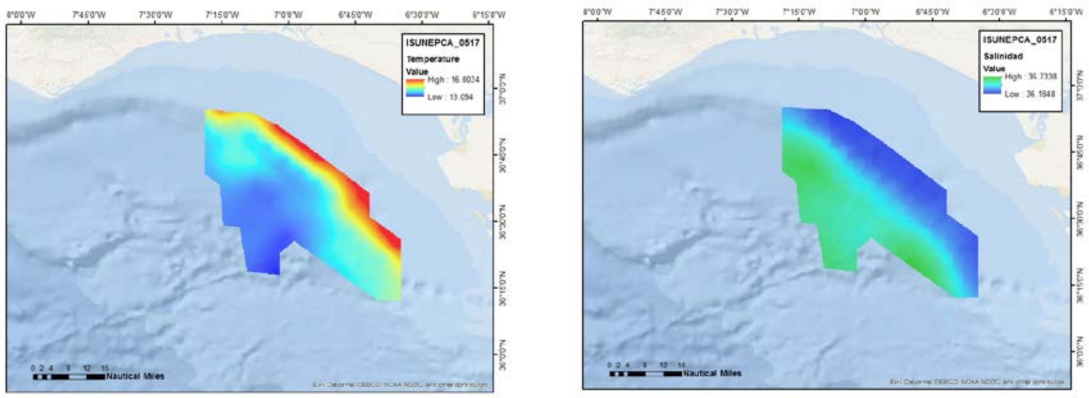


Figure 4. Temperature and salinity on the seabed collected during the survey.

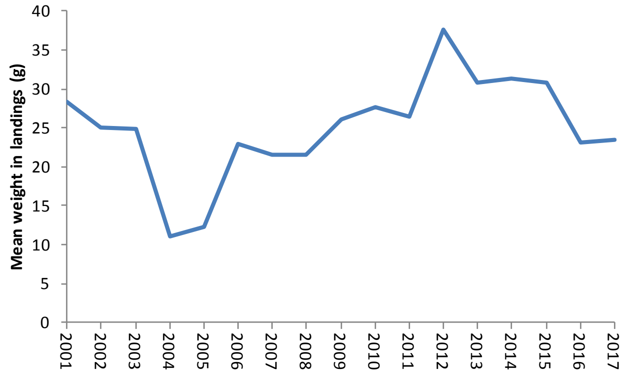


Figure 5. Mean weight in the commercial landings in FU 30.

Applying catch-only-model with sampling-importance re-sampling (COM-SIR) to common sole (*Solea solea)* species in 8c9a areas.

Working document to the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion- WGBIE – Lisbon 2-9 May 2019

Maria Grazia Pennino[1]

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Background

The common sole (*Solea solea*) species in the ICES areas 8c and 9a belong to the ICES category 5 and no assessment model has been performed until now. A catch-only-model with sampling-importance resampling (COM-SIR) was computed this year as first approximation.

Data

The data available for the common sole are catches from Portugal and Spain. There is some evidence that *Solea* spp. may have been misclassified in the past for both Portuguese and Spanish landings, which means *Solea solea* official landings might not then have corresponded only to this species but a mix of *Solea solea* with very few *Solea senegalensis.* Using port sampling length data, it was possible to separate the *Solea* spp. and apply the proportions to provide a raised landings total for *Solea solea.* Catches of Solea spp. (*Solea solea* and *Solea senegalensis* combined) are available from 2000, whereas catches by species are available from 2012. Discards are considered negligible (almost zero in last three years) for common sole. For this reason we used both catch series to fit two different models, one from 2000, and another from 2012.

Methods

Stock biomass was computed using the catch-only-model with sampling-importance resampling (COM-SIR), proposed by Vasconcellos and Cochrane (2005), and implemented by Minte-Vera (Rosenberg et al., 2014). This model has been widely used in stock assessment, contributing to the estimation of several species key management parameters (Wetzel and Punt 2015; Bevilacqua et al., 2016; Rosemberg et al., 2017).

The COM-SIR model predict the biomass dynamics according to the Schaeffer model, using catch data alone in combination with prior information from a Bayesian approach (based on the sampling importance resampling algorithm) (Gelman et al., 2004). The model considers that the harvest rate can be modeled as a logistic function and it predicts the catch over time from a coupled effort-biomass dynamics model (Vasconcellos and Cochrane, 2005). It allows an estimation of r (intrinsic population growth rate) and K (carrying capacity), as well as it can calculate management parameters, such as the maximum sustainable yield (MSY). Besides the catch data, the method needs as input information on the biological traits of the species (e.g. $L\infty$, Tmax, Tmat, and resilience – all collected from Fishbase.org), from which prior and posterior distributions for growth parameters (r and K) are obtained. This method also assumes that the initial biomass is equal to the carrying capacity of the stock.

For the Bayesian approach, we considered that the importance function was equal to the joint prior function, and thus the importance ratio was equal to the likelihood (Rosenberg et al., 2014). The maximum single density (MSD) means that the resampling was done until no vector was assigned more than one percent of the posterior probability, and it must be lower than 1% (Punt and Hilborn, 1997). The entropy of the importance weights relative to uniformity (ERU) describes the degree of proximity between the importance function and the posterior distribution, and it must be close to one (Kinas, 1996). Following Rosenberg et al., (2014), we used these two indicators to verify if the sample of parameters was estimated from an importance function similar to the posterior distribution.

All these estimates were carried out with R software (R Development Core Team, 2018), and the R code of the COM-SIR model was written by C. V. Minte-Vera (available in Rosenberg et al. 2014).

