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

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

H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Editors

Cristina Silva • Ching-Maria Villanueva

Authors

Esther Abad • Luke Batts • Santiago Cerviño • Mickaël Drogou • Spyros Fifas • Dorleta Garcia • Hans Gerritsen • Isabel González Herraiz • Ane Iriondo • Eoghan Kelly • Jean-Baptise Lecomte • Hugo Mendes • Teresa Moura • M. Grazia Pennino • Bárbara Pereira • Lisa Readdy • Naiara Rodriguez-Ezpeleta • Paz Sampedro • Cristina Silva • Agurtzane Urtizberea Ijurco • Youen Vermard • Yolanda Vila Ching-Maria Villanueva • Mathieu Woillez

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Contents

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 14 stocks using analytical, forecast methods or trends indicators to provide catch forecasts and a first draft of the ICES advice for 2021. 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. For the remaining 9 stocks not scheduled for advice this year, after the stock information update, no specific revision of the advice was proposed. The advice for these stocks, released in 2019, is valid for the years 2020 and 2021 or for 2020 to 2022.

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 in Iberian Waters 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 analytical 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 length-structured assessment for the southern stock of hake was rejected during the working group which resulted in the downgrading of the stock from Category 1 to 3 as an interim solution. This decision was also supported by the absence of clear guidelines on how to adjust forecasts for advice when using the decision tree recommended by WKFORBIAS (ICES, 2020) for stocks with strong retrospective patterns. This year advice for the stock followed the 2 over 3-year rule based on survey and LPUE trends. A SPiCT model for the stock was explored for reference points but some inconsistencies were found among biomass indices and the retrospective patterns were also problematic. Intersessional work (online workshop) to migrate assessment analyses to a Stock Synthesis model is planned before the end of the year.

Despite an ICES data call with a deadline of six weeks before the meeting, the recurrent late data submission to ICES for most stocks has occurred, worsened by the COVID-19 disruption. 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.

In response to the spread of COVID-19 virus, all ICES assessment and advice physical meetings were suspended and held remotely. The 2020 advice sheets for 13 stocks were abbreviated and will be released with advice released in 2019 as annex. A full advice sheet, however, was done for the southern hake due to the change in category of the stock.

The structure of the report is set out with section 1 presenting a summary for 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 contain 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	2020
Reporting year in cycle	1/1
Chair(s)	Cristina Silva, Portugal
	Ching-Maria Villanueva, France
Meeting venue(s) and dates	6 – 13 May 2020, web conference meeting, 27 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 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. Total Allowable Catch (TAC) for both species combined was set at 19 836 t for 2019 and 20 526 t for 2020. Since 2011, the landings of both species combined have been above the average of the time series.

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). In 2018, both stocks were benchmarked (WKANGLER) 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 (ICES, 2018a).

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 time series. 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 time series. 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 within 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 ports statistics. Landings of both species combined in 2019 were 909 t. The combined TAC was set at 4 166 t in 2019 and 4 023 t for 2020.

The two species were benchmarked in 2018 (WKANGLER; ICES 2018a) and are assessed separately, using a surplus-production model (SPiCT software; Pedersen and Berg, 2017), tuned with commercial LPUE series for *L. budegassa* and a length-based stock synthesis (SS; Methot Jr. and Wetzel, 2013) 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 12 476 t in 2020. 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 increasing trend was observed with the highest estimated biomass of the time series recorded in 2016. Fishing mortality remained at high levels between late eighties and late nineties the progressively declining since 2000. In 2016, fishing mortality was 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 Divisions 7.b-k and 8.a, b, d are caught in a mixed demersal fishery catching anglerfish, hake and *Nephrops*, both as targeted species and as valuable by-catch. The two species are landed and recorded together in ports statistics. Information from landings was available for 2017 for *L. boscii* that provided a rough proportion for splitting the two species. The 2019 and 2020 TAC were set at 19 836 and 20 526 t, respectively. Landings in recent years were relatively stable around 15 000 t reaching 12 164 t in 2019. 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 6 300 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 with the most recent period, 2015-2017 showing a slight increase. Recruitment has fluctuated without trend over the time series with 2016 and 2017 giving above average values. Biomass has steadily declined to its lowest level in 2006, increasing since then. The 2017 value was estimated to be the highest of the time-series.

The *L. boscii* data on catch, landings and discards for 2017-2019, were available to the WG 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. An 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 2019 were 981 t (of which <30% correspond to *L. whiffiagonis*). The agreed combined TAC for megrim and four-spot megrim in ICES Divisions 8.c and 9.a was 1 872 t in 2019 and 2 322 t in 2020.

Both species are assessed separately, using the Extended Survivor Analysis (XSA) model (Shepherd, 1999).

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, SSB 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 second period at a lower level, with small ups and downs. The last four years show a fall in fishing mortality, with the lowest value in 2019 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). Assessment analysis is done using an Extended Survivor Analysis (XSA) model (Shepherd, 1999). The TAC was set at 3 872 and 3 666 t for 2019 and 2020, respectively. Landings have been declining until 2017 (3 263 t) but have slightly increased since the last two years: 3 468 t in 2018 and 3 351 t in 2019.

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 and decreased substantially the following two years. After 2005, F was stable at around 0.43 (= F_{pa}). In 2017, F is estimated to be below $F_{MSY,}$ but between F_{MSY} and F_{pa} in 2018-2019. The SSB trend in earlier years increased from 1984 to a high value in 1993 showing afterwards a continuous decrease until 2003, the lowest value of the series. SSB has been increasing and was above MSY $B_{trigger}$ in the period 2004–2013. In 2014, SSB dropped below MSY $B_{trigger}$ increasing again since 2016, and staying above MSY $B_{trigger}$ and B_{pa} (both equal to 10 600 t). The recruitment series is stable between 2004 and 2008, 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 $GM_{1993-2014}$ (21 million). However, the 2012 and 2013 values are the lowest of the series (13 million). Recruitment is declining since 2015, with the lowest value of the series observed in 2019 (around 11 million).

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* though in recent years official catches are reported separated by species. There is some evidence that *Solea* spp. may have been misclassified in the past in Portuguese landings, which means that *Solea solea* official landings might not correspond only to this species but a mix of *Solea solea* with very few *S. senegalensis* and some *P. lascaris*.Total landings of *S. solea* was 579 t and 553 t for 2018 and 2019, respectively. Until now no assessment was performed for this species. Currently, the advice for *S. solea* only is provided from official landings on the basis of a category 5 stock, but this may be progressed to a category 4 or 3 next year, depending on the benchmark results.

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 were below the agreed TAC, 141 160 t in 2019 and 112 903 t in 2020.

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, 2017a) 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, 2018d). Although the revision of 2018 discards data had a negligible impact on the stock status estimates this year, it had a negative impact in the retrospective pattern. The patterns are significantly worse than in previous years. The spawning stock biomass estimates obtained this year are mostly below those obtained in previous year and the fishing mortalities are above. The highest Mohn's rho index (Mohn, 1999) was obtained for spawning stock biomass Platform (windows/linux) dependent convergence issues were detected.

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 millions) and the one in 2019 the third highest (~600 millions). From high levels at the start of the series (100K t in 1980), the SSB decreased steadily to a low level at the end of the 90s (23K t in 1998). Since that year, SSB has increased to the highest value of the series in 2016 (291K t) and decreased afterwards. 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. Between 2006 and 2011, F declined sharply and since 2012, it fluctuates around F_{MSY} (0.26). The F estimate for 2019 is 0.23 but the three-year mean is to 0.26.

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 increased in 2018 and 2019 up to 10 183 t and 11 800 t, respectively. Total discards in 2018 was 1 942 t and decreased to 1 061 t in 2019. Total catches were 12 125 t in 2018, and increased to 12 861 t in 2019.

The TAC for 2019 was 9 258 t which means that total catches exceeded the advised TAC. The TAC for 2020 is 8 752 t.

The southern hake stock was benchmarked in 2014 (WKSOUTH; ICES 2014) to address the difficulties encountered by the GADGET model (Begley and Howell, 2004) 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 45 000 t, then decreased to a minimum of 5 706t in 1998. From 1998, biomass has continuously increased, reaching 16 210 t in 2011, above the average of the series. Since 2012, biomass trend started to decline from 14 860 t to 11 790 t in 2016 and slightly increasing since 2017. SSB values for 2018 and 2019 were 13 200 t and 13 160 t, respectively.

This year assessment was updated with the 2019 data with no revisions of data from previous years. The model was rejected and a new advice based on category 3 was produced.

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

Nephrops in ICES Division 8.a,b

There are two Functional Units (FU) 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 2019 was 3 878 t. In 2019, total nominal landings reached 2 154 t, close to the historically lowest level of 2018 (2 125 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 change of landings and discards patterns recently observed. 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 benchmarked in WKNEP 2016 (ICES, 2017b) which has reviewed 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 considered appropriate for assessing the stock and provision of advice.

No quantitative analytical assessment was carried out during the WG in spring since the survey used for the assessment had not been completed yet. An update of the assessment and of the report will be carried out after the WG and the advice will be 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 a 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 (ICES, 2015). 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 Cadiz).

Landings in 2019 from the five FUs combined were 355 t. The TAC set for the whole of Subareas 9 and 10 and Union waters of CECAF 34.1.1 was 401 t for 2019 and 386 t for 2020.

A recovery plan for southern hake and Iberian *Nephrops* stocks had been in force since 2006. The aim of the recovery plan was 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). In March 2019, the European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (Parliament and Council Regulation (EU) 2019/472) which repealed the previous recovery plan. This plan applies to demersal stocks including *Nephrops* in ICES divisions 9a.

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. Since 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 from 1975-2016. During 1975-1989, the mean landing was 680 t, fluctuating at approximately between 575 and 800 t. 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 (ICES, 2015). 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 followed by a declining period in 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 were stable at around 150 t, increasing to 299 t over the years 2014-2018. Landings in 2019 were 284 t. There are no discards of *Nephrops* in the fishery.

According to the ICES data-limited approach, this stock is classified in the category 3.2.0 (ICES, 2015) and the advice is based on standardized CPUE and effort trends. Standardised effort shows a consistent declining trend until 2010, fluctuating at low levels since. The fleet standardised CPUE, used as an index of biomass, decreased in the period 2006-2011, increase since then. The proxy reference points were estimated using the the Mean Length Z approach with the standardized effort. 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. In 2013-2015, landings dropped to around 20 t, due to a sanction applied by the European Commission for Spain having exceeded the quota in 2012 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 3.2.0 (ICES, 2015) and the advice is based on the underwater TV survey (UWTV) series trends. No quantitative analytical assessment was carried out during the WG in spring since the survey used for the assessment had not been completed yet. An update of the assessment and of this report will be carried out after the WG and advice will be 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 in 2018 (WKBASS and IBPbass; ICES 2018b, c) 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 then an increase in 2017. The SSB fluctuated around 20 000 t. A low SSB was observed just before the 2000s then a high value was observed around year 2010. Since then, a decreasing trend was observed. The recruitment series was variable around ~30 million individuals per year. Recruitment below average was observed for years 2009 and 2014. Fishing mortality, estimated as the average of ages 4-15, has fluctuated without trend over the time series.

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 represented 788 t in 2019, a value slightly higher to the previous year, 716 t in 2018. A peak in landings was observed in 1989-90 and again in 2013, reaching more than 1 000 t while the 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 and it was issued in 2019 for the years 2020 and 2021. Landings are more than the advised catch (502 t) 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 (Regulation (EC) No. 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 2008–2009. 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 time series of landings and discards including 2019 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 time series of landings and discards including 2019 data do not change the perception of the stock. This year, length-based methods for data limited stocks (ICES, 2015) and the stochastic production model SPiCT (Pedersen and Berg, 2017) were explored.

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 t. In 2017, landings decreased 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 (DLS) in category 5.2.0 as the only available information is on catches. This year, the updated time series 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 27 March 2020 was set in order to prepare the datasets for the WG 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 WG 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. This year, the delay was even greater due to the COVID-19 disruption. Spanish and French data for 2019 were made available well after the data call deadline and for some stocks it was not possible to complete the assessment before the group started. 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.

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 within 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. Norway data have to be added to Northern hake assessment with a different procedure, because in recent years Norway does not upload the data to InterCatch and also the information is provided in a different format.

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

In 2019, issues lists were completed for 9 stocks with full analytical assessment and 3 stocks ranging from category 3 to 5 in preparation for benchmarking and to review future research needs. The WG had 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.

Only sole in 8c9a was selected by ACOM for a benchmark in 2020-2021 according to the benchmark prioritization scoring table. However, some preparatory work has been developed for several stocks in preparation for a future benchmark and described in this section.

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.

An extensive simulation work has been done to solve the strong retrospective pattern of hake in Divisions 8c and 9a (Southern Hake), but no clear solution is envisaged with the same assessment model (GADGET). It is proposed that, like Northern Hake, Stock Synthesis is tested in the assessment of Southern Hake.

Some work has been developed for several other stocks in preparation for a future benchmark. This is the case of megrim and white anglerfish in 7.b-k8.abd stocks for which more appropriate models were tested and discussed in this WG. To speed up the process of preparing the benchmark, online inter-sessional work has been proposed for the assessment of the megrims and four-spot megrims stocks using a4a and of hakes and anglerfishes using Stock Synthesis. At present, there is one anglerfish stock (white anglerfish in Divisions 8c9a) being assessed with Stock Synthesis, but there are still issues remaining from previous benchmark. It is proposed that this inter-sessional work ends up with a physical workshop at the end of the year, with the participation of external reviewers. This proposal is presented in Annex XX-Recommendations as a resolution to be approved by ACOM.

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 (ICES, 2014), IBPHake (ICES, 2019)		Yes	Revision of biological data and von Bertalanffy growth parameters, analysis of convergence issues, inclusion of north sea surveys, revision of model setting in general (weighting of different data sources).
Hake in Divisions 8.c and 9.a (Southern stock)	Downgraded to category 3	WKSouth (ICES, 2014)		Yes	Assessed with Gadget. Strong retrospective pattern, the cause of which is unclear. Revision of biological data. Change of assessment model is proposed
Black Anglerfish in Subarea 7 and Divisions 8abde	Survey trends (category 3)	WKAngler (ICES, 2018a)			Other models are being explored
White Anglerfish in Subarea 7 and Divisions 8abde	a4a (provisional)	WKAngler (ICES, 2018a)			a4a is age-based assessment and Lengths are converted to ages outside the model; change to SS3
Black Anglerfish in Divisions 8c9a	SPiCT trends (category 3)	WKAngler (ICES, 2018a)			Other models are being explored
White Anglerfish in Divisions 8c9a	Update	WKAngler (ICES, 2018a)			Remaining issues (tuning fleets, length composition). Absence of large size individuals.
Megrim in Subarea 7 and Divisions 8abde	Bayesian catch-at-age	IBPMegrim (ICES, 2016)			Change to a4a; long computational time for the Bayesian model
Megrim in Divisions 8c9a	XSA	WKSOUTH (ICES, 2014)			XSA deterministic; change to a4a
Four-spot Megrim in Divisions 8c9a	XSA	WKSOUTH (ICES, 2014)			XSA deterministic; change to a4a

1.8 Mohn's rho

As standard practice, for each of the stocks assessed using a full analytical assessment within a category 1 of stock assessment, the Mohn's rho was calculated (Figure 1.3) using a 5–year peel. WGBIE assesses nine stocks which fall into this category of assessment using a combination of age and/or length structured models. Mohn's rho is also calculated for one category 3 stock (black anglerfish in Divisions 8c and 9a) , assessed with SPiCT. With the exception of megrims in 7.b-k8.abd and 8c9a, and hake in 8c9a, all stocks are within the 20% threshold for SSB and F. Recruitment shows much more retrospective bias suggesting that recruitment is not easily estimated by the models for five of the nine stocks as these were evaluated as being outside the threshold of ±20%. However, a marked and stronger retrospective pattern for all stock characteristics is perceived for Hake in Divisions 8c9a. The southern hake case study has been discussed in WKFORBIAS (ICES, 2020) and an extensive simulation work was developed in this workshop and prior to this WGBIE meeting with no conclusive results. The assessment was rejected and the stock was downgraded to category 3 as an interim solution until a new assessment model is developed and accepted in a benchmark.

1.9 Evaluation of *Nephrops* Functional Units 29 and 30

Some stations were in FU 29 near the border with FU30, were covered by the Spanish ISUNEPCA survey with some stations with UWTV and some hauls carried out with beam trawl. The purpose was to investigate the continuity of *Nephrops* distribution in the two Functional Units. The WG recommended that further investigation is needed, and available data are standardised across the two units to facilitate comparisons.

1.10 Fisheries overviews

Some progress was made last year on the development of a mixed-fishery analysis. Due to delays in the data submissions coupled with the meeting being held remotely, have impacted on the completion of the ToR to further review and develop the fisheries overviews.

1.11 Ecosystem overviews

No progress has been made on this ToR.

1.12 Research needs of relevance for the expert group

The group assess 6 data-limited stocks classified as category 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 *Nephrops* 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.

1.13 References

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ICES. 2014. Report of the Benchmark Workshop on Southern megrim and hake (WKSOUTH). 3–7 February 2014, Copenhagen, Denmark. ICES CM 2014/ACOM: 40.

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ICES. 2016. Inter-Benchmark Protocol Workshop Megrim (*Lepidorhombus whiffiagonis*) in Divisions 7.b–k and 8.a, 8.b, and 8.d (West and Southwest of Ireland, Bay of Biscay) (IBP Megrim 2016), July 2015 – March 2016, By correspondence. ICES CM 2016/ACOM: 32. 124 pp.

ICES. 2017a. 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. 2017b. Report of the Benchmark Workshop on Nephrops Stocks (WKNEP), 24–28 October 2016, Cadiz, Spain. ICES CM 2016/ACOM:38. 105 pp.

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. 172 pp.

ICES. 2018b. Report of the Benchmark Workshop on Sea bass (WKBASS), 20-24 February 2017 and 21-23 February 2018, Copenhagen, Denmark. ICES CM 2018/ACOM:44. 259 pp.

ICES. 2018c. Report of the Inter-benchmark Protocol on Sea Bass (*Dicentrarchus labrax*) in divisions 8.ab (Bay of Biscay North and Central) (IBPBass 2018), July–September 2018, By correspondence. ICES CM 2018/ACOM:54. 23 pp.

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

Shepherd, J.G., 1999. Extended survivors' analysis: an improved method for the analysis of catch at age data and abundance indices. ICES Journal of Marine Science. Vol. 56, No. 5.pp. 584-591.

Table 1.4a. Biological sampling levels by stock and country. Number of individuals measured and aged from landings in 2019.

		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	7.b–k &8.a,b,d	8.c &9.a	8.a,b	8.c &9.a
Belgium	No. lengths	2522		1792		4358					
	No. ages			0		487					
	No. samples**	17		34		17					
E & W (UK)	No. lengths	24226		6974		16539					
	No. ages			0		860					
	No. samples*	237		287		205					
France	No. lengths	7713		10017		11223		393		19730	
	No. ages			0		-				1396	
	No. samples*	597		492		288		45			
Portugal	No. lengths		98	0	655		77		2449		3525
	No. ages***			0							
	No. samples*		40	0	55		4		44		229
Republic of	No. lengths			7876		15735		459			
Ireland	No. ages			0		-					
	No. samples**			259		116		4			

		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	7.b–k &8.a,b,d	8.c &9.a	8.a,b	8.c &9.a
Spain	No. lengths	10325	4197	13728	3904	23299	9896	7410	30547		3604
	No. ages			0		-	744		955		
	No. samples	91	414	430	448	81	171	323	197		209
Denmark	No. lengths			0							
	No. ages			0							
	No. samples			0							
Total	No. lengths	8298		40387		71154					
	No. ages			0		1709					
Total nb. in international landings ('000)		**44786**	**139**	**6067551**		**51894**					
Nb. measured as % of annual nb. caught		**0.0185 %**	**3%**	**0.67%**	**2%**	**0.14%**					

*** 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	7991									
	No. ages										
	No. samples*	215									
E & W (UK)	No. lengths	20737									
	No. ages										
	No. samples*	550									
France	No. lengths	22243		16902			6118		418	2727	154
	No. Ages*****						2174				
	No. samples****	1076		432			852		53	155	
Portugal	No. lengths		16270			5380		2725	326		1326
	No. ages***										
	No. samples*		308			36		170	41		
Republic of Ireland	No. lengths	22010									
	No. ages*****										
	No. samples*	393									

		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
Spain	No. lengths	67791	77142		16108	6777	676	1854	1056	395	
	No. ages				Na						
	No. samples*	729					11	90			
Denmark	No. lengths	9375									
	No. ages										
	No. samples*	24									
Total	No. lengths	149603			16108	12157				3122	
	No. ages										
Total No. in international landings ('000)		**44677**	**31359**	**96919**	**56**	**8261**			**Na**	**4658**	
Nb. meas. as % of annual nb. caught		**0.30%**	**0.3%**	**0.02%**	**29%**	**0.15%**			**Na**	**0.067%**	

*** Vessels**

**** Categories**

***** Ages, surveys**

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

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

(a) Trips

Table 1.4b. Biological sampling levels by stock and country. Number of individuals measured and aged from discards in 2019.

		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	7.b–k &8.a,b,d	8.c &9.a	8.a,b	8.c &9.a
Belgium	No. lengths	3571				2642					
	No. ages					207					
	No. samples	17				20					
E & W (UK)	No. lengths	1868				5588					
	No. ages					239					
	No. samples	587				398					
France	No. lengths	216				1327					
	No. ages					-					
	No. samples	24				5					
Portugal	No. lengths		0		1		3		73		
	No. ages										
	No. samples (a)		31		32		32		32		
Republic of Ireland	No. lengths	4784				3589					
	No. ages										
	No. samples	196				67					

		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	7.b–k &8.a,b,d	8.c &9.a	8.a,b	8.c &9.a
Spain	No. lengths	16	28		13	1848	335		2097		
	No. ages					-					
	No. samples	165	201		204	341	220		295		
Denmark	No. lengths										
	No. ages										
	No. samples										
Total	No. lengths	5695				11411					
	No. ages										
Total no. in international discards ('000)		**5905.2**				**8077**					
Nb. meas. as % of annual nb. Discarded		**0.096 %**				**0.14%**					

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		2037			191		0	460	
	No. Ages										
	No. samples	416		58					0	50	
Portugal	No. lengths		497			0			0	0	0
	No. ages										
	No. samples (a)		31			8			31	32	32
Republic of Ireland	No. lengths	71923									
	No. ages										
	No. samples	1494									

		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
Spain	No. lengths	6814	3034		558				0	7	
	No. ages				na						
	No. samples	607	388		20(a)				0	3	
Denmark	No. lengths	2001									
	No. ages										
	No. samples	170									
Total	No. lengths	37107			558	0					
	No. ages										
Total no. in international discards ('000)		**0.27%**	**17374**	**59102**	**8**	**0**			**Na**		
Nb. meas. as % of annual nb. Discarded			**0.2%**	**0.003%**	**7%**	**Na**			**Na**		

(a) Trips

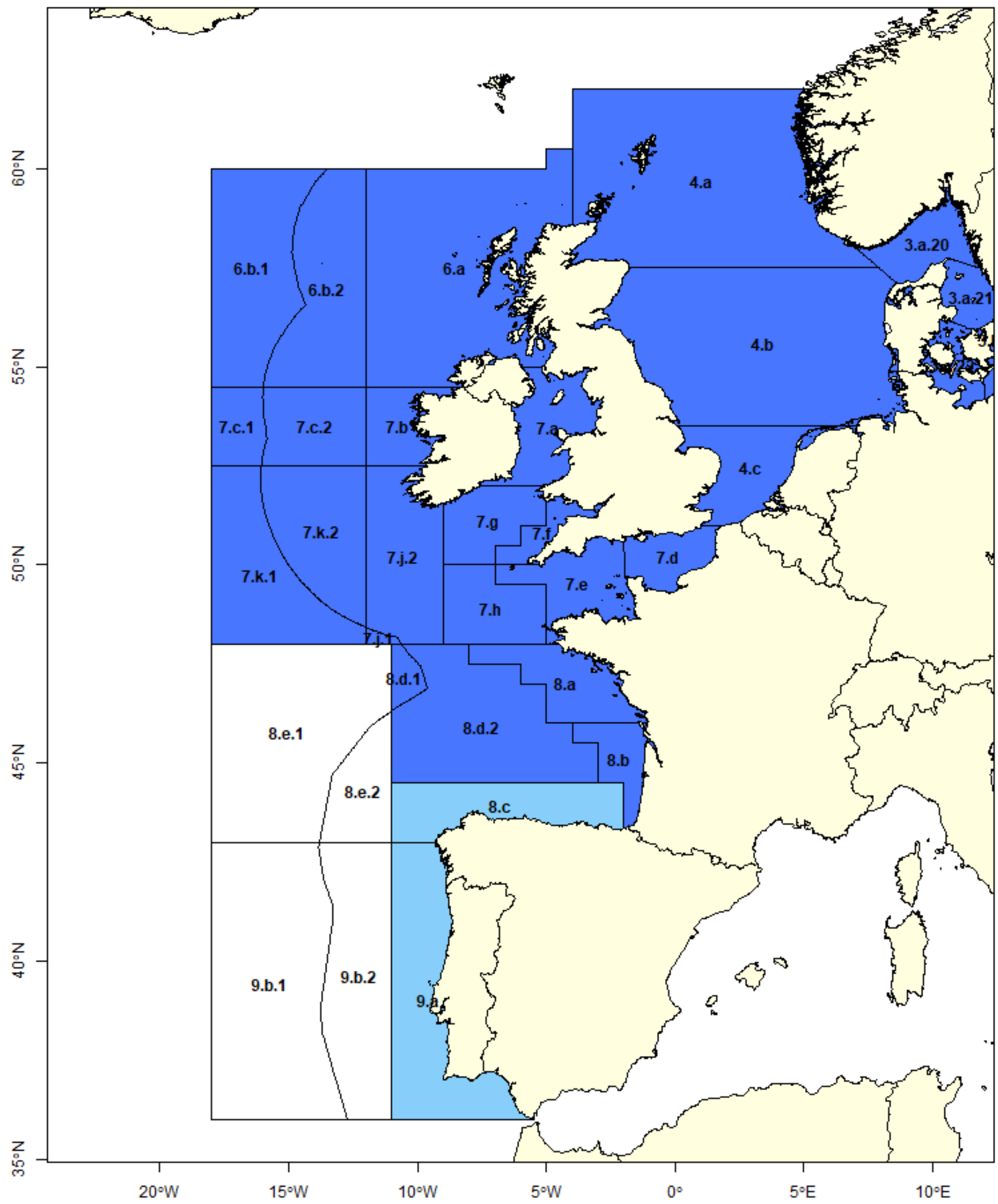

Figure 1.1. Map of ICES Divisions. Northern (3.a, 4, 6, 7. and 8.abd) and Southern (8.c and 9.a) Divisions with different shading.

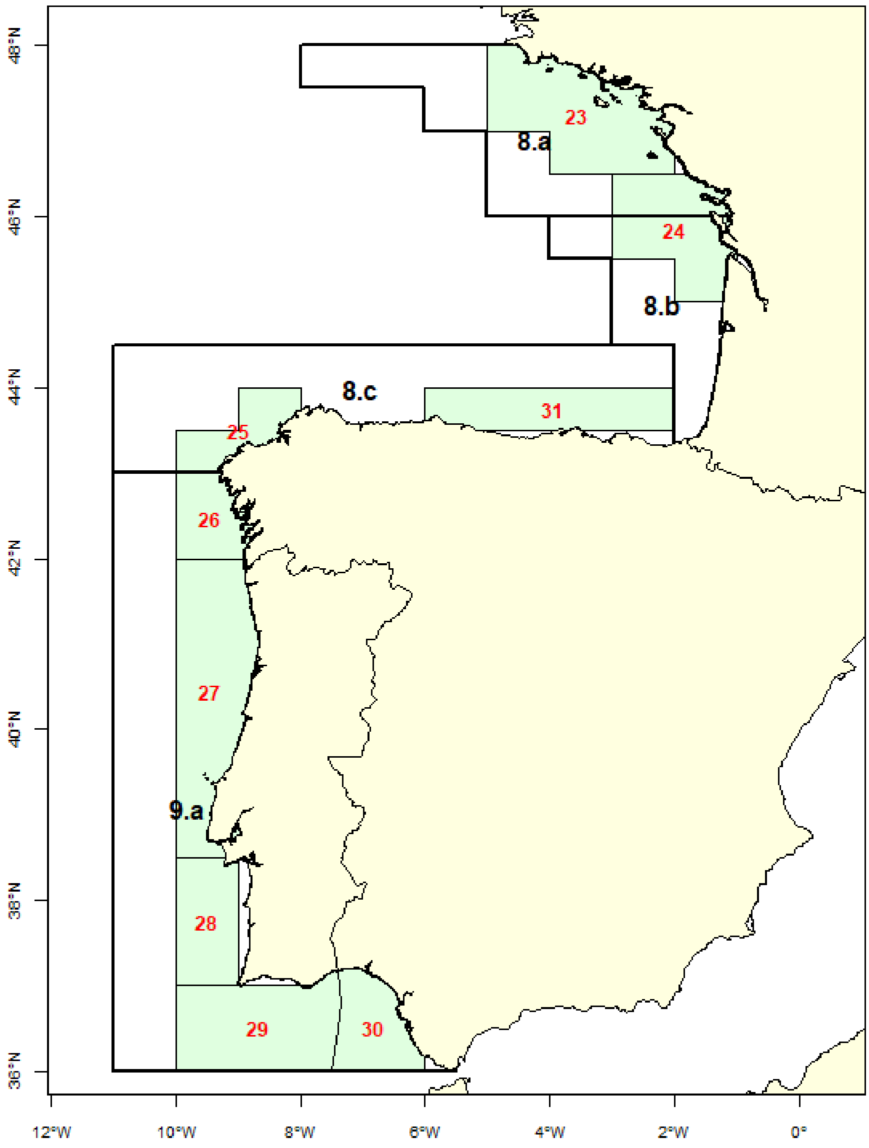

Figure 1.2. ICES Divisions 8 and 9.a *Nephrops* Functional Units. Division 8.ab: FUs 23-24. Division 8.c: FUs 25 and 31. Division 9.a: FUs 26-30.

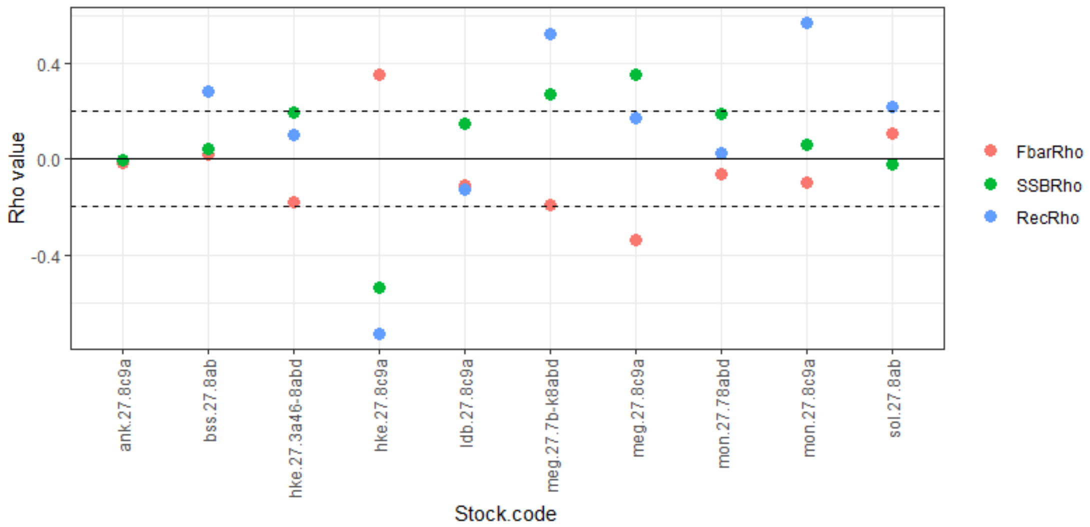

Figure 1.3. Mohn's rho for each of the stocks that used a category 1 full analytical assessment of stock status and one category 3 stock assessed with SPiCT (black anglerfish in 8c9a, ank.27.8c9a). Southern hake stock (hke.27.8c9a), down-graded to category 3 this year due to its strong retrospective pattern, is still presented in the graph.

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 8abd)

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

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
FU00	French unknown	

Under the implementation of the mixed fisheries approach in the ICES WG's new information, updating some of the 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 FUs 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.

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 provided to InterCatch according 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	

FU	Fleet for InterCatch	DCF MÉTIER (Level 6)	DESCRIPTION	FR	IR	SP	UK
FU13	GNS_DEF	GNS_DEF_45-59_0_0	Set gillnet directed to demersal fish (45-59 mm)	X			
		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 FUs and DCF métiers has also been compiled for the southern stock fleets and is presented in the following table.

COUNTRY	FU (STECF, 1994)	Métiers (Level 5)	MÉTIERS (Level 6)	DESCRIPTION (mesh size in brackets)	SP	PT
Spain	Gillnet	GNS_DEF	GNS_DEF_80-99_0_0	Set gillnet directed to demersal species (80-99 mm)	X	
			GNS_DEF_280_0_0	Set gillnet directed to demersal species (at least 280 mm)	X	
	Small gillnet		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	
	Southern artisanal	LLS_DWS	LLS_DWS_0_0_0	Set longline directed to deep-water species	X	
	Northern Trawl	PTB_MPD	PTB_MPD _> = 55_0_0	Pair bottom trawl directed to mixed pelagix and demersal fish (at least 55 mm)	X	
		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_MCD	OTB_MCD_>=55_0_0	Otter bottom trawl directed to mixed crustacean and demersal fish (at least 55 mm)	X	
Portugal	Artisanal	GTR_DEF	GTR_DEF_>=100_0_0	Trammel net directed to demersal fish (at least 100 mm)		X
		GNS_DEF	GNS_DEF_80-99_0_0	Set gillnet directed to demersal fish (80-99 mm)		X
		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 (ICES, 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 (ICES, 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
Spanish Cadiz ISUNEPCA *Nephrops* UWTV survey		UWTV30	
Portuguese groundfish survey – October	P-GFS-oct	IBTS-EA-4Q	PtGFS-WIBTS-Q4
Portuguese groundfish survey – July (ended in 2001)	P-GFS-jul		----
Portuguese crustacean trawl survey / *Nephrops* Survey Offshore Portugal NepS	P-CTS	NepS (FU 28-29)	PT-CTS (UWTV (FU 28-29))
Portuguese winter groundfish survey/Western IBTS 1st quarter (2005 – 2008)	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
French *Nephrops* UWTV survey in Bay of Biscay		UWTV23-24	
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. General maps identifying survey areas can be found in ICES IBTS WG report (ICES, 2018a) and WGNEPS report (ICES, 2019).

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 Spanish FU30 UWTV surveys in the Gulf of Cadiz (ISUNEPCA)

The ISUNEPCA UWTV survey was launched in 2015 although an exploratory UWTV survey was conducted previously in 2014. ISUNEPCA is a multi-disciplinary survey in nature but the main objective is to estimate the *Nephrops* burrows density using underwater videos and to confirm the boundaries of the *Nephrops* area distribution in FU30. As results, geo-statistical *Nephrops* abundance is estimated. Other ecosystem data are also collected (temperature, salinity, sediment samples, trawl marks and sea bed morphological and backscatter data). Survey design follows a randomly isometric grid with stations at 4 nm spacing. Survey area covers 3 000 km^2 between 100 and 700 m of depth and about 70 stations are planned every year.

2.2.5 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.

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

The *Nephrops* Survey Offshore Portugal, NepS (FU 28-29), 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 trawl 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.

2.2.7 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 comprised 75 fishing stations, 66 at fixed positions and 9 at random. The main aim of the survey was to estimate spawning biomass of hake. This survey ended in 2008.

2.2.8 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.

2.2.9 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.

2.2.10 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 (ICES, 2018b).

2.2.11 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.11

680 Km²), 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 (ICES, 2012), this survey is included as tuning series in the stock assessment.

2.2.12 French *Nephrops* UWTV survey in Bay of Biscay

A new experimental UWTV survey for burrow counting has been undertaken since 2014 covering the five sedimentary muddy strata of the former trawl survey on the FU23-24 *Nephrops* stock. The survey is carried out by the Irish scientific vessel "Celtic Voyager" with a French scientific team on the basis of a systematic sampling plan. A longer survey in the period 2016-2019 allowed to cover the area contained in the outline of the Central Mud Bank not belonging to any sedimentary stratum: this area, known as not trawled due to rough sea bottom, is crossed by muddy channels and concentrates a moderate fishing effort targeting *Nephrops*. Investigations on the basis of stratified statistical estimators as well as on geostatistics were carried out and examined by WKNEP 2016 (ICES, 2017), which validated the UWTV approach.

2.2.13 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.

2.2.14 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.

2.2.15 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.

2.2.16 English Bottom-trawl Survey

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

2.2.17 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).

2.2.18 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.

2.2.19 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 1 000 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.

2.3 References

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

3.1 General

3.1.1 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.

3.1.2 ICES advice applicable to 2020

For *L. budegassa*: ICES advises that when the precautionary approach is applied, catches in 2020 should be no more than 12 959 t.

For *L. piscatorius*: ICES advises that when the EU multiannual plan (MAP) for Western waters and adjacent waters is applied, catches in 2020 that correspond to the F ranges in the MAP are between 21 248 t and 42 331 t. According to the MAP, catches higher than those corresponding to F_{MSY} (31 798 t) can only be taken under conditions specified in the MAP, while the entire range is considered precautionary when applying the ICES advice rule.

3.1.3 Management applicable to 2020

Species: **Anglerfish** *Lophiidae*	**Zone: 7 (ANF/07.)**[1,]	**Zone: 8a, 8b, 8d and 8e (ANF/8ABDE.)**
Belgium	3 262	-
Germany	364	-
Spain	1 296	1 372
France	20 932	7 636
Ireland	2 675	-
The Netherlands	422	-
United Kingdom	6 348	-
Union	35 299	9 008
TAC	35 299 Precautionary TAC	9 008 Precautionary TAC

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

The combined TAC for 27.7 and 27.8abde was 44 237 t, this was 1.1% below the combined advice for the two species of 44 757 t. 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.

3.1.4 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 t (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.

3.1.5 Information from stakeholders

WGBIE did not receive information from stakeholders regarding these stocks.

3.2 Data

3.2.1 Data revisions

No revised catch data prior to 2018 were submitted.

The 2018 catches (landings and discards) and length frequency data from France were reviewed following a new methodology to estimate effort explained previously in the report. In the case of *L. piscatorius*, the differences are small, in total landings is 26 t lower than in WGBIE2019 (ICES, 2019) and in total discards 146 t lower.

3.2.2 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.

3.2.3 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 considerably in many fleets 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

3.1.1 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.

ICES.2019. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion(WGBIE).ICES Scientific Reports. 1:31. 692pp.http://doi.org/10.17895/ices.pub.5299.

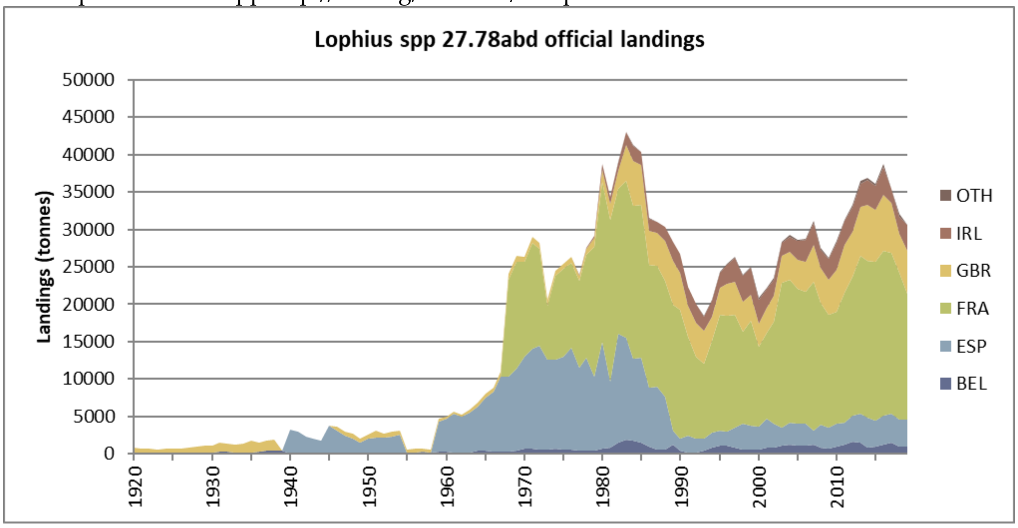

Figure 3.1.1. *Lophius* spp in 27.78abd. Time series of the official landings.

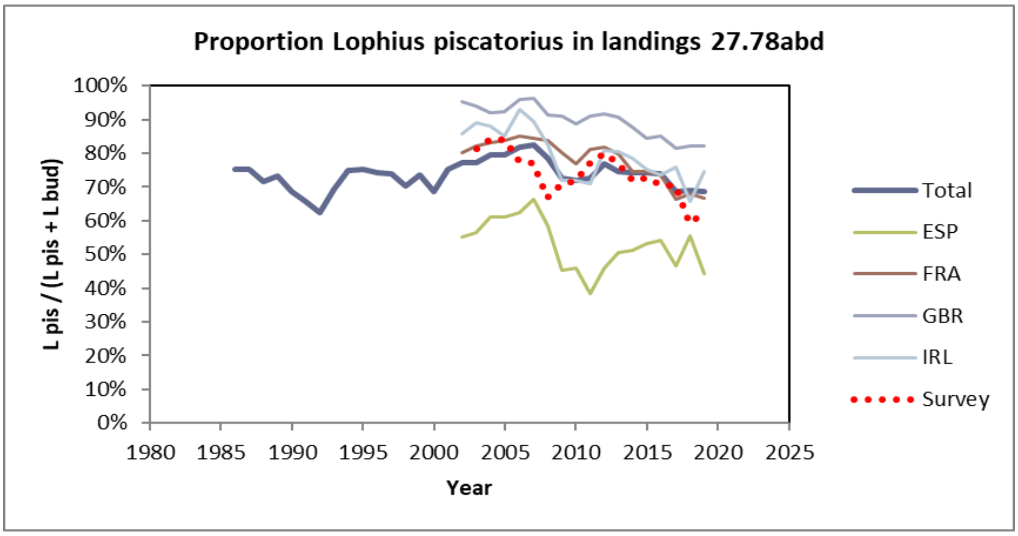

Figure 3.1.2. *Lophius* spp in 27.78abd. Species composition by country. The species proportion in the combined FR_IE_IBTS survey is also shown (but not used to split the catches).

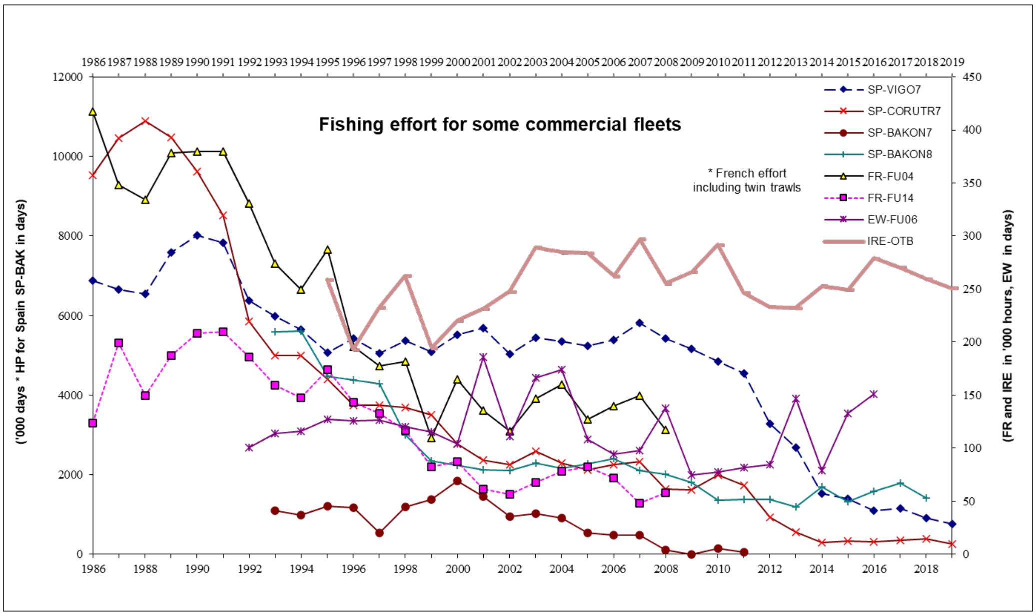

Figure 3.1.3. ***Lophius*** **spp in 27.78abd. Effort by the main fleets.**

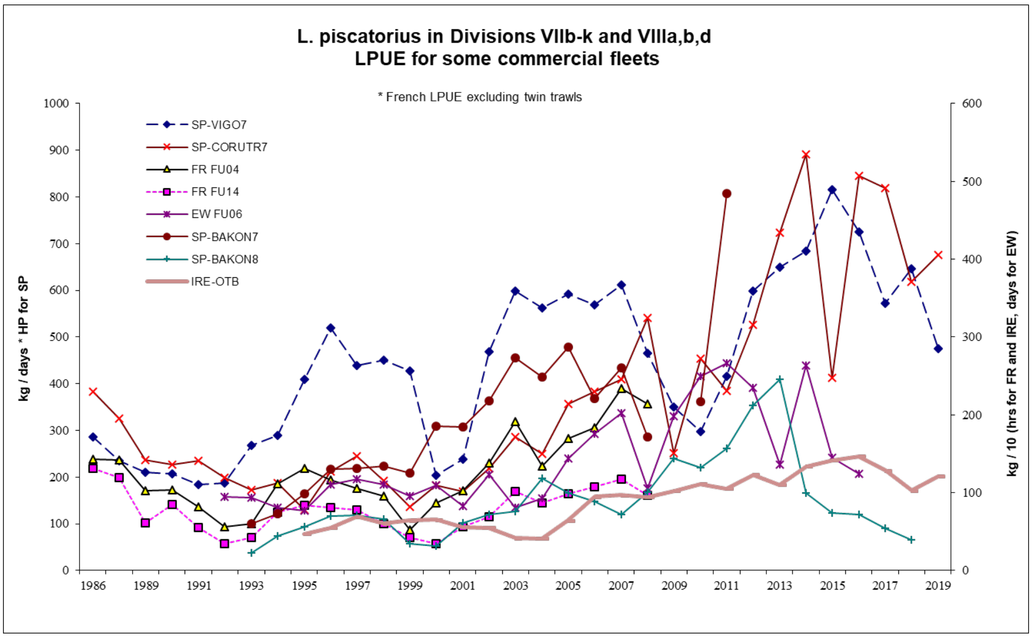

Figure 3.1.4. ***Lophius piscatorius*** **in 27.78abd. LPUE of** ***L. piscatorius*** **by the main fleets.**

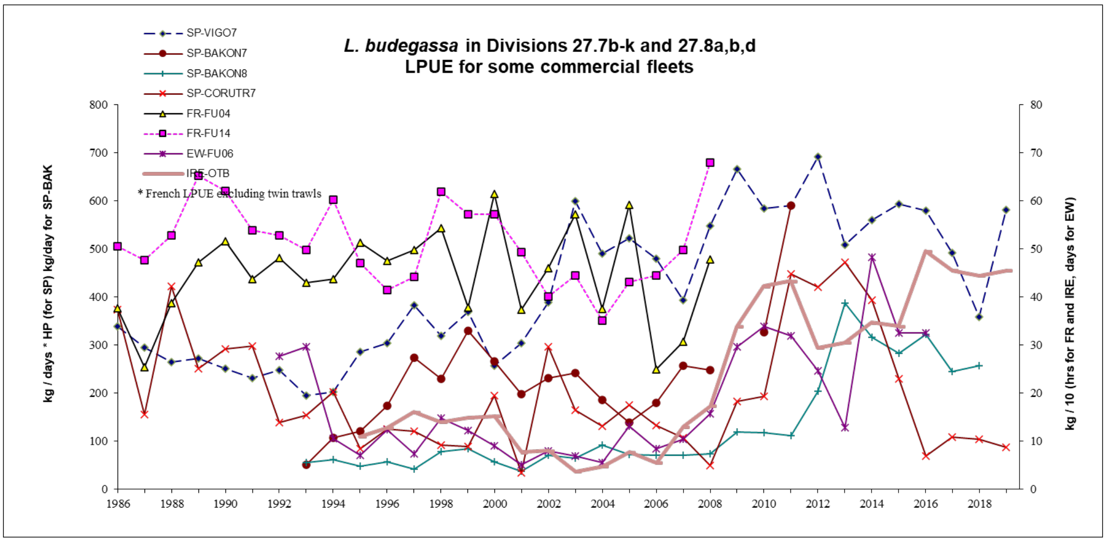

Figure 3.1.5. *Lophius budegassa* in 27.78abd. LPUE of *L. budegassa* by the main fleets.

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	

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
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
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	6341	3734	10076	1727	32420	3123
2019	-	19085	2181	21266	1444	3800	2880	9680	1084	30946	2528

***since 2019 landings of 7a included here.**

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

3.3.1 Type of assessment

Update Category 1 assessment.

3.3.1.1 Feedback from ADG

No issues identified.

3.3.1.2 Feedback from EG audit 2018

No issues identified.

3.3.2 Data

In 2018, WGBIE were made aware of an issue with the sampling level in Q1 and Q2 of 2017 from France (ICES, 2018b). 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.

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 Linf = 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 10 cm 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. When the total discards and the multiplication between numbers-at-length discarded and the weight were different, until now the total discards were modified to fit the summatory. However, this year the code was modified to keep total discards as it was and instead the number of individuals is modified. In this way, the total discards in the assessment match the estimated total discards when the discards per country or area are summed. This affect the historical time series of discards, with a difference of between -1 and 3 % in comparison with the values we had from last year's assessment (Figure 3.2.3). 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.

Figures 3.2.4a and 3.2.4b show the age distribution of the catches in terms of abundance and biomass, respectively. 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 3.2.5 shows the cohort tracking of the catch numbers-at-age. Cohort tracking is reasonably consistent up to age 7.

Figure 3.2.6 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.

3.3.2.1 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_IE_IBTS for short) very consistent cohort tracking for the younger ages (Figure 3.2.7a). 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 five recent years of data but appears to track the 2014 and 2010 cohorts (Figure 3.2.7b).

The SP_Porc (SpPGFS-WIBTS-Q4) survey tracks cohorts very consistently up to at least age 7 (Figure 3.2.7c).

Figures 3.2.8a and b show the internal and external consistency of the surveys. The FR_IE_IBTS is very consistent for young ages; the IE_Monksurvey is too short to clearly show internal consistency and the SP_Porc survey is somewhat noisy at ages 1 and 6 but otherwise quite consistent (Figure 3.2.8a). The FR_IE_IBTS and IE_MONKSURVEY have very similar signals for the 1 and 2-year olds but the IE_MONKSURVEY and SP-PORC do not show much agreement for the ages 2-5 where these surveys overlap (Figure 3.2.8b). Figure 3.2.8c shows the overall abundance indices of the surveys.

3.3.2.2 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

3.3.3 Historical stock development

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

Software used*:* R package Fla4a (version 1.6.4; Jardim et al. 2015) in R (version 3.5.2; R, Core Team, 2020)

An overview of the available input data by year and age is shown in Figure 3.2.9.

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

3.3.3.1 Data screening and exploratory model runs

The data were thoroughly explored using the functionality of FLR and other R packages. The sensitivity of the model to the 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 WGBIE2020 sharepoint.

3.3.3.2 Final update assessment

Figure 3.2.10 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 ages 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 waters. 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 latter survey uses commercial fishing gear and the catchability follows a similar pattern to the estimated F-at-age. For the SP_Porc 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 3.2.11 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 3.2.12 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 3.2.12) 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 0.024, for SSB 0.187 and for F -0.064). A sensitivity analysis was done during the WKANGLER benchmark (ICES, 2018a), introducing different F-patterns before discards data were available and after. The results suggest 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	0.024
Fbar	0.064
SSB	0.187

3.3.3.3 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 (ICES, 2018a).

3.3.3.4 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.

3.3.4 Biological reference points

Biological reference points were established by WKANGLER (ICES, 2018a).

	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 at the end of the time series, the working group in WGBIE2019 investigated if the biological reference points are still appropriate (ICES, 2019). The analysis showed that the F_{MSY} estimate were still sensitive to the addition of an extra year of data. It was estimated to be 0.23 using the 2019 assessment but the 2018 assessment would result in an estimate of 0.36. WGBIE (like WKANGLER 2018) considers that a 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, WGBIE2018 did not propose to update the reference points in 2019 (ICES, 2018b).

This year, a WD03 (Urtizberea et al. 2020 in this report) was presented where a base case is developed under similar assumptions as a4a (Jardim et al. 2015) and with similar results. The advantage of using SS3 (Methot Jr. and Wetzel, 2013) is that the transformation from length to age is done within the model and therefore, the uncertainty due to that transformation is also considered. A sensitivity analysis was done with the base case considering the results of a sensitivity analysis after a reference case was developed with a better retrospective pattern of SSB and F than with the assessment model.

3.3.5 Short-term projections

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

- Because F shows a trend, F_{2020} was scaled to the last year. Because this is a separable assessment, this means that F_{2020}=F_{2019}.
- 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 3.2.13 shows the contribution of the cohorts to the 2021 forecasted landings and 2022 SSB. The assumed GM recruitment in 2020 contributes 7% to the forecasted landings.

3.3.6 Uncertainties in the assessment and forecast

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

WKANGLER2018 (ICES, 2018a) 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 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 mortality was well above 0.28 during that period.

3.3.7 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.

3.4 Recommendations for the next benchmark

During the WKANGLER2018 (ICES, 2018a), it was agreed that the current assessment model will be an interim solution until a more appropriate model could be developed. One of the main concerns was that the allocation of length data into pseudo-ages was done outside the model. Other concerns include the retrospective pattern and the apparent loss of cohort tracking after age 4 or 5.

Benchmark scoring

1. The assessment is judged to have substantial deficiencies as outlined above (score: 3)
2. New methods will be available: SS3 as outlined below (score: 4)
3. - Catch advice is requested by EC
   - The stock managed under the WWMAP
   - Most catches of anglerfish originate from directed fisheries
   - The stock is included in the mixed fisheries analysis for the Celtic Sea

   (score: 5)
4. The biomass is perceived to be near the highest on record (score: 1)
5. The stock was last benchmarked in 2018 (score: 2)

Roadmap of work in preparation for the next benchmark

- There is no need for a data compilation workshop as it is unlikely that additional data would be available. Additionally, there is little progress on stock identity or new information on the biology of the stock. The work on improving the basis for the advice will therefore be focussed on developing a more appropriate assessment model.
- WD03 (Urtizberea et al. 2020 in this report) presented an SS3 model for this stock that is in an advanced state of development. The base case provides similar results to the a4a model with an improved retrospective pattern.
- WGBIE will form an intersessional subgroup to further develop this SS3 model. This subgroup will meet a number of times over the next months (by video conference).
- WGBIE proposes a workshop to take place once the model is suitably developed. The workshop will be aimed at further refining the model with the help of an external expert as well as providing training to stock assessment scientists (See: recommendations)
- Through this process WGBIE intends to demonstrate that this stock will be ready for an efficient benchmarking process.

3.5 References

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

ICES. 2018b. Report of the Working Group for the Bay of Biscay and and Iberian Waters Ecoregion (WGBIE). 3–10 May 2018, Copenhagen, Denmark. ICES CM 2018/ACOM: 12, 544 pp.

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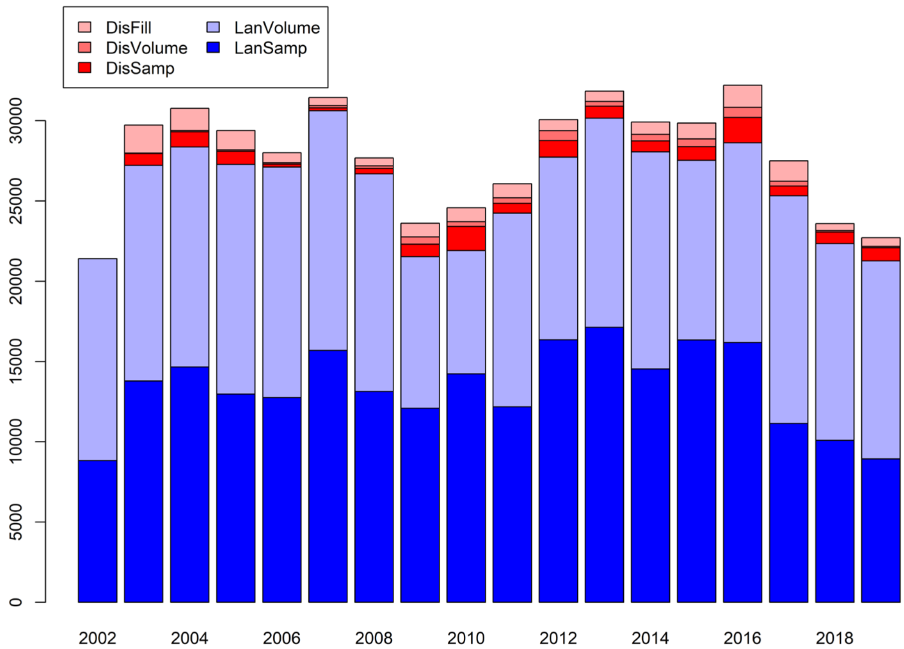

Figure 3.2.1. *Lophius piscatorius* in 27.78abd. Allocations of unsampled landings and discards by year. Dark blue represents the sampled landings; light blue represents landings for which only the tonnage was available but no sampling

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.

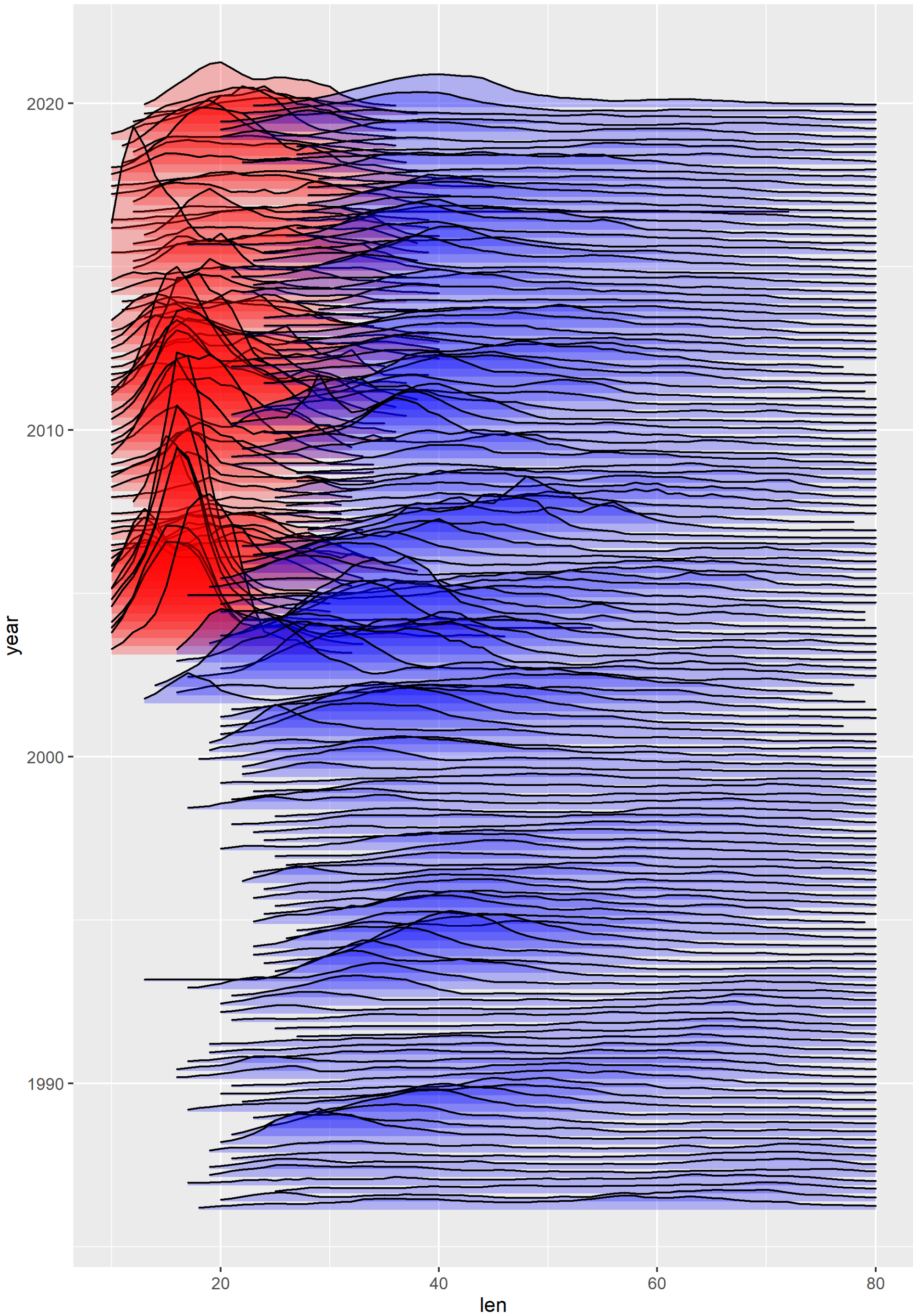

Figure 3.2.2. *Lophius piscatorius* in 27.78abd. Quarterly length frequency distributions of the landings (blue) and discards (red). No discard data were available prior to 2003.

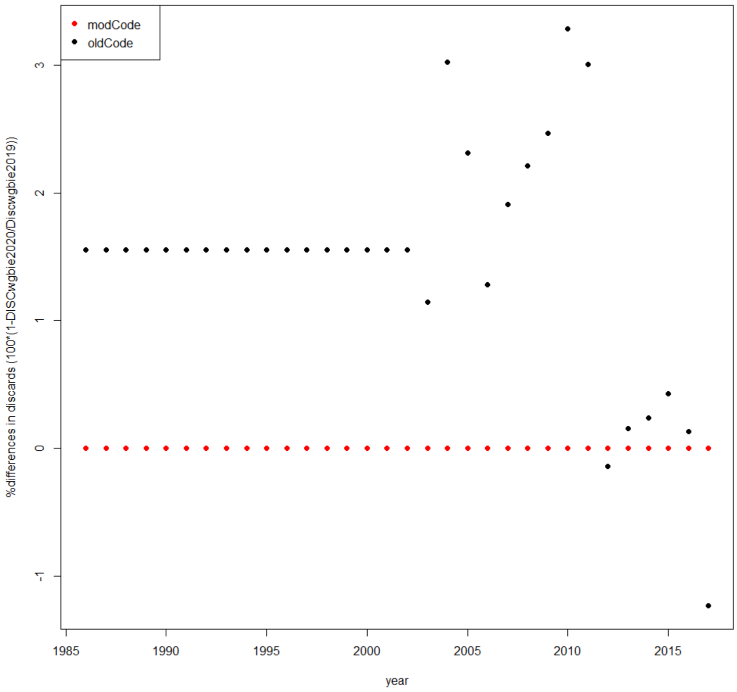

Figure 3.2.3 The difference in discards in comparison to data of the last year. In black the differences in discards running the data of this year with the same code as of last year, and in red after modifying the code, so the numbers-at-length are modified in order to fit the total discards, instead of modifying the total discards.

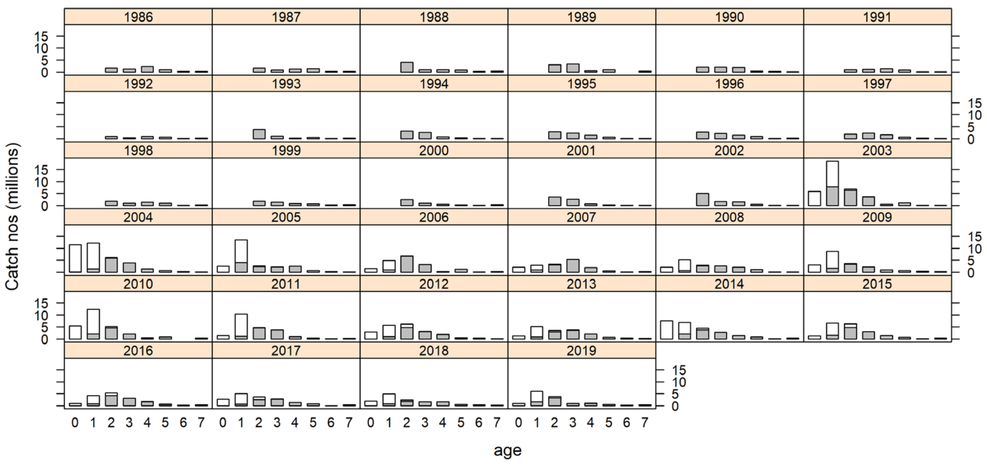

Figure 3.2.4a. *Lophius piscatorius* in 27.78abd. Age distributions of the catches by year in terms of abundance of discards (white) and landings (grey).

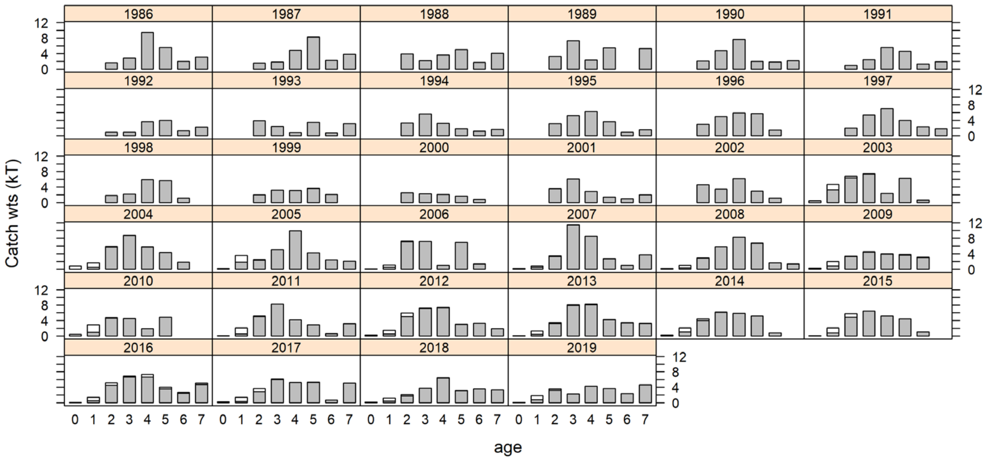

Figure 3.2.4b. ***Lophius piscatorius*** **in 27.78abd. Age distribution of the catches by year in terms of biomass of discards (white) and landings (grey).**

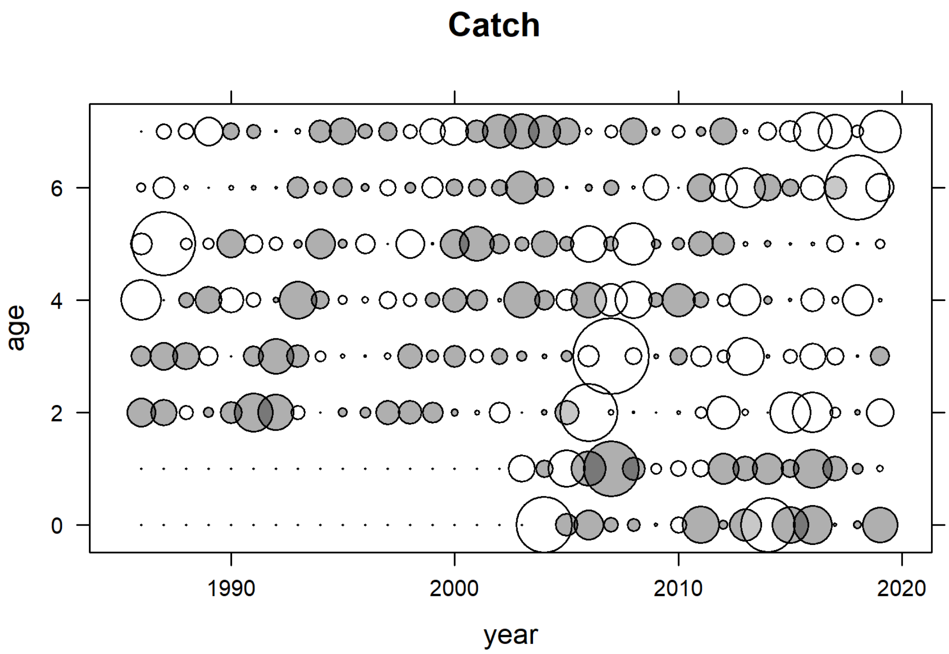

Figure 3.2.5 ***Lophius piscatorius*** **in 27.78abd. Standardised proportion at age per year of the catch numbers (white positive and grey negative values). Cohorts can be tracked consistently up to age 7.**

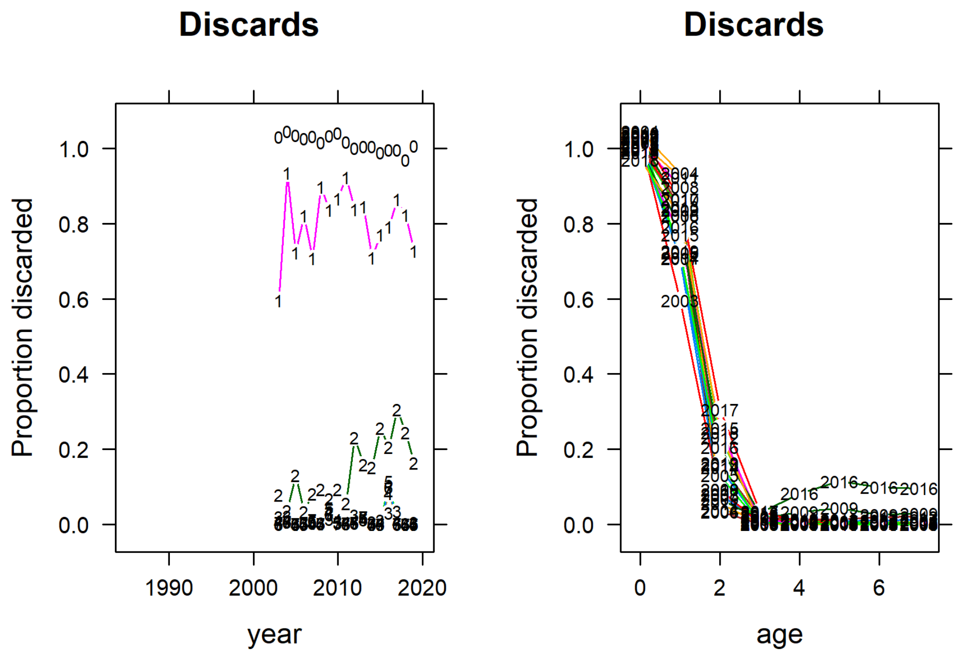

Figure 3.2.6. ***Lophius piscatorius*** **in 27.78abd. Proportions of discards-at-age over time (left) and by age (right).**

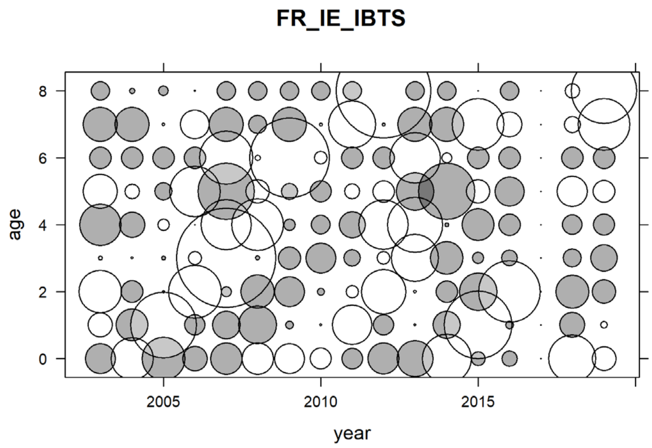

Figure 3.2.7a. ***Lophius piscatorius*** **in 27.78abd. Standardised proportion-at-age per year of the FR_IE_IBTS index.**

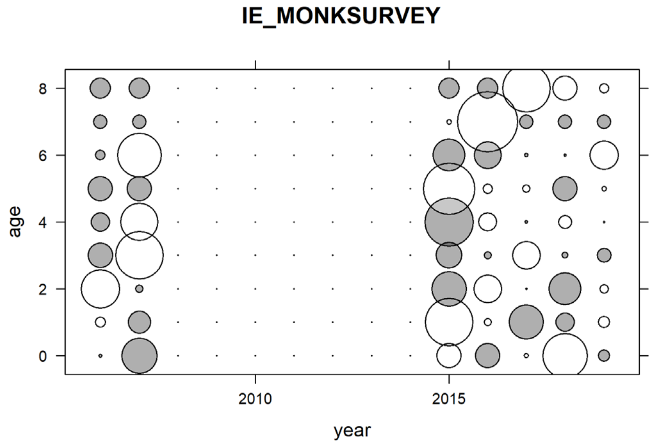

Figure 3.2.7b. ***Lophius piscatorius*** **in 27.78abd. Standardised proportion-at-age per year of the IE_Monksurvey index.**

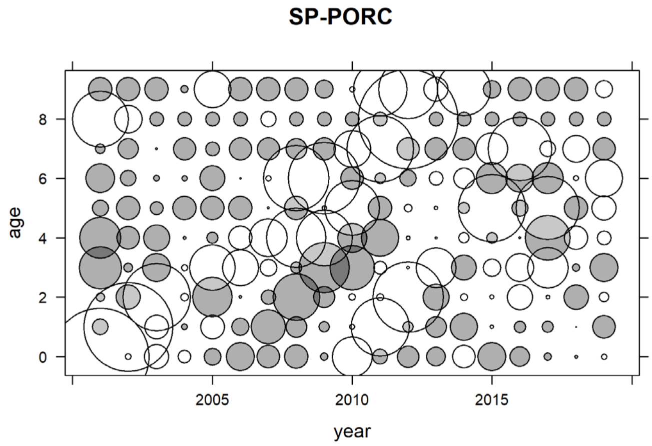

Figure 3.2.7c. ***Lophius piscatorius*** **in 27.78abd. Standardised proportion at age per year of the SP_Porc index. Cohorts can be tracked consistently up to age 6.**

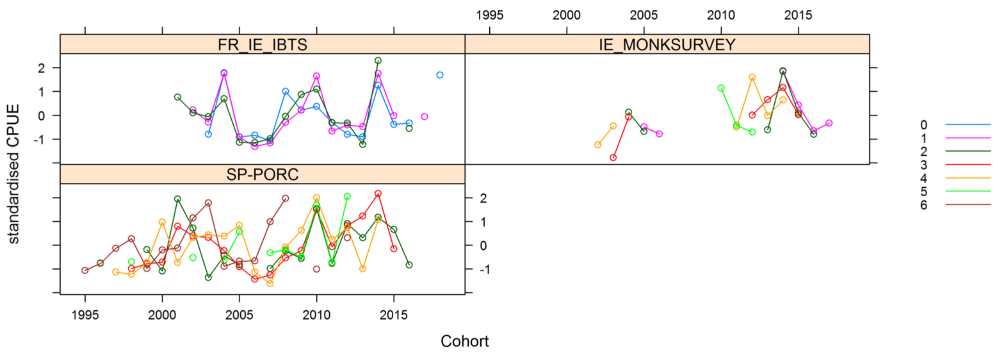

Figure 3.2.8a. ***Lophius piscatorius*** **in 27.78abd. Internal consistency of the survey indices.**

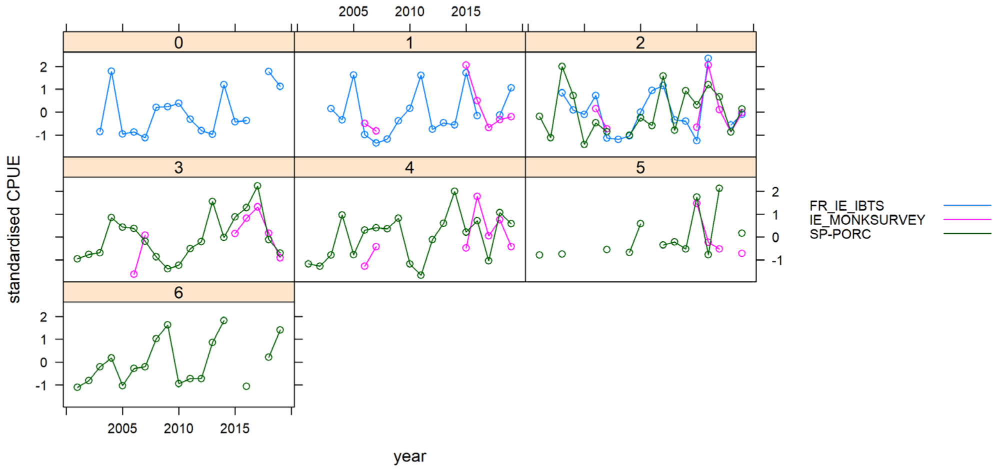

Figure 3.2.8b. ***Lophius piscatorius*** **in 27.78abd. External consistency of the survey indices.**

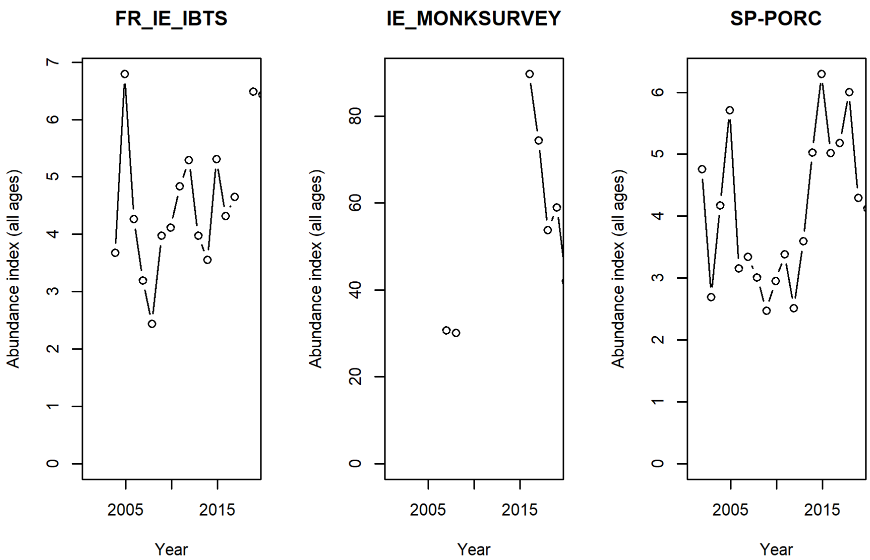

Figure 3.2.8c. ***Lophius piscatorius*** **in 27.78abd. Overall survey abundance trends (all ages combined).**

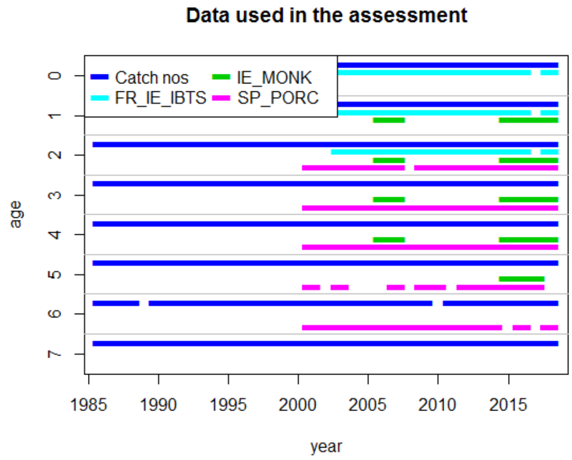

Figure 3.2.9. ***Lophius piscatorius*** **in 27.78abd. Overview of the available catch and survey data. Age 7 is a plus group.**

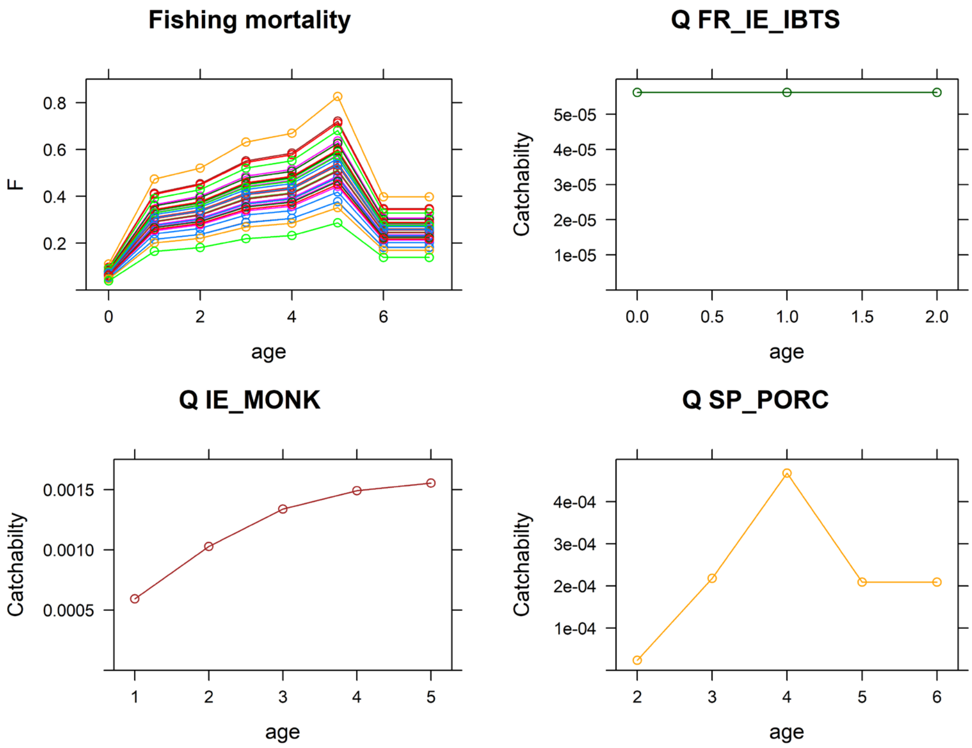

Figure 3.2.10. ***Lophius piscatorius*** **in 27.78abd. Pattern in F-at-age (colours indicate years) and catchability-at-age of the surveys.**

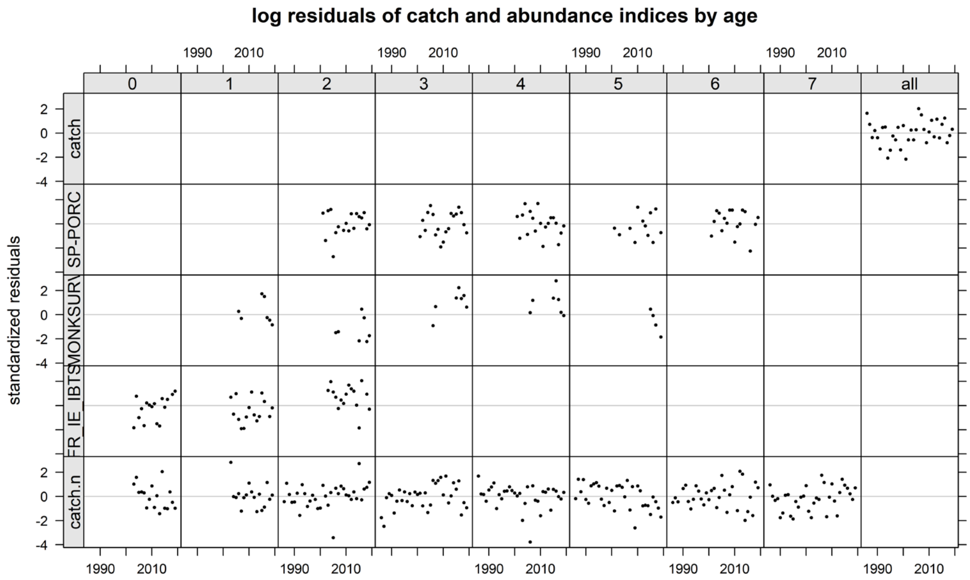

Figure 3.2.11. ***Lophius piscatorius*** **in 27.78abd. Standardised residuals of the catch and the surveys.**

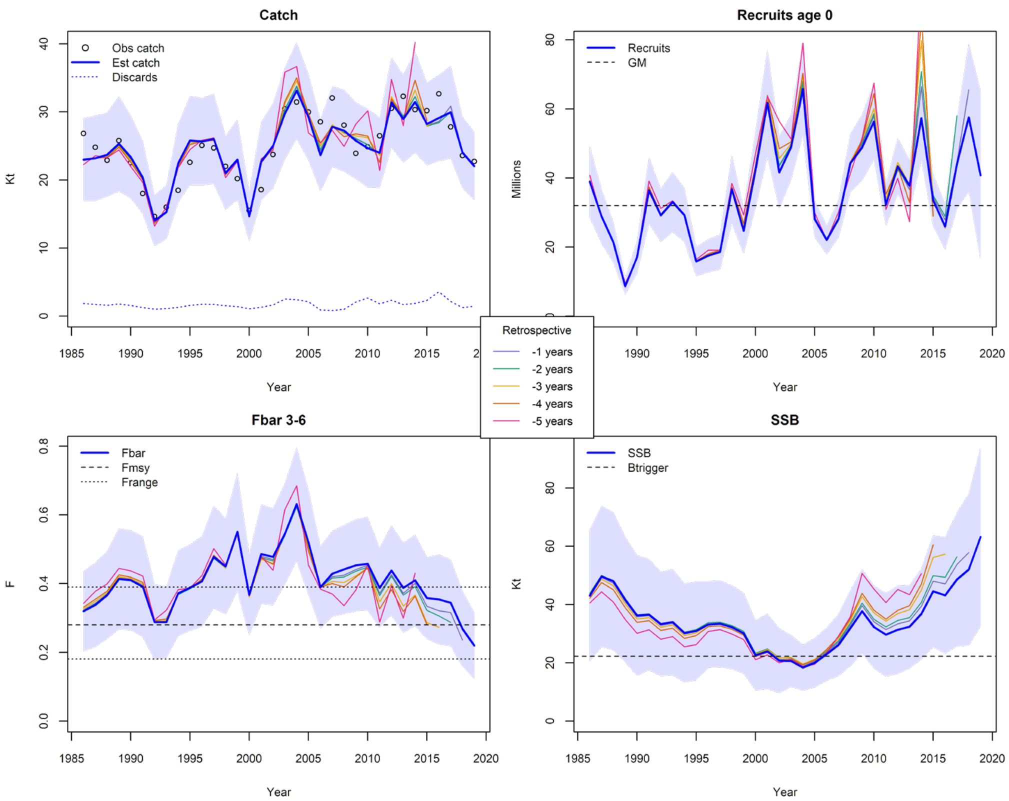

Figure 3.2.12. ***Lophius piscatorius*** **in 27.78abd. Summary plot of the assessment outputs. Light blue areas are the 95% confidence intervals. The coloured lines are the retrospective runs.**

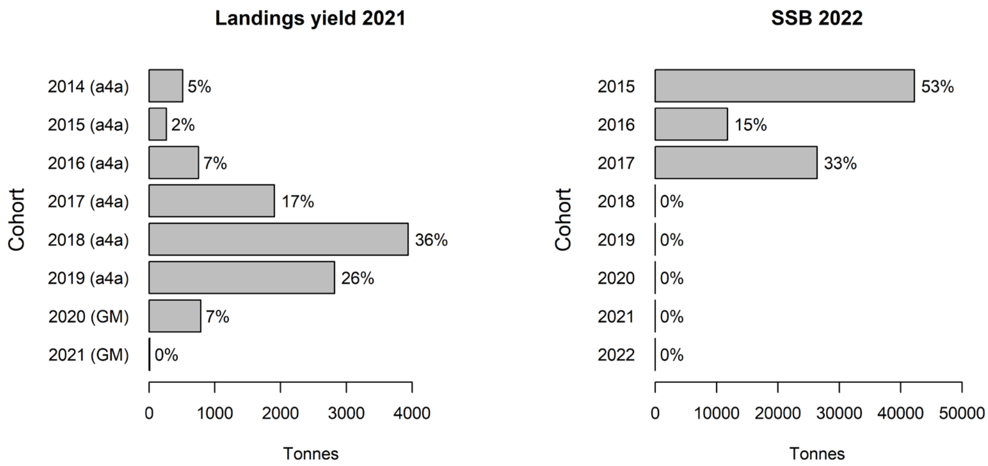

Figure 3.2.13. *Lophius piscatorius* in 27.78abd. Cohort contributions to the forecast landings in 2020 and SSB in 2021.