Results

The COM-SIR model showed that the simulated data of catch fitted adequately with the observed catch for both the series from 2000 (Figure 1) and 2012 (Figure 2).

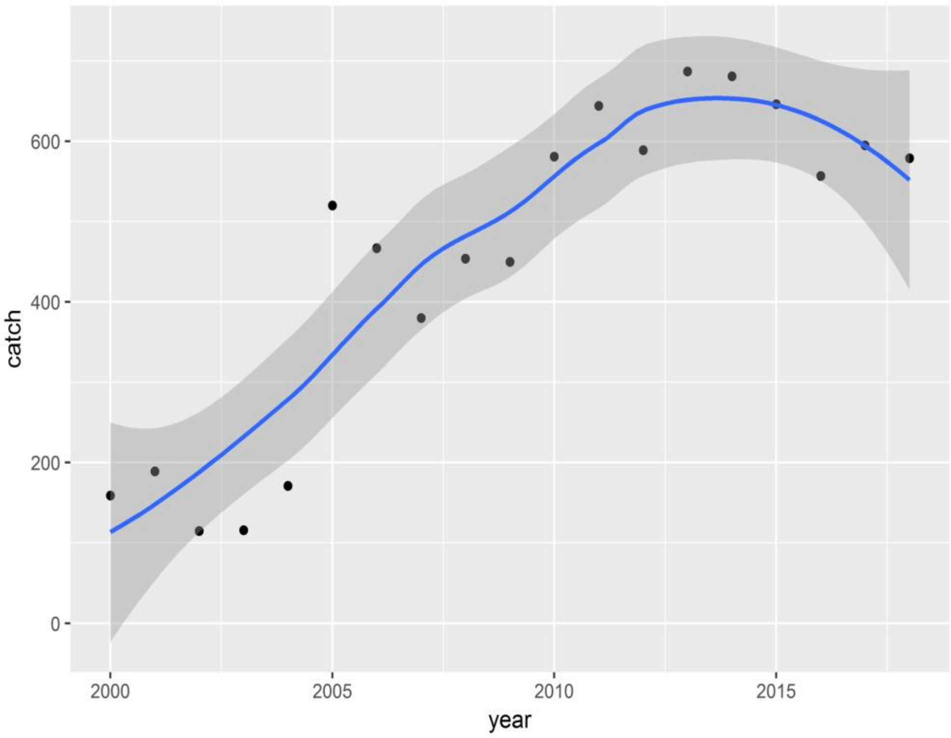

Figure 1: Catch (tons) from 2000 to 2018 for *Solea solea.*

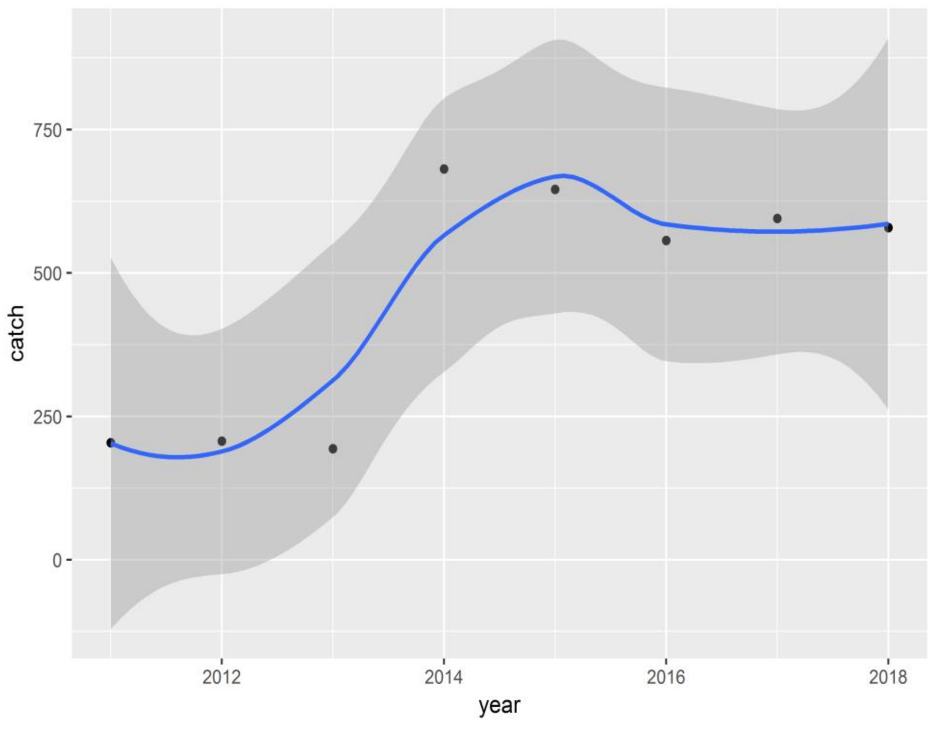

Figure 2: Catch (tons) from 2012 to 2018 for *Solea solea.*

The values of ERU and MSD corroborated that the degree of proximity between the importance function, and the posterior distribution were satisfactory in both cases (from 2000 ERU=0.97 and MSD=0.04; from 2012: ERU=0.99 and MSD=0.04).

The MSY computed with the time series from 2000 was 941.05, with an ICr of 473.97 - 5858.05. For the model that used the time series from 2012 the MSY computed was 1125.388, with an ICr of 327.73 - 8841.55.

Predicted biomasses for both models are presented in Figure 3 and Figure 4. In both cases the biomass pattern highlighted a decreasing pattern although the difference from the first year to the series to the last one is about 1000 t.

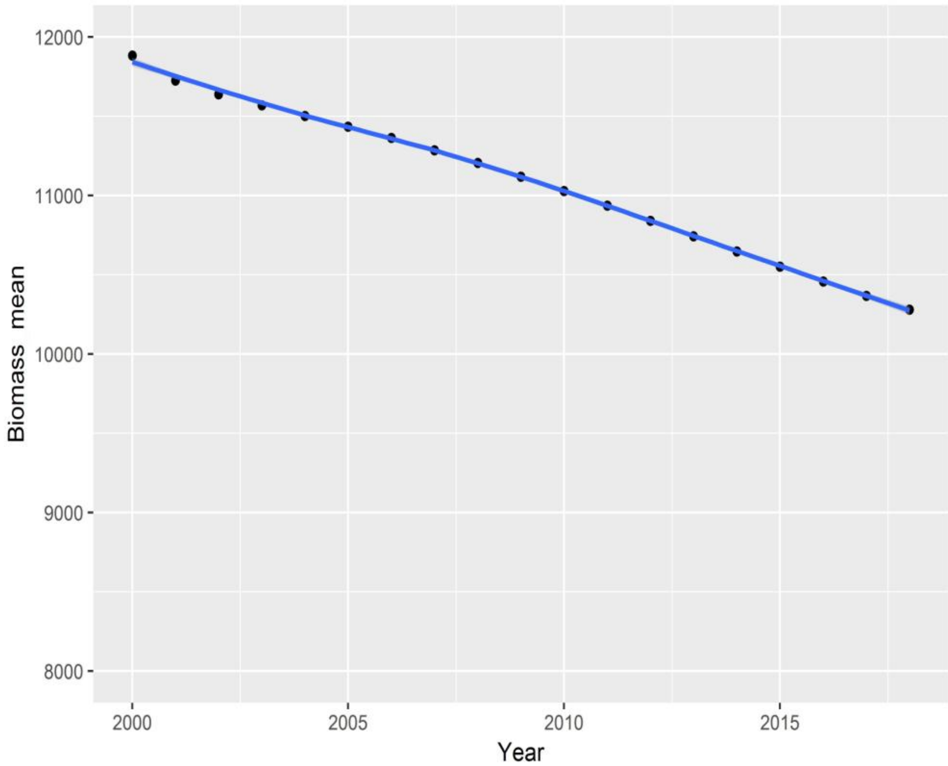

Figure 3: Predicted biomass (tons) from 2000 to 2018 for *Solea solea.*

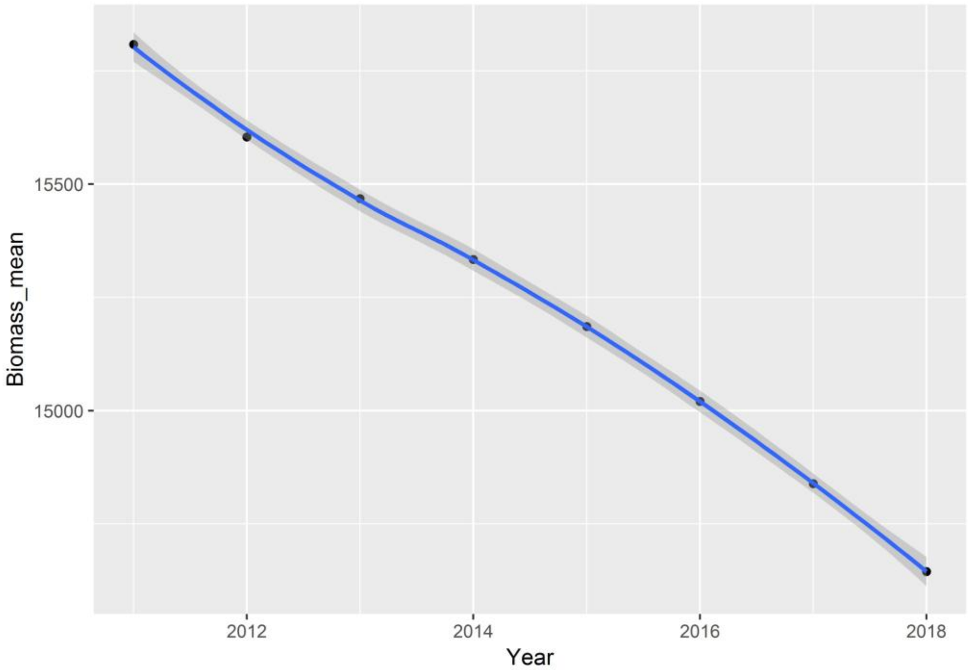

Figure 4: Predicted biomass (tons) from 2012 to 2018 for *Solea solea.*

Conclusions

This was a first approximation for this species, although the COM_SIR doesn't seem to be the best model for this species as this method assumes that the initial biomass is equal to the carrying capacity of the stock. Further analysis need to be done for the next year using alternative assessment models as the SPICT.