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/km²) and SP_PORC (n/30mis) are the tuning indices.**

catch.n	0	1	2	3	4	5	6	7
1986			1649	1239	2365	935	219	244
1987			1661	828	1168	1386	266	295
1988			4159	971	883	840	205	331
1989			2920	3152	539	862		410
1990			2069	2120	1941	338	203	161
1991			927	1094	1423	789	146	154
1992			976	417	897	669	141	192
1993			3827	1089	196	564	82	253
1994			3350	2649	788	325	130	135
1995			2966	2401	1546	617	101	114
1996			2915	2243	1492	978	163	183
1997			1954	2460	1762	694	266	157
1998			1812	965	1489	965	129	290
1999			1957	1508	808	642	263	346
2000			2594	1034	527	295	97	344
2001			3676	2844	720	262	111	140
2002			4882	1574	1460	492	121	80
2003	5732	17935	6673	3486	517	1053	60	137
2004	10892	11633	5977	3879	1423	717	188	164
2005	2447	12958	2583	2255	2465	693	253	146
2006	1476	4779	6812	3172	273	1165	161	280
2007	2006	2915	3241	5247	1983	472	106	282
2008	2062	4981	2937	2618	2079	1102	177	97
2009	3025	8459	3604	2167	950	635	337	230
2010	5278	11951	5094	2045	483	798		452
2011	1343	10009	4780	3760	1034	475	66	245
2012	2895	5763	6047	3138	1869	481	369	127
2013	1300	5157	3471	3706	2049	703	364	253

2014	7467	6777	4472	2784	1441	846	78	459
2015	1263	6531	6285	3053	1327	740	116	389
2016	948	4101	5254	3111	1789	670	287	414
2017	2618	5116	3661	2777	1355	843	73	400
2018	1960	4938	2353	1629	1629	537	389	234
2019	950	5924	3850	1041	1060	631	253	367
prop.dis	0	1	2	3	4	5	6	7
1986								
1987								
1988								
1989								
1990								
1991								
1992								
1993								
1994								
1995								
1996								
1997								
1998								
1999								
2000								
2001								
2002								
2003	1.03	0.596	0.078	0.019	0.007	0.001	0	0.005
2004	1.046	0.935	0.036	0.022	0.009	0.006	0.007	0.006
2005	1.036	0.723	0.13	0.001	0.001	0.002	0	0.002
2006	1.027	0.821	0.034	0	0.002	0.002	0.004	0
2007	1.033	0.707	0.08	0.004	0.003	0.008	0.01	0.012
2008	1.016	0.898	0.093	0.001	0.001	0.001	0.003	0.001

2009	1.033	0.836	0.067	0.014	0.033	0.043	0.026	0.029
2010	1.041	0.866	0.092	0.003	0.013	0.006		0.001
2011	1.018	0.923	0.056	0.002	0.005	0.001	0.002	0.003
2012	1.001	0.839	0.231	0.024	0.007	0.005	0.004	0.004
2013	1.005	0.845	0.159	0.019	0.013	0.013	0.02	0.02
2014	1.006	0.71	0.151	0.006	0	0	0	0
2015	0.989	0.77	0.256	0.011	0.003	0.001	0	0
2016	0.997	0.791	0.205	0.029	0.082	0.114	0.099	0.096
2017	0.996	0.865	0.306	0.034	0.007	0.001	0	0.001
2018	0.97	0.823	0.244	0.002	0	0	0	0
2019	1.007	0.728	0.164	0.004	0.002	0.001	0	0
catch.wt	0	1	2	3	4	5	6	7
1986	0.124	0.385	1.015	2.367	4.114	6.131	9.078	13.062
1987	0.141	0.385	0.941	2.226	4.263	6.115	8.63	13.242
1988	0.125	0.466	0.964	2.276	4.225	6.175	8.395	12.717
1989	0.12	0.384	1.067	2.239	4.196	6.069	9.089	12.415
1990	0.118	0.352	1.027	2.331	4.077	6.109	8.907	13.784
1991	0.134	0.39	1.016	2.302	4.092	6.11	8.895	12.663
1992	0.12	0.451	1.003	2.252	4.133	6.016	9.008	11.944
1993	0.08	0.5	1.017	2.217	4.375	6.006	9.138	12.345
1994	0.097	0.549	1.027	2.208	4.202	5.802	9.366	12.772
1995	0.097	0.496	1.093	2.231	4.173	6.039	9.379	14.085
1996	0.097	0.414	1.04	2.278	4.12	6.073	9.125	12.455
1997	0.126	0.455	1.034	2.266	4.144	5.968	9.009	11.903
1998	0.127	0.412	1.019	2.371	4.138	6.117	9.071	11.617
1999	0.123	0.462	1.071	2.26	4.094	6.038	8.272	12.158
2000	0.11	0.452	1.034	2.298	4.077	5.979	7.907	12.623
2001	0.098	0.363	1.021	2.293	4.207	5.763	9.044	15.462
2002	0.117	0.362	0.921	2.132	4.095	5.833	8.958	18.112
2003	0.071	0.255	0.999	2.088	4.39	5.813	9.721	13.381

2004	0.077	0.136	0.965	2.231	4.015	5.976	9.606	12.579
2005	0.061	0.267	0.954	2.206	3.961	6.054	9.38	13.832
2006	0.07	0.232	1.053	2.243	3.707	5.873	8.696	11.95
2007	0.071	0.297	1.047	2.161	4.252	5.73	9.504	13.12
2008	0.087	0.195	1.002	2.194	3.951	6.067	9.367	13.689
2009	0.085	0.233	0.943	2.063	4.202	5.92	9.136	11.688
2010	0.078	0.235	0.941	2.202	3.971	6.103	9.089	11.717
2011	0.086	0.201	1.08	2.178	3.998	5.965	8.699	12.862
2012	0.084	0.259	0.972	2.289	3.914	6.186	8.813	14.622
2013	0.091	0.244	1.008	2.164	3.993	6.013	9.409	12.989
2014	0.04	0.311	0.983	2.192	4.015	6.094	9.577	11.92
2015	0.096	0.32	0.907	2.108	3.936	6.006	9.258	12.422
2016	0.083	0.338	0.963	2.188	4.06	5.944	9.295	12.206
2017	0.086	0.278	0.981	2.201	3.838	6.2	9.555	12.573
2018	0.091	0.247	0.879	2.287	3.945	5.822	9.159	14.035
2019	0.1	0.3	0.928	2.194	4.052	5.802	9.476	12.538
stock.wt	0	1	2	3	4	5	6	7
1986	0.011	0.197	0.702	1.784	3.394	5.45	7.845	12.427
1987	0.011	0.222	0.643	1.788	3.397	5.459	7.78	12.252
1988	0.011	0.248	0.589	1.789	3.412	5.452	7.853	11.642
1989	0.011	0.186	0.748	1.719	3.436	5.36	7.877	11.417
1990	0.011	0.203	0.661	1.801	3.4	5.452	7.836	13.008
1991	0.011	0.189	0.701	1.736	3.428	5.447	7.845	11.9
1992	0.011	0.227	0.647	1.751	3.444	5.441	7.845	11.092
1993	0.011	0.122	0.679	1.736	3.448	5.385	7.862	11.437
1994	0.011	0.253	0.711	1.736	3.424	5.385	7.877	12.128
1995	0.011	0.221	0.769	1.725	3.455	5.362	7.877	13.897
1996	0.011	0.26	0.618	1.777	3.43	5.449	7.813	11.35
1997	0.011	0.199	0.752	1.732	3.424	5.443	7.852	11.273
1998	0.011	0.187	0.73	1.739	3.433	5.449	7.849	10.743

1999	0.011	0.199	0.694	1.8	3.364	5.48	7.848	11.186		
2000	0.011	0.217	0.691	1.736	3.423	5.455	7.831	11.564		
2001	0.011	0.219	0.708	1.733	3.438	5.366	7.877	14.726		
2002	0.011	0.2	0.609	1.718	3.438	5.264	7.877	15.449		
2003	0.011	0.133	0.738	1.648	3.498	5.182	7.877	12.234		
2004	0.011	0.094	0.72	1.727	3.409	5.407	7.877	11.657		
2005	0.014	0.129	0.608	1.768	3.411	5.442	7.877	12.61		
2006	0.007	0.135	0.713	1.646	3.495	5.29	7.877	10.758		
2007	0.013	0.145	0.69	1.744	3.443	5.338	7.877	11.969		
2008	0.011	0.128	0.677	1.692	3.387	5.405	7.877	13.175		
2009	0.011	0.117	0.695	1.667	3.444	5.378	7.998	10.994		
2010	0.01	0.135	0.698	1.65	3.476	5.29	7.877	10.66		
2011	0.011	0.113	0.787	1.693	3.43	5.336	7.877	11.836		
2012	0.011	0.138	0.662	1.797	3.37	5.504	7.959	13.782		
2013	0.011	0.136	0.649	1.731	3.392	5.456	7.877	12.261		
2014	0.011	0.134	0.717	1.695	3.404	5.483	7.877	11.095		
2015	0.011	0.162	0.655	1.68	3.419	5.447	7.877	11.663		
2016	0.011	0.159	0.684	1.713	3.416	5.46	7.994	11.347		
2017	0.011	0.149	0.69	1.708	3.419	5.494	7.877	11.874		
2018	0.011	0.148	0.605	1.733	3.389	5.461	8.032	13.279		
2019	0.011	0.182	0.563	1.74	3.424	5.416	7.877	11.841		
FR_IE_IBTS	0	1	2	3	4	5	6	7	8	9
2003	0.859	1.12	1.058	0.529		0.097				0.01
2004	3.888	0.865	0.79	0.952	0.141	0.141			0.006	0.014
2005	0.735	1.885	0.725	0.558	0.285	0.05		0.024	0.002	
2006	0.833	0.526	1.013	0.521	0.169	0.101		0.03	0.004	
2007	0.548	0.339	0.359	0.808	0.281		0.071			0.032
2008	2.069	0.427	0.34	0.519	0.472	0.093	0.041	0.01		
2009	2.108	0.847	0.39	0.388	0.159	0.049	0.166			0.009
2010	2.281	1.13	0.76	0.38	0.141	0.051	0.064	0.027		

2011	1.479	1.882	1.094	0.559	0.105	0.111		0.065		
2012	0.909	0.656	1.168	0.643	0.46	0.091		0.019	0.03	
2013	0.728	0.798	0.638	0.819	0.436	0.02	0.101			0.012
2014	3.206	0.755	0.62	0.389	0.257		0.065			0.018
2015	1.345	1.932	0.318	0.503	0.055	0.101		0.056	0.005	
2016	1.413	0.959	1.584	0.498	0.12	0.038		0.042		
2017										
2018	3.869	0.976	0.561	0.669	0.185	0.165		0.049	0.014	
2019	3.121	1.599	0.725	0.553	0.169	0.148		0.084	0.036	
IE_MONKSURVEY	0	1	2	3	4	5	6	7	8	
2006	6.63	7.951	8.249	4.318	2.669		0.811			
2007	2.714	4.614	3.948	11.913	4.631		2.252			
2008										
2009										
2010										
2011										
2012										
2013										
2014										
2015	28.72	34.967	4.313	12.264	4.496	4.072	0.525	0.367		
2016	9.883	18.559	17.502	15.179	9.693	1.464	0.783	1.306		
2017	12.965	6.036	8.065	17.438	5.717	0.996	1.724		0.87	
2018	23.624	9.784	3.306	12.334	7.334		1.957		0.617	
2019	7.772	11.085	7.385	7.53	4.614	0.707	2.538		0.288	
SP-PORC	0	1	2	3	4	5	6	7	8	9
2001	2.933	0.228	0.254	0.567	0.608	0.064	0.016	0.049	0.035	
2002	0.45	0.82	0.085	0.705	0.557		0.058	0.004	0.012	
2003	1.077	0.597	0.655	0.754	0.8	0.077	0.145	0.069		
2004	1.153	0.42	0.424	1.831	1.648		0.201			0.038
2005	0.198	0.452	0.032	1.543	0.803		0.028	0.022		0.077

2006	0.027	0.15	0.205	1.5	1.326		0.136			
2007	0.099	0.008	0.135	1.104	1.38	0.13	0.147		0.009	
2008	0.076	0.09		0.624	1.355		0.324	0.004		0
2009	0.323	0.181	0.105	0.251	1.578	0.098	0.411			0.006
2010	1.135	0.329	0.244	0.369	0.607	0.462	0.04	0.16		0.038
2011	0.179	0.576	0.183	0.883	0.365		0.071	0.18		0.079
2012	0.14	0.221	0.578	1.101	1.128	0.19	0.072		0.043	0.121
2013	0.266	0.183	0.145	2.34	1.471	0.229	0.301			0.096
2014	1.57	0.124	0.46	1.219	2.151	0.138	0.439			0.196
2015	0.036	0.466	0.347	1.855	1.286	0.798		0.217		0.012
2016	0.254	0.303	0.509	2.144	1.525	0.067	0.023	0.358		
2017	0.655	0.361	0.412	2.816	0.671	0.909		0.182		
2018	0.559	0.371	0.132	1.158	1.701		0.207	0.169		
2019	0.686	0.13	0.316	0.743	1.465	0.34	0.38			0.067

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	24981	1861.3756	26842.3756	23004.176	81.9059456	43.0769848	0.2671431	38.899262	0.1358119	0.31985675	0.18545848
1987	23091	1720.54857	24811.5486	23186.4407	83.3707942	49.6455826	0.24869968	28.8975088	0.13919015	0.33796675	0.18489673
1988	21314	1588.14137	22902.1414	23717.1694	80.0865531	48.0253872	0.25075311	21.3614196	0.13935813	0.36658375	0.17710236
1989	24015	1789.39734	25804.3973	25315.4275	77.9300509	41.7191428	0.26368118	8.63356489	0.14291827	0.4136845	0.18090408
1990	20982	1563.4035	22545.4035	23370.3766	73.5516197	36.251966	0.29072452	17.0409978	0.13965948	0.40991975	0.18041697
1991	16763	1249.03884	18012.0388	20372.5985	62.7211637	36.5838524	0.26631687	36.4307948	0.1349023	0.39106325	0.19109035
1992	13617	1014.62518	14631.6252	14017.8279	56.8058549	33.3120253	0.27321367	29.1907825	0.13386604	0.2881695	0.1941509
1993	14895	1109.85107	16004.8511	15281.5588	59.9965294	34.0112272	0.2732405	33.0673306	0.13437687	0.2879535	0.18205913
1994	17201	1281.67494	18482.6749	22446.6737	72.925432	30.2469518	0.28525075	29.2344739	0.13578974	0.371794	0.17042294
1995	21033	1567.20359	22600.2036	25814.3588	79.2994477	30.9714681	0.27928951	15.7903799	0.13768061	0.3881255	0.16478817
1996	23333	1738.58039	25071.5804	25648.3552	72.5863496	33.1481323	0.22796869	17.5045906	0.13895505	0.406492	0.16404102
1997	22983	1712.50132	24695.5013	26042.8865	67.5901626	33.4314471	0.22675586	18.5696167	0.13874978	0.477693	0.15878639
1998	20474	1525.55158	21999.5516	21043.0206	57.6202244	32.1980423	0.22761917	36.780036	0.13741576	0.45002975	0.15782879
1999	18792	1400.22298	20192.223	22991.0178	53.2977896	30.1652892	0.23475507	24.7003315	0.13556177	0.550745	0.15920443
2000	14451	1076.76789	15527.7679	14649.7554	48.3565937	22.6228569	0.27004589	42.2638862	0.13226911	0.36696775	0.16476817
2001	17294	1288.60452	18582.6045	22723.8877	59.070877	23.9481843	0.27536551	61.7892038	0.12901446	0.48595275	0.15168501
2002	22083.0098	1645.44156	23728.4513	25012.4254	62.3586241	20.7335598	0.27310205	41.6036821	0.12822263	0.4779375	0.14991691
2003	27933.4631	2510.81717	30444.2803	29744.7711	66.4491627	20.662327	0.21879398	48.9234409	0.09823845	0.5446345	0.13693111

2004	29028.0013	2410.55622	31438.5575	33144.0897	67.6232429	18.3978355	0.21826191	65.8069757	0.10464381	0.6313375	0.13351197
2005	27869.3594	2110.33806	29979.6974	29234.5684	66.0481753	20.0176795	0.21574507	28.1303961	0.09617088	0.520116	0.1494305
2006	27652.4933	892.252806	28544.7461	23640.543	68.6766841	23.0019022	0.20154745	22.0529423	0.09658554	0.389487	0.15540471
2007	31213.0469	816.318968	32029.3658	27826.7863	76.1258838	26.1149611	0.2078783	28.109807	0.09747098	0.428732	0.1479028
2008	27052.9267	993.06744	28045.9941	27262.0142	75.3348571	31.889379	0.20768008	44.2900263	0.09767958	0.4413295	0.1496145
2009	21835.0887	2077.85673	23912.9455	25775.8691	68.9938454	37.7003717	0.19668388	48.8329649	0.09953906	0.4532005	0.15026099
2010	22214.8459	2671.61032	24886.4562	24676.3423	68.4186196	32.3042314	0.22318389	56.3880966	0.09938222	0.45785	0.15142195
2011	24657.2995	1831.6273	26488.9268	24006.4029	76.1827269	29.671226	0.24643545	32.2807888	0.09874317	0.38763075	0.15208938
2012	28188.3008	2330.43765	30518.7385	31404.973	87.268885	31.3749356	0.24584286	43.3978326	0.09626078	0.43816175	0.15218038
2013	30610.8475	1684.48173	32295.3292	28977.1717	86.4923485	32.3704501	0.22495942	37.7346736	0.10112782	0.3876885	0.17193038
2014	28474.4762	1858.62402	30333.1003	31465.9633	89.8203592	36.7923081	0.21702179	57.3282349	0.1080557	0.40938325	0.16564641
2015	27858.7795	2324.19703	30182.9765	28217.9963	92.1427965	44.5526324	0.21943058	33.5362398	0.1133675	0.357918	0.1688463
2016	29082.5818	3585.10722	32667.689	29107.887	98.7297001	43.1803689	0.23588173	25.901555	0.13069311	0.353907	0.18763615
2017	25633.5773	2174.83467	27808.412	29956.6295	103.676067	48.6222689	0.24072349	44.0548468	0.15137029	0.34424225	0.18629329
2018	22344.8131	1249.80509	23594.6182	24030.5832	106.130465	52.0191471	0.25548471	57.5716308	0.18978505	0.2684285	0.20868657
2019	21266.2136	1443.73968	22709.9533	22034.3689	112.947725	63.2217319	0.2482726	40.7758655	0.30499888	0.219383	0.22452165

*** 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 (%).**

Basis21	Catch21	Land21	Dis	FCatch21	FLand21	FDis21	SSB22	dSSB	dLand	dCatch	dadv21
FMSY	34579	33100	1479	0.28000	0.27878	0.00122	80416	11.36	60.13	56.93	8.75
FMSYlower	23320	22330	989	0.18100	0.18021	0.00079	87686	21.43	8.03	5.83	-26.66
FMSYupper	45996	44012	1984	0.39000	0.38830	0.00170	73101	1.23	112.92	108.73	44.65
F = Fsq	27802	26619	1183	0.21938	0.21843	0.00096	84785	17.41	28.77	26.17	-12.57
F = 0	0	0	0	0.00000	NaN	NaN	102907	42.50	-100.00	-100.00	-100.00
F = 0.181	23320	22330	989	0.18100	0.18021	0.00079	87686	21.43	8.03	5.83	-26.66
F = 0.18	23201	22217	984	0.18000	0.17922	0.00078	87763	21.53	7.48	5.29	-27.04
F = 0.19	24384	23349	1035	0.19000	0.18917	0.00083	86997	20.47	12.96	10.66	-23.32
F = 0.2	25557	24471	1086	0.20000	0.19913	0.00087	86237	19.42	18.38	15.98	-19.63
F = 0.21	26720	25584	1136	0.21000	0.20908	0.00092	85485	18.38	23.77	21.26	-15.97
F = 0.22	27873	26686	1186	0.22000	0.21904	0.00096	84740	17.35	29.10	26.49	-12.34
F = 0.23	29015	27779	1236	0.23000	0.22900	0.00100	84002	16.33	34.39	31.67	-8.75
F = 0.24	30148	28862	1285	0.24000	0.23895	0.00105	83271	15.31	39.63	36.82	-5.19
F = 0.25	31270	29936	1334	0.25000	0.24891	0.00109	82547	14.31	44.82	41.91	-1.66
F = 0.26	32383	31000	1383	0.26000	0.25887	0.00113	81830	13.32	49.97	46.96	1.84
F = 0.27	33486	32055	1431	0.27000	0.26882	0.00118	81119	12.33	55.07	51.96	5.31
F = 0.28	34579	33100	1479	0.28000	0.27878	0.00122	80416	11.36	60.13	56.93	8.75
F = 0.29	35663	34137	1527	0.29000	0.28874	0.00126	79719	10.39	65.14	61.84	12.15
F = 0.3	36738	35164	1574	0.30000	0.29869	0.00131	79028	9.44	70.11	66.72	15.54
F = 0.31	37803	36182	1621	0.31000	0.30865	0.00135	78344	8.49	75.04	71.55	18.88
F = 0.32	38858	37191	1667	0.32000	0.31860	0.00140	77667	7.55	79.92	76.34	22.20
F = 0.33	39905	38191	1713	0.33000	0.32856	0.00144	76996	6.62	84.76	81.09	25.50
F = 0.34	40942	39183	1759	0.34000	0.33852	0.00148	76331	5.70	89.56	85.79	28.76
F = 0.35	41971	40166	1805	0.35000	0.34847	0.00153	75673	4.79	94.31	90.46	31.99
F = 0.36	42990	41140	1850	0.36000	0.35843	0.00157	75021	3.89	99.02	95.09	35.20
F = 0.37	44001	42106	1895	0.37000	0.36839	0.00161	74375	2.99	103.70	99.67	38.38
F = 0.38	45003	43063	1940	0.38000	0.37834	0.00166	73735	2.11	108.33	104.22	41.53

F = 0.39	45996	44012	1984	0.39000	0.38830	0.00170	73101	1.23	112.92	108.73	44.65

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

3.6.1 Type of assessment

Category 3 assessment using survey trends.

3.6.1.1 Feedback from ADG, WC and audit

VAST model

Because the EVHOE survey in 2017 was severely curtailed, the biomass index that depends partly on this survey could not be calculated. Instead WGBIE 2019 proposed using a spatio-temporal model (VAST; Thorson, 2019) to estimate the index, either for the full time series or for 2017 alone (see W01 Gerritsen and Minto, 2019 in ICES, 2019b).

The ADG discussed the use of the VAST model to estimate the biomass index in 2017 alone or for the full time series. The ADG decided that it would be simpler to only use the modelled index for 2017.

WGBIE response: WGBIE had proposed to use the VAST model for the full time series but because the estimates and confidence intervals are nearly identical this decision is academic.

The ADG decided not to include the confidence limits on the 2017 biomass index in advice figure 1 because the estimate was based on different assumptions on the error structure. However, Figure 3.3.5b (in the current report) shows that the VAST model does not only produce very similar biomass index values as the traditional index estimation, the confidence intervals are also nearly identical. WGBIE therefore considered that it would be appropriate to use both the index value and confidence limits for 2017 in the advice figure 1.

Advice figure 1

During the Web conference, it was noted that Figure 1 in the advice is a bit misleading as the F plot derives from the MLZ analysis, while the biomass and recruit indices are estimated directly from the surveys. The WC changed the figure heading to make this clearer.

WGBIE response: WGBIE agrees with this comment; in the advice for 2021, the figure heading was further clarified. By adding "F/F_{MSY} is derived from a Mean-Length Z analysis."

Biomass reference point

The Web conference also raised an issue with the estimation of Biomass reference points.

- Reference points are usually estimated during benchmarks
  WGBIE response: Working groups are explicitly asked to do this in the generic terms of reference for working groups c)iv): "Estimate MSY proxy reference points for the category 3 and 4 stocks".
- It is unusual for these to be based on survey indices.
  WGBIE response: The approach closely follows the guidelines from WKLIFE IX (ICES, 2019a) for an improved 3-over-2 rule. WKLIFE recommends the use of the reference point $I_{trigger} = 1.4\ I_{loss}$ where I is the (biomass) index (page 103 of WKLIFE IX).

In the current report, WGBIE again proposes to establish a biomass proxy reference point with additional documentation to back this up.

Feedback from EG audit 2019

No specific issues raised

3.6.2 Data

3.6.2.1 Catch numbers at length

France resubmitted catch data for 2018. This resulted in a minor change (-1%) in the international landings for 2018 and a substantial reduction in the international discard estimate (-34%).

The stock annex describes the methods for filling-in unsampled landings and discards. Figure 3.3.1 shows that about 2/3 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 shows the annual length frequency distribution of the catch data both before and after allocating length data to unsampled catches. Figure 3.3.2b shows the quarterly length frequency distributions and shows that there is limited cohort tracking in the length data.

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.

Discards

Discarding occurs nearly exclusively in the smaller length classes (Figure 3.3.2a). In the last three years the average discard rate was 10% (in weight).

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.

Figure 3.3.4a shows the spatial 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 spatial 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 3.3.5a 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 high biomass in the last 2 years. 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.

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; Thorson 2019) 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. Details are provided in Working Document 01 to WGBIE 2019 (Gerritsen and Minto, 2019).

The VAST model provided nearly identical biomass trends to the traditional combined survey index (Figure 3.3.5.b). Any differences are well within the confidence limits.

Advice rule

Table 3.3.1 provides the index values. The 3-over-2 ratio (mean biomass index in the most recent 2 years and the preceding 3 years) is 1.88. The current 3-over-2 harvest rule will therefore result in a 20% increase in advice (after applying the uncertainty cap and not applying the precautionary buffer.

WKLIFE IX advice rule

WKLIFE IX (ICES, 2019a) recommended a new advice rule that uses some length-based indicators (Annex 3 of the report). This rule is not applied this year but its application to *L. budegassa* in 7,8abd is explored here.

The rule is defined as $C_{y+1} = m \times C_y \times r \times f \times b$

Where the advised catch (C) for next year y+1 is based on the most recent year's advised catch C_y adjusted by the following components:

Component	Definition	Value
m	Multiplier to maintain the probability of the biomass declining below B_{lim} to less than 5%. For medium-lived stocks *m* = 0.90 is recommended.	*m* = 0.90
r	Rate of change in the index (mean biomass index in the most recent 2 years and the preceding 3 years)	*r* = 1.88
f	L_{mean} / $L_{F=M}$. Where L_{mean} is the mean length of the catch above the length at first capture (L_c) and L_c is the length at first capture, defined as half the modal length and $L_{F=M}$ is the target reference length, defined as: $0.75L_c+0.25L_\infty$. For this stock, L_∞ is assumed to be 90% or the largest observed fish (WKAngler 2018).	L_c = 10 L_{mean} = 35.4 L_∞ = 112.5 $L_{F=M}$ = 35.6 *f* = 0.99
b	I_y / $I_{trigger}$ where I_y is the most recent index value and $I_{trigger}$ is $1.4I_{loss}$. Only applied when $I_y < I_{trigger}$, otherwise *b* = 1	I_y = 4.45 $I_{trigger}$ = 1.44 *b* = 1
Stability clause	Change in advice is limited to +20 or -30%	+20%

The catch advice multiplier following WKLIFE IX would therefore have been:

$C_{y+1} = 0.90 \times C_y \times 1.88 \times 0.99 \times 1 = 1.58 \times C_y$,

which would have been capped at $1.20 \times C_y$. In this case the outcome would therefore be the same as the current 3-over-2 rule.

3.6.3 Deviations from the stock annex

Apart from using the modelled 2017 index value, there were no deviations from the stock annex.

3.6.4 Biological reference points

Length-based indicators

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 sceening 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 Lc).

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).

F/FMSY proxy

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 by dividing the biomass index of the survey by the commercial catches of *L. budegassa*. WGBIE considered this to be more appropriate than the approach used in the previous 2 years (where the fishing effort from the *L. piscatorius* assessment was used under the assumption that the two stocks are exposed to similar fishing effort). Figure 3.3.8 shows the outputs of both approaches. The new approach appears to be somewhat noisier but both show a declining trend in F and $F<F_{MSY}$ proxy in recent years. WGBIE preferred the new approach because it follows what is done for other stocks using the mean-length Z analysis and because now both the biomass and F trends originate from the same data source. F is estimated to be below the proxy reference point of F0.1 in the most recent years. 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 few years.

Proposed biomass reference points

One of the terms of reference for WGBIE is to estimate MSY proxy reference points for the category 3 and 4 stocks. However, the technical guidelines only offer SPICT (Pedersen and Berg, 2017) as a method for estimating biomass reference points and SPICT is not an appropriate method for this stock (mainly due to lack of contrast in the catch).

The biomass index from the surveys is used as the basis for the advice, therefore it is appropriate that biomass reference points are estimated from this index. WKLIFE recommend the use of the reference point $I_{trigger} = 1.4\ I_{loss}$ where I_{loss} is the lowest observed (biomass) index (guidelines for an improved 3-over-2 rule, page 103 of WKLIFE IX – ICES, 2019a).

Following this line of reasoning, a slightly more sophisticated approach would be to examine the relationship between the biomass and recruitment and decide on a $B_{lim\ proxy}$ reference point using the guidelines for category 1 and 2 stocks. Figure 3.3.9 shows the biomass index – recruit index plot (the equivalent of the stock-recruit plot in an analyitical assessment). The plot indicates that this is either a Type 1 (Spasmodic stocks, occational large year classes) or Type 5 (Stocks showing no evidence of impaired recruitment or no clear SR signal). For Type 1, the $B_{lim\ proxy}$ would be the lowest SSB where large recruitment is observed, for Type 5 $B_{lim\ proxy}$ would be B_{loss}. The more conservative approach is therefore to use the lowest biomass value with large recruitment, which is the 2004 value (biomass index of 1.23). $B_{pa\ proxy}$ would then be 1.23 * exp(1.645 × σ), and because σ is unknown the default value of 0.20 was used, resulting in $B_{pa\ proxy}$ = B_{lim} * 1.4 = 1.72.

MSY $B_{trigger\ proxy}$ is then the same as $B_{pa\ proxy}$ = 1.72. WGBIE propose that these reference points are adopted.

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger\ proxy}$	1.72	$B_{pa\ proxy}$
	$F_{MSY\ proxy}$	1.00	Relative value (F/F_{MSY}) from YPR and mean length-based Z.
Precautionary approach	$B_{lim\ proxy}$	1.23	Lowest SSB where large recruitment is observed (2004)
	$B_{pa\ proxy}$	1.72	B_{lim} × exp(1.645 × 0.20)
	F_{lim}	-	
	F_{pa}	-	

3.6.5 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.
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 2017 index. The VAST model provided nearly identical biomass trends to the original survey index for the other years. The model was able to accurately predict the index when the missing data were simulated for other years (see Gerritsen and Minto, 2019 WD01 in ICES, 2019b).
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.

3.6.6 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. However, currently the stock size of both species is increasing and neither species appears to be at risk of over-exploitation.

3.6.7 Recommendations for the next benchmark

The last benchmark, WKANGLER (ICES, 2018) could not agree on an analytical assessment for this stock. There are two possible ways forward

1) Continue as a category 3 stock but with a more robust biomass trend. Working document 2 (Batts et al., 2020 in this report) describes two delay-difference models that have been fitted to both black and white anglerfish. The model estimates of biomass are likely to be more reliable than the survey index alone but this approach currently offers no forecast or reference points
2) "Piggy-back" on the development of an SS3 model (Methot Jr. and Wetzel, 2013) for *L. piscatorius* stock in 7,8abd to develop a similar model for *L. budegassa*.

Benchmark scoring

1. The assessment is judged to have high potential to be upgraded to cat1 (SS3 model in development; see roadmap below) (score: 4)
2. New methods will be available: SS3 as outlined below (score: 4)
3. - Catch advice is requested by EC
   - The stock managed under the WWMAP
   - Most catches of anglerfish originate from directed fisheries
   - The stock is included in the mixed fisheries analysis for the Celtic Sea

   (score: 5)
4. The biomass is precieved to be near the highest on record (score: 1)
5. The stock was last benchmarked in 2018 (score: 2)

Roadmap of work in preparation for the next benchmark

- There is no need for a data compilation workshop as it is unlikely that additional data would be available. Additionally, there is little progress on stock identity, or new information on the biology of the stock. The work on improving the basis for the advice will therefore be focussed on developing a more appropriate assessment model.
- WD 3 (Urtizberea et al., 2020 in this report) presented an SS3 model for *L. piscatorius* stock in 7,8abd that is in an advanced state of development. WGBIE will form an intersessional subgroup to further develop this SS3 model. This subgroup will also be a forum for development of a similar model for *L. budegassa*. Because the two stocks are very similar in biology, exploitation and data availability, it is likely that similar solutions will work for both stocks.
- WGBIE proposes a workshop to take place once the model is suitably developed. The workshop will be aimed at further refining the model with the help of an external expert as well as providing training to stock assessment scientists (See: recommendations)
- Through this process WGBIE intends to demonstrate that this stock will be ready for an efficient benchmarking process.

3.6.8 References

Batts, L., Minto, C., Gerritsen, H. and Brophy, D. 2020. Stage-based assessment models for black and white anglerfish in areas 7b-k, 8abd. *In* ICES, 2020 (this report). Report of the Working Group for the Bay of Biscay and and Iberian Waters Ecoregion (WGBIE). 6–13 May 2020. Working Document 02.

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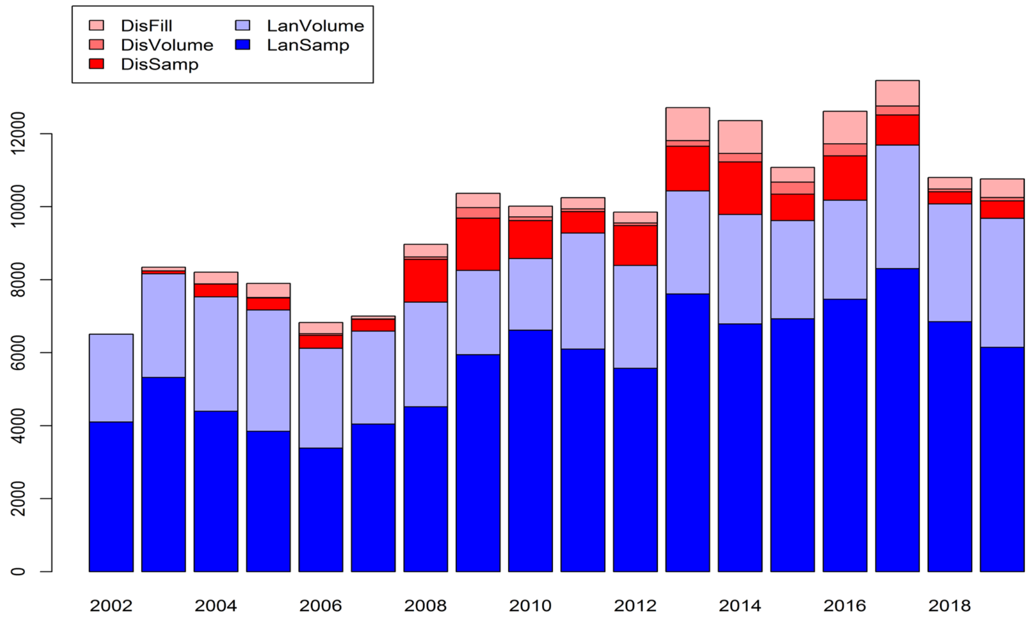

Figure 3.3.1. *Lophius budegassa* in 27.78abd. Allocations of unsampled landings and discards by year. Dark blue represents the sampled landings; light blue represents landings for which only the tonnage was available but no sampling data; Red represents the sampled discards; medium pink represents discards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

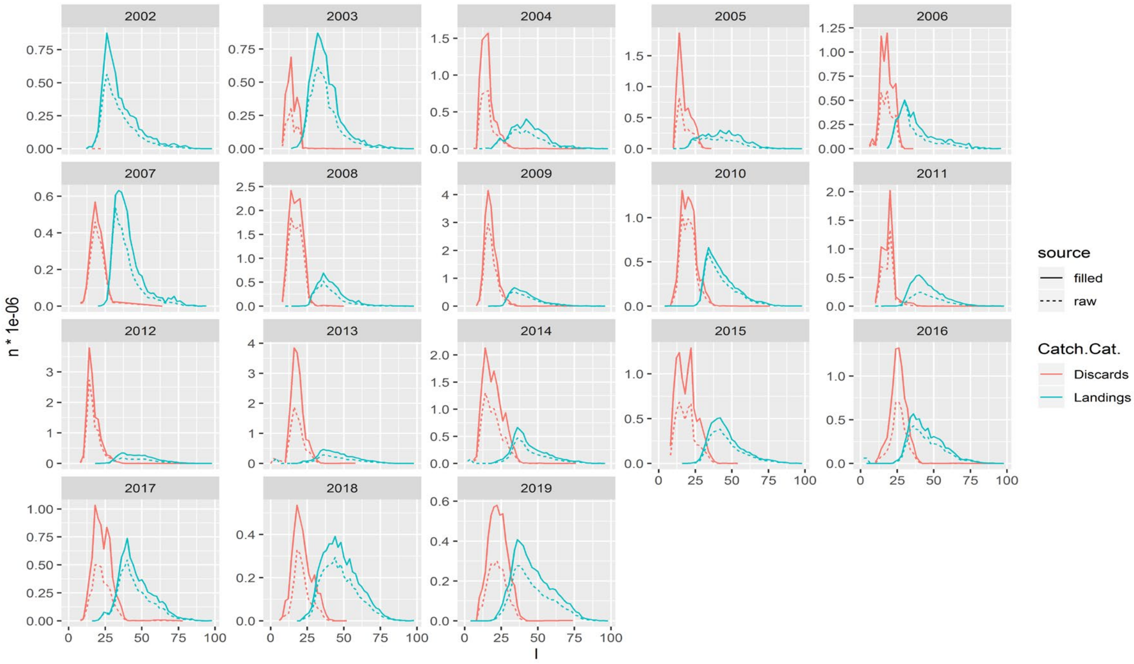

Figure 3.3.2a. *Lophius budegassa* in 27.78abd. Annual length frequency distributions of the landings (blue) and discards (red). The dotted lines show the sampled strata submitted to intercatch; the solid lines are the estimates after allocations of unsampled catches. No discard data were available prior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

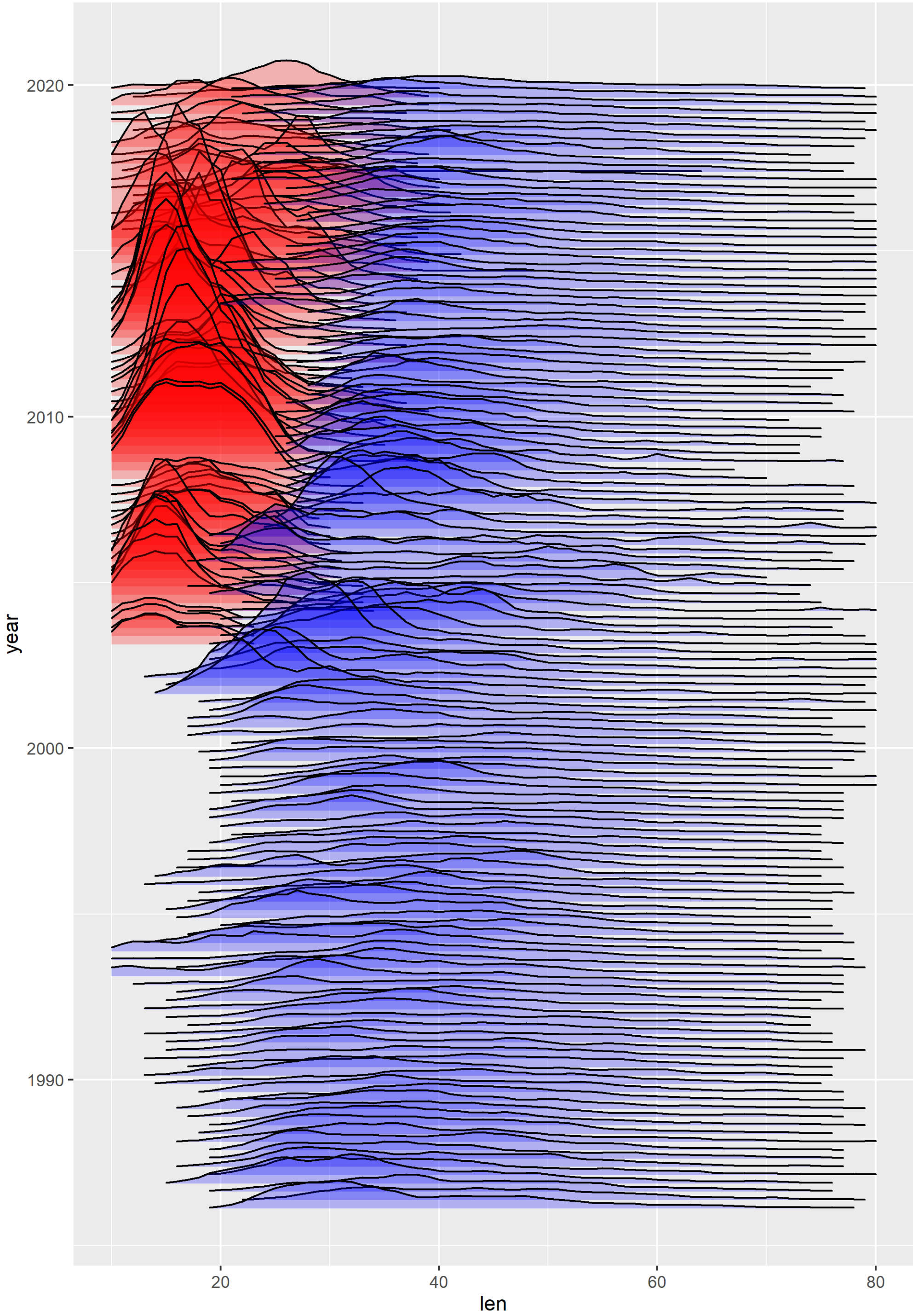

Figure 3.3.2b. ***Lophius budegassa*** **in 27.78abd. quarterly raised length frequency distributions of the landings (blue) and discards (red). No discard data were available prior to 2003.**

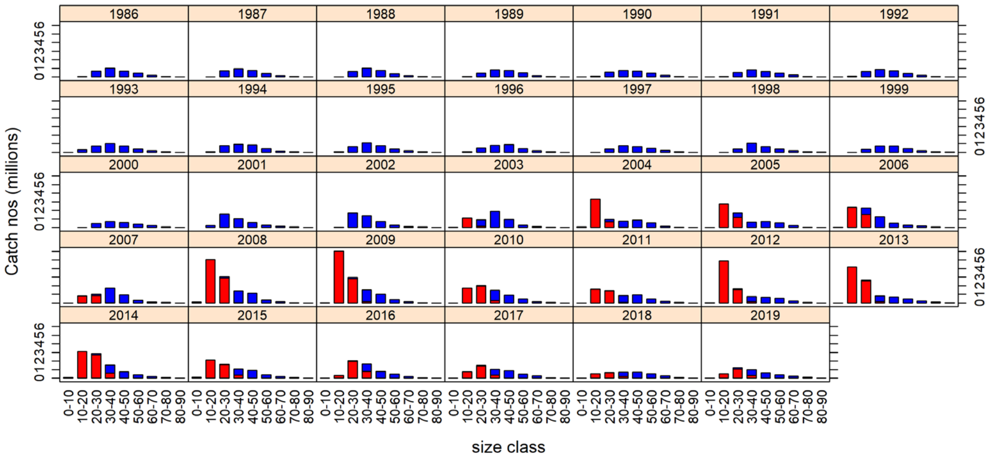

Figure 3.3.3a. ***Lophius budegassa*** **in 27.78abd. Length distributions of the catches (landings – blue, discards – red) by year in terms of abundance.**

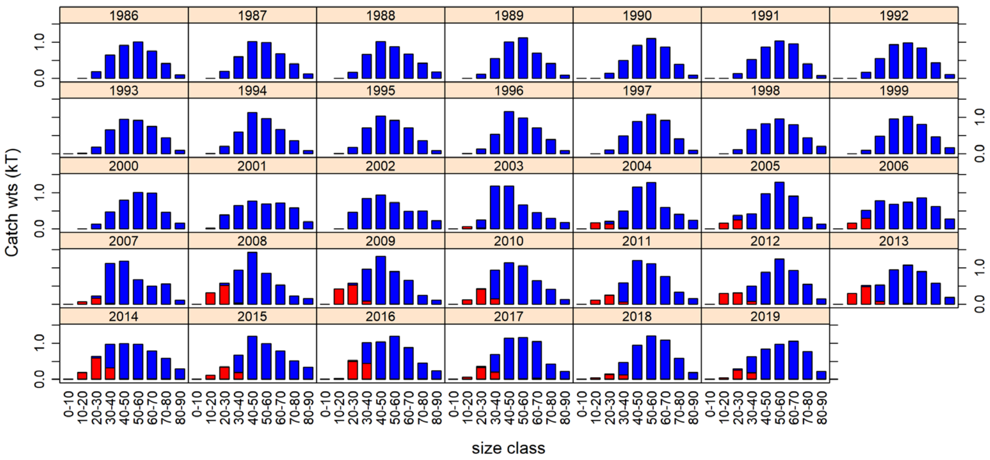

Figure 3.3.3b. ***Lophius budegassa*** **in 27.78abd. Length distributions of the catches (landings – blue, discards – red) by year in terms of biomass.**

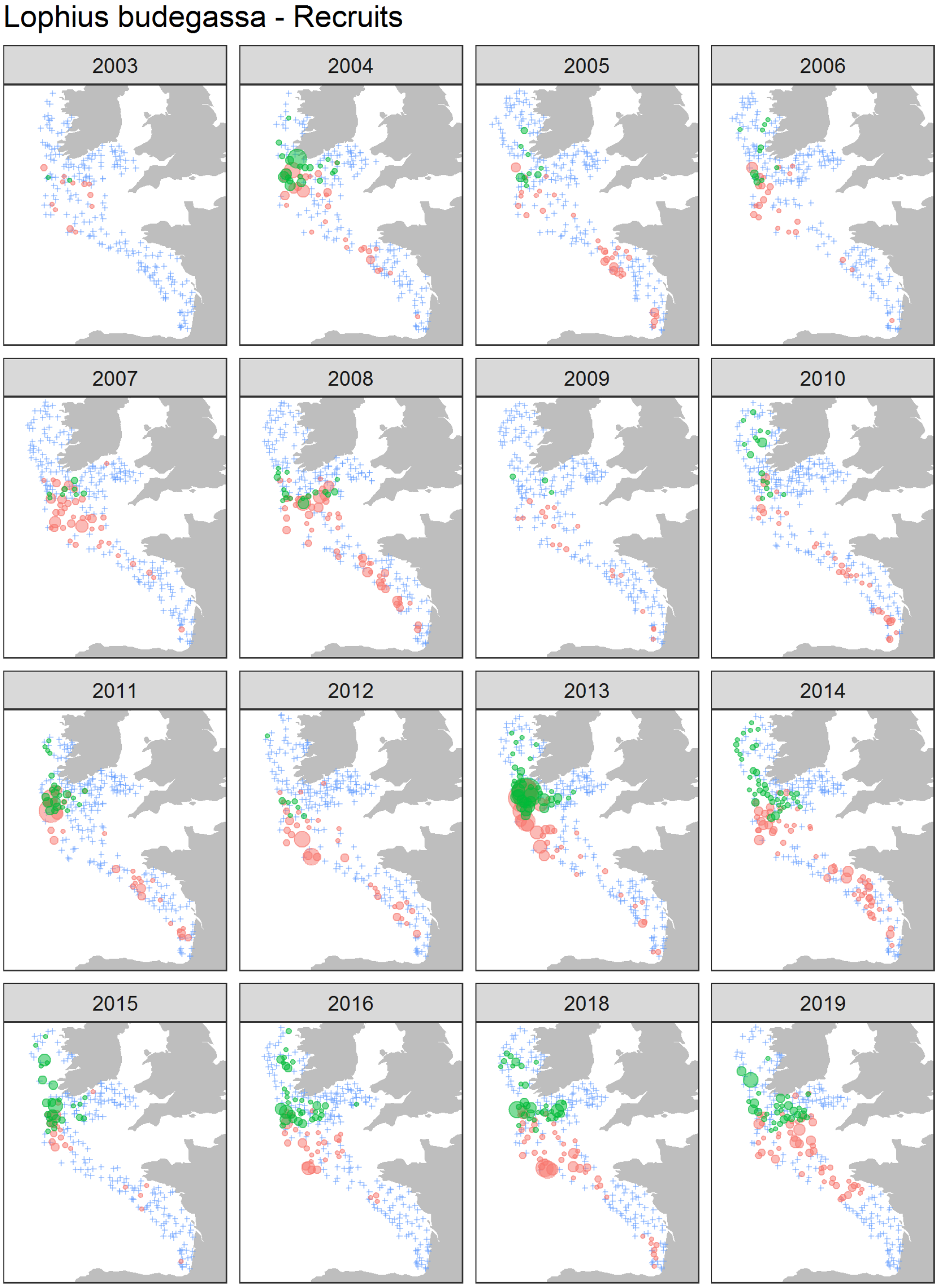

Figure 3.3.4a. *Lophius budegassa* in 27.78abd. Abundance of recruits on the IGFS-WIBTS-Q4 (green) and EVHOE-WIBTS-Q4 surveys (red).

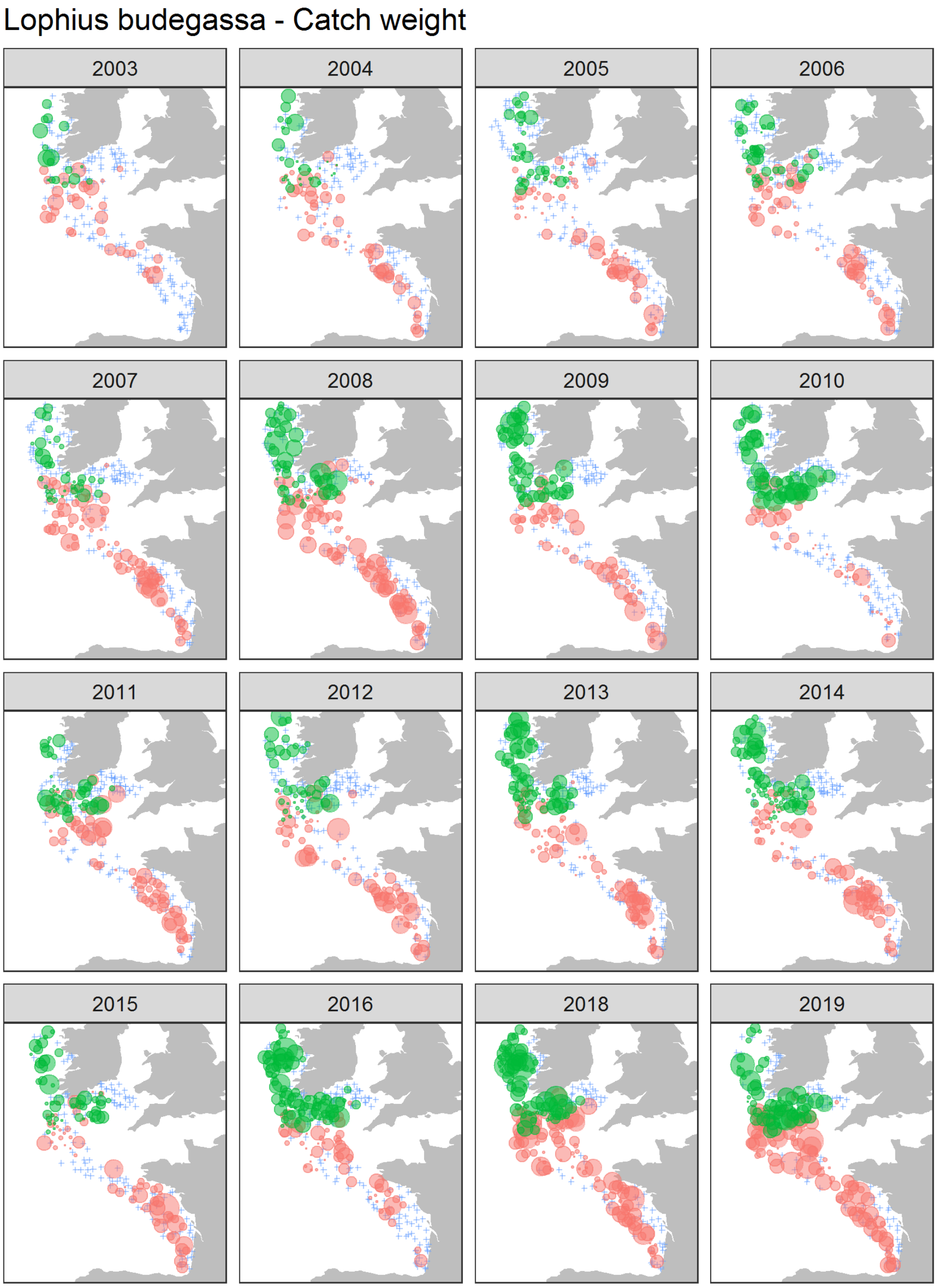

Figure 3.3.4b. ***Lophius budegassa*** **in 27.78abd. Catch weights on the IGFS-WIBTS-Q4 (green) and EVHOE-WIBTS-Q4 surveys (red).**

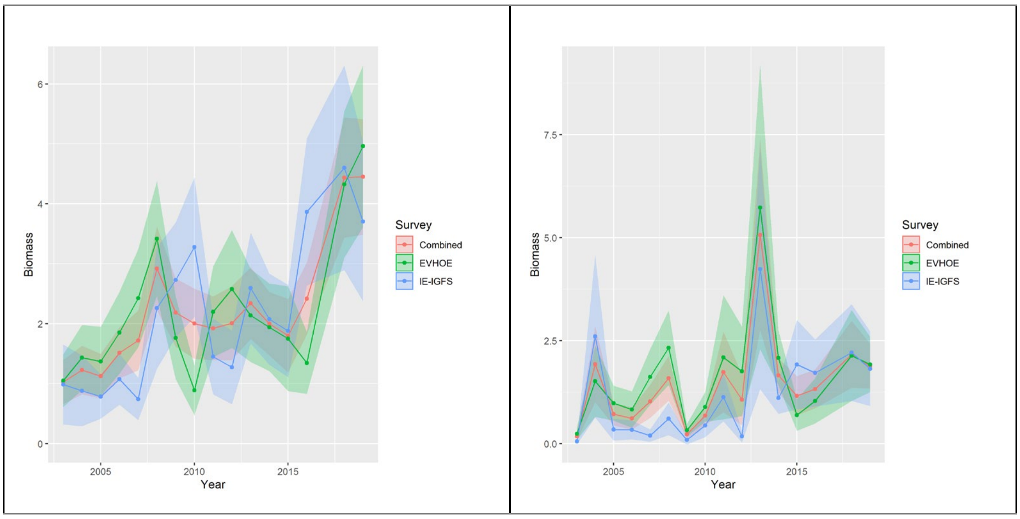

Figure 3.3.5a. ***Lophius budegassa*** **in 27.78abd. Survey trends in terms of biomass (left) and recruits (<16cm; right). The Evhoe index is shown in green, IGFS in blue and the combined index in red, all with 95% confidence intervals.**

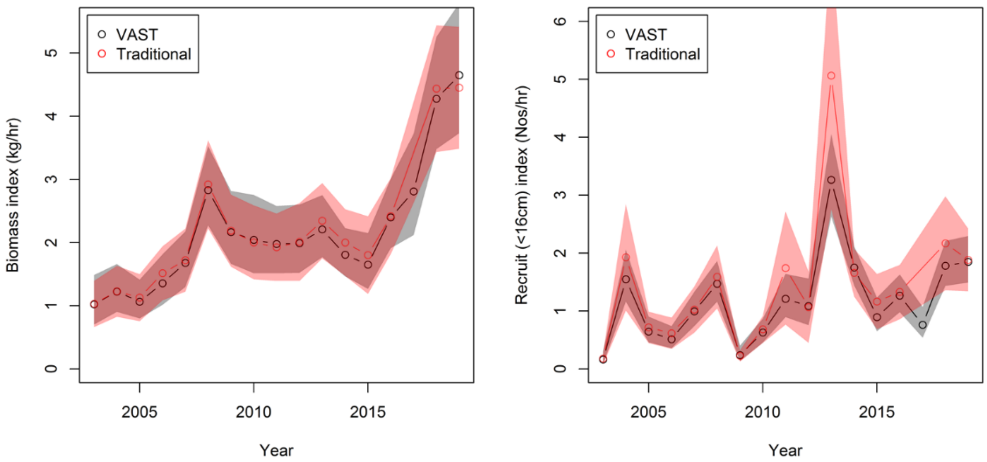

Figure 3.3.5b. ***Lophius budegassa*** **in 27.78abd. Survey trends in terms of biomass (left) and recruits (<16cm; right). The traditional combined index is shown in red and the vast index in grey, both with 95% confidence intervals.**

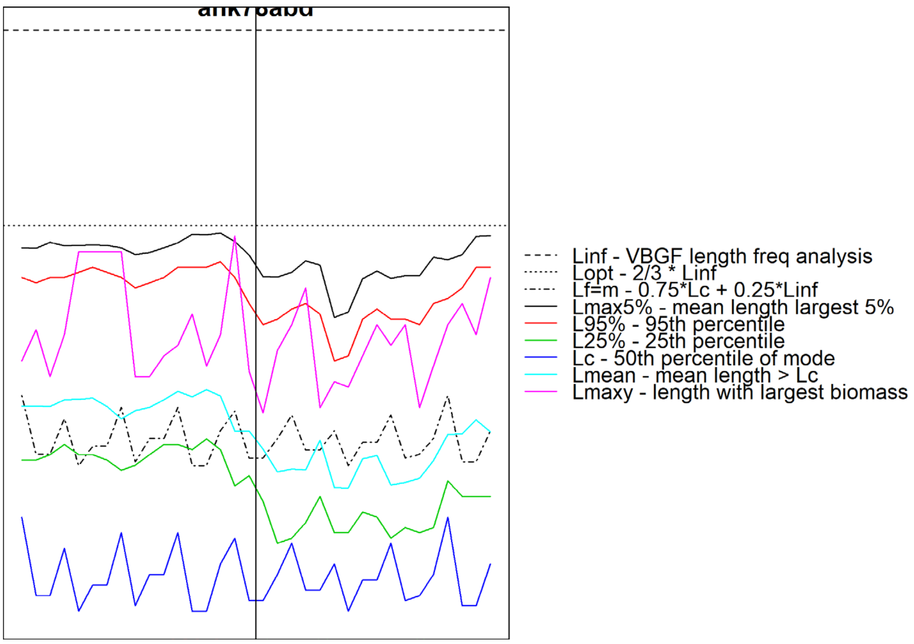

Figure 3.3.6. ***Lophius budegassa*** **in 27.78abd. Length-based indicators. Data prior to 2003 do not include discards (vertical black line). Length-based indicators are presented for information only as WGBIE does not consider them appropriate for determining reference points.**

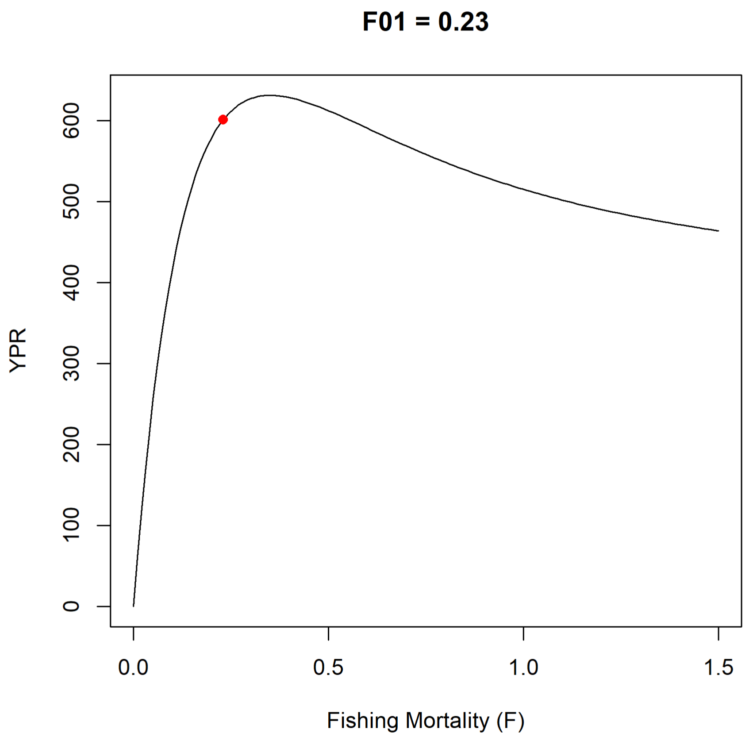

Figure 3.3.7. ***Lophius budegassa*** **in 27.78abd. YPR curve. F01.**

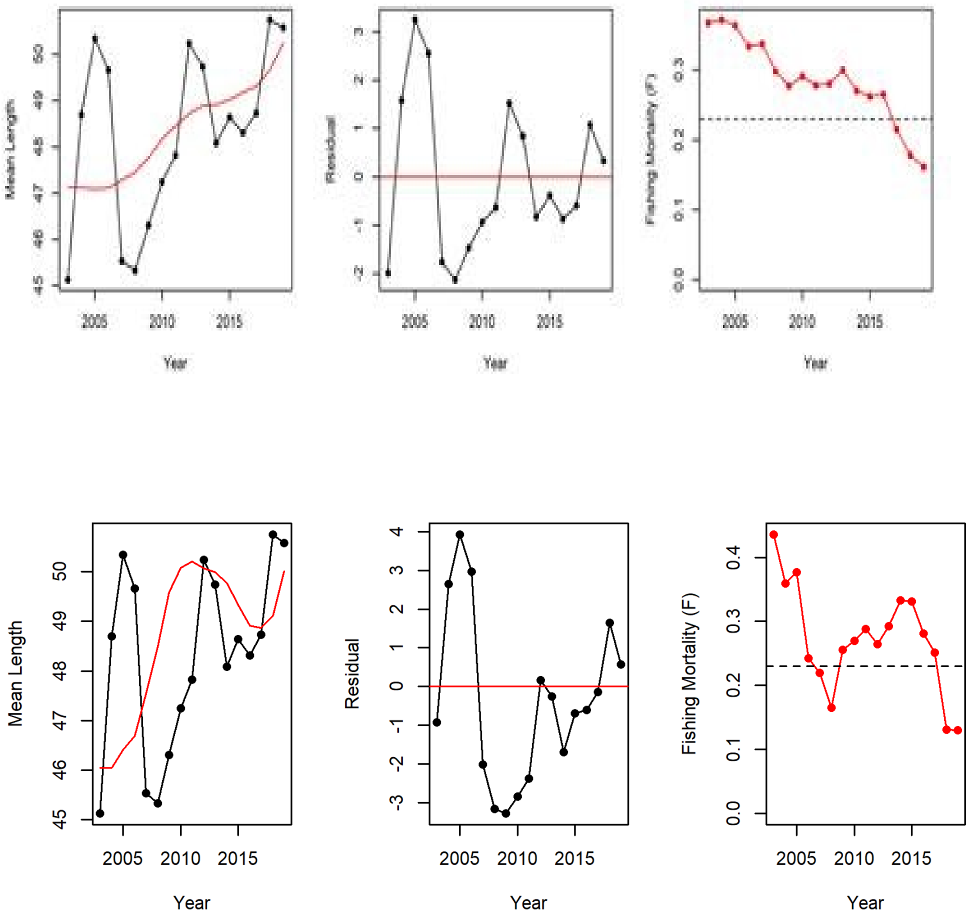

Figure 3.3.8. *Lophius budegassa* in 27.78abd. Length-based Z (with effort) estimate of fishing mortality (right), the dashed line is F01. The top panels show the analysis using the same approach as last year: the trend in fishing effort was estimated from the *L. piscatorius* assessment, under the assumption that the two species are subject to the same effort. The bottom panels show the analysis with the new estimate of trend in fishing effort which is based on the commercial catch of *L. budegassa*, divided by the survey index of biomass.

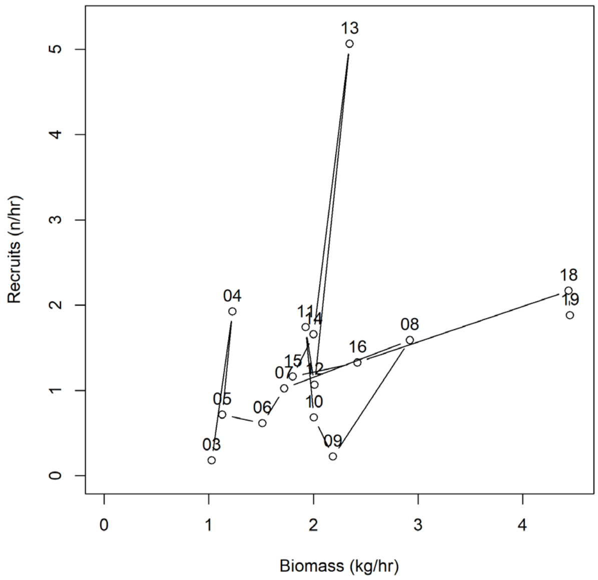

Figure 3.3.9. *Lophius budegassa* in 27.78abd. Stock-recruit plot based on the biomass index and recruit index used to provide advice.

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	0.07	0.29	1.03	0.66	0.29	1.90
2004	1.93	1.01	2.85	1.23	0.82	2.85	1.56
2005	0.72	0.44	0.99	1.13	0.76	0.99	1.64
2006	0.62	0.35	0.89	1.51	1.09	0.89	1.06
2007	1.02	0.63	1.42	1.72	1.22	1.42	0.95
2008	1.59	1.04	2.13	2.92	2.22	2.13	0.72
2009	0.22	0.13	0.32	2.19	1.62	0.32	1.11
2010	0.68	0.45	0.92	2.00	1.42	0.92	1.17
2011	1.74	0.76	2.72	1.93	1.39	2.72	1.25
2012	1.07	0.45	1.68	2.01	1.39	1.68	1.15
2013	5.06	2.75	7.37	2.34	1.75	7.37	1.27
2014	1.66	1.25	2.07	2.00	1.47	2.07	1.45

2015	1.16	0.69	1.64	1.80	1.19	1.64	1.44
2016	1.33	0.86	1.80	2.42	1.82	1.80	1.22
2017	0.84	0.60	1.17	2.88	2.19	3.78	1.09
2018	2.17	1.36	2.98	4.44	3.43	2.98	0.57
2019	1.88	1.34	2.42	4.45	3.49	2.42	0.57
2018-19	Average A			4.44			
2015-17	Average B			2.37			
	Ratio A/B			1.88			

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

L. piscatorius and L. budegassa

Type of assessment in 2020: 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: French landings for 2018 have been reviewed 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 increased in the early eighties reaching a maximum level in 1986 (9 433 t) and 1988 (10 021 t), and decreased after that to a minimum of 1 801 t in 2001. In 2002-2005 period landings increased reaching 4 757 t. This period was followed by another one where landings gradually declined and in 2011 landings were less than half of the 2005 amount (2 179 t). From 2011 to 2014, landings slightly increased to 3 030 t. Annual values then progressively decreased again in the next 5 years to 1 577 t in 2019, the lowest value recorded of the stocks' historical time series.

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 in the annual landings but in 1999-2002 both species showed approximately the same weight. In 2003, the proportion of *L. piscatorius* started to increase again, with a mean proportion of 61% in total landings from 2010 to 2019.

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 (Pedersen and Berg, 2017) for *L. budegassa* was approved while new settings and data were incorporated to the existing Stock Synthesis (SS) model (Methot Jr. and Wetzel, 2013) for *L. piscatorius.*

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

4.2 Summary of ICES advice for 2020 and management for 2019 and 2020

ICES advice for 2020:

ICES gave a separate advice for each of these species in 2019. ICES advises for *L. piscatorius* that when the EU multiannual plan (MAP) for Western waters and adjacent waters (European Parliament and Council Regulation (EU) No. 2019/472) is applied, catches in 2020 that correspond to the F ranges are between 1 519 and 2 813 t. Catches higher than those corresponding to F_{MSY} (2 146 t) can only be taken under conditions specified in the MAP. For *L. budegassa,* ICES advises that when the precautionary approach is applied, catches in 2020 should be no more than 2 050 t.

Management applicable for 2019 and 2020:

The two species are managed under a common TAC that was set at 4166 t for 2019 and 4023 t for 2020. The reported landings in 2019 were 38% of the established TAC.

There is no minimal landing size for anglerfish. However, the Council Regulation (EC) No. 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 implemented 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. 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 1978-2019 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			n/a	222	728	728		
1979	n/a	n/a				n/a	625			n/a	435	1 060	1 060		
1980	4 008	1 477				5 485	786			n/a	654	1 440	6 926		6926
1981	3 909	2 240				6 149	1 040			n/a	679	1 719	7 867		7867
1982	2 742	3 095				5 837	1 716			n/a	598	2 314	8 151		8151
1983	4 269	1 911				6 180	1 426			n/a	888	2 314	8 494		8494
1984	3 600	1 866				5 466	1 136			409	950	2 495	7 961		7961
1985	2 679	2 495				5 174	977			466	1 355	2 798	7 972		7972
1986	3 052	3 209				6 261	1 049			367	1 757	3 172	9 433		9433
1987	3 174	2 571				5 745	1 133			426	1 668	3 227	8 973		8973
1988	3 583	3 263				6 846	1 254			344	1 577	3 175	10 021		10021
1989	2 291	2 498				4 789	1 111			531	1 142	2 785	7 574		7574
1990	1 930	1 127				3 057	1 124			713	1 231	3 068	6 124		6124
1991	1 993	854				2 847	878			533	1 545	2 956	5 802		5802
1992	1 668	1 068				2 736	786			363	1 610	2 758	5 493		5493
1993	1 360	959				2 319	699			306	1 231	2 237	4 556		4556
1994	1 232	1 028				2 260	629			149	549	1 327	3 587		3587
1995	1 755	677				2 432	814			134	297	1 245	3 677		3677
1996	2 146	850				2 995	749			265	574	1 589	4 584		4584
1997	2 249	1 389				3 638	838			191	860	1 889	5 527		5527
1998	1 660	1 507				3 167	865			209	829	1 903	5 070		5070
1999	1 110	1 140				2 250	750			119	692	1 561	3 811		3811
2000	710	612				1 322	485			146	675	1 306	2 628		2628
2001	614	364				978	247			117	459	823	1 801		1801
2002	587	415		61	8	1 072	344			104	380	828	1 901		1901
2003	1 190	771		55	0	2 016	617			96	529	1 242	3 258		3258
2004	1 513	1 389		87	32	3 021	549			77	602	1 229	4 250		4250
2005	1 651	1 719		160	55	3 586	653			60	458	1 171	4 757		4757
2006	1 490	1 371		72	6	2 938	801			68	351	1 220	4 158		4158
2007	1 327	1 076		26	7	2 437	866			78	303	1 247	3 683		3683
2008	1 280	1 238		31	9	2 558	473			50	246	770	3 328		3328
2009	1 151	1 207		20	10	2 389	386			43	262	691	3 080		3080
2010	689	1 036		14	3	1 742	355			72	203	630	2 372		2372
2011	458	598	105	18	2	1 180	216	88	146	122	199	770	1 951	154	2105
2012	432	610	89	14	2	1 148	163	60	132	161	533	1 049	2 197	339	2536
2013	495	853	52	23	7	1 430	142	85	140	114	412	893	2 323	288	2612
2014	545	1 073	35	30	11	1 694	211	93	8	143	408	863	2 557	474	3030
2015	557	943	5	13	14	1 532	190	114	3	161	422	890	2 422	395	2818
2016	579	964	9	12	10	1 573	179	146	3	127	377	832	2 405	419	2824
2017	410	879	1	4	11	1 305	215	128	2	98	440	883	2 188	119	2307
2018	414	770	34	12	15	1 245	244	72	2	58	280	656	1 901	16	1916
2019	299	553	0	2	2	856	183	81	1	65	239	570	1 426	152	1577

n/a: not available

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

4.3.1 General

4.3.1.1 Ecosystem aspects

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

4.3.1.2 Fishery description

L. piscatorius is mainly caught by Spanish and Portuguese bottom trawlers and gillnet fisheries. For 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 2010, Spanish landings were on average 84% of total landings of the stock.

The length distribution of the landings is considerably different between both fisheries, with the gillnet landings showing higher mean lengths compared to those landed by trawls. From 2005 to 2019, the Spanish landings were on average 39% from the trawl fleet (in 2019, mean lengths of 63 cm and 73 cm in Divisions 8c and 9a, respectively were observed) and 61% from the gillnet fishery (mean length of 85 cm in Division 8c was observed in 2019). For the same period, Portuguese landings were on average 11% from bottom trawlers (mean length of 54 cm in 2019) and 89% from the artisanal fleet (mean length of 70 cm in 2019).

4.3.2 Data

4.3.2.1 Commercial catches and discards

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

Spanish discards estimates and landings below minimum size of *L. piscatorius* in weight are shown in Table 4.3.2. No discards were reported in logbooks by any country. For the available time series, anglerfish discards represent less than 16% of trawl catches. The maximum value observed from the time series occurred in 2006 (99 t). Discards from the Spanish gillnet fleet are only available from 2013 to 2019 with quantities between 0 t and 144 t. The occasional high and zero values of discards reported for the gillnet fleet could be related to a very low sampling level. *L. piscatorius* discards in the Portuguese trawl fisheries are considered negligible (Fernandes and Prista, 2012; Prista *et al*., 2014). Based on the Spanish and Portuguese discards information, the WG concluded that discards could be considered negligible.

4.3.2.2 Biological sampling

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

The sampling levels for Portugal in 2019 are shown in Table 1.4. Following the requirement of the EU Data Collection Framework, the métier sampling adopted in Spain and Portugal in 2009 can have an effect on the provided data. Spanish sampling levels are similar to previous years but a significant reduction of Portuguese samplings was observed in 2009-2011. Since 2012, Portugal increased their sampling effort.

Length composition

Table 4.3.3 gives the available annual length composition by ICES division, country and gear and adjusted length composition for total stock landings for 2019. The annual length compositions for all combined fleets for the period 1986–2019 are presented in Figure 4.3.1.

Landings in number, the mean length and mean weight in the landings between 1986 and 2019 are 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. In the last 3 years, there is a strong downward trend in total landings number reaching 139 thousands in 2019 (value almost similar to the lowest number, 127 thousands in 2001, observed for the whole time series). This decrease coincides with an increase in the mean length.

Mean lengths and mean weights in the landings increased sharply between 1995 and 2000. In 2002, low values of mean lengths and mean weights were observed, around the minimum of the time series, due to the increase in smaller individuals. After that, increases in mean length were observed reaching 71 cm in 2010. In 2018, mean length and mean weight in landings increased with respect to the previous year and that year values, 77 cm and 7 163 g respectively, were the highest of the time series.

Biological information

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

4.3.2.3 Abundance indices from surveys

Spanish and Portuguese survey results for the period 1983–2019 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, following this year a downward trend was observed. In 2015, 2016, 2017 and 2018, the abundance indices were the lowest of the series (Figure 4.3.2) and almost no individuals < 20 cm were recorded (Figure 4.3.3). In 2019, a slight increase in the abundance was observed which corresponds to individuals between 17 and 23 cm.

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.

4.3.2.4 Commercial catch-effort data

Landings, effort and LPUE data are given in Table 4.3.6 and Figure 4.3.4. Values for Spanish trawlers (Division 8c) from the ports of Santander and Avilés were collected 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: (1) A Coruña port for trips that are exclusively landed in the port, (2) A Coruña trucks for trips that are landed in other ports and (3) A Coruña fleet that takes into account all the trips of the fleet. For 2019, only information for A Coruña port was provided. Although abundance series from A Coruña port can be potentially used in the assessment, a previous analysis of the whole time series must be done before taking it into account. The A Coruña fleet index, used in the assessment as abundance index from 1982–2012, is not available since 2013.

Until 2011, most logbooks of Portuguese fleets were filled in paper but have been progressively replaced thereafter by electronic logbooks. In 2013, more than 90% of the logbooks is 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 Table 4.3.6. 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 of data and the latest available standardized series, from 1999–2011, is presented. Due to the reduction in the number of vessels of Cedeira fleet, this tuning series could not be considered as a representative abundance index of the stock and it is no longer recorded. 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. Slight increases in 1996 and 1997 landings can be observed in all fleets. From 2000 to 2005, Spanish fleets of A Coruña, Avilés and Cedeira showed an increase in landings while those landed by the Portuguese fleets remained at low levels. Since 2005–2009, landings from A Coruña and Cedeira fleets showed an overall decreasing trend. Proportion in total landings per fleet is higher for the Cedeira and A Coruña. Landings for both Portuguese fleets increased in 2014 and 2015 then decreased in 2016 and 2018.

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

LPUEs from all available fleets show a general decline during the eighties and early nineties followed by some increase (Table 4.3.6). From 2002 to 2005, LPUEs increased for all fleets. This general LPUE trend is consistent between fleets including the artisanal fleet. In 2010 and 2011, an important increase of Cedeira LPUE was observed. Portuguese fleets 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 Kg/hour.

4.3.3 Assessment

A new model assessment was adopted in 2018 benchmark. The assessment approved in the WKANGLER (ICES, 2018) was updated with 2019 data.

4.3.3.1 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 2019 were not included in the assessment.

4.3.3.2 Model

The Stock Synthesis (SS) software was selected to be used in the assessment (Methot Jr. and Wetzel, 2013). The description of the model including the structure, settings, and parameters assumptions are provided in the Stock Annex.

4.3.3.3 Assessment results

The model diagnosis is carried out by means of the analysis of residuals of abundance indices. Residual plots of the fits to the abundance indices are shown in Figure 4.3.5. Although some minor trends have been detected, as it happened for A Coruña indices from 1995 to 2000, it can be considered that the model follows trends of the abundance indices used in the model (A Coruña, Cedeira and the Spanish survey). For the Spanish survey in the last 6 years, the model overestimates the index. Pearson residual plots are presented for the model fits to the length-composition data of the abundance indices (Figure 4.3.6). No specific pattern was detected in any of the abundance indices. However, some high positive residuals are evident for the 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, from smaller to very large individuals. The Spanish artisanal fleet is most efficient at a narrow length range of large-sized fish, mainly from 75 to 90 cm. The Portuguese trawl fleet selection pattern indicates that this fishery is most efficient for individuals ranging between 30 and 60 cm. This selection pattern shows strange selection over larger fish, possibly the effect of an insufficient length sampling. The Portuguese artisanal fleet 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 a selectivity directed to larger individuals. The Spanish survey index shows a well-defined selectivity to 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) do not correspond to the F summary used here (the average of over lengths 30 to 130 cm). The uncertainty of F could not be calculated from the variance-covariance matrix.

4.3.3.4 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, 1987 and 1989) with values over 3 million. Along the time series, other high recruitment values were detected in 1994 and 2001. Since 2006, the recruitment has been below 1 million except in 2010, 2011 and 2014. The abundance of age-0 in years 2015, 2016, 2017 and 2018 was very low, being at the minimum values throughout the time series. Landings steadily decreased from 3.8 Kt in 2005 to 1.1 Kt in 2011, coinciding with the decrease in F, from 0.39 in 2005 to 0.131 in 2011. Compared to 2018, landings and F decreased in 2019 by 21% and 12%, respectively. Since 2005, SSB was above 6 Kt and it steadily increased to the highest value of the times-series (12.6 Kt) estimated at the beginning of 2019.

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

4.3.3.5 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 (2019), two years (2019 and 2018), three years (2019-2017), four years (2019-2016) and five years (2019-2015) of data while using the same model configuration (Figure 4.3.10). All the retrospective analysis runs were similar in the recruitment estimates. Although there is some uncertainties in recent recruitment estimates, no consistent bias was observed. Retrospective analysis showed an underestimation of the SSB in the final years and an overestimation of F. Nevertheless, there was no strong retrospective pattern and the assessment was accepted for projections. Mohn's Rho index (Mohn, 1999) for the last 5 years were estimated for recruitment (0.54), F (0.10) and SSB (-0.06).

4.3.4 Catch options and prognosis

4.3.4.1 Short-term projections

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

For fishing mortality, the F *status quo* equal to 0.087, estimated as the F_{2019} over lengths 30–130 cm, was used for 2020. In the case of recruitment, the geometric mean of the recent period (2003–2019) was used following the option indicated in the Stock Annex when a trend in the time series was detected.

Projected landings in 2021 and SSB at the beginning of 2022 for different management options in 2021 are presented in Table 4.3.8. Under F *status quo* scenario in 2021, a small decrease in landings with respect to 2020 as well as a decrease in SSB in 2022 with respect to 2021 are expected.

4.3.4.2 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	0.13	3.13	0.272	2.04	6.29
F0.1	0.25	1.97	0.171	1.93	11.91
F40%	0.40	1.25	0.109	1.64	18.88
F35%	0.35	1.45	0.126	1.75	16.53
F30%	0.30	1.69	0.147	1.85	14.17

The F that maximizes the yield-per-recruit, F_{max}, is estimated at 0.272 which is over F_{sq} (0.087) and which corresponds to a SPR level of 13%. 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 0.171 and it is corresponding to a SPR level of 25%. Fishing mortality of $F_{30\%}$, $_{35\%}$ and $_{40\%}$ were estimated at 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 $F_{40\%}$.

4.3.5 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 points	Value	Rational
Precautionary approach	B_{lim}	1993 t	B_{loss}
	B_{pa}	2769 t	B_{lim}*exp (1.645*0.2)
	F_{lim}	0.56	Stochastic simulations of recruitment with B_{lim} as the breakpoint
	F_{pa}	0.40	F_{lim}*exp (-0.2*1.645)

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

4.3.6 Comments on the assessment

The spawning-stock biomass has increased from 2007 to 2019. SSB in 2020 is estimated at 12.5 Kt which is well above of B_{pa} (2 769 t) and MSY $B_{trigger}$ (6 283 t). Fishing mortality in 2019 has decreased by 12% relative to 2018. F in 2019 is estimated to be at a value of 0.087, 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 but declined to 0.9 Kt in 2019. For the period 2015-2018, recruitments were extremely low, being the main concern about the status of the stock. In 2019, the recruitment estimated indicates a moderate increase in the abundance of age-0.

4.3.7 Quality considerations

The available unallocated and non-reported landings for years 2011–2019 are included in the stock assessment since the estimates were considered to be realistic information. However, the importance of the 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. For the last 10 years, the model lacks of an abundance indicator for larger individuals which might have an impact on the precision of SSB estimates.

In order to avoid a ‘cryptic’ biomass phenomenon, which may translate to population estimates of larger fish that are not comparable to those observed through sampling efforts, the selectivity of the fleet PT-ART-9a is forced to be asymptotic. However, this fleet is down-weighted in the model due to its low sample size, thus, potentially reducing its capacity of buffering the cryptic biomass.

4.3.8 Management considerations

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

4.3.9 References

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Table 4.3.1 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a.
Tonnes landed by the main fishing fleets for 1978-2019 as determined by the Working Group.