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Annex 5: Audits

Stock Name: Black-bellied Anglerfish (*Lophius budegassa*) in Subarea 7 and 8.a-b, and 8.d (west and southwest of Ireland, Bay of Biscay)

Date: 22/05/2019

Auditor: Ricardo Alpoim and Yolanda Vila

General

- This stock was benchmarked in 2018
- The combined IGFS-WIBTS-Q4 and EVHOE-WIBTS-Q4 surveys abundance provide a more robust basis for the advice than the individual indices. This combined index is used in the assessment; following the 2/3 rule according to category 3 stocks.
- Stock size MSY reference points proxies were derived in WGBIE2019

For single stock summary sheet advice:

1) **Assessment type:** Update
2) **Assessment**: Category 3 assessment
3) **Forecast**: Not presented
4) **Assessment model**: None
5) **Data issues:** The combined IGFS-WIBTS-Q4 and EVHOE-WIBTS-Q4 surveys abundance index was not available for 2017 since EVHOE survey did not take place. The spatial model (VAST) was used to estimate the full time series of the index (including 2017). Discard data are only available since 2003 they are considered low.
6) **Consistency**: The assessment is consistent with the available information.
7) **Stock status**: Fishing pressure on the stock is below F_{MSY} and spawning stock size is above MSY $B_{trigger}$, B_{pa} and B_{lim}.
8) **Management Plan**:
   - The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including anglerfish (*Lophiidae*) in ICES divisions 7b–k, 8a, 8b and 8d.
   - The stock assessment area (27.78abd) is the same for both species of anglerfish (*Lophius piscatorius* and *Lophius budegassa*). The two stocks are managed through TACs for the two species combined.

General comments

The report is well written and well ordered section. It was easy to follow and interpret. No significant criticism overall.

Technical comments

The VAST model provided nearly identical biomass trends to the original survey index. The model was to be able to accurately predict the index when the missing data were simulated for other years. In 2018 both surveys used in the assessment registered the highest biomass of their time series.

The index is estimated to have increased by more than 20% and thus the uncertainty cap was applied.

Conclusions

The assessment has been performed correctly

Stock Name: ank.27.8c9a

Date: 23/05/2019

Auditor: Paz Sampedro and Cristina Silva

General

- This stock was benchmarked in 2018 and a stochastic production model in continuous-time (SPiCT) was accepted and considered more reliable than the previous non-equilibrium production model (ASPIC).
- Given the uncertainties regarding the absolute levels of biomass and fishing pressure, the assessment in 2018 was considered as indicative of trends only, and the stock was classified within the category 3.2, with proxy reference points using SPiCT results.
- Mohn's rho does not indicate strong retrospective pattern.

For single stock summary sheet advice:

1) **Assessment type:** Update.
2) **Assessment**: Analytical assessment; results used only for trend analysis.
3) **Forecast**: Not presented; the advice for this stock follows the ICES rules for Data Limited Stocks, category 3.2.0.
4) **Assessment model**: Surplus Production in Continuous Time (SpiCT); tuned by 3 commercial indices.
5) **Data issues:**
   a. The data are as described in Stock Annex.
   b. The Spanish LPUE series used in the assessment (A Coruña fleet) was not updated for 2013-2018. This update was carried out for another Spanish fleet but it was not possible to evaluate, during the WG, the potential use of this series for the assessment instead of the incomplete A Coruña fleet series.
6) **Consistency**: There is not a strong retrospective pattern. The assessment was accepted as indicative of trends.
7) **Stock status**: Stock biomass was above $MSYB_{trigger}$ proxy over the whole time series; F has been below F_{MSY} proxy for the last 20 years.
8) **Management Plan**: A multiannual plan for demersal stocks (which includes this stock) and their fisheries in the Western Waters and adjacent waters has recently been published (EU Parliament and Council Regulation no. 2019/472, of 19 March 2019). This plan defines the target fishing mortality within the range of F_{MSY}.

General comments

The report is well structured and clear.

Technical comments

No comments.

Conclusions

The assessment has been performed correctly

Stock Name: meg.27.7b-k8abd

Date: 11/06/2019

Auditor: Esther Abad

General

- This stock was assessed and projections were performed without no particular issues.
- Retrospective analysis does not indicate a strong pattern.
- The assessment results show an increasing trend in SSB and a decreasing F trend, being below FMSY.

For single stock summary sheet advice:

1) **Assessment type:** Update.
2) **Assessment**: Analytical assessment.
3) **Forecast**: Presented; the advice for this stock follows the ICES rules for Stocks, category 1.
4) **Assessment model:** Statistical catch-at-age – tuning by 2 commmercial indices and 2 surveys
5) **Data issues:** Data available as described in stock annex.
6) **Consistency**: Results are consistent with the last year assessment and the assessment was accepted.
7) **Stock status** Fishing pressure on the stock is below FMSY and spawning stock size is above MSY Btrigger.
8) **Management Plan**: The European Parliament and the Council have published a multi-annual management plan (MAP) for the Western Waters (EU Parliament and Council Regulation no. 2019/472, of 19 March 2019). This plan defines the target fishing mortality within the range of F_{MSY} and it applies to demersal stocks including megrims in ICES divisions 7.b–k, 8.a–b, and 8.d.

General comments

This was a well documented and well documented section. Some minor issues were reported and corrected.

Inputs and outputs of the forecast and outputs of the assessment would be useful to be presented in the report as a table.

Technical comments

The assessment is done according to the stock annex.

Good recruitments in 2016 and 2017.

Recruitment 2018 was replaced for short term projections to historical mean (GM 1984-2016).

F status quo is unscaled and set as mean F (years 2016-18)

Conclusions

The assessment has been performed properly.

Stock Name: meg.27.7b-k8abd

Date: 11/06/2019

Auditor: Esther Abad

General

- This stock was assessed and projections were performed without no particular issues.
- Retrospective analysis does not indicate a strong pattern.
- The assessment results show an increasing trend in SSB and a decreasing F trend, being below FMSY.

For single stock summary sheet advice:

9) **Assessment type:** Update.
10) **Assessment**: Analytical assessment.
11) **Forecast**: Presented; the advice for this stock follows the ICES rules for Stocks, category 1.
12) **Assessment model:** Statistical catch-at-age – tuning by 2 commmercial indices and 2 surveys
13) **Data issues:** Data available as described in stock annex.
14) **Consistency**: Results are consistent with the last year assessment and the assessment was accepted.
15) **Stock status** Fishing pressure on the stock is below FMSY and spawning stock size is above MSY Btrigger.
16) **Management Plan**: The European Parliament and the Council have published a multi-annual management plan (MAP) for the Western Waters (EU Parliament and Council Regulation no. 2019/472, of 19 March 2019). This plan defines the target fishing mortality within the range of F_{MSY} and it applies to demersal stocks including megrims in ICES divisions 7.b–k, 8.a–b, and 8.d.

General comments

This was a well documented and well documented section. Some minor issues were reported and corrected.

Inputs and outputs of the forecast and outputs of the assessment would be useful to be presented in the report as a table.

Technical comments

The assessment is done according to the stock annex.

Good recruitments in 2016 and 2017.

Recruitment 2018 was replaced for short term projections to historical mean (GM 1984-2016).

F status quo is unscaled and set as mean F (years 2016-18)

Conclusions

The assessment has been performed properly.

Stock Name: European Seabass in Division 8c, 9a Choose an item.

Date: 15/05/2019

Auditor: Maria Grazia Pennino and Yolanda Vila

For single stock summary sheet advice:

1) **Assessment type:** Update
2) **Assessment**: ICES framework for category 5 stocks
3) **Forecast**: Not presented
4) **Assessment model**: No specific analytical model was used
5) **Data issues:** Commercial data are obtained from official statistics recorded in the Fishstat database since around the mid-1970s with addition of Spanish landings for 2007-2011 (sale notes) and Portuguese estimated landings (1986-2011) including distinction between *Dicentrarchus labrax* and *D. punctatus*. Official landings are available since 2012 onwards. LFDs are available in the 9a area for Portuguese fleet in 2016-2018 period and for Spanish fleet for 2017 and 2018. The Portuguese onboard sampling discards coverage is not satisfactory for the overall fishing area. No discards are observed in Spain for the 2003-2018 period. Effort data were available for Spanish fleet from 2013 and for Portuguese fleet from 2015. Recreational catches are not known. However, recreational catches estimates were provided in 2016 by a study involving in the Basque Country. Results showed recreational catches are comparable to commercial catches and therefore they should be quantified and included into the stock assessment.
6) **Consistency**: The assessment is consistent with the available information.
7) **Stock status**: The stock and exploitation status relative to MSY and precautionary approach (PA) reference points cannot be assess because the reference points are unknown. The commercial landings in the last two decades have been variable, discards are negligible and recreational catches unknown but important.
8) **Management Plan**: The European Parliament and the Council have published a multi-annual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including seabass in ICES divisions 8c and 9a.

General comments

No significant criticism overall.

Technical comments

The information necessary for the assessment was available and it was done according the Stock Annex. The precautionary buffer was applied in 2017 to this stock then it was not applied in 2019 according to the ICES guidelines for preparing the stock advice.

Conclusions

The assessment has been performed correctly

Stock Name: European Seabass in Division 8c, 9a Choose an item.

Date: 15/05/2019

Auditor: Maria Grazia Pennino and Yolanda Vila

For single stock summary sheet advice:

1) **Assessment type:** Update
2) **Assessment**: ICES framework for category 5 stocks
3) **Forecast**: Not presented
4) **Assessment model**: No specific analytical model was used
5) **Data issues:** Commercial data are obtained from official statistics recorded in the Fishstat database since around the mid-1970s with addition of Spanish landings for 2007-2011 (sale notes) and Portuguese estimated landings (1986-2011) including distinction between *Dicentrarchus labrax* and *D. punctatus*. Official landings are available since 2012 onwards. LFDs are available in the 9a area for Portuguese fleet in 2016-2018 period and for Spanish fleet for 2017 and 2018. The Portuguese onboard sampling discards coverage is not satisfactory for the overall fishing area. No discards are observed in Spain for the 2003-2018 period. Effort data were available for Spanish fleet from 2013 and for Portuguese fleet from 2015. Recreational catches are not known. However, recreational catches estimates were provided in 2016 by a study involving in the Basque Country. Results showed recreational catches are comparable to commercial catches and therefore they should be quantified and included into the stock assessment.
6) **Consistency**: The assessment is consistent with the available information.
7) **Stock status**: The stock and exploitation status relative to MSY and precautionary approach (PA) reference points cannot be assess because the reference points are unknown. The commercial landings in the last two decades have been variable, discards are negligible and recreational catches unknown but important.
8) **Management Plan**: The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including seabass in ICES divisions 8c and 9a.

General comments

No significant criticism overall.

Technical comments

The information necessary for the assessment was available and it was done according the Stock Annex. The precautionary buffer was applied in 2017 to this stock then it was not applied in 2019 according to the ICES guidelines for preparing the stock advice.

Conclusions

The assessment has been performed correctly

Audit of Sole (*Solea solea*) in Division 8ab (Bay of Biscay)

Date: 2019-May-22

Auditor: Spyros FIFAS

Audience: advice drafting group, ACOM and EG next year.

Auditing of:

- the stock assessment – the input data, settings and output data from the assessment
- the correct use of the assessment output in the forecast.
- if forecast settings are applied correctly.