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

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 Below Minimum Size	Trawl	Gillnet
Year	Weight (t)	Weight (t)
2018	0.027	0.111
2019	0	0

Discards Estimates: Trawl

Year	Weight (t)	CV	% Trawl Catches	% Total Catches
1994	20.9	34.05	2.2	1.0
1995	n/a	n/a	n/a	n/a
1996	n/a	n/a	n/a	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	2.0	1.1
2004	64.9	n/a	3.8	2.0
2005	56.2	n/a	2.9	1.4
2006	99.3	n/a	6.2	3.2
2007	17.2	n/a	1.4	0.7
2008	5.1	n/a	0.5	0.2
2009	24.5	n/a	2.2	1.1
2010	12.5	n/a	2.3	0.8
2011	30.1	n/a	7.7	2.5
2012	66.7	n/a	16.3	4.6
2013	65.8	n/a	15.7	3.8
2014	24.4	n/a	4.6	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	3.3	0.9
2018	4.1	n/a	1.2	0.4
2019	1.9	n/a	0.7	0.2

Discards Estimates: Gillnet

Year	Weight (t)	CV	% Gillnet Catches	% Total Catches
2013	143.8	n/a	13.7	8.2
2014	0.0	n/a	0.0	0.0
2015	7.6	n/a	0.7	0.4
2016	24.2	n/a	2.3	1.3
2017	17.0	n/a	1.8	1.2
2018	1.8	n/a	0.2	0.2
2019	16.7	n/a	2.8	1.8

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 2019.
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	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.07	0.00	0.00	0.07	0.07	0.07
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.13	0.00	0.13	0.12	0.00	0.00	0.12	0.25	0.25
31	0.27	0.00	0.27	0.00	0.03	0.00	0.03	0.30	0.30
32	0.54	0.00	0.54	0.00	0.00	0.00	0.00	0.54	0.54
33	0.59	0.00	0.59	0.00	0.00	0.00	0.00	0.59	0.59
34	1.23	0.00	1.23	0.00	0.00	0.00	0.00	1.23	1.23
35	0.75	0.00	0.75	0.00	0.00	0.00	0.00	0.75	0.75
36	0.92	0.00	0.92	0.00	0.06	0.00	0.06	0.99	0.99
37	0.90	0.00	0.90	0.18	0.06	0.00	0.25	1.15	1.15
38	0.74	0.00	0.74	0.00	0.17	0.00	0.17	0.92	0.92
39	0.99	0.00	0.99	0.00	0.06	0.00	0.06	1.05	1.05
40	1.01	0.00	1.01	0.10	0.69	0.00	0.78	1.80	1.80
41	0.91	0.00	0.91	0.06	0.84	0.00	0.91	1.82	1.82
42	0.78	0.00	0.78	0.23	0.33	0.00	0.56	1.34	1.34
43	0.65	0.00	0.65	0.04	1.17	2.43	3.64	4.29	4.30
44	0.64	0.00	0.64	0.25	0.45	0.00	0.70	1.34	1.34
45	0.72	0.00	0.72	0.00	0.17	0.00	0.17	0.89	0.89
46	0.77	0.00	0.77	0.62	0.14	4.39	5.15	5.91	5.92
47	0.40	0.00	0.40	0.28	0.00	0.00	0.28	0.68	0.68
48	0.66	0.01	0.67	0.30	0.01	0.00	0.31	0.98	0.98
49	0.93	0.00	0.93	0.20	0.14	0.00	0.34	1.27	1.27
50	0.43	0.00	0.43	0.17	0.00	0.00	0.17	0.60	0.60
51	0.75	0.01	0.76	0.04	0.14	0.00	0.18	0.94	0.94
52	0.71	0.00	0.71	0.26	0.00	0.00	0.26	0.97	0.97
53	0.47	0.08	0.55	0.28	0.45	0.00	0.73	1.28	1.29
54	0.71	0.09	0.80	0.17	0.00	0.00	0.17	0.97	0.98
55	0.94	0.04	0.98	0.12	0.03	0.84	0.98	1.96	1.96
56	0.56	0.08	0.64	0.06	0.00	0.00	0.06	0.70	0.71
57	0.79	0.04	0.83	0.06	0.00	0.00	0.06	0.89	0.89
58	0.75	0.15	0.90	0.43	0.00	0.00	0.43	1.33	1.34
59	0.50	0.12	0.63	0.04	0.00	0.00	0.04	0.67	0.68
60	0.67	0.21	0.88	0.24	0.00	0.00	0.24	1.12	1.14
61	0.86	0.36	1.21	0.25	0.00	0.00	0.25	1.46	1.49
62	0.86	0.58	1.44	0.28	0.00	0.00	0.28	1.73	1.76
63	0.58	0.52	1.10	0.19	0.00	0.00	0.19	1.29	1.33
64	0.71	0.57	1.29	0.15	0.00	0.00	0.15	1.44	1.48
65	0.61	0.62	1.23	0.26	0.00	0.31	0.57	1.81	1.86
66	1.06	0.94	2.00	0.09	0.00	0.15	0.24	2.23	2.29
67	0.74	1.02	1.77	0.13	0.05	0.00	0.18	1.94	2.01
68	1.01	1.30	2.31	0.42	0.00	0.00	0.42	2.73	2.81
69	0.66	1.09	1.75	0.39	0.04	1.31	1.75	3.49	3.56
70	0.81	1.86	2.66	0.16	0.00	0.15	0.31	2.98	3.10
71	0.52	1.44	1.96	0.24	0.00	0.31	0.55	2.51	2.60
72	0.43	1.57	2.00	0.25	0.00	0.00	0.25	2.25	2.35
73	0.39	1.69	2.08	0.35	0.00	0.77	1.12	3.20	3.30
74	0.68	1.84	2.52	0.50	0.00	0.00	0.50	3.01	3.15
75	0.44	1.93	2.37	0.33	0.00	0.00	0.33	2.70	2.83
76	0.74	1.33	2.07	0.46	0.00	0.03	0.49	2.56	2.66
77	0.76	1.47	2.23	0.32	0.00	0.15	0.47	2.70	2.80
78	0.35	1.33	1.68	0.26	0.00	0.15	0.41	2.08	2.18
79	0.68	1.48	2.16	0.24	0.00	0.00	0.24	2.40	2.51
80	0.83	1.28	2.11	0.22	0.00	0.14	0.36	2.47	2.57
81	0.22	0.98	1.20	0.24	0.00	0.00	0.24	1.44	1.51
82	0.39	1.28	1.68	0.56	0.00	0.00	0.56	2.23	2.33
83	0.64	0.71	1.36	0.27	0.05	0.31	0.64	1.99	2.05
84	0.69	1.40	2.09	0.16	0.05	0.46	0.67	2.76	2.85
85	0.49	0.90	1.38	0.13	0.03	0.00	0.15	1.54	1.61
86	0.65	0.96	1.62	0.23	0.00	0.15	0.38	2.00	2.07
87	0.31	0.80	1.12	0.26	0.00	0.00	0.26	1.37	1.44
88	0.79	0.93	1.73	0.18	0.00	0.00	0.18	1.90	1.96
89	0.27	0.90	1.17	0.09	0.00	0.00	0.09	1.26	1.33
90	0.42	0.93	1.35	0.17	0.00	0.07	0.24	1.59	1.66
91	0.68	1.05	1.73	0.21	0.00	0.00	0.21	1.94	2.01
92	0.16	1.01	1.17	0.40	0.00	1.34	1.74	2.91	2.98
93	0.50	1.00	1.50	0.22	0.10	0.00	0.32	1.82	1.89
94	0.36	1.22	1.59	0.31	0.00	0.00	0.31	1.89	1.98
95	0.32	1.03	1.36	0.11	0.00	0.00	0.11	1.46	1.54
96	0.29	0.84	1.14	0.05	0.00	0.07	0.12	1.25	1.32
97	0.12	0.77	0.89	0.12	0.00	0.07	0.19	1.08	1.14
98	0.18	0.60	0.78	0.02	0.00	0.67	0.69	1.47	1.52
99	0.09	0.93	1.02	0.11	0.00	0.00	0.11	1.13	1.20
100+	1.73	9.75	11.48	1.28	0.76	2.41	4.45	15.93	16.65
TOTAL	44.9	53.0	97.9	14.9	6.0	16.7	37.6	135.5	139.4
Tonnes	195.4	461.9	657.3	91.5	22.3	103.9	217.7	874.9	908.7
Mean Weight (g)	4353	8711	6713	6150	3689	6226	5788	6456	6519
Mean length (cm)	62.9	85.1	74.9	72.9	54.5	69.7	68.5	73.2	73.5

Table 4.3.4 ANGLERFISH (*L. piscatorius*). Divisions 8c and 9a.
Numbers, mean weight and mean length of landings between 1986 and 2019.

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

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
2019**	113	0.53	0.21	0.31	0.07	ns	ns	n/a

Yst = stratified mean
se = standard error
ns = no survey
n/a = not available
+ = less than 0.01
* For Portuguese Surveys - R/V Capricornio, other years R/V Noruega
** For Spanish Surveys - R/V Miguel Oliver, other years R/V Coornide de Saavedra

Table 4.3.6 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	--	--	--	--	--	--	--	--
2019	42	5	12 824	3	--	--	--	--	--	--	--	--

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

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

	Recruit Age0 (thousands)	Total Biomass (t)	Total SSB (t)	Landings (t)	Yield/SSB	F (30-130 cm)
1980	683	15 462	9 767	4 817	0.49	0.30
1981	1 951	16 496	11 344	5 566	0.49	0.33
1982	7 374	15 561	11 882	5 782	0.49	0.38
1983	1 918	14 358	10 629	6 113	0.58	0.49
1984	776	14 045	8 811	6 031	0.69	0.51
1985	1 837	13 019	8 414	6 139	0.73	0.53
1986	6 542	10 774	7 768	6 870	0.88	0.80
1987	3 708	7 406	4 799	5 139	1.07	0.92
1988	1 071	7 300	3 140	6 321	2.01	1.40
1989	3 347	5 953	2 474	4 995	2.02	1.10
1990	2 224	4 936	2 407	3 790	1.58	0.82
1991	1 063	4 804	2 210	3 640	1.65	0.84
1992	1 320	4 506	2 111	3 382	1.60	0.87
1993	1 706	3 783	1 970	2 329	1.18	0.63
1994	3 139	3 822	2 060	2 007	0.97	0.50
1995	1 815	4 629	2 325	1 835	0.79	0.33
1996	333	6 578	3 285	2 956	0.90	0.39
1997	283	7 532	4 354	3 715	0.85	0.45
1998	224	6 815	4 745	2 981	0.63	0.38
1999	744	5 788	4 587	1 933	0.42	0.30
2000	649	5 097	4 249	1 256	0.30	0.24
2001	3 728	4 939	3 988	788	0.198	0.16
2002	1 613	5 819	4 188	1 093	0.26	0.189
2003	347	7 961	4 809	2 326	0.48	0.29
2004	2 186	9 371	5 880	3 258	0.55	0.33
2005	1 366	9 588	6 820	3 827	0.56	0.39
2006	1 294	9 028	6 537	2 998	0.46	0.34
2007	716	8 832	6 322	2 377	0.38	0.28
2008	788	9 119	6 685	2 372	0.36	0.26
2009	892	9 184	7 069	2 307	0.33	0.25
2010	1 550	8 997	7 180	1 620	0.23	0.181
2011	1 202	9 439	7 521	1 156	0.154	0.131
2012	544	10 676	8 312	1 396	0.168	0.136
2013	850	11 884	9 294	1 540	0.166	0.133
2014	1 623	12 825	10 432	2 033	0.195	0.165
2015	255	13 171	10 967	1 771	0.161	0.143
2016	213	13 782	11 417	1 809	0.158	0.150
2017	200	13 886	11 812	1 447	0.123	0.119
2018	357	13 882	12 344	1 144	0.093	0.099
2019	903	13 706	12 596	908	0.072	0.087
2020	715*	13 493	12 476			

*geometric.mean(2003-2019)

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

SSB(2020)	Rec proj	F(30-130cm)	Land(2020)	SSB(2021)
12 476	715	0.087	799	12 151

Fmult	Fland (30-130cm)	Landings (2021)	SSB (2022)
0	0	0	12 861
0.1	0.0087	76	12 772
0.2	0.0174	151	12 683
0.3	0.026	225	12 596
0.4	0.035	299	12 509
0.5	0.044	372	12 422
0.6	0.052	444	12 337
0.7	0.061	516	12 252
0.8	0.070	587	12 168
0.9	0.078	658	12 084
1	0.087	728	12 001
1.1	0.096	798	11 919
1.2	0.104	867	11 838
1.3	0.113	935	11 757
1.4	0.122	1003	11 677
1.5	0.130	1070	11 597
1.6	0.139	1137	11 518
1.7	0.148	1203	11 440
1.8	0.157	1269	11 362
1.9	0.165	1334	11 285
2	0.174	1399	11 209
2.1	0.183	1463	11 133
2.2	0.19	1526	11 058
2.3	0.20	1589	10 983
2.4	0.21	1652	10 909
2.5	0.22	1714	10 835
2.6	0.23	1775	10 763
2.7	0.23	1836	10 690
2.8	0.24	1897	10 619
2.9	0.25	1957	10 547
3	0.26	2016	10 477

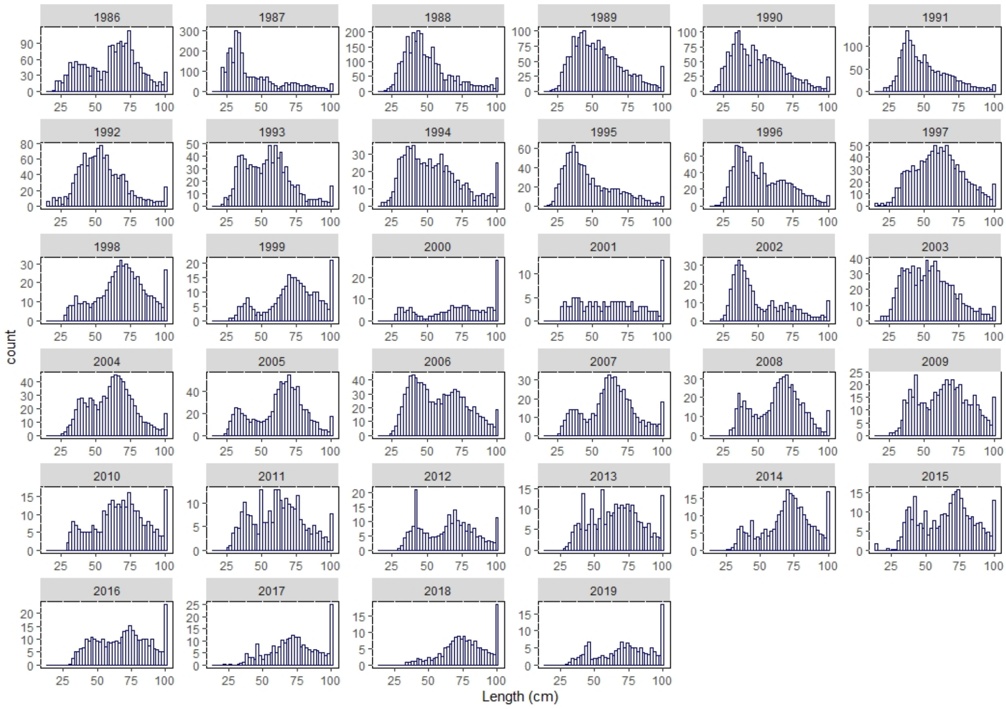

Figure 4.3.1. ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Length distributions of landings (thousands for 1986 to 2019).

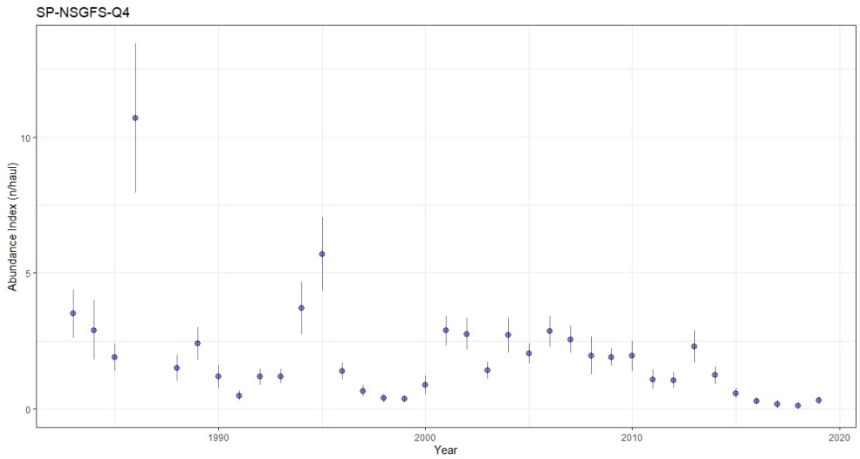

Figure 4.3.2 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Abundance index from survey SP-NSGFS-Q4 in numbers/haul. Bars represent 95% confidence intervals.

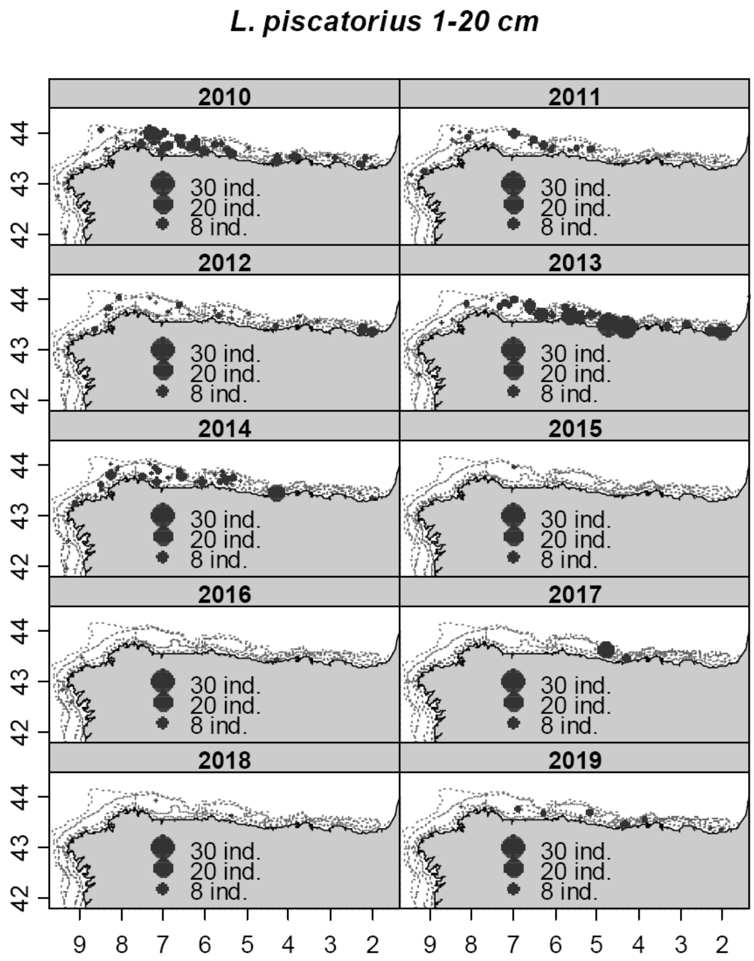

Figure 4.3.3. ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Spatial distribution of juveniles (length 0-20 cm) in North Spanish Coast demersal survey (SP-NSGFS-Q4) between 2010 and 2019.

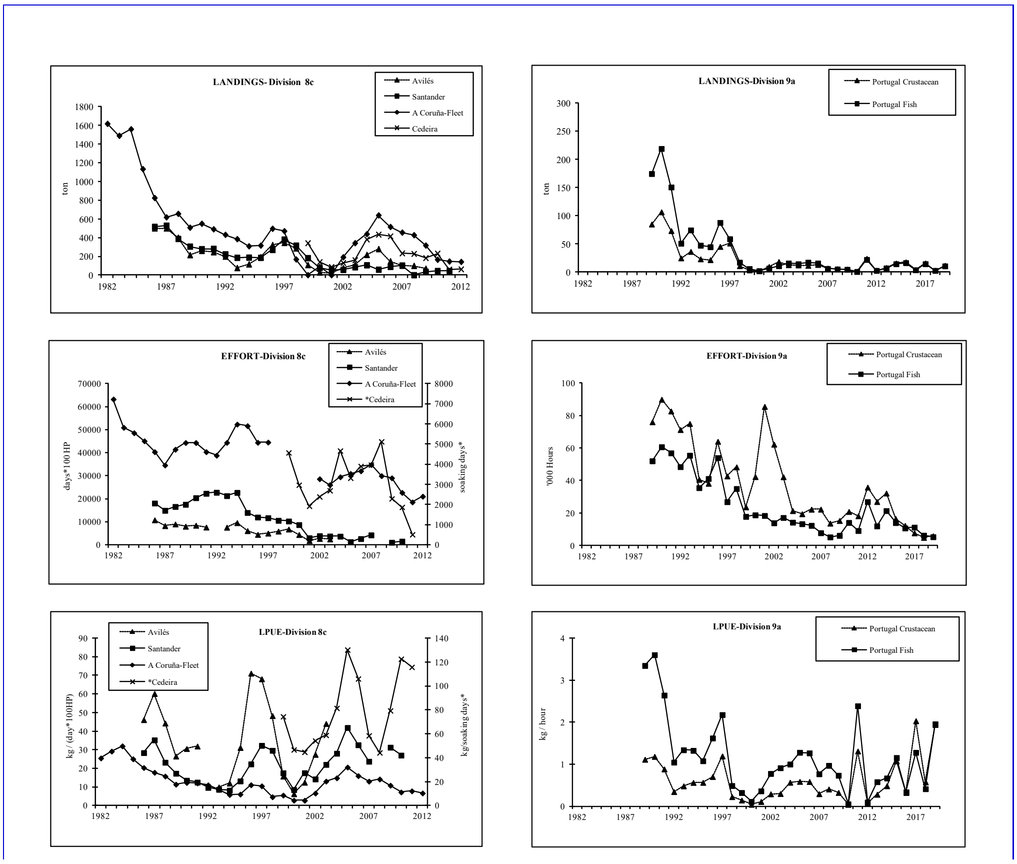

Figure 4.3.4. ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Trawl and gillnet landings, effort and LPUE data between 1986-2019.

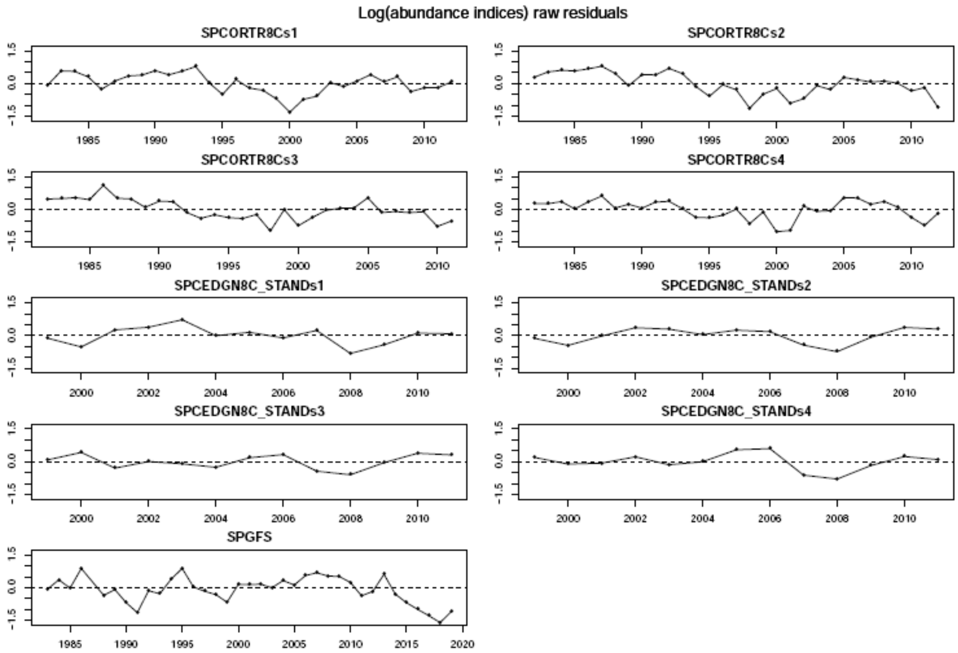

Figure 4.3.5 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Residuals of the fits to the surveys in log(abundance indices). A Coruña and Cedeira are by quarters.

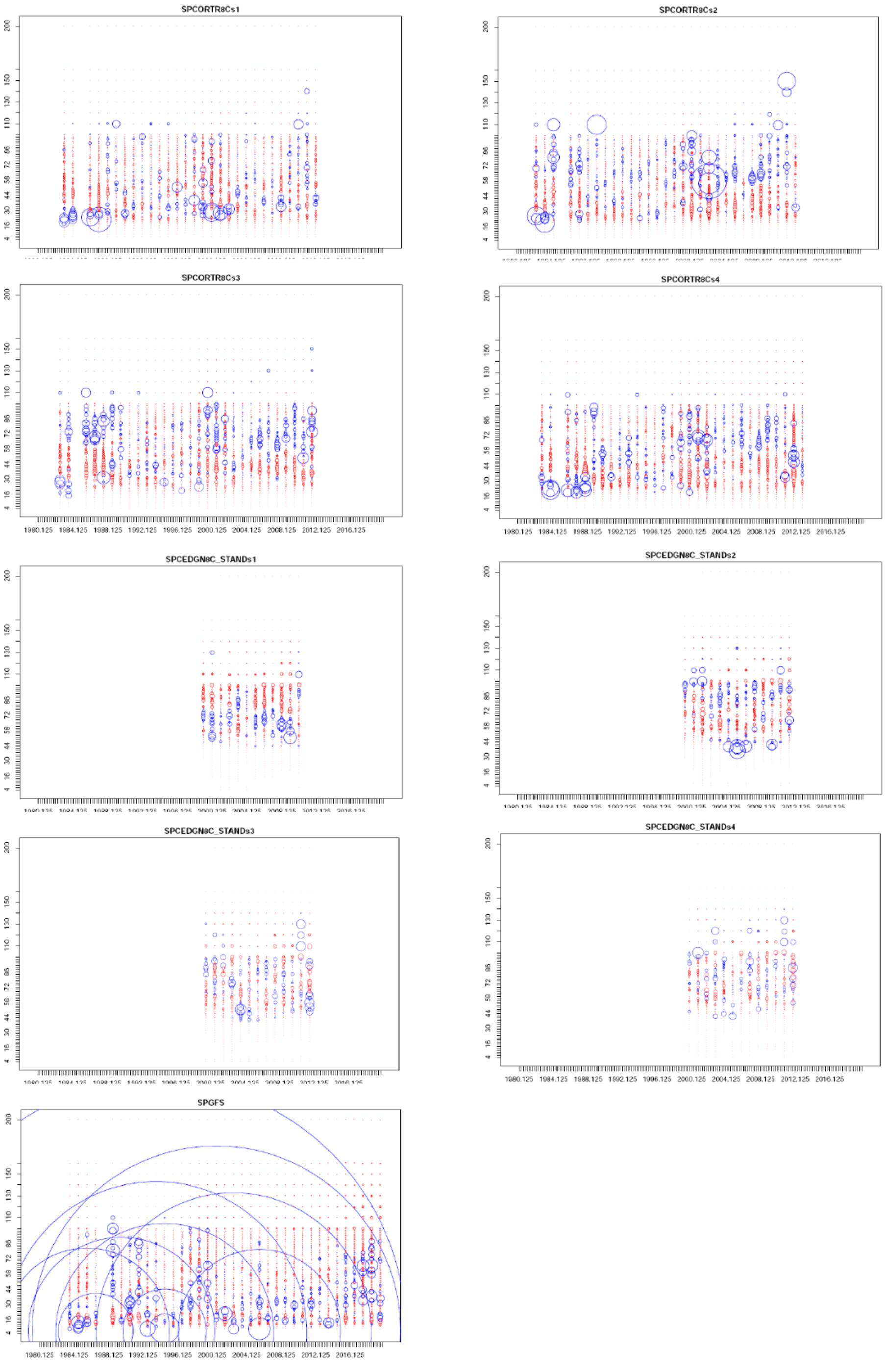

Figure 4.3.6 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Pearson residuals of the fit to the length distributions of the abundance indices. Blue=positive residuals and red=negative residuals.

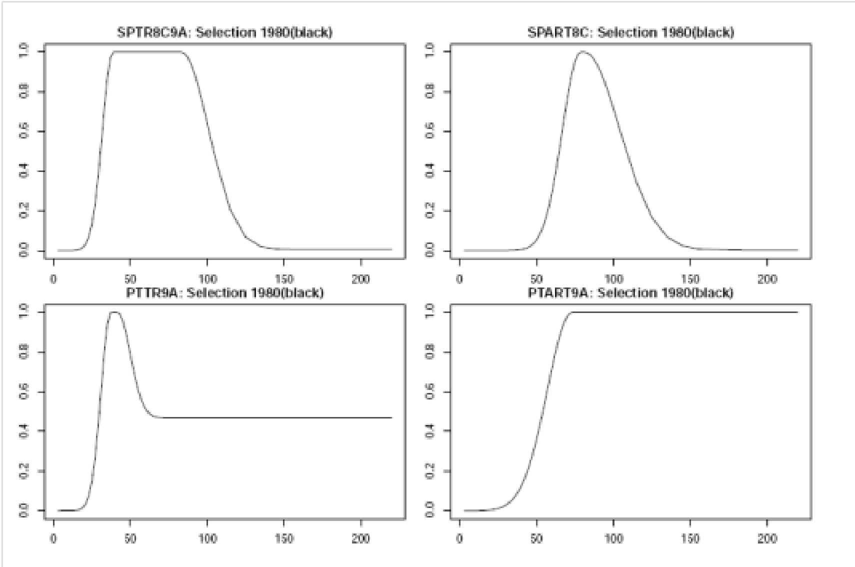

Figure 4.3.7 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Relative selection patterns at length by fishery estimated by SS3.

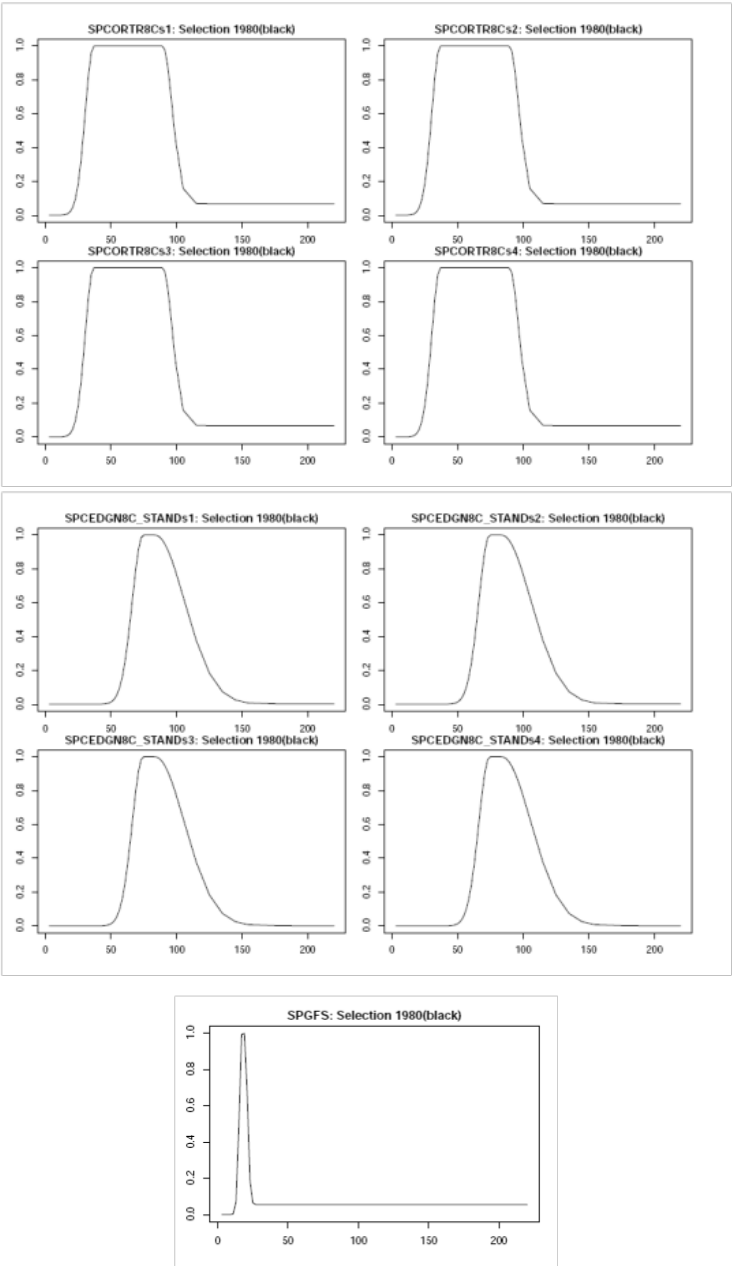

Figure 4.3.8 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Relative selection patterns at length by abundance index estimated by SS3. A Coruña and Cedeira indices are by quarter.

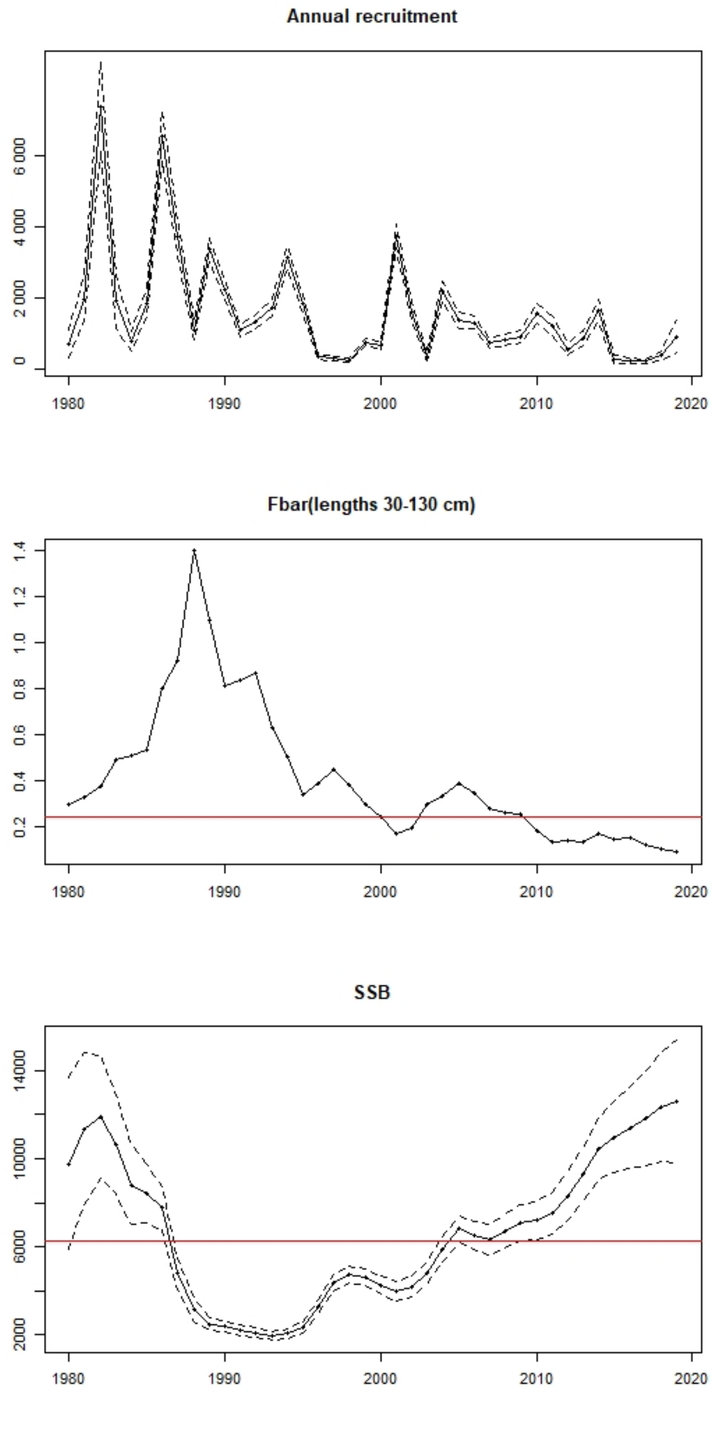

Figure 4.3.9 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Summary plots of stock trends (with 95% intervals).

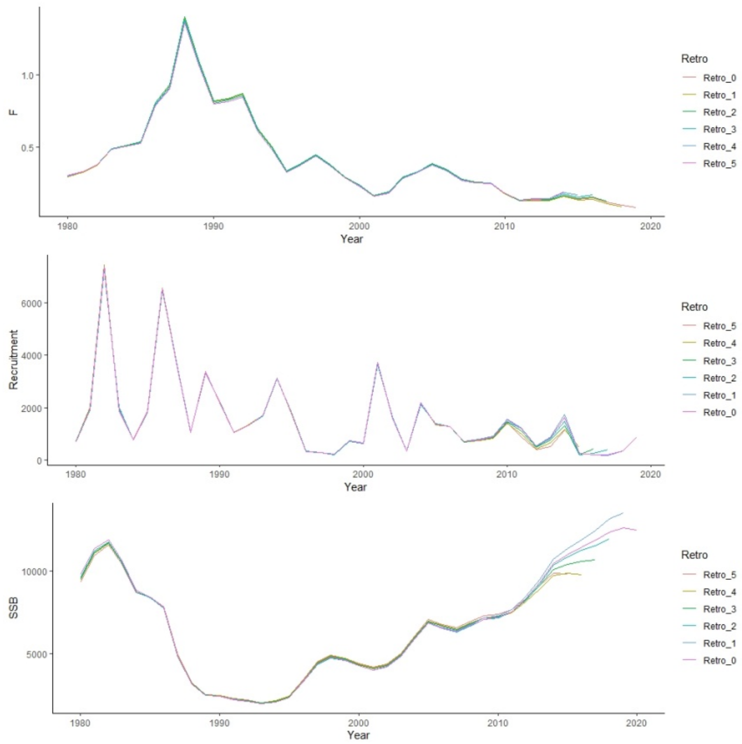

Figure 4.3.10 ANGLERFISH (*L. piscatorius*) - Divisions 8c and 9a. Retrospective plots from the SS3 model.

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

4.4.1 General

4.4.1.1 Ecosystem aspects

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

4.4.1.2 Fishery description

L. budegassa is mainly caught by Spanish and Portuguese bottom trawlers and net fisheries (gillnet and trammel nets). As with *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 represent <1% (on average) of the total landings of the stock.

The length distribution of the landings varies among fisheries, with gillnet and artisanal landings showing higher mean lengths compared to the trawl landings, except in 2017, when the mean lengths of the trawl and artisanal fisheries were similar. Since 2008, the Spanish landings were mostly allocated to the trawl fleet (65%; mean lengths in 2019 of 45.7 cm in Divisions 8.c and 9.a), followed by the gillnet fishery (30%; mean length in 2019 of 59.7 cm in Division 8.c) and other fleets (5%). Portuguese landings, for the same period were mainly from the artisanal fleet (71%; mean length of 59.5 cm in 2019), followed by the trawl fleet (29%; mean length of 46.3 cm in 2019). French landings since 2008 correspond, on average, to 64% from the trawl fleet, 36% from the gillnet fleet and <0.5% from others fleets.

4.4.2 Data

4.4.2.1 Commercial catches and discards

Total landings of *L. budegassa* by country and gear for the period 1978–2019, as estimated by the Working Group, are given in Table 4.4.1. Portuguese and Spanish landing data and discards were revised for using during the WKANGLER 2018 benchmark (ICES, 2018a). French landings data were available to WGBIE from 2002 to 2019. French landings from 2018 were updated and used in the model. As the difference from the previous and revised 2018 data was negligible, no significant change was observed in the assessment. Unallocated/non reported landings for this stock were available from 2011 to 2016 and again in 2018-2019. Historical landings analysis is presented in the Stock Annex. The unallocated/non reported values were considered realistic and are included in 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 and 1 141 t but have been decreasing since then, reaching 669 t in 2019.

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 observed from 1994–2019, show two peaks, in 2006 (114 t) and in 2010 (64 t), being relatively low since then. The estimated Spanish gillnet discards are available since 2011 and varied between 0 and 14.3 t.

Sampling effort and percentage of occurrence of *L. budegassa* discards in the trawl Portuguese fisheries were presented for the 2004–2013 period (Prista *et al*. 2014 – WD3 in ICES, 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 Prista *et al*. 2014 – WD3 in ICES, 2014). For this reason, discard estimates were not calculated since 2014.

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

4.4.2.2 Biological sampling

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

The sampling levels for 2019 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 data provided. Spanish sampling levels are similar to previous years but a notable reduction of Portuguese sampling levels was observed in 2009-2011. Since 2012, Portugal increased the sampling effort.

Length composition

Table 4.4.3 gives the annual length compositions by ICES division, country and gear and the adjusted length composition for total stock landings for 2019 (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 2019 are presented in Figure 4.4.1. In 2002, an increase of smaller individuals is apparent (around 30–35 cm), also 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. Such high values of small-sized individuals were not observed since then. In 2014, a small mode was observed at smaller lengths (43 cm) decreasing the annual mean length, but since then the levels of small-sized 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. The estimated total number of landed individuals show a remarkable decrease in the year 2000, when compared to previous years. In 2005, the value was 9% of the maximum value (observed in 1987). In 2006 and 2007, the number of landed fish more than doubled the 2005 number. The estimated number of landed fish decreased to a minimum in 2009. This value increased in 2010 and 2011 but has been decreasing to minimum levels since then. The estimated mean weight is relatively high since 2012 (>2 Kg).

4.4.2.3 Abundance indices from surveys

Spanish and Portuguese survey results for the period 1983–2019 are summarized in Table 4.4.5. The Portuguese survey was not performed in 2012 and 2019. Considering the very small amount of anglerfish caught in the SpGFS-WIBTS-Q4 and PtGFS-WIBTS-Q4 surveys, these indices were considered unsuitable to evaluate the change in abundance of this species. On the contrary, data from SPGFS-caut-WIBTS-Q4 (Gulf of Cadiz) are regular and its usefulness has been considered promising (ICES, 2018a). The biomass index from this survey increased since the beginning of the time series, reaching a maximum value in 2015. The biomass value in 2019 is lower than the value estimated for 2018 but it is still amongst the highest values of the time series.

The absence of *L budegassa* in the Portuguese ground fish survey and the near zero numbers of specimens <21 cm in the Spanish bottom trawl surveys on the Northern Spanish Shelf in 2014-2015 suggest a lack of recruitment in the surveyed area (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. In 2018 and 2019, very few individuals below 20 cm were observed.

4.4.2.4 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 for this tuning fleet in 2013 were calculated using the information from electronic logbooks and following different criteria than those established for previous years. In order to check the consistency of the Spanish time series, a backward revision of the time series is needed to compare the different estimation methods and sources of information used.

Three LPUE series were presented in the past for the A Coruña trawler fleet: (a) “A Coruña port” for trips that are exclusively landed in the port; (b) “A Coruña trucks” for trips that are landed in other ports; (c) and “A Coruña fleet” that takes into account all the trips of the 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 as 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.

Until 2011, for the Portuguese fleets, most logbooks were filled in paper but have thereafter been progressively replaced by electronic logbooks. Since 2013, >90% of the logbooks were reported in the electronic version. The two LPUE series available were revised from 2012 onwards. To revise the series backwards, further refinement of the algorithms is required. Logbook data from the Portuguese artisanal fleet, particularly from vessels targeting *Lophius* spp. are also available since 2007 (electronic and paper). A LPUE series from a reference fleet is under development and preliminary results were presented to this WG.

Excluding the Avilés and Santander fleets, the overall trend in landings for all fleets was decreasing from the late eighties to mid-nineties (Figure 4.4.3). A slight increase was observed from 1995 to 1998. The A Coruña fleet showed the most important drop in landings and in relative proportion of total landings in 2002.

LPUEs of Spanish Avilés and Santander fleets show high values during the second half of the 90s. Despite the variability observed, a decreasing trend was observed for all fleets from 2000 to 2005 which was then followed by a slightly increasing trend. The LPUE time series from the Portuguese trawl fleet targeting crustaceans shows an increasing trend reaching a maximum value of 5.41 $Kg.hr^{-1}$ in 2018 which decreased to 3.74 $Kg.hr^{-1}$ in 2019. The LPUE time series from the Portuguese trawl fleet targeting fish is variable but also reached a maximum value of 5.30 $Kg.hr^{-1}$ in 2016. In 2019, the value (3.78 $Kg.hr^{-1}$) was slightly lower than the value estimated for 2018 (3.90 $Kg.hr^{-1}$).

Effort trend analysis was presented in section 4.3.4.4.

4.4.3 Assessment

In WKANGLER 2018, the assessment of the status of each anglerfish species was carried out separately (ICES, 2018a). A new model, SPiCT (Pedersen and Berg, 2017), was proposed for the assessment of *L. budegassa*, a stochastic production model in continuous time. This model was considered more reliable than the previous model used, ASPIC (Prager, 1992; 1994), since it does not require the use of fixed parameters, such as B1/k, to be stable.

The SPiCT assessment model is more optimistic in estimating the status of the stock and, hence, provides a lower ratio between the fishing mortality and F_{MSY}. 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 ~5 500 t, 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 (~4 000 t) the biomass decreased in the following years. In 2018, WGBIE agreed that those values provide greater uncertainty especially considering that historical catches have never been at this level before. A stepwise procedure to achieve F_{MSY} was recommended during the WKANGLER (ICES, 2018a). In 2018, WGBIE agreed that a good step-wise approach to F_{MSY} was to adopt the lower confidence interval value of F_{MSY} scenario which gave fishing opportunities of no more than 2 682 t, an increase of 12% compared to the 2017 advice (ICES, 2018b).

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 step-wise approach proposed by WGBIE 2018 was rejected by the ACOM. Given the uncertainties regarding the absolute levels of biomass and fishing pressure, the assessment was considered as indicative of trends only and it was decided to present the advice as a category 3.2 stock with proxy reference points, based on SPiCT results (ICES, 2018b).

4.4.3.1 SPiCT Model

The SPiCT model, accepted at the WGANGLER 2018 (ICES, 2018a), 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 1980–2019 (discards are considered negligible).

- Portuguese trawl fleet targeting crustaceans (1989–2019) (Index1)
- Portuguese trawl fleet targeting fish (1989–2019) (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).

4.4.3.2 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. This auto-correlated residual pattern may reflect spatiotemporal changes in the distribution or may indicate transitory changes in catchability (ICES, 2018a). 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), an index to measure the retrospective patterns, were estimated as - 0.004 and for - 0.014 for B/B_{MSY} and F/F_{MSY}, respectively, indicating no strong retrospective pattern.

4.4.3.3 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, thus, the estimated value from 2020 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.

4.4.4 Short-term projections

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

4.4.5 Biological Reference Points

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

Framework	Reference point	Relative value	Technical basis	Source
MSY approach	MSY $B_{trigger}$ proxy	$0.5 \times B_{MSY\,proxy} = 0.25 \times K$*	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)

4.4.6 Comments on the assessment

This stock was benchmarked in 2018 (WKANGLER; 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 patterns are 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 current SPiCT model is considered more reliable than the previous ASPIC assessment model (Prager, 1992; 1994) since it does not require the use of fixed parameters, such as B1/k, to be stable. Thus, since 2018, the SPiCT model has been used as the basis for advice (ICES, 2018a).

4.4.7 Quality considerations

Three LPUE series were presented in the past for the A Coruña trawler fleet: (a) "A Coruña port" for trips that are exclusively landed in the port; (b) "A Coruña trucks" for trips that are landed in other ports; (c) and "A Coruña fleet" that takes into account all the trips of the 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. However, it was not possible to analyse the potential use of this series for the assessment instead of the incomplete A Coruña fleet series during the WG.

Until 2011, for the Portuguese fleets, most logbooks were filled in paper but have thereafter been progressively replaced by e-logbooks. Since 2013 more than 90% of the logbooks are being completed in the electronic version. The LPUE series were revised from 2012 onwards in 2015. To revise the series backwards further refinement of the algorithms is required.

4.4.8 Management considerations

Management considerations are in section 4.2.

4.4.9 References

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

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Table 4.4.1. Black-bellied anglerfish (*L. budegassa*) - Divisions 8c and 9a. Tonnes landed by the main fishing fleets for

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

n/a: not available

Table 4.4.2. Black-bellied 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
2019	2.2	n/a	0.9	0.3
GILLNETS				
2011	10.6	n/a		
2012	14.3	n/a		
2013	0	n/a		
2014	0.1	n/a	0.03	0.01
2015	0.4	n/a	0.18	0.04
2016	5.0	n/a	2.47	0.49
2017	10.9	n/a	4.82	1.26
2018	2.6	n/a	1.33	0.34
2019	13.3	n/a	7.40	1.98

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 (thousands) in 2019. 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									
16									
17				0,142			0,142	0,142	0,161
18									
19									
20				0,284			0,284	0,284	0,322
21				1,134			1,134	1,134	1,287
22				3,839			3,839	3,839	4,358
23				1,134			1,134	1,134	1,287
24				1,634			1,634	1,634	1,855
25				1,668	0,116		1,784	1,784	2,009
26				2,526			2,526	2,526	2,868
27				4,729			4,729	4,729	5,368
28				2,325	0,003		2,328	2,328	2,643
29				1,753	0,357		2,110	2,110	2,347
30				5,179	0,006		5,185	5,185	5,886
31	0,137		0,137	0,895	0,116		1,011	1,148	1,289
32	0,168		0,168	2,329	0,315		2,644	2,812	3,151
33	0,009		0,009	1,268	0,261		1,529	1,538	1,711
34	0,320		0,320	4,176	1,115		5,291	5,611	6,222
35	0,153		0,153	1,304	1,441		2,745	2,898	3,097
36	0,488		0,488	0,911	0,970		1,881	2,370	2,564
37	0,368	0,213	0,580	1,565	1,743	0,908	4,216	4,796	5,094
38	0,442	0,052	0,495	1,880	0,911	0,908	3,698	4,193	4,520
39	0,768	0,052	0,820	2,034	1,257	0,246	3,537	4,357	4,752
40	0,911	0,045	0,956	1,968	1,193	0,463	3,624	4,581	4,986
41	1,077	0,029	1,106	1,711	0,981	5,518	8,210	9,316	9,708
42	1,479	0,041	1,520	2,036	0,697	0,448	3,181	4,700	5,197
43	1,732	0,773	2,505	1,533	0,417	0,170	2,119	4,624	5,202
44	2,422	0,135	2,557	1,515	0,724	0,339	2,577	5,134	5,713
45	2,966	0,305	3,270	1,899	0,540	1,323	3,762	7,032	7,768
46	2,538	4,186	6,723	2,156	1,180		3,336	10,060	11,363
47	2,209	0,271	2,480	1,158	0,375	0,170	1,702	4,182	4,702
48	2,037	0,494	2,532	1,149	0,194		1,343	3,874	4,402
49	1,960	0,570	2,530	1,331	0,731	0,730	2,792	5,323	5,876
50	1,442	0,591	2,033	0,768	0,329	0,170	1,267	3,300	3,705
51	1,473	1,531	3,003	0,926	0,156		1,082	4,085	4,660
52	1,412	0,089	1,501	0,626	0,061		0,687	2,188	2,492
53	1,166	0,119	1,285	0,368	0,166	0,109	0,643	1,928	2,166
54	1,103	0,765	1,868	0,737	0,094	0,924	1,755	3,622	4,000
55	0,427	0,909	1,335	0,228	0,202	1,325	1,755	3,091	3,323
56	0,949	0,379	1,328	0,769	0,807	0,695	2,271	3,600	3,900
57	0,765	1,612	2,377	0,326	0,475	0,908	1,709	4,085	4,488
58	0,510	0,871	1,382	0,497	0,048	1,527	2,072	3,453	3,728
59	1,230	0,171	1,402	0,609	0,212	0,587	1,408	2,809	3,097
60	0,782	0,805	1,587	1,057	0,074	0,280	1,411	2,999	3,379
61	0,980	1,420	2,400	0,732	0,081		0,813	3,213	3,673
62	0,766	1,363	2,129	0,629	0,065	3,116	3,811	5,940	6,345
63	0,790	1,118	1,908	0,780	0,008	0,109	0,897	2,805	3,198
64	0,685	1,457	2,142	0,671	0,073		0,744	2,886	3,300
65	1,081	1,575	2,656	0,561	0,024		0,585	3,241	3,716
66	0,958	1,578	2,536	0,535	0,011		0,546	3,082	3,536
67	0,868	0,780	1,648	0,336	0,011		0,347	1,995	2,287
68	0,761	0,715	1,476	0,413	0,019	0,280	0,712	2,188	2,464
69	0,886	1,650	2,535	0,368			0,368	2,903	3,336
70	0,445	0,613	1,058	0,197	0,103	0,137	0,437	1,495	1,680
71	0,513	0,945	1,458	0,268	0,093	0,109	0,470	1,928	2,184
72	0,536	0,298	0,834	0,349	0,008	0,439	0,797	1,630	1,801
73	0,382	0,262	0,644	0,144	0,089	0,238	0,471	1,115	1,230
74	0,257	0,279	0,536	0,206	0,041	0,635	0,882	1,417	1,525
75	0,234	0,352	0,586	0,061	0,092	0,205	0,358	0,944	1,041
76	0,458	0,256	0,714	0,153	0,008	0,109	0,270	0,984	1,111
77	0,263	0,199	0,462	0,122	0,588	0,306	1,016	1,478	1,564
78	0,703	0,538	1,242	0,188	0,003	1,667	1,858	3,099	3,310
79	0,512	0,322	0,834	0,038	0,011	0,339	0,388	1,222	1,352
80	0,206	0,295	0,501	0,172		0,068	0,240	0,742	0,840
81	0,483	0,093	0,576	0,149	0,386	0,314	0,850	1,426	1,531
82	0,197	0,127	0,324	0,182	0,065	1,941	2,188	2,512	2,585
83	0,253	0,038	0,291	0,126	0,003	2,009	2,138	2,429	2,488
84	0,154	0,058	0,213	0,137	0,006	0,403	0,546	0,759	0,809
85	0,252	0,098	0,350	0,132	0,063	0,170	0,365	0,715	0,784
86	0,416	0,069	0,484	0,141	0,728	0,559	1,428	1,912	2,002
87	0,080	0,013	0,093	0,140			0,140	0,233	0,265
88	0,203	0,067	0,270	0,119	0,036		0,155	0,425	0,481
89	0,221	0,005	0,226	0,058		0,068	0,126	0,352	0,393
90		0,015	0,015	0,074		0,137	0,211	0,226	0,238
91	0,106	0,038	0,144	0,078		0,137	0,215	0,360	0,391
92	0,082	0,005	0,087	0,084			0,084	0,171	0,196
93	0,100		0,100	0,028	0,032		0,060	0,160	0,179
94				0,068		0,068	0,136	0,136	0,146
95				0,090		0,246	0,336	0,336	0,348
96		0,014	0,014	0,058				0,014	0,024
97	0,056								
98						0,266	0,266	0,266	0,266
99	0,023			0,013			0,013	0,013	0,018
100+	0,026	0,036		0,081		0,266	0,347	0,347	0,367
TOTAL	48	32	80	75	21	32	128	208	230
Landings (t)	137	117	255	109	43	135	288	542	595
Mean Weight (g)	2841	3702	3182	1459	2056	4223	2251	2610	2591
Mean Length (cm)	54,9	59,7	56,7	39,8	46,3	59,5	45,8	50,0	49,9
Measured weight (t)	n/a	n/a	n/a	n/a	1171,3	738,8	1910,1	n/a	n/a

n/a: not available

Table 4.4.4. Black-bellied anglerfish (*L. budegassa*) - Divisions 8c and 9a. Number, mean weight and mean length of landings between 1986 and 2019.

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
2014	442	2011	43
2015	406	2195	49
2016	340	2602	52
2017	297	2672	50
2018	285	2636	51
2019	278	2141	50

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

	SpGFS-WIBTS-Q4					PtGFS-WIBTS-Q4			SPGFS-caut-WIBTS-Q4				
	Total area: Miño-Bidasoa								Gulf of Cádiz				
Year	Hauls	kg/30 min		n/30 min		Hauls	n/h	kg/h	Hauls	g/h	se (biom.)	n/h	se (abund.)
		Yst	Sst	Yst	Sst								
1983	145	0.68	0.17	0.50	0.09	117	n/a	n/a					
1984	111	0.60	0.17	0.60	0.11	na	n/a	n/a					
1985	97	0.46	0.11	0.50	0.07	150	n/a	n/a					
1986	92	1.42	0.32	2.50	0.33	117	n/a	n/a					
1987	ns	ns	ns	ns	ns	81	n/a	n/a					
1988	101	2.27	0.38	1.50	0.21	98	n/a	n/a					
1989	91	0.45	0.10	0.90	0.21	138	0.23	0.19					
1990	120	1.52	0.47	1.50	0.22	123	0.11	0.17					
1991	107	0.83	0.14	0.60	0.10	99	+	0.02					
1992	116	1.16	0.19	0.80	0.11	59	+	+					
1993	109	0.90	0.20	0.90	0.13	65	0.02	0.04	29.00	215	20.95	0.22	0.02
1994	118	0.75	0.17	1.00	0.12	94	0.06	0.09	ns	ns	ns	ns	ns
1995	116	0.72	0.12	1.00	0.11	88	0.02	0.08	ns	ns	ns	ns	ns
1996*	114	0.95	0.17	1.30	0.18	71	0.27	0.50	ns	ns	ns	ns	ns
1997	116	1.16	0.20	0.97	0.11	58	0.03	0.01	27	267	28.94	0.24	0.02
1998	114	0.88	0.18	0.57	0.09	96	0.02	0.12	34	139	10.18	0.17	0.01
1999*	116	0.43	0.12	0.26	0.06	79	0.08	0.07	38	89	8.21	0.27	0.02
2000	113	0.66	0.18	0.40	0.08	78	0.13	0.13	30	514	29.84	0.92	0.04
2001	113	0.19	0.06	0.52	0.10	58	+	+	39	298	24.36	0.41	0.04
2002	110	0.26	0.09	0.33	0.07	67	0	0	39	224	22.58	0.33	0.02
2003*	112	0.36	0.11	0.35	0.10	80	0.22	0.21	41	370	30.2	0.3	0.02
2004*	114	0.76	0.23	0.44	0.12	79	0.14	0.21	40	509	37.94	0.26	0.02
2005	116	0.64	0.20	1.62	0.30	87	0.01	+	42	990	43.43	2.6	0.08
2006	115	1.08	0.22	1.16	0.19	88	0.02	0.46	41	465	37.91	0.22	0.01
2007	117	0.59	0.12	0.48	0.08	96	0.02	0.03	37	703	54.25	0.4	0.03
2008	115	0.35	0.09	0.29	0.05	87	0.07	0.36	41	449	25.49	0.24	0.01
2009	117	0.30	0.08	0.35	0.08	93	0.02	+	43	561	35.11	0.43	0.02
2010	127	0.35	0.09	0.53	0.09	87	0.09	0.18	44	726	60.01	0.73	0.04
2011	111	0.63	0.15	0.52	0.08	86	0.02	0.06	40	806	43.58	0.57	0.03
2012	115	0.61	0.10	0.74	0.11	ns	ns	ns	37	723	53.73	0.77	0.03
2013**	114	1.27	0.36	1.40	0.35	93	0.02	0.03	43	1572	69.91	1.29	0.07
2014**	116	1.11	0.27	0.87	0.15	81	0.00	0.00	45	531	28.31	0.38	0.02
2015**	114	0.55	0.13	0.36	0.08	90	0.00	0.00	43	2058	96.93	1.45	0.05
2016**	114	0.51	0.10	0.40	0.06	85	0.02	0.30	45	1196	51.7	1.16	0.05
2017**	112	0.55	0.15	0.35	0.08	89	0.09	0.05	44	1085	49.24	0.76	0.03
2018**	113	0.76	0.23	0.29	0.07	53	0.08	0.10	45	1645	82.01	1.85	0.05
2019**	113	0.43	0.17	0.17	0.04	ns	ns	ns	43	1302	51.25	0.71	0.02

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

Table 4.4.6. Black-bellied 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 gill-net fleets (STAND-SP-CEDGNS8C). For landings, the percentage relative to the total annual stock landings is given.

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

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

	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	3	5	--	5,41	--	25	3	6	--	3,90	--
2019	22	3	6		3,74		21	3	5		3,78	

Table 4.4.7. Black-bellied 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
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	773		5.41	3.90
2019	669		3.74	3.78

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

Model parameter estimates w 95% CI				
	estimate	**cilow**	**ciupp**	**log.est**
alpha1	1.623	0.982	2.680	0.484
alpha2	1.356	0.787	2.336	0.304
alpha3	1.494	0.943	2.367	0.402
beta	0.137	0.023	0.814	-1.991
r	0.479	0.218	1.048	-0.737
rc	0.479	0.218	1.048	-0.737
rold	0.479	0.218	1.048	-0.737
m	2072	1495	2871	7.636
K	17319	7372	40685	9.760
q1	0.000	0.000	0.000	-8.667
q2	0.000	0.000	0.001	-8.001
q3	0.001	0.000	0.002	-7.002
sdb	0.204	0.148	0.280	-1.592
sdf	0.146	0.101	0.211	-1.926
sdi1	0.330	0.220	0.496	-1.108
sdi2	0.276	0.185	0.412	-1.288
sdi3	0.304	0.224	0.414	-1.190
sdc	0.020	0.003	0.115	-3.917

Deterministic reference points (Drp)				
	estimate	**cilow**	**ciupp**	**log.est**
B_{MSYD}	8660	3686	20343	9.066
F_{MSYD}	0.239	0.109	0.524	-1.430
MSYd	2072	1495	2871	7.636

Stochastic reference points (Srp)					
	estimate	**cilow**	**ciupp**	**log.est**	**rel.diff.Drp**
B_{MSYS}	8176	3544	18864	9.009	-0.059
F_{MSYS}	0.229	0.102	0.514	-1.474	-0.044
MSYs	1868	1353	2579	7.533	-0.109

States w 95% CI (inp$msytype: s)				
	estimate	**cilow**	**ciupp**	**log.est**
B_2018.00	14146	5441	36776	9.557
F_2018.00	0.050	0.019	0.129	-2.994
B_2018.00/B_{MSY}	1.730	1.140	2.625	0.548
F_2018.00/F_{MSY}	0.219	0.127	0.377	-1.521

Predictions w 95% CI (inp$msytype: s)				
	prediction	**cilow**	**ciupp**	**log.est**
B_2019.00	13614	5254	35276	9.519
F_2019.00	0.048	0.018	0.126	-3.033
B_2019.00/B_{MSY}	1.665	1.078	2.572	0.510
F_2019.00/F_{MSY}	0.210	0.119	0.373	-1.559
Catch_2019.00	665	464	953	6.500
E(B_inf)	13932			9.542

Table 4.4.9. Black-bellied 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} Estimate	CI high	CI Low	F/F_{MSY} Estimate	CI high	CI Low
1980	1.41	2.93	0.68	0.79	1.65	0.38
1981	1.44	2.72	0.77	0.82	1.62	0.41
1982	1.47	2.62	0.83	0.85	1.61	0.44
1983	1.52	2.66	0.87	0.87	1.64	0.46
1984	1.33	2.30	0.77	0.87	1.62	0.47
1985	1.08	1.83	0.64	0.85	1.57	0.46
1986	1.22	2.04	0.73	0.91	1.64	0.50
1987	1.66	2.80	0.98	1.08	1.97	0.59
1988	1.70	2.94	0.98	1.29	2.44	0.69
1989	1.21	2.08	0.70	1.29	2.44	0.68
1990	1.05	1.83	0.61	1.23	2.34	0.65
1991	0.95	1.65	0.55	1.25	2.39	0.66
1992	0.88	1.52	0.51	1.31	2.47	0.69
1993	0.79	1.36	0.46	1.50	2.84	0.80
1994	0.63	1.06	0.37	1.49	2.78	0.79
1995	0.64	1.07	0.38	1.38	2.54	0.75
1996	0.74	1.24	0.44	1.28	2.37	0.69
1997	0.79	1.31	0.47	1.10	2.02	0.59
1998	1.08	1.84	0.63	1.01	1.90	0.54
1999	1.21	2.11	0.70	0.93	1.78	0.48
2000	1.06	1.87	0.60	0.83	1.62	0.43
2001	0.80	1.41	0.45	0.78	1.51	0.40
2002	0.62	1.08	0.36	0.73	1.41	0.38
2003	0.62	1.08	0.36	0.74	1.41	0.39
2004	0.66	1.13	0.38	0.81	1.55	0.43
2005	0.59	1.01	0.35	0.80	1.53	0.42
2006	0.71	1.22	0.42	0.74	1.41	0.39
2007	1.04	1.80	0.59	0.69	1.33	0.36
2008	1.06	1.83	0.62	0.58	1.11	0.30
2009	0.91	1.53	0.54	0.47	0.88	0.25
2010	1.00	1.63	0.61	0.40	0.73	0.22
2011	1.20	1.96	0.74	0.37	0.68	0.21
2012	1.49	2.42	0.92	0.39	0.70	0.21
2013	1.61	2.56	1.01	0.37	0.66	0.21
2014	1.66	2.58	1.07	0.33	0.57	0.19
2015	1.84	2.83	1.20	0.30	0.52	0.17
2016	2.06	3.16	1.34	0.28	0.49	0.16
2017	1.86	2.83	1.23	0.26	0.45	0.15
2018	1.88	2.84	1.24	0.24	0.41	0.14
2019	1.73	2.63	1.14	0.22	0.38	0.13
2020	1.67	2.57	1.08			
Average	1.19	2	0.71	0.81	1.52	0.43

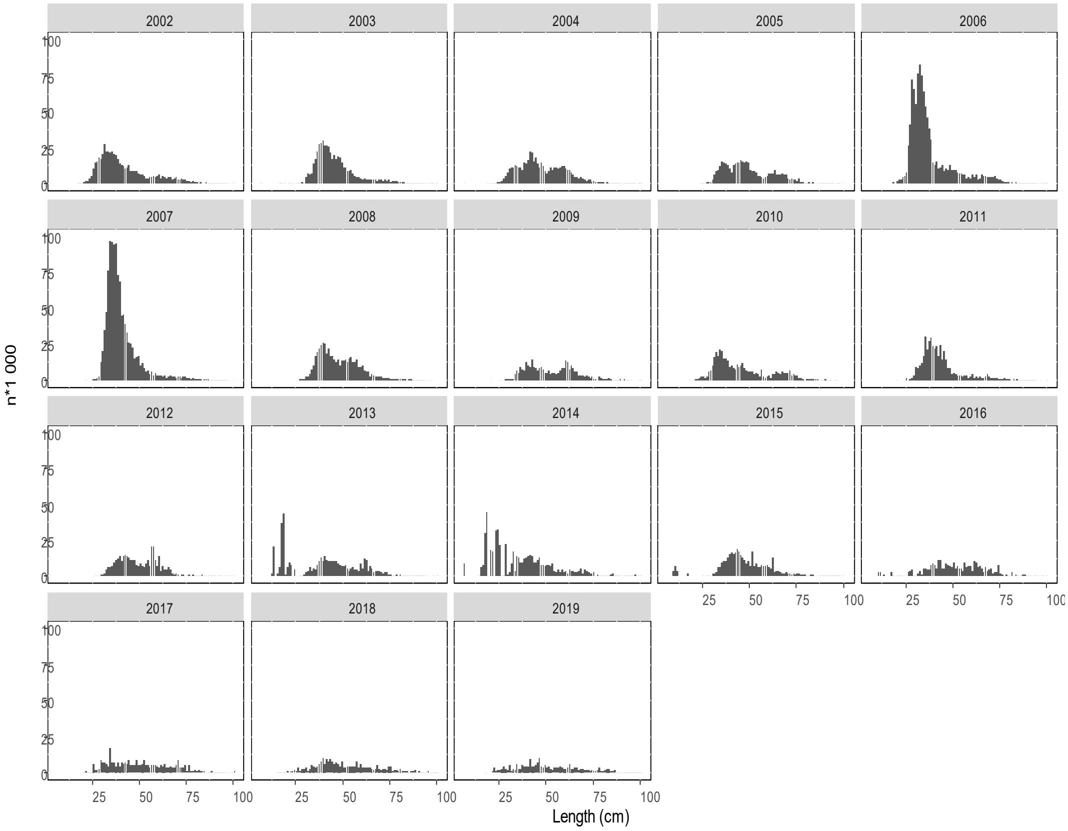


Figure 4.4.1. Black-bellied anglerfish (*L. budegassa*) - Divisions 8c and 9a. Length distributions of landings (thousands for 2002–2019).

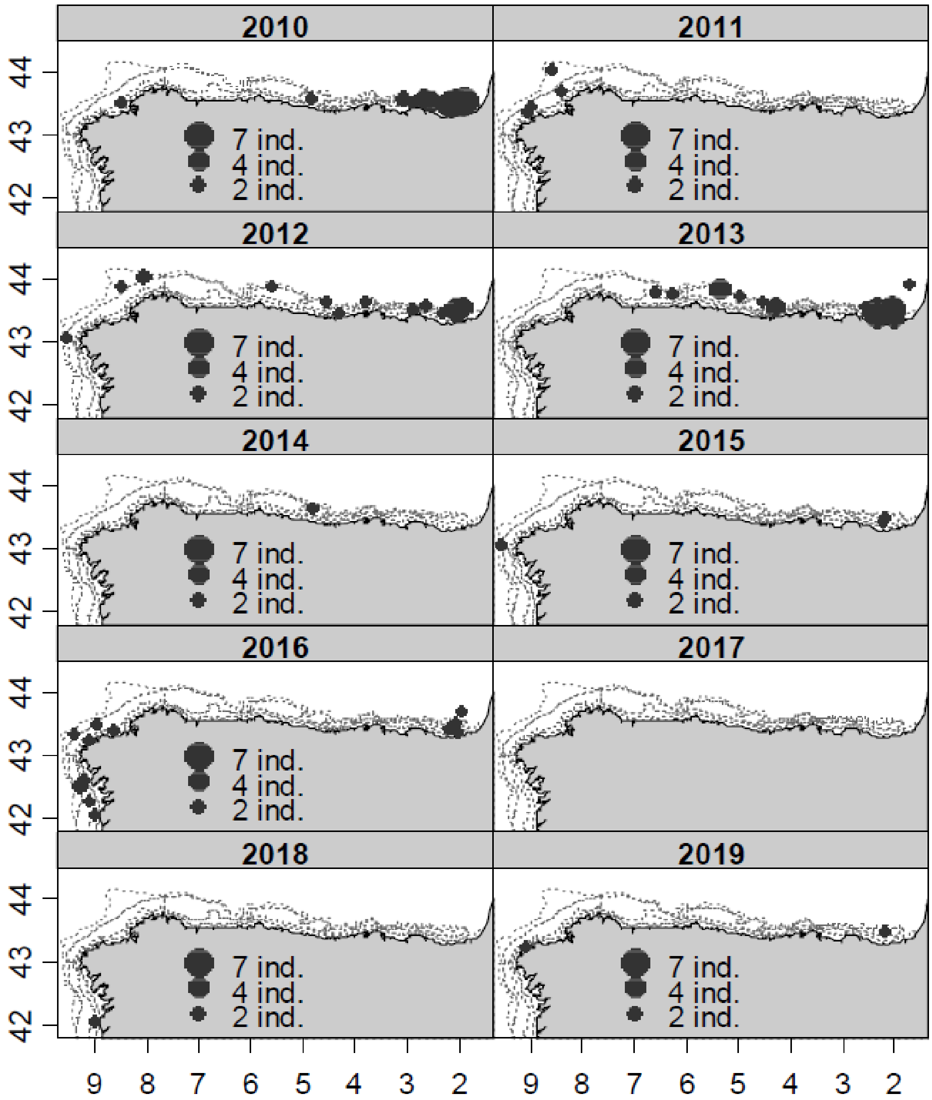


Figure 4.4.2. Black-bellied anglerfish (*L. budegassa*) - Divisions 8c and 9a. Distribution of black anglerfish (*L. budegassa*) juveniles (0–20 cm) in SpGFS-WIBTS-Q4 between 2009–2019.

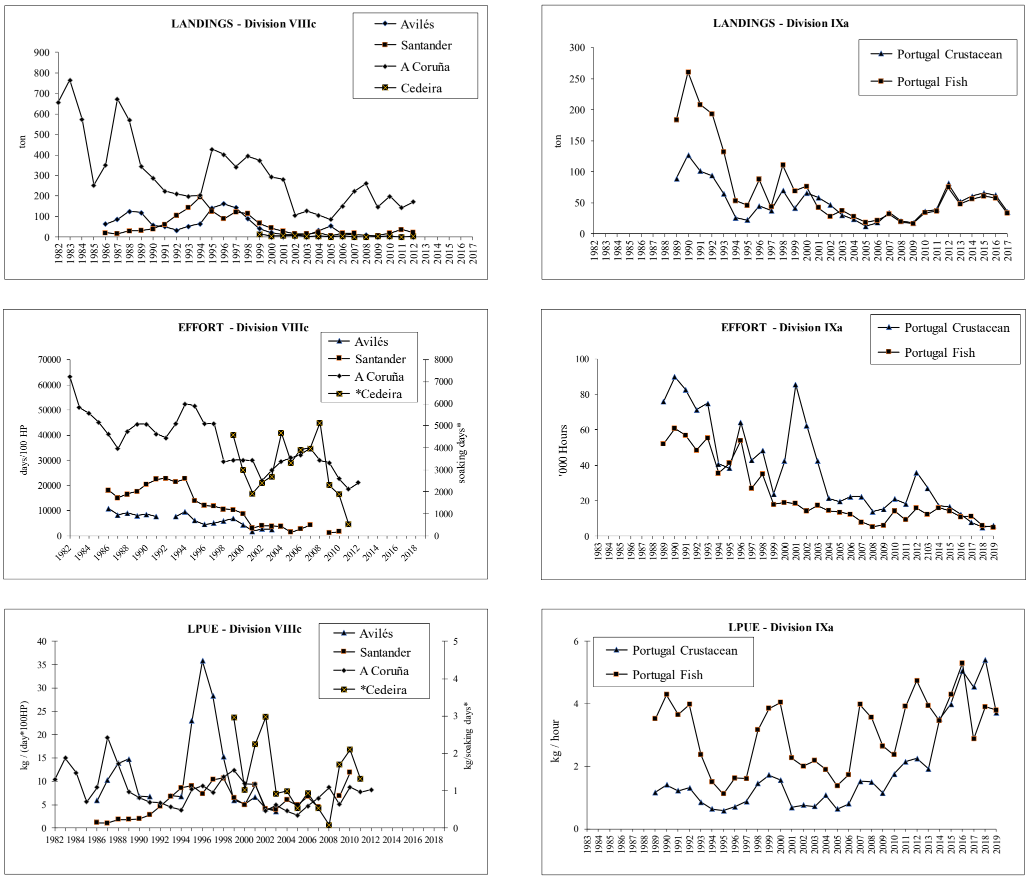


Figure 4.4.3. Black-bellied anglerfish (*L. budegassa*) - Divisions 8c and 9a. Trawl and gillnet landings, effort and LPUE data between 1986 and 2019.

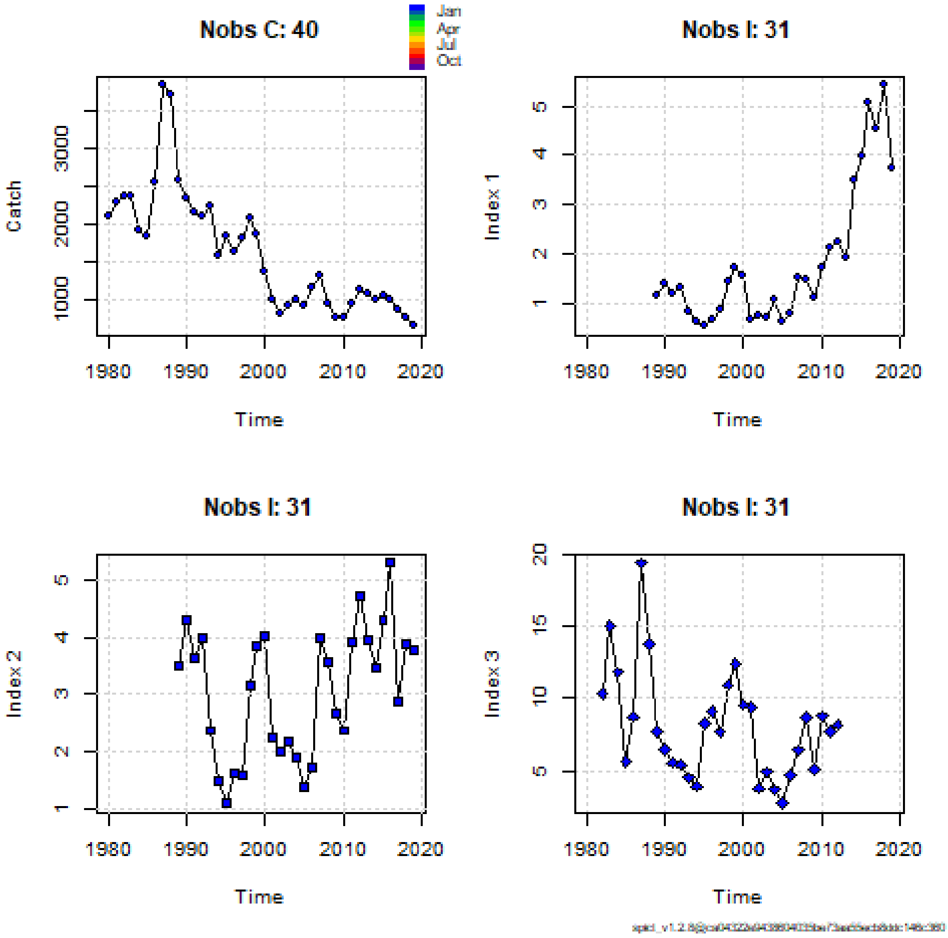


Figure 4.4.4. Black-bellied anglerfish (*L. budegassa*) - Divisions 8c and 9a. SPiCT input data. Upper panel, Catch and PT-TRC9a LPUE index (Portuguese trawl fleet targeting crustaceans, 1989 - 2019). Lower panel, PT-TRF9a LPUE index (Portuguese trawl fleet targeting fish, 1989 - 2019) and SP-CORTR8C-FLEET LPUE index (A Coruña trawl fleet, 1982 - 2012).

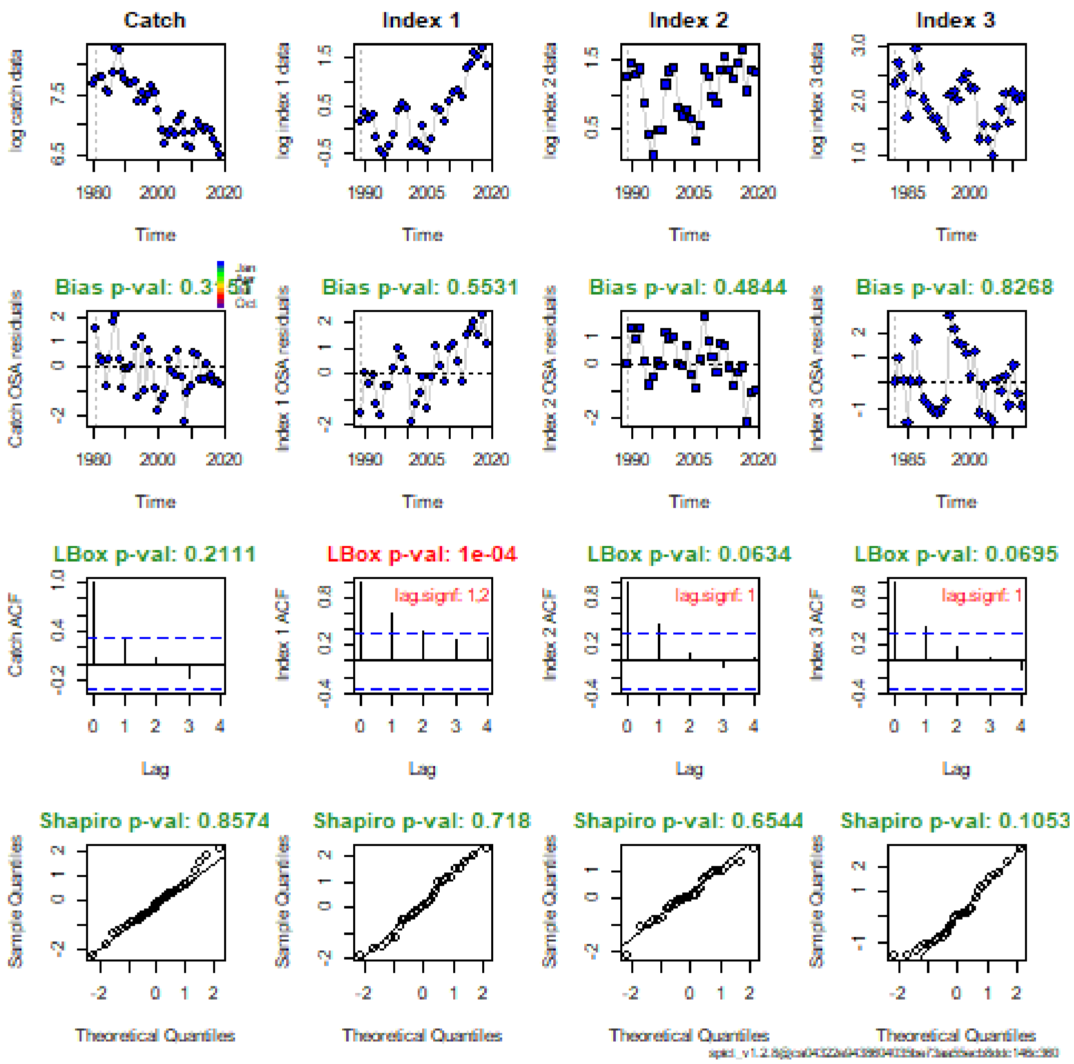


Figure 4.4.5. Black-bellied anglerfish (*L. budegassa*) - Divisions 8c and 9a. SPiCT diagnostics. Row1, Log of the input data series. Row 2, OSA residuals with the p-value of a test for bias. Row 3, Empirical autocorrelation of the residuals with tests for significant autocorrelation. Row 4, Tests for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

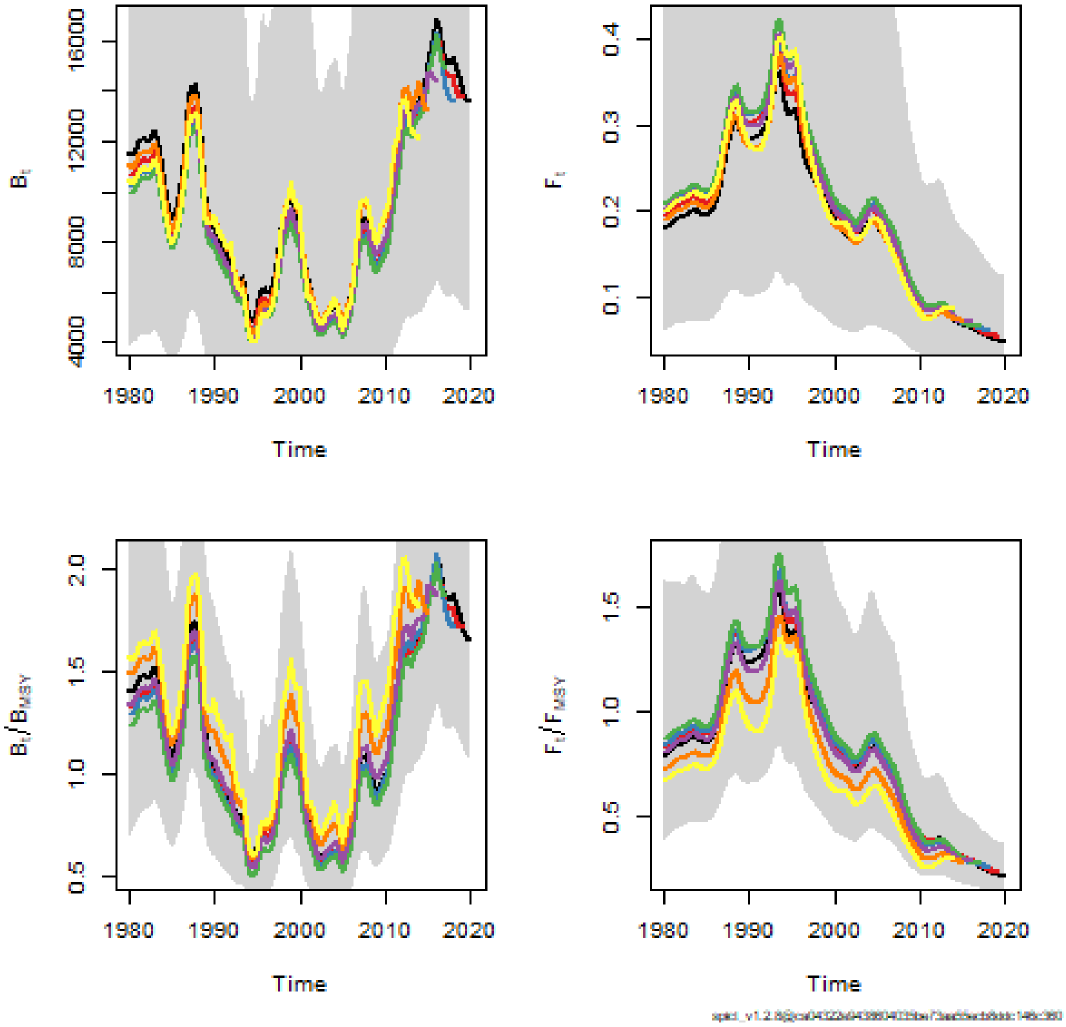


Figure 4.4.6. Black-bellied anglerfish (*L. budegassa*) - Divisions 8c and 9a. 6 years' retrospective analysis. Upper panel, absolute biomass and fishing mortality. Lower panel, relative biomass and fishing mortality. Grey regions represent 95% CIs.

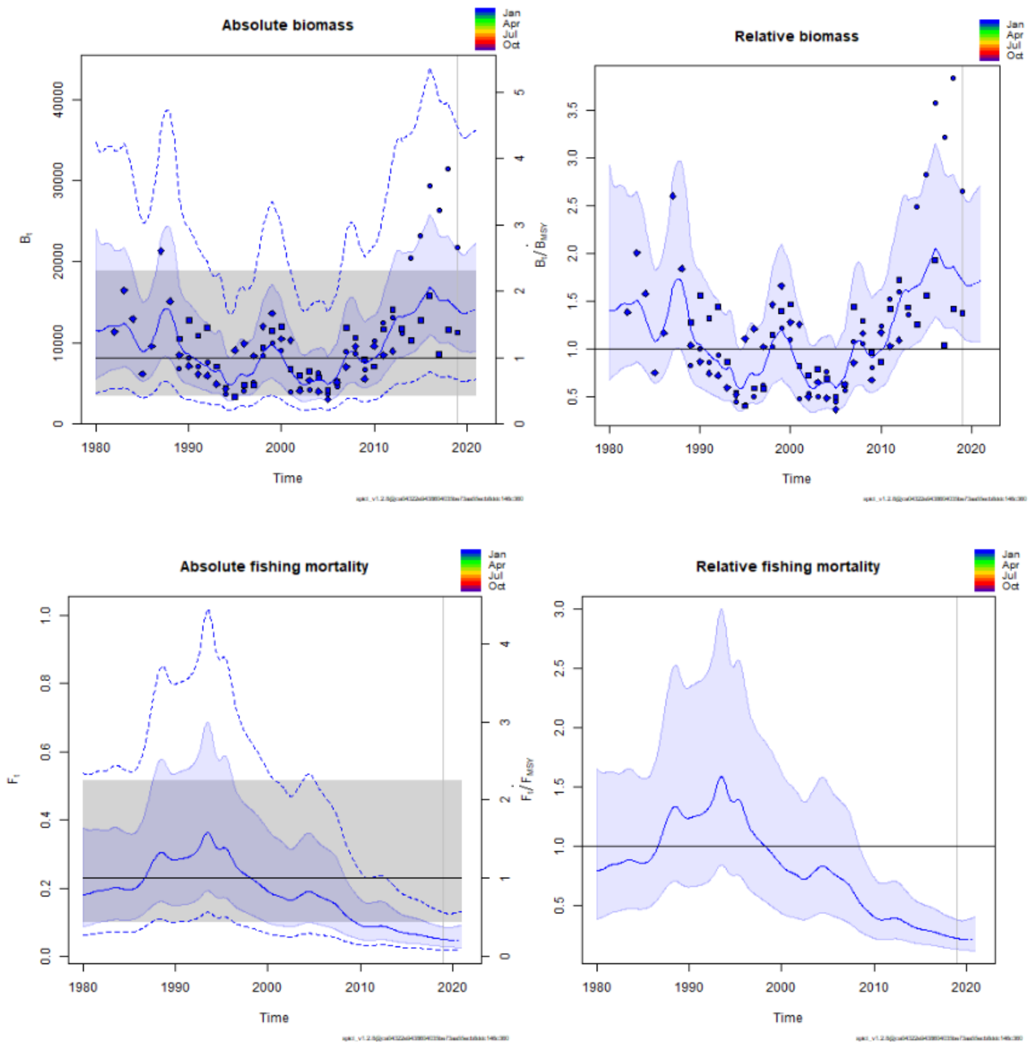


Figure 4.4.7. Black-bellied anglerfish (*L. budegassa*) - Divisions 8c and 9a. SPiCT results: Upper panels, absolute and relative biomass. Lower panels, absolute and relative fishing mortality. Solid blue lines are estimated values; vertical grey lines indicate the time of the last observation beyond 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 considered as category 1.

Data revisions: data revision was done in the Inter-Benchmark (IBPMegrim; ICES, 2016a) 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 2019, the four countries together have reported around 95% of the total landings (Table 5.1.1.1.). Estimates of total landings (including unreported or misreported landings) and catches (landings and discards) as used by the Working Group (WG) up to 2019 are shown in Table 5.1.1.2.

5.1.3 Summary of ICES advice for 2020 and management for 2019 and 2020

ICES advice for 2020 (as extracted from ICES Advice 2019):

The two megrim species are not separated in the landings and are managed by a single TAC. 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.