For single stock summary sheet advice:

1) **Assessment type:** Update.
2) **Assessment**: the assessment was carried out using XSA model including five tuning fleets among them two interrupted commercial time series (FR-SABLES and FR-ROCHELLE), two seasonal inshore and offshore commercial fleets (FR-BB-IN-Q4 and FR-BB-OFF-Q2) as well as the scientific beam trawl survey ORHAGO. In this year's assessment the retrospective analyses show that since 2012 the recruitments (overall downwards trend since 1993) were generally well estimated by XSA, thus the estimated values are retained for the short term projections.
3) **Forecast**: Forecast input parameters are provided in the table 7.12 (not presented in the report section), management option outputs are also given. They are compatible with previous years' investigations since the interim benchmark 2013.
4) **Assessment model**: XSA.
5) **Data issues:** Landings are available from 1979 onwards and up to 2008 the nominal values were systematically revised upwards by the WG. LFDs for landings are available owing to biological sampling for French (trawlers and gill-netters) and Belgian fleets whereas for discards available data do not seem to be representative for the assessment and were not kept for further investigations.
6) **Consistency:** Results are consistent and the assessment and forecast were accepted.
7) **Stock status**: Overall decreasing trend is observed for recruitment for the last 25 years apart from high value occurring in late 2000's. Same signal involve in catches whereas SSB showed an increasing period in 2000's after a continuous decline in 1990's. F bar decreased compared to the beginning of 2000's and seems to be within safety biological levels.
8) **Man. Plan**: A proposal for a management plan for sole in the Bay of Biscay was evaluated by ICES (2013). The plan aims to decrease fishing mortality by applying a constant TAC until F is estimated to have reached FMSY. A season closure was also applied during the spawning period, 1 January to the 31 March, for the directed fishery for common sole. The fishery during the spawning period is closed for 21 days, which consists of 3 periods of seven consecutive days. Since 2016, additional measures have involved in a fishing stop of at least 15 days during the first quarter for netters and a reinforcement of the selectivity for at least 8 months of the year (including the first quarter) for trawlers.

General comments

No significant criticism overall.

Technical comments

No relevant

Conclusions

The assessment has been performed correctly and it is conform with previous years investigations.

Stock Name: hke.27.8c9a

Date: 24/05/2019

Auditor: Teresa Moura

General

- There is a strong retrospective bias in the assessment (SSB overestimation and F underestimation)
- Given the above, setting catches above Fmsy are not recommended as increases the risk of overshooting Fupper.

For single stock summary sheet advice:

1) **Assessment type:** Update
2) **Assessment**: Analytical assessment
3) **Forecast**: presented
4) **Assessment model**: GADGET – catches+2 commercial LPUE + 3 research surveys
5) **Data issues:** data available as described in stock annex. Some critical catch data was available to the group a few days before the start of the meeting which compromised the data quality control and, consequently, the quality of the advice.
6) **Consistency**: Consistent with previous year
7) **Stock status**: B>MSY Btrigger, Fmsy<F<Fpa, R close to the historical average
8) **Management Plan**: 1) A recovery plan was agreed by the EU in 2005, based on precautionary reference points that are no longer appropriate. 2) EU multiannual plan (EU, 2019) where catches advice corresponds to F ranges; however, due to the strong retrospective bias in the assessment (SSB overestimation and F underestimation), catches above Fmsy are not recommended.

General comments

Report is well documented.

Technical comments

Data and assessment (including recruitment and forecast) are in accordance to the stock annex.

Conclusions

The assessment has been performed correctly following ICES guidelines.

An ICES workshop is planned (WKFORBIAS) to quantify the severity, identify causes for the retrospective pattern bias, and provide guidance to correct for the bias in the assessment and forecast.

Audit of Hake in Division 3.a, Subareas 4, 6 and 7 and Divisions 8.a,b,d (Northern stock)

Date: 08/05/2019

Auditor: Hans Gerritsen and Hugo Mendes

General

- The high estimated recruitment for 2017 leads to a projected SSB increase and would constribute considerably to the 2020 catch. Because the actual size of this cohort is uncertain (see retro) the wg considered it more precautionary to replace this cohort with GM. The 2018 cohort is estimated to be around average by the model even though the IGFS survey shows very poor recruitment. This cohort will not contribute much to the landings in 2020 so this is less of a concern than the 2017 cohort.
- Some of the selection patterns estimated by the model appear unrealistic for the larger fish (e.g. sudden drops in selectivity, like SPTRAWL8). (benchmark issue)
- A model with fewer fleets may be more robust (benchmark issue)
- Reference points were updated. Choice of Blim: no strong evidence of impaired recruitment but there is a suggestion there may have been some impairment during the period with low SSB. More precautionary to set blim = breakpoint of segreg, rather than bloss. Conclusion: type 2 recruitment.

For single stock summary sheet advice:

1) **Assessment type: update**
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: SS3; 7 commercial fleets; tuning by 3 survey indices
5) **Data issues:** No EVHOE survey data for 2017
   Late submission of data reduced the time for analysis and QC
6) **Consistency**: The assessment has consistently been accepted
7) **Stock status**: SSB was below Btrigger until 2008 but now well above Btrigger; F just below Fmsy for the last 5 years.
8) **Management Plan**:
   - Recovery plan EC Reg. No. 811/2004 is defunct as the reference points in it are no longer appropriate.
   - The stock is included in the WW MAP

General comments

The report is clear; uncertainties and issues are clearly highlighted. The assessment and forecast appear to have been performed correctly.

Technical comments

The stock annex needs to be updated:

- Reference points need to be updated, Fupper and Flower need to be included and F_{MSY} ranges (mainly Fupper) should be compared with Fp.05.
- No definition of F status-quo (i.e. average F in the last 3 years)
- Do definition of GM recruitment (GM 1990 to last year minus 2)

Conclusions

The assessment has been performed correctly

Stock Name: ldb.27.7b-k8abd

Date: 22/05/2019

Auditor: Mathieu Woillez

General

No general remarks

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

1) **Assessment type:** Update
2) **Assessment**: Precautionary approach based on ICES framework for category 6 stocks
3) **Forecast**: No forecast
4) **Assessment model**: No model
5) **Data issues:** Survey indices updated and commercial landings, discards and length data added.
6) **Consistency**: This was the third year that an assessment was carried out for this stock and the second year that the stock was included in the WGBIE data call. The lack of historical (2003-2018) catch and sampling data from Spain hampered the assessment.
7) **Stock status**: The stock and exploitation status relative to MSY and precautionary approach (PA) reference points cannot be assessed, because the reference points are undefined.
8) **Management Plan**: The European Commission has published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including megrims (Lepidorhombus spp.) in ICES divisions 7b–k, 8a, 8b and 8d. However, ICES has not been requested to provide advice on fishing opportunities for this stock.

General comments

The report and the advice are well written. Following the technical guidelines for reference points for stocks in categories 3 and 4, length-based indicators and mean-length-Z analysis were explored to potentially upgrade the stock category. However, it is unclear whether the survey catches are representative of the stock, considering the survey only covers a small portion of the stock area. Therefore the stock status relative to reference points cannot be assessed currently.

Technical comments

In the draft report, one can read: "The agreed TAC for four-spot megrim in ICES Divisions 7b-k and 8abd was 350 t for 2019 and is 280 t for 2020. Management of four-spot megrim and megrim under a combined species TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species." The first sentence is incoherent with the second one. Is there a specific TAC or only a combined one ? It should be clarified.

Conclusions

The assessment has been performed correctly

Stock Name: mon.27.8c9a

Date: 07/05/2019

Auditor: Ching Villanueva and Mickael Drogou

General

- This stock was benchmarked in 2018. The SS3 continues to be the best model to assess this stock, only two changes in the settings were done at the benchmark: weight-at-length and the selectivity of the PTART9A series.
- Besides the low recruitment in recent years SSB continues to increase. F are at the lowest values of the series. Retrospective analysis showed an underestimation of the SSB in the final years an overestimation of F.
- The commercial index time series SPCORTR8C, stopped in 2012.

For single stock summary sheet advice:

1) **Assessment type:** Update
2) **Assessment**: Analytical assessment
3) **Forecast**: Presented
4) **Assessment model**: Stock Synthesis 3 (SS3)
5) **Data issues:** Time series of commercial index SPCORTR8C are incomplete.
6) **Consistency**: The assessment is consistent, it passed through a benchmark with minor changes, and has been accepted for stock status and forecast.
7) **Stock status**: The spawning-stock biomass (SSB) has been increasing since 1994 and has been above MSY Btrigger since 2005. Fishing mortality (F) has been below FMSY since 2010. Recruitment (R) has been low in recent years with no evidence of strong year classes since 2001.
8) **Management Plan**: EU 2019 Multiannual management plan.

General comments

The report is well structured and clear. Uncertainties and issues are clearly explained. The assessment and forecast appear to have been performed correctly.

Technical comments

No comments

Conclusions

The assessment has been performed correctly

Stock Name: mon.27.78ab

Date: 07/05/2019

Auditor: Ching Villanueva and Dorleta Garcia

General

- This stock was benchmarked in 2018. An aged-based analytical model, a4a, was accepted and is used to assess this stock. This is the first year since 2007 that an analytical assessment has been carried out. The assessment is sensitive to assumptions in the model and the addition of new data.
- Besides variable annual recruitment over the time-series, SSB began and continues to shown an increasing trend since 2006. F trended downwards since 2005 but has been above FMSY except in 2018. Retrospective analysis showed an underestimation of the SSB in the final years an overestimation of F.
- In 2017, the French survey vessel, Thalassa, suffered major mechanical issues and the majority of the IBTS EVHOE bottom trawl survey could not be completed. A VAST model was used to estimate the 2017 missing data.
- Quality of assessment may have been impacted by the issue on combined simulated and actual data uploaded to InterCatch and used for assessment. Simulated data were estimated for Q1 and Q2 of 2017 to fill lack of market sampling for length from France which can not be distinguished from actual data. Sensitivity analyses on with and without simulated data were carried.

For single stock summary sheet advice:

1) **Assessment type:** Update
2) **Assessment**: Analytical assessment
3) **Forecast**: Presented
4) **Assessment model**: a4a (as an interim analytical assessment)
5) **Data issues:** Lack of market sampling for length (biological and onboard sampling) in 2017.
6) **Consistency**: A new advice was provided by ICES in 2018 based on analytical assessment. Estimated stock trends are robust to various assumptions on growth, natural mortality, selection of tuning fleets and model specification. However, FMSY reference point seems sensitive to early part of time-series of SSB retrospective pattern. The assessment has been accepted for status assessment and forecast.
7) **Stock status**: The spawning-stock biomass (SSB) has been increasing since 2004 and has been above MSY Btrigger since 2006. Fishing mortality (F) is now below FMSY while FMSYupper is below since 2003. Recruitment (R) is highly variable with evidence of some strong inter-annual peaks in year classes since 2001.
8) **Management Plan**: Multiannual management plan.