ICES advises that when the EU multiannual plan (MAP; European Parliament and Council Regulation (EU) No. 2019/472) for Western waters and adjacent waters is applied, catches in 2020 that correspond to the F ranges in the MAP are between 13 218 and 28 838 t. According to the MAP, catches higher than those corresponding to F_{MSY} (19 982 t) can only be taken under conditions specified in the MAP, while the entire range is considered precautionary when applying the ICES advice rule.

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

If a single TAC continues to be set for both megrim species, then the combined megrim landings in 2020 should be no more than 19 982 t.

Management applicable for 2019 and 2020:

The agreed TAC for the combined species was set at 19 836 t for 2019 and 20 526 t for 2020.

The minimum landing size for 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 1984-2019, as estimated by the WG, are given in Table 5.1.1.1. This is the fourth year where all landing and discard data that have been uploaded to InterCatch were used to make data allocations.

Landings in 2019 (12 164 t) are slightly lower than in 2018 (<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.

Spanish data showed a decreasing trend from 2009 onwards. During the Inter-Benchmark held in 2016 (IBPMegrim; ICES, 2016a), France landing data series were updated from 2003–2014. Landing data from France showed initially an increasing trend from 2015 onwards then decreased in the last two years. In 2019, landings from Ireland and Belgium increased while those from the UK slightly decreased.

French discard data from 2004–2014 were provided for the IBPMegrim in 2016 (ICES, 2016a), and have been updated in 2017. Increase in discards was only observed in Belgium while significant decreases were declared by France, Spain, Ireland and UK.

Discard data available by country and the procedure to derive them are summarized in Table 5.1.2.1.1. 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 2019.

Table 5.2.1.1. presents the discard ratio in percentage (%) from catches in weight of the most recent years.

Table 5.2.1.1. Discard ratio in percentage (%) from catches in weight of the years 2008-2019.

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
% Discard	21%	18%	26%	24%	20%	24%	16%	12%	17%	14%	13%	8%

5.2.2.2 Biological sampling

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

Age

France, Ireland, UK and Belgium provided numbers-at-age in InterCatch and consequently completed number and weights at age up to 2019. Age distribution for landings and discards from 2011–2019 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 2019.

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) indices for the period 1997–2019 are summarized in Table 5.1.2.3.1. Due to vessel technical problems, no French EVHOE survey was carried out in 2017, but recommenced in 2018 and 2019.

The UK-WCGFS-D and UK-WCGFS-S show the same pattern of 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 age groups and in 2004 for the younger ages (1-2).

Oscillations of high and low values of scaled biomass indices for the three surveys (FR-EVHOE, SP-PGFS and IR-IGFS) can be observed in the time series (Figure 5.1.2.3.1).

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 an increasing but fluctuating trend until 2014 then declined from 2015-2018. A slight increase is observed in 2019. In the case of the Irish Groundfish Survey (IGFS-WIBTS-Q4), the highest biomass index was estimated in 2005. In 2011, a slight increase occurred following a sharp decline of the index in 2010 compared to 2009, a trend similarly observed in the Spanish survey in the same year. Biomass index trends from this survey declined since 2009 but remains stable with some fluctuations in recent years.

Figure 5.1.2.3.2 shows the abundance indices by age group for the three surveys. The abundance index by age group for Irish Groundfish Survey (IGFS-WIBTS-Q4) from 2003-2019 shows a declining trend during the last five years in the data series for both middle (3-5) and older (6-9) ages. For the latter, the survey shows the lowest values observed for the time series. For the younger ages (1-2), an increasing trend is observed during the last 5 years.

A revised abundance index in ages was provided for the Spanish Porcupine Groundfish Survey (SpPGFS-WIBTS-Q4) from 2001 to 2019 due to a change in the calculation methodology of the tow trawling time. In Figure 5.1.2.3.3, the time series of *L. whiffiagonis* abundance by age composition of the SP-PORCUPINE survey from 2010–2019 is presented.

The abundance index per age group for the French EVHOE Survey (EVHOE-WIBTS-Q4) from 1997-2019, with the absence of 2017 value, is shown in Figure 5.1.2.3.2. In the case of this survey, abundance indices for all age groups seem to show increasing trends in the last 5 years. In Figure 5.1.2.3.4, the time series of abundance per age composition of the FR-EVHOE survey from 2011 to 2019 is presented. Except in 2012, when the abundance of *L. whiffiagonis* was low in all age groups, middle ages (3-5) show the highest abundant in most years of the time series.

For a more detailed inspection of the abundance indices of different age groups, the whole data series for surveys were considered in the analysis (Figure 5.1.2.3.2). Age groups were categorized 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 is age group ii) from the beginning until the end of the data series for all the surveys. However, it shows a decreasing trend in the last three years. Age group i) appears most abundant during the years 2005 to 2008 in all three surveys. As a consequence, it is still difficult to provide a conclusion based 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

During the WKFLAT Benchmark (ICES, 2012), 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 mesh sizes of 80-89mm, larger mesh sizes are not used since 2006.

The evolution of the different bottom-trawler fleets effort is described in Figure 5.1.2.4.1. Efforts of SP-CORUTR7 and SP-VIGOTR7 fleets have decreased sharply until 1993 and continues to progressively decline until 2019. SP-VIGOTR7 showed a very slight increase in 2007 then gradually declined again until 2014. SP-CANTAB7 remains quite stable since 1991 and decreased slightly since 2000. In 2009, no effort has been deployed by this fleet. Although 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 after which no more information was provided to the WG.

Commercial series of catch-at-age and effort data were available for the three Spanish fleets in Subarea 7 (Figure 5.1.2.4.2): A Coruña (SP-CORUTR7) in the period 1984–2019, Cantábrico (SP-CANTAB7) from 1984 to 2011 as no effort has been deployed onwards by this fleet in subarea 7 and Vigo (SP-VIGOTR7) in 1984–2019. The CPUE of SP-CORUTR7 has fluctuated until 1990 when it started to decrease, with a slight increase in 2003, a peak in 2011 and a decrease afterwards. Over the same period, SP-VIGOTR7 has remained relatively stable until 1999, reaching in 2004 and 2014, the highest CPUE values of the time series. In recent years the CPUE has fluctuated but with a decreasing trend.

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 and Figure 5.1.2.4.3). No data from 2009 onwards was received for these fleets.

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

An analysis of the abundance indices of different age groups in the data series for commercial fleets was carried out (Figure 5.1.2.4.5). Age groups were categorized 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 data series. Age group i) appears more abundant than group iii) from 2003 onwards in the Spanish fleets. French fleets appear to land mostly old individuals at the beginning of the data series but a marked decrease in abundance index for this age group was observed.

5.2.3 Assessment

An analytical assessment was conducted using updated landings and discards data for 2019. With the inclusion of French discard data in 2016, some changes to the model were executed in relation to the discard estimation coefficient and the data input for the Bayesian model (ICES. 2016a).

5.2.3.1 Data Exploratory Analysis

In summary, the stock catch-at-age matrix shows three periods: 1984–1989; 1990–1998 and 1999–2019.

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 for 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 1999–2019 (VIGO99), and Irish Otter trawlers LPUE (IRTBB), based on their representativeness of the megrim stock abundance. Several exploratory data analyses were performed to examine their ability to track cohorts through time.

These analyses were carried out with the R software (R Core Team, 20xx). The analysis of the standardized log abundance indices for the updated data revealed an increase in ages 1-5 in the EVHOE-WIBTSQ4 survey (Figure 5.2.3.1.1). Otherwise, a slight increase in ages 4-8 was observed in SpPGFS-WIBTS-Q4. Thus, Figure 5.2.3.1.1. shows little or no cohort tracking in the surveys. Presumably this is a consequence of a 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 with an increase in the index of group iii) individuals detected in 2019. IRTBB shows a slight increase of ages 1–2 (group i).

The time series of catch-at-age (Figure 5.2.3.1.2) 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 (especially age 1) in previous years and probably, due to the sparseness of discard data in that period. For ages 6 and older, large discrepancies in the amount of individuals 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 since 1990 is presented in Figure 5.2.3.1.3. Landings of ages 1 and 2 have increased from the beginning of the time series. In fact, the proportion of older ages in the landings decreased significantly from 2004 to 2009, as already discussed in relation to the catch. From year 2017, ages 1 increased significantly mainly due to the French landings.

The signal coming from the discard data showed that, at the beginning of the data series, discards of age 1 were low (Figure 5.2.3.1.4-5). Discards of this age increased along the dataseries, particularly from 2003 onwards. From 2010 to 2013, ages 1 to 3 appear to be highly discarded and in the last five years (2015-2019) general discards decrease.

5.2.3.2 Model

The model explored during the WKFLAT benchmark (ICES, 2012) is an adaptation of the one originally developed 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 allowing for missing discards data in certain fleets and/or in some years. These are all relevant features for the megrim stock.

The model is described in Stock Annex.

5.2.3.3 Results

The model results were analysed by 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 the French discards during the IBP Megrim in 2016 (ICES, 2016a), which are input data instead of being estimated by the model. Settings used in WGBIE 2020 are listed in Table 5.2.3.3.1.

In order to ensure 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 and autocorrelation plots for most parameters in the model (Figure 5.2.3.3.1 to Figure 5.2.3.3.3) showing a good behaviour.

Model diagnostic plots examined were: prior-posterior plots and time series and bubble plots of the residuals. Prior-posterior distributions are shown in Figure 5.2.3.3.4. 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 indicates 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 sufficient information concerning these parameters and that the priors have to be chosen carefully to be realistic.

Results of the estimated spawning-stock biomass (SSB), reference fishing mortality (F_{bar}), recruits and catch, landings and discards time series are shown in Figure 5.2.3.3.5. The SSB shows an overall decreasing trend from the start of the series in 1984–2005 followed by a marked increasing trend until 2019. The uncertainty in the SSB was low in the whole time series. The median recruitment fluctuated between 200 000 and 300 000 thousand in the whole series, with a decreasing trend in the last years. The fishing mortality showed three marked periods which coincide with the data periods, 1984–1989, 1990–1998 and 1999–2019. The lowest F_{bar} was observed during the first period while the highest value in 2005. This was followed by a decreasing trend, reaching its lowest value in 2019 with a 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 a slight decreasing trend reaching its minimum value in 2015 with the landings showing similar trend. In the last year, a decreasing trend in landings and discards can be observed.

5.2.3.4 Retrospective pattern

Retrospective analysis was conducted for 5 years, the retrospective time series of most relevant indicators are shown in Figure 5.2.4.1. In terms of SSB, estimates were very similar throughout the entire time series and there was a downward revision of the SSB. 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 the 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 the R script developed by Fernández *et al*. (2010). Some modifications have been done to the script during the IBP Megrim in 2016 (ICES, 2016a) as the previous results of the projection were inconsistent with the stock dynamics 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 the last year recruitment data, if it is not considered credible (ICES, 2017a). As the recruitment at age 1 estimated by the model for the year 2020 was not considered credible, it was replaced by the geometric mean of all the recruitments since 1984 except for the last two years (1984-2017). The Baranov population equation (Baranov, 1918) was used to project the recruitment one year forward.

For the current projection, the following short-term forecast settings were used: 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.

Due to the absence of a clear decreasing trend of F in the results of the assessment time series and the existing significant retro in the F value when comparing the most recent years, a more precautionary approach was proposed. Therefore, F status quo was unscaled and the mean of the last three years used for the projections. For the 2020 recruitment, the geometric mean of the recruitment posteriors in all assessment years except the final 2 is used.

Landings in 2021 and SSB in 2022 predicted for various levels of fishing mortality in 2021 are given in Table 5.2.5.1. Maintaining F status quo in 2021 is expected to result in a decrease in landings with respect to 2020 and an increase in SSB in 2021 with respect to 2020.

5.2.4 Biological reference points

Biological reference points were calculated in IBPMegrim 2016 (ICES, 2016a) and reviewed by the WGBIE (ICES, 2016b). The reference points for this stock were estimated using methods based on the recommendations from the WKMSYREF4 (ICES, 2017b). They are listed in Table 5.1.6.1. and in the Stock Annex, and where F_{MSY} ranges have also been included.

5.2.5 Conclusions

The incorporation of the requested data, mainly French discards data (but also the reviewed French landings) was completed and the script to deal with these new data was 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 in 2015 (ICES, 2015).

The group considers that the model diagnosis is adequate to evaluate the quality of the 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.

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.

However, the increase of assessment years makes the JAGS software (Plummer, 2003) not to be so efficient as 10 hours were needed to run the model.

In addition, in the issue list identified in WGBIE 2019 it was stated: *"The Bayesian SCA model was ad-hoc implemented to solve the lack of discard data from France. After IBP, Megrim 2016 discard from France were provided, so the problem disappeared. Therefore, a change to a more standardized model is proposed to ease the implementation and shorten the iteration times."*

To provide an answer to this issue, intersessional work was done to implement a4a model which was presented in WD06 in WGBIE2020 (Iriondo et al., 2020 in this report). It shows promising results and a proposal to change to this model will be analysed.

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 2021 and Management applicable for 2020 and 2021

ICES advice for 2021

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 2020 & 2021

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 and 2020 data calls and France, Ireland, Spain and UK responded to this request. Spanish catches are still unavailable prior to 2017. Landings from the UK for 2018 and 2019 are close to zero and discards were not sampled.

Commercial catch of Four-spot megrim in 2019 by gear type and country.

	BMS Landings	Discards	Landings	Logbook Registered Discard	Total
France					
MIS_MIS			28		28
OTB_CRU			1		1
OTB_DEF		0	329		329
OTT_CRU		0	1		1
OTT_DEF		24	20		43
Ireland					
FPO_CRU			0		0
GNS_DEF		0	1		1
MIS_MIS			0		0
OTB_CRU		41	7		48
OTB_DEF		0	34		34
SSC_DEF		0	6		6
TBB_DEF		0	14		14
Spain					
GNS_DEF			0		0
OTB_DEF	0	40	374	0	415
OTB_MCF		0	1		1
OTB_MPD		0	2		2
PTB_DEF			0		0
UK (England)					
MIS_MIS			0		0
UK(Scotland)					
MIS_MIS			0		0
Grand Total	**0**	**106**	**819**	**0**	**926**

Commercial catch of Four-Spot megrim by year and country.

	France		Ireland		Spain				UK (England)	UK (Scotland)	
Year	Discards	Landings	Discards	Landings	BMS Landings	Discards	Landings	Logbook Registered Discard	Landings	Landings	Total
2003		0									0
2004		0									0
2005	0	62									62
2006	4	1									5
2007	3	123									126
2008		0									0
2009	1	2									2
2010	8	65									73
2011	2	39	31								71
2012	1	2	73								75
2013	3	33									36
2014	2	31									33
2015	2	131									133
2016	8	268									275
2017	5	25	288	130		273	439				1160

	France		Ireland		Spain				UK (England)	UK (Scotland)	
Year	Discards	Landings	Discards	Landings	BMS Landings	Discards	Landings	Logbook Registered Discard	Landings	Landings	Total
2018	4	16	35	64		214	833	0	0		1166
2019	24	380	41	62	0	41	378	0	0	0	926

5.3.2.2 Biological sampling

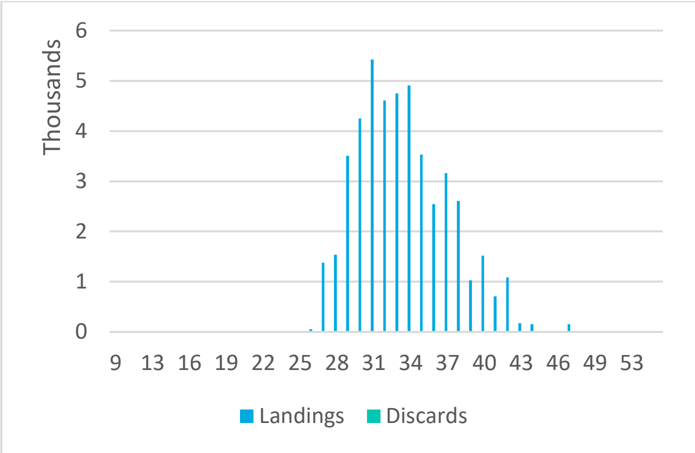
Biological sampling data for Four-Spot Megrim were included in the data call for the first time in 2018. Data on length were made available to the 2019 working group from Ireland and Spain. Historical data on length, going back to 2003, were requested in the 2019 and 2020 data calls and Ireland, France, Spain and UK have responded to this request (UK has not sampled this species).

Age

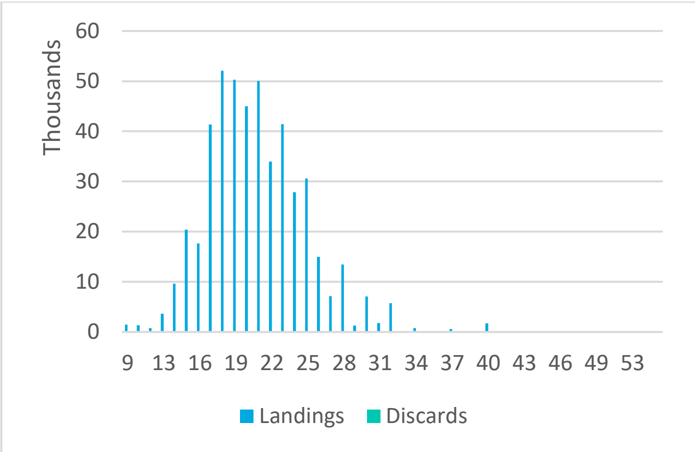
Not available.

Lengths

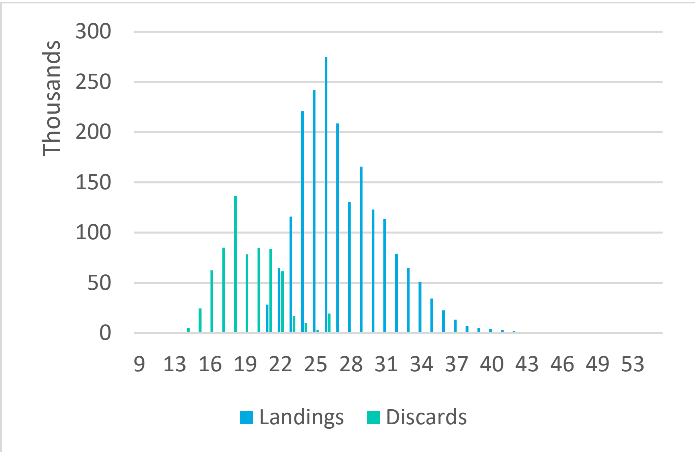
	Number of Length Samples	Number of Length Measurements
France		
2007	140	202
2014	8	124
2015	9	32
2016	14	103
2017	23	39
2019	45	393
Ireland		
2011	168	2120
2012	184	8352
2017	402	34736
2018	171	1198
2019	100	11475
Spain		
2017	424	13396
2018	427	15502
2019	323	7410
Total	2438	95082



Length frequency distribution of landings and discards from French fleets.



Length frequency distribution of landings and discards from Irish fleets.



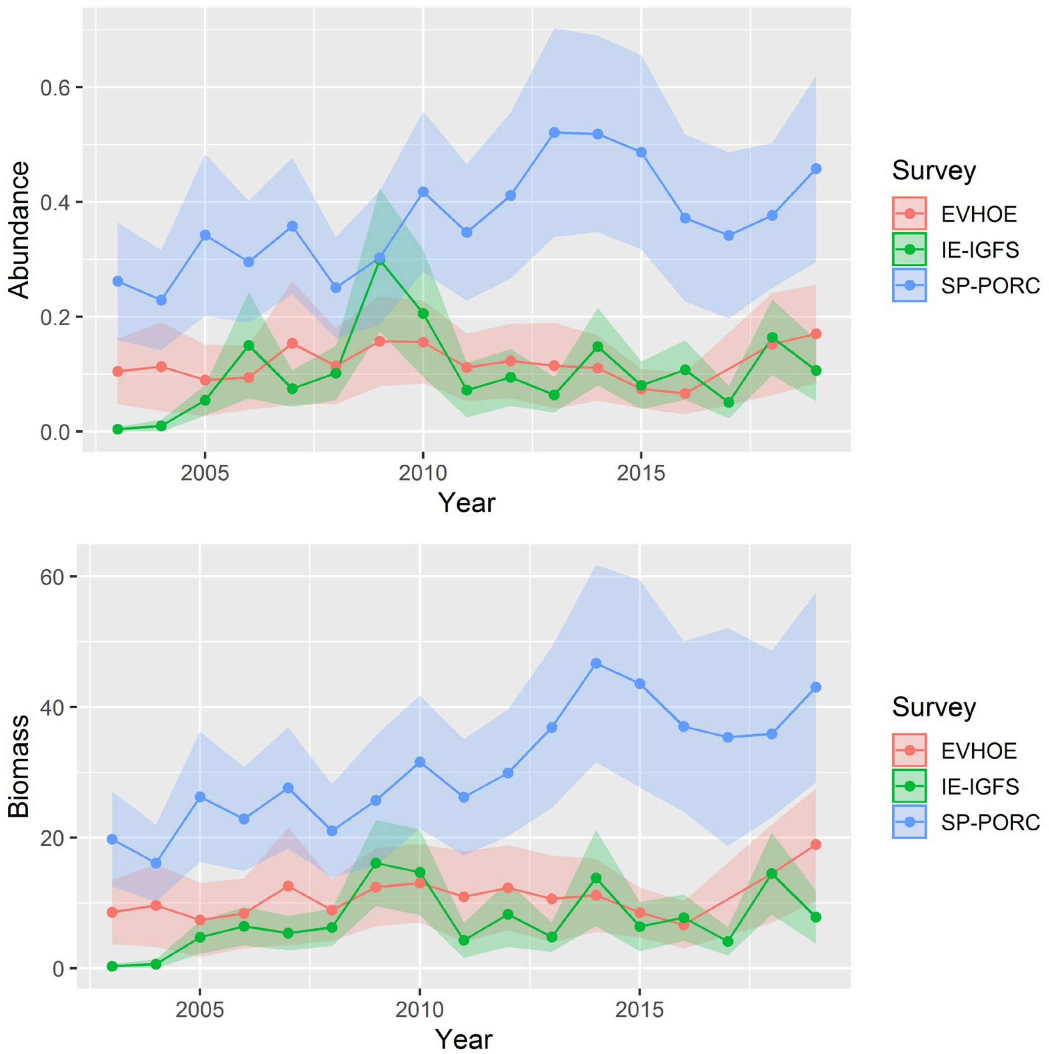
Length frequency distribution of landings and discards from Spanish fleets.

Natural Mortality

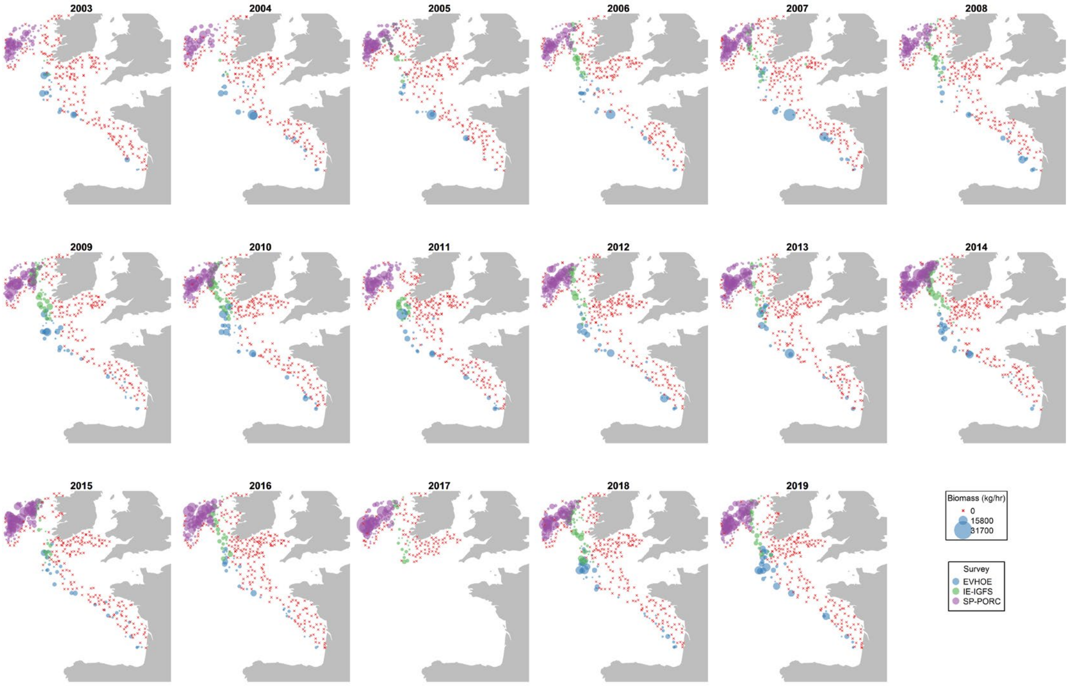
Not included in the assessment.

5.3.2.3 Survey data

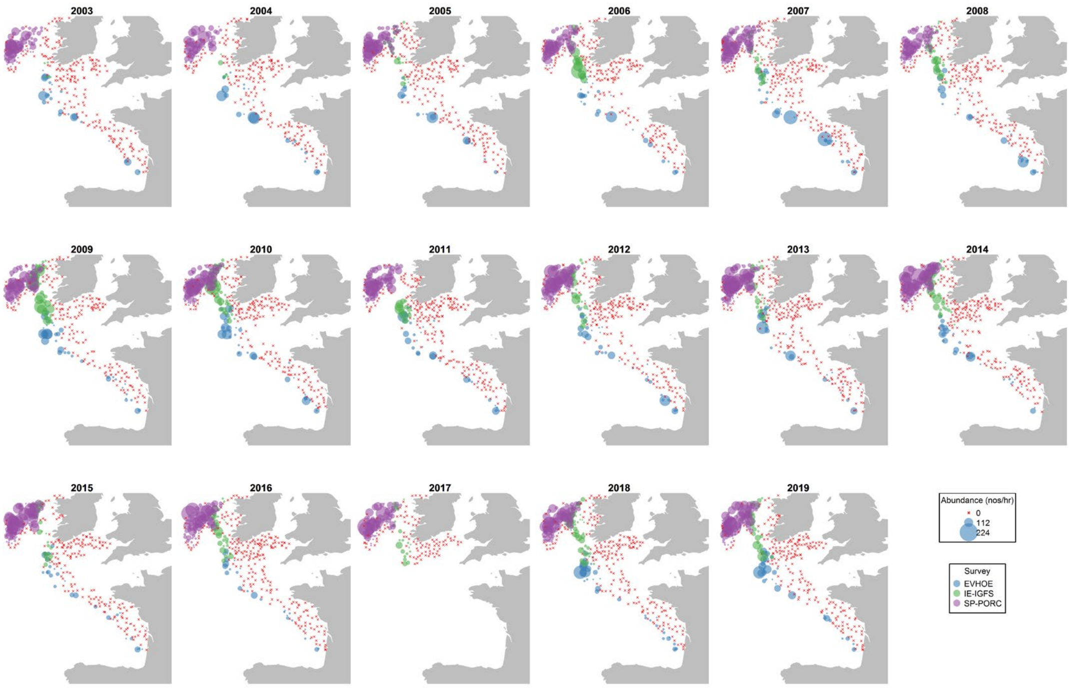
Survey data was extracted from DATRAS for Spanish Porcupine (SpPorc), Irish Groundfish Survey (IE-IGFS) and French EVHOE surveys (French survey data was not available for 2017 but recommenced in 2018). The Spanish Porcupine index was initially down weighted by an arbitrary factor of ten because the Baka 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 in catchability 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 densities distribution of Four-spot megrim from French EVHOE, Irish IGFS and Spanish Porcupine surveys.



Abundance densities distribution of Four-spot megrim from French EVHOE, Irish IGFS and Spanish Porcupine surveys.

5.3.3 Assessment

No stock assessment was carried out in 2020 although the analysis was updated with data from 2019. The proportion of *L. boscii* averaged over the period 2007-2016 (no EVHOE survey was carried out in 2017) and 2018-2019 in the EVHOE and 2007-2019 in the IGFS surveys was used to split the commercial landings of *L. boscii* and *L. 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 *L. boscii* averaged over the period 2007-2016 and 2018-2019 in the EVHOE and 2007-2019 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 *L. 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 11.4% in 2019.

5.3.3.4 Retrospective pattern

No retrospective analysis was performed.

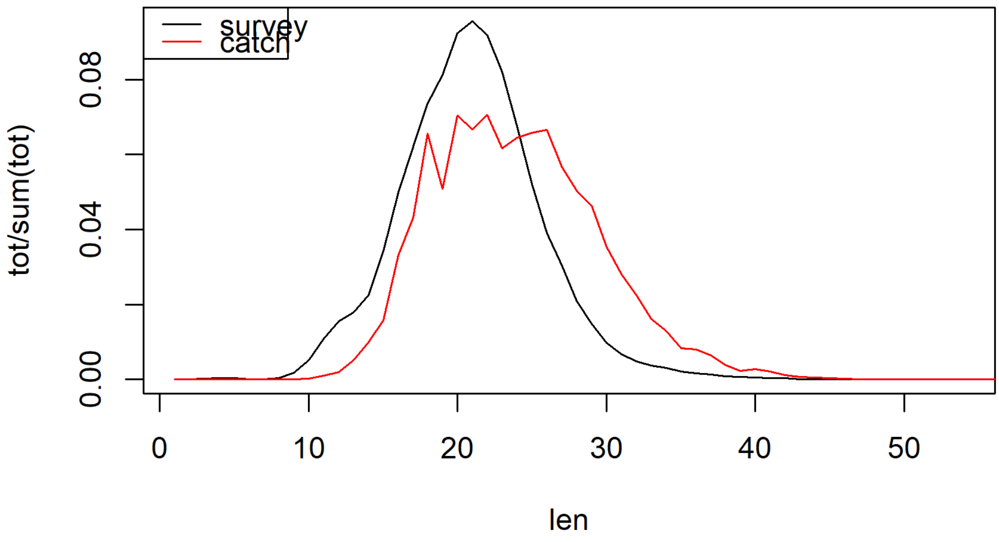
5.3.3.5 Short term forecasts

No short-term forecast was produced.

5.3.4 Biological reference points

5.3.4.1 Length-based indicators

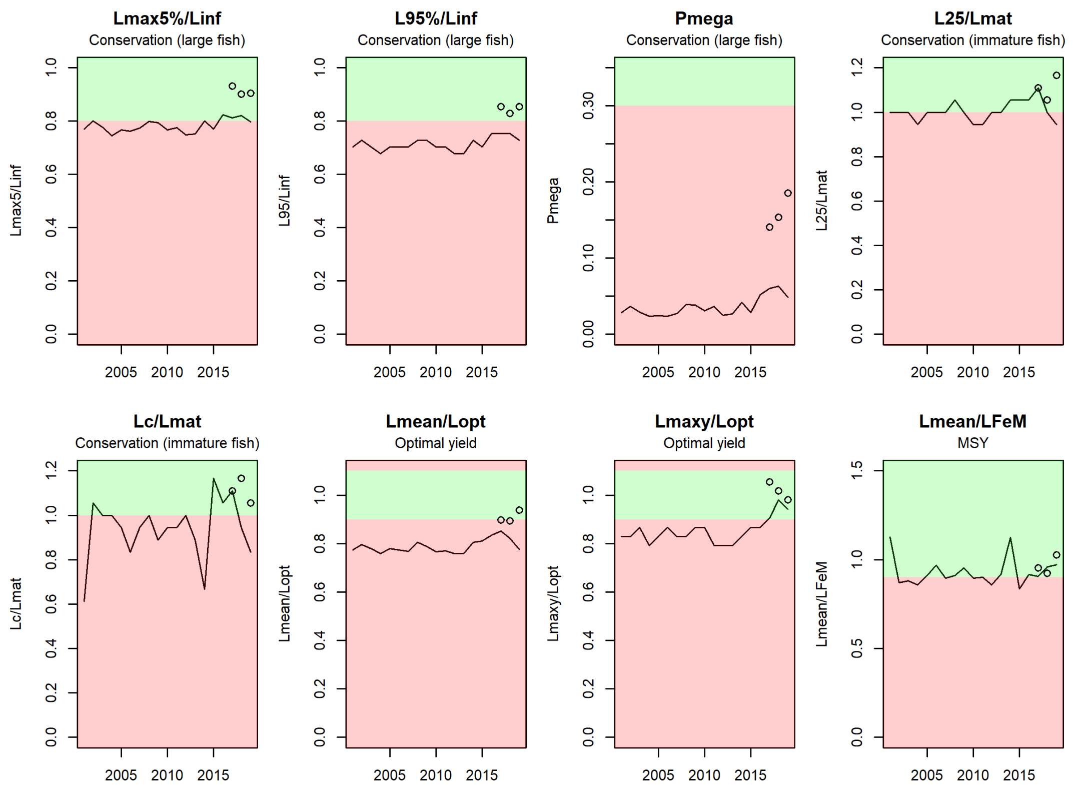
Following the technical guidelines for the reference points for stocks in categories 3 and 4 (ICES, 2018), length-based indicators were explored. Because the main country in the fishery (Spain) only submitted data for the last 3 years, there was limited catch data available for this analysis. Therefore, WGBIE decided to also explore the length distributions of the only survey that catches four-spot megrim in reasonable numbers i.e. the Spanish Porcupine survey.



→ *The figure above shows the total length frequency distributions of the catch (2017-2019) and the Spanish Porcupine survey (2001-2019).*

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

- Growth from Fishbase (Froese and Pauly, 2020) (*L. boscii* in areas 7,8abd)
  - Linf = 39.8 (average Fishbase)
  - Also explored Linf = 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
  - L_{50} = 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.

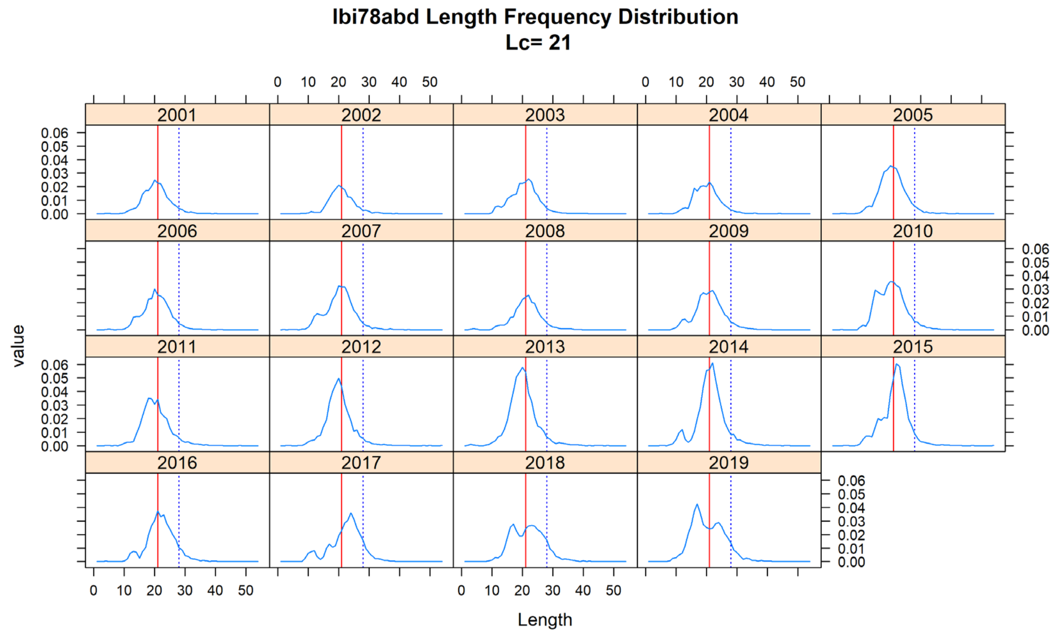
Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above L_{opt} + 10%. (L_{opt} 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	L_{opt} = $^2/_3$ 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 overexploited, 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 L_{inf} brought the indicator to around 0.85 while the lower value of L_{inf} resulted in an indicator around 1.0.

5.3.4.2 Mean length Z

Because there is not a sufficiently long time series of catch available yet, the only length-based method that may be appropriate for this stock is Mean Length Z (ICES, 2015). 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.

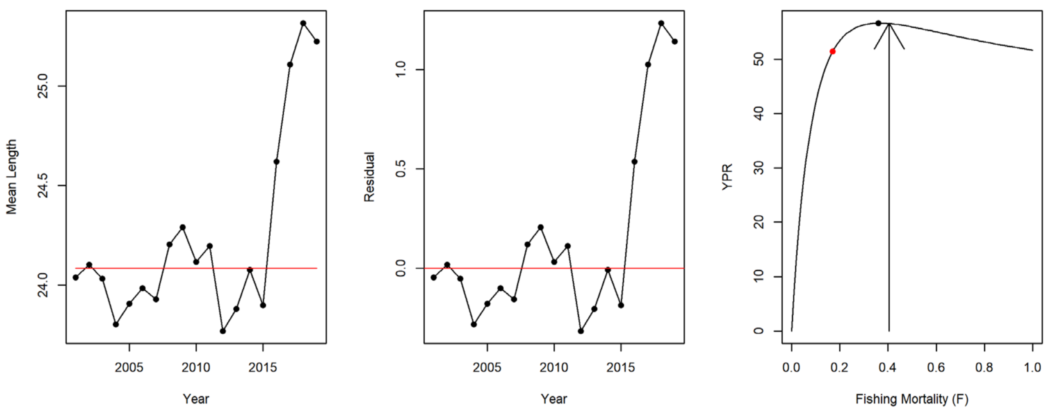


→ *The figure above shows the length frequency distributions of the Spanish porcupine survey. The vertical red line is the assumed length at full selectivity (21cm), which corresponds to the mode of the overall distribution.*

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 0.40 (arrow in right plot) which is well above F01 (red dot in right plot) and just above* F_{max} *(black dot).*

WGBIE 2019 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. WGBIE decided to look at survey-based assessment approaches in more detail during next year working group (ICES, 2019).

5.3.5 Conclusions

This was the fourth year that an assessment was carried out for this stock and the third 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 incomplete historical (2003-2016) 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.

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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.

	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	4680	2276	2337	112	2128	6	347	261	**12147**	610	483	85	495		66		**1738**	**13885**	13528
2019	4332	2617	2150	129	2454	1	481		**12164**	424	130	63	252		120		**989**	**13153**	19836

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	12147	1738	13528	13528
2019	12164	989	13153	19836

(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**
2019	**FR19**	**SP19 (*)**	**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) in 2019.

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	254658	
11	221119	
12	100287	
13	21412	
14	12843	
15	19244	
16	25692	
17	19252	
18	19252	
19	128403	
20	143295	385
21	177576	7486
22	88011	26959
23	79635	80878
24	133788	179766
25	99136	414540
26	69581	485666
27	35662	436620
28	42352	374552
29	26663	275765
30	52763	248516
31	19490	153617
32	13574	128715
33	14034	92220
34	15899	72630
35	13902	57275
36	10318	49390
37	14184	37645
38	4273	31484
39	5715	21646
40	3727	22128
41	8517	14778
42	2494	13998
43	1624	9454
44	4299	8907
45	114	13533
46	3457	8516
47	171	5988
48	390	5022
49	171	5204
50	57	4200
51	57	1583
52		1446
53		1307
54		75
55		0
56		173
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
TOTAL	1907092	3292067

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
2019		1.69	3.30	6.97	5.22	3.86	2.41	1.97	0.63	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
2019	100	23	204	264	236	72	40	13	14	9	31

	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
2019	100	12	939	4392	5543	3262	3292	1880	565

Table 5.1.2.3.1 (cont). Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Abundance Indices by kilograms and numbers per 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	
2019	3.62	23.67	

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
			2019	13.64	205.12

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
2019	908

Table 5.1.2.4.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. French and Spanish CPUEs for the 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	13.7
2019	NA	NA	NA	NA	2.4	0.0	78.2	15.9

(*) LPUEs, no discards available

Table 5.2.3.3.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. IBP 2016 Prior distributions of the final run.

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

Table 5.2.5.1. 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_2020	SSB_2020	TSB_2020	Fbar_2020	Catch_2020	Land_2020	Disc_2020	Rec_2021	SSB_2021	TSB_2021
5%	218024	93126	127913	0.19	18509	15681	2566	218024	94139	130438
50%	223393	107600	149344	0.21	20350	17179	3149	223393	111674	152113
95%	229387	123589	177928	0.24	22461	18898	3935	229387	134680	182708

Table for quantile: 0.5

Fmult	F_2021	Catch_2021	Land_2021	Disc_2021	Rec_2022	SSB_2022	TSB_2022
0	0	0	0	0	223393	136281	177363
0.1	0.021	2344	2013	327	223393	133832	174784
0.2	0.043	4638	3981	649	223393	131393	172238
0.3	0.064	6880	5905	966	223393	128929	169781
0.4	0.086	9081	7787	1277	223393	126553	167379
0.5	0.107	11230	9628	1584	223393	124267	165020
0.6	0.128	13332	11430	1885	223393	122005	162745
0.7	0.15	15394	13192	2181	223393	119815	160475
0.8	0.171	17407	14910	2472	223393	117648	158206
0.9	0.193	19379	16591	2758	223393	115520	156066
1	0.214	21310	18230	3041	223393	113491	154022
1.1	0.236	23205	19840	3318	223393	111514	151944
1.2	0.257	25052	21424	3591	223393	109545	149898
1.3	0.278	26859	22970	3860	223393	107643	147881
1.4	0.3	28629	24467	4123	223393	105788	145928
1.5	0.321	30375	25936	4384	223393	103953	144064
1.6	0.343	32079	27369	4641	223393	102204	142191
1.7	0.364	33741	28772	4893	223393	100481	140377
1.8	0.385	35366	30151	5141	223393	98751	138584
1.9	0.407	36951	31489	5385	223393	97068	136851
2	0.428	38509	32821	5625	223393	95413	135157

Table 5.2.6.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Reference points table updated in WGBIE 2018 (ICES, 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	$\mathrm{F_{lim}} e^{-1.645\,\sigma}$ where $\boldsymbol{\sigma} = \mathbf{0.105}$ is the standard deviation of the logarithm of F in 2014

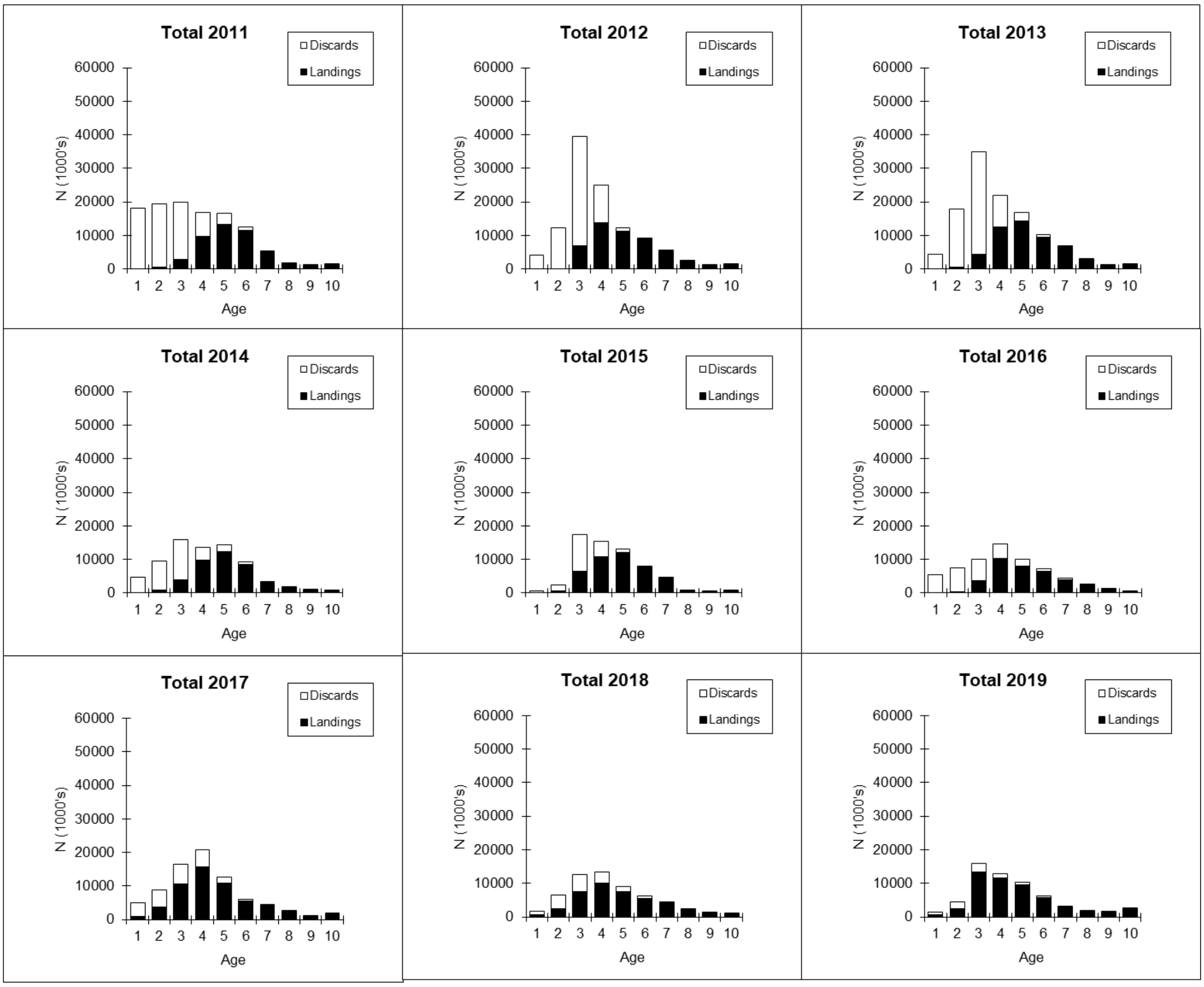

Figure 5.1.2.2.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Age composition of catches for the years 2011–2019.

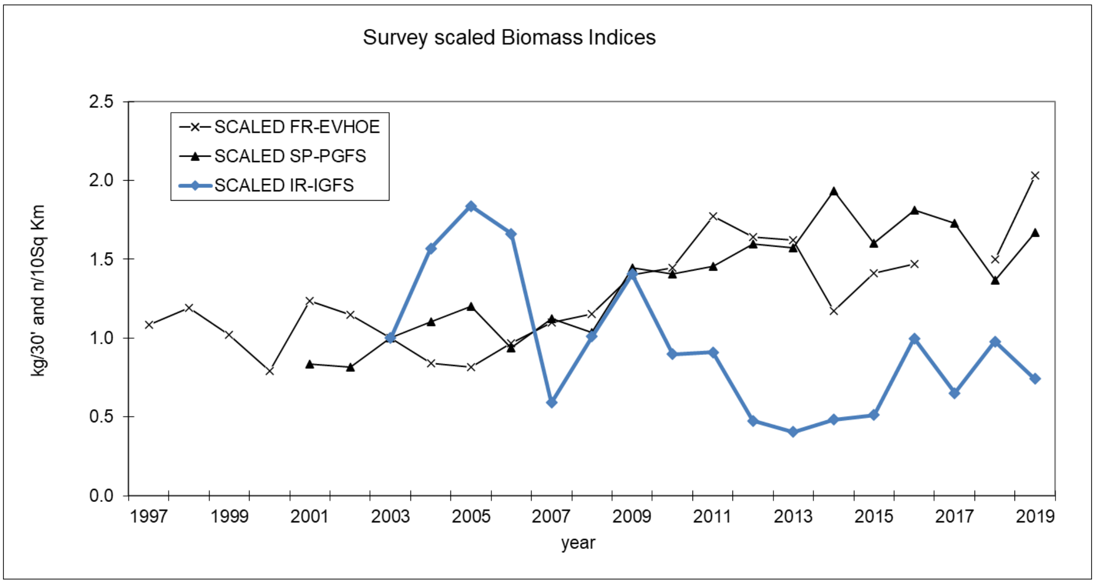

Figure 5.1.2.3.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Scaled Biomass Indices for FR-EVHOE, SP-PGFS and IR-IGFS.

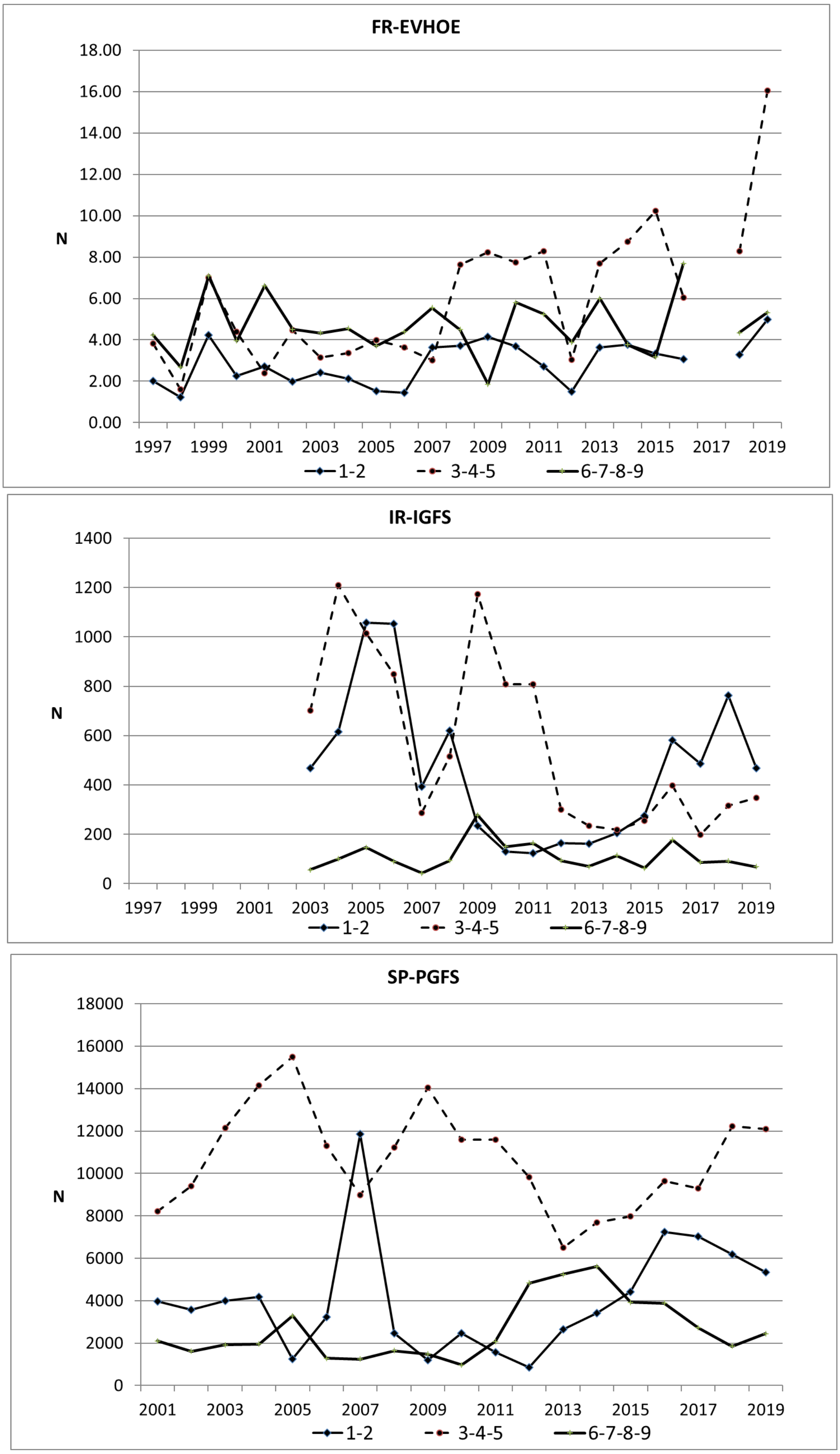

Figure 5.1.2.3.2. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Abundance Indices for EVHOE, IGFS and SP-PGFS by ages grouped: i) 1+2; ii) 3+4+5 and iii) 6+7+8+9+10+.

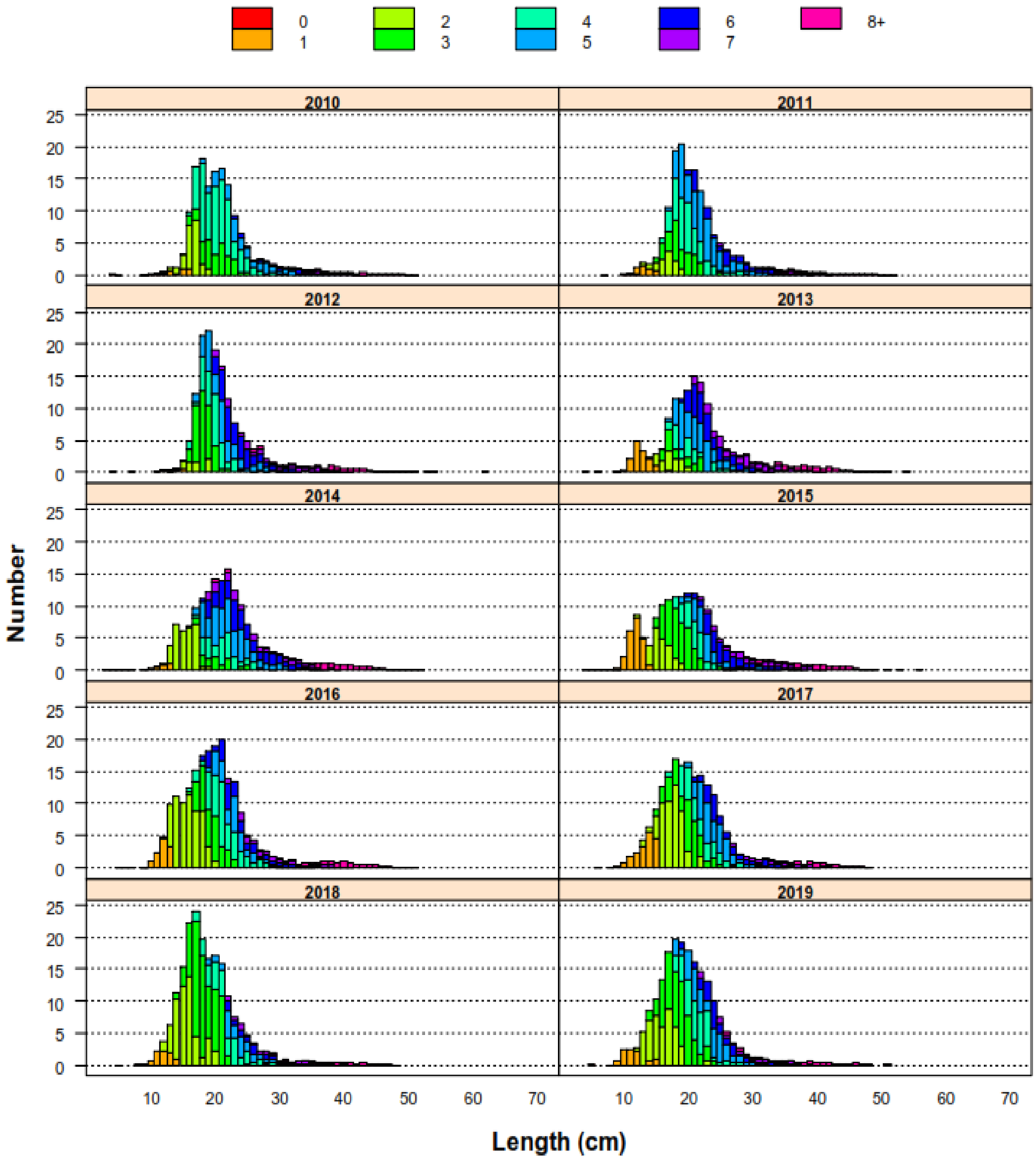

Figure 5.1.2.3.3. **Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Age composition of SP-PORCUPINE survey in abundance (numbers).**

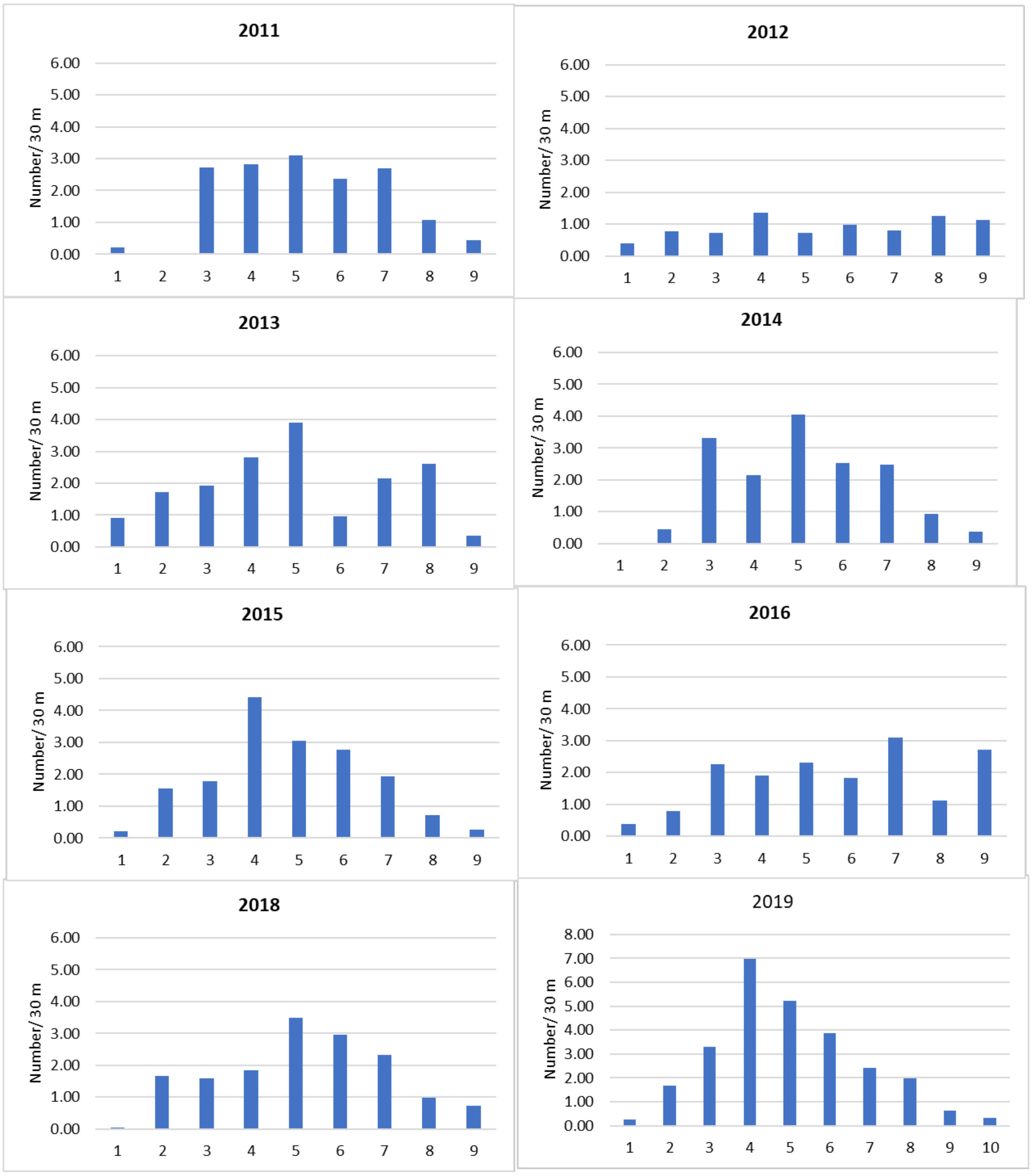

Figure 5.1.2.3.4. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Age composition of FR-EVHOE survey in abundance (numbers/30min haul).

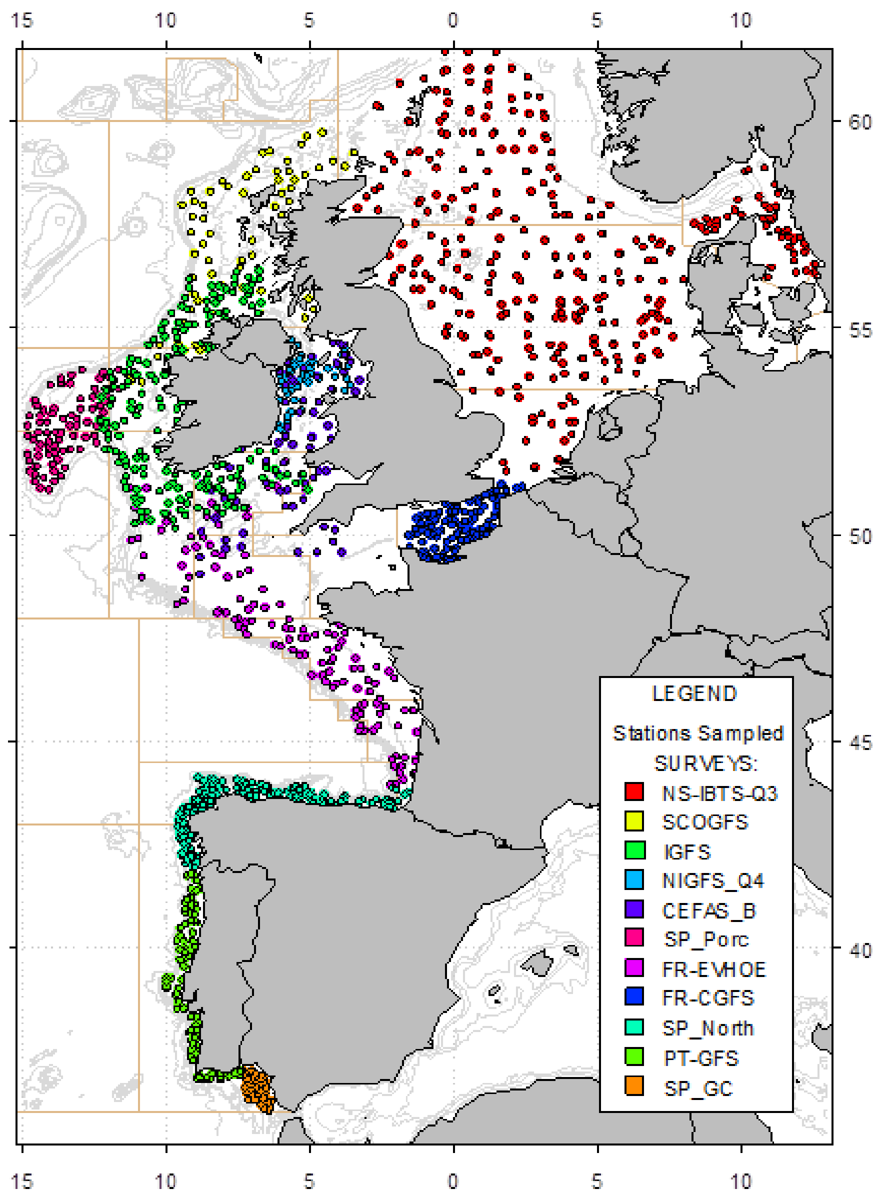

Figure 5.1.2.3.5. Station positions for the IBTS Surveys carried out in the Western Atlantic and North Sea area in autumn/winter of 2008. (From IBTSWG Report, ICES 2009). Just to be used as general location of the surveys.

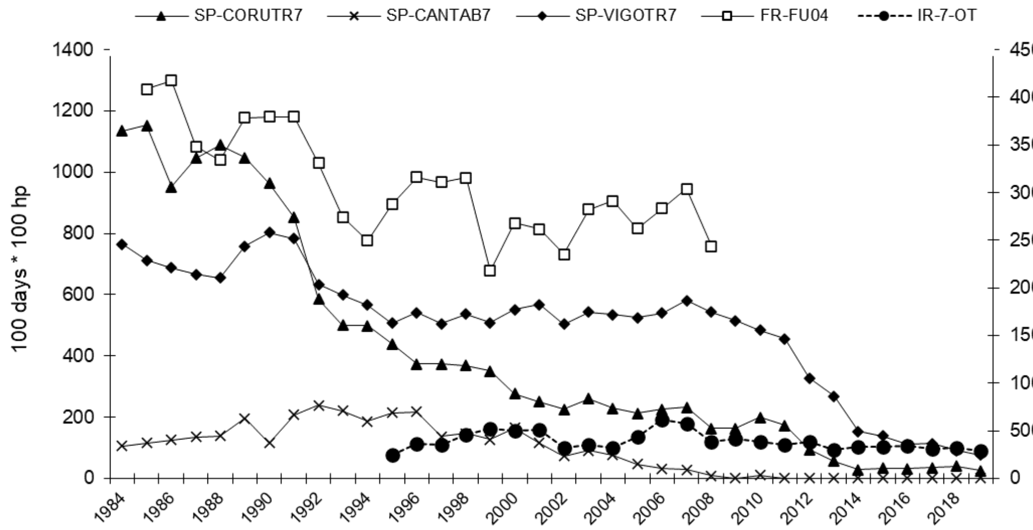

Figure 5.1.2.4.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Evolution of effort for different bottom-trawler fleets.

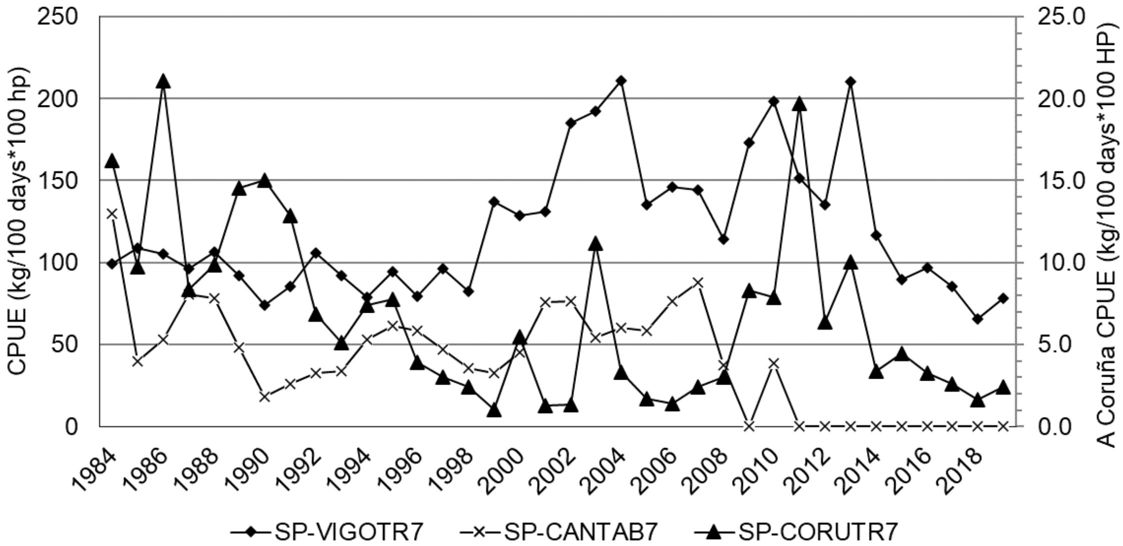

Figure 5.1.2.4.2. Megrim *(L. whiffiagonis*) in Divisions 7b,c,e-k and 8a,b,d. Spanish cpue for different bottom-trawler fleets.

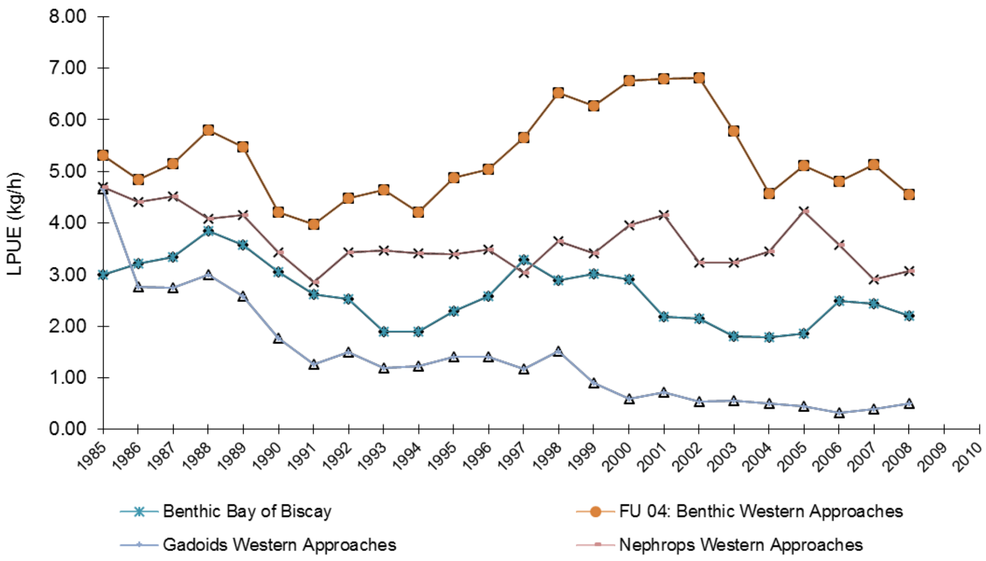

Figure 5.1.2.4.3. Megrim *(L. whiffiagonis*) in Divisions 7b,c,e-k and 8a,b,d. French LPUE for different bottom-trawler fleet.

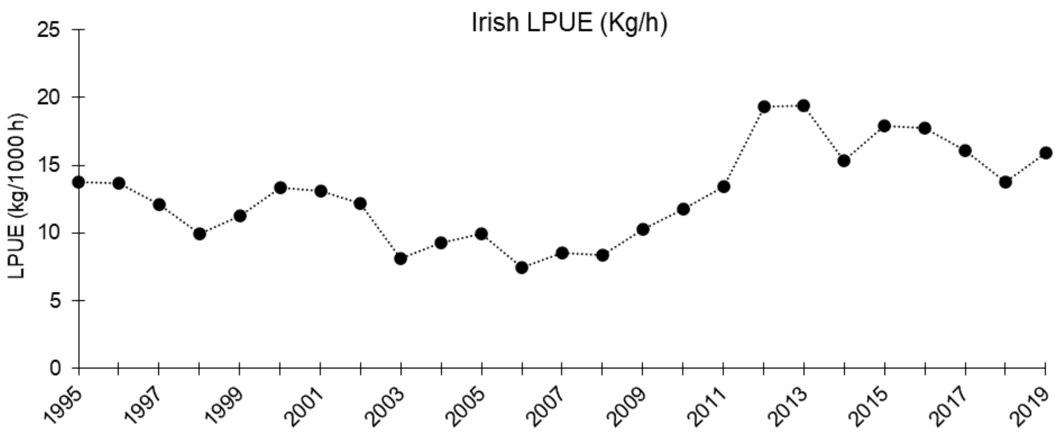

Figure 5.1.2.4.4. Megrim (*L. whiffiagonis*) in Divisions 7b,c,e-k and 8a,b,d. Irish LPUE for beam trawl fleet.

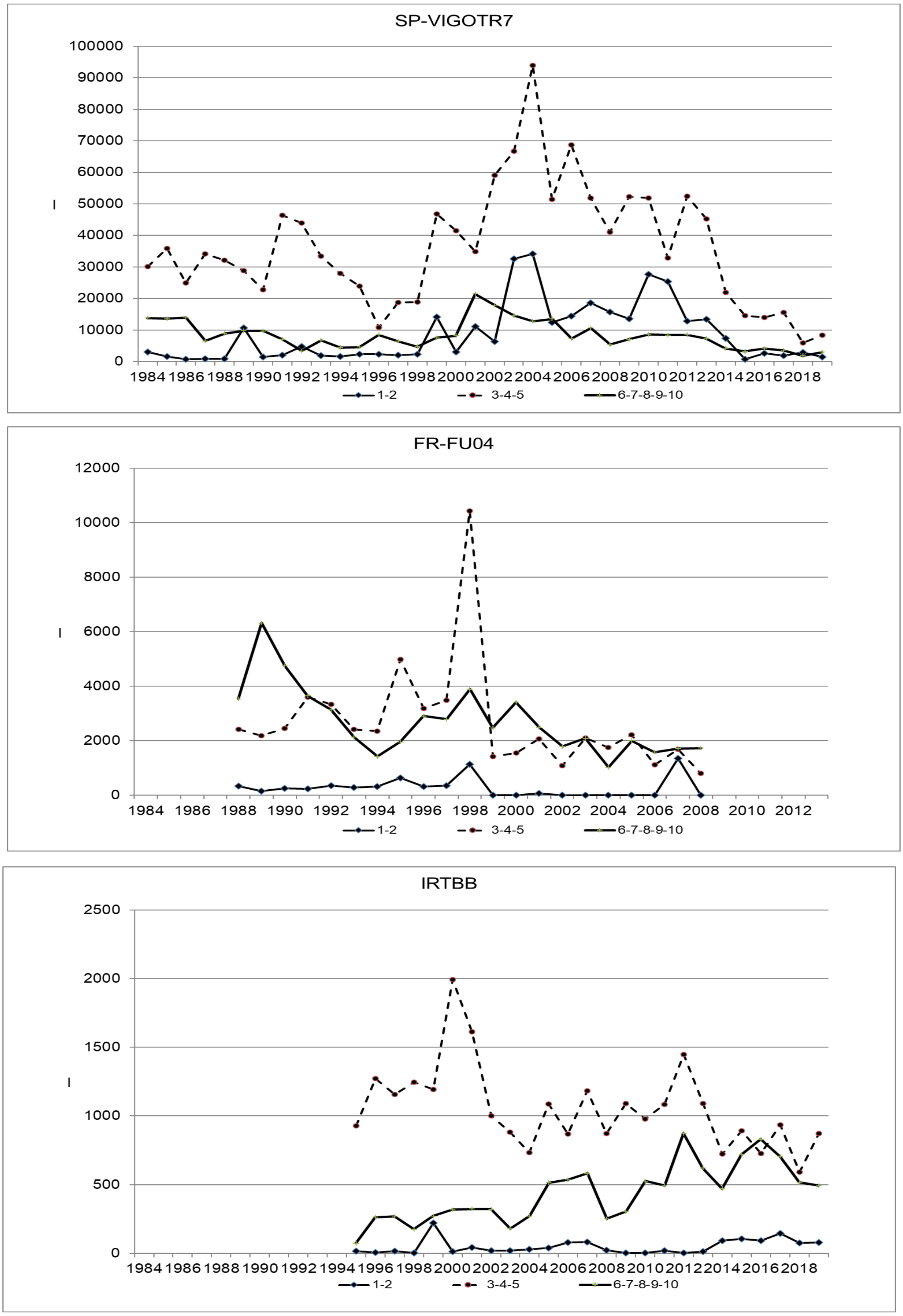

Figure 5.1.2.4.5. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Abundance Indices for SP-VIGOTR7, FR-FU04 and IRTBB by ages grouped: i) 1+2; ii) 3+4+5 and iii) 6+7+8+9+10+.

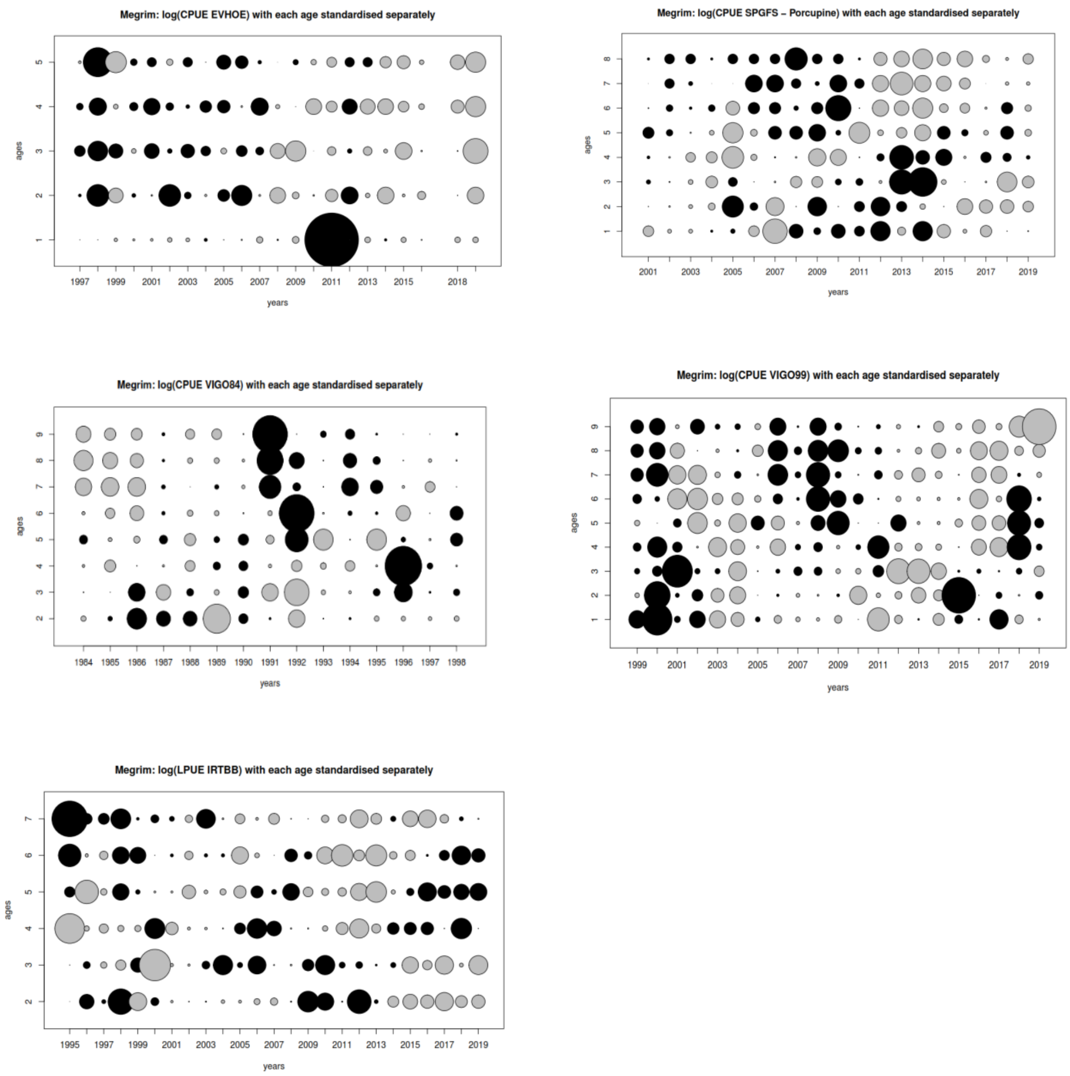

Figure 5.2.3.1.1. Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Bubble plots of the standardized log abundance indices of the surveys and commercial fleets used as tuning fleets (grey – positive values, black – negative values).

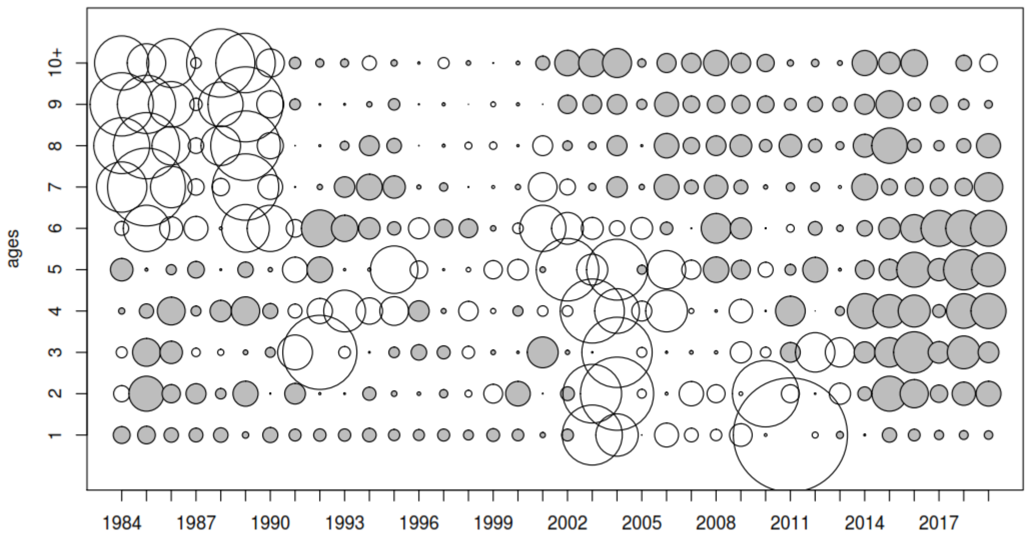

Figure 5.2.3.1.2. . Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Bubble plots for catch numbers-at-age (grey – positive values, black – negative values).

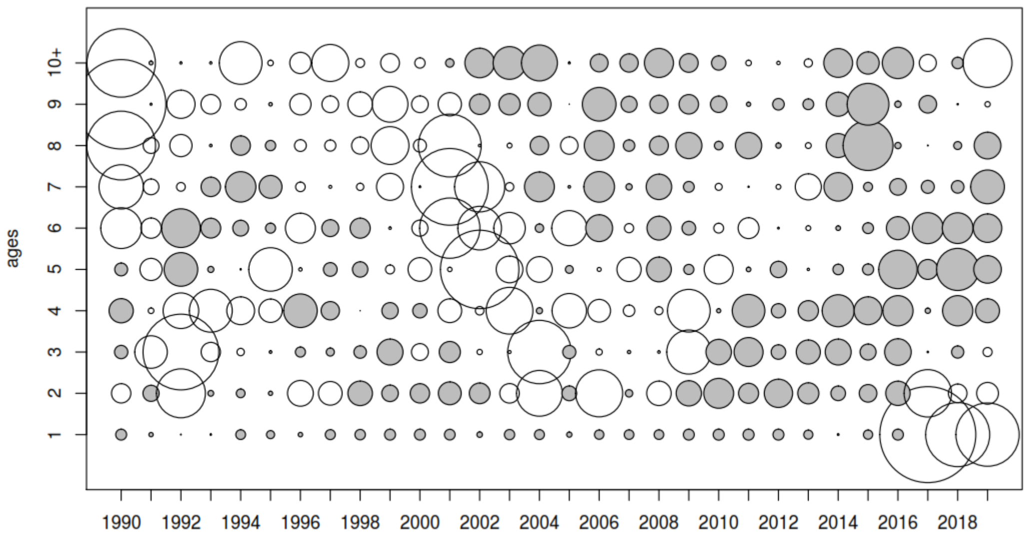

Figure 5.2.3.1.3. . Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Bubble plots for landing numbers-at-age (grey – positive values, black – negative values).

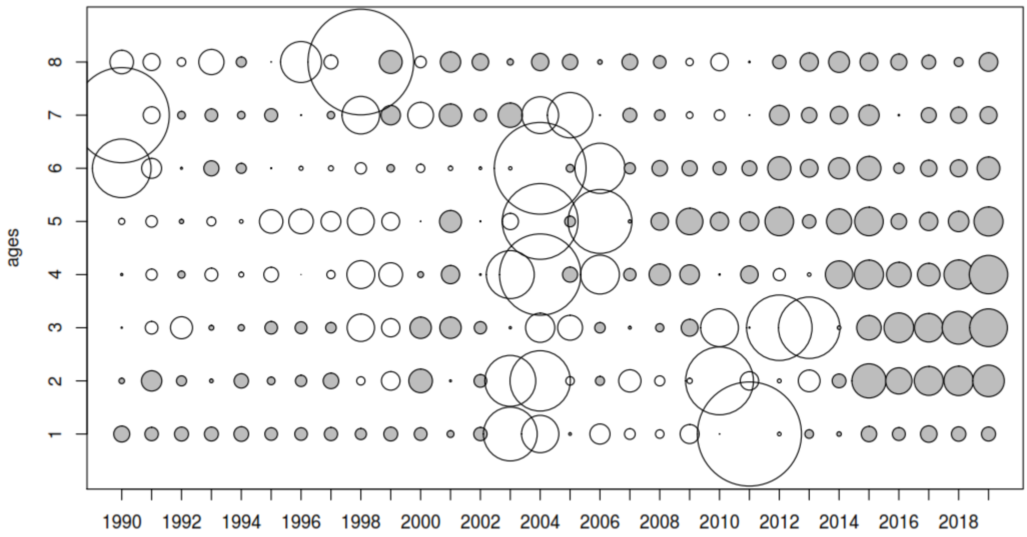

Figure 5.2.3.1.4. . Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Bubble plots for discarded numbers-at-age (grey – positive values, black – negative values).

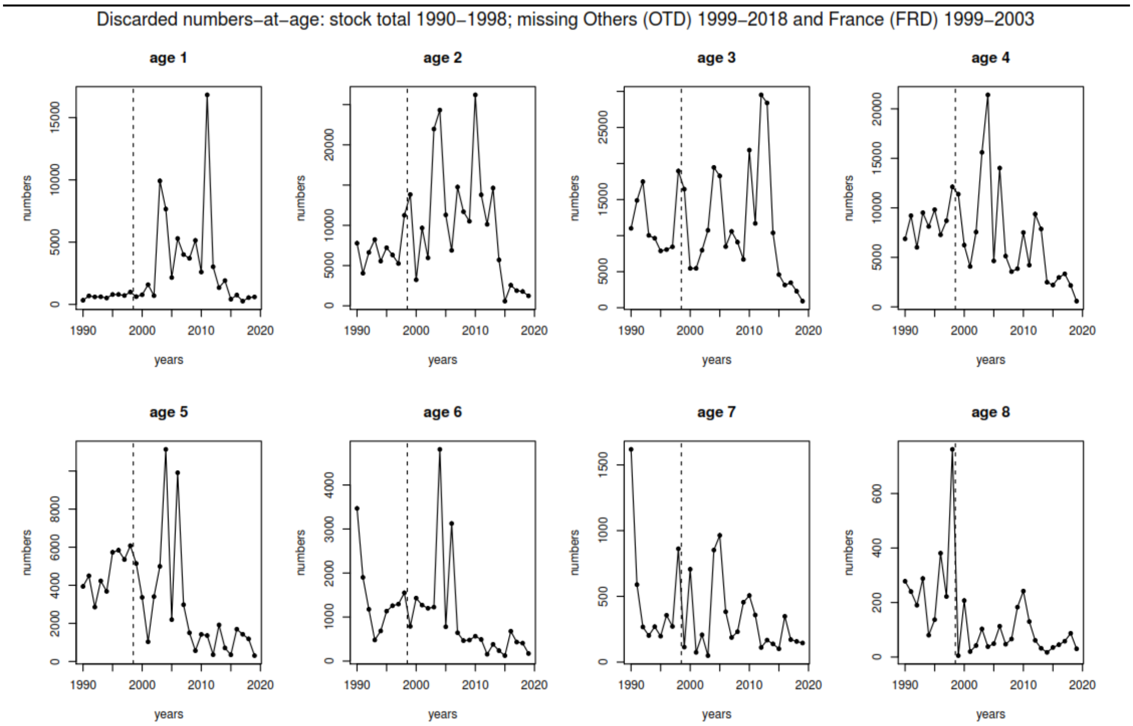

Figure 5.2.3.1.5. . Megrim (*L. whiffiagonis*) in Divisions 7b-k and 8a,b,d. Discarded numbers at age separated by age from 1990 to 2019.