General comments

The report is well structured and clear. Uncertainties and issues are clearly explained. The assessment and forecast appear to have been performed correctly.

Technical comments

No comments

Conclusions

The assessment has been performed correctly

Stock Name: nep.fu.25

Date: 16/05/2019

Auditor: Cristina Silva and M. Grazia Pennino

General

- The stock is classified as DLS category 3.1.4 and assessed with LPUE trends.
- Last assessment was in 2016. The advice for this stock is triennial.
- The stock abundance is very low; zero catch has been recommended since 2002; 0-TAC is applied since 2017.
- As it was not possible to conduct an UWTV survey, a sentinel fishery of ≈2 t was allowed in August-September, in 2017 and 2018, supervised by a scientific institute, to obtain an abundance index.

For single stock summary sheet advice:

1) **Assessment type:** Update
2) **Assessment**: ICES framework for category 3 stocks
3) **Forecast**: No forecast; zero catch recommended
4) **Assessment model**: No analytical assessment; assessment of LPUE trends
5) **Data issues:** New data were presented:

   i) data from the sentinel fishery in 2017-2018 (cpue and length distributions);
   ii) maps of fishing area with occurrence of Norway lobster from VMS records coupled with logbooks (2009-2018) and the sentinel fishery (2017-2018);
   iii) Norway lobster abundance spatial distribution from a demersal survey time series (1983-2018), although not directed at this species;
   iv) Discards quantities from demersal trawl fishery recorded in logbooks, in 2018;
   v) Proportion of males in landings for the period 1981-2010.

   No length composition of landings is available for 2017-2018, due to fishery closure.

6) **Consistency**: The assessment is consistent with the available information.
7) **Stock status**: The stock size very low, below any possible biomass reference point.
8) **Management Plan**: A recovery plan for southern hake and Atlantic Iberian *Nephrops* stocks was agreed by EU in 2005 and enforced since January 2006. This plan, based on precautionary reference points for southern hake, was outdated and repealed in March 2019. The plan was not evaluated by ICES.

General comments

The report is well structured and clear.

Technical comments

No comments.

Conclusions

The assessment has been performed correctly.

Stock Name: nep.fu.31

Date: 06/06/2019

Auditor: Hugo Mendes

General

- This stock is considered as category 3.1.4 and assessed by the analysis of the LPUE series trend.
- The advice for this *Nephrops* stock is triennial and valid for 2017, 2018 and 2019.
- A zero TAC was set for *Nephrops* in the whole of Division 8c. Management should be implemented at the Functional Unit level.
- Stock with extremely low biomass and zero catch advice.

For single stock summary sheet advice:

17) **Assessment type:** Update (assessed by the analysis of the LPUE)
18) **Assessment**: ICES category 3 stock
19) **Forecast**: No forecast; zero catch recommended
20) **Assessment model**: No analytical assessment; assessment of LPUE trends
21) **Data issues**: Spanish "Demersales" trawl survey (SP-NSGFS) information, VMSs data, and discards data registered in logbooks were also analyzed:

    vi) Information on discards was sent to the WG through InterCatch. There have never been discards in this functional unit.

    vii) VMS data of trawl fleet in FU 31 provided some information about the spatial distribution of *Nephrops* landings in this FU

    viii) *Nephrops* general evolution could be followed through the Spanish "Demersales" trawl survey (SP-NSGFS)

22) **Consistency**: Assessment is consistent with the available information.
23) **Stock status**: Stock with extremely low biomass and zero catch advice
24) **Management Plan**: A recovery plan for 8c and 9a hake and *Nephrops* stocks (except FU 30, Gulf of Cádiz) has been in force since the end of January 2006 (CR (EC) No. 2166/2005) to March 2019 (Regulation EU 2019/472). This plan was based on precautionary reference points for 8c and 9a hake that are no longer appropriate and was considered outdated and cancelled in March 2019.

General comments

The section of the report is well prepared and clear.

Technical comments

IBTS "Demersales" trawl survey (SP-NSGFS) data seem promising and could be further explored to improve the assessment of *Nephrops* in this FU

Conclusions

The evaluation of *Nephrops* in this FU has been concluded and done correctly.

Pollack (Pollachius pollachius) in Subarea 8 and Division 9.a (pol.27.89a)

Date: 05-May-19

Auditors: Ching Villanueva and Teresa Moura

General

- Only commercial landings were presented
- The landings statistics do not show any remarkable changes. The available scientific data for the stock are not sufficient to evaluate the stock trends and exploitation status.
- Recreational catches may be considerable but have not been quantified.
- Discard estimates show negligible levels.
- No reliable assessment was presented for this species in the southern European At-lantic shelf ecoregion due to the lack of sufficient data. However, the existence of a landings time-series makes it feasible to apply DLS assessment methods in future.

For single stock summary sheet advice:

25) **Assessment type: Update**
26) **Assessment**: Not presented
27) **Forecast**: Not presented
28) **Assessment model:** No assessment
29) **Data issues:** Lack of sufficient data. Only commercial landings were presented. Recreational catches may be considerable but have not been quantified.
30) **Consistency** No assessment was presented for this species
31) **Stock status**: Unknown
32) **Management Plan**: There is not management plan implemented for this stock

General comments

Report well documented.

Technical comments

Assessment and advice has been carried out following ICES procedures.

Conclusions

The assessment has been performed correctly as far as possible.