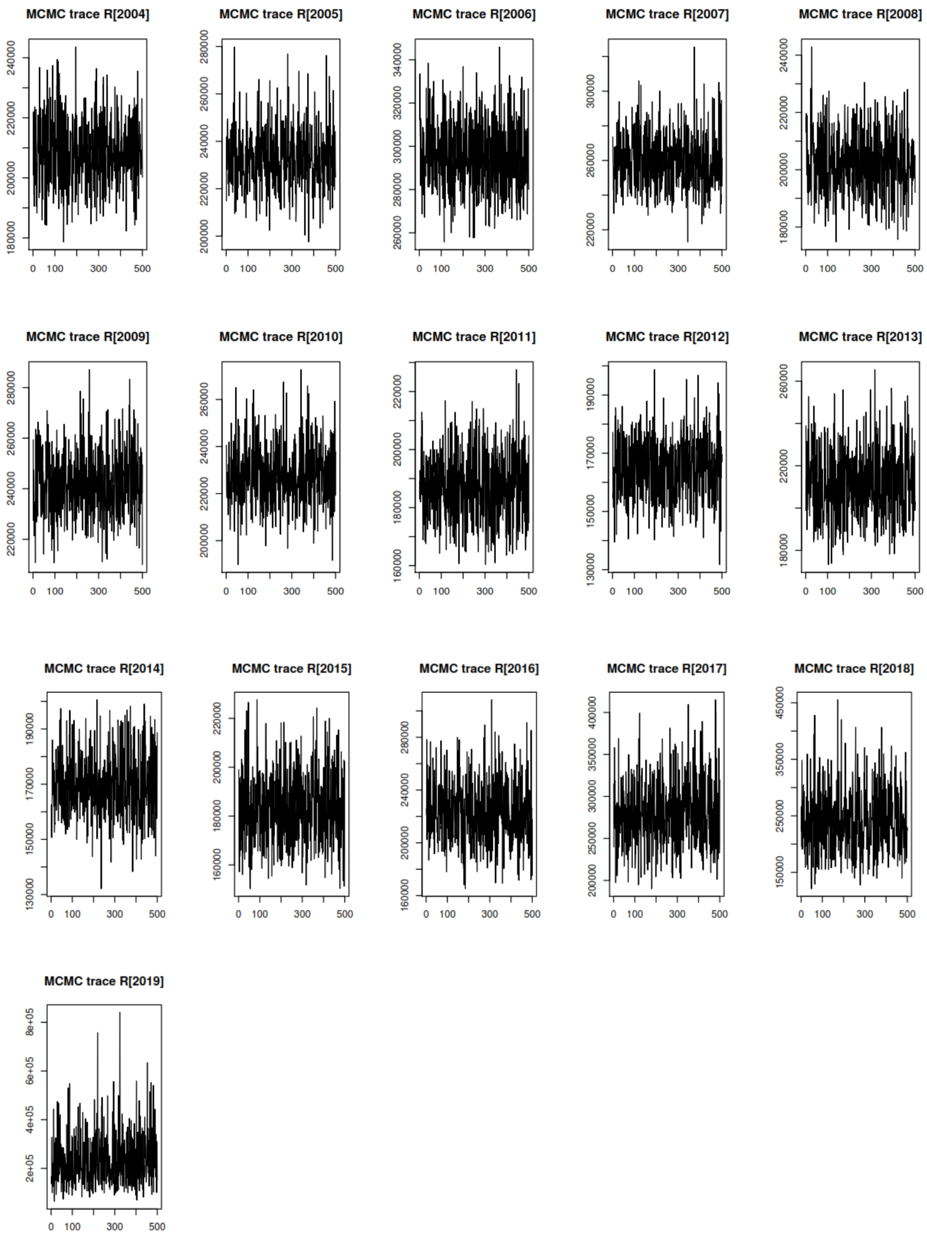

Figure 5.2.3.3.1. Trace plots of recruitment draws from 2004 to 2019.

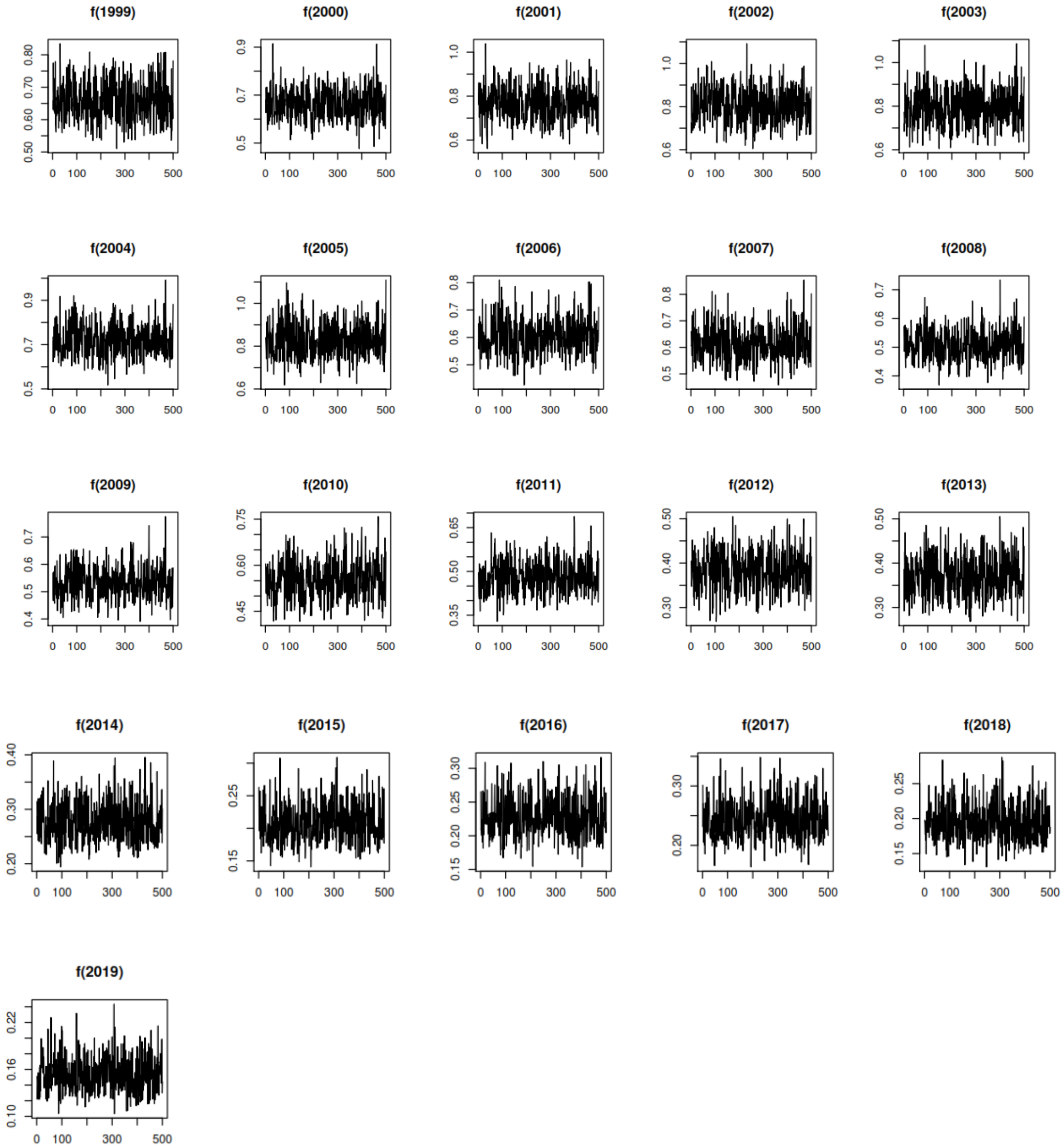

Figure 5.2.3.3.2. Trace plots of f(y) fishing mortality in ages 9 and 10 from 1999 to 2019.

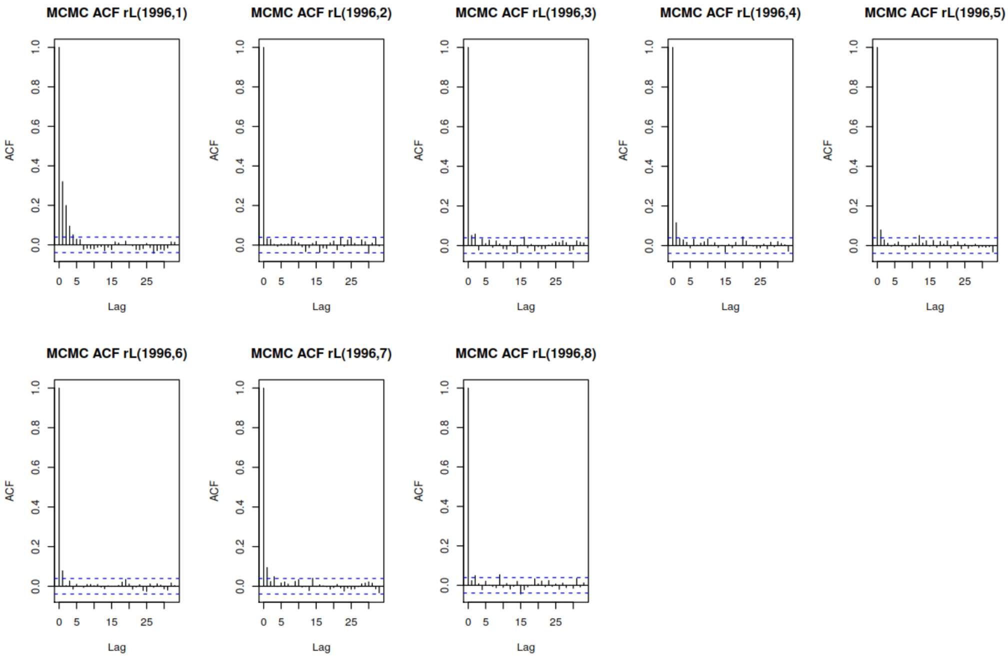

Figure 5.2.3.3.3. Autocorrelation plots of rL for years 1996 and 2019.

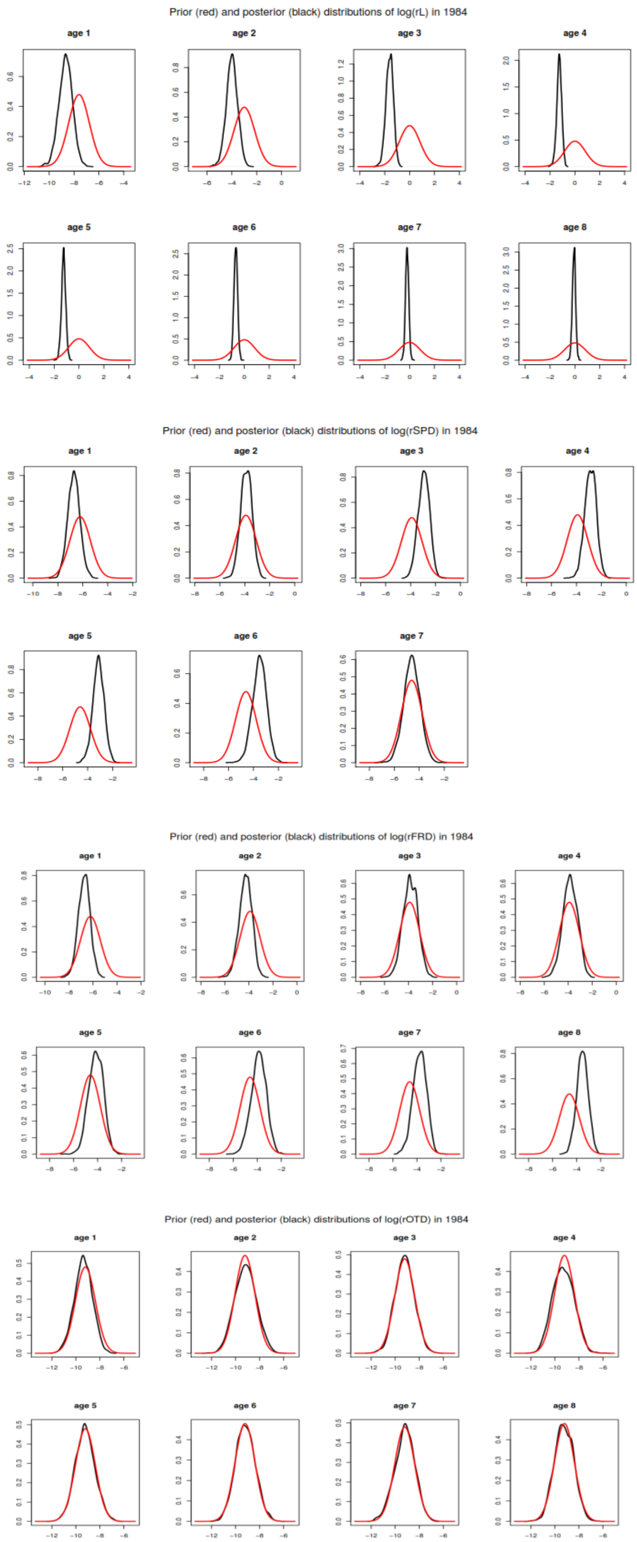

Figure 5.2.3.3.4. Prior (red) and posterior distribution of log (L) in 1984, log (rSPD) at age in 1984, log (rFRD) at age in 1984 and log (rOTD) at age in 1984.

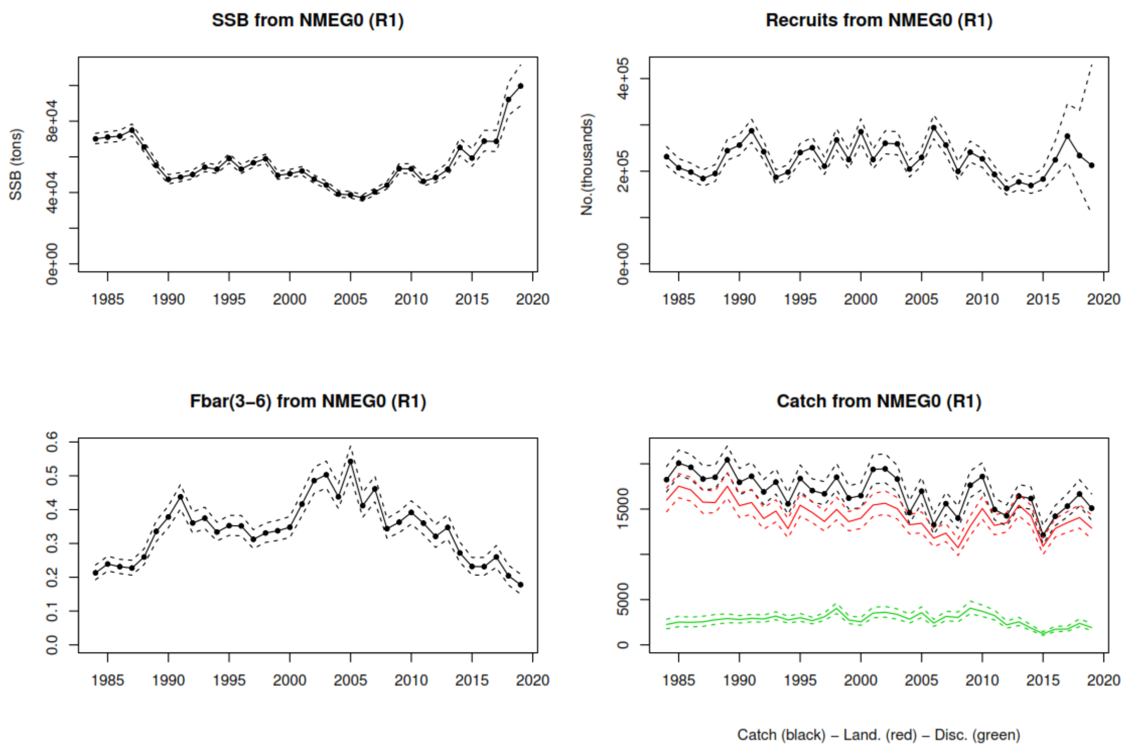

Figure 5.2.3.3.5. WGBIE 2020 results of time series of spawning stock biomass (SSB), recruits, Fbar, catch (black), landings (red) and discards (green) from 1984 to 2019. The solid dotted lines correspond to the median of the distribution and the dashed lines to the 5% and 95% quantiles.

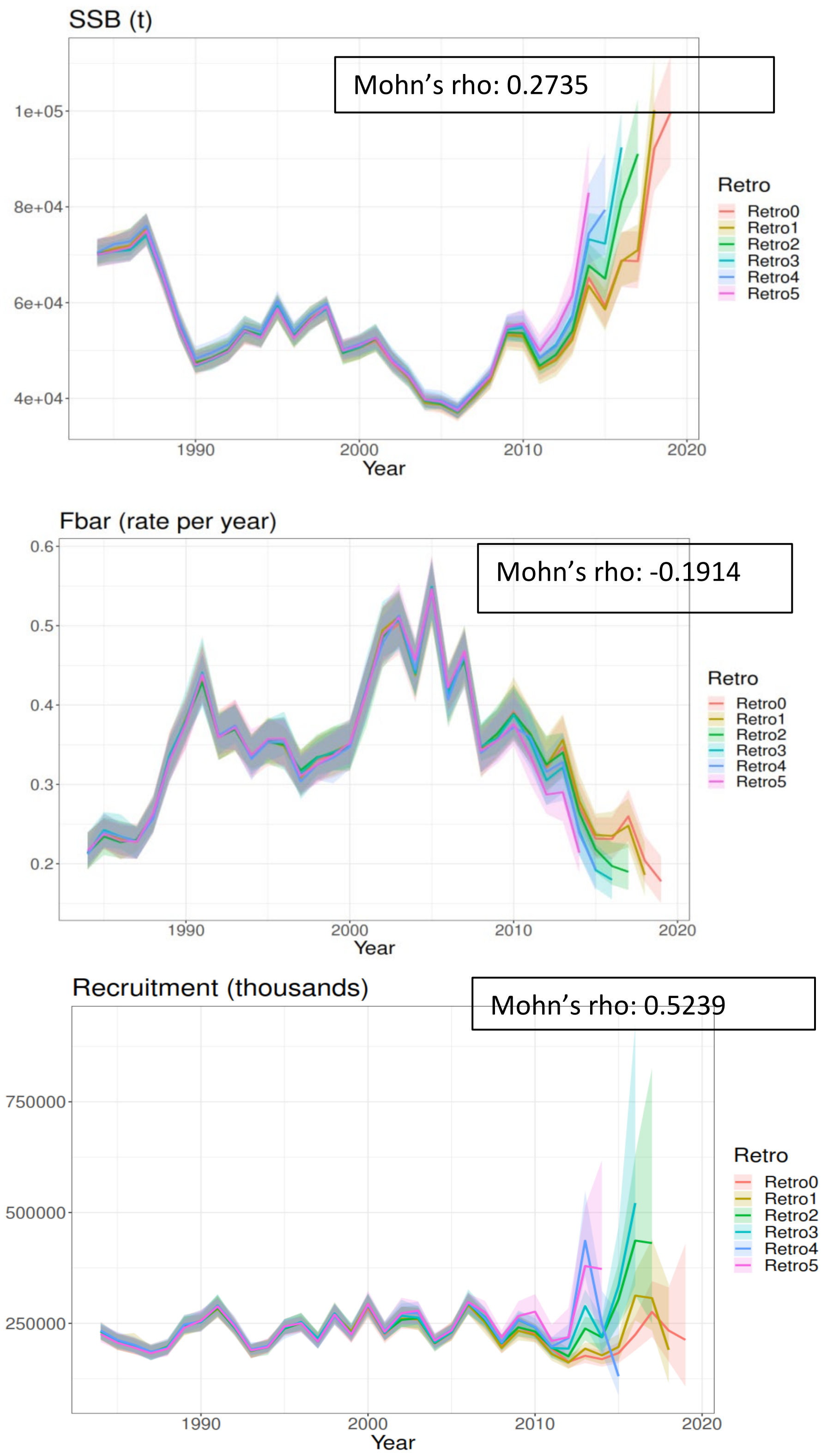

Figure 5.2.4.1. Time series of median SSB, recruitment and F_{bar} in retrospective analysis.

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

x *Lepidorhombus whiffiagonis*:

Type of assessment in 2020: Update.

Data revisions this year:

No revisions this year.

Lepidorhombus boscii:

Type of assessment in 2020: 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 2020 and management for 2019 and 2020

ICES advice for 2020 (as extracted from ICES Advice on fishing opportunities, catch and effort 2019):

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, 2019). 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 F_{MSY}.

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 EU multiannual plan (MAP; European Parliament and Council Regulation (EU) No. 2019/472) for Western waters and adjacent waters is applied, catches in 2020 that correspond to the F ranges in the MAP are between 357 and 648 t for *L. whiffiagonis* and between 1 275 and 2 651 t for *L. boscii*. According to the MAP, catches higher than those corresponding to F_{MSY}, 534 t for *L. whiffiagonis* and 1 885 t for *L. boscii*, can only be taken under conditions specified in the MAP, while the entire range is considered precautionary when applying the ICES advice rule.

Management applicable for 2019 and 2020:

The agreed combined TAC for megrim and four-spot megrim in ICES Divisions 8c and 9a was 1 872 t in 2019 and 2 322 t in 2020.

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

The Working Group estimates of landings, discards and catches for the period 1986 to 2019 are given in Table 6.3.1. 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 the 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 2019 were 239 t. Landings reached a peak of 977 t in 1990, followed by a steady decline until 2002. Some increase in landings has been observed since then, but landings have again decreased annually since 2007 until 2010 to 83 t, the lowest value of the entire time-series. Since 2011, the stock increased again and has then remained stable. Historical landings for both species combined are shown in Figure 6.1.1. The last period shows a decreasing trend since 2014 and in 2019, the international landings were 981 t, the second lowest value of the time-series.

Discards estimates were available from the Spanish "observers' onboard sampling programme" for the years displayed in Table 6.3.2(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 in 2011 when the value observed was extremely high. Following the recommendations, during the WKSOUTH benchmark in 2014 (ICES, 2014), an effort was made to complete the time-series back until 1986 in years without samplings. Total discards, given in tonnes (Table 6.3.1) and in numbers-at-age (Table 6.3.2b), were included in the assessment model.

6.3.2.2 Biological sampling

Annual length compositions of total stock landings are provided in figure 6.3.2 for the whole period and in Table 6.3.3a for 2019. Unallocated/non reported value was included in the raising of total length distribution in previous years. The bulk of sampled specimens corresponds to individuals 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 6.3.3b. The mean length and mean weight values observed in 2013 were the highest in the historic series.

Age compositions of catches are presented in Table 6.3.4 and weights-at-age of catches in table 6.3.5, from 1986 to 2019. 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 provided 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 6.3.6. In 2012 and in 2019, Portuguese surveys were not conducted.

As noted in the Stock Annex, indices from these Portuguese surveys are not considered representative of the 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 were common throughout 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 with the highest value in 2019 (Figure 6.3.3a, 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 performed between both vessels, the results were not consistent with the results of the inter-calibration. Therefore, the WG 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 considered suitable for inclusion in the assessment.

The Spanish survey recruitment index for age 1 (Recruitment age) indicates an extremely weak year class in 1994, which improved in the following years. From 2000 to 2014, low values of year classes were observed except in 2010. However, since 2015, there was a considerable increase in age 1 with the highest value of the time-series in 2016. In 2019, the value was within this last period trend.

Catch numbers-at-age per unit effort and effort values for the Spanish survey are given in Table 6.3.7. In addition, Figure 6.3.3b displays a bubble plot of log (survey abundance-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 grey 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 1988–2019 (Table 6.3.8 and Figure 6.3.3a).

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 Data Collection Framework (DCF; Commission Regulation (EC) No 1639/2001, Council Regulation (EC) No 199/2008) sampling programme, such that they can be then re-aggregated under two DFC métiers: bottom otter trawl targeting demersal species (OTB_DEF_>=55_0_0) and bottom otter trawl targeting pelagic stocks accompanied by some demersal species (OTB_MPD_>55_0_0). Therefore, the LPUE of these métiers was estimated 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 WKSOUTH benchmark in 2014 (ICES, 2014). These tuning fleets (SP-LCGOTBDEF and SP-AVSOTBDEF) were accepted to tune the assessment model instead of the old ones based on A Coruña (SP-CORUTR8c) and Avilés (SP-AVILESTR) trawls. The LPUEs and effort values are given in Table 6.3.8 and Figure 6.3.3a.

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 reached its highest value and in 2019 decreases again. The LPUE shows a general faintly increasing trend. The 2019 value represents an increase, being the highest value of the time-series.

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 trend from 1986 to 2003. Since then, upward and downward fluctuations were observed, with a peak in 2011. A similar value to the previous year is shown in 2019.

Landed numbers-at-age per unit effort and effort data for these fleets are given in Table 6.3.7.

Figure 6.3.3c 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 values above average are frequent. Avilés fleet shows 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 lowest ones in the time-series (Table 6.3.8 and Figure 6.3.3a). The Portuguese LPUE series was revised from 2012 onwards. Further refinement of the algorithms is required to revise the series backwards. The LPUE shows a steep decrease between 1990 and 1992, and has since then remained at low levels, with the exception of a peak in 1997-1998. LPUE for recent years shows a slight increase relative to the previous years.

6.3.3 Assessment

An update assessment was conducted, according to the Stock Annex specifications. Assessment years are 1986-2019 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 2019 and adding the year 2019 indices from A Coruña (SP-LCGOTBDEF) and Avilés (SP-AVSOTBDEF) tuning fleets and Spanish survey (SP-NSGFS-Q4).

6.3.3.2 Model

Data screening

Figure 6.3.4a shows catch proportions-at-age where higher proportions can be observed for ages 1 and 2 until 2000 due to the high discards at these ages during this period, and also for age 1 since 2011. The top panel of Figure 6.3.4b shows landings proportions at age, indicating that the bulk of the landings consisted of ages 1 and 2 before 1994 then shifted mostly to ages 2 to 4 since the mid-1990s. 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 observed in this figure, particularly around the mid 1990's. In 2010, an increase in landings of older ages, especially ages 5 to 7+ was observed. In the last period, the high abundance of age 1 in the Spanish survey in 2010 can be tracked in the following years. Figure 6.3.4c shows discards proportions-at-age, being more abundant for age 1 from 2000 onwards. Before this year, discarding was higher in age 2. Visual inspection of Figures 6.3.3b and 6.3.3c 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 (Extended Survivor Analysis; Shepherd, 1999) was selected for use in this assessment. Model description and settings are detailed in the Stock Annex.

The retrospective analysis shows a small but consistent pattern of overestimation of SSB and underestimation of F in recent years (Figure 6.3.5).

6.3.3.3 Assessment results

Diagnostics from the XSA run are presented in Table 6.3.9 and log catchability residuals plotted in Figure 6.3.6. Residuals in A Coruña tuning fleet in the last years present mainly positive values. No pattern was found in the survey residuals. Several year effects are apparent in all tuning series. Differently from previous years, the model has converged.

Fishing mortality and population numbers-at-age from the final XSA run are given in Tables 6.3.10 and 6.3.11, respectively. The summary results are presented in Table 6.3.12 and Figure 6.3.7a.

Fishing mortality and catches decreased in the last year. The SSB values in 2007-2010 are the lowest in the series. Since 2011, values are significantly higher, especially the last two years. After high recruitment values (at age 1) in 2015, 2016 and 2017, recruitment decreased significantly in the last two years.

Bubble plots of standardised estimated F-at-age (by subtracting the mean and dividing by the standard deviation over the years) and relative F-at-age (F-at-age divided by F_{bar}) are presented in Figure 6.3.7b. The top panel of the figure indicates that fishing mortality has been lower for all ages in 2000 until 2011, afterwards slightly increasing again afterwards. However, since 2017, a decrease in all the ages was observed. In terms of the relative exploitation pattern-at-age (bottom panel of the figure), the most obvious changes are the reduction of ages 1 and 2 around 1994 and the increase of age 3 soon after that. This might be related to the discarding practices. There is no clear pattern over time in the age 4 selection, whereas for ages 5 and older, there seems to be an increase during the mid to late 1990's, which dropped down to lower values afterwards. 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 2016 year class is estimated to have 10.2 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 (13% of weight) and F shrinkage (4%).

The 2017 year class is estimated to have 7.1 million individuals at 1 year of age based on the information from the Spanish survey (SP-NSGFS-Q4) (71% of weight), P-shrinkage (26% of the weight) and F-shrinkage (4%).

The 2018 year class is estimated to have 7.7 million fish at 1 year of age, based on the information from the Spanish survey (SP-NSGFS-Q4) (64% of weight), P-shrinkage (30% of the weight) and F-shrinkage (6%).

The working group considered that the XSA last year recruitment value was well estimated (ICES, 2019). The signal from the survey index is in accordance with the estimated value and age 1 is well represented in the 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
2016	10200	XSA	71%	26%	4%
2017	7140	XSA	71%	0%	30%
2018	7700	XSA)	64%	0%	36%
2019	3517	GM (98-17)			

6.3.3.5 Historic trends in biomass, fishing mortality and recruitment

From Table 6.3.12 and Figure 6.3.7a, we see that SSB decreased from 2 435 t in 1990 to 945 t in 1995. From 1996 to 2000, it remained relatively stable at low levels with an average value close to 1 200 t. Starting from 2001, SSB is estimated to have decreased further. The values for 2001-2010 are the lowest in the series, with SSB in 2008 (611 t) corresponding to the lowest value. Since 2011, SSB values are significantly increasing, being the 2019 value (1 936 t), the highest of the recent years.

After a decline from 2006 (0.44) to 2010 (0.08), F showed an increasing trend reaching 0.49 in 2015. In the most recent years, F presents lower values, with 0.17 in 2019.

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 was estimated as 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 seems to be very high, with values similar to those of mid-90s.

6.3.3.6 Catch Options and prognosis

Stock projections were calculated with the settings specified in the Stock Annex.

6.3.3.7 Short-term projections

Short-term projections have been made using MFDP (Multi Fleet Deterministic Projection; Smith, 2000).

The input data for deterministic short-term predictions are shown in Table 6.3.13. 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 F_{bar} = 0.204 for landings and F_{bar}=0.022 for discards, being 0.23 for catches).

According to the Stock Annex, geometric mean (GM) recruitment is computed over years 1998-final assessment year minus 2.

Management options for catch prediction are in Table 6.3.14. Figure 6.3.8 shows the short-term forecast summary. The detailed output by age group is given in Table 6.3.15 for landings and discards.

Under *status quo* F, landings in 2020 and 2021 are predicted to be 506 and 524 t respectively, and discards 25 and 18 t, respectively. SSB would decrease from the 2 427 t estimated for 2020 to 2 334 t in 2021 and to 2 143 t in 2022.

The contributions of recent year classes to the predicted landings in 2020 and SSB in 2021, assuming GM_{98-17} recruitment, are presented in Table 6.3.16. The assumed GM_{98-17} age 1 recruitment for the 2019 and 2020 year classes contributes 7% to landings in 2021 and 20% to the predicted SSB at the beginning of 2022. Megrim starts to contribute strongly to SSB at 2 years of age (see maturity ogive in Table 6.3.13).

6.3.3.8 Yield and biomass per recruit analysis

The results of the yield- and SSB-per-recruit analyses are in Table 6.3.17 (see also left panel of Figure 6.3.8, which plots yield-per-recruit and SSB-per-recruit versus F_{bar}). Assuming s*tatus quo* exploitation F_{bar} = 0.204 for landings and F_{bar}=0.022 for discards and GM_{98-17} for recruitment, the equilibrium yield would be 261 t of landings and 15 t of discards with an SSB of 1 245 t.

6.3.4 Biological reference points

The stock-recruitment time-series is plotted in Figure 6.3.9. 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 are only taken for ages 3 and older, as set in the stock annex. However, the Spanish survey (SP-NSGFS-Q4) provides good information on age 1 abundance.

Megrim starts to contribute strongly to SSB at 2 years of age. Around 20% of the predicted SSB in 2022 relies on year classes for which recruitment has been assumed to be GM_{98-17}.

This year the model converged for the first time.

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 megrim species (*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 1 224 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 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.

The WG considers that this stock could be just "the tail" of the much larger stock of megrim in ICES Subarea 7 and Divisions 8abd and suggested reconsidering 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 References

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6.3.8 Tables and Figures

Table. 6.3.1. Megrim (*L. whiffiagonis*) in Divisions 8c9a. Landings, discards and catch in tonnes.

	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
2019	226	7	233	6		239	51	289

^Data revised in WG2015

*9a is without Gulf of Cádiz till 2016

** Data revised in WG2010

*** Official data by country and unallocated landings

Table. 6.3.2a. Megrim (*L. whiffiagonis*) in Divisions 8c9a. Discard/Total Catch ratio and estimated CV for Spain from on-board sampling.

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

Year	2008	2009	2010	2011*	2012	2013	2014	2015	2016
Weight Ratio	0.08	0.13	0.06	0.23	0.12	0.07	0.06	0.07	0.21
CV	58.8	52.9	61.6	23.7	28.8	30.3	44.7	49.8	57.1
Number Ratio	0.20	0.36	0.27	0.57	0.37	0.24	0.20	0.29	0.47

Year	2017	2018	2019
Weight Ratio	0.14	0.10	0.17
CV	28.9		
Number Ratio	0.34	0.26	0.37

All discard data revised in WG2011

*Data revised in WG2013

Table. 6.3.2b. Megrim (*L. whiffiagonis*) in Divisions 8c9a. Discards in numbers at age (thousands) for Spanish trawlers.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	138	138	138	138	138	138	138	138	104
2	339	339	339	339	339	339	339	339	93
3	425	425	425	425	425	425	425	425	136
4	130	130	130	130	130	130	130	130	51
5	10	10	10	10	10	10	10	10	3
6	4	4	4	4	4	4	4	4	1
7	1	1	1	1	1	1	1	1	0

	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	138	138	41	138	270	27	10	10	0
2	339	339	453	339	471	611	338	338	239
3	425	425	857	425	284	160	82	82	57
4	130	130	142	130	197	73	31	31	12
5	10	10	1	10	26	19	9	9	4
6	4	4	5	4	6	0	1	1	0
7	1	1	3	1	0	0	1	1	0

	2004	2005	2006	2007	2008	2009	2010	2011*	2012
1	4	20	0	0	0	96	16	12	8
2	164	223	19	11	126	142	119	2044	808
3	28	61	108	0	86	21	6	346	85
4	6	38	115	0	8	15	1	1	41
5	5	11	28	0	5	7	2	2	2
6	3	4	13	0	2	7	0	0	1
7	2	1	4	0	0	3	1	0	1

	2013	2014	2015	2016	2017	2018	2019
1	330	442	624	1074	492	203	487
2	53	94	10	373	410	387	337
3	13	16	4	3	43	110	135
4	5	2	1	1	0	28	40
5	0	0	0	0	0	1	6
6	0	0	0	0	0	1	0
7	0	0	0	0	0	0	0

Table 6.3.3a. Megrim (*L. whiffiagonis*) Divisions 8c - 9a. Annual length distribution of landings in 2019.

Length (cm)	Total
10	
11	
12	
13	
14	
15	
16	17
17	3774
18	5701
19	16465
20	54280
21	122736
22	135799
23	165905
24	173618
25	160546
26	176960
27	138525
28	114429
29	96420
30	86769
31	67900
32	48432
33	31486
34	26755
35	20683
36	14280
37	7750
38	7905
39	7100
40	5158
41	5591
42	3342
43	2088
44	2723
45	812
46	1157
47	535
48	113
49	429
50+	686
Total	1706870

Table 6.3.3b. 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	2019
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	26.71
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	139.9

Table 6.3.4. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Catch numbers-at-age.

Catch numbers at age Numbers*10**-3

YEAR	1986	1987	1988	1989
AGE				
1	1352	2359	3316	1099
2	2377	2728	3769	2328
3	798	882	1168	808
4	649	404	748	641
5	505	293	534	505
6	202	81	182	191
+gp	194	71	130	253
TOTALNUM	6077	6818	9847	5825
TONSLAND	705	537	858	761
SOPCOF %	95	95	95	99

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
1	4569	1357	1401	858	133	848	537	535	416	491
2	2560	2777	817	2128	568	461	1911	1919	1307	524
3	905	931	807	442	1835	384	167	1153	1335	1157
4	878	700	1130	536	552	630	289	77	891	719
5	333	647	595	361	625	245	506	367	218	448
6	377	142	78	103	330	70	148	308	329	105
+gp	558	59	68	36	119	72	81	116	149	207
TOTALNUM	10180	6613	4896	4464	4162	2710	3639	4475	4645	3651
TONSLAND	1022	655	558	421	492	258	373	408	482	386
SOPCOF %	99	100	100	101	100	101	101	100	100	101

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	*2008	2009
AGE										
1	620	378	369	368	210	346	110	90	133	170
2	282	387	233	299	264	276	526	161	370	111
3	671	331	341	277	211	438	582	232	215	159
4	526	253	95	179	247	171	276	297	153	102
5	361	221	165	80	187	156	183	142	168	80
6	83	161	81	54	102	87	110	81	60	60
+gp	161	118	37	48	72	41	36	56	35	29
TOTALNUM	2704	1849	1321	1305	1293	1515	1823	1059	1134	711
TONSLAND	288	194	136	149	160	166	226	155	144	95
SOPCOF %	101	100	99	101	100	98	100	100	100	101

YEAR	2010	2011**	2012**	2013**	2014	2015	2016	2017	2018	2019
AGE										
1	149	2054	812	359	469	712	1187	530	206	554
2	39	1087	275	152	705	224	1275	1160	782	716
3	53	156	834	320	420	536	218	877	668	658
4	112	220	157	612	432	239	116	64	912	553
5	97	266	192	81	518	257	87	81	141	197
6	81	209	106	61	74	191	85	35	74	14
+gp	43	184	139	89	144	82	96	41	78	20
TOTALNUM	574	4176	2515	1674	2762	2241	3064	2788	2861	2712
TONSLAND	88	371	293	250	399	297	298	288	352	289
SOPCOF %	100	100	100	101	100	100	100	101	100	100

* Data revised in WG2010 from original value presented

** Data revised in WG2014 from original value presented

Table 6.3.5. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Catch weights-at-age (Kg).

Mean weight at age

YEAR	1986	1987	1988	1989
AGE				
1	0.041	0.046	0.043	0.045
2	0.095	0.079	0.086	0.094
3	0.113	0.086	0.098	0.114
4	0.163	0.142	0.149	0.163
5	0.215	0.175	0.191	0.223
6	0.315	0.311	0.289	0.292
+gp	0.477	0.415	0.424	0.52
SOPCOFAC	0.9502	0.9535	0.9509	0.995

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
1	0.04	0.035	0.031	0.031	0.039	0.051	0.041	0.033	0.032	0.033
2	0.091	0.085	0.075	0.073	0.063	0.044	0.08	0.062	0.061	0.058
3	0.121	0.102	0.116	0.102	0.099	0.087	0.081	0.095	0.095	0.084
4	0.165	0.145	0.155	0.146	0.13	0.126	0.127	0.126	0.13	0.118
5	0.206	0.173	0.209	0.194	0.15	0.164	0.164	0.14	0.154	0.159
6	0.24	0.251	0.318	0.235	0.19	0.21	0.21	0.198	0.189	0.216
+gp	0.369	0.42	0.534	0.538	0.344	0.34	0.354	0.341	0.324	0.296
SOPCOFAC	0.9874	1.0041	0.9983	1.005	1.0004	1.0091	1.014	1.0005	1.0047	1.0057

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	*2008	2009
AGE										
1	0.037	0.039	0.038	0.047	0.0480	0.0510	0.057	0.061	0.033	0.031
2	0.057	0.078	0.07	0.083	0.0820	0.0770	0.082	0.088	0.084	0.088
3	0.089	0.085	0.111	0.115	0.1090	0.1080	0.11	0.11	0.118	0.135
4	0.119	0.117	0.115	0.149	0.1300	0.1400	0.15	0.144	0.145	0.16
5	0.161	0.148	0.162	0.194	0.1570	0.1640	0.174	0.197	0.187	0.189
6	0.215	0.171	0.205	0.252	0.2030	0.1990	0.223	0.236	0.246	0.246
+gp	0.296	0.256	0.387	0.382	0.3190	0.3790	0.39	0.366	0.409	0.404
SOPCOFAC	1.0107	1.0046	0.9944	1.0061	1.0008	0.9847	1.0034	0.9966	1.0034	1.0062

YEAR	2010	2011**	2012**	2013**	2014	2015	2016	2017	2018	2019
AGE										
1	0.037	0.026	0.027	0.039	0.035	0.037	0.041	0.038	0.035	0.041
2	0.091	0.088	0.089	0.079	0.097	0.102	0.086	0.081	0.073	0.076
3	0.116	0.135	0.138	0.127	0.13	0.133	0.147	0.131	0.107	0.112
4	0.168	0.134	0.164	0.179	0.166	0.174	0.198	0.184	0.144	0.146
5	0.203	0.201	0.172	0.232	0.22	0.197	0.244	0.217	0.224	0.209
6	0.228	0.242	0.228	0.281	0.264	0.277	0.304	0.295	0.243	0.414
+gp	0.37	0.371	0.343	0.391	0.381	0.388	0.388	0.43	0.438	0.496
SOPCOFAC	0.9989	0.9976	1.0031	1.0124	0.9988	0.9986	1.0012	1.006	1.0033	1.0019

* Data revised in WG2010 from original value presented

** Data revised in WG2014 from original value presented

Table 6.3.6. Megrim (*L. whiffiagonis*) Divisions 8c9a. Biomass, Abundance and Recruitment indices from Portuguese and Spanish surveys.

	Biomass Index						Abundance index					Recruitment in	
												At age 1	At age 0
	Portugal (k/h)			Spain (k/30 min)			Portugal (n/h)		Spain (n/30 min)			Portugal (n)	Spain (n
	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
1984				1.92	0.34	1984			28.0	4.57	1984		0.32
1985				0.89	0.15	1985			9.0	1.34	1985		0.10
1986				1.65	0.2	1986			33.0	6.22	1986		13.78
1987				ns		1987			ns		1987		ns
1988				3.52	0.64	1988			43.0	8.82	1988		0.65
1989				3.13	0.5332	1989			42.0	7.04	1989		2.90
1990	0.08			3.08	0.86	1990			28.0	5.5	1990	5	0.11
1991	0.11			1.22	0.17	1991			10.0	1.67	1991	5	1.26
1992	0.11			1.39	0.2	1992			18.0	3.35	1992	8	0.01
1993	0.04			1.46	0.24	1993			15.0	3.23	1993	1	0.00
1994	0.05			1.02	0.2	1994			8.0	1.87	1994 +		0.60
1995	0.01			1.03	0.16	1995			11.0	1.86	1995 +		0.41
A,1996 +				1.64	0.22	A,1996			21.0	3.6	A,1996 +		0.45
1997 +		1.41	1.04	1.79	0.25	1997	7.22	4.82	20.0	3.26	1997 +		0.15
1998	0.01	0.20	0.09	1.47	0.23	1998	1.09	0.51	14.8	2.64	1998 +		0.02
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
2000 +		0.06	0.05	1.8	0.35	2000	0.27	0.17	19.4	4.46	2000 +		0.05
2001	0	0.04	0.03	1.45	0.28	2001	0.07	0.04	12.8	2.77	2001 +		0.19
2002	0.04	0.07	0.04	1.26	0.24	2002	0.21	0.10	12.1	2.65	2002 +		0.08
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
A,2004	0.01	ns		1.08	0.2	A,2004	ns		8.44	1.39	A,2004 +		0.14
2005	0.01	0.37	0.20	1.29	0.21	2005	0.71	0.35	9.76	1.73	2005 +		0.08
2006	0.02	0.29	0.18	1.03	0.18	2006	0.43	0.24	6.38	1.16	2006		0.00
2007	0	0.15	0.09	1.13	0.24	2007	0.49	0.37	6.87	1.52	2007		0.01
2008	0	0.25	0.11	0.68	0.15	2008	1.49	0.71	4.33	1.07	2008		0.00
2009	0.00	*0.05	0.03	0.80	0.12	2009	*0.19	0.10	4.17	0.59	2009		0.19
2010	0.01	0.20	0.10	0.89	0.16	2010	0.56	0.23	10.15	1.97	2010		0.01
2011	0.00	0.84	0.67	1.83	0.35	2011	1.75	1.30	17.45	3.86	2011		0.00
2012	ns	ns	ns	1.38	0.19	2012	ns	ns	9.07	1.29	2012		0.03
**2013	0	0.20	0.13	2.44	0.39	2013	0.43	0.22	15.89	2.58	2013		0.02
2014	0.02	0.30	0.18	1.34	0.21	2014	0.81	0.41	9.04	1.26	2014		0.40
2015	0.06	0.27	0.14	1.86	0.26	2015	0.89	0.39	30.75	5.64	2015		0.28
2016	0.06	0.26	0.13	2.71	0.28	2016	0.90	0.35	43.10	5.35	2016		0.02
2017	0.06	0.21	0.09	3.75	0.39	2017	2.04	1.37	50.23	6.04	2017		0.00
2018	0.04	0.18	0.11	3.42	0.30	2018	1.49	1.01	41.45	4.37	2018		0.05
2019	ns	ns	ns	3.93	0.43	2019	ns	ns	46.19	5.86	2019		0.09

\+ 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 6.3.7. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Tuning data.

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

1986	2019								
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
10	28.7	120.0	153.1	137.0	48.2	1.8	2.8	7.8	2019

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

1986	2019								
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
10	8.2	86.7	161.8	197.3	104.0	17.5	25.6	2.0	2019

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

1988	2019								
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
1	14.58	18.46	9.50	2.40	0.68	0.13	0.35	113	2019

Table 6.3.8. 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
2019	48	7.8	6.19	23	2.0	11.39	5.2	7.1	0.73

[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 6.3.9. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Tuning diagnostics.

Lowestoft VPA Version 3.1

29/04/2020 17:56

Extended Survivors Analysis

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

CPUE data from file fleetw.txt

Catch data for 34 years. 1986 to 2019. Ages 1 to 7.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SP-LCGOTBDEF	1986	2019	3	6	0	1
SP-AVSOTBDEF	1986	2019	3	6	0	1
SP-GFS	1990	2019	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 converged after 50 iterations

Regression weights

	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	0.025	0.549	0.367	0.134	0.318	0.100	0.145	0.059	0.032	0.083
2	0.041	0.251	0.127	0.107	0.420	0.246	0.26	0.207	0.116	0.151
3	0.062	0.231	0.310	0.215	0.480	0.664	0.403	0.287	0.176	0.135
4	0.142	0.392	0.385	0.395	0.502	0.558	0.287	0.196	0.549	0.216
5	0.187	0.584	0.717	0.351	0.694	0.642	0.404	0.333	0.873	0.215
6	0.322	0.780	0.488	0.522	0.632	0.600	0.451	0.281	0.58	0.185

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6
2010	6790	1060	974	935	628	325
2011	5370	5420	836	750	665	426
2012	2920	2540	3450	543	415	303
2013	3170	1660	1830	2070	303	166
2014	1900	2270	1220	1210	1140	174
2015	8300	1130	1220	617	600	468
2016	9700	6150	726	515	289	259
2017	10200	6870	3880	398	316	158
2018	7140	7900	4580	2380	268	186
2019	7700	5660	5760	3140	1130	91.5

Estimated population abundance at 1st Jan 2020

0	5810	3990	4120	2070	744

Taper weighted geometric mean of the VPA populations:

4990	3500	2170	1270	697	325

Standard error of the weighted Log(VPA populations) :

0.657	0.6639	0.577	0.5476	0.4787	0.5149

Log catchability residuals.

Fleet : SP-LCGOTBDEF

Age	1986	1987	1988	1989
1	No data for this fleet at this age			
2	No data for this fleet at this age			
3	-0.7	-0.42	-0.09	-0.86
4	-0.53	-0.74	-0.71	-0.22
5	-0.53	-0.84	-0.54	-1.04
6	-0.63	-0.85	-0.56	-0.59

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.7	-0.74	-0.73	-0.85	0.1	-0.75	-1.62	-0.08	-0.06	-0.01
4	-0.24	-0.07	-0.4	-0.55	0.3	-0.15	-0.66	-1.22	0.4	0.03
5	0.43	0.33	0.35	-0.59	1.06	-0.39	0.29	-0.3	0.07	0.13
6	-0.56	0.67	0.88	0.32	1.32	-0.19	0.48	0.52	0.9	0.21

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	0.59	0.23	0.46	-0.36	-0.54	0.3	-0.04	0.14	-0.07	0.01
4	0.69	0.47	-0.48	-0.3	-0.29	-0.53	0.13	0.35	-0.21	-0.55
5	0.5	0.17	0.65	-0.6	-0.36	-0.64	-0.47	0.3	0.05	-0.76
6	-0.16	0.3	0.03	0.02	0.05	-0.66	-0.6	-0.18	-0.07	-0.31

Age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.34	0.71	1.99	0.61	0.02	1.38	0.82	1.16	-0.01	0.46
4	0.11	0.82	1.74	0.67	-0.43	0.71	-0.05	0.52	0.8	0.61
5	-0.01	0.38	1.79	-0.16	-0.72	0.33	-0.18	0.53	0.66	0.12
6	0.47	0.21	0.99	0.29	-0.62	0.25	-0.16	0.16	0.21	-1.02

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	-6.2211	-5.8389	-5.3644	-5.3644
S.E(Log q)	0.7214	0.6059	0.5998	0.5644

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	1.15	-0.587	6	0.33	34	0.84	-6.22
4	1.28	-1.138	5.47	0.34	34	0.77	-5.84
5	1.75	-2.051	4.48	0.19	34	1	-5.36
6	0.98	0.094	5.34	0.46	34	0.56	-5.33
1							

Fleet : SP-AVSOTBDEF

Age	1986	1987	1988	1989
1	No data for this fleet at this age			
2	No data for this fleet at this age			
3	0.52	0.33	1.18	0.66
4	0.21	0.22	0.27	0.66
5	0.32	0.12	0.05	-0.41
6	0.68	0.9	1.03	0.96

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.1	-0.34	99.99	-0.68	0.51	-1.57	-1.96	0.72	0.22	0.59
4	-0.03	-0.49	99.99	-0.42	0.1	-0.39	-0.37	-0.83	0.18	0.34
5	-0.52	-0.03	99.99	-0.81	0.57	-0.21	0.54	0.1	-0.27	0.27
6	-0.78	-0.72	99.99	0.11	0.21	0.25	0.63	0.79	0.13	0.24

Age		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	1	No data for this fleet at this age									
	2	No data for this fleet at this age									
	3	0.6	0.64	0.53	-0.3	0.62	1.06	0.61	-0.27	-0.24	-0.53
	4	0.52	0.41	-0.21	-0.48	0.78	0.26	0.61	0.16	-0.4	-0.64
	5	0.04	0.12	0.36	-0.91	0.68	0.08	0.08	-0.1	-0.16	-0.57
	6	-0.6	0.12	-0.11	-0.44	0.69	-0.06	-0.26	-0.62	-0.1	0.22

Age		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	1	No data for this fleet at this age									
	2	No data for this fleet at this age									
	3	-0.27	0.34	-0.85	-0.17	-0.33	0.2	0.14	0.12	-0.91	-1.08
	4	0.51	0.65	-0.77	0.36	-0.37	0.05	0.01	-0.69	0.22	-0.45
	5	0.41	0.75	-0.55	0	-0.11	-0.05	0.16	-0.19	0.64	-0.41
	6	1.01	1.04	-0.67	0.49	-0.02	0.18	0.42	-0.08	0.41	0.43

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	-4.6084	-4.4093	-4.0618	-4.0618
S.E(Log q)	0.7259	0.4605	0.415	0.5737

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	0.98	0.089	4.67	0.4	33	0.72	-4.61
4	0.86	1.046	4.78	0.66	33	0.4	-4.41
5	0.99	0.084	4.09	0.58	33	0.42	-4.06
6	0.94	0.36	3.99	0.51	33	0.51	-3.87

Fleet : SP-GFS

Age		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	1	-0.33	-0.58	-0.19	-0.18	-1.48	-0.27	-0.04	-0.09	0.1	0.06
	2	-0.17	-0.47	-0.69	-0.19	-1.04	-1.02	-0.23	-0.14	-0.2	0.41
	3	0.03	-0.96	-0.52	-1.21	0.16	-1.53	-1.52	-0.04	0.25	0.57
	4	0.69	0.1	0.17	0.04	0.03	-0.3	-0.63	-0.71	0.05	0.23
	5	0.62	0.39	0.69	-0.29	0.37	-0.14	-0.32	-0.33	-0.4	0.26
	6	0.31	-0.06	-0.13	-0.11	-0.02	-0.06	-0.01	-0.22	0.22	0.5

Age		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	1	0.67	0.13	0.43	0.26	0.09	0.33	0.05	0.32	-0.36	-0.24
	2	0.41	0.51	0.33	0.06	0.2	-0.12	0.08	-0.14	0.1	-0.29
	3	0.69	-0.05	0.81	-0.04	-0.04	0.53	0.09	0.09	-0.08	0.09
	4	0.88	0.96	-0.75	-0.1	0.04	0.34	0.19	0.37	-0.41	-0.16
	5	0.48	0.45	0.83	-0.47	-0.21	0.45	0.18	0.49	-0.08	-0.59
	6	0.03	-0.19	-0.22	-0.33	0.29	-0.03	0.01	0.04	-0.15	-0.04

Age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	0.06	-0.2	-0.28	99.99	0.55	0.5	0.38	0.02	0.01	0.28
2	-0.43	0.38	0.04	99.99	0.43	0.55	0.36	0.55	0.2	0.53
3	-1.37	0.47	0.41	99.99	0.28	0.53	0.34	0.87	0.73	0.44
4	-0.41	-0.9	-0.27	99.99	0.23	0.34	0.03	-0.33	0.68	-0.4
5	-0.59	-0.14	-0.94	99.99	0.05	0.15	-0.19	-0.19	0.35	-0.89
6	0.13	0	-0.18	99.99	0.08	-0.09	-0.05	-0.04	-0.12	-0.05

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	-6.5816	-6.4524	-6.1988	-6.1988
S.E(Log q)	0.6907	0.4734	0.4689	0.1766

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	0.51	3.846	7.75	0.7	29	0.42	-7.11
2	0.6	2.969	7.24	0.68	29	0.45	-6.69

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	0.88	0.636	6.71	0.49	29	0.61	-6.58
4	0.82	1.348	6.56	0.68	29	0.38	-6.45
5 0.95		0.263	6.21	0.49	29	0.45	-6.2
6	0.93	1.076	6.18	0.91	29	0.16	-6.22

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2018

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	7718	0.438	0	0	1	0.639	0.063
P shrinkage mean	3499	0.66				0.302	0.134
F shrinkage mean	3574	1.5				0.059	0.131

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5806	0.36	0.33	3	0.941	0.083

Age 2 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	5119	0.319	0.261	0.82	2	0.706	0.119
P shrinkage mean	2171	0.58				0.256	0.261
F shrinkage mean	2270	1.5				0.038	0.251

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3986	0.28	0.3	4	1.071	0.151

Age 3 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-LCGOTBDEF	6518	0.732	0	0	1	0.128	0.087
SP-AVSOTBDEF	1394	0.737	0	0	1	0.126	0.356
SP-GFS	4887	0.293	0.109	0.37	3	0.711	0.115
F shrinkage mean	1193	1.5				0.035	0.405

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4120	0.25	0.23	6	0.919	0.135

1

Age 4 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	3025	0.472	0.296	0.63	2	0.185	0.153
SP-AVSOTBDEF	1180	0.396	0.2	0.51	2	0.268	0.354
SP-GFS	2509	0.258	0.262	1.01	4	0.523	0.182
F shrinkage mean	955	1.5				0.024	0.421

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2072	0.2	0.19	9	0.954	0.216

Age 5 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	1220	0.394	0.296	0.75	3	0.198	0.136
SP-AVSOTBDEF	620	0.302	0.209	0.69	3	0.357	0.253
SP-GFS	734	0.248	0.368	1.48	5	0.424	0.217
F shrinkage mean	220	1.5				0.022	0.594

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
744	0.17	0.19	12	1.089	0.215

1
Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2013

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SP-LCGOTBDEF	47	0.36	0.476	1.32	4	0.126	0.239
SP-AVSOTBDEF	79	0.293	0.29	0.99	4	0.167	0.149
SP-GFS	62	0.17	0.08	0.47	6	0.694	0.186
F shrinkage mean	61	1.5				0.012	0.189

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
62	0.14	0.11	15	0.804	0.185

Table 6.3.10. 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

At 29/04/2020 18:00

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	0.1625	0.2247	0.3744	0.1207	0.4819	0.2892	0.1444	0.1915	0.0623	0.1029	0.0662	0.0875
2	0.3907	0.5709	0.6766	0.4934	0.4541	0.6155	0.2832	0.34	0.1872	0.3174	0.3543	0.3546
3	0.3116	0.2441	0.5152	0.292	0.3608	0.2948	0.3594	0.2437	0.5561	0.1863	0.1806	0.3759
4	0.4675	0.2563	0.3375	0.601	0.5981	0.5284	0.7098	0.4321	0.5465	0.3739	0.2085	0.1182
5	0.6679	0.3985	0.6379	0.402	0.7398	1.3348	1.2829	0.5163	1.4686	0.5012	0.5883	0.4457
6	0.4495	0.206	0.4643	0.4941	0.5999	0.8453	0.5314	0.8013	1.4051	0.6112	0.6542	0.905
+gp	0.4495	0.206	0.4643	0.4941	0.5999	0.8453	0.5314	0.8013	1.4051	0.6112	0.6542	0.905
FBAR 2- 4	0.3899	0.3571	0.5097	0.4621	0.471	0.4796	0.4508	0.3386	0.4299	0.2925	0.2478	0.2829

Table 8 Fishing mortality (F) at age

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE												
1	0.1259	0.2084	0.2007	0.1361	0.1566	0.1529	0.075	0.1433	0.0544	0.0395	0.0877	0.135
2	0.3186	0.2312	0.1774	0.1856	0.1162	0.1836	0.1564	0.1335	0.3371	0.1053	0.2263	0.0981
3	0.4488	0.5202	0.5221	0.3262	0.2479	0.1972	0.1909	0.4202	0.4586	0.2433	0.1998	0.1431
4	0.5634	0.4662	0.4763	0.3794	0.1453	0.1989	0.2711	0.2334	0.5141	0.4504	0.2508	0.1371
5	0.569	0.6248	0.4529	0.3755	0.4582	0.1753	0.3296	0.2747	0.421	0.5489	0.4994	0.201
6	0.9541	0.5996	0.2187	0.374	0.2282	0.2644	0.3544	0.2508	0.3178	0.3327	0.4739	0.332
+gp	0.9541	0.5996	0.2187	0.374	0.2282	0.2644	0.3544	0.2508	0.3178	0.3327	0.4739	0.332
FBAR 2- 4	0.4436	0.4059	0.392	0.2971	0.1698	0.1932	0.2061	0.2624	0.4366	0.2663	0.2256	0.1261

Table 8 Fishing mortality (F) at age

YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	FBAR 17-19
AGE											
1	0.0246	0.5489	0.3672	0.1337	0.3177	0.0996	0.1452	0.0589	0.0324	0.0828	0.0581
2	0.0414	0.2505	0.1274	0.107	0.4203	0.2461	0.2602	0.2065	0.1159	0.1506	0.1577
3	0.062	0.231	0.3103	0.2145	0.4797	0.664	0.403	0.2873	0.1759	0.135	0.1994
4	0.1419	0.392	0.3848	0.3947	0.5018	0.5584	0.2865	0.1959	0.5494	0.2163	0.3206
5	0.1872	0.5841	0.7166	0.3507	0.6938	0.6415	0.4043	0.3326	0.8734	0.2147	0.4736
6	0.322	0.7803	0.488	0.5217	0.6324	0.5996	0.4515	0.2808	0.5805	0.1853	0.3489
+gp	0.322	0.7803	0.488	0.5217	0.6324	0.5996	0.4515	0.2808	0.5805	0.1853	
FBAR 2- 4	0.0818	0.2912	0.2742	0.2387	0.4673	0.4895	0.3166	0.2299	0.2804	0.1673	

Table 6.3.11. 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

At 29/04/2020 18:00

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE												
1	9960	12955	11734	10682	13205	5971	11513	5440	2435	9583	9271	7059
2	8123	6931	8472	6606	7752	6677	3661	8159	3678	1874	7079	7104
3	3294	4500	3206	3526	3302	4030	2954	2258	4754	2497	1117	4067
4	1921	1975	2886	1568	2156	1885	2457	1688	1449	2232	1697	763
5	1146	985	1251	1686	704	970	910	989	897	687	1257	1128
6	617	481	542	541	924	275	209	207	483	169	341	572
+gp	587	419	383	710	1351	113	180	71	170	172	184	212
TOTAL	25647	28247	28474	25321	29394	19922	21885	18812	13867	17214	20946	20904

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	3887	2884	3768	3284	2814	2868	3213	2864	2296	2566	1750	1487
2	5295	2806	1917	2524	2346	1970	2015	2441	2031	1781	2019	1313
3	4080	3153	1823	1314	1717	1710	1342	1411	1749	1187	1312	1318
4	2286	2133	1534	886	777	1097	1150	908	759	905	762	880
5	555	1066	1095	780	496	550	736	718	589	372	472	486
6	591	257	467	570	439	257	378	433	446	316	176	235
+gp	263	501	901	415	199	227	265	203	145	217	102	113
TOTAL	16958	12799	11506	9773	8787	8678	9099	8978	8016	7344	6593	5831

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

YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	GM 98-17
AGE												
1	6786	5374	2920	3170	1904	8298	9704	10233	7141	7703	0	3517
2	1064	5421	2541	1656	2270	1135	6150	6871	7898	5660	5806	
3	974	836	3455	1832	1218	1221	726	3881	4576	5759	3986	
4	935	750	543	2074	1210	617	515	398	2384	3142	4120	
5	628	665	415	303	1144	600	289	316	268	1127	2072	
6	325	426	303	166	174	468	259	158	186	91	744	
+gp	171	370	394	239	335	199	289	184	194	130	151	
TOTAL	10884	13841	10571	9439	8257	12538	17932	22041	22646	23613	16880	

Table 6.3.12. 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

At 29/04/2020 18:00

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	9960	2586	2239	705	0.3149	0.3899
1987	12955	2307	1859	537	0.2889	0.3571
1988	11734	2535	2130	858	0.4029	0.5097
1989	10682	2663	2283	761	0.3333	0.4621
1990	13205	2854	2435	1022	0.4197	0.471
1991	5971	1745	1550	655	0.4225	0.4796
1992	11513	1708	1445	558	0.3862	0.4508
1993	5440	1520	1349	421	0.3121	0.3386
1994	2435	1271	1185	492	0.4153	0.4299
1995	9583	1276	945	258	0.2729	0.2925
1996	9271	1595	1288	373	0.2896	0.2478
1997	7059	1499	1301	408	0.3135	0.2829
1998	3887	1415	1300	482	0.3707	0.4436
1999	2884	1148	1069	386	0.3612	0.4059
2000	3768	1137	1034	288	0.2785	0.392
2001	3284	859	755	194	0.2569	0.2971
2002	2814	798	711	136	0.1912	0.1698
2003	2868	916	811	149	0.1837	0.1932
2004	3213	892	774	160	0.2068	0.2061
2005	2864	894	779	166	0.213	0.2624
2006	2296	862	759	226	0.2977	0.4366
2007	2566	801	682	155	0.2271	0.2663
2008	1750	666	611	144	0.2358	0.2256
2009	1487	675	633	95	0.15	0.1261
2010	6786	883	708	88	0.1243	0.0818
2011	5374	1204	1064	371	0.3486	0.2912
2012	2920	1146	1072	293	0.2734	0.2742
2013	3170	1069	974	250	0.2567	0.2387
2014	1904	1072	1006	399	0.3967	0.4673
2015	8298	1017	803	297	0.3697	0.4895
2016	9704	1397	1081	298	0.2756	0.3166
2017	10233	1721	1409	288	0.2044	0.2299
2018	7141	1849	1627	352	0.2164	0.2804
2019	7703	2188	1936	289	0.1493	0.1673
Arith. Mean	6080	1417	1224	369	0.287	0.3228
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.3.13. Megrim (*L. whiffiagonis*) in Division 8c9a. Prediction with management option table: Input data.

MFDP version 1a
Run: meg
Time and date: 19:42 01/05/2020
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

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	3517	0.2	0.34	0	0	0.038	0.0067	0.062	0.0623	0.036
	2	5806	0.2	0.9	0	0	0.084	0.1127	0.098	0.0470	0.057
	3	3986	0.2	1	0	0	0.126	0.2282	0.131	0.0118	0.083
	4	4120	0.2	1	0	0	0.169	0.2721	0.170	0.0057	0.109
	5	2072	0.2	1	0	0	0.218	0.3790	0.219	0.0019	0.066
	6	744	0.2	1	0	0	0.307	0.3173	0.307	0.0012	0.017
	7	151	0.2	1	0	0	0.428	0.3185	0.428	0.0000	0.038

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	3517	0.2	0.34	0	0	0.038	0.0067	0.062	0.0623	0.036
	2		0.2	0.9	0	0	0.084	0.1127	0.098	0.0470	0.057
	3		0.2	1	0	0	0.126	0.2282	0.131	0.0118	0.083
	4		0.2	1	0	0	0.169	0.2721	0.170	0.0057	0.109
	5		0.2	1	0	0	0.218	0.3790	0.219	0.0019	0.066
	6		0.2	1	0	0	0.307	0.3173	0.307	0.0012	0.017
	7		0.2	1	0	0	0.428	0.3185	0.428	0.0000	0.038

Age	2022	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	3517	0.2	0.34	0	0	0.038	0.007	0.062	0.062	0.036
	2		0.2	0.9	0	0	0.084	0.113	0.098	0.047	0.057
	3		0.2	1	0	0	0.126	0.228	0.131	0.012	0.083
	4		0.2	1	0	0	0.169	0.272	0.170	0.006	0.109
	5		0.2	1	0	0	0.218	0.379	0.219	0.002	0.066
	6		0.2	1	0	0	0.307	0.317	0.307	0.001	0.017
	7		0.2	1	0	0	0.428	0.319	0.428	0.000	0.038

Input units are thousands and kg - output in tonnes

Table 6.3.14. Megrim (*L. whiffiagonis*) in Div. 8c and 9a catch forecast: management options table.

MFDP version 1a
Run: meg
Time and date: 19:42 01/05/2020
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

2020		Catch	Landings		Discards	
Biomass	**SSB**	**FMult**	**FBar**	**Yield**	**FBar**	**Yield**
2565	2427	1	0.2043	506	0.0215	25

2021		Catch	Landings		Discards		2022	
Biomass	**SSB**	**FMult**	**FBar**	**Yield**	**FBar**	**Yield**	**Biomass**	**SSB**
2446	2334	0	0.0000	0	0.0000	0	2907	2794
.	2334	0.1	0.0204	60	0.0022	2	2833	2720
.	2334	0.2	0.0409	118	0.0043	4	2760	2648
.	2334	0.3	0.0613	174	0.0065	6	2690	2578
.	2334	0.4	0.0817	229	0.0086	7	2622	2510
.	2334	0.5	0.1022	282	0.0108	9	2556	2444
.	2334	0.6	0.1226	333	0.0129	11	2492	2380
.	2334	0.7	0.1430	383	0.0151	13	2430	2318
.	2334	0.8	0.1635	431	0.0172	14	2370	2258
.	2334	0.9	0.1839	479	0.0194	16	2311	2199
.	2334	1	0.2043	524	0.0215	18	2254	2143
.	2334	1.1	0.2248	569	0.0237	19	2199	2088
.	2334	1.2	0.2452	612	0.0258	21	2146	2034
.	2334	1.3	0.2656	654	0.0280	23	2094	1982
.	2334	1.4	0.2861	694	0.0301	24	2043	1932
.	2334	1.5	0.3065	734	0.0323	26	1994	1883
.	2334	1.6	0.3269	772	0.0344	27	1947	1836
.	2334	1.7	0.3474	810	0.0366	29	1900	1790
.	2334	1.8	0.3678	846	0.0387	30	1855	1745
.	2334	1.9	0.3882	881	0.0409	32	1812	1702
.	2334	2	0.4087	915	0.0430	33	1770	1660

Input units are thousands and kg - output in tonnes

Table 6.3.15. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Single option prediction. Detailed tables.

MFDP version 1a
Run: meg
Time and date: 19:42 01/05/2020
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

Year: 2020 F multiplier: 1 Fleet1 HCFbar: 0.2043 Fleet1 DFbar: 0.0215

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0067	21	1	0.0623	192	7	3517	135	1196	46	1196	46
2	0.1127	550	54	0.047	229	13	5806	485	5225	437	5225	437
3	0.2282	736	96	0.0118	38	3	3986	502	3986	502	3986	502
4	0.2721	891	152	0.0057	19	2	4120	697	4120	697	4120	697
5	0.379	596	130	0.0019	3	0	2072	452	2072	452	2072	452
6	0.3173	184	57	0.0012	1	0	744	228	744	228	744	228
7	0.3185	38	16	0	0	0	151	65	151	65	151	65
Total		3015	506		482	25	20396	2565	17494	2427	17494	2427

Year: 2021 F multiplier: 1 Fleet1 HCFbar: 0.2043 Fleet1 DFbar: 0.0215

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0067	21	1	0.0623	192	7	3517	135	1196	46	1196	46
2	0.1127	254	25	0.047	106	6	2687	225	2419	202	2419	202
3	0.2282	748	98	0.0118	39	3	4052	511	4052	511	4052	511
4	0.2721	555	95	0.0057	12	1	2567	434	2567	434	2567	434
5	0.379	734	161	0.0019	4	0	2555	558	2555	558	2555	558
6	0.3173	287	88	0.0012	1	0	1159	355	1159	355	1159	355
7	0.3185	132	57	0	0	0	533	228	533	228	533	228
Total		2732	524		353	18	17071	2446	14481	2334	14481	2334

Year: 2022 F multiplier: 1 Fleet1 HCFbar: 0.2043 Fleet1 DFbar: 0.0215

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0067	21	1	0.0623	192	7	3517	135	1196	46	1196	46
2	0.1127	254	25	0.047	106	6	2687	225	2419	202	2419	202
3	0.2282	346	45	0.0118	18	1	1876	236	1876	236	1876	236
4	0.2721	565	96	0.0057	12	1	2610	442	2610	442	2610	442
5	0.379	458	100	0.0019	2	0	1592	347	1592	347	1592	347
6	0.3173	354	109	0.0012	1	0	1429	438	1429	438	1429	438
7	0.3185	250	107	0	0	0	1007	431	1007	431	1007	431
Total		2248	484		332	16	14718	2254	12128	2143	12128	2143

Input units are thousands and kg - output in tonnes

Table.6.3.16. Megrim (*L. whiffagonis*) 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 1 year-olds	10233	7141	7703	3517	3517
Source	XSA	XSA	XSA	GM98-17	GM98-17
Status Quo F:					
% in 2020 catch	29.0	18.6	12.6	1.5	-
% in 2021	29.7	17.7	18.6	5.7	1.5
% in 2020 SSB	28.7	20.7	18.0	1.9	-
% in 2021 SSB	23.9	18.6	21.9	8.7	2.0
% in 2022 SSB	20.4	16.2	20.6	11.0	9.4

GM : geometric mean recruitment

Megrim (L. whiffiagonis) in Divisions 8c and 9a : Year-class % contribution to

a) 2021 catches b) 2022 SSB

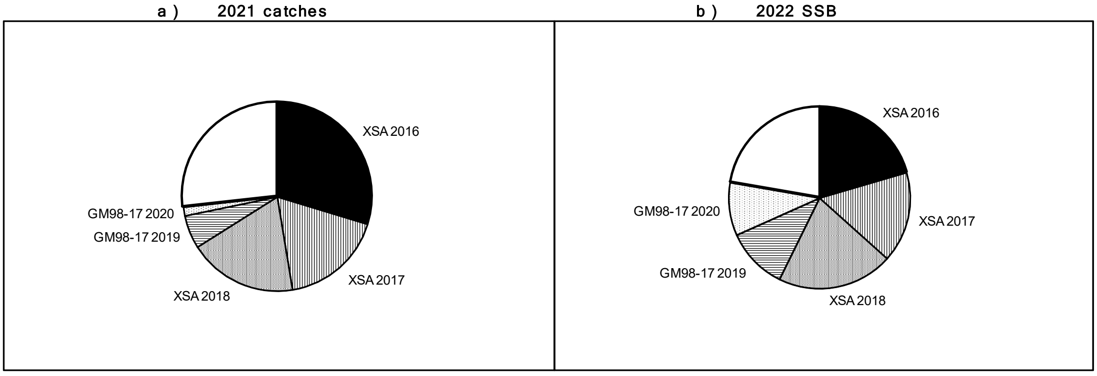


Table 6.3.17. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a, yield-per-recruit results.

MFYPR version 2a
Run: meg
Time and date: 20:00 01/05/2020
Yield per results

Catch FMult	Landings Fbar	CatchNos	Yield	Discards Fbar	CatchNos	Yield	StockNos	Biomass	pwnNosJa	SSBJan	wnNosSpv	SSBSpwn
0	0	0	0	0	0	0	5.5167	1.2062	4.7748	1.174	4.7748	1.174
0.1	0.0204	0.0942	0.026	0.0022	0.0101	0.0005	4.9972	1.0084	4.2559	0.9762	4.2559	0.9762
0.2	0.0409	0.1638	0.0431	0.0043	0.02	0.001	4.6013	0.8621	3.8605	0.83	3.8605	0.83
0.3	0.0613	0.217	0.0545	0.0065	0.0297	0.0014	4.289	0.7503	3.5488	0.7182	3.5488	0.7182
0.4	0.0817	0.2585	0.0621	0.0086	0.0391	0.0019	4.0358	0.6626	3.2962	0.6306	3.2962	0.6306
0.5	0.1022	0.2916	0.0671	0.0108	0.0484	0.0023	3.8261	0.5923	3.087	0.5604	3.087	0.5604
0.6	0.1226	0.3183	0.0704	0.0129	0.0575	0.0027	3.6491	0.5351	2.9106	0.5031	2.9106	0.5031
0.7	0.143	0.34	0.0724	0.0151	0.0663	0.0031	3.4975	0.4877	2.7595	0.4558	2.7595	0.4558
0.8	0.1635	0.358	0.0735	0.0172	0.075	0.0035	3.366	0.448	2.6285	0.4162	2.6285	0.4162
0.9	0.1839	0.3729	0.07	0.0194	0.0835	0.0039	3.25	0.4144	2.5137	0.3826	2.5137	0.3826
1	0.2043	0.3853	0.0741	0.0215	0.0919	0.0043	3.1484	0.3856	2.412	0.3539	2.412	0.3539
1.1	0.2248	0.3956	0.0739	0.0237	0.1	0.0047	3.057	0.3608	2.3211	0.3291	2.3211	0.3291
1.2	0.2452	0.4043	0.0734	0.0258	0.1081	0.005	2.9748	0.3392	2.2394	0.3076	2.2394	0.3076
1.3	0.2656	0.4117	0.0727	0.028	0.1159	0.0054	2.9002	0.3203	2.1654	0.2887	2.1654	0.2887
1.4	0.2861	0.4178	0.072	0.0301	0.1237	0.0057	2.8323	0.3036	2.0979	0.272	2.0979	0.272
1.5	0.3065	0.4229	0.0712	0.0323	0.1313	0.0061	2.77	0.2887	2.0362	0.2572	2.0362	0.2572
1.6	0.3269	0.4272	0.0703	0.0344	0.1387	0.0064	2.7126	0.2755	1.9793	0.244	1.9793	0.244
1.7	0.3474	0.4307	0.0694	0.0366	0.1461	0.0067	2.6596	0.2636	1.9268	0.2322	1.9268	0.2322
1.8	0.3678	0.4336	0.0685	0.0387	0.1533	0.007	2.6103	0.2529	1.878	0.2215	1.878	0.2215
1.9	0.3882	0.4359	0.0676	0.0409	0.1603	0.0073	2.5644	0.2432	1.8326	0.2118	1.8326	0.2118
2.0	0.4087	0.4378	0.0667	0.0430	0.1673	0.0076	2.5214	0.2343	1.7901	0.203	1.7901	0.203

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar(2-4	1	0.2043
FMax	0.9661	0.1974
F0.1	0.5519	0.1128
F35%SPR	0.8148	0.1665

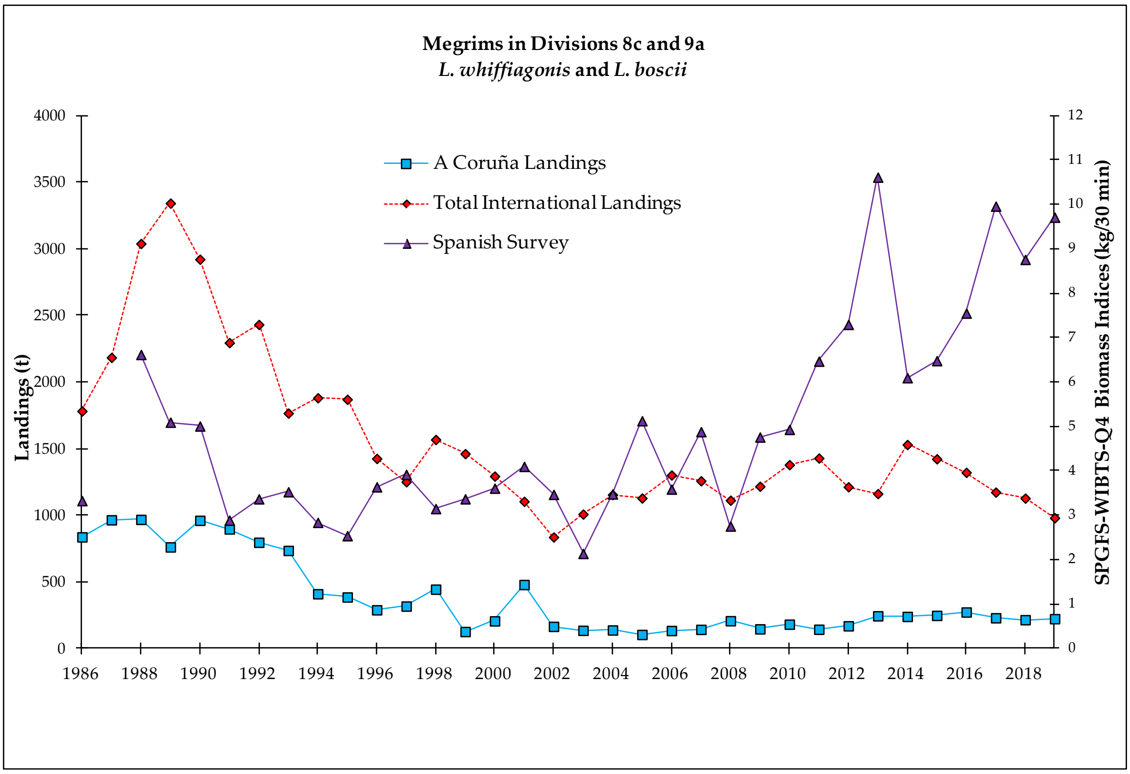


Figure 6.3.1. Historical landings and biomass indices of Spanish survey of megrims (both species combined).

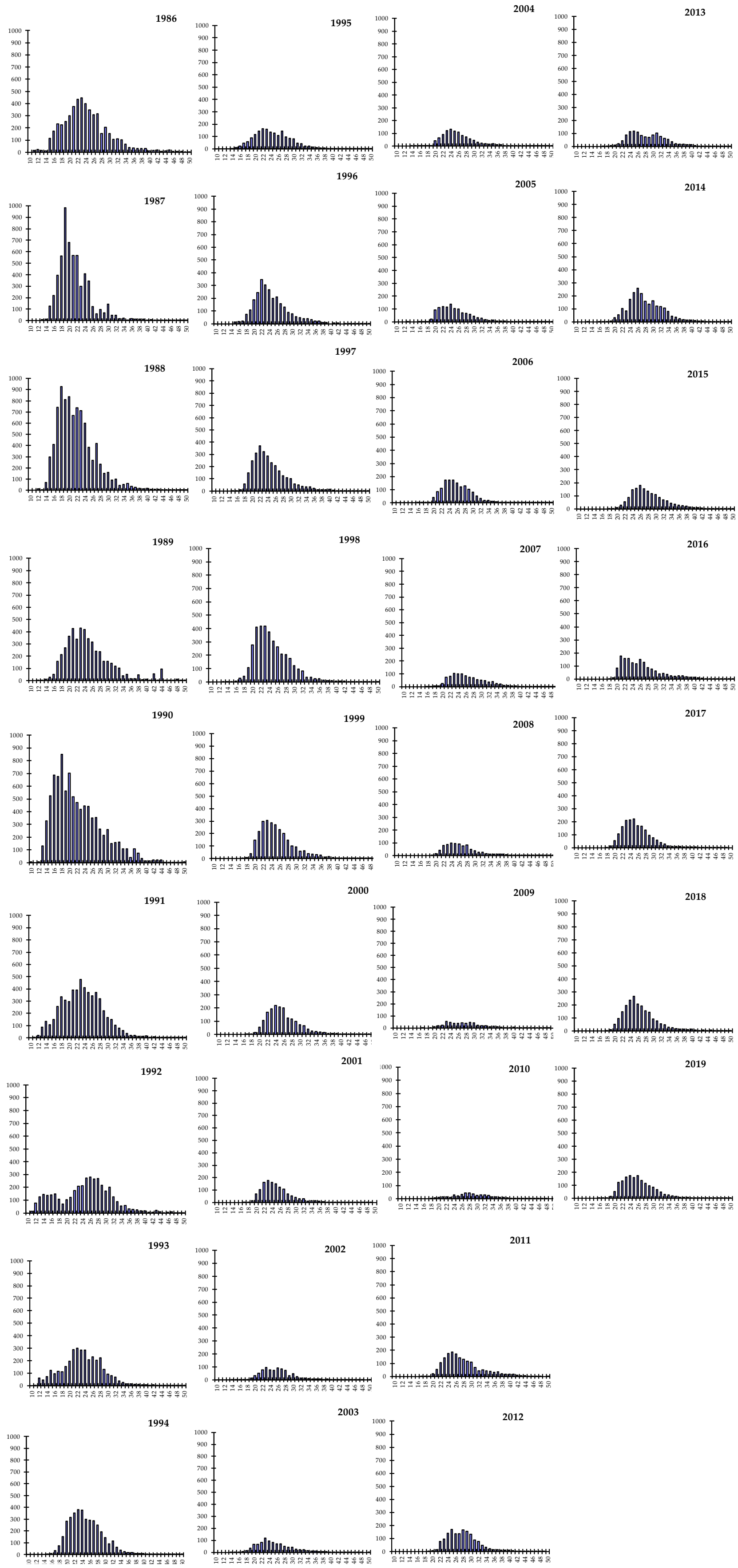


Figure 6.3.2. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Annual length compositions of landings ('000).

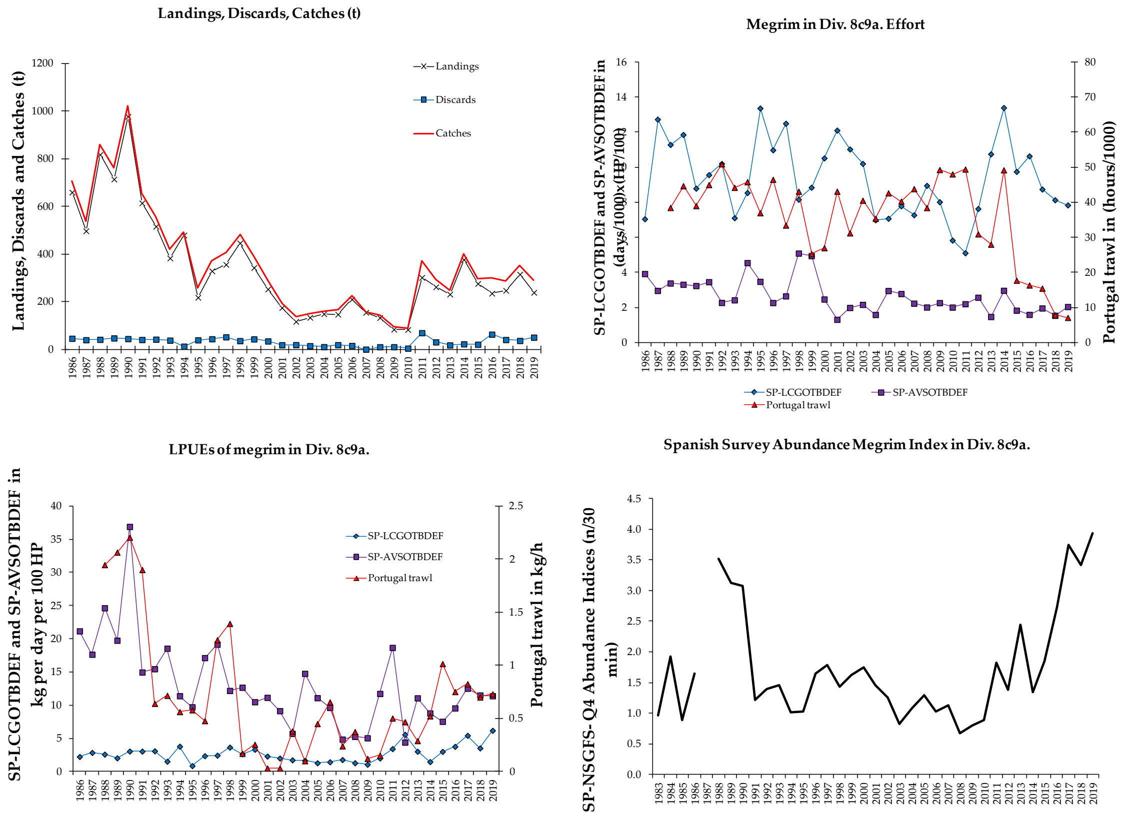
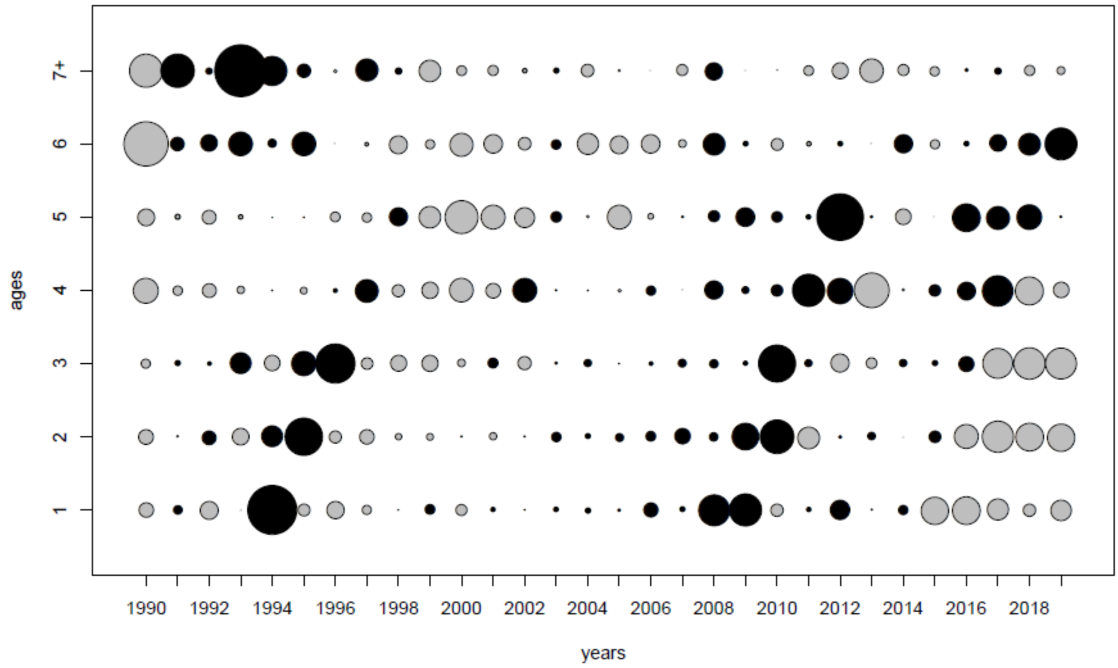


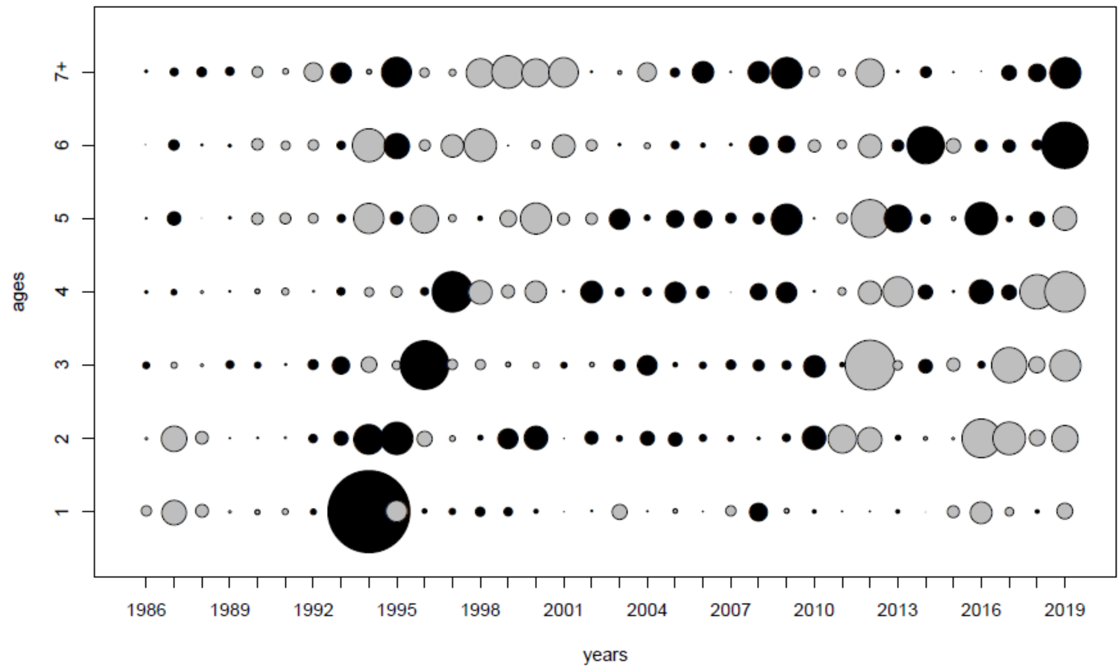
Figure 6.3.3a. Megrim (*L.whiffiagonis*) in Divisions 8c9a. Catches (t), Efforts, LPUEs and Abundance Indices.



*** 2013 data not included in the assessment**

Figure 6.3.3b. Megrim (*L. whiffiagonis*) in Divisions 8c & 9a. Standardized log (abundance index at age) from survey SP-NSGFS-Q4 (Bubbles colour scale: black – negative, grey – positive).

Standardized log (abundance index at age) from A Coruña fleet (SP-LCGOTBDEF).



Standardized log (abundance index at age) from Avilés fleet (SP-AVSOTBDEF).

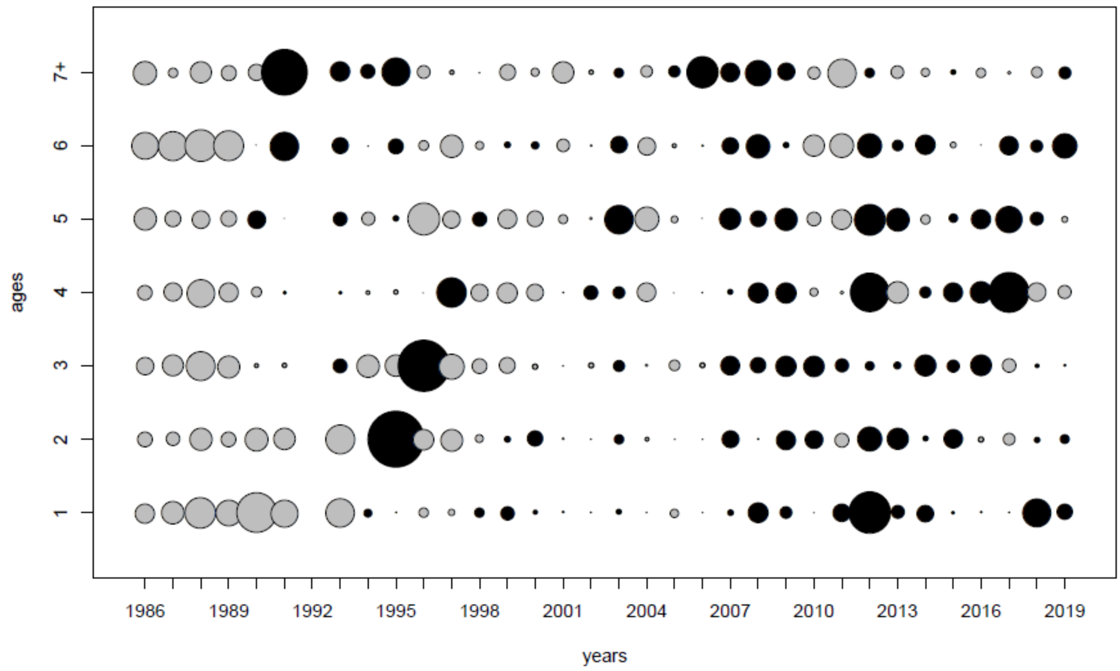
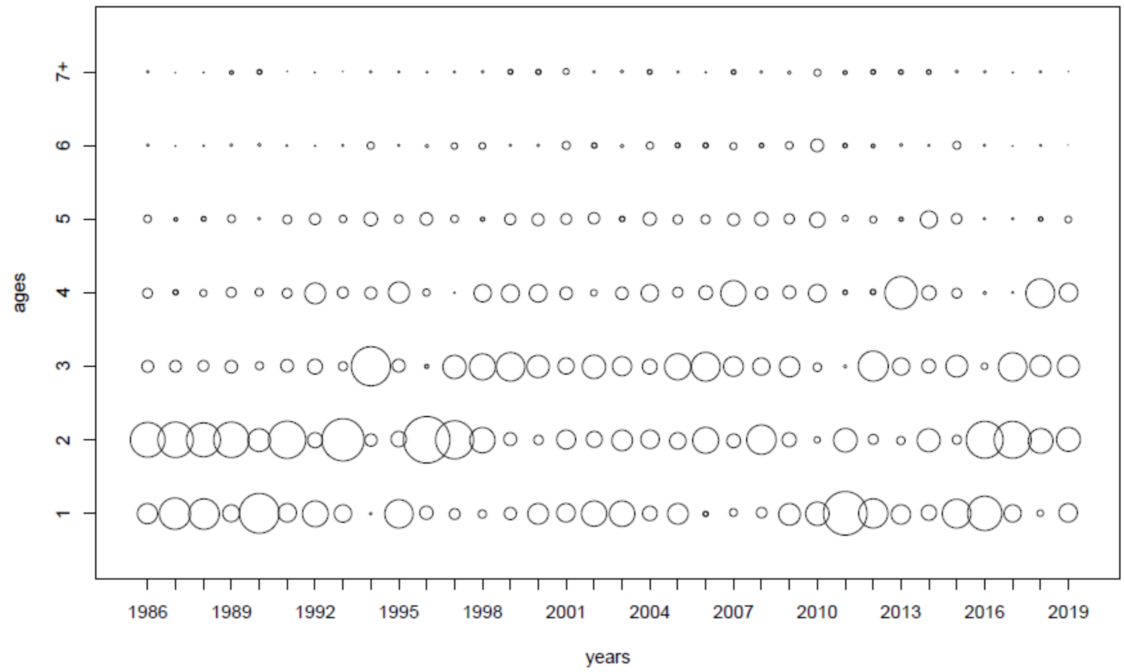


Figure 6.3.3c. Megrim (*L. whiffiagonis*) in Divisions 8c & 9a. Standardized log (abundance index at age) from A Coruña SP-LCGOTBDEF) and Avilés (SP-AVSOTBDEF) fleets. Bubbles colour scale: black – negative, grey – positive.

Catches proportions at age



Standardized catches proportions-at-age (Bubbles colour scale: black – negative, grey – positive)

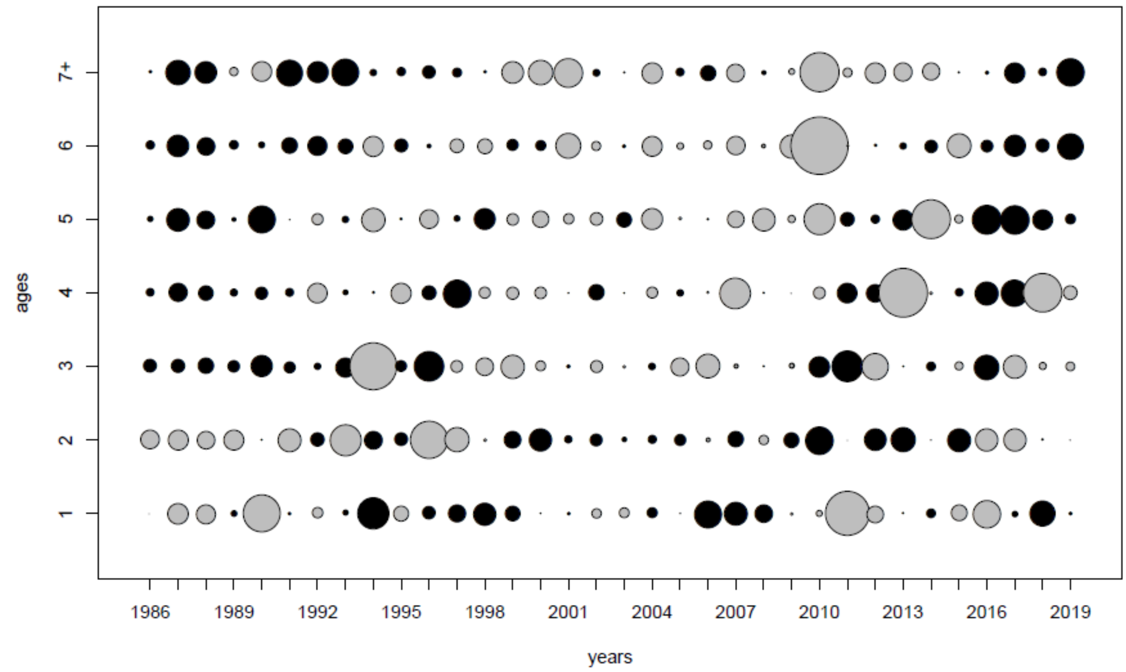
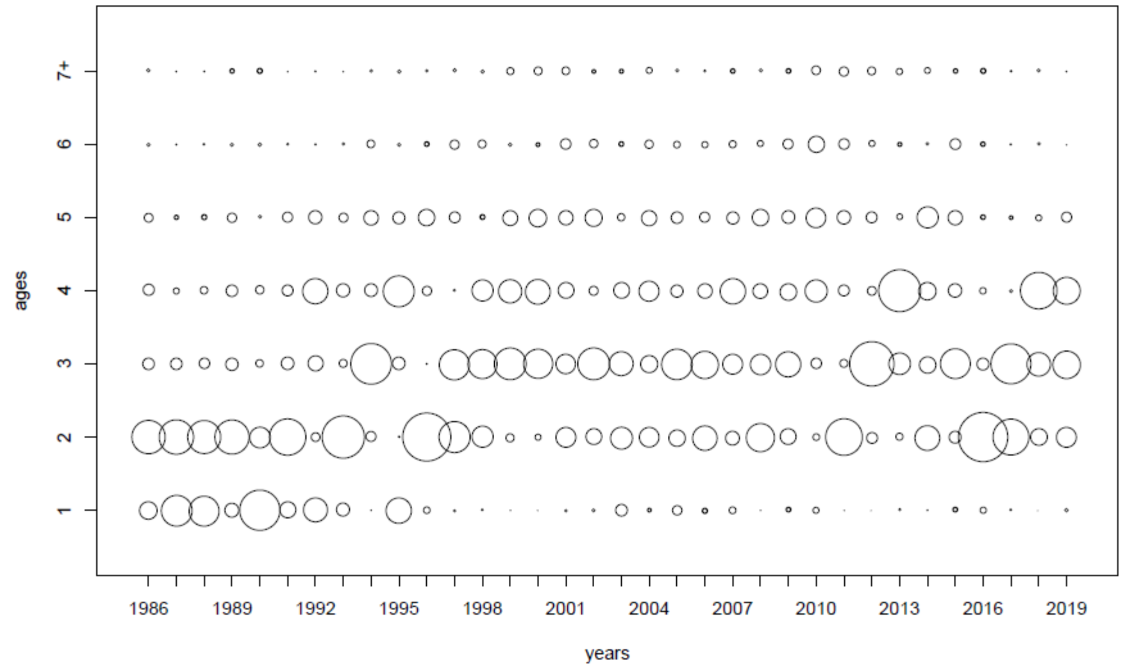


Figure 6.3.4a. Megrim (*L. whiffiagonis*) in Divisions 8c & 9a. Catch proportions-at-age.

Landings proportions-at-age



Standardized landings proportions-at-age (Bubbles colour scale: black – negative, grey – positive)

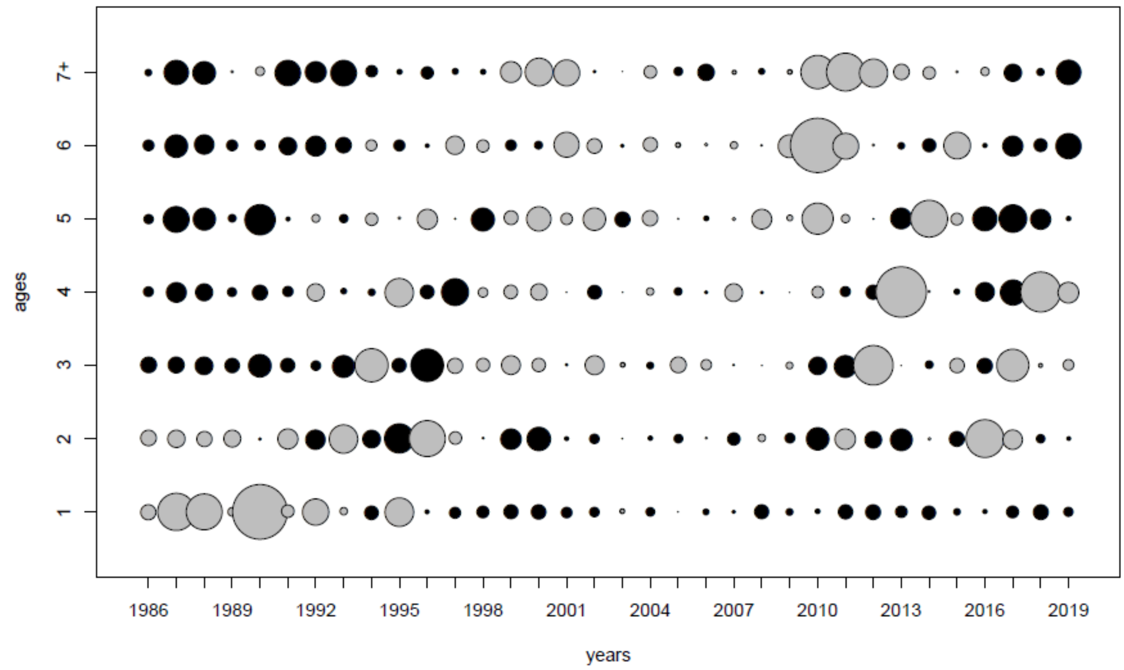
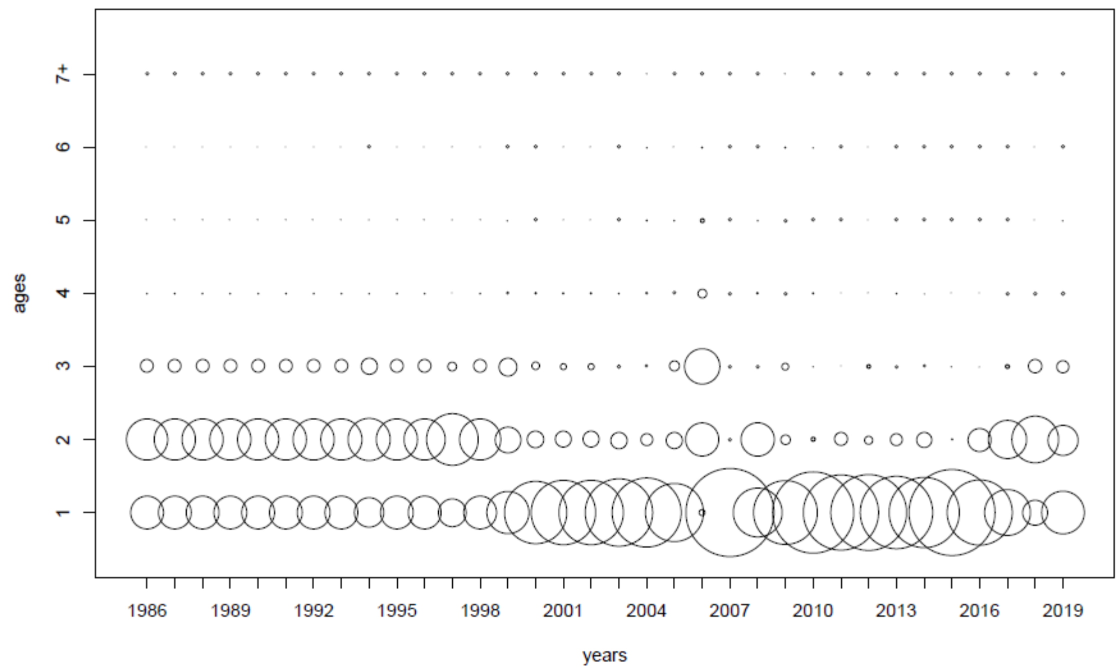


Figure 6.3.4b. Megrim (*L. whiffiagonis*) in Divisions 8c & 9a. Landings proportions-at-age.

Discards proportions-at-age



Standardized discards proportions-at-age (Bubbles colour scale: black – negative, grey – positive)

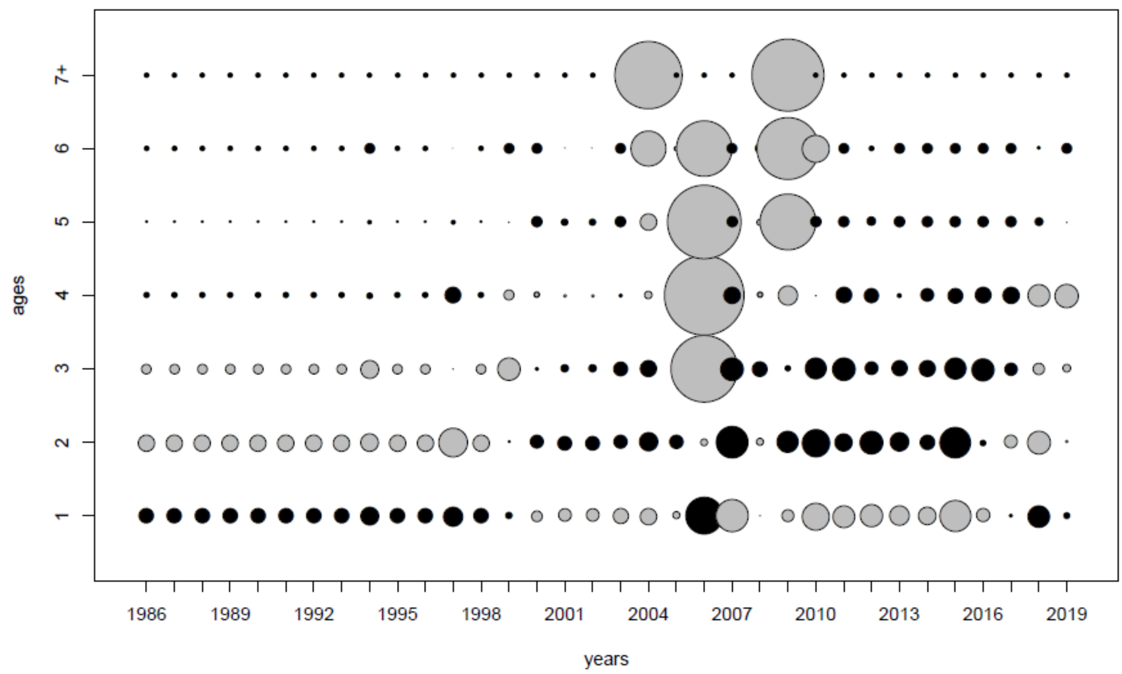


Figure 6.3.4c. Megrim (*L. whiffiagonis*) in Divisions 8c & 9a. Discards proportions-at-age.

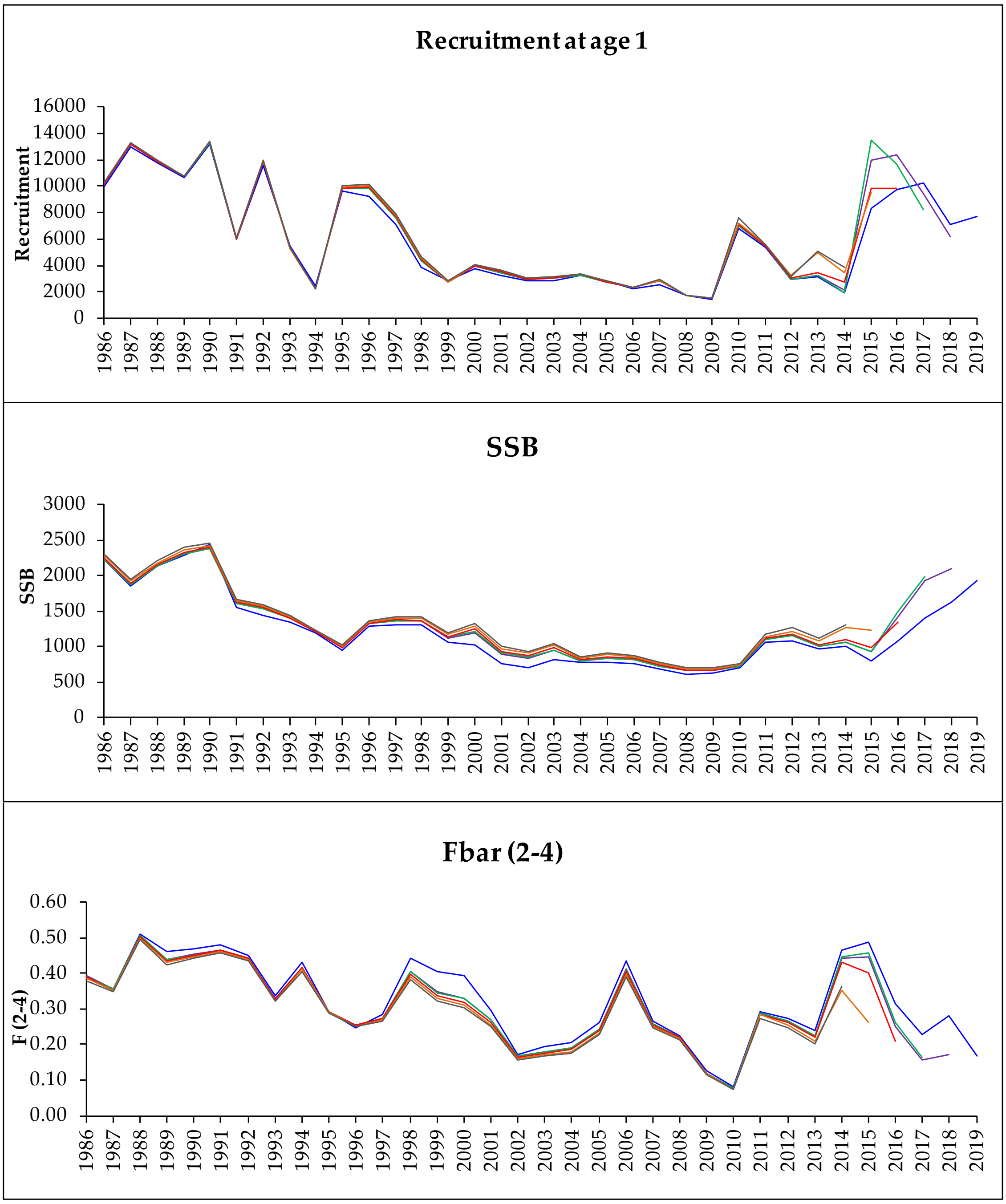


Figure 6.3.5. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Retrospective XSA.

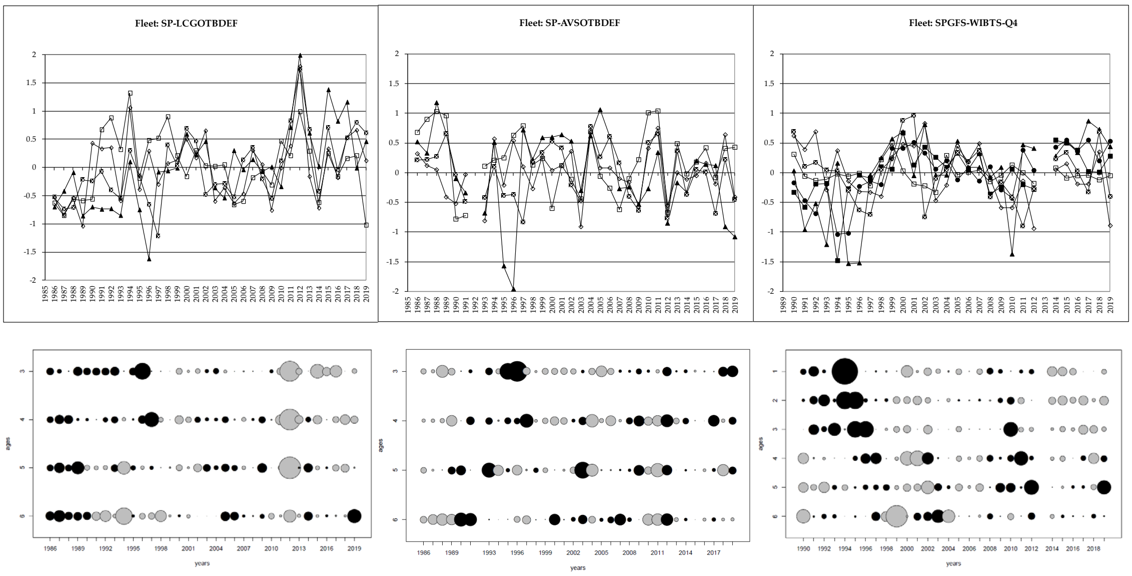


Figure 6.3.6. Megrim in Divisions 8c and 9a. Log catchability residual plots (XSA).

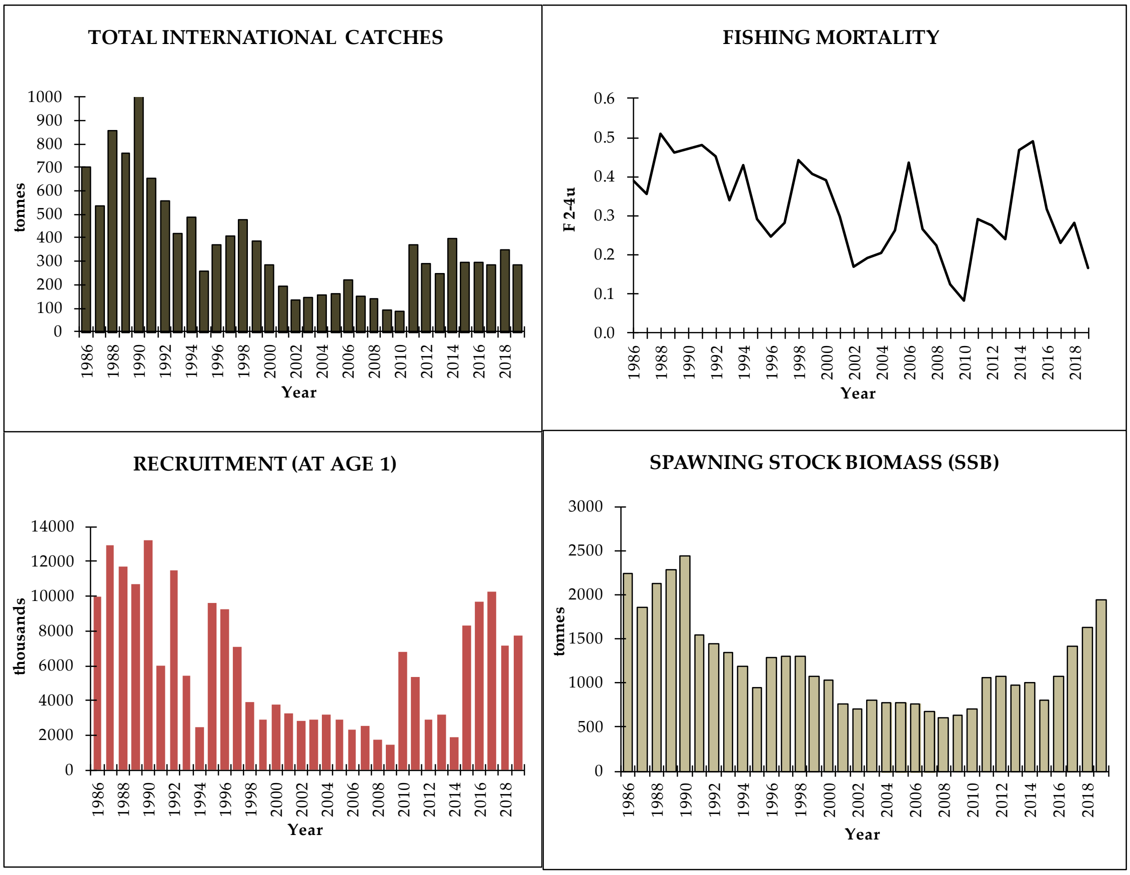
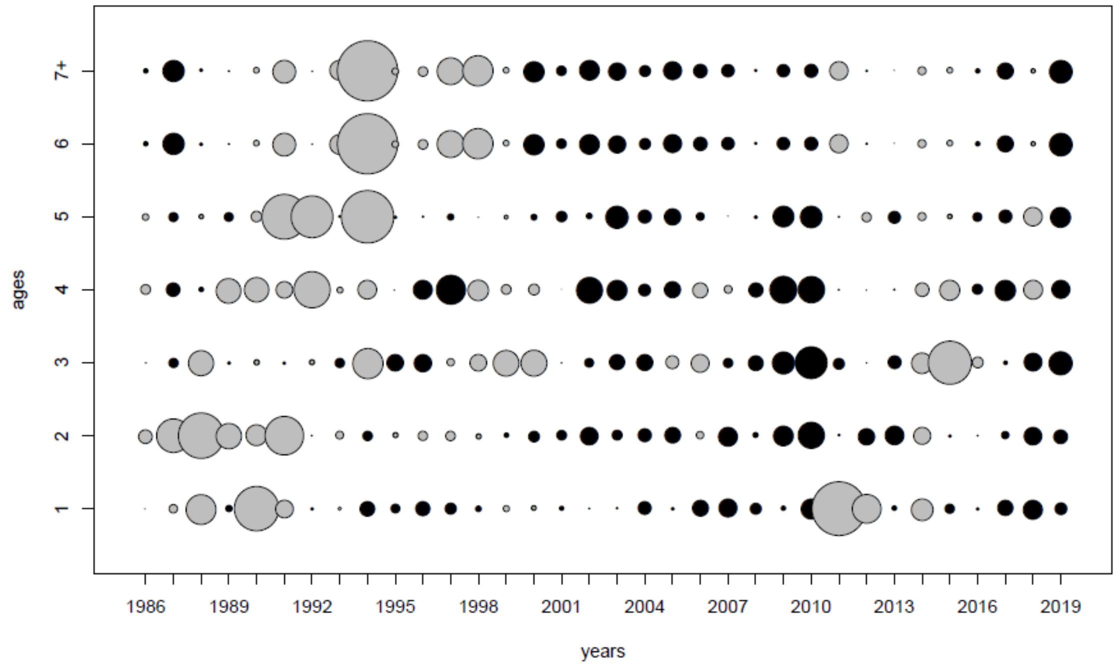


Figure 6.3.7a. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a. Stock Summary.

Standardized F-at-age (Bubbles colour scale: black – negative, grey – positive)



Standardized relative F-at-age (Bubbles colour scale: black – negative, grey – positive)

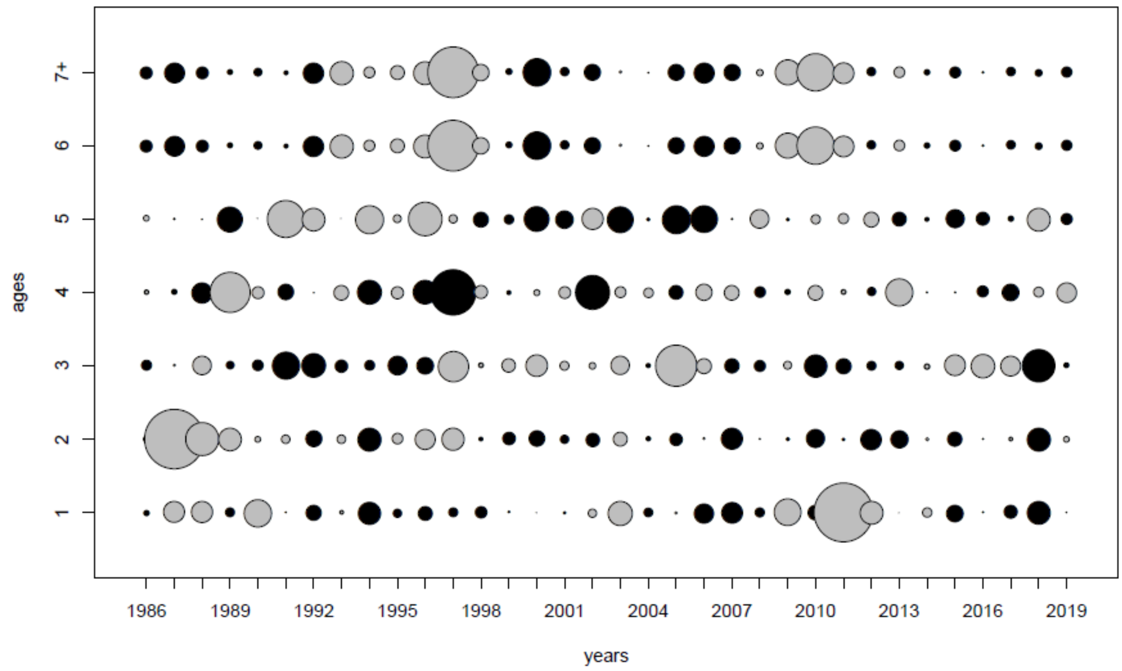
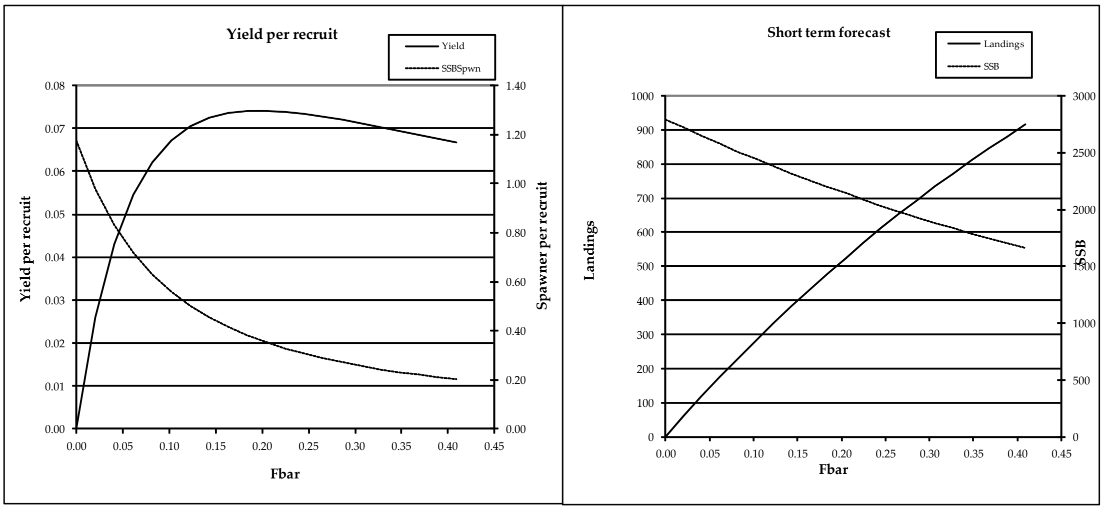


Figure 6.3.7b. Megrim (*L. whiffiagonis*) in Divisions 8c & 9a. F-at-age.



MFYPR version 2a
Run: meg
Time and date: 20:00 01/05/2020

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar	1.0000	0.2043
FMax	0.9661	0.1974
F0.1	0.5519	0.1128
F35%SPR	0.8148	0.1665

MFDP version 1a
Run: meg
Time and date: 19:42 01/05/2020
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

Input units are thousands and kg - output in tonnes

Figure 6.3.8. Megrim (*L. whiffiagonis*) in Divisions 8c and 9a, forecast summary.

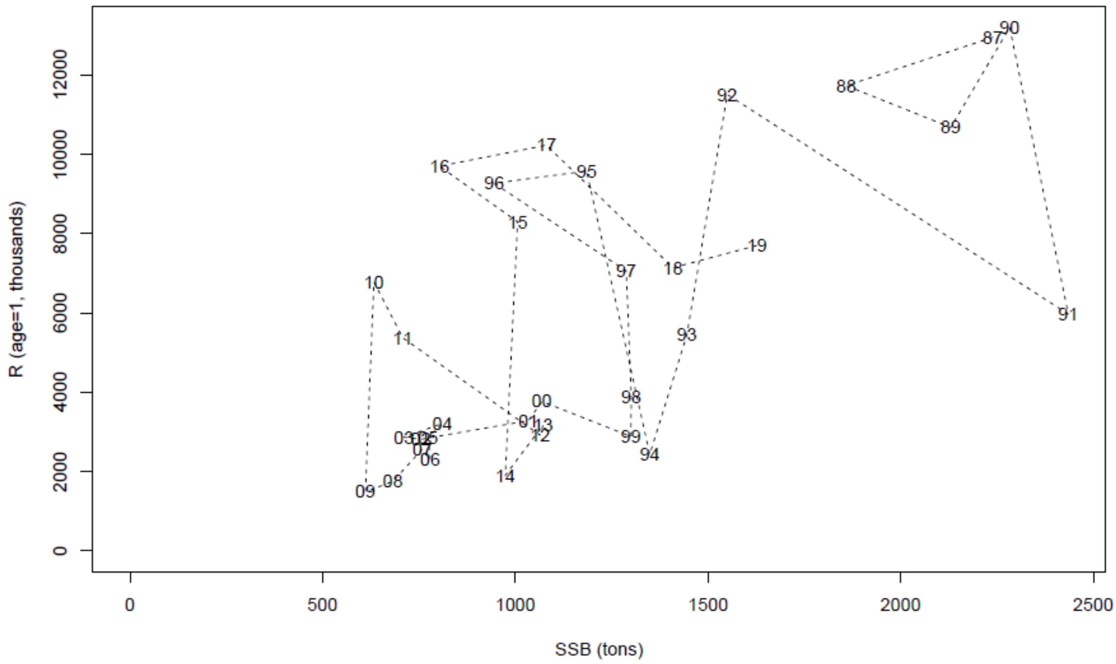


Figure 6.3.9. Megrim (*L.whiffiagonis*) in Divisions 8c and 9a. SSB-Recruitment plot (numbers in graph, 1987–2019, are recruitment years).

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 2019 are given in Table 6.4.1. 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 the period 2011-2013 were provided. This revision produced an improvement in the allocation of sampling trips and the data revised are used in the assessment. Landings reached a peak of 2 629 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 1 297 t, the highest value after 1995. In 2019, the landings value of 742 t is one of the lowest of the time-series.

Discards estimates were available from "observers' onboard sampling programme" for Spain in the years displayed in Table 6.4.2,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 WKSOUTH benchmark in 2014 (ICES, 2014). Spanish discards in numbers-at-age are shown in Table 6.4.2b, indicating that the bulk of discards (in numbers) is for ages 1 to 3. Total discards are given in tons in Table 6.4.1

6.4.2.2 Biological sampling

Annual length compositions of total stock landings are provided in Figure 6.4.1 for the period 1986-2019 and in Table 6.4.3a for the year 2019.

Mean length and mean weight in landings since 1990 are shown in the Table 6.4.3b.

Age compositions of catches are presented in Table 6.4.4. Weights-at-age of catches (given in Table 6.4.5) 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 6.4.6.

Two Portuguese surveys, named "Crustacean" (PT-CTS (UWTV(FU28-29))) and "October" (PtGFS-WIBTS-Q4), provide biomass and abundance indices. The October survey was conducted with a different vessel and gear in 2003 and 2004. Excluding these two years, the biomass index 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 and last year, 2019 Portuguese Surveys were not carried out. Total biomass, abundance and recruitment indices from the Spanish Groundfish Survey (SP-NSGFS-Q4) are also presented in Table 6.4.6. Total biomass indices from this survey generally remained stable after a maximum level in 1988 until 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 a period of higher values until the 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 reason that for *L. whiffiagonis*, i.e. the survey carried out in a new vessel, the abundance value of 2013 was not included in the assessment model. In 2017, the survey presents the second highest value in both indices and in 2019 the third one.

The recruitment index for age 0 in 2005 was very high and also in 2009 and 2014. The 2019 value is low. The high index in 2009 applies to all ages and not just the recruitment (see Table 6.4.7, which gives abundance indices by age, and Figure 6.4.2, 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 appear to be above average. From Figure 6.4.2, the survey appears to have been quite good in tracking cohorts in the last ten years, the stronger cohorts of 2005, 2009 and 2014 can be followed, especially the last two.

6.4.2.4 Commercial catch-effort data

Two new commercial tuning indices were also provided for this stock as in the case of *L. whiffiagonis*. The LPUEs of the métiers of bottom otter trawl targeting demersal species, previously described in section 6.1.2.4, one per port (A Coruña and Avilés), were made available for the WKSOUTH benchmark in 2014 (ICES, 2014). From these new tuning fleets, SP-LCGOTBDEF and SP-AVSOTBDEF, only the first one was accepted to tune the assessment model. The LPUE and effort values and landed numbers-at-age are given in Table 6.4.7 and Figure 6.4.3a.

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 6.4.8 displays landings (in tonnes), fishing effort and LPUE for the Spanish trawl fleets SP-LCGOTBDEF for the period 1986-2019, SP-AVSOTBDEF for the period 1986-2015 and for the Portuguese trawl fleet fishing in Division 9a for the period 1988–2019 (see also Figure 6.4.3). As SP-AVSOTBDEF is not used in the assessment, the sampling for this species in this port has been suspended since 2015. After very high value in 2010 and a drop in the two following years, the LPUE of Coruña (SP-LCGOTBDEF) shows in 2019 a small decrease relative to the previous year. The Portuguese LPUE series was revised from 2012 onwards. To revise the series backwards, further refinement of the algorithms is required.

6.4.2.4.1.1 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 2019, as indicated in the Stock Annex. In Figure 6.4.3b, 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 the SP-LCGOTBDEF fleet had been generally stable until year 2009, when effort is declining to its lowest value in the series, reached in 2011. After this year, the effort began to increase until 2014 when the highest value of the time-series was observed. The 2019 value represents a small decrease relative to previous year.

6.4.2.4.1.2 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 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 from 1992 to 2001, followed by an increase until 2010, when the values started a decreasing trend. Since 2014, there is an increasing trend and the 2019 value is the highest observed over the years.

6.4.3 Assessment

An update assessment was conducted, according to the Stock Annex specifications. Assessment years are 1986-2019 and ages 0-7+.

6.4.4 Model

6.4.4.1.1.1 Data screening

Figures 6.4.4a, b and c are bubble plots representing catch, landings and discards proportions-at-age, respectively. 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 6.4.4a, b and c also present bubble plots corresponding to standardized catch, landings and discards proportions-at-age, respectively, 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 stronger cohorts corresponding to year classes of 1991, 1992, 1995, 2005 and 2009 can also be tracked.

6.4.4.1.1.2 Final XSA run

Settings for the assessment are those detailed in the Stock Annex.

The retrospective analysis shows no particular worrying features (Figure 6.4.5). The model has a tendency to underestimate F and an overestimate SSB in the last years.

6.4.4.2 Assessment results

Diagnostics from the XSA final run are presented in Table 6.4.9 and log catchability residuals plotted in Figure 6.4.6. 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 6.4.10 presents the fishing mortality-at-age estimates. F_{bar} (=$F_{2\text{-}4}$) is estimated to be 0.15 in 2019.

Population numbers-at-age estimates are presented in Table 6.4.11.

6.4.4.3 Year class strength and recruitment estimations

The 2017 year class estimate is 25 million individuals, obtained by averaging estimates coming from the Spanish survey tuning data (97% of weight) and F-shrinkage (3% weight).

The 2018 year class estimate is 40 million individuals, estimated from the Spanish survey (95% of weight) and F-shrinkage (5% weight).

The 2019 year class estimate is 30 million individuals, obtained a value from the Spanish survey (100% weight).

The working group considered that the XSA last year recruitment is poorly estimated (ICES, 2019). Following the procedure stated in the Stock Annex, the geometric mean of estimated recruitment over the years 1990–2017 has been used for the computation of 2019 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
2017	25800	XSA	97%	-	3%
2018	40300	XSA	95%	-	5%
2019	43332	GM_{90-17}		-	
2020	43332	GM_{90-17}			

6.4.4.4 Historic trends in biomass, fishing mortality, and recruitment

Estimated fishing mortality and population numbers-at-age from the XSA run are given in Tables 6.4.10 and 6.4.11. Further results, including SSB estimates, are summarised in Table 6.4.12 and Figure 6.4.7a.

SSB decreased gradually from 6 713 t in 1988 to 3 181 t in 2001, the lowest value in the series, and has since increased. In 2019, the SSB was estimated at 6 524 t, one of 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 third one in the series. Last year value is considered below the average.

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 at a lower level, with small ups and downs. From 2007, the F has been decreasing until 2013. After two years of increasing values, the last four years show a decline in F, with the lowest values of the time-series observed in 2018-2019.

There seems to be inter-annual variability in the relative fishing exploitation pattern at age (F over F_{bar} (Figure 6.4.7b), bottom panel), with alternating periods of time with higher and lower relative exploitation pattern on 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 (Multi Fleet Deterministic Projection; Smith, 2000). The input data for deterministic short-term projections are given in Table 6.4.13. 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} = 0.10 for landings and F_{bar} = 0.07 for discards, being 0.17 for catches). The recruitment in 2019 (age 0) has been replaced by the geometric mean (in accordance with stock annex, GM is computed over years 1990-final assessment year minus 2), age 1 in 2020 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 6.4.14 gives the management options for 2021, and their consequences in terms of projected landings and stock biomass. Figure 6.4.8 (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 6.4.15 for landings and discards. Under this scenario, projected landings for 2020 and 2021 are 1 219 and 1 296 t, respectively. Projected discards for the same years are 180 and 190 t.

Under F *status quo*, projected SSB values for 2021 and 2022 are about 8 042 t in 2021and 8 190 t in 2022.

The contributions of recent year classes to the projected landings and SSB are presented in Table 6.4.16. The year classes for which GM_{90-17} recruitment is assumed contribute in an 8% to catches in 2021 and with a 35% to SSB in 2022.

6.4.5.2 Yield and biomass per recruit analysis

The analysis is conducted following the Stock Annex specifications and results presented in Table 6.4.17. The left panel of Figure 6.4.8 plots yield-per-recruit and SSB-per-recruit versus F_{bar}.

Under F s*tatus quo* (F_{bar} = 0.10 for landings and F_{bar} = 0.07 for discards and assuming GM_{90-17} recruitment of 43 million, the equilibrium yield would be around 1 361 t of landings and 204 t of discards, with an SSB value of 8 588 t.

6.4.5.3 Biological reference points

The stock-recruitment time-series is plotted in Figure 6.4.9. See Stock Annex for more information about the biological reference points.

The BRPs are:

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	4600 t	B_{pa}
	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.

6.4.7 Management considerations

This assessment indicates that SSB decreased substantially between 1988 and 2001, the year with the lowest SSB, followed by a smooth increasing trend from 2001 to present. Fishing at *status quo* F during 2020 would result in some biomass increase for 2020 and 2021.

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.

6.4.8 References

ICES. 2014. Report of the Benchmark Workshop on Southern megrim and hake (WKSOUTH), 3-7 February 2014, ICES HQ, Copenhagen, Denmark. ICES CM 2014/ACOM:40. 236 pp.

ICES. 2019. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. 1:31. 692 pp. http://doi.org/10.17895/ices.pub.5299

Smith, M.T. 2000. Multi Fleet Deterministic Projection (MFDP): a user guide. NAFO Scientific Council Studies, 36: 115–134.

6.4.9 Tables and Figures

Table 6.4.1. 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
2019	385	240	625	118		742	201	943

^Data revised in WG2015

*9a is without Gulf of Cádiz till 2016

** Data revised in WG2010

* Official data by country and unallocated landings

Table. 6.4.2a. Four-spot megrim (*L. boscii*) in Divisions 8c9a. Discard/Total Catch ratio and estimated CV for Spain from onboard sampling.

Year	1994	1997	1999	2000	2003	2004	2005	2006	2007
Weight Ratio	0.30	0.28	0.24	0.29	0.21	0.30	0.32	0.27	0.25
CV	23.2	11.2	14.4	16.5	10.2	23.1	24.0	48.4	18.3
Number Ratio	0.50	0.63	0.59	0.61	0.47	0.55	0.55	0.42	0.47

Year	2008	2009	2010	2011*	2012	2013	2014	2015	2016
Weight Ratio	0.20	0.23	0.19	0.24	0.39	0.35	0.41	0.34	0.23
CV	22.6	21.1	18.8	16.0	15.5	23.2	17.8	20.1	16.4
Number Ratio	0.42	0.39	0.62	0.50	0.52	0.63	0.67	0.60	0.47

Year	2017	2018	2019
Weight Ratio	0.21	0.10	0.21
CV	15.2		
Number Ratio	0.39	0.24	0.41

**All discard data revised in WG2011

*Data revised in WG2013

Table. 6.4.2b. 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
0	1289	1289	1289	1289	1289	1289	1289	1289	678
1	3322	3322	3322	3322	3322	3322	3322	3322	2741
2	4322	4322	4322	4322	4322	4322	4322	4322	4134
3	2211	2211	2211	2211	2211	2211	2211	2211	2710
4	605	605	605	605	605	605	605	605	581
5	94	94	94	94	94	94	94	94	189
6	20	20	20	20	20	20	20	20	55
7	4	4	4	4	4	4	4	4	11

	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	1289	1289	256	1289	2933	354	208	208	238
1	3322	3322	3273	3322	3954	6148	5673	5673	4479
2	4322	4322	6099	4322	2734	1207	1750	1750	989
3	2211	2211	2108	2211	1815	1888	1025	1025	495
4	605	605	146	605	1088	1218	477	477	50
5	94	94	90	94	3	171	67	67	2
6	20	20	3	20	0	12	4	4	0
7	4	4	0	4	1	2	1	1	

	2004	2005	2006	2007	2008	2009	2010	2011*	2012
0	33	10	1	100	202	2	2879	30	682
1	6393	3515	1233	3248	2342	1525	10362	5132	5313
2	3053	5482	2497	4541	2374	2490	1301	3595	2480
3	693	609	1445	757	1384	1970	696	544	1057
4	163	183	486	105	52	480	283	174	15
5	27	56	168	44	10	51	83	37	5
6		23	22	7	3	7	11	1	2
7		6	9	1	3		1		0

	2013	2014	2015	2016	2017	2018	2019
0	275	0	157	2	0	0	0
1	5499	5645	2437	1606	526	209	717
2	4379	11089	7061	5506	2116	1066	1183
3	3030	2139	4588	785	2305	638	2192
4	707	582	532	232	363	297	446
5	39	161	26	70	29	16	86
6	12	11	4	30	1	3	1
7	2	0	0	1	0	0	0

Table 6.4.3a. Four-spot megrim (*L. boscii*) Divisions 8c and 9a. Annual length distributions in landings in 2019.

Length (cm)	Total
10	
11	
12	11
13	
14	676
15	1568
16	5797
17	27133
18	100533
19	285352
20	675944
21	920066
22	966913
23	880047
24	772450
25	552893
26	437778
27	274429
28	225967
29	137550
30	101924
31	66295
32	45892
33	18780
34	14505
35	8095
36	8195
37	1652
38	2533
39	1057
40	345
41	350
42	276
43	295
44	257
45	228
46	
47	
48	
49	
50+	
Total	6535786

Table 6.4.3b. 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	2019
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	23.8
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	112.5

Table 6.4.4. Four-spot megrim (*L. boscii*) in Divisions 8c9a. Catch numbers-at-age.

YEAR	1986	1987	1988	1989
AGE				
0	1289	1289	1289	1289
1	3432	5605	4847	4055
2	7797	15902	14414	11462
3	5901	7284	7666	7603
4	4545	4198	5384	6514
5	1226	1438	2460	3573
6	869	589	1181	1798
+gp	233	145	467	634
TOTALNUM	25292	36450	37708	36928
TONSLAND	1408	2021	2586	3037
SOPCOF %	100	100	100	100

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
0	1289	1289	1289	1289	678	1289	1289	256	1289	2933
1	4766	4482	4168	3868	2824	4743	3719	3308	3367	3992
2	9506	8001	6989	6656	7049	6527	6458	7343	5526	3895
3	4096	5539	6211	4307	7225	8349	3478	4978	6447	4596
4	4434	2516	5784	4404	2849	6201	4419	890	3545	4996
5	2405	2744	2294	1245	1801	1150	1990	1714	792	1405
6	1403	1048	758	655	894	602	224	1069	849	235
+gp	807	483	71	282	457	284	555	443	353	489
TOTALNUM	28706	26102	27564	22706	23777	29145	22132	20001	22168	22541
TONSLAND	2354	2129	2353	1822	1920	2058	1466	1204	1501	1442
SOPCOF %	100	99	103	99	100	100	100	102	100	101

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE										
0	354	208	208	238	33	10	1	100	202	2
1	6193	5840	5863	4846	6785	3638	1267	3257	2357	1546
2	1862	2888	4139	3791	5568	8004	5232	6147	3935	3136
3	3533	2276	3386	3368	3777	3604	5951	3390	4879	4887
4	4000	2870	1220	1526	2602	2024	2639	2705	2204	4640
5	2020	1937	454	501	1155	1426	1156	1909	1003	1662
6	797	941	240	447	279	802	274	855	354	640
+gp	840	358	360	142	337	399	228	461	298	222
TOTALNUM	19599	17318	15870	14859	20536	19907	16748	18824	15232	16735
TONSLAND	1414	1221	1028	1067	1354	1358	1427	1396	1182	1413
SOPCOF %	100	100	100	101	101	100	101	101	101	100

YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AGE										
0	2879	30	682	275	0	157	2	0	0	0
1	10377	5139	5342	5499	5646	2438	1610	527	209	720
2	2364	4397	3260	4919	11954	7412	6739	2458	1296	1251
3	3568	2454	4101	4820	4249	7742	2844	4986	2050	3783
4	3817	2833	1926	4113	3214	3622	2495	2469	2754	2783
5	2529	2711	1620	1363	2983	1580	1936	1817	1388	2072
6	496	1164	991	846	751	1105	1153	684	954	365
+gp	438	399	422	371	562	462	559	618	555	188
TOTALNUM	26468	19127	18344	22206	29359	24518	17338	13559	9206	11162
TONSLAND	1562	1397	1321	1427	1942	1745	1419	1173	906	943
SOPCOF %	101	101	101	101	100	100	100	101	101	101

* Data revised in WG2010 from original value presented

** Data revised in WG2014 from original value presented

Table 6.4.5. Four-spot megrim (*L. boscii*) in Divisions 8c9a. Mean weights-at-age in catches (Kg).

YEAR	1986	1987	1988	1989
AGE				
0	0.004	0.004	0.004	0.004
1	0.013	0.027	0.027	0.027
2	0.034	0.046	0.049	0.055
3	0.055	0.062	0.069	0.079
4	0.090	0.089	0.100	0.108
5	0.129	0.125	0.138	0.144
6	0.159	0.151	0.167	0.167
+gp	0.263	0.239	0.280	0.275
SOPCOFAC	1.0014	1.0022	1.0034	0.9996

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
0	0.003	0.004	0.004	0.003	0.005	0.004	0.003	0.004	0.0040	0.006
1	0.019	0.022	0.021	0.014	0.023	0.030	0.023	0.016	0.019	0.018
2	0.051	0.055	0.052	0.052	0.056	0.046	0.043	0.030	0.040	0.045
3	0.081	0.097	0.093	0.092	0.082	0.082	0.054	0.063	0.073	0.072
4	0.134	0.114	0.120	0.136	0.114	0.096	0.106	0.091	0.105	0.09
5	0.154	0.164	0.159	0.174	0.148	0.143	0.135	0.123	0.137	0.147
6	0.183	0.190	0.225	0.218	0.178	0.168	0.209	0.180	0.179	0.197
+gp	0.272	0.263	0.351	0.295	0.243	0.255	0.231	0.252	0.293	0.268
SOPCOFAC	1.0009	0.9930	1.0284	0.9892	1.0015	0.9963	0.9993	1.0171	1.0027	1.009

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE										
0	0.006	0.004	0.006	0.008	0.006	0.006	0.006	0.005	0.005	0.004
1	0.023	0.024	0.024	0.025	0.027	0.021	0.023	0.022	0.017	0.025
2	0.057	0.05	0.057	0.066	0.053	0.05	0.06	0.045	0.053	0.045
3	0.066	0.073	0.09	0.088	0.081	0.083	0.091	0.079	0.079	0.069
4	0.087	0.099	0.109	0.123	0.108	0.108	0.104	0.114	0.112	0.104
5	0.126	0.122	0.163	0.142	0.131	0.122	0.136	0.123	0.151	0.142
6	0.169	0.166	0.209	0.201	0.175	0.132	0.176	0.152	0.201	0.175
+gp	0.228	0.255	0.247	0.247	0.235	0.197	0.233	0.198	0.235	0.288
SOPCOFAC	1.001	1.0012	0.9993	1.0129	1.0069	1.0038	1.0066	1.0109	1.0063	1.0011

YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AGE										
0	0.004	0.003	0.009	0.004	0.002	0.008	0.004	0.001	0.001	0.002
1	0.012	0.02	0.033	0.017	0.024	0.026	0.022	0.029	0.013	0.018
2	0.056	0.039	0.052	0.045	0.044	0.04	0.048	0.044	0.041	0.037
3	0.084	0.078	0.076	0.063	0.071	0.066	0.086	0.067	0.068	0.061
4	0.108	0.099	0.105	0.099	0.101	0.099	0.107	0.096	0.093	0.095
5	0.141	0.128	0.127	0.131	0.133	0.136	0.13	0.126	0.126	0.126
6	0.182	0.168	0.159	0.159	0.165	0.172	0.149	0.164	0.156	0.186
+gp	0.271	0.24	0.199	0.21	0.222	0.23	0.217	0.212	0.224	0.274
SOPCOFAC	1.0104	1.009	1.006	1.0065	1.0046	1.0018	1.0027	1.0054	1.0073	1.0087

* Data revised in WG2010 from original value presented

** Data revised in WG2014 from original value presented

Table 6.4.6. Four-spot megrim (*L. boscii*) Divisions 8c9a. Abundance and Recruitment indices of Portuguese and Spanish surveys.

	Biomass Index						Abundance index					Recruitment index		
	Portugal (k/h)			Spain (k/30 min)			Portugal (n/h)		Spain (n/30 min)			At age 1	At age 0	At age 1
												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
A,1996	0.10			2.00	0.19	A,1996			44.80	4.05	A,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
A,B,1999	+	0.04	0.02	1.93	0.24	A,B,1999	1.23	1.07	29.30	3.22	A,B,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
A,2003	1.36	3.65	1.20	1.32	0.16	A,2003	60.80	20.97	16.90	1.54	A,2003	8	0.65	4.95
A,2004	1.27	ns		2.40	0.24	A,2004	ns		43.94	3.71	A,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
2019	ns	ns	ns	5.77	0.48	2019	ns	ns	102.03	8.21	2019		0.94	20.46

+ 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 WGHMM2011
** From 2013 new vessel for Spanish survey (Miguel Oliver)

Table 6.4.7. 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	2019									
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
10		0.3	21	514	725	613	104	51	7.8	2019

FLT03: SP-NSGFS-Q4 (n/30 min)

1988	2019									
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
1	0.9	20.5	18.5	41.5	12.8	6.33	0.9	0.62	113	2019

Table 6.4.8. 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
2019	175.3	7.8	22.4				102.3	7.1	14.4

[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 6.4.9. Four-spot megrim (*L.boscii*) in Divisions 8c and 9a. Tuning diagnostics.

Lowestoft VPA Version 3.1

27/04/2020 18:38

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 34 years. 1986 to 2019. Ages 0 to 7.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SP-LCGOTBDEF1	1986	2019	3	6	0	1
SP-LCGOTBDEF2	2000	2019	3	6	0	1
SP-GFS	1988	2019	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 32 iterations

Regression weights

	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
0	0.066	0.001	0.011	0.007	0.000	0.004	0.000	0	0	0
1	0.251	0.162	0.166	0.116	0.196	0.051	0.047	0.013	0.011	0.024
2	0.167	0.160	0.146	0.227	0.394	0.425	0.194	0.094	0.039	0.084
3	0	0	0	0	0	0	0	0.215	0.106	0.151
4	0	0	0	0	0	0	0	0.431	0.177	0.204
5	1	0	0	0	0	0	1	0.336	0.462	0.196
6	0	0	0	0	0	0	0	0.347	0.296	0.209

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6
2010	49600	51600	17000	15900	13700	7040	1750
2011	47200	38000	32800	11800	9800	7740	3480
2012	68700	38600	26400	22900	7420	5460	3880
2013	43200	55700	26800	18700	15000	4330	3000
2014	66200	35100	40600	17500	10900	8600	2310
2015	47600	54200	23700	22400	10500	6060	4340
2016	57200	38800	42200	12700	11300	5290	3530
2017	25800	46800	30300	28400	7790	7030	2580
2018	40300	21200	37900	22600	18800	4150	4110
2019	30200	33000	17100	29800	16600	12900	2140

Estimated population abundance at 1st Jan 2020

0	24700	26400	12900	21000	11100	8670

Taper weighted geometric mean of the VPA populations:

44300	36600	26500	16600	9060	4190	1780

Standard error of the weighted Log(VPA populations) :

	0.3016	0.3135	0.3565	0.3737	0.4251	0.4765	0.5319
1							

Log catchability residuals.

Fleet : SP-LCGOTBDEF1

Age	1986	1987	1988	1989
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	0.86	-0.09	-0.41
4	0.29	0.27	-0.6	-0.54
5	0.05	-0.25	-0.84	-0.86
6	-0.29	-0.17	-0.41	-0.24

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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	-0.76	-0.19	-0.46	-0.03	-0.09	0.37	-0.56	-0.31	0.7	0.41
4	-0.21	-0.58	-0.08	0.31	0.48	0.13	0.05	-0.46	0.65	0.28
5	-0.19	0.42	-0.02	-0.24	0.53	0.79	-0.32	-0.05	0.78	0.19
6	0.15	0.81	0.04	0.33	0.71	1.01	-0.06	0.35	0.56	0.63

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
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

Age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
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	-6.7028	-5.8325	-5.3883	-5.3883
S.E(Log q)	0.5014	0.4172	0.5149	0.5188

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	2.057	8.02	0.66	14	0.26	-6.7
4	0.95	0.165	5.98	0.52	14	0.41	-5.83
5	-25.16	-4.685	80.19	0	14	8.02	-5.39
6	1.19	-0.588	4.73	0.44	14	0.55	-5.14
1							

Fleet : SP-LCGOTBDEF2

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
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	-0.57	0.37	-0.23	0.23	0.47	0.14	0.54	0.21	0.2	-0.11
4	-0.03	0.78	-0.46	-0.35	0.42	-0.3	-0.17	0.18	0.26	-0.05
5	-0.2	1	-0.63	-0.22	-0.03	0.22	-0.5	0.37	-0.06	-0.09
6	0.2	0.26	-0.27	0.05	0.28	0.1	-0.51	0.18	-0.03	-0.39

Age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
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	0.21	-0.35	0.14	-0.37	-0.32	0.12	0.18	-0.19	-0.2	-0.49
4	0.06	-0.17	0.38	0.03	-0.27	0.2	-0.3	0.24	-0.25	-0.24
5	0.3	0.16	0.31	0.07	-0.27	-0.28	0.11	-0.17	0.36	-0.45
6	0.09	0.34	0.11	-0.2	-0.45	-0.35	-0.02	-0.15	-0.21	-0.43

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	-5.6992	-5.0003	-4.7008	-4.7008
S.E(Log q)	0.3238	0.3153	0.3743	0.2788

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	1.31	-1.268	4.48	0.49	20	0.42	-5.7
4	1.13	-0.672	4.48	0.61	20	0.36	-5
5	1.03	-0.171	4.59	0.65	20	0.4	-4.7
6	1	0.017	4.78	0.8	20	0.28	-4.77

Fleet : SP-GFS

Age		1986	1987	1988	1989
	0	99.99	99.99	0.51	1.65
	1	99.99	99.99	0.38	-0.13
	2	99.99	99.99	0.05	-0.43
	3	99.99	99.99	-0.44	-0.97
	4	99.99	99.99	-1.15	-0.7
	5	99.99	99.99	-0.54	-0.66
	6	99.99	99.99	-0.03	-0.09

Age		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	0	-1.02	0.27	0.28	-1.08	0.86	0.06	1.01	1.33	-0.85	-0.1
	1	0.09	-0.31	0.5	0.09	-1.15	0.23	0.03	-0.05	-0.02	0.26
	2	-0.26	-0.53	-0.95	-0.24	-0.54	-1.05	-0.01	-0.33	-0.29	0.17
	3	-1.11	-0.93	-0.66	-0.82	-0.65	-0.78	-0.65	0.1	-0.18	-0.21
	4	-0.39	-0.75	-0.41	-0.68	-0.27	-0.46	-0.77	-0.16	-0.02	-0.53
	5	0.18	-0.16	-0.08	-0.87	-0.28	-0.5	0.08	-0.17	0.37	-0.55
	6	0.19	-0.35	0.02	0.05	0.04	-0.34	0.05	-0.06	-0.03	-0.17

Age		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	0	-0.03	-0.66	-0.17	99.99	0.04	1.06	-0.99	-0.28	-0.84	0.54
	1	0.37	0.45	-0.12	99.99	0.28	0.38	-0.25	-0.45	-0.46	-0.25
	2	-0.01	0.3	0.24	99.99	-0.02	0.48	0.17	0.11	-0.48	0
	3	0.08	0.51	0.35	99.99	0.03	0.54	0.22	0.47	-0.41	0.18
	4	0.35	0.82	0.37	99.99	0.08	0.25	-0.24	0.48	-0.28	0.46
	5	-0.27	1.07	-0.15	99.99	-0.51	0.63	-0.44	0.26	-0.69	0.78
	6	-0.25	-0.1	-0.05	99.99	-0.2	0.08	0.22	0.1	-0.09	0.29

Age		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	0	-0.81	-0.48	-0.21	99.99	0.59	-0.28	0.31	0.25	-1	0
	1	0.58	-0.53	-0.28	99.99	-0.1	0.34	0.06	0.12	-0.4	0.33
	2	0.5	0.55	0.33	99.99	0.08	0.22	0.62	0.5	0.26	0.53
	3	0.24	0.77	0.88	99.99	0.29	0.44	0.45	0.92	0.48	0.85
	4	0.09	0.51	0.97	99.99	0.39	0.51	-0.3	0.86	0.61	0.35
	5	-0.23	-0.09	0.37	99.99	0.85	0.19	0.32	0.31	0.8	-0.02
	6	-0.38	-0.48	0	99.99	0.18	-0.01	0.31	0.02	0.31	-0.16

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	-10.2201	-7.5419	-7.1416	-7.1557	-7.1968	-7.2884	-7.2884
S.E(Log q)	0.7383	0.3803	0.4341	0.6092	0.554	0.5057	0.2057

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	0.55	1.862	10.42	0.38	30	0.39	-10.22
1	0.71	1.728	8.38	0.57	30	0.26	-7.54
2	1.01	-0.029	7.12	0.39	30	0.44	-7.14
3	0.98	0.059	7.2	0.29	30	0.61	-7.16
4	1.28	-0.929	6.66	0.28	30	0.71	-7.2
5	0.95	0.237	7.34	0.48	30	0.49	-7.29
6	0.94	0.969	7.33	0.89	30	0.19	-7.32
1							

Terminal year survivor and F summaries :

Age 0 Catchability constant w.r.t. time and dependent on age

Year class = 2019

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	24740	0.75	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
24740	0.75	0	1	0	0

Age 1 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	27808	0.344	0.544	1.58	2	0.949	0.023
F shrinkage mean	9929	1.5				0.051	0.064

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
26384	0.33	0.41	3	1.222	0.024

Age 2 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	13404	0.271	0.311	1.15	3	0.965	0.081
F shrinkage mean	4373	1.5				0.035	0.23

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12895	0.27	0.28	4	1.038	0.084

Age 3 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	12880	0.332	0	0	1	0.361	0.236
SP-GFS	28557	0.248	0.147	0.59	4	0.619	0.113
F shrinkage mean	10526	1.5				0.021	0.282

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
20996	0.2	0.2	6	1.001	0.151

1

Age 4 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	8907	0.232	0.017	0.07	2	0.513	0.249
SP-GFS	14435	0.228	0.122	0.53	5	0.471	0.161
F shrinkage mean	5921	1.5				0.016	0.354

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
11112	0.16	0.11	8	0.707	0.204

Age 5 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	6451	0.201	0.078	0.39	3	0.566	0.255
SP-GFS	13360	0.215	0.135	0.63	6	0.419	0.131
F shrinkage mean	3478	1.5				0.015	0.431

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8675	0.15	0.14	10	0.979	0.196

1

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

Year class = 2013

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	1311	0.182	0.205	1.12	4	0.547	0.225
SP-GFS	1564	0.209	0.179	0.85	6	0.439	0.192
F shrinkage mean	1630	1.5				0.014	0.184

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1421	0.14	0.12	11	0.883	0.209

Table 6.4.10. 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 27/04/2020 18:41

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989
AGE				
0	0.02	0.0277	0.0253	0.027
1	0.0641	0.1138	0.1379	0.1037
2	0.2436	0.4691	0.4756	0.5572
3	0.3795	0.378	0.4346	0.4981
4	0.7267	0.5125	0.5357	0.8322
5	0.6317	0.5324	0.6523	0.8543
6	1.0241	0.7274	1.2217	1.7222
+gp	1.0241	0.7274	1.2217	1.7222
FBAR 2-4	0.4499	0.4532	0.4819	0.6292

Table 8 Fishing mortality (F) at age

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
0	0.036	0.0229	0.0246	0.0496	0.0158	0.0244	0.0339	0.0094	0.0691	0.0939
1	0.132	0.1693	0.0959	0.0959	0.1463	0.1465	0.0909	0.1144	0.1647	0.3153
2	0.3754	0.3415	0.4328	0.2186	0.2536	0.5883	0.3044	0.2607	0.2841	0.2915
3	0.3938	0.3919	0.4877	0.5237	0.3914	0.5404	0.7366	0.408	0.3847	0.4061
4	0.6159	0.4496	0.9464	0.7862	0.8122	0.6976	0.6225	0.416	0.5766	0.5872
5	0.8807	1.0312	1.0001	0.5352	0.9087	0.9615	0.5033	0.5261	0.8227	0.4741
6	1.0422	1.3938	0.9386	0.9146	0.9696	0.928	0.4851	0.5607	0.5427	0.6211
+gp	1.0422	1.3938	0.9386	0.9146	0.9696	0.928	0.4851	0.5607	0.5427	0.6211
FBAR 2-4	0.4617	0.3943	0.6223	0.5095	0.4857	0.6088	0.5545	0.3616	0.4151	0.4283

Table 8 Fishing mortality (F) at age

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE										
0	0.011	0.0062	0.0058	0.0052	0.001	0.0002	0	0.003	0.0081	0
1	0.2931	0.2515	0.2428	0.1813	0.2003	0.1441	0.0333	0.0899	0.0891	0.0791
2	0.2372	0.2156	0.2844	0.2447	0.327	0.3851	0.3178	0.2239	0.1494	0.1641
3	0.47	0.5104	0.4225	0.396	0.4116	0.365	0.5561	0.3511	0.2788	0.2803
4	0.7605	0.9047	0.5727	0.3417	0.6132	0.4054	0.5009	0.5326	0.4065	0.4677
5	0.5018	1.1204	0.3344	0.4906	0.4725	0.836	0.4289	0.8543	0.3835	0.6198
6	0.5452	0.4633	0.3749	0.6493	0.5634	0.718	0.3664	0.6612	0.3648	0.4531
+gp	0.5452	0.4633	0.3749	0.6493	0.5634	0.718	0.3664	0.6612	0.3648	0.4531
FBAR 2-4	0.4892	0.5436	0.4265	0.3275	0.4506	0.3852	0.4582	0.3692	0.2782	0.304

Table 8 Fishing mortality (F) at age

YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	FBAR 17-19
AGE											
0	0.0663	0.0007	0.011	0.0071	0	0.0037	0	0	0	0	0
1	0.2514	0.162	0.1659	0.1156	0.1955	0.051	0.0469	0.0125	0.011	0.0244	0.016
2	0.167	0.1601	0.1465	0.2269	0.3937	0.4251	0.1942	0.0939	0.0386	0.0841	0.0722
3	0.2848	0.2619	0.2204	0.3353	0.313	0.4808	0.2854	0.2153	0.1056	0.151	0.1573
4	0.3691	0.3851	0.3383	0.3596	0.3922	0.4823	0.2784	0.431	0.1768	0.2043	0.2707
5	0.5057	0.4899	0.3976	0.4277	0.4834	0.3402	0.5185	0.3362	0.462	0.1957	0.3313
6	0.3753	0.4621	0.3316	0.3731	0.445	0.3303	0.4481	0.3471	0.2961	0.209	0.2841
+gp	0.3753	0.4621	0.3316	0.3731	0.445	0.3303	0.4481	0.3471	0.2961	0.209	0.2841
FBAR 2-4	0.2737	0.269	0.2351	0.3073	0.3663	0.4627	0.2526	0.2467	0.107	0.1465	

Table 6.4.11. 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 27/04/2020 18:41

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1986	1987	1988	1989
AGE				
0	71784	52203	56976	53453
1	61118	57605	41574	45482
2	39852	46934	42091	29652
3	20653	25573	24037	21419
4	9725	11569	14347	12744
5	2893	3850	5674	6875
6	1499	1259	1851	2419
+gp	394	306	716	829
TOTAL	207917	199300	187267	172872

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

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
0	40271	62943	58537	29434	47722	59203	42730	30221	21349	36149
1	42597	31805	50367	46759	22932	38458	47305	33818	24512	16313
2	33568	30563	21984	37466	34783	16220	27195	35365	24695	17022
3	13906	18882	17783	11675	24652	22100	7374	16422	22310	15218
4	10657	7679	10447	8940	5662	13646	10540	2890	8941	12432
5	4539	4713	4011	3320	3334	2058	5561	4631	1561	4113
6	2395	1540	1376	1208	1592	1100	644	2753	2240	561
+gp	1352	693	127	511	800	510	1580	1128	922	1154
TOTAL	149287	158819	164632	139313	141476	153295	142929	127228	106529	102962

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

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE										
0	35842	36936	39684	50714	36630	52234	51142	37450	27654	63011
1	26942	29024	30053	32302	41306	29960	42757	41871	30571	22458
2	9744	16455	18479	19300	22062	27679	21237	33860	31334	22897
3	10412	6293	10859	11384	12371	13025	15419	12654	22160	22093
4	8301	5328	3093	5827	6273	6711	7403	7240	7293	13728
5	5658	3177	1765	1428	3390	2782	3663	3673	3480	3976
6	2096	2805	848	1034	716	1730	987	1953	1280	1941
+gp	2185	1057	1262	325	855	849	815	1040	1069	667
TOTAL	101180	101075	106043	122314	123603	134970	143423	139740	124839	150772

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

YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	GMST 90-17
AGE												
0	49567	47194	68730	43215	66239	47575	57193	25841	40331	30217	0	43332
1	51587	37977	38612	55655	35133	54232	38809	46824	21157	33020	24740	
2	16988	32846	26443	26779	40590	23656	42195	30317	37859	17132	26384	
3	15909	11770	22914	18700	17474	22416	12661	28449	22598	29824	12895	
4	13667	9796	7416	15049	10949	10462	11348	7793	18780	16646	20996	
5	7041	7736	5457	4329	8600	6056	5288	7033	4146	12884	11112	
6	1752	3477	3880	3002	2311	4342	3529	2578	4114	2139	8675	
+gp	1535	1181	1641	1306	1714	1802	1695	2312	2378	1096	2149	
TOTAL	158045	151976	175093	168036	183009	170541	172717	151146	151362	142958	106950	

Table 6.4.12. 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

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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	71784	5163	4286	1408	0.3285	0.4499
1987	52203	7283	6014	2021	0.3361	0.4532
1988	56976	7799	6713	2586	0.3852	0.4819
1989	53453	7763	6704	3037	0.453	0.6292
1990	40271	6702	5929	2354	0.397	0.4617
1991	62943	6587	5722	2129	0.3721	0.3943
1992	58537	6334	5402	2353	0.4356	0.6223
1993	29434	5973	5273	1822	0.3455	0.5095
1994	47722	6352	5536	1920	0.3468	0.4857
1995	59203	5868	4940	2058	0.4166	0.6088
1996	42730	5151	4347	1466	0.3373	0.5545
1997	30221	4370	3823	1204	0.3149	0.3616
1998	21349	4991	4500	1501	0.3336	0.4151
1999	36149	4516	4015	1442	0.3591	0.4283
2000	35842	4365	3765	1414	0.3755	0.4892
2001	36936	3777	3181	1221	0.3838	0.5436
2002	39684	4104	3361	1028	0.3059	0.4265
2003	50714	4696	3712	1067	0.2875	0.3275
2004	36630	4954	4032	1354	0.3358	0.4506
2005	52234	4867	4037	1358	0.3364	0.3852
2006	51142	5599	4622	1427	0.3088	0.4582
2007	37450	5412	4558	1396	0.3063	0.3692
2008	27654	5920	5255	1182	0.2249	0.2782
2009	63011	5893	5184	1413	0.2726	0.304
2010	49567	6309	5644	1562	0.2768	0.2737
2011	47194	5928	5228	1397	0.2672	0.269
2012	68730	7424	5980	1321	0.2209	0.2351
2013	43215	6311	5493	1427	0.2598	0.3073
2014	66239	7014	6203	1942	0.3131	0.3663
2015	47575	7237	6035	1745	0.2892	0.4627
2016	57193	6992	6051	1419	0.2345	0.2526
2017	25841	7171	6283	1173	0.1867	0.2467
2018	40331	6848	6403	906	0.1415	0.107
2019	30217	7011	6524	943	0.1445	0.1465
Arith. Mean	46187	5961	5140	1588	0.3127	0.3987
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.4.13. 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: 19:37 30/04/2020
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

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	43332	0.2	0	0	0	0.003	0.0000	0.002	0.0003	0.003
1	35477	0.2	0.55	0	0	0.022	0.0000	0.032	0.0205	0.022
2	26384	0.2	0.86	0	0	0.042	0.0096	0.069	0.0905	0.038
3	12895	0.2	0.97	0	0	0.070	0.0892	0.083	0.0795	0.052
4	20996	0.2	0.99	0	0	0.098	0.2002	0.103	0.0311	0.065
5	11112	0.2	1	0	0	0.129	0.3193	0.130	0.0076	0.087
6	8675	0.2	1	0	0	0.165	0.2673	0.166	0.0025	0.114
7	2149	0.2	1	0	0	0.231	0.2696	0.231	0.0001	0.031

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	43332	0.2	0	0	0	0.003	0.0000	0.002	0.0003	0.003
1		0.2	0.55	0	0	0.022	0.0000	0.032	0.0205	0.022
2		0.2	0.86	0	0	0.042	0.0096	0.069	0.0905	0.038
3		0.2	0.97	0	0	0.070	0.0892	0.083	0.0795	0.052
4		0.2	0.99	0	0	0.098	0.2002	0.103	0.0311	0.065
5		0.2	1	0	0	0.129	0.3193	0.130	0.0076	0.087
6		0.2	1	0	0	0.165	0.2673	0.166	0.0025	0.114
7		0.2	1	0	0	0.231	0.2696	0.231	0.0001	0.031

2022 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	43332	0.2	0	0	0	0.003	0.0000	0.002	0.0003	0.003
1		0.2	0.55	0	0	0.022	0.0000	0.032	0.0205	0.022
2		0.2	0.86	0	0	0.042	0.0096	0.069	0.0905	0.038
3		0.2	0.97	0	0	0.070	0.0892	0.083	0.0795	0.052
4		0.2	0.99	0	0	0.098	0.2002	0.103	0.0311	0.065
5		0.2	1	0	0	0.129	0.3193	0.130	0.0076	0.087
6		0.2	1	0	0	0.165	0.2673	0.166	0.0025	0.114
7		0.2	1	0	0	0.231	0.2696	0.231	0.0001	0.031

Input units are thousands and kg - output in tonnes

Table 6.4.14. Four-sport megrim (*L. boscii*) in Div. 8c and 9a catch forecast: management option table.

MFDP version 1a
Run: ldb
Time and date: 19:37 30/04/2020
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

2020

		Catch	Landings		Discards	
Biomass	**SSB**	**FMult**	**FBar**	**Yield**	**FBar**	**Yield**
8332	7645	1	0.0997	1219	0.067	180

2021							2022	
		Catch	**Landings**		**Discards**			
Biomass	**SSB**	**FMult**	**FBar**	**Yield**	**FBar**	**Yield**	**Biomass**	**SSB**
8742	8042	0	0.0000	0	0.0000	0	10627	9908
.	8042	0.1	0.0100	146	0.0067	20	10434	9716
.	8042	0.2	0.0199	287	0.0134	40	10246	9529
.	8042	0.3	0.0299	425	0.0201	60	10062	9347
.	8042	0.4	0.0399	560	0.0268	79	9883	9169
.	8042	0.5	0.0498	691	0.0335	98	9708	8995
.	8042	0.6	0.0598	818	0.0402	117	9538	8826
.	8042	0.7	0.0698	943	0.0469	136	9372	8661
.	8042	0.8	0.0797	1064	0.0536	154	9210	8500
.	8042	0.9	0.0897	1182	0.0603	173	9052	8343
.	8042	1	0.0997	1296	0.0670	190	8898	8190
.	8042	1.1	0.1096	1408	0.0737	208	8747	8040
.	8042	1.2	0.1196	1517	0.0804	226	8600	7894
.	8042	1.3	0.1296	1623	0.0871	243	8457	7752
.	8042	1.4	0.1395	1727	0.0938	260	8317	7613
.	8042	1.5	0.1495	1828	0.1006	277	8181	7478
.	8042	1.6	0.1595	1926	0.1073	293	8048	7346
.	8042	1.7	0.1694	2022	0.1140	310	7918	7217
.	8042	1.8	0.1794	2115	0.1207	326	7791	7091
.	8042	1.9	0.1894	2206	0.1274	342	7667	6968
.	8042	2	0.1993	2294	0.1341	357	7546	6848

Input units are thousands and kg - output in tonnes

Table 6.4.15. Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Single option prediction. Detail Tables.

MFDP version 1a
Run: ldb
Time and date: 19:37 30/04/2020
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

Year: 2020 F multiplier: 1 HCFbar: 0.0997 Fleet1 DF 0.067

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	43332	139	0	0	0	0
1	0	1	0	0.0205	653	14	35477	766	19512	421	19512	421
2	0.0096	219	15	0.0905	2063	79	26384	1108	22690	953	22690	953
3	0.0892	962	80	0.0795	857	45	12895	897	12508	871	12508	871
4	0.2002	3414	352	0.0311	530	35	20996	2058	20786	2037	20786	2037
5	0.3193	2758	359	0.0076	66	6	11112	1431	11112	1431	11112	1431
6	0.2673	1850	307	0.0025	17	2	8675	1435	8675	1435	8675	1435
7	0.2696	462	107	0.0001	0	0	2149	497	2149	497	2149	497
Total		9667	1219		4198	180	161020	8332	97433	7645	97433	7645

Year: 2021 F multiplier: 1 HCFbar: 0.0997 Fleet1 DF 0.067

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	43332	139	0	0	0	0
1	0	1	0	0.0205	652	14	35467	766	19507	421	19507	421
2	0.0096	236	16	0.0905	2225	85	28456	1195	24472	1028	24472	1028
3	0.0892	1458	122	0.0795	1299	68	19544	1360	18957	1319	18957	1319
4	0.2002	1450	149	0.0311	225	15	8919	874	8829	865	8829	865
5	0.3193	3385	440	0.0076	81	7	13640	1757	13640	1757	13640	1757
6	0.2673	1399	232	0.0025	13	1	6561	1085	6561	1085	6561	1085
7	0.2696	1456	337	0.0001	1	0	6767	1566	6767	1566	6767	1566
Total		9386	1296		4508	190	162685	8742	98733	8042	98733	8042

Year: 2022 F multiplier: 1 HCFbar: 0.0997 Fleet1 DF 0.067

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	43332	139	0	0	0	0
1	0	1	0	0.0205	652	14	35467	766	19507	421	19507	421
2	0.0096	236	16	0.0905	2224	85	28448	1195	24465	1028	24465	1028
3	0.0892	1573	131	0.0795	1402	73	21079	1467	20446	1423	20446	1423
4	0.2002	2198	226	0.0311	341	22	13517	1325	13382	1311	13382	1311
5	0.3193	1438	187	0.0076	34	3	5794	746	5794	746	5794	746
6	0.2673	1718	285	0.0025	16	2	8054	1332	8054	1332	8054	1332
7	0.2696	1792	415	0.0001	1	0	8332	1928	8332	1928	8332	1928
Total		8956	1260		4682	200	164021	8898	99979	8190	99979	8190

Input units are thousands and kg - output in tonnes

Table 6.4.16. Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Stock numbers of recruits and their source of recent year classes used in predictions and the relative (%) contributions to catches and SSB (byweight) of these year classes.

Year-class	2017	2018	2019	2020	2021
Stock No. (thousands) of 0 year-olds	25841	40331	43332	43332	43332
Source	XSA	XSA	GM90-17	GM90-17	GM90-17
Status Quo F:					
% in 2020 catch	8.9	6.7	1.0	0.0	-
% in 2021	11.0	12.8	6.8	0.9	0.0
% in 2020 SSB	11.4	12.5	5.5	0.0	-
% in 2021 SSB	10.8	16.4	12.8	5.2	0.0
% in 2022 SSB	9.1	16.0	17.4	12.6	5.1

GM : geometric mean recruitment

Four-spot megrim (L. boscii) in Divisions 8c and 9a : Year-class % contribution to

a) 2021 catches b) 2022 SSB

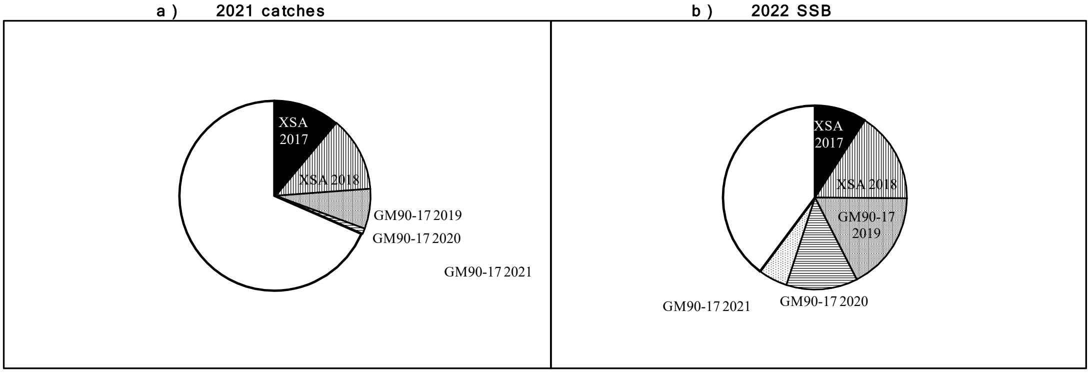


Table 6.4.17. Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Yield per recruit results.

MFYPR version 2a
Run: ldb
Time and date: 19:59 30/04/2020
Yield per results

Catch FMult	Landings Fbar	CatchNos	Yield	Discards Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	0	0	0	5.5167	0.5433	4.0334	0.5266	4.0334	0.5266
0.1	0.01	0.0555	0.0097	0.0067	0.0124	0.0006	5.1783	0.4715	3.6956	0.4549	3.6956	0.4549
0.2	0.0199	0.0972	0.0164	0.0134	0.0244	0.0011	4.911	0.416	3.4288	0.3994	3.4288	0.3994
0.3	0.0299	0.1291	0.0212	0.0201	0.0361	0.0016	4.6943	0.3719	3.2126	0.3553	3.2126	0.3553
0.4	0.0399	0.1539	0.0247	0.0268	0.0474	0.0021	4.5148	0.3361	3.0337	0.3195	3.0337	0.3195
0.5	0.0498	0.1734	0.0271	0.0335	0.0584	0.0026	4.3636	0.3066	2.883	0.2901	2.883	0.2901
0.6	0.0598	0.1888	0.0288	0.0402	0.0691	0.003	4.2343	0.282	2.7541	0.2655	2.7541	0.2655
0.7	0.0698	0.201	0.0299	0.0469	0.0795	0.0035	4.1223	0.2611	2.6426	0.2447	2.6426	0.2447
0.8	0.0797	0.2107	0.0307	0.0536	0.0896	0.0039	4.0242	0.2433	2.5451	0.2269	2.5451	0.2269
0.9	0.0897	0.2184	0.03	0.0603	0.0995	0.0043	3.94	0.2279	2.4589	0.2115	2.4589	0.2115
1	0.0997	0.2245	0.0314	0.067	0.109	0.0047	3.8603	0.2145	2.3822	0.1982	2.3822	0.1982
1.1	0.1096	0.2292	0.0314	0.0737	0.1184	0.0051	3.791	0.2028	2.3133	0.1865	2.3133	0.1865
1.2	0.1196	0.2329	0.0313	0.0804	0.1274	0.0054	3.7283	0.1925	2.2511	0.1762	2.2511	0.1762
1.3	0.1296	0.2356	0.0311	0.0871	0.1363	0.0058	3.6713	0.1833	2.1945	0.167	2.1945	0.167
1.4	0.1395	0.2376	0.0308	0.0938	0.1449	0.0061	3.6192	0.1751	2.1429	0.1588	2.1429	0.1588
1.5	0.1495	0.239	0.0305	0.1006	0.1533	0.0065	3.5713	0.1677	2.0955	0.1515	2.0955	0.1515
1.6	0.1595	0.2398	0.0301	0.1073	0.1615	0.0068	3.5272	0.1611	2.0517	0.1449	2.0517	0.1449
1.7	0.1694	0.2402	0.0297	0.114	0.1694	0.0071	3.4862	0.1551	2.0113	0.1389	2.0113	0.1389
1.8	0.1794	0.2402	0.0293	0.1207	0.1772	0.0074	3.4482	0.1496	1.9736	0.1335	1.9736	0.1335
1.9	0.1894	0.2399	0.0289	0.1274	0.1848	0.0077	3.4127	0.1446	1.9386	0.1285	1.9386	0.1285
2.0	0.1993	0.2393	0.0284	0.1341	0.1922	0.0080	3.3794	0.1401	1.9057	0.124	1.9057	0.124

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar(2-4)	1	0.0997
FMax	1.0767	0.1073
F0.1	0.6497	0.0648
F35%SPR	1.1201	0.1116

Weights in kilograms

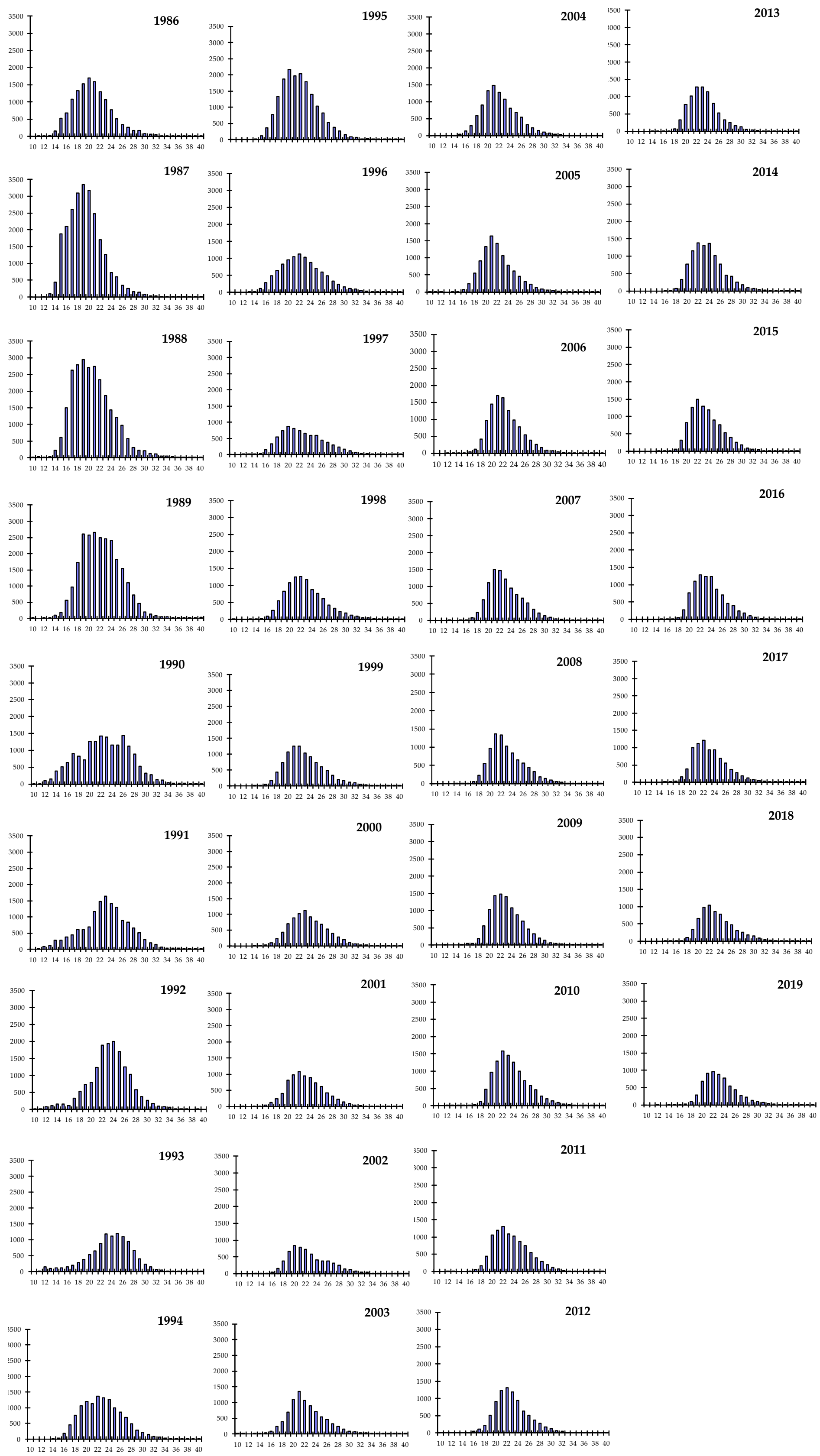


Figure 6.4.1. Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Annual length compositions of landings ('000).

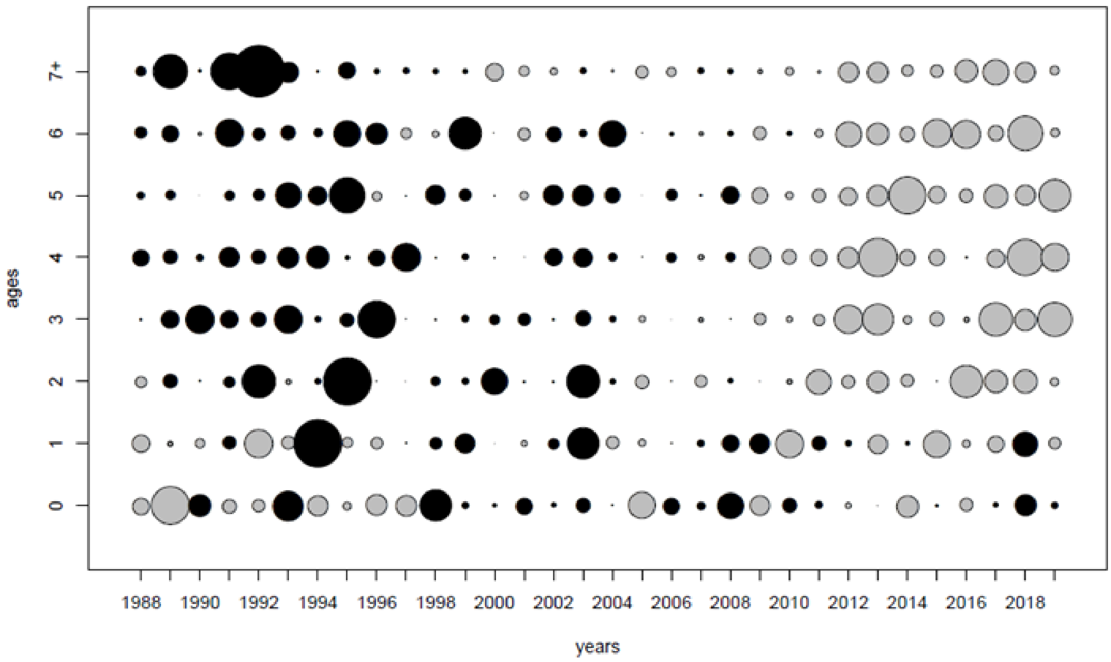
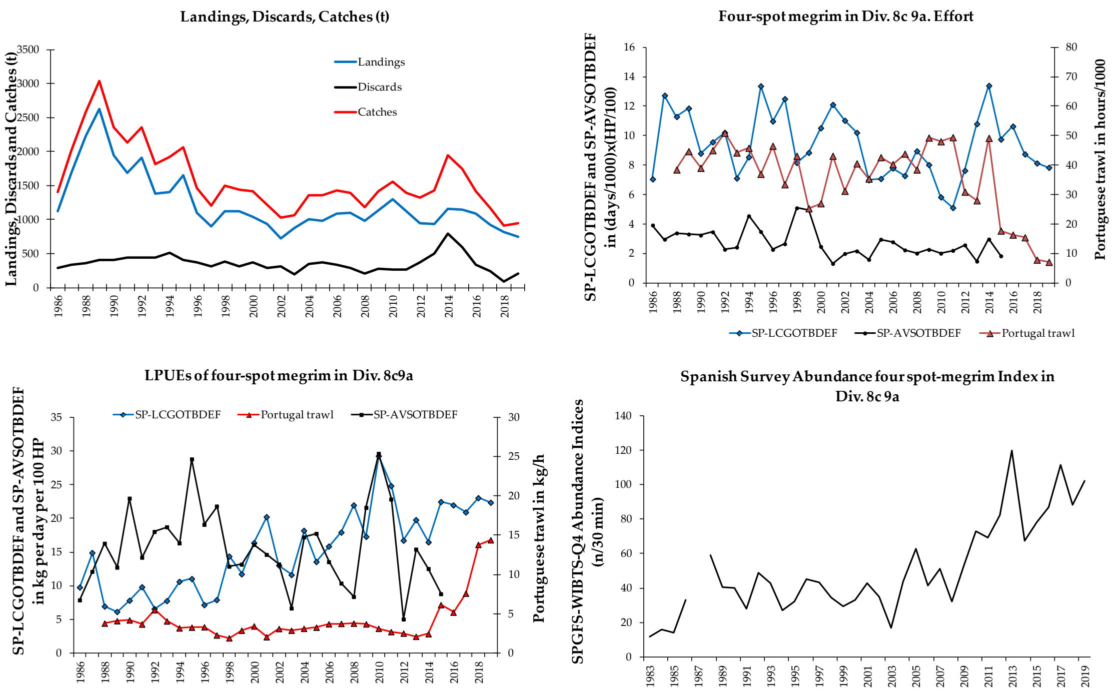


Figure 6.4.2. Four-spot megrim (*L. boscii*) in Divisions 8c&9a. Standardized log (abundance index at age) from survey SP-NSGFS-Q4 (Bubbles colour scale: black – negative, grey – positive).



* 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 6.4.3a. Four-spot megrim (*L.boscii*) in Divisions 8c and 9a. Landings (t), Efforts, LPUEs and Abundance Indices.

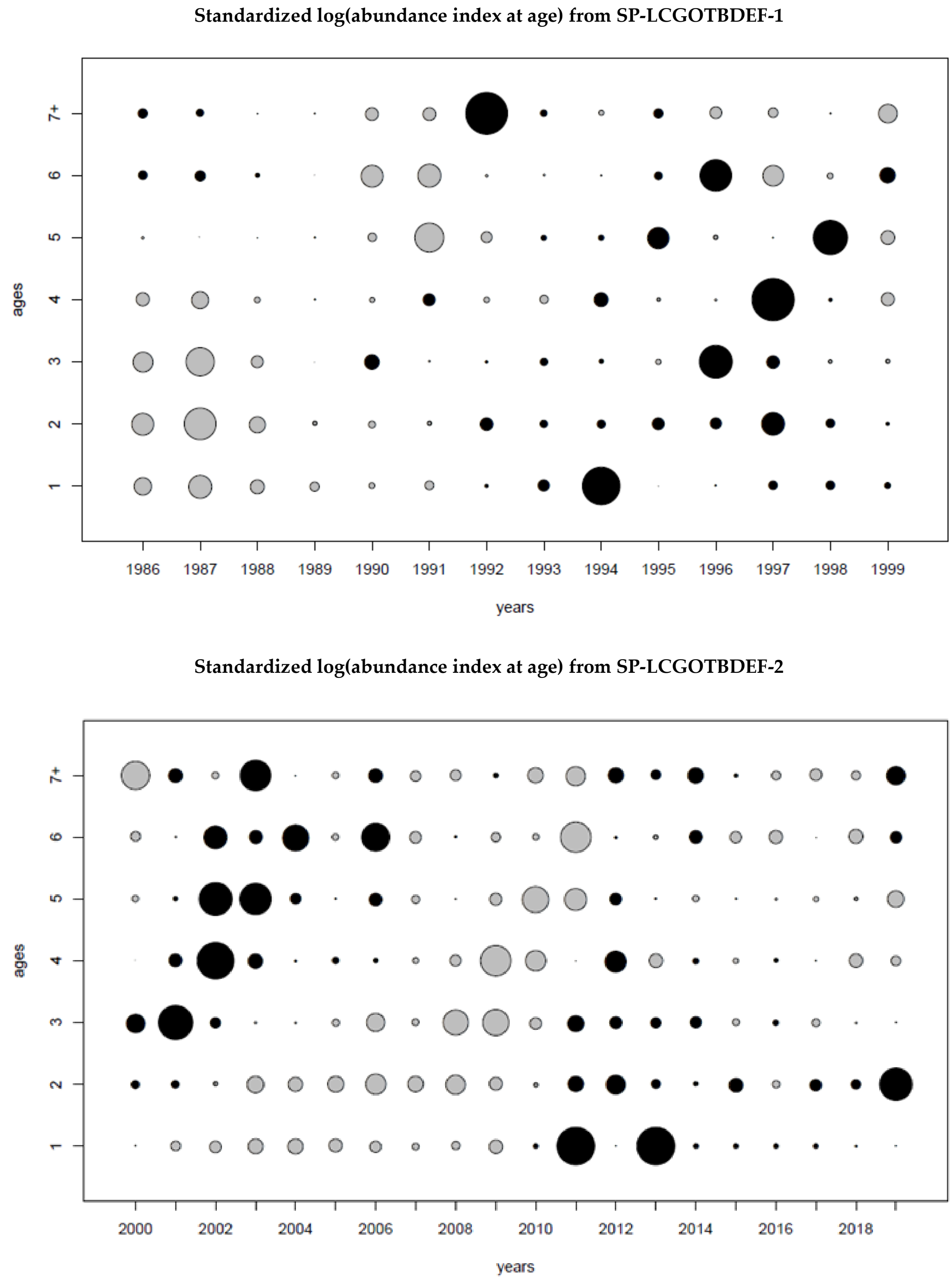
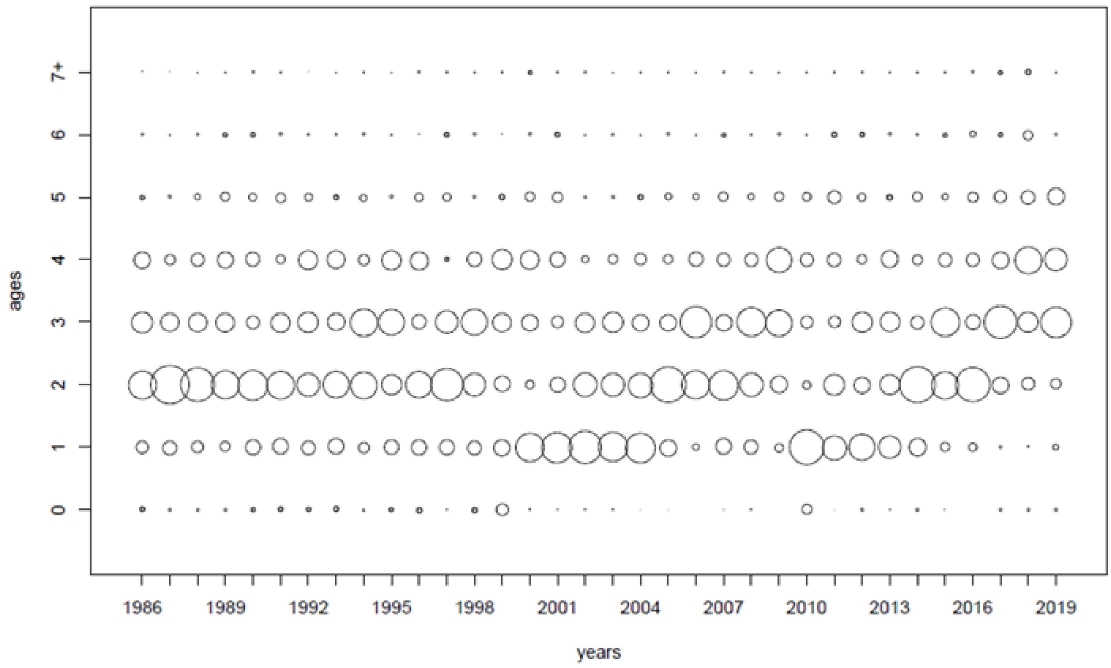


Figure 6.4.3b. Four-spot megrim (*L. boscii*) in Divisions 8c&9a. Standardized log(abundance index at age) of SP-LCGOTBDEF-1 and SP-LCGOTBDEF-2 (Bubbles colour scale: black – negative, grey – positive).

Catches proportions-at-age



Standardized catches proportions-at-age (Bubbles colour scale: black – negative, grey – positive)

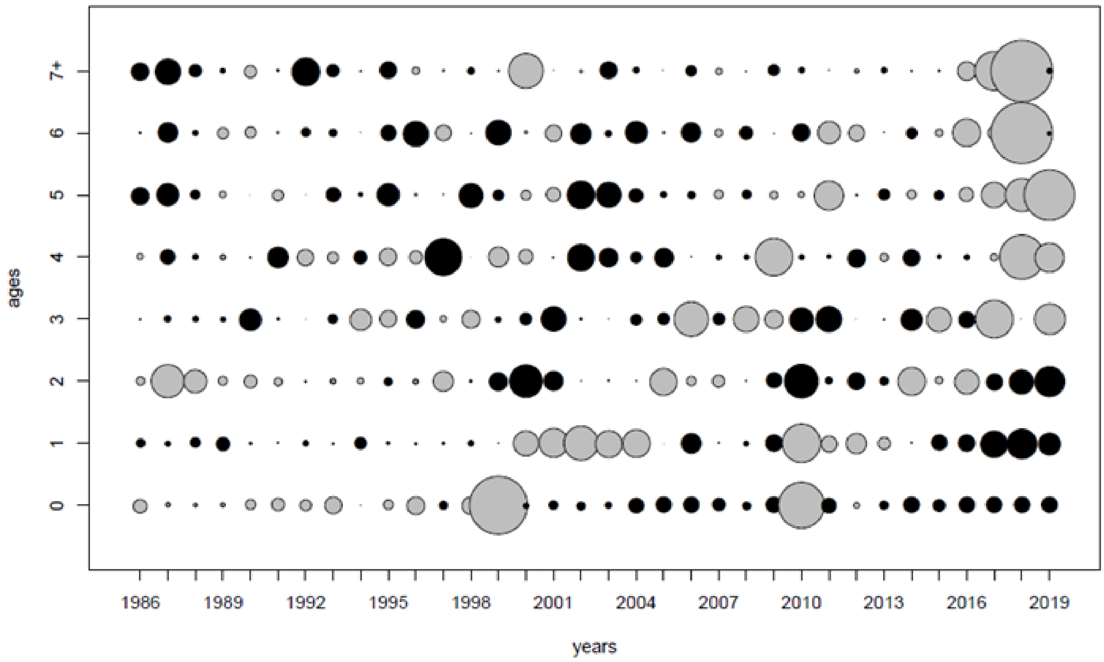
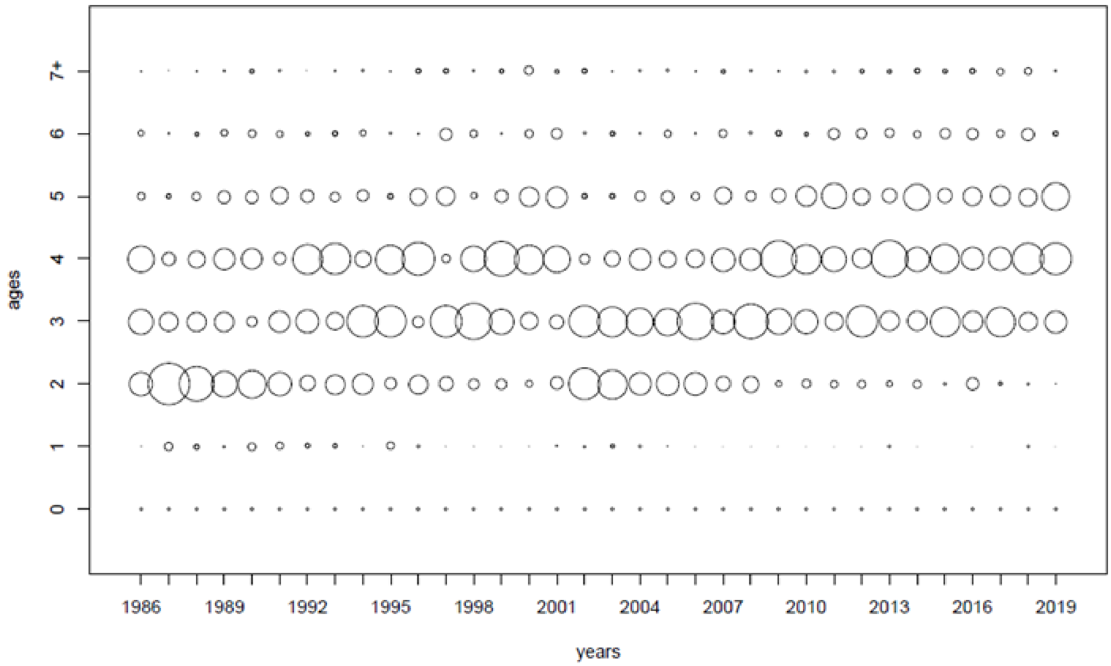


Figure 6.4.4a. Four-spot megrim (*L. boscii*) in Divisions 8c & 9a. Catches proportions-at-age.

Landings proportions-at-age



Standardized landings proportions-at-age (Bubbles colour scale: black – negative, grey – positive)

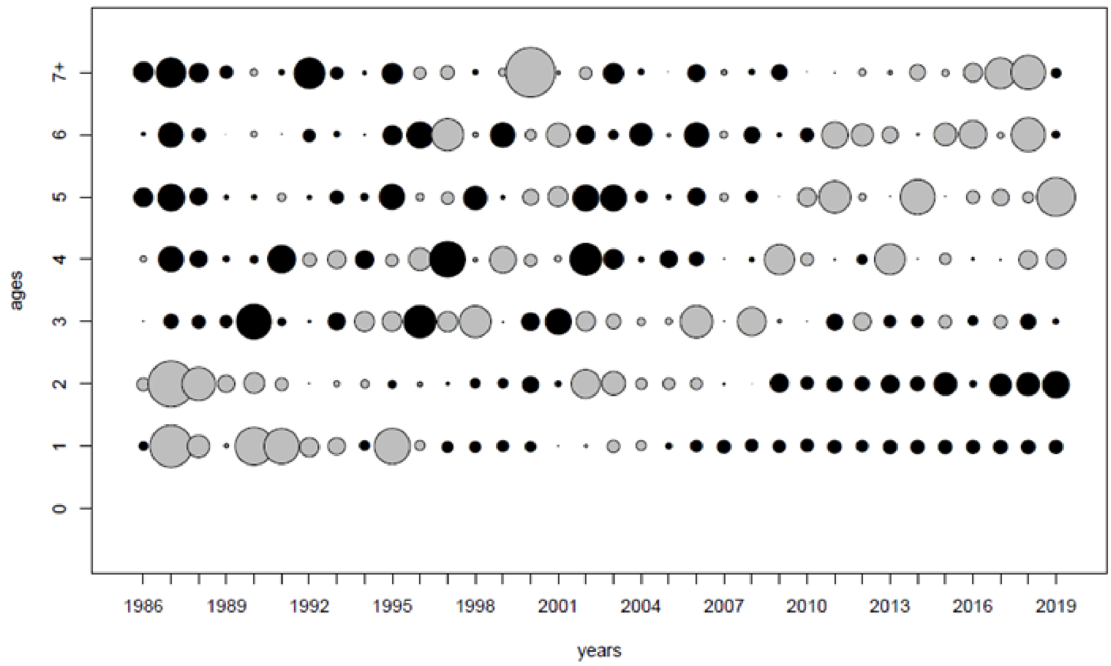
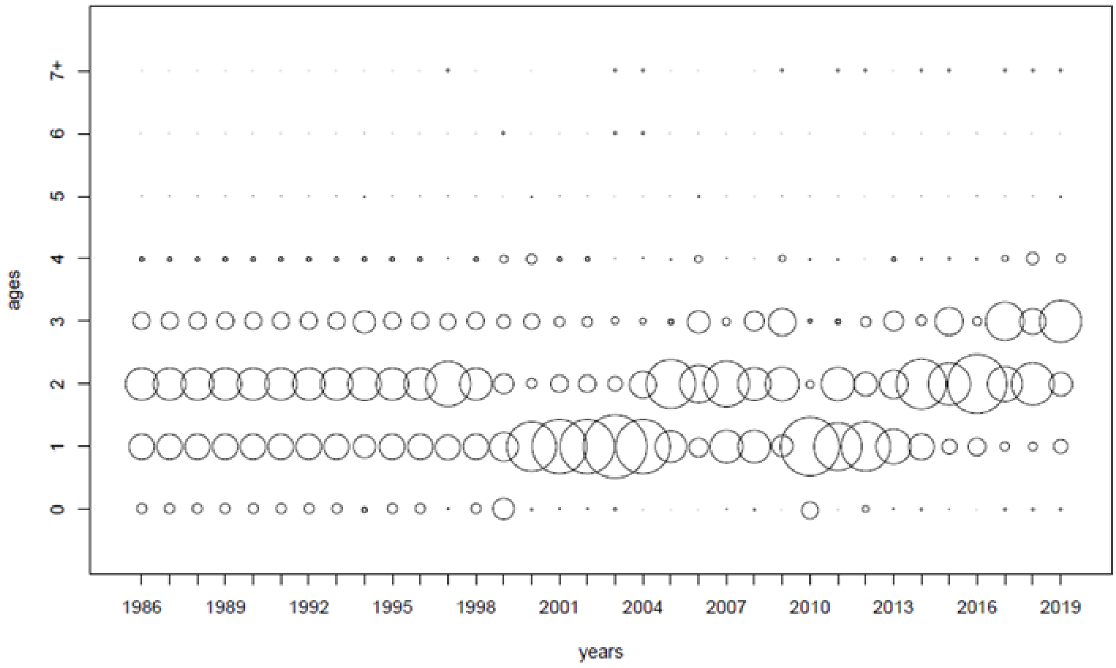


Figure 6.4.4b. Four-spot megrim (*L. boscii*) in Divisions 8c & 9a. Landings proportions-at-age.

Discards proportions-at-age



Standardized discards proportions-at-age (Bubbles colour scale: black – negative, grey – positive)

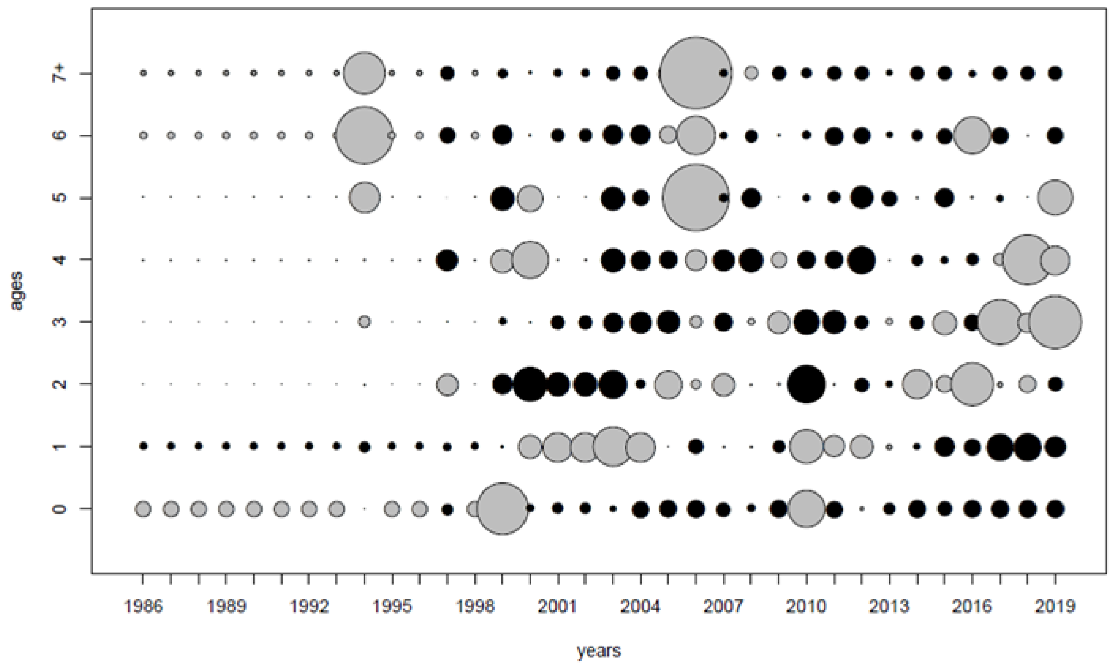


Figure 6.4.4c. Four-spot megrim (*L. boscii*) in Divisions 8c & 9a. Discards proportions-at-age.

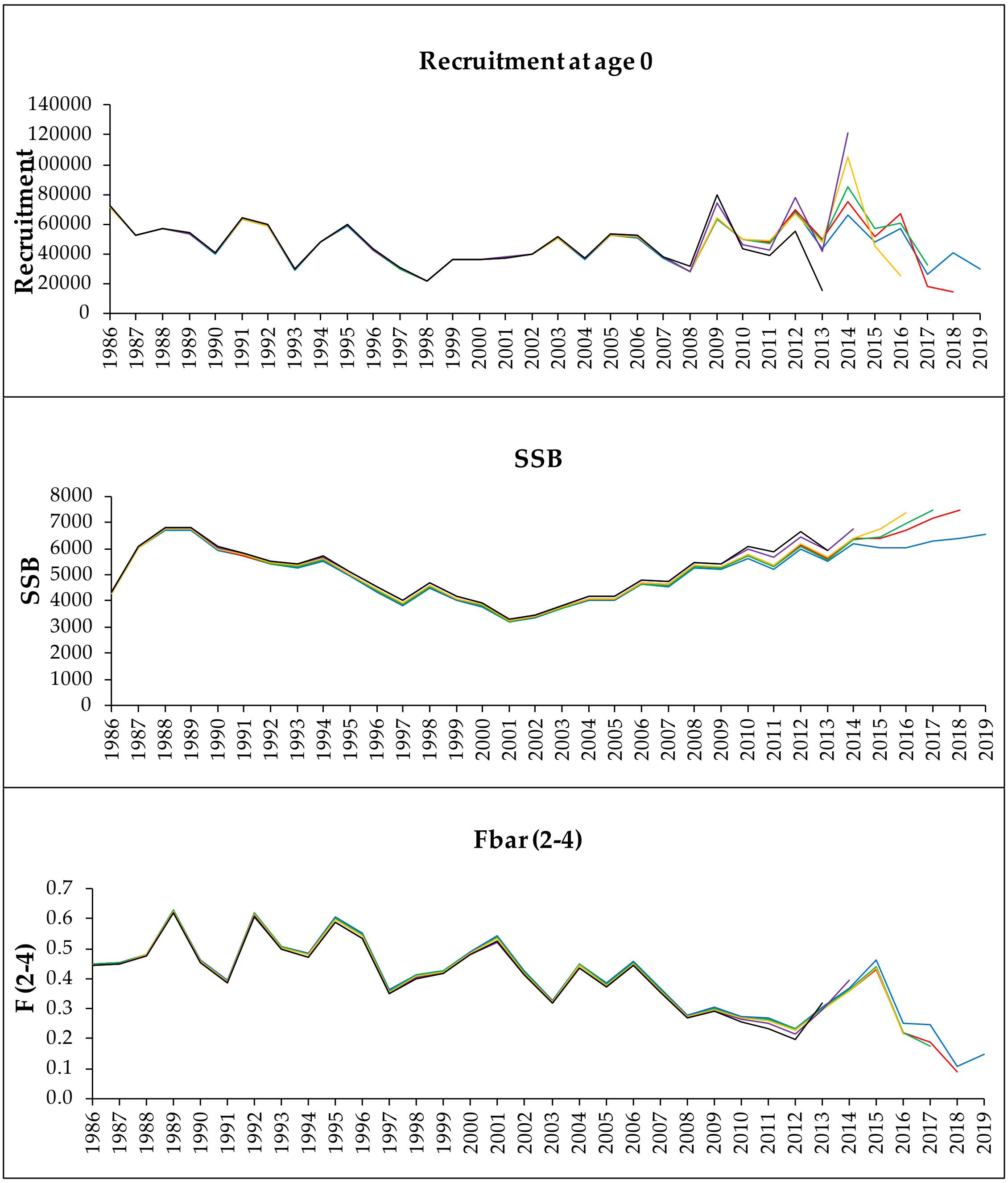


Figure 6.4.5. Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Retrospective XSA.

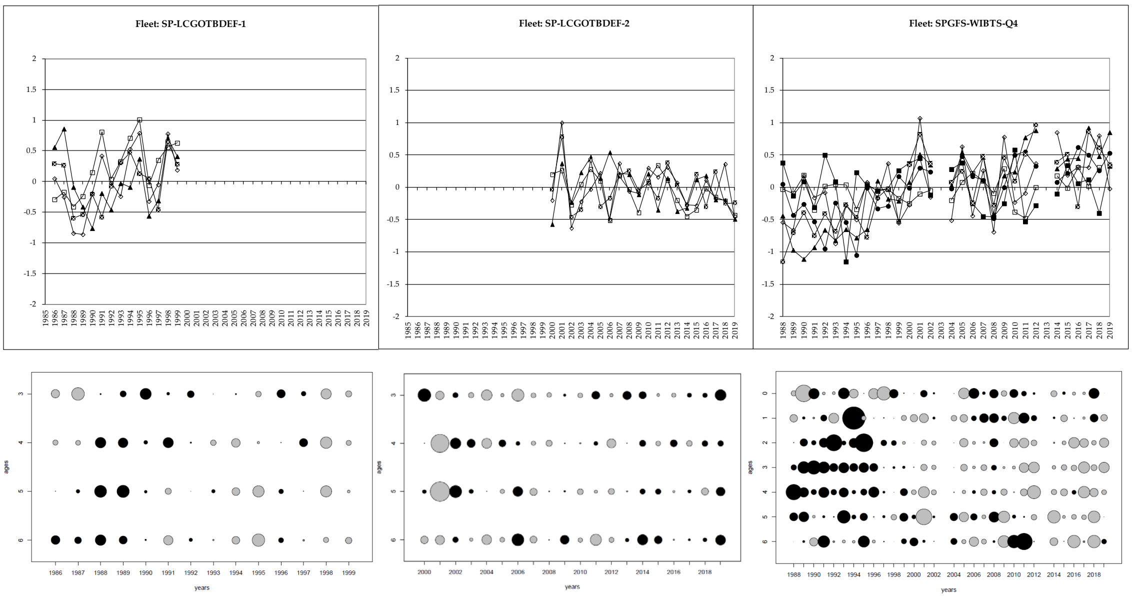


Figure 6.4.6. Four spot megrim (*L. boscii*) in Divisions 8c and 9a. LOG CATCHABILITY RESIDUAL PLOTS (XSA)

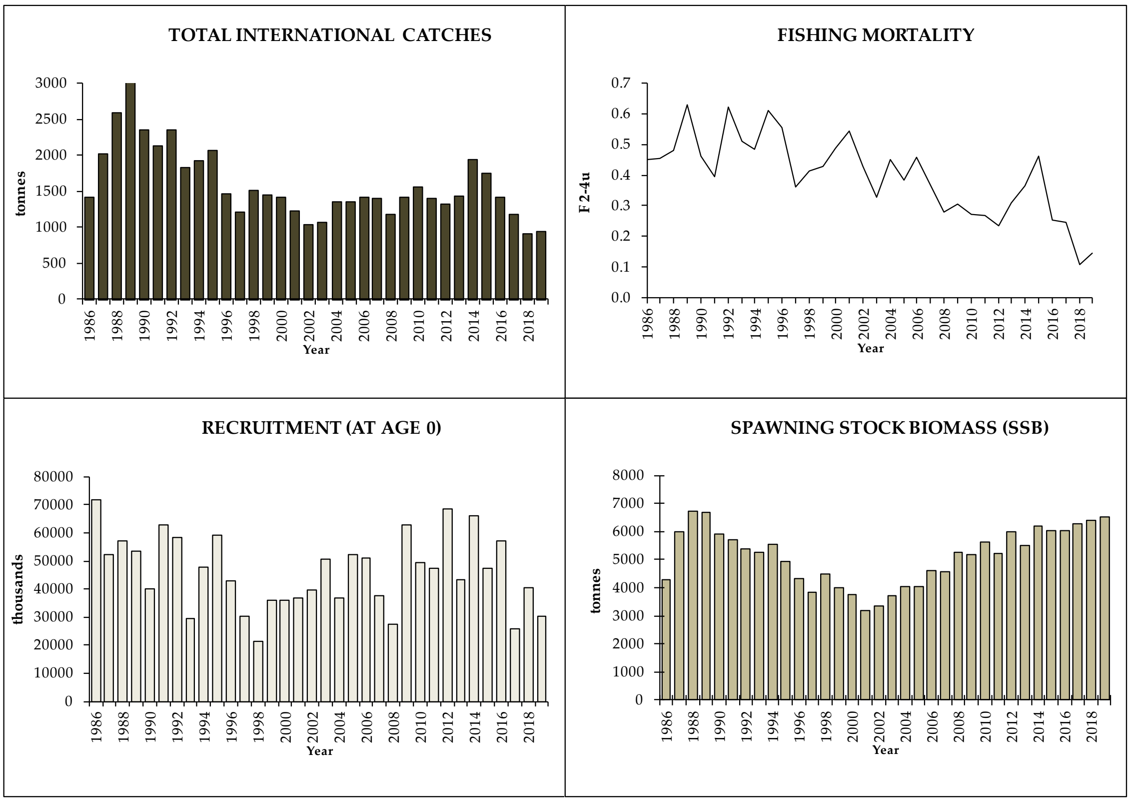
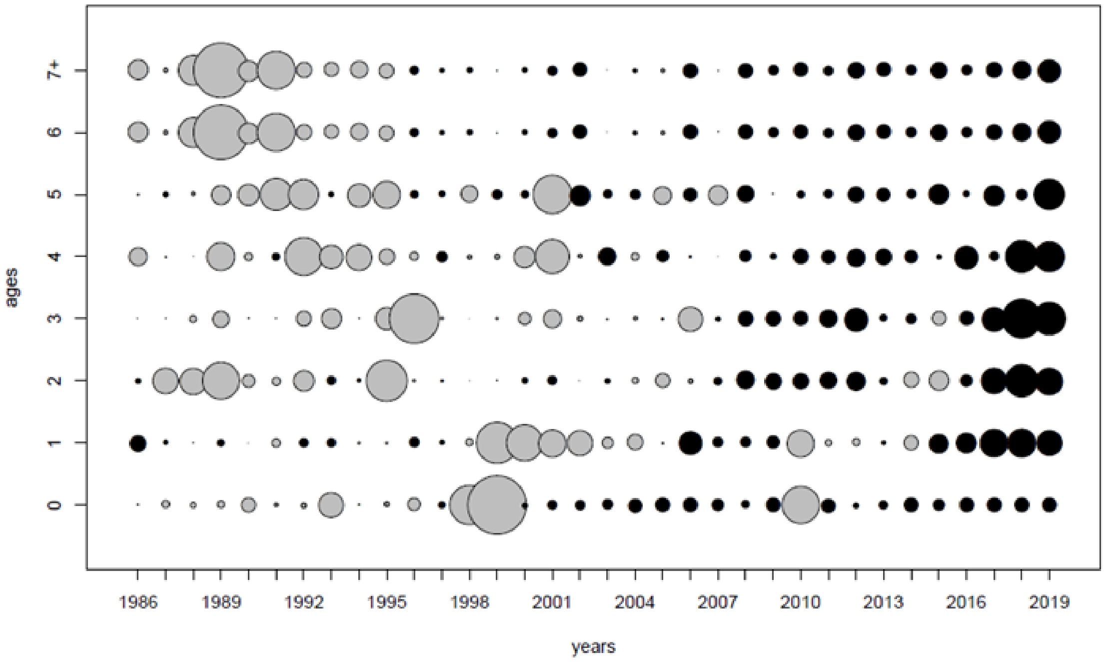


Figure 6.4.7a. Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Stock Summary.

Standardized F-at-age (Bubbles colour scale: black – negative, grey – positive)



Standardized relative F-at-age (Bubbles colour scale: black – negative, grey – positive)

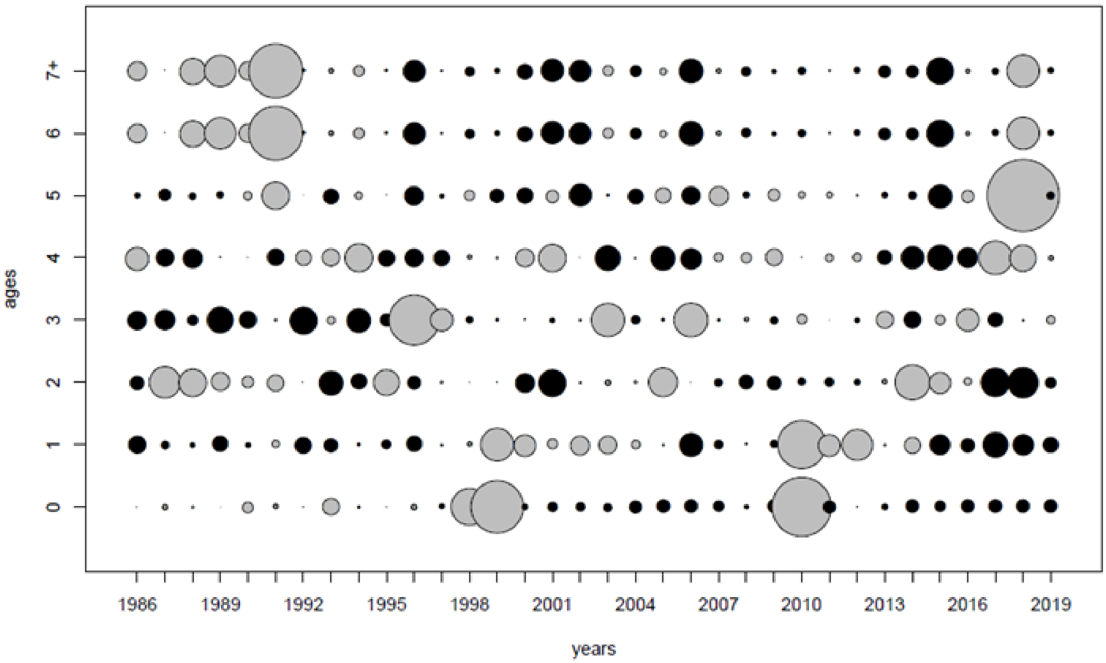
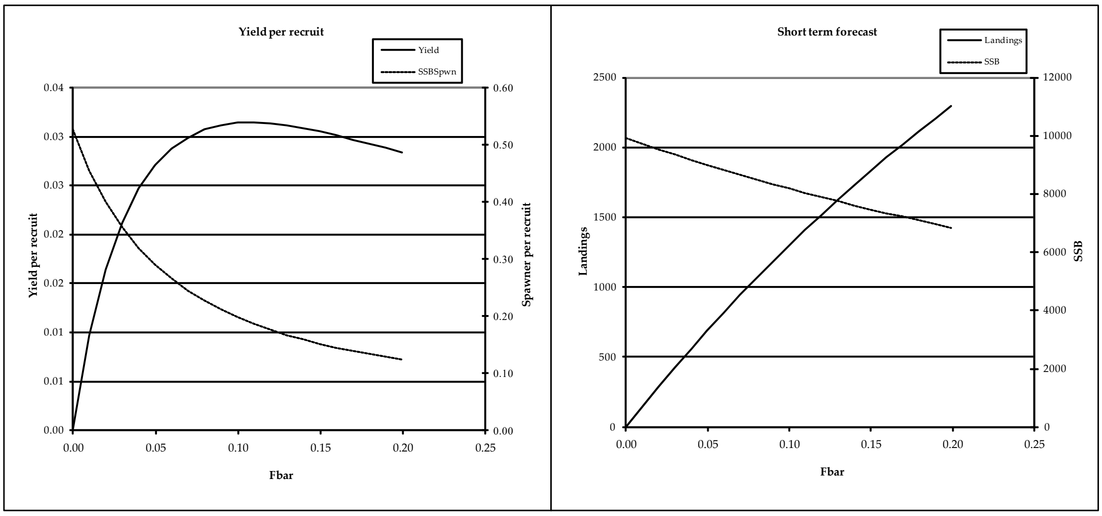


Figure 6.4.7b. Four-spot megrim (*L. boscii*) in Divisions 8c&9a. F-at-age.



MFYPR version 2a
Run: ldb
Time and date: 19:59 30/04/2020

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar	1.0000	0.0997
FMax	1.0767	0.1073
F0.1	0.6497	0.0648
F35%SPR	1.1201	0.1116

MFDP version 1a
Run: ldb
Time and date: 19:37 30/04/2020
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4

Input units are thousands and kg - output in tonnes

Figure 6.4.8. Four-spot megrim (*L. boscii*) in Divisions 8c and 9a. Forecast summary.

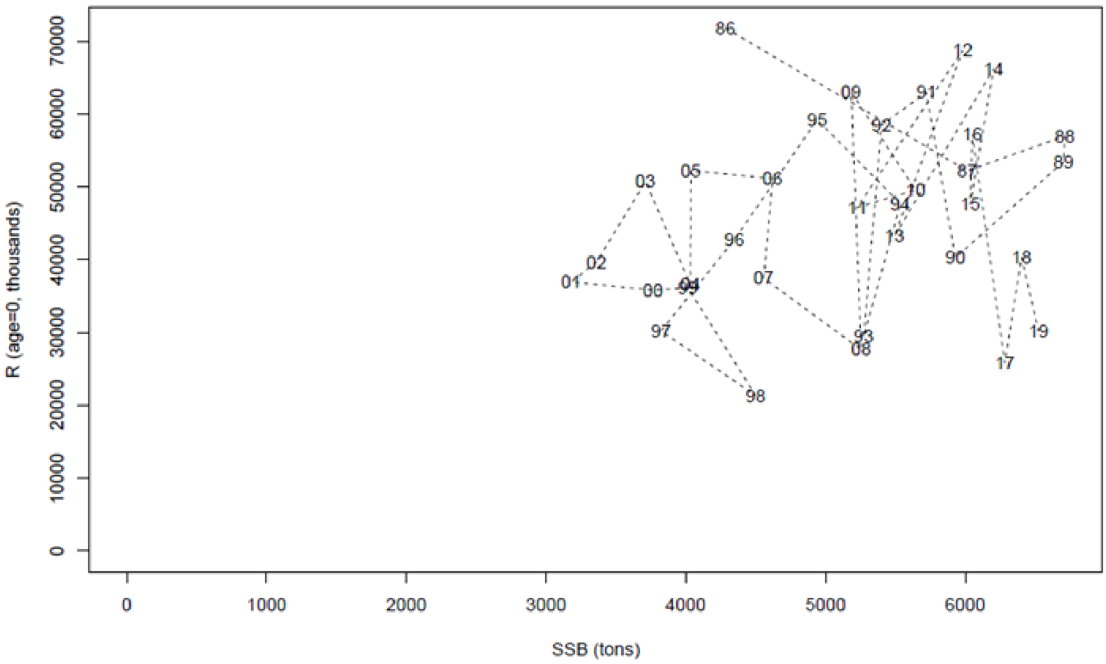


Figure 6.4.9. Four spot megrim (*L. boscii*) in Divisions 8c and 9a. SSB-Recruitment plot.

6.5 Combined Forecast for Megrims (*L. whiffiagonis* and *L. boscii*)

Figure 6.5.1 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 megrims are included in the landings from ICES Divisions 8c and 9a. Both are taken as bycatch in mixed bottom trawl fisheries.

Assuming status quo F for both species in 2020 (average of estimated F over 2017–2019, corresponding to F_{bar} = 0.204 for landings and F_{bar} = 0.022 for discards for *L. whiffiagonis* and F_{bar} = 0.10 for landings and F_{bar} = 0.07 for discards for *L. boscii*). Figure 6.5.2 gives the combined predicted landings for 2021 and individual SSB for 2022, 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 F *status quo* (average F over 2017–2019) for both species, predicted combined landings in 2021 are 1 820 t and individual SSBs in 2022 are 2 143 t for *L. whiffiagonis* and 8 190 t for *L. boscii*.

6.5.1 Figures

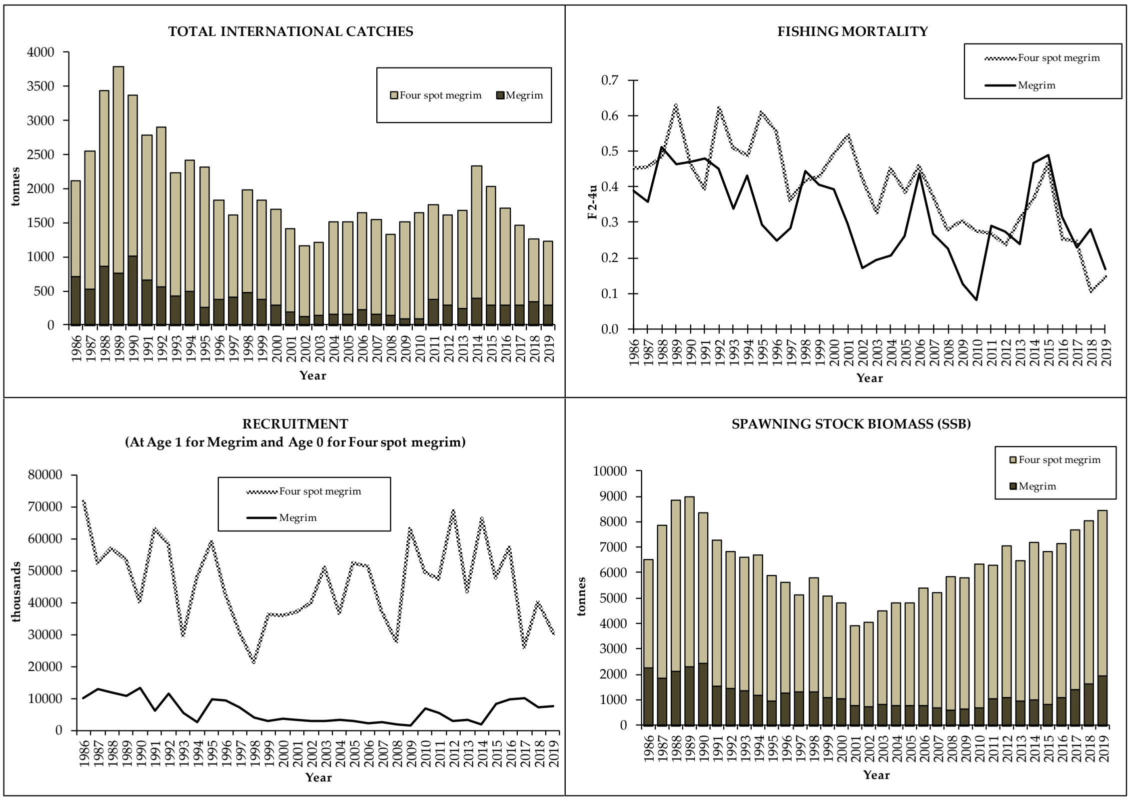


Figure 6.5.1. Stock trends for both stocks. Megrin and Four-spot megrim in Divisions 8c and 9a.

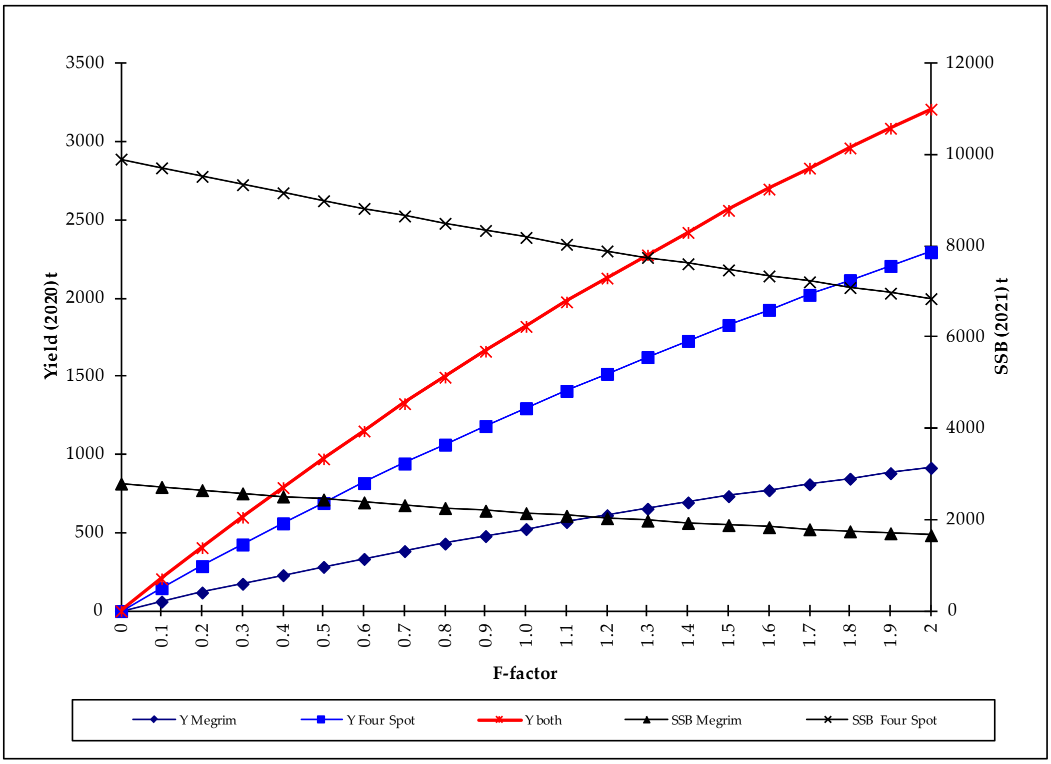


Figure 6.5.2. Megrims (*L. whiffiagonis and L. boscii*) in Divisions 8c and 9a. Combined Short-term Forecasts assuming *status quo* in 2019 and 2020.

7 Bay of Biscay Sole

Type of assessment in 2020 : update.

Data revisions in 2020 : Compared to last year assessment, there is only very limited change in ORAGHO survey CPUE. 2018 French data, resubmitted by France, have been used for this assessment.

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 2020 and management applicable to 2019

ICES advice for 2020

ICES advises that when the EU multiannual plan (MAP; European Parliament and Council Regulation (EU) No. 2019/472) for Western waters and adjacent waters is applied, catches in 2020 that correspond to the F ranges in the MAP are between 2 209 tonnes and 5 196 t. According to the MAP, catches higher than those corresponding to FMSY (3 768 t) can only be taken under the conditions specified in the MAP, whilst the entire range is considered precautionary when applying the ICES advice rule.

Management applicable to 2019 and 2020

The sole landings in the Bay of Biscay are subject to a TAC regulation. The TAC was set at 3 872 t and 3 666 t for 2019 and 2020, respectively.

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 multiannual plan (MAP) for Western waters and adjacent waters was adopted in March 2019 (EU, 2019). One of the objectives is to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield (MSY) in a context of mixed fisheries. The target fishing mortality (F) corresponds to the objective of reaching and maintaining MSY as ranges of values which are consistent with achieving MSY(F_{MSY}). The F_{MSY} upper limit is set that the probability of the stock falling below B_{lim} is no more than 5%. ICES considers that the F_{MSY} range for this stock used in the MAP is precautionary.

In addition to this MAP, 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 seasonal closure was also applied during the spawning period, 1 January to the 31 March, for the directed fishery for common sole. During this period, the fishery 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.

7.1.4 Data

7.1.4.1 Commercial catches and discards

The WG estimates of landings and catches are shown in Table 7.1. Over 90% of the total landings are caught by France, with Belgium catches amounting to less than 10%. There is some incidental landing by other countries such as Spain.

The official landings are lower than the WG landings estimates before 2008 but higher from 2009. 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 5 486 t due to very favourable weather conditions for the fixed nets' fishery (frequent strong swell periods in the first quarter).

The 2019 landings (3 351 t) is 11 % below the landings constraint set at 3 872 t 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 the discards are not used in the assessment. However, the survey showed that discards of offshore trawlers are low for age classes 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 trawler 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 area.

The analysis of the discards with the data from the OBSMER (2003) project shows that the overall discard rate for the sole in the Bay of Biscay is less than 5 % (2.5% average discard ratio over 2015-2019).

7.1.4.2 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 by metier and length class is described in Stock Annex. The observed split between fleets is presented in the Table 7.2.

French and Belgian data were extracted from InterCatch for 2019.

Even though age reading from otoliths now uses the same method in France and Belgium (see Stock Annex), the discrepancy between French and Belgian mean weight-at-age, observed by preceding WGs, are still present. Work was carried out in the beginning of 2012 by the PGCCDBS WG to compare the age reading methods (ICES, 2012). The conclusion was the absence of 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 determination 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 and landings numbers-at-age are shown in Table 7.3 and in Figure 7.1, respectively, and the mean catch weight-at-age in Table 7.4.

7.1.5 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 (ICES, 2013a). The index found to be the most appropriate was the one based on all the reference stations and carried out by daylight. This was used to provide the abundance index for sole in Division 8.a-b. The 2013 WGHMM assessment was carried out according to a 2013 revised stock annex, which adds the ORHAGO survey to the tuning files (ICES, 2013b). 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 remained the same as in the previous year and the conclusion of the WGBEAM 2016 was: “This change has had no consequence on the gear configuration” (ICES, 2016). On this basis, the WG agreed to retain the ORHAGO abundance index in the assessment. The Figure 7.2 shows the tuning fleets’ time series and their internal consistency.

7.1.6 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 is not driven by the 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 (Figure 7.2). The Les Sables d’Olonne LPUE series (FR-SABLES) also shows 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 tuning series 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, with stabilization from 2013 onward.

ORHAGO shows a slight decrease in numbers-at-age 2 (Figure 7.2) in the last 5 years but the index is about the average of the time series. It is worth noting an important decrease of the ORHAGO and FR-BB-IN-Q4 tuning fleets indices in 2019 for the age 2. Both show a decrease of the age 3 indices. In general, these two fleets are consistent among ages.

7.2 Assessment

7.2.1 Input data

See stock annex

7.2.2 Model

The model used in 2020 to assess sole in the Bay of Biscay is the R FLXSA package (Kell, 2020). The age range in the assessment is 2–8+, as last year assessment. The year range used is 1984–2019.

Result of XSA runs

The final XSA was run using the same settings as in last year assessment run. Figure 7.1 shows a distribution of landings-at-age and shows that, as in last year the landings consist mainly of ages 3 and 4 year old individuals.

			2019 XSA		2020 XSA
Catch data range			84–18		84–19
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	00-18	3–7	00–19	3–7
	FR-BB-OFF-Q2	00-12	2–6	00–12	2–6
	FR-ORHAGO	07-18	2–8	07–19	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 log-catchability residuals are shown in Figure 7.4 and retrospective results in Figure 7.5. The retrospective pattern shows a good estimation of F, SSB for 2017 data. The Table 7.5 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 (2015–2019). Mohn's rho value is -0.22 for recruitment, for 0.02 SSB and -0.11 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. Recruits-at-age 2 were not well estimated for 2018.

Fishing mortalities and stock numbers-at-age are given in Tables 7.6 and 7.7, respectively. The results are summarised in Table 7.8. Trends in yield, F, SSB and recruitments are plotted in Figure 7.6. Fishing mortality in 2019 is estimated by XSA (Shepherd, 1999) to have been at 0.36. Fishing mortality was 0.34 in 2018 and 0.28 in 2017.

7.2.2.1 Estimating year class abundance

In this year's assessment, the retrospective analyses show that from 2011 the recruitment was well estimated by the XSA model. The retrospective analysis shows uncertain recruitment estimates from 2012 onward. The recruitment for the most recent period tends to be not well estimated and the surveys used in the assessment do not adequately provide the information needed to be able to achieve a better estimate. The recruitment assumed for projections is computed as the geometric mean of the estimated recruitment over the period 2004-2017, which is equal to 18 497 thousand recruits.

7.2.2.2 Historic trends in biomass, fishing mortality and recruitment

A full summary of the XSA time series results are given in Table 7.8 and illustrated in Figure 7.6. Since 1984, fishing mortality gradually increased, peaked in 2002 and decreased substantially in the following two years. It increased since 2005 and F was stable at around F_{pa} (= 0.43). In 2017, the value was below F_{MSY} but in 2018 and 2019 they are in between F_{MSY} and F_{pa}. The SSB trend in earlier years increased from 12 300 t in 1984 to 16 300 t in 1993. Afterwards it showed a continuous decline to 9 600 t in 2003. After an increase between 2003 and 2006, the SSB remained close to 11 000 t from 2007 to 2009. The SSB although above the MSY $B_{brigger}$ (10 600 t) from 2004 has been decreasing since 2012. The SSB values for 2014 and 2015 are below the B_{pa}. Since 2016, the SSB is above the Bpa, and for the last year (2019), estimated SSB are above MSY $B_{trigger}$ and B_{pa} (both equal to 10 600 t). The recruitment values are decreasing since 1993. Between 2004 and 2008, the series is stable at around 17 or 18 million and the 2009 year class is the highest value since 1992. After a short increase, the recruitment is declining since 2015, with the lowest value of the series observed in 2019 (around 11 million).

7.2.3 Catch options and prognosis

The exploitation pattern is the mean over the period 2017–2019 scaled to the last year. As the take up of TAC is less than 80%, a F-status quo for the intermediate year is used and set at 0.36. The recruits at age 2 from 2019 to 2020 are assumed equal to GM04-17. Stock numbers-at-age 3 and above are the XSA survivor estimates. Weights-at-age in the landings are the 2017–2019 means using the fresh/gutted transformation coefficient of French landings which was changed from 1.11 to 1.04 in 2007. Weights-at-age in the stock are the 2017–2019 means using the old fresh/gutted transformation coefficient of French landings (1.11). The fresh/gutted transformation coefficient of French landings was not computed in 2020. The predicted spawning biomass is consequently still comparable to the biomass reference point.

7.2.3.1 Short term predictions

Input values for the catch forecast are given in Table 7.10. For the intermediate year (2020), the F *status quo* was used to perform the short-term predictions (F_{2020} = 0.36). In 2019, the TAC was not reached (80% of the TAC was taken). The F corresponding to the assumptions about catch for this run is 0.36.

The WGBIE was concerned by the decrease in recruitment over the past two decades. The time series used to compute the recruitment as a geometric mean was shortened to account for lower recruitment in the past 10 years. The retro-analysis of the recruitment was used to identify an appropriate time period to use for the GM calculation. The retro-analysis shows that the recruitment is well estimated from 2004 to 2011. The geometric mean of the recruitment was consequently computed over the time period 2004-2017, giving the value of 18 497 thousand of recruits. The above period to compute the GM of the recruitment is more precautionary than the time period used in the stock annex.

Assuming recruitment at GM2004–2017, the SSB is predicted to increase to 12 098 t in 2020. It will continue to increase at F_{MSY}, to reach 12 759 t in 2021 (Table 7.11).

7.2.4 Biological reference points

WKMSYRef4 for MSY approach reference points (ICES, 2015) are given below with technical basis with the value adopted for the precautionary approach reference points:

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	10 600 t	B_{pa}
Approach	F_{MSY}	0.33	F_{MSY} without $B_{trigger}$
	B_{lim}	7 600 t	$B_{lim} = B_{pa} / \exp(\sigma \times 1.645)$
Precautionary	B_{pa}	10 600 t	The third lowest value
Approach	F_{lim}	0.6	In equilibrium gives a 50% probability of SSB>B_{lim}
	F_{pa}	0.43	$F_{pa} = F_{lim} \times \exp(-\sigma \times 1.645)$

The fishing mortality pattern is known with a low uncertainty because of the low discards levels and the quality and sampling level of the catches.

7.2.5 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 from age 2. At other ages, it is particularly useful to have a survey in the tuning file because the recent use of electronic logbooks has caused some obvious misrecording of effort which limits the available commercial tuning data in 2012 and 2013 coupled with 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 longer the case with the 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 requires further investigation.

Discarding

Available data on discards have shown that discards may be important at age 1 for some trawlers. Discards at age 2 were assumed to be low in the past due to 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' organizations. Overall, discards remain low in recent years and are used to produce catch advice. Discards could be included in the assessment after a benchmark.

Consistency

Since the 2013 assessment, the ORHAGO survey has been included in the tuning fleets. This survey is the only tuning fleet which provides a recruitment index series for the more recent period. A geometric mean (GM) is used only for recruitment prediction (2019–2022). It is worth noting that the variability of the recruitment series has increased in period 2001 to 2019. The retrospective pattern in F shows that F_{2016} is well estimated (Figure 7.5). 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 LPUE representative of changes 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.

Misreporting

Misreporting is likely to be limited for this stock but it may have occurred for fish of the smallest market size category for some years. There are some reports of high-grading practices due to the landing limits adopted by some producers' organizations.

Industry input

The traditional meeting with representatives of the fishing industry was organised in France prior to the WG to present the data used during the WGBIE 2019 to assess the state of stock in the Bay of Biscay (ICES, 2019).

Since 2015, the French sole fishery in the Bay of Biscay (ICES divisions 8.a-b) has been subjected to additional management measures aimed at reducing fishing mortality and improving the stock's recruitment level.

Since 2016, these measures include a fishing closure 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 stock (Council Regulation (EC) No. 388/2006) 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. In 2019, this management regime provides for:

- a fishing closure 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 with highest yields should significantly reduce landings. A study made by IFREMER (IFREMER, 2015) quantified that closing 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 limit catches of sole that have not reached maturity (26 cm). A study made by AGLIA (AGLIA, 2009) 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 9 641t in 2003 from a peak in 1993 (16 349 t) which has then increased to 14 746 t in 2011. After another decrease between 2011 to 2015, the SSB is now increasing in the last years and has stabilized at 11 602 t in 2019. The SSB in 2019 is above Bpa and MSYBtriger (10 600 t) when assuming GM2004–2017 recruitment value for 2019. An increase of SBB is predicted by the short-term prediction in 2020 and 2021. In 2006, a management plan (Council Regulation (EC) No 388/2006) was agreed for the Bay of Biscay sole but a long-term F target was not set. This plan was not evaluated by ICES.

7.2.6 References

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Table 7.1. Bay of Biscay sole (Division 8a,b). Internationals landings and catches used by the Working Group (in tonnes).

Year	Belgium	France	Spain	Total	Ices landings	discards	Ices catches
1979	0	2376	62	2443	2619	-	-
1980	33	2549	107	2689	2986	-	-
1981	4	2581	96	2694	2936	-	-
1982	19	1618	57	1746	3813	-	-
1983	9	2590	38	2669	3628	-	-
1984	0	2968	40	3183	4038	99	4137
1985	25	3424	308	3925	4251	64	4315
1986	52	4228	75	4567	4805	27	4832
1987	124	4009	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	0	4334	6027	127	6154
1999	504	3280	0	3784	5249	110	5359
2000	451	5293	5	5749	5760	51	5811
2001	361	4350	0	4912	4836	39	4875
2002	303	3680	2	3985	5486	22	5508
2003	296	3805	4	4105	4108	21	4129
2004	324	3739	9	4072	4002	-	-
2005	358	4003	10	4371	4539	-	-
2006	393	4030	9	4432	4793	-	-
2007	401	3707	9	4117	4363	-	-

Year	Belgium	France	Spain	Total	Ices landings	discards	Ices catches
2008	305	3018	11	3336	4299	-	-
2009	364	4391	0	4755	3650	-	-
2010	451	4248	0	4699	3966	-	-
2011	386	4259	0	4645	4632	-	-
2012	385	3819	0	4204	4321	-	-
2013	312	4181	0	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	3304
2018	295	3165	8	3468	3308	24	3332
2019	328	2999	24	3351	3376	88	3464

Table 7.2. Bay of Biscay sole (Division 8a,b). Total landings by different fleets.

Year	Offshore trawlers	Inshore trawlers	Offshore gillnetters	Inshore gillnetters	Belgian Beam trawlers
1997	1874	667	1927	1356	435
1998	1826	605	1674	1414	463
1999	1261	289	2094	1105	499
2000	1197	474	2510	1114	459
2001	994	411	1947	913	368
2002	968	373	2760	1054	311
2003	992	329	1736	749	296
2004	898	369	1710	686	319
2005	923	326	2053	788	365
2006	923	373	2117	896	393
2007	920	392	1768	870	401
2008	813	238	2085	856	305
2009	745	235	1615	692	363
2010	792	323	1733	667	451
2011	807	327	2197	915	386

Year	Offshore trawlers	Inshore trawlers	Offshore gillnetters	Inshore gillnetters	Belgian Beam trawlers
2012	744	365	1938	889	385
2013	744	313	2052	814	312
2014	716	345	1811	748	307
2015	537	263	1786	748	302
2016	471	259	1522	687	288
2017	514	245	1545	663	274
2018	470	230	1667	725	295
2019	457	227	1589	759	322

Table 7.3. Bay of Biscay sole, catch number at age.

Year	2	3	4	5	6	7	8
1984	5901	3164	2786	2034	1164	880	1181
1985	8493	4606	2479	1962	906	708	729
1986	6126	4208	2673	2301	1512	1044	1235
1987	3794	5634	3578	2005	1482	690	714
1988	4962	5928	4191	2293	1388	874	766
1989	4918	6551	3802	3147	2046	967	499
1990	7122	6312	4423	2833	972	1018	870
1991	4562	6302	4512	2083	1113	1063	981
1992	4640	7279	4920	2991	2236	1124	951
1993	1897	7816	6879	3661	1625	566	708
1994	2603	5502	8803	5040	1968	970	696
1995	3249	5663	6356	3644	1795	843	986
1996	3027	5180	5409	2343	1697	1366	1319
1997	3801	9079	5380	3063	1578	692	877
1998	4096	5550	6351	2306	1237	785	1188
1999	2851	5113	4870	2764	1314	902	977
2000	5677	7015	5143	2542	955	421	444
2001	3180	6528	4948	1776	899	513	486
2002	5198	4777	4932	3095	1269	615	432

Year	2	3	4	5	6	7	8
2003	4274	6309	2236	1220	729	377	250
2004	3411	5415	3291	917	661	272	333
2005	3976	3464	3738	2309	991	461	508
2006	3535	4436	2747	2012	1030	530	1537
2007	3885	5181	2615	1419	1262	686	946
2008	3173	4794	2886	1353	938	892	1193
2009	2860	3986	2233	1501	946	541	960
2010	2084	7707	3758	1272	484	269	284
2011	1516	5222	8347	1019	570	275	516
2012	1302	4680	4264	3787	1008	225	517
2013	2312	2939	3777	3205	1450	286	635
2014	3767	3198	1769	2426	1810	791	522
2015	2531	3365	1742	2057	1305	939	636
2016	1144	3368	2682	1193	762	759	867
2017	1492	3608	2199	1023	606	587	949
2018	1134	2970	2108	1621	1030	724	1394
2019	1084	3529	2783	1642	1134	571	815

Table 7.4. Bay of Biscay sole, catch weight-at-age (in Kg).

Year	2	3	4	5	6	7	8
1984	0.130	0.180	0.228	0.288	0.352	0.394	0.614
1985	0.109	0.179	0.260	0.322	0.402	0.471	0.719
1986	0.104	0.176	0.250	0.334	0.417	0.508	0.670
1987	0.144	0.206	0.292	0.385	0.479	0.509	0.699
1988	0.135	0.192	0.274	0.360	0.499	0.507	0.609
1989	0.137	0.189	0.259	0.356	0.439	0.546	0.803
1990	0.132	0.180	0.242	0.349	0.438	0.603	0.857
1991	0.146	0.196	0.265	0.331	0.445	0.545	0.728
1992	0.146	0.196	0.262	0.341	0.404	0.490	0.715
1993	0.145	0.197	0.267	0.341	0.439	0.569	0.678

Year	2	3	4	5	6	7	8
1994	0.147	0.195	0.251	0.325	0.422	0.570	0.775
1995	0.160	0.206	0.253	0.309	0.404	0.485	0.660
1996	0.159	0.204	0.268	0.319	0.399	0.453	0.625
1997	0.143	0.194	0.257	0.321	0.408	0.504	0.681
1998	0.162	0.214	0.259	0.338	0.414	0.506	0.706
1999	0.177	0.219	0.246	0.305	0.404	0.533	0.582
2000	0.172	0.208	0.278	0.345	0.455	0.577	0.760
2001	0.154	0.222	0.268	0.344	0.432	0.524	0.625
2002	0.173	0.211	0.266	0.324	0.472	0.599	0.689
2003	0.181	0.227	0.309	0.363	0.490	0.661	0.646
2004	0.192	0.229	0.293	0.395	0.498	0.650	0.818
2005	0.192	0.229	0.303	0.373	0.437	0.475	0.666
2006	0.198	0.245	0.286	0.352	0.426	0.461	0.540
2007	0.176	0.226	0.299	0.327	0.389	0.420	0.512
2008	0.174	0.229	0.287	0.352	0.392	0.401	0.519
2009	0.173	0.218	0.279	0.322	0.367	0.454	0.610
2010	0.179	0.206	0.273	0.338	0.415	0.478	0.769
2011	0.194	0.224	0.254	0.344	0.434	0.491	0.609
2012	0.182	0.225	0.258	0.308	0.370	0.415	0.586
2013	0.210	0.242	0.274	0.306	0.371	0.522	0.525
2014	0.179	0.243	0.283	0.299	0.351	0.397	0.581
2015	0.198	0.226	0.318	0.314	0.389	0.367	0.520
2016	0.188	0.238	0.286	0.352	0.372	0.382	0.526
2017	0.219	0.239	0.301	0.376	0.434	0.427	0.523
2018	0.198	0.240	0.290	0.356	0.394	0.400	0.466
2019	0.200	0.248	0.288	0.334	0.332	0.372	0.424

Table 7.5. Mohn's Rho for R, SSB and R.

Variable	Mohn's rho
SSB	-0.0151
Mean F	0.1080
Recruits	0.2200

Table 7.6. Fishing mortality-at-age.

	2	3	4	5	6	7	8
1984	0.3	0.24	0.34	0.35	0.32	0.34	0.34
1985	0.36	0.35	0.27	0.37	0.23	0.29	0.29
1986	0.26	0.27	0.32	0.39	0.48	0.4	0.4
1987	0.17	0.36	0.35	0.37	0.41	0.38	0.38
1988	0.22	0.4	0.43	0.35	0.42	0.4	0.4
1989	0.2	0.44	0.43	0.6	0.53	0.52	0.52
1990	0.27	0.38	0.53	0.58	0.33	0.48	0.48
1991	0.14	0.35	0.46	0.45	0.42	0.63	0.63
1992	0.15	0.32	0.46	0.56	1.1	0.86	0.86
1993	0.08	0.35	0.5	0.64	0.61	0.82	0.82
1994	0.11	0.33	0.75	0.74	0.77	0.8	0.8
1995	0.16	0.33	0.68	0.72	0.57	0.79	0.79
1996	0.11	0.35	0.53	0.51	0.79	1.04	1.04
1997	0.18	0.52	0.67	0.58	0.68	0.77	0.77
1998	0.21	0.4	0.74	0.6	0.43	0.77	0.77
1999	0.13	0.39	0.64	0.74	0.74	0.56	0.56
2000	0.27	0.48	0.77	0.72	0.54	0.49	0.49
2001	0.22	0.51	0.65	0.58	0.53	0.56	0.56
2002	0.25	0.53	0.81	1.01	0.97	0.76	0.76
2003	0.2	0.48	0.44	0.42	0.61	0.76	0.76
2004	0.24	0.38	0.43	0.29	0.37	0.43	0.43
2005	0.26	0.36	0.44	0.54	0.52	0.42	0.42
2006	0.23	0.46	0.47	0.39	0.44	0.51	0.51
2007	0.26	0.53	0.48	0.42	0.4	0.53	0.53
2008	0.2	0.53	0.56	0.43	0.47	0.49	0.49
2009	0.09	0.37	0.45	0.57	0.54	0.49	0.49
2010	0.09	0.34	0.62	0.44	0.32	0.26	0.26
2011	0.08	0.32	0.67	0.3	0.32	0.27	0.27
2012	0.1	0.34	0.41	0.65	0.47	0.18	0.18

	2	3	4	5	6	7	8
2013	0.19	0.32	0.44	0.55	0.49	0.21	0.21
2014	0.26	0.39	0.29	0.5	0.61	0.48	0.48
2015	0.16	0.35	0.33	0.56	0.49	0.66	0.66
2016	0.07	0.29	0.46	0.36	0.37	0.52	0.52
2017	0.1	0.3	0.28	0.28	0.28	0.48	0.48
2018	0.14	0.32	0.3	0.35	0.37	0.33	0.33
2019	0.11	0.4	0.41	0.31	0.34	0.38	0.38

Table 7.7. Bay of Biscay Sole, Stock number-at-age (start of year) Numbers*10-3.**

	2	3	4	5	6	7	8
1984	24152	15407	10265	7275	4472	3246	4343
1985	29514	16241	10931	6638	4648	2940	3018
1986	28315	18627	10314	7533	4140	3344	3941
1987	24898	19793	12851	6790	4627	2308	2380
1988	26727	18920	12550	8225	4236	2777	2425
1989	28136	19464	11481	7369	5261	2513	1291
1990	32081	20780	11380	6772	3674	2814	2394
1991	35705	22254	12799	6090	3432	2400	2203
1992	35322	27968	14141	7289	3529	2047	1719
1993	24881	27547	18382	8115	3750	1066	1324
1994	26199	20709	17491	10090	3861	1848	1316
1995	23567	21230	13505	7453	4335	1621	1883
1996	29373	18234	13823	6174	3277	2215	2120
1997	23712	23699	11572	7362	3357	1351	1701
1998	22584	17839	12807	5353	3748	1537	2310
1999	24391	16539	10862	5547	2650	2215	2387
2000	24982	19358	10101	5196	2390	1148	1205
2001	16920	17204	10843	4248	2284	1254	1182
2002	24820	12285	9357	5105	2154	1211	845
2003	24383	17514	6572	3775	1675	742	489

	2	3	4	5	6	7	8
2004	17048	17997	9846	3820	2256	822	1002
2005	18165	12181	11134	5778	2584	1412	1550
2006	18370	12654	7727	6519	3032	1395	4028
2007	17618	13259	7230	4379	3984	1764	2421
2008	18422	12246	7069	4055	2612	2405	3202
2009	33896	13650	6520	3651	2382	1471	2599
2010	24504	27950	8560	3776	1876	1255	1322
2011	20637	20190	17959	4171	2206	1237	2315
2012	13850	17231	13301	8310	2804	1454	3335
2013	14015	11293	11140	7980	3917	1579	3497
2014	17280	10482	7423	6487	4172	2165	1422
2015	18149	12052	6442	5034	3562	2053	1382
2016	17365	14014	7705	4172	2598	1981	2253
2017	16404	14625	9477	4420	2640	1626	2617
2018	14438	13423	9801	6483	3026	1813	3483
2019	11320	11413	8820	6540	4132	1897	2697

Table 7.8. Bay of Biscay Sole, Summary.

Year	Recruits (in thousands)	SSB (in t)	Landings (in t)	Mean F (age 3-6)
1984	24152	12316	4038	0.31
1985	29514	13359	4251	0.31
1986	28315	14469	4805	0.37
1987	24898	15462	5086	0.37
1988	26727	15336	5382	0.40
1989	28136	14438	5845	0.50
1990	32081	14787	5916	0.45
1991	35705	14746	5569	0.42
1992	35322	15937	6550	0.61
1993	24881	16336	6420	0.53
1994	26199	15807	7229	0.65

Year	Recruits (in thousands)	SSB (in t)	Landings (in t)	Mean F (age 3-6)
1995	23567	14204	6205	0.58
1996	29373	13781	5854	0.54
1997	23712	13290	6259	0.61
1998	22584	13212	6027	0.54
1999	24391	12312	5249	0.63
2000	24982	11827	5760	0.63
2001	16920	10560	4836	0.57
2002	24820	9796	5486	0.83
2003	24383	9627	4108	0.49
2004	17048	11143	4002	0.37
2005	18165	11512	4539	0.46
2006	18370	12119	4793	0.44
2007	17618	11157	4363	0.46
2008	18422	11050	4299	0.50
2009	33896	10872	3650	0.48
2010	24504	12815	3966	0.43
2011	20637	14654	4632	0.40
2012	13850	14270	4321	0.47
2013	14015	13394	4235	0.45
2014	17280	10768	3928	0.45
2015	18149	10390	3644	0.43
2016	17365	10932	3232	0.37
2017	16404	13227	3244	0.28
2018	14438	12492	3517	0.34
2019	11320	11487	3400	0.36

Table 7.9: XSA tuning diagnostics

Fleet = FR-SABLES

Catchability residuals:

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	-0.23	-0.14	-0.38	-0.41	-0.08	-0.21	-0.12	-0.04	-0.18	0.19	-0.17
3	0.10	-0.19	0.16	-0.11	-0.18	-0.03	0.20	-0.01	-0.42	0.39	0.06
4	0.13	-0.28	-0.09	0.36	0.14	0.01	0.01	0.44	-0.23	0.13	-0.06
5	0.07	-0.17	-0.12	0.22	-0.01	-0.13	-0.25	0.15	0.28	-0.10	-0.28
6	-0.19	0.16	-0.39	0.03	-0.25	0.24	-0.03	-0.40	0.43	-0.03	-0.23
7	-0.06	-0.15	-0.26	0.19	0.07	0.49	0.00	0.11	0.54	0.10	-0.20

	2002	2003	2004	2005	2006	2007	2008	2009
2	0.22	-0.13	0.30	0.48	0.82	0.26	0.15	-0.31
3	0.25	0.01	-0.30	-0.18	-0.01	-0.03	0.16	0.14
4	0.13	-0.30	-0.19	-0.16	-0.47	0.06	0.34	0.05
5	0.34	-0.19	-0.51	0.23	-0.74	0.34	0.32	0.54
6	0.34	0.04	-0.35	0.15	-0.54	0.27	0.33	0.43
7	0.07	0.07	-0.12	0.05	-0.16	0.66	0.36	0.33

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

	2	3	4	5	6	7
Mean log q	-15.0683	-14.5145	-14.4698	-14.6516	-14.6471	-14.6471
S.E. log q	0.3156	0.2001	0.2393	0.3238	0.3032	0.2843

Regression Statistics:

	Model used?	slope	Intercept	RSquare	Num Pts	Reg s.e	Mean Q
2	"No"	"5.54"	"37.76"	"0.03"	"19"	"1.41"	"-15.07"
3	"No"	"1.03"	"14.64"	"0.63"	"19"	"0.21"	"-14.51"
4	"No"	"0.86"	"13.76"	"0.7"	"19"	"0.21"	"-14.47"
5	"No"	"1.2"	"15.84"	"0.36"	"19"	"0.39"	"-14.65"
6	"No"	"1.43"	"17.51"	"0.27"	"19"	"0.43"	"-14.65"
7	"No"	"0.73"	"12.58"	"0.8"	"19"	"0.17"	"-14.54"

Fleet = FR-ROCHELLE

Catchability residuals:

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	-0.09	-0.18	-0.46	-0.40	-0.04	0.33	-0.06	0.19	-0.03	0.19	-0.24
3	0.19	-0.04	-0.01	-0.22	-0.11	0.05	0.11	-0.11	-0.49	-0.27	-0.09
4	0.44	0.12	-0.22	0.29	0.30	-0.15	-0.08	0.47	-0.25	-0.12	0.14
5	0.45	0.17	-0.09	0.19	0.21	-0.36	-0.36	0.01	0.18	-0.17	-0.07
6	0.11	0.33	-0.26	0.11	-0.35	-0.11	-0.01	-0.54	0.52	-0.29	0.08
7	0.01	0.08	-0.02	0.00	-0.05	-0.09	-0.09	0.03	0.23	-0.20	0.14

	2002	2003	2004	2005	2006	2007	2008	2009
2	0.70	0.16	0.37	0.12	0.00	0.07	0.21	-0.83
3	0.18	0.23	-0.09	-0.38	-0.25	0.58	0.58	0.15
4	-0.33	-0.07	-0.23	-0.21	-0.29	-0.18	0.37	0.01
5	-0.07	-0.08	-0.48	0.32	-0.29	-0.27	0.27	0.43
6	-0.02	0.11	-0.22	0.40	-0.05	-0.24	0.14	0.29
7	-0.10	-0.23	-0.02	0.18	-0.02	-0.19	0.24	0.19

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

	2	3	4	5	6	7
Mean log q	-15.0026	-14.5558	-14.7727	-15.1254	-15.1839	-15.1839
S.E. log q	0.3384	0.2830	0.2626	0.2793	0.2761	0.1424

Regression Statistics:

	Model used?	slope	Intercept	RSquare	Num Pts	Reg s.e	Mean Q
2	"No"	"1.98"	"19.82"	"0.13"	"19"	"0.64"	"-15"

```
3 "No"         "1.25" "15.77"   "0.37"  "19"    "0.36"  "-14.56"
4 "No"         "0.83" "13.86"   "0.68"  "19"    "0.22"  "-14.77"
5 "No"         "0.94" "14.73"   "0.55"  "19"    "0.27"  "-15.13"
6 "No"         "1.61" "19.54"   "0.28"  "19"    "0.43"  "-15.18"
7 "No"         "0.84" "13.93"   "0.91"  "19"    "0.11"  "-15.18"
```

```
Fleet =  FR-BB-IN-Q4

 Catchability residuals:

   2000  2001  2002  2003 2004  2005  2006  2007  2008  2009  2010
3  0.38 -0.27  0.38  0.80 0.36 -0.17  0.05  0.09  0.23 -0.05 -0.13
4  0.49 -0.43 -0.61  0.21 0.42  0.19 -0.42  0.28  0.62 -0.29  0.45
5  0.12 -0.32 -0.10 -0.70 0.53  0.25 -0.48  0.26  0.21 -0.02  0.17
6 -0.46 -0.01  0.60 -0.33 0.85 -0.01  0.04  0.04 -0.01  0.10 -0.51
7 -0.19 -0.11  0.56  0.29 0.23 -0.13  0.47 -0.54 -0.21 -0.33 -0.90
   2011  2012  2013  2014  2015  2016  2017  2018  2019
3 -0.39  0.23 -0.35  0.05 -0.22 -0.14  0.04 -0.45 -0.42
4 -0.05  0.58  0.14 -0.46 -0.27 -0.29 -0.21 -0.45  0.10
5 -0.04  0.82 -0.12 -0.22  0.18  0.09 -0.51 -0.15  0.03
6 -0.20  0.02  0.31 -0.10 -0.13  0.01 -0.07  0.02 -0.18
7 -0.48 -0.01 -0.03 -0.71  0.19 -0.40  0.16  0.12  0.29


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

                  3        4        5        6        7
Mean log q -14.5692 -14.9924 -15.1988 -15.0829 -15.0829
S.E. log q   0.3262   0.3949   0.3548   0.3144   0.4005


 Regression Statistics:

  Model used? slope  Intercept RSquare Num Pts Reg s.e Mean Q
3 "No"         "0.8"  "13.59"   "0.48"  "20"    "0.26"  "-14.57"
4 "No"         "0.82" "13.93"   "0.4"   "20"    "0.33"  "-14.99"
5 "No"         "0.85" "14.19"   "0.43"  "20"    "0.31"  "-15.2"
6 "No"         "0.91" "14.44"   "0.46"  "20"    "0.29"  "-15.08"
7 "No"         "1.51" "19.18"   "0.22"  "20"    "0.59"  "-15.17"
```

```
Fleet =  FR-BB-OFF-Q2

 Catchability residuals:

   2000  2001 2002  2003  2004  2005  2006  2007  2008  2009  2010
2  0.42  0.46 0.89  0.94  0.44  0.39 -0.25  0.56  0.93 -1.69 -1.42
3 -0.43 -0.14 0.21  0.16  0.19 -0.18 -0.19  0.78  0.41 -0.10  0.00
4  0.35  0.23 0.14 -0.02 -0.07 -0.02 -0.65 -0.38  0.04 -0.20  0.29
5  0.73  0.46 0.79 -0.19 -0.92  0.26 -0.56 -0.98  0.01 -0.12  0.35
6  0.71  1.14 1.37  0.39 -0.51 -0.75  0.31  0.00 -0.77 -0.37 -1.35
   2011  2012
2 -1.96  0.29
3 -0.70 -0.01
4  0.44 -0.17
5 -0.33  0.51
6  0.16 -0.34


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

                  2        3        4        5        6
Mean log q -15.9034 -14.5029 -14.7333 -15.3432 -15.8690
S.E. log q   1.0185   0.3714   0.3049   0.5844   0.7877


 Regression Statistics:

  Model used? slope   Intercept RSquare Num Pts Reg s.e Mean Q
2 "No"         "-1.33" "1.98"    "0.04"  "13"    "1.29"  "-15.9"
```

```
3 "No"          "2.23"  "20.43"   "0.1"   "13"    "0.8"   "-14.5"
4 "No"          "0.66"  "12.83"   "0.74"  "13"    "0.18"  "-14.73"
5 "No"          "0.58"  "12.42"   "0.38"  "13"    "0.33"  "-15.34"
6 "No"          "1.21"  "17.6"    "0.05"  "13"    "1"     "-15.87"


Fleet =  FR-ORHAGO

 Catchability residuals:

   2007  2008  2009  2010  2011  2012  2013  2014  2015 2016  2017
2  0.06 -0.29  0.35 -0.23  0.00 -0.42 -0.41  0.44  0.13 0.07  0.02
3  0.09  0.17  0.25  0.02 -0.42  0.06 -0.23 -0.09 -0.18 0.32  0.14
4  0.13  0.00 -0.18 -0.22 -0.52  0.16  0.49 -0.04 -0.05 0.01 -0.01
5  0.42 -0.79 -0.48 -1.25 -1.29  0.39  0.41  0.53  0.56 0.63  0.22
6  0.30 -0.61 -0.70 -3.55 -0.94  0.18  0.94  1.14  0.95 0.60  0.93
7 -1.22 -0.34 -2.06 -1.01 -0.19  0.07  0.38  0.77  0.93 0.44  1.00
   2018 2019
2  0.26 0.01
3 -0.17 0.04
4 -0.06 0.29
5  0.45 0.21
6  0.59 0.17
7  0.91 0.50


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

                2       3       4        5        6        7
Mean log q -9.0467 -9.4018 -9.7976 -10.2256 -10.5153 -10.5153
S.E. log q  0.2725  0.2093  0.2459   0.6991   1.2635   0.9479


 Regression Statistics:

  Model used? slope  Intercept RSquare Num Pts Reg s.e Mean Q
2 "No"        "0.77" "9.21"    "0.66"  "13"    "0.21"  "-9.05"
3 "No"        "1.07" "9.39"    "0.6"   "13"    "0.23"  "-9.4"
4 "No"        "1.14" "9.9"     "0.54"  "13"    "0.29"  "-9.8"
5 "No"        "0.41" "9.24"    "0.6"   "13"    "0.25"  "-10.23"
6 "No"        "0.22" "8.55"    "0.66"  "13"    "0.2"   "-10.52"
7 "No"        "0.34" "8.5"     "0.32"  "13"    "0.31"  "-10.5"
```

Table 7.10. Short-term predictions input parameters.

Variable	Value	Notes
Fage 3–6 (2020)	0.36	Corresponding to catch assumption in 2019 (F status quo).
SSB (2021)	12098	Assessment forecast; in tonnes.
Rage 2 (2020-2021)	18497	Geometric mean (2004–2017); in thousands.
Landings (2020)	3436	TAC for 2020; in tonnes.
Discards (2020)	88	Computed using the average discard ratio (2.5%) over 2015–2019 but not used in the assessment; in tonnes.

Table 7.11. Management options table. Annual catch scenarios (all weights are in tonnes).

Basis	Total catch* (2021)	Wanted catch** (2021)	Unwanted catch** (2021)	Fwanted (2021)	SSB (2022)	% SSB change ^	% TAC change ^^	% Advice change^^^
ICES advice basis								
EU MAP#: FMSY	3483	3399	84	0.33	12759	5.5%	-5%	-7.6%
F = MAP FMSY lower	2036	1987	49	0.18	14358	18,4%	-44.5%	-7.8%
F = MAP FMSY up-per	4814	4698	116	0.49	11294	-6.6%	31.3%	-7.4%
Other sce-narios								
MSY ap-proach = FMSY	3483	3399	84	0.33	12759	5.5%	-5.0%	-7.6%
F = 0	0	0	0	0	16618	37%	-100%	-100%
Fpa	4339	4140	108	0.43	11817	-3.5%	18.4%	15.2%
Flim	5620	5361	139	0.6	10411	-15.1%	53.3%	49.2%
SSB (2022) = Blim	7087	6917	171	0. 835	8811	-27.0%	-93.3%	88.1%
SSB (2022) = Bpa = MSY Btrig-ger	4343	4239	105	0.431	11811	-2.4%	18.5%	15.3%
F = F2020	3748	3658	90	0.36	12467	3.1%	2.2%	-0.5%
Wanted catch equal to 2019 TAC	3756	3666	90	0.36	12458	3.00%	2.5%	-0.3%
Total catch equal to 2019 TAC	3666	3578	88	0.35	12557	3.8%	0.00%	-2.7%

*** Total catch is calculated based on wanted catch (fish that would be landed in the absence of the EU landing obligation) and the assumed unwanted catch ratio (2.5%).**

**** "Wanted" and "unwanted" catch are used to describe fish that would be landed and discarded in the absence of the EU landing obligation, based on the average discard rate estimate of 2015–2019 (2.5%).**

 # MAP multiannual plan (EU, 2019).

^ SSB 2022 relative to SSB 2021.

^^ Total advised catch in 2021 relative to TAC in 2020 (3 666 t).

^^^ Advice value for 2021 relative to the advice value for 2022.

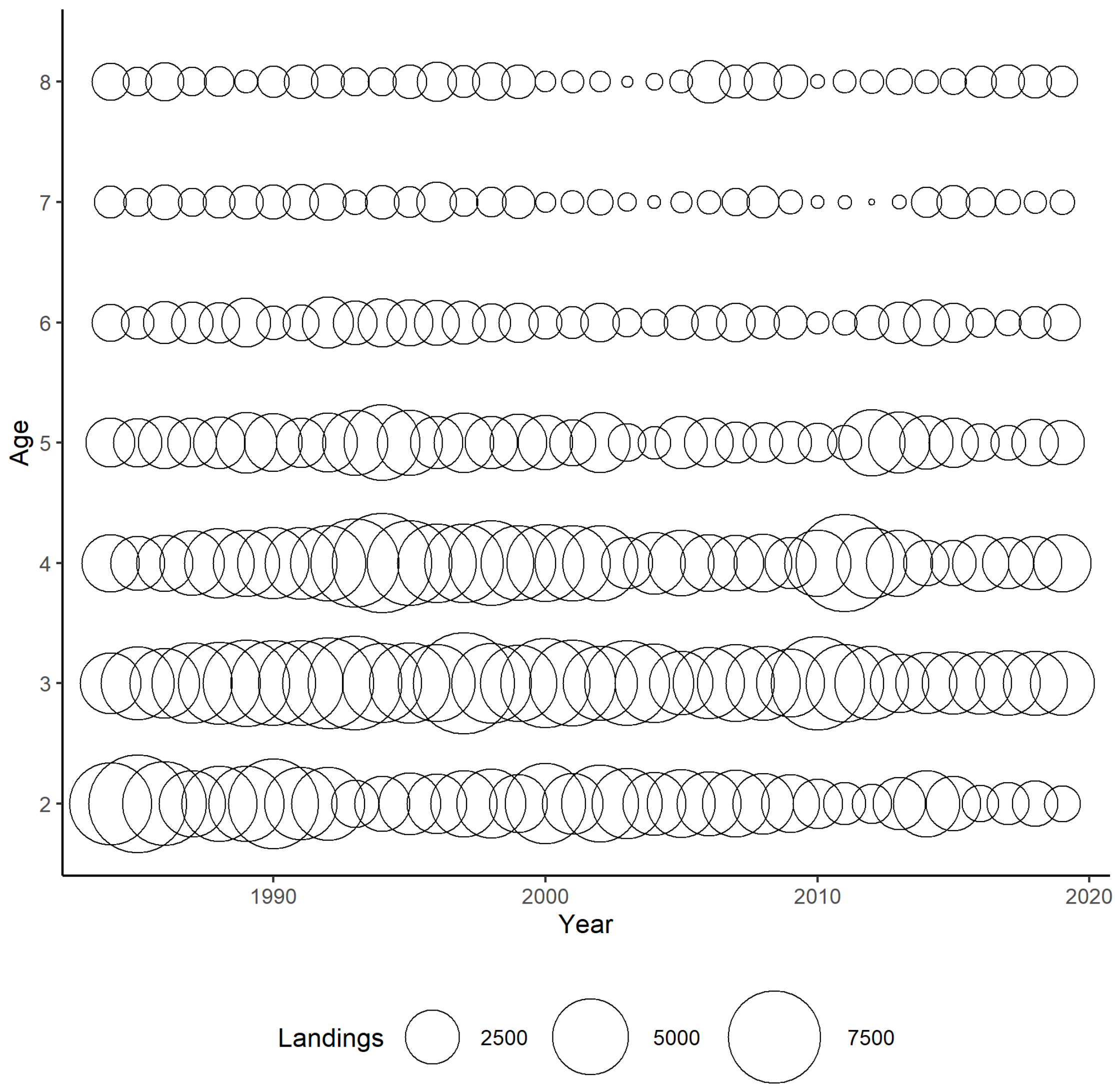

Figure 7.1. Bay of Biscay sole landings age distributions.

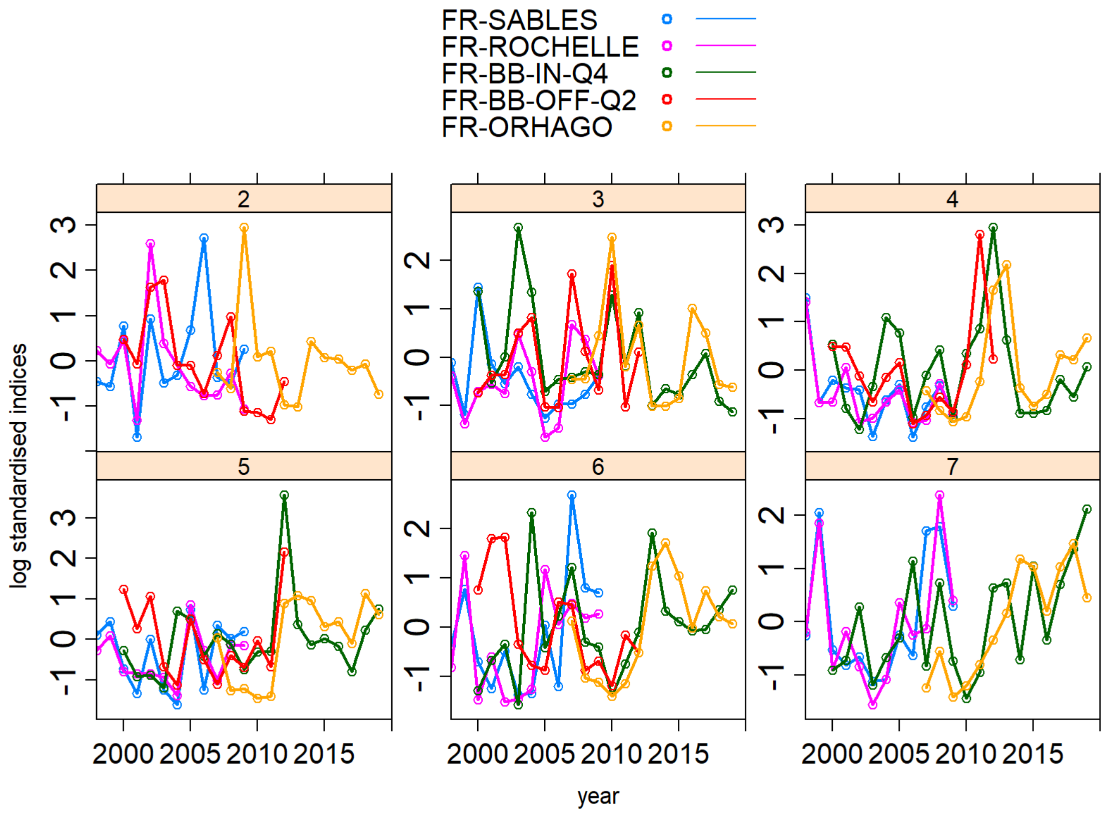

Figure 7.2. Time series of log standardised indices per age classes. Colours represent tuning fleets.

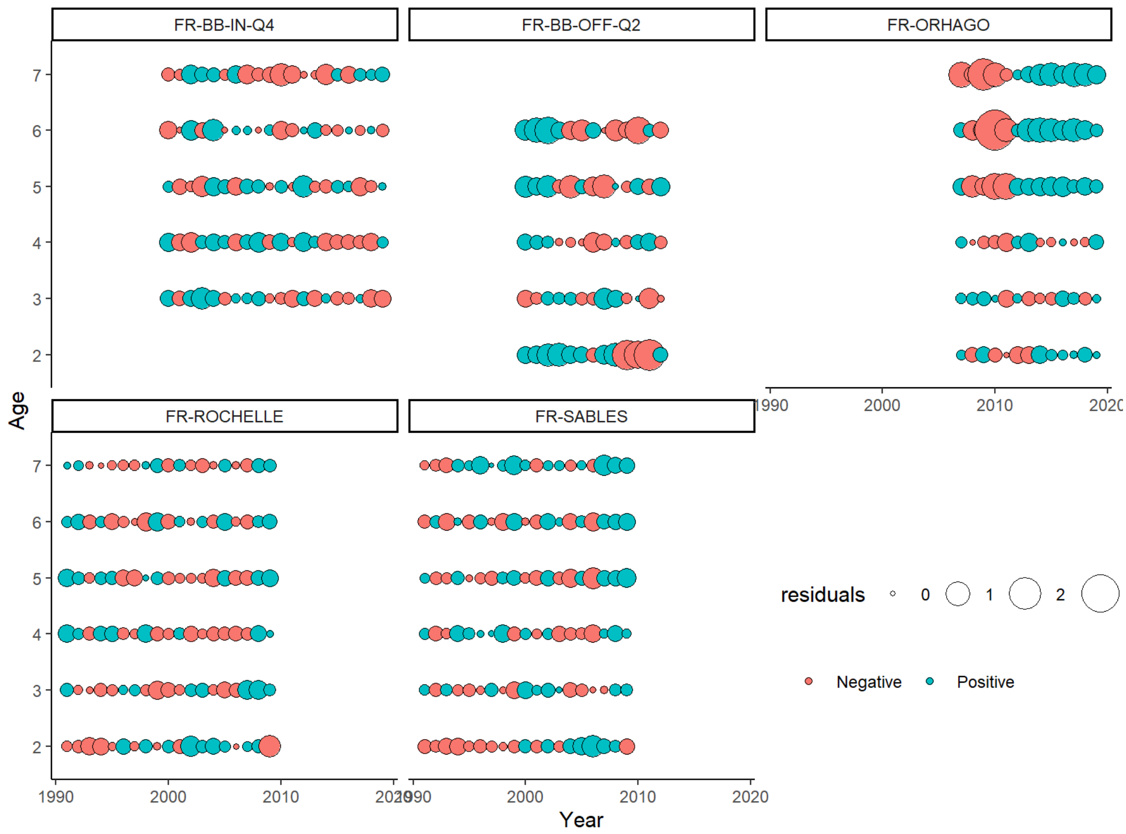

Figure 7.4. Bay of Biscay sole (Division 8a,b), assessment residuals XSA (No Taper, mean q, s.e. shrink = 2.5, s.e. min = .2).

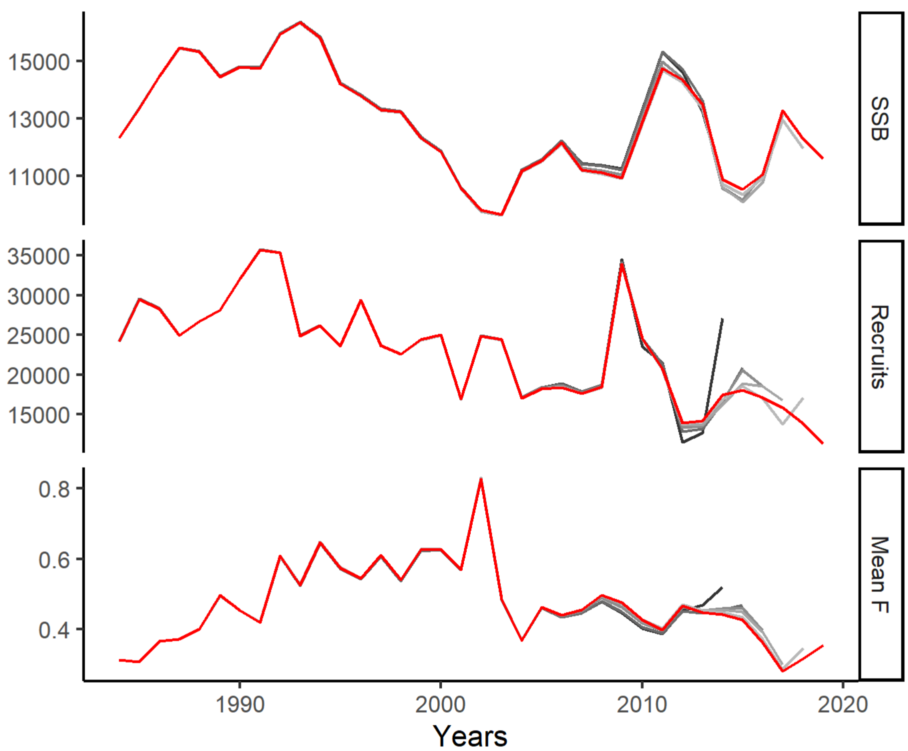

Figure 7.5. Bay of Biscay sole (Division 8a,b) - Retrospective results (No taper, q indep. stock size all ages, q indep. of age>=6, shr.=1.5).

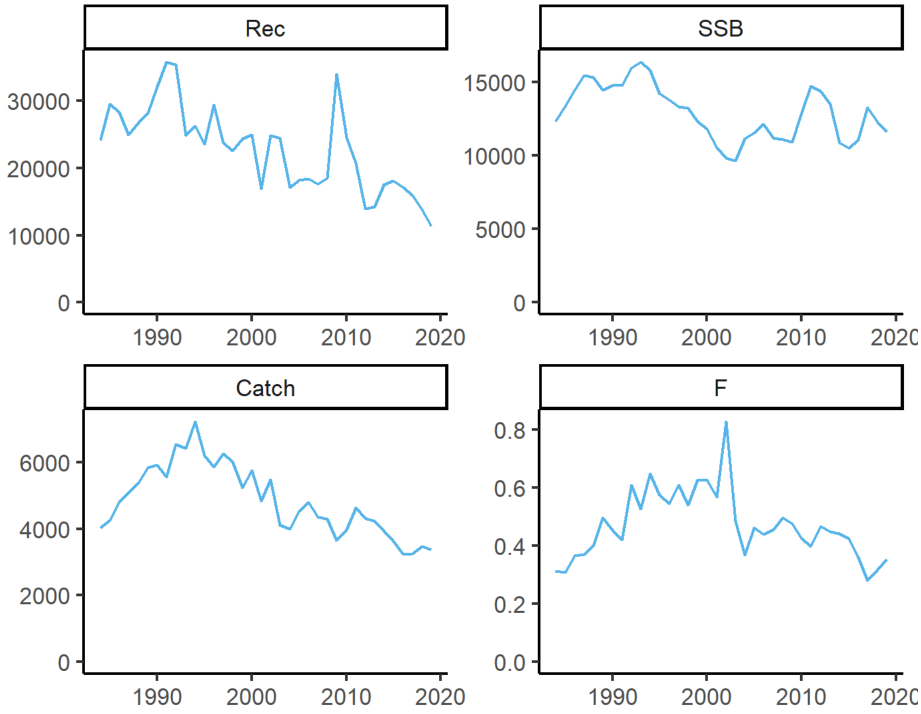

Figure 7.6. Sole in Division 8a,b (Bay of Biscay) – Trends for Landings, F, R, SSB and total catch data.

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 was estimated as 25 cm 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 45.7 cm for males. The growth coefficient estimate of females (K=0.23) was slightly higher than for males (K=0.21) and t_0 estimate, -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 at market (PNAB-DCF) attained 60 cm. According to Vinagre (2007), off the Portuguese coast *S. solea* 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 vessels size. A precautionary TAC is applied for *Solea spp*. in the ICES divisions 8.ce and subareas 9 and 10, sole is under the Landing Obligation in Divisions 8.abcde (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.

8.4 Fisheries data

Table 8.4.1 presents sole 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 in Portuguese landings, which means that *Solea solea* official landings might have not corresponded only to this species but a mix of *Solea solea* with very few *Solea senegalensis* and some *Pegusa lascaris*. Using the Data Collection Framework (DCF; Commission Regulation (EC) No 1639/2001, Council Regulation (EC) No 199/2008) market length sampling data, it was possible to separate the different *Solea* spp. and apply the proportions to provide raised landings for *Solea solea* and an additional mix for the Portuguese landings in Division 9.a (ICES, 2012; Borges, et al**.**, 2014).

Catch estimates of *Solea solea* were considered reliable from 2011 but a recent WD presented in WGBIE2020 concluded that the official landings from Portugal of *Solea solea* still have problems of misidentification in some ports (Dinis *et al.*, 2020; WD18 in this report).

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 (< 1% in last three years). Currently, 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 catch only 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), at seasonal level (Figure 8.4.4) and by fleet (Figure 8.4.5).

8.5 Survey data, recruit series

A series of abundance indices (Figure 8.5.1) and length-frequency distribution (Figure 8.5.2) from Spanish SP-SPNGFS trawl research surveys is available. However, it is worth mentioning that only few individuals are caught during the surveys due to the fact that the first bathymetric stratum of the survey is from 70 to 120 m, while this species is mostly found in a bathymetric range between 0 and 80 m. This species is rarely caught in the existing Portuguese bottom-trawl research surveys (Jardim *et al.,* 2011).

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 stochastic surplus production model in continuous time (SPiCT; Pedersen and Berg, 2017) was explored. The SPiCT model requires as inputs a catch time-series and one or multiple biomass indices. Spatio-temporal Bayesian models were performed to improve the Spanish SP-SPNGFS biomass index in order to be more representative. Additionally, this year a new dataset collected onboard artisanal fisheries in the Galician waters by observers was also used to produce a standardized catch-per-unit-effort (CPUE) index which was additionally used in the SPiCT model. Results are still preliminary but will be improved in next months (Pennino et al., 2020; WD14 in this report) .

8.9 General problems

Data on *Solea solea* (SOL) is officially reported to ICES from Spain and Portugal and to the WG 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. Currently, the best option seems to provide advice only for *Solea solea* from the official landings.

Advice has been provided on the basis of a category 5 stock, but this may be progressed to a category 4 or 3 next year, depending on the benchmark results.

8.10 References

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Jardim, E., Alpoim, R., Silva, C., Fernandes, A.C., Chaves, C., Dias, M., Prista, N. and Costa, A.M. 2011. Portuguese data provided to WGHMM for stock assessment in 2011. Working document presented in WGHMM (ICES, 2011) and WGNEW (ICES, 2012) Reports.

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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
2019	553		553

*** Solea spp. (S. solea, and S. senegalensis).**

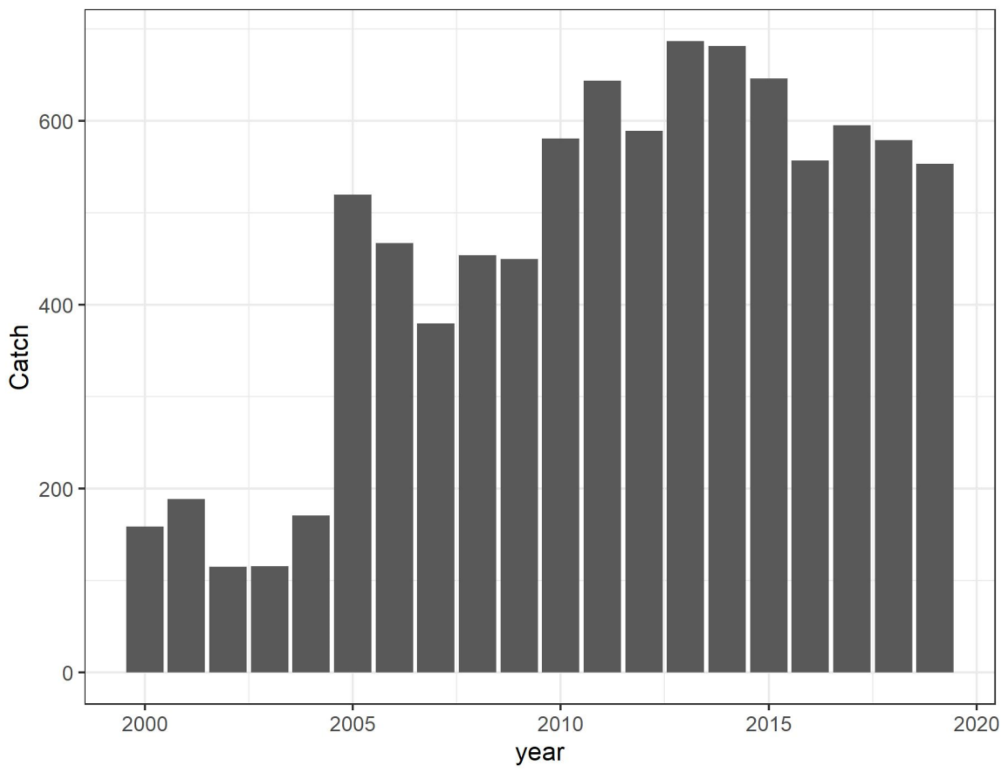

Figure 8.4.1. –*Solea solea* catches from 2000-2019 for ICES divisions 8c9a.

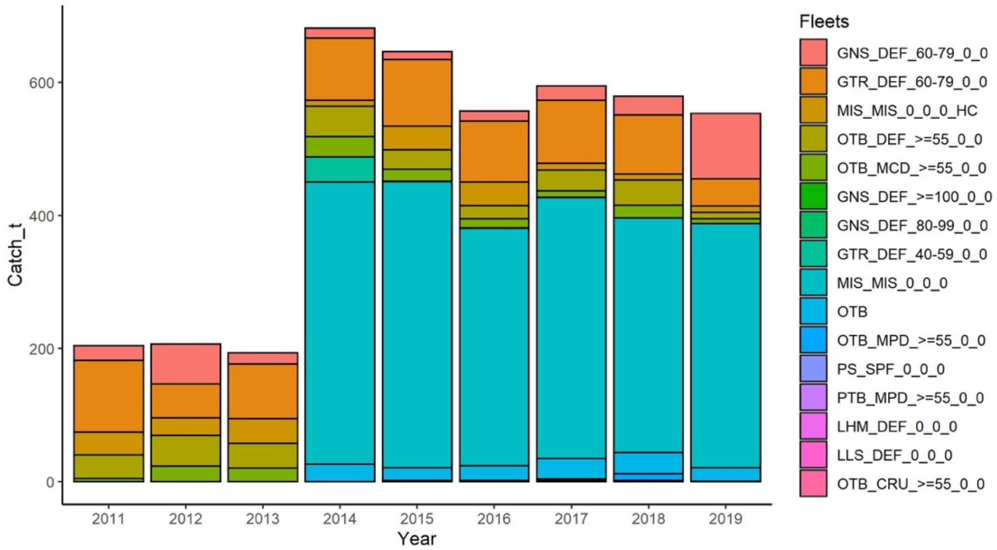

Figure 8.4.2. –*Solea solea* 8c9a catch by métiers from 2011 to 2019.

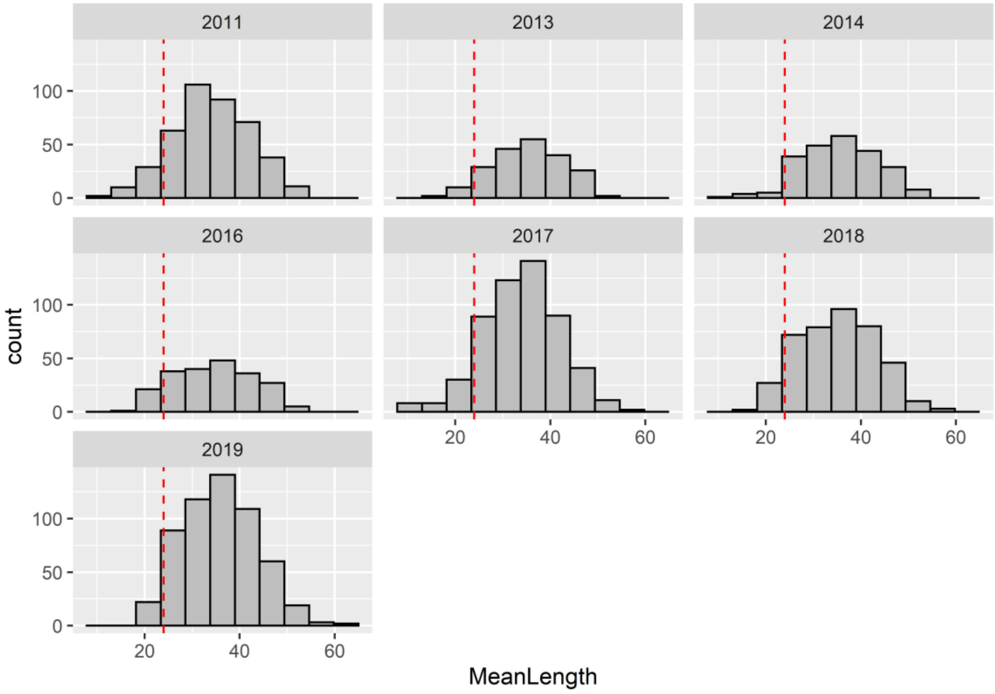

Figure 8.4.3. Divisions 8c and 9a. *Solea solea* length frequency for all métiers from sampling. The dashed red line represents the minimum landings size of 24 cm.

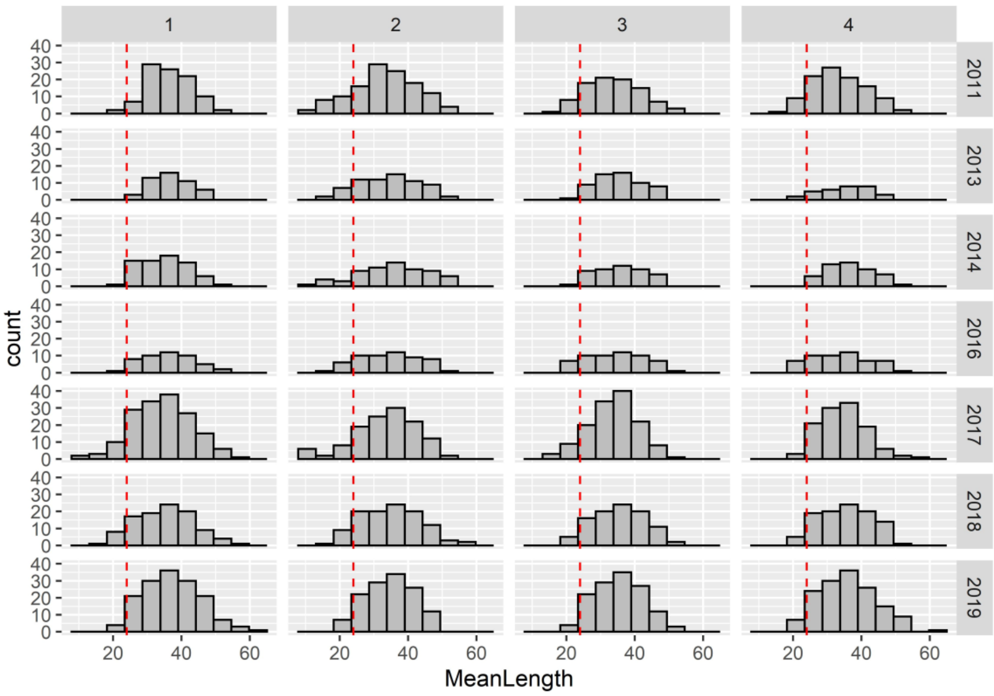

Figure 8.4.4. Quarterly length-frequency distribution for *Solea solea* from ICES 8c and 9a in 2011-2019. The dashed red line represents the minimum landings size of 24 cm.

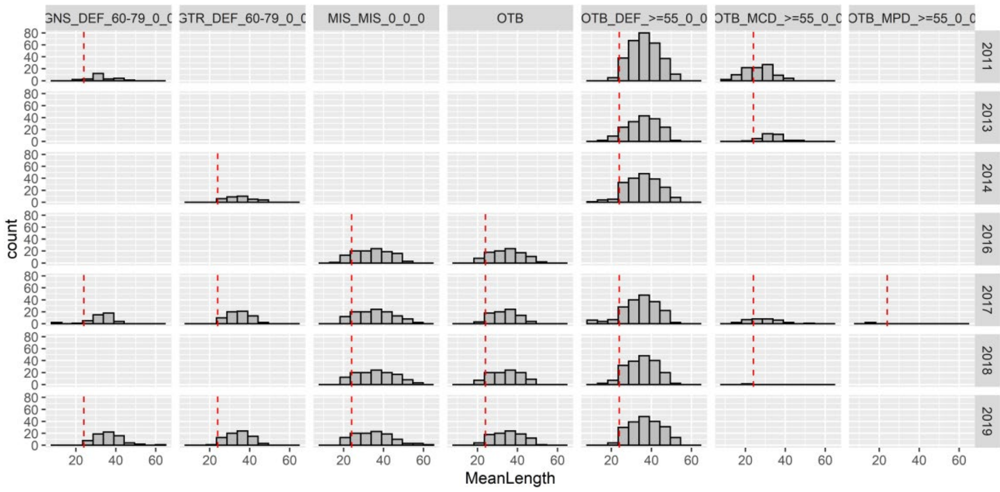

Figure 8.4.5. Length-frequency distribution for *Solea solea* from ICES 8.c and 9.a in 2011-2019 by fleet. The dashed red line represents the minimum landings size of 24 cm.

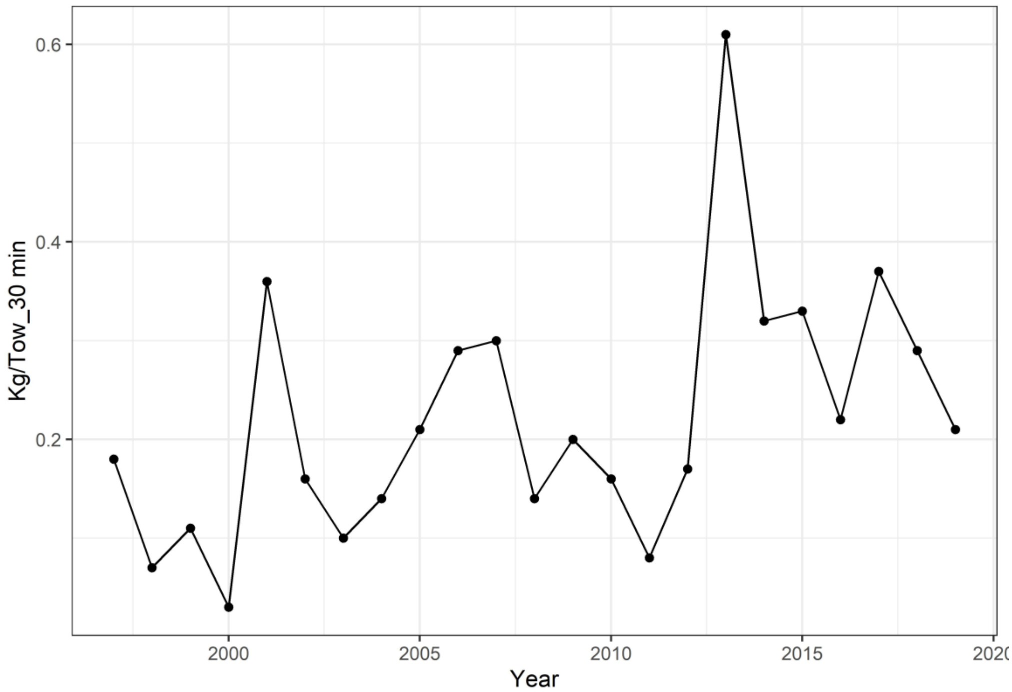

Figure 8.5.1. Spanish Survey derived abundance index for *Solea solea* (Kg/tow 30 minutes).

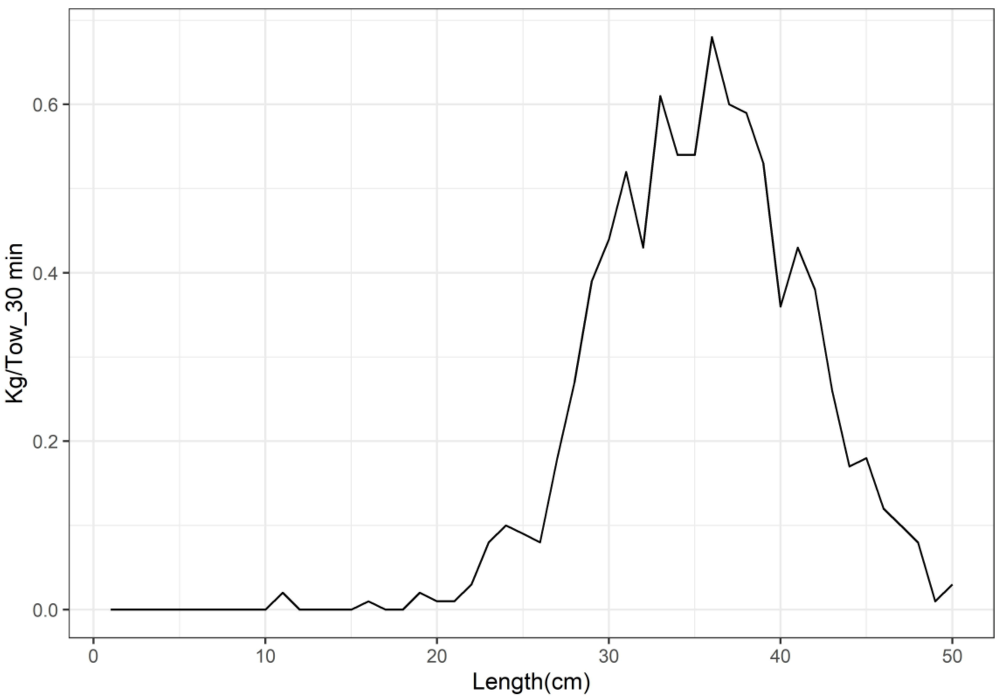

Figure 8.5.2. – Spanish Survey derived length-frequency distribution for *Solea solea* (Kg/tow 30 minutes).

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

x **Type of assessment:** update (stock benchmarked in 2014) inter-benchmarked in 2019, stock on observation list.

Data revisions: French discard volume in 2018 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 2021

The stock was considered to be above any potential MSY $B_{trigger}$. Following the ICES MSY framework implied fishing mortality to be maintained at 0.26, resulting in landings of 92 821 t and total catches of 98 657 t in 2020.

Like the main stocks of the EU, Northern hake is managed by a TAC and quotas. The TACs for recent years are presented below:

TAC (t)	2013	2014	2015	2016	2017	2018	2019	2020
3a, 3b,c,d (EC Zone)	2 093	2 466	2 738	2 997	3 371	3 136	4 286	3 403
2a (EC Zone), 4	2 438	2 874	3 190	3 492	3 928	3 653	4 994	3 940
Vb (EC Zone), 6, 7, XII, XIV	38 938	45 896	50 944	61 902	67 658	62 536	79 762	63 325
8a,b,d,e	25 970	30 610	33 977	40 393	44 808	42 460	52 118	42 235
Total Northern Stock [IIa-8abd]	69 440	81 846	90 849	108 784	119 765	111 785	141 160	112 903

Management for 2019 and 2020

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).

Since 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 aims at increasing the quantities of mature fish to values equal to or greater than 140 000 t. This could be achieved by limiting fishing mortality to 0.25 and by allowing a maximum change of 15% in TAC between years.

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 no longer be considered because the plan uses target values based on precautionary reference points that are no longer appropriate.

The TACs from 2016 and 2019 were slightly below the ICES advised TAC. The difference was due to the way the STECF calculated the TAC adjustments for stocks subject to the landing obligation. In 2019, according to the MSY framework, ICES proposed a decrease in the 2020 TAC advice of a 26% from 142 240 to 104 763 t. The agreed TAC, was higher than the advice (112 903 t) to limit the interannual variability in TAC at 20%.

9.2 Data

9.2.1 Commercial catches and discards

Total landings for the Northern hake stock by area for the period 1961-2019 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. Landings were high during the first decade (1961-1970) when the uncertainties in the fisheries statistics were significant. In the years 2011, 2012 and 2013, they increased again due to differences between the official statistics and scientific estimations. In 2014 and 2015, the differences between scientific and official landings decreased significantly that resulted to a considerable decrease in unallocated landings. In 2016, unallocated landings were reported by area and since 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 landing aggregation level as provided 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, as well as, the catches in 2016 were above the TAC. Since 2017, catches are below the TAC.

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 2019. This year, discards for 2018 were revised by France. The discards had an increasing trend until 2011 then decreased steadily afterwards. The increase was general for all fleets, but the decrease depended on the type of fleet. Discards from gillnetters have been consistently at high levels since 2012, the first year when these data were made available. The two main fleets contributing to discards until 2015 were the Spanish trawlers in area 7 (SP-TRAWL7) and the OTHER fleet. However, the discards from these fleets decreased significantly until 2019. The OTHER fleet is the main contributor to discards, together with other trawl fleets (TRAWL-OTH), but the contribution of the SP-TRAWL7 has decreased to around 300 t in 2019. Nevertheless, in 2019 this fleet was not sampled in the second and fourth quarters so the values in the table are underestimated. However, the model estimates discards for these missing quarters. For TRAWL-OTH and Spanish trawlers in area 8 (SP-TRAWL8), discard levels were similar to those observed in 2016. Discard levels from *Nephrops* trawlers vary in the whole series.

9.2.2 Biological sampling

The sampling level is given in Table 1.4.

Length compositions of the 2019 landings by Fishery Unit (FU) and quarter were provided by Denmark, France, Ireland, Scotland, Spain and UK (E&W).

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: (1) the French RESSGASC survey conducted in the Bay of Biscay from 1978 to 2002, (2) the EVHOE-WIBTS-Q4 survey covering the Bay of Biscay and the Celtic Sea with a new design since 1997, (3) the SpPGFS-WIBTS-Q4 survey conducted in the Porcupine Bank since 2001 and (4) the Irish Groundfish Survey (IGFS-WIBTS-Q4) carried out in the west of Ireland and the Celtic Sea since 2003. A brief description of each survey is given in the Stock Annex and in section 2 of this report. Figure 9.1 present the abundances indices obtained from these surveys.

From 1985 until the end of the survey in 2002, the index from RESSGASC showed a slightly decreasing trend. The 2002 index is considered not 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 was 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, it increased and the 2016 index value was three times higher than the 2015 value. In 2017, the index was not available since the survey was not conducted. In 2018, the index value decreased relative to the 2016 value and was around the value in 2015 and it increased again in 2019.

The abundance index provided by the IGFS-WIBTS-Q4 is consistent with EVHOE WIBTS-Q4 survey over recent years. The index showed four peaks coincident with those observed in the EVHOE index but to a lesser extent. In 2012, the index achieved the highest value of the series, 268% higher than the 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 with the EVHOE index. The index decreased in 2018 and 2019 with negligible variation between these years.

The abundance index from SpPGFS-WIBTS-Q4 survey follows an increasing trend since 2003, reaching its highest value in 2009 and slightly decreasing in 2010 and 2011. After two years of an increasing trend, with an accumulated increase of 218%, the index decreased sharply in 2015 and again but moderately in 2016. The peaks detected by EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4 were also detected in this survey but occurring a year later, confirming the sharp increase observed in 2017. This is consistent with the fact that this survey catches bigger individuals. In the last two years, the index has decreased to a value comparable to that observed in the 2007.

The spatial distribution of the EVHOE-WIBTS-Q4, IGFS-WIBTS-Q4 and SpPGFS-WIBTS-Q4 biomass indices (Kg/hr) is provided in Figure 9.2 since 2003. The SpPGFS-WIBTS-Q4 biomass index shows a homogenous spatial distribution in the sampled area throughout 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, with the year 2018 showing the greatest contraction (Figure 9.2). For the IGFS-WIBTS-Q4 the spatial distribution of the biomass index was stable throughout the time-series, with a slight decrease in 2018. The southern region of the sampled area showed a higher biomass index in recent years. For the IGFS-WIBTS-Q4, high biomass concentration seems to occur in areas closer to the continental French shelf. Overall for all surveys, a contraction of the spatial distribution is visible since 2015.

EVHOE-WIBTS-Q4and IGFS-WIBTS-Q4 surveys catch mainly young individuals below 25 cm while SpPGFS-WIBTS-Q4captures larger size individuals (35 – 75 cm). In the case of EVHOE-WIBTS-Q4, the distribution is quite homogeneous year after year, with the mode around 12 cm. In the case of the Irish survey, in 2018, most of the individuals were around 25 cm, and there were almost no individuals around 12 cm, which is the mode of the distribution in most of the years. The length distribution from SpPGFS-WIBTS-Q4 is quite flat between 40 and 65 cm, with a peak around 20 cm which is associated to previous year recruitment in previous year. This peak was very high in 2017.

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 9.4.

Since the start of the time-series, the effort of A Coruña and Vigo trawl 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 then had an increasing trend since 2014 with the highest 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 to increase. 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 at megrim, taking hake only as bycatch.

LPUE from Ondarroa pair trawlers operating in Divisions 8a,b, shows an increasing trend until 2009. A significant increase in LPUE was observed in 2008 and, especially in, 2009. A decreasing trend was observed until 2012, although levels were not as low as in the beginning of the time-series. In 2013, it increased slightly declining again in 2014. Since 1999, effort shows a decreasing trend. The LPUE has not been updated since 2015 due to a change in data reporting as this fleet was using e-logbooks for the first time.

9.3 Assessment

This is an update assessment in relation to the assessment carried out during the inter-benchmark working group at the beginning of 2019 (ICES, 2019a).

9.3.1 Input data

See Stock Annex (under "*Input data for SS3*").

The catch contribution of the fleets used in the configuration of the model has changed over time (Figure 9.5). At the beginning of the time-series more than 75% of the catch was caught by trawlers fleets. However, in the last years they contribute less than 25% to the total catch. On the contrary, the catch of longliners and gillnetters was residual in the past but currently, each fleet contributes with more than 25% to the total catch. The catch of the OTHER fleet has also increased in the last decade.

The quarterly length frequency distributions for landings and discards are given in Figure 9.6. For most of the fleets, the length-frequency distribution of landings is quite stable over time. The fleets in area 8 catch smaller individuals. For most fleets, discards occur in the lower part of the distribution but gillnetters discard in the whole range indiscriminately.

9.3.1.1 Data Revisions

France revised the discards volume in 2018. The main differences were in the discards from gillnetters that were doubled and in those from OTHER fleet which were divided by four. The seasonal distribution also changed significantly. However, the impact of the changes in the stock estimates was inappreciable. The discards are seasonally estimated by the model using selection and retention curves that are fixed over time for most of the fleets. Hence, the model is not very sensitive to discards volume.

9.3.2 Model

The Stock Synthesis (SS) assessment model (Methot Jr. 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 9.7. 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 two years, the model has over-estimated the three contemporary indices.

The Pearson residuals of the length frequency distributions of the EVHOE survey have a "fairly random" pattern with no trend or lack of fit (Figure 9.8, where blue and red circles denote positive and negative residuals, respectively). However, in the other two surveys the model has problems to explain the peak in small individuals observed in SP-PORC (SpPGFS) index and that of the older individuals in IGFS index.

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 9.9 presents the selectivity (for the total catch; solid lines) and retention functions (dashed lines) by fleet 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 area 7, three retention functions are estimated, one for the period 1978-1997 (black), a second one for the period 1998-2009 (red) and a third one for the period 2010-present (green). For the Spanish trawl fleets in area 8, two retention functions are estimated: one for the period

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 more rigorous enforcement of the minimum landing size. The most recent change in the 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 varying 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 only slight changes were observed in the last four years (Figure 9.9, 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 9.10) 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 especially in the most recent years without any trend. In turn, a change in the recruitment estimates provokes a retrospective pattern in the SSB and fishing mortality. Although the revision of 2018 discards volume data had a negligible impact on the stock status estimates this year, it had a negative impact in the retrospective pattern. The patterns are significantly worse than in previous years. It was noted that there were some problems with the convergence of the model, for example with exactly the same input files, the retrospective for year -3 did not converge in Windows but it did in Linux. Furthermore, in year -3, the model converged before the revision of the data, although for this year the data used by the model are the same. The spawning stock biomass estimates obtained this year are mostly below those obtained in previous year and the fishing mortalities are above. The highest Mohn's rho index (Mohn, 1999) was obtained for spawning stock biomass (0.196). Figure 9.11 shows the differences of the time-series in percentage in comparison with the last year estimates. There are differences in the whole time-series that increased in the most recent years. For recruitment and SSB, the differences are bigger than for fishing mortality.

Summary results from SS3 are given in Table 9.5 and Figure 9.12.

Recruitment values (age 0) estimated by the model are provided in Table 9.5. For the recruitment, fluctuations appear to be without substantial trend over the whole series. The recruitment in 2008 was the highest in the whole series with 753 millions of individuals and the one in 2019 was the third highest with around 600 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 (23 000 t in 1998). Since then, SSB has increased to the highest value of the series in 2016 (291 000 t) and decreased afterwards.

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 fluctuates around F_{MSY} (0.26). The F estimate for 2019 is equal to 0.23 and the three-year mean equal to 0.26.

The 90% confidence intervals are quite narrow (Figure 9.12). 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 2018 and 2019 by the geometric mean recruitment

Last year, recruitment estimates for the last two years (2017 and 2018) were replaced by the geometric mean (GM). The recruitment in 2017 was the second highest value in the time-series but this high estimate was not supported by the available data at that time, length frequency distributions and abundance indices (ICES, 2019b). The 2017 year class had a large contribution to the TAC advice, thus, a reliable and precautionary recruitment was required for the short-term projections. This year, the assessment model has revised the 2017 recruitment downwards and this year estimate is closer to the geometric mean than to the last year estimate for 2017 (Figure 9.13).

This year, the recruitment estimates for the last two years (2018 and 2019) were also replaced by the GM. The 2018 recruitment was close to the GM. However, the 2019 estimate was well above that level. The assessment model overestimated the three abundance indices available in the last two years. Furthermore, the model has revised the most recent recruitments downwards. Hence, replacing the recruitment estimates for the last two years was considered more reliable and precautionary for projections.

9.4.2 Short – Term projection

SS3 has a forecast module which provides the capability to do a projection for a user-specified number of years that is directly linked to the model ending conditions, and associated uncertainty, and to a specified level of fishing intensity. The forecast requires information on life history, fishery selectivity, relative harvest rate between fleets, overall fishing intensity, and recruitment. However, due to some inconsistencies with the ICES short term forecast observed in 2010 on SS short term projection, forecast has never been done internally in the model but transferred to and estimated by another module, a specific R script written for this specific task.

For the current projection, unscaled F is used, corresponding to $F_{(15\text{-}80cm)}$ = 0.26.

The recruitment used for projections in this WG is the GM calculated from 1990 to the final assessment year minus 2 (2017). Recruitment short-term projection assumption values are given in Table 9.5.

Landings in 2019 and SSB in 2020 predicted for various levels of fishing mortality in 2019 are given in Table 9.6 and Figure 9.14. Maintaining *status quo* F in 2021 is expected to result in an increase in the catch and the SSB with respect to 2019.

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 9.15. The F-multiplier in Table 9.7 is with respect to *status quo* F (average F in the final 3 assessment years, 2017-2019). Considering the yield and SSB per recruit curves, F_{max}, $F_{0.1}$, $F_{35\%}$ and $F_{30\%}$ are respectively estimated to be 103%, 65%, 73% and 88% 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 (Garcia, 2019 – WD 06, in ICES, 2019b).

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	56 000	B_{pa} (WD 06, ICES, 2019b)
Approach	F_{MSY}	0.26	F_{MSY} in the segmented regression stock recruitment relationship (WD 06, ICES, 2019b)
	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 (WD 06, ICES, 2019b)
Approach	F_{lim}	0.84	Fishing mortality resulting in a 5% probability of SSB falling below B_{lim} (WD 06, ICES, 2019b)
	F_{pa}	0.6	F_{lim}/1.4 (WD 06, ICES, 2019b)
MAP	F_{low}	0.18	The lowest F that produces catch in the long term 5% below of the catch at F_{MSY}. (WD 06, ICES, 2019b)
	F_{upp}	0.4	The lowest F that produces catch in the long term 5% below of the catch at F_{MSY}. (WD 06, ICES, 2019b)

9.6 Comments on the assessment

The retrospective pattern in the 2008 recruitment was partially corrected during the last benchmark (ICES, 2014a) but it retrograded again in the following assessment working group when 2013 data was included (ICES, 2014c). The retrospective pattern in recruitment increased with the revision of the 2014 LFD data during the 2016 assessment working group (ICES, 2016). It 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). This year, the retrospective pattern deteriorated again when the 2018 French data were revised and included in the assessment. Platform (windows/linux) dependent convergence issues were detected.

The range of some selection and retention curves has been expanded again this year as the model estimates were outside or hitting the bounds.

The convergence problems and the necessity to increase the bounds will be investigated intersessionally. If approved, the methods workshop proposed by the WG would be a good opportunity to delve and solve the optimization problems detected.

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 estimates from the 2011 assessment but the parameters could be incorrect as the model is no longer able to estimate the parameters consistently year by year. The revision of the 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 in section 1.7.

9.7 Management considerations

The significant increase in SSB and the decrease in fishing mortality are the consequences from 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, ICES, 2010) 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. The ICES catch advice is for the whole stock but the sum of the TACs for 2019 and 2020 in this report are only for the EU member states.

9.8 References

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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 1961-2019.

Table 3.1. Northern Hake. Estimates of catches ('000 t) by area for 1961-2010.

	Landings (1)										Discards (2)						Catches (3)
Year	1	2	3	4	5	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	15	7065	44396	28497	0 (4)	95038	93	3444	71	4208	3096	10900	105938
2016*			695	19603	13	11365	49377	26490	0 (4)	107543	142	4189	344	2281	4150	11114	118656
2017*			775	19690	14	9614	45737	28853	0	104669	148	1777	314	1168	3692	7099	111768
2018*			698	18915	7	7274	36906	25894	0	89695	287	1256	266	2124	3105 (5)	7038	96733
2019*	0	786	736	15569	8	6835	36873	21492	0	82299	235	926	297	1423	2059	4940	87239

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	2019
SPTRAWL7	na	537	1712	2010	5674	5077	5054	3495	1464	2604	615	652	902	317
	na	4526	21437	17542	27619	27954	26452	38293	8335	5241	2006	3556	4945	1292
TRAWLOTH	na	na	na	1025	1192	130	1142	2934	2510	1560	1665	829	2071	1428
	na	na	na	6814	3831	1037	5101	16863	7483	4460	11269	4786	10904	4909
FRNEP8	532	767	858	4283	726	871	624	1475	392	1133	2310	1819	889	816
	18031	24277	18245	68524	14709	21208	25228	32535	4099	19126	50343	34579	15958	12021
SPTRAWL8	206	471	352	580	101	292	364	379	184	589	655	907	346	586
	3397	10002	7153	7925	1719	5036	5329	5552	2718	8011	16293	14871	5604	10468
GILLNET	na	na	na	na	na	na	1503	1256	42	857	1175	656	1014	332
	na	na	na	na	na	na	4061	3283	53	623	1600	1143	916	929
LONGLINE	na	na	na	na	na	na	na	na	na	558	3	1	4	0
	na	na	na	na	na	na	na	na	na	402	0	0	14	0
OTHER	484	390	446	3135	4425	7533	6183	6287	4343	4151	4675	2235	1809	1458
	na	na	na	na	na	na	na	16855	4866	4171	4435	5730	4333	4442
Total Weight (t)	1222	2165	3368	11033	12118	13903	14870	15826	8935	11452	11098	7099	7031	4937
Total Number ('000)	21428	39654	47488	101349	48325	58210	66171	113381	27554	42034	85946	64665	42660	34061

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.

Sub-area VII

	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

Before 1988 landings and effort refer to Vigo trawl fleet only, from 1988 to 2002 to combined Vigo+Marín trawl fleet

* 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	320067	110364	71627	50551	NA	50551	0.71	0.54
1979	294321	119197	91815	51096	NA	51096	0.56	0.58
1980	322273	117516	94245	57265	NA	57265	0.61	0.69
1981	607189	100888	80251	53918	NA	53918	0.67	0.69
1982	418350	93196	64481	54994	NA	54994	0.85	0.72
1983	147245	100259	63004	57507	NA	57507	0.91	0.67
1984	291904	106338	76192	63286	NA	63286	0.83	0.7
1985	636034	92194	73121	56099	NA	56099	0.77	0.85
1986	370624	76271	54268	57092	NA	57092	1.05	0.95
1987	447415	72643	40024	63369	NA	63369	1.58	1.05
1988	506866	74208	43279	64823	2.2	64825.2	1.5	1.06
1989	490230	74675	42531	66473	72.8	66545.8	1.56	1.14
1990	497774	68551	39745	59954	NA	59954	1.51	1.08
1991	275441	65528	38795	58129	NA	58129	1.5	1.03
1992	300646	64578	37401	56617	NA	56617	1.51	1.06
1993	529934	57284	36778	52144	NA	52144	1.42	1.1
1994	300814	51564	28876	51259	356.2	51615.2	1.78	1.12
1995	152730	57940	28165	57621	NA	57621	2.05	1.19
1996	372329	52892	33231	47210	NA	47210	1.42	1.03
1997	260405	45240	28416	42465	NA	42465	1.49	1.12
1998	430128	42821	22748	35060	NA	35060	1.54	1.04
1999	214276	47118	26088	39814	348.6	40162.6	1.53	1.03
2000	192079	52391	28814	42026	82.6	42108.6	1.46	0.97
2001	355215	51936	34135	36675	NA	36675	1.07	0.8
2002	281556	54698	34798	40107	NA	40107	1.15	0.86
2003	164759	59869	35177	43162	2109.804	45271.804	1.23	0.86
2004	342872	61989	40263	46417	2552.443	48969.443	1.15	0.87
2005	222762	57745	38648	46550	4675.8487	51225.8487	1.2	1.01
2006	296639	53697	30926	41467	1816.1534	43283.1534	1.34	0.92
2007	452277	59449	36442	45028	2191.4212	47219.4212	1.24	0.82
2008	753946	73410	42008	47739	3247.73	50986.73	1.14	0.68
2009	247866	115057	62259	58818	10589.772	69407.772	0.94	0.56
2010	262622	186608	114755	72799	9977.6677	82776.6677	0.63	0.42
2011	267086	238364	189693	87540	14155.978	101695.978	0.46	0.33
2012	506945	252586	213320	85677	12680.2225	98357.2225	0.4	0.28
2013	372523	259818	214155	77753	15886.1017	93639.1017	0.36	0.27
2014	215809	288931	226330	89940	9913.4663	99853.4663	0.4	0.26
2015	218866	321340	263844	93670	9820.384	103490.384	0.36	0.25
2016	337428	333329	291152	109106	12740.652	121846.652	0.37	0.27
2017	417247	307130	269134	104671	7385.5581	112056.558	0.39	0.29
2018	401894 [2] 308019 [3]	286642	239087	89671	7034.2148	96705.2148	0.38	0.27
2019	601576 [2] 308019 [3]	298571	239829	82298	4940.1384	87238.1384	0.34	0.23
Arith.Mean	501735	121543	89520	60425	6026	63582	1.03	0.75
Units	Thousands Individuals	Thousands	Tonnes	Tonnes	Tonnes	Tonnes	percentage	

[1] Discards used in the assessment. In years with NA discards are not available or considerent unreliable.

[2] Recruitment estimated by the assessment model.

[3] Geometric mean (1990-2017) recruitment used to carry out the short term forecast.

Table 9.6. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Catch option table.

SSB(2020)	Rec proj	F(15-80cm)	Catch(2020)	Land(2020)	SSB(2021)
265202	308019	0.26	103027	97059	257712

Fmult	Fcatch(15-80cm)	Catch(2021)	Land(2021)	Disc(2021)	SSB(2022)
0	0.000	0	0	0	343745
0.1	0.026	11635	10986	649	332601
0.2	0.053	22864	21581	1284	321850
0.3	0.079	33702	31797	1905	311477
0.4	0.105	44163	41650	2513	301469
0.5	0.132	54261	51153	3109	291813
0.6	0.158	64009	60318	3692	282494
0.7	0.184	73420	69158	4263	273501
0.8	0.211	82506	77685	4821	264822
0.9	0.237	91279	85910	5369	256445
1	0.263	99750	93845	5905	248359
1.1	0.290	107930	101499	6430	240553
1.2	0.316	115829	108884	6945	233017
1.3	0.342	123458	116009	7449	225741
1.4	0.369	130826	122884	7943	218716
1.5	0.395	137944	129517	8427	211932
1.6	0.421	144819	135918	8901	205381
1.7	0.448	151460	142094	9366	199054
1.8	0.474	157876	148055	9821	192943
1.9	0.500	164075	153807	10268	187040
2	0.527	170065	159359	10705	181338

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
0.84	0.1	0.03	0.10	0.09	2.69
0.71	0.2	0.05	0.16	0.16	2.28
0.61	0.3	0.08	0.22	0.21	1.96
0.53	0.4	0.11	0.25	0.24	1.69
0.46	0.5	0.13	0.28	0.26	1.48
0.41	0.6	0.16	0.30	0.28	1.30
0.36	0.7	0.18	0.31	0.29	1.15
0.32	0.8	0.21	0.32	0.30	1.03
0.29	0.9	0.24	0.32	0.30	0.92
0.26	1	0.26	0.33	0.31	0.83
0.24	1.1	0.29	0.33	0.31	0.76
0.22	1.2	0.32	0.33	0.30	0.69
0.20	1.3	0.34	0.32	0.30	0.63
0.18	1.4	0.37	0.32	0.30	0.58
0.17	1.5	0.39	0.32	0.29	0.53
0.15	1.6	0.42	0.32	0.29	0.49
0.14	1.7	0.45	0.31	0.28	0.46
0.13	1.8	0.47	0.31	0.28	0.43
0.13	1.9	0.5	0.30	0.28	0.40
0.12	2	0.53	0.30	0.27	0.37

	SPR level	Fmult	F(15-80cm)	YPR(catch)	YPR(landings)	SSB PR
Fmax	0.25	1.03	0.27	0.33	0.3	0.8
F0.1	0.38	0.66	0.17	0.3	0.29	1.21
F35%	0.35	0.72	0.19	0.31	0.29	1.12
F30%	0.3	0.86	0.23	0.32	0.3	0.96

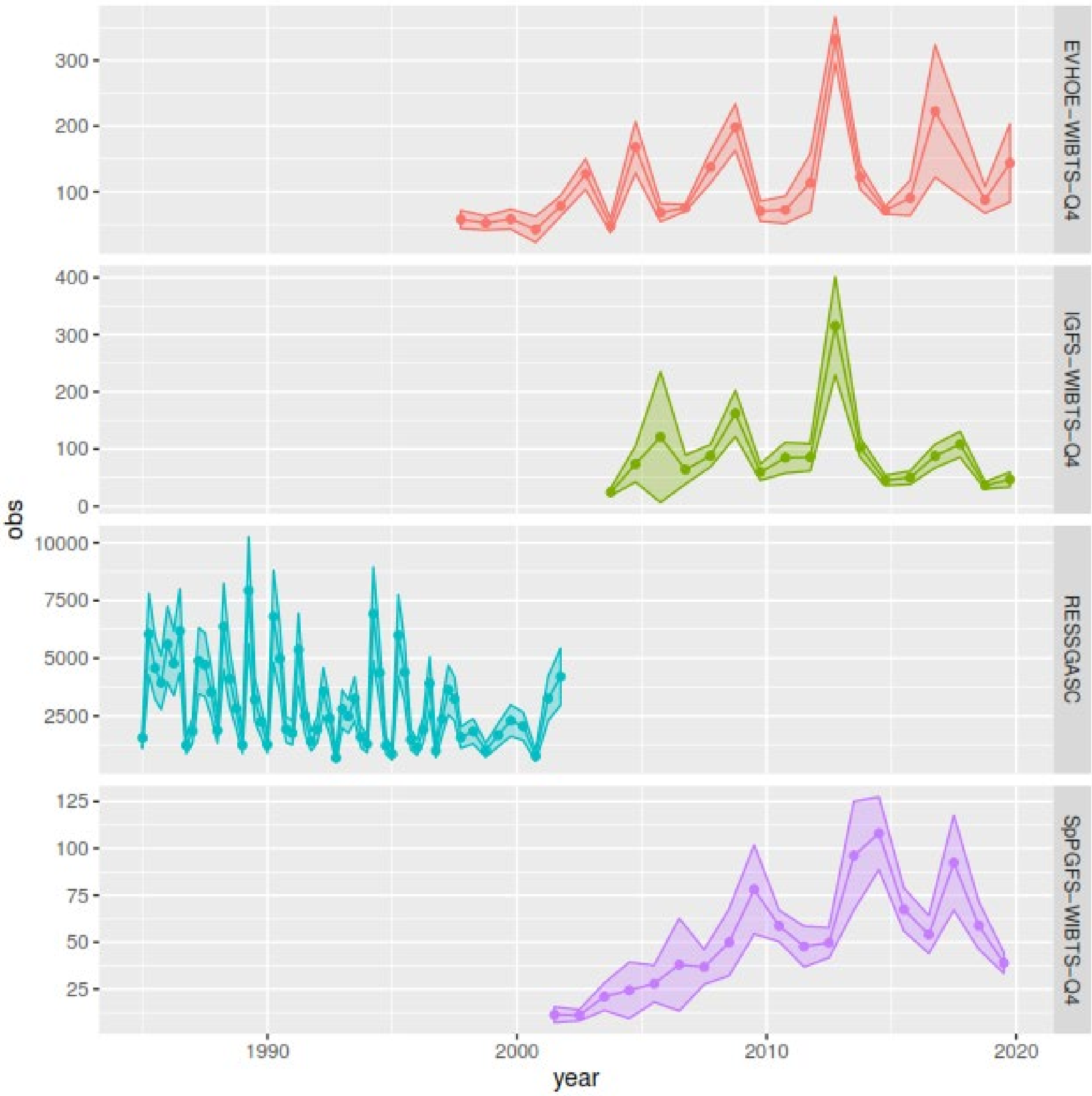

Figure 9.1. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (Northern stock). Abundance indices from surveys.

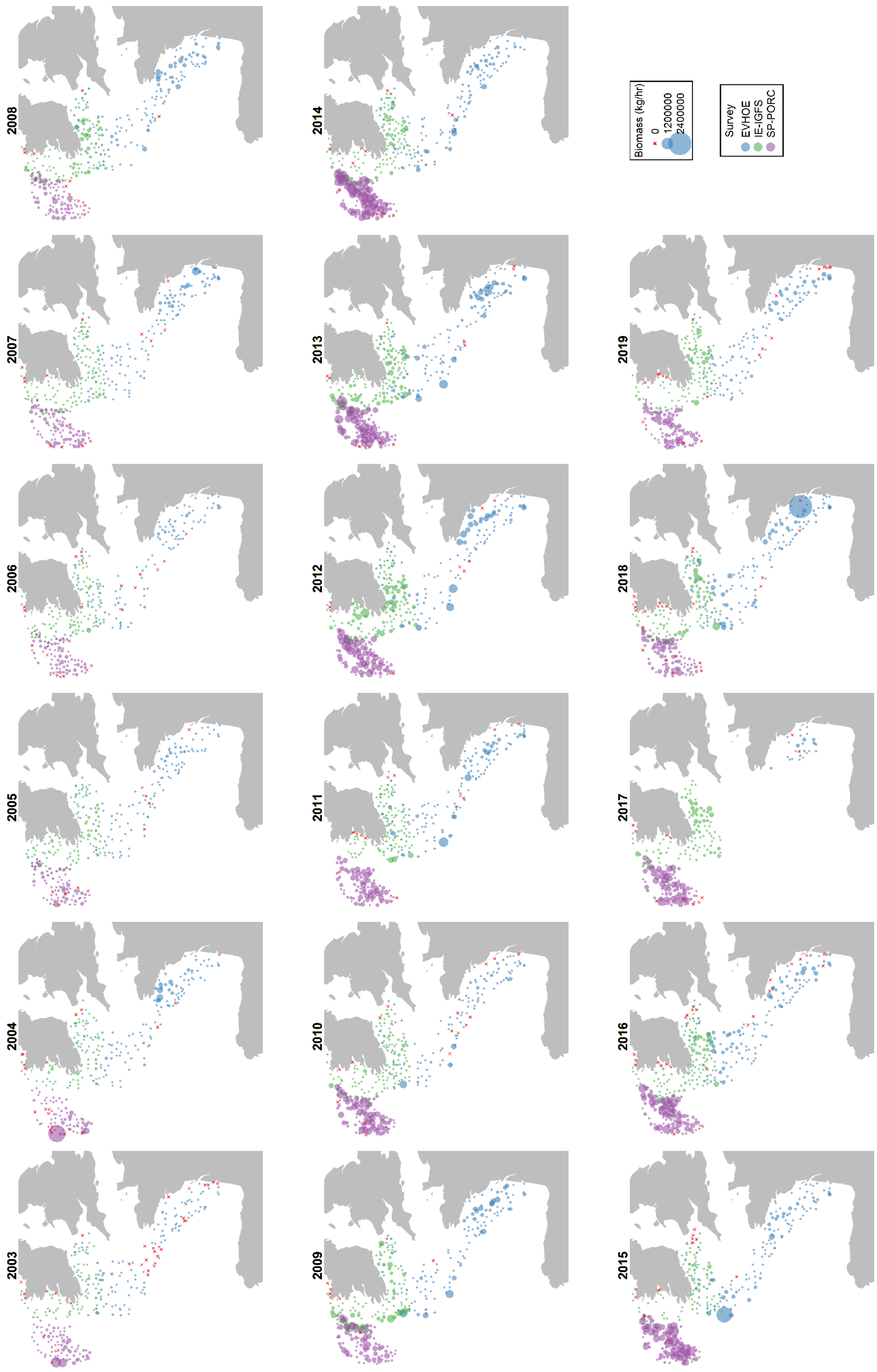

Figure 9.2. Spatial distribution of the EVHOE-WIBTS-Q4, IGFS-WIBTS-Q4 and SpPGFS-WIBTS-Q4 index of biomass (Kg/hr) from 2003 to 2019.

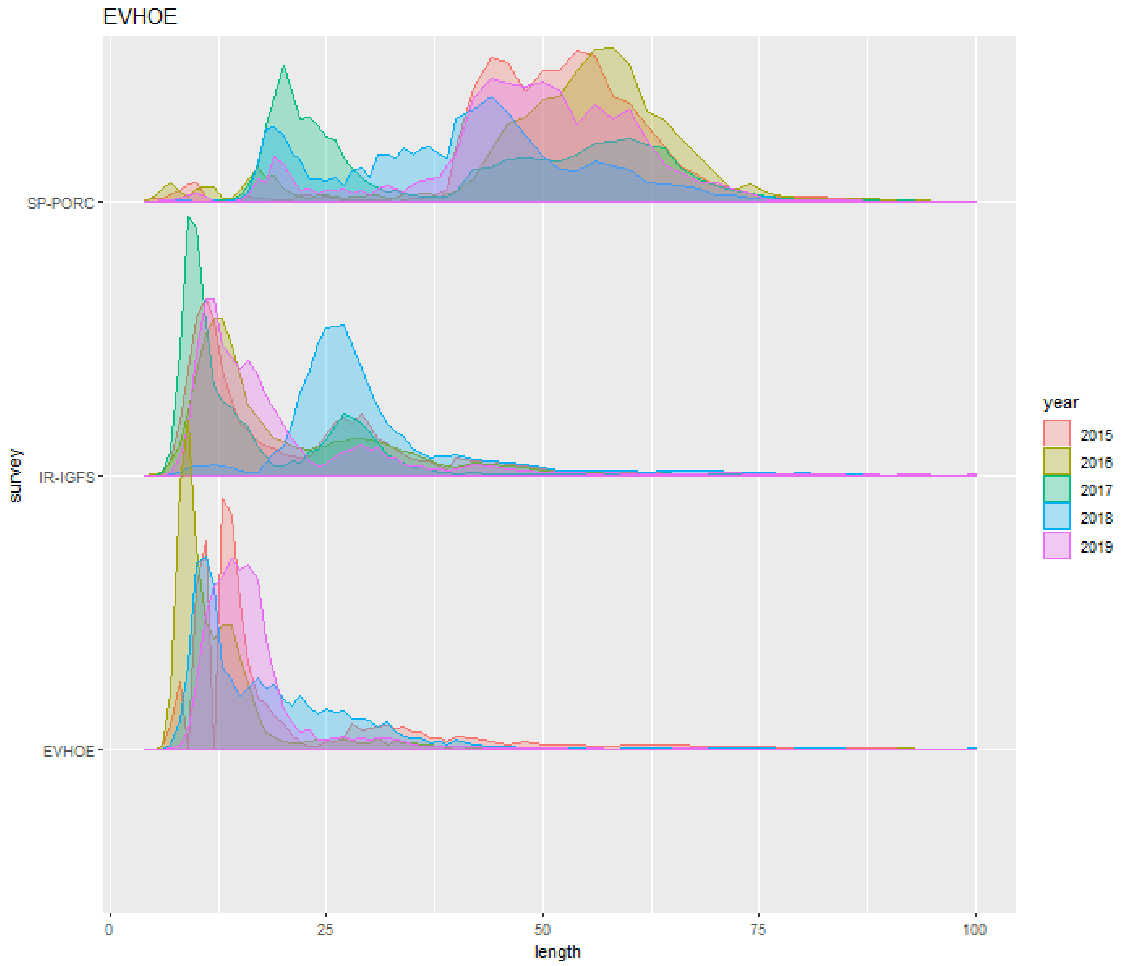

Figure 9.3. Northern hake. Length frequency distribution of surveys in the most recent years, from 2015 to 2019.

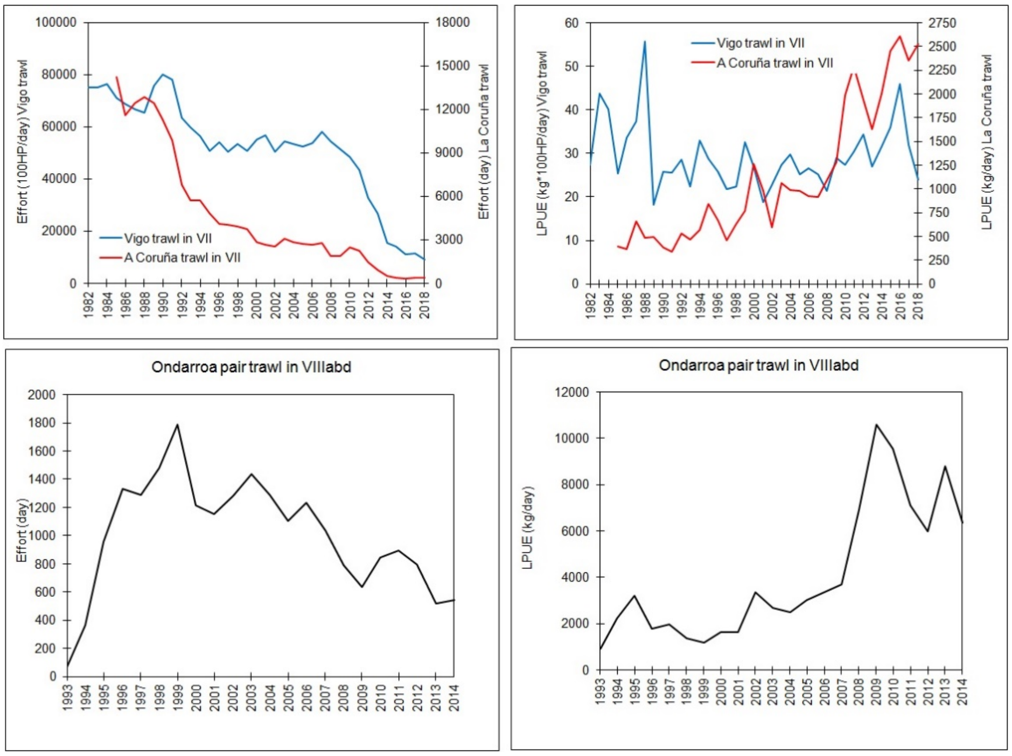

Figure 9.4. Northern hake. Effective effort indices and LPUE values of commercial fleets estimated by national laboratories.

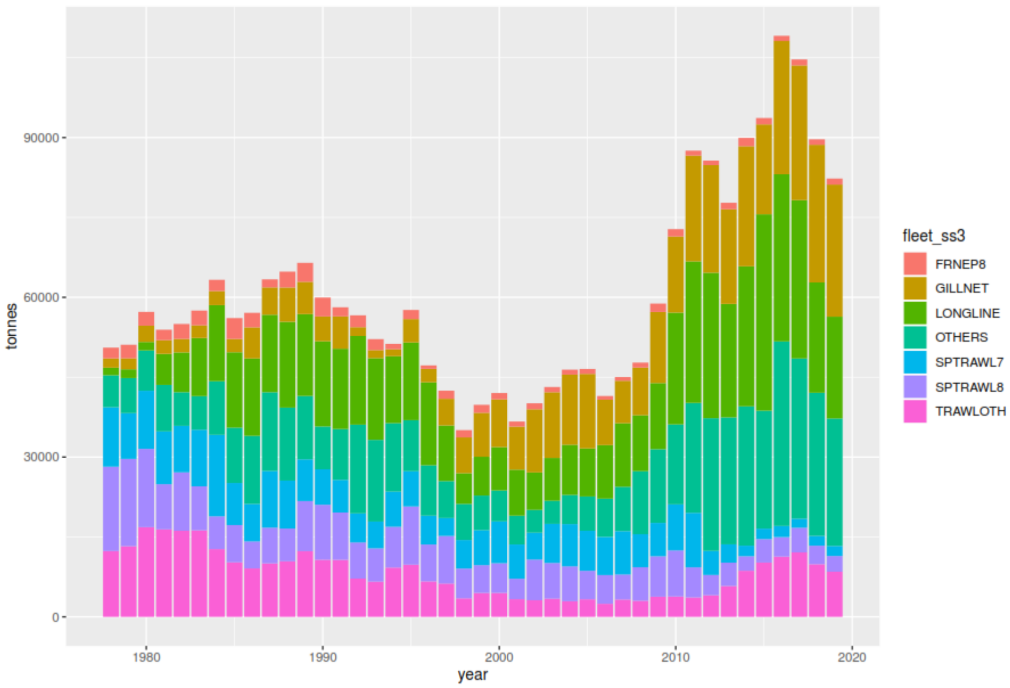

Figure 9.5. Northern hake. Total catch composition by fleet as used in the assessment model configuration.

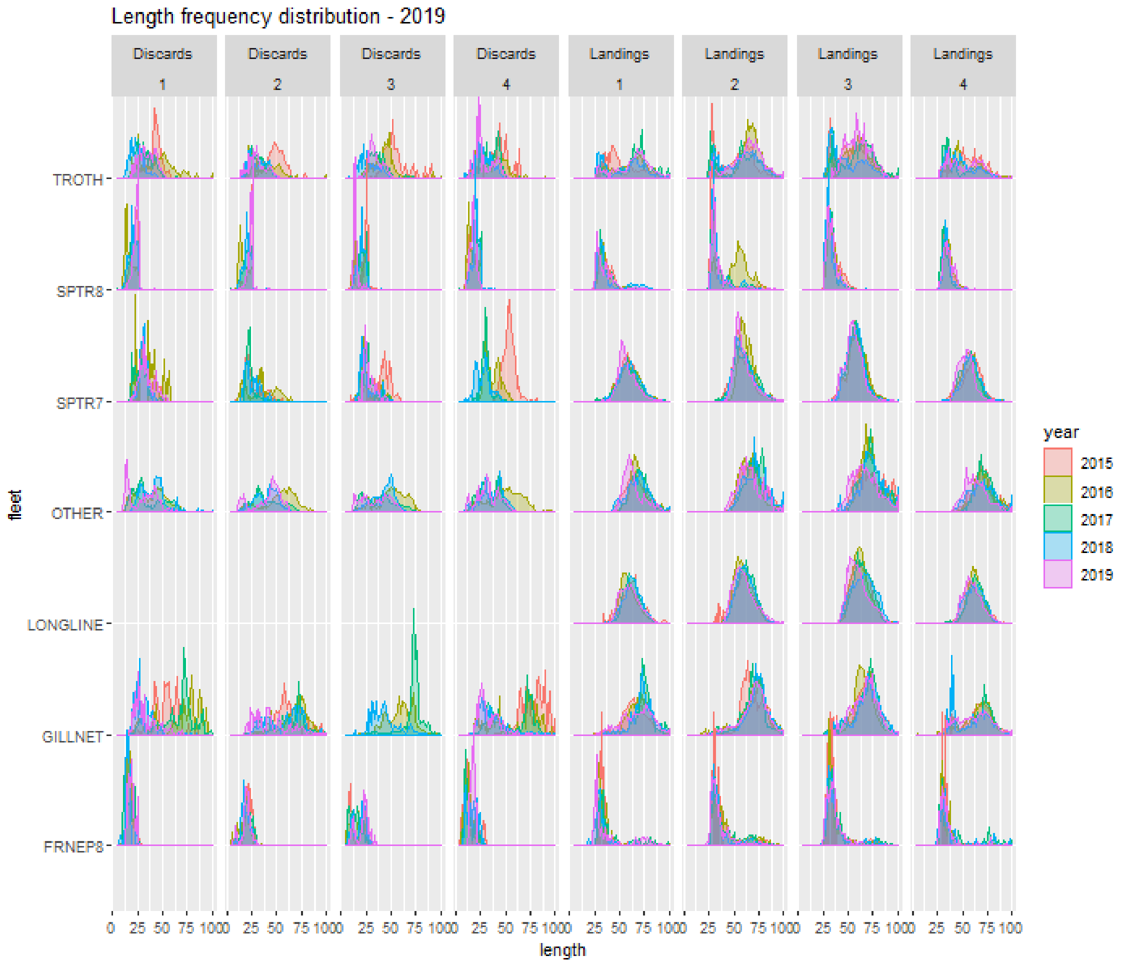

Figure 9.6. Northern hake. Length frequency distribution for landings and discards by fleet in the most recent years, from 2015 to 2019, by season and the fleet as used in the assessment model configuration.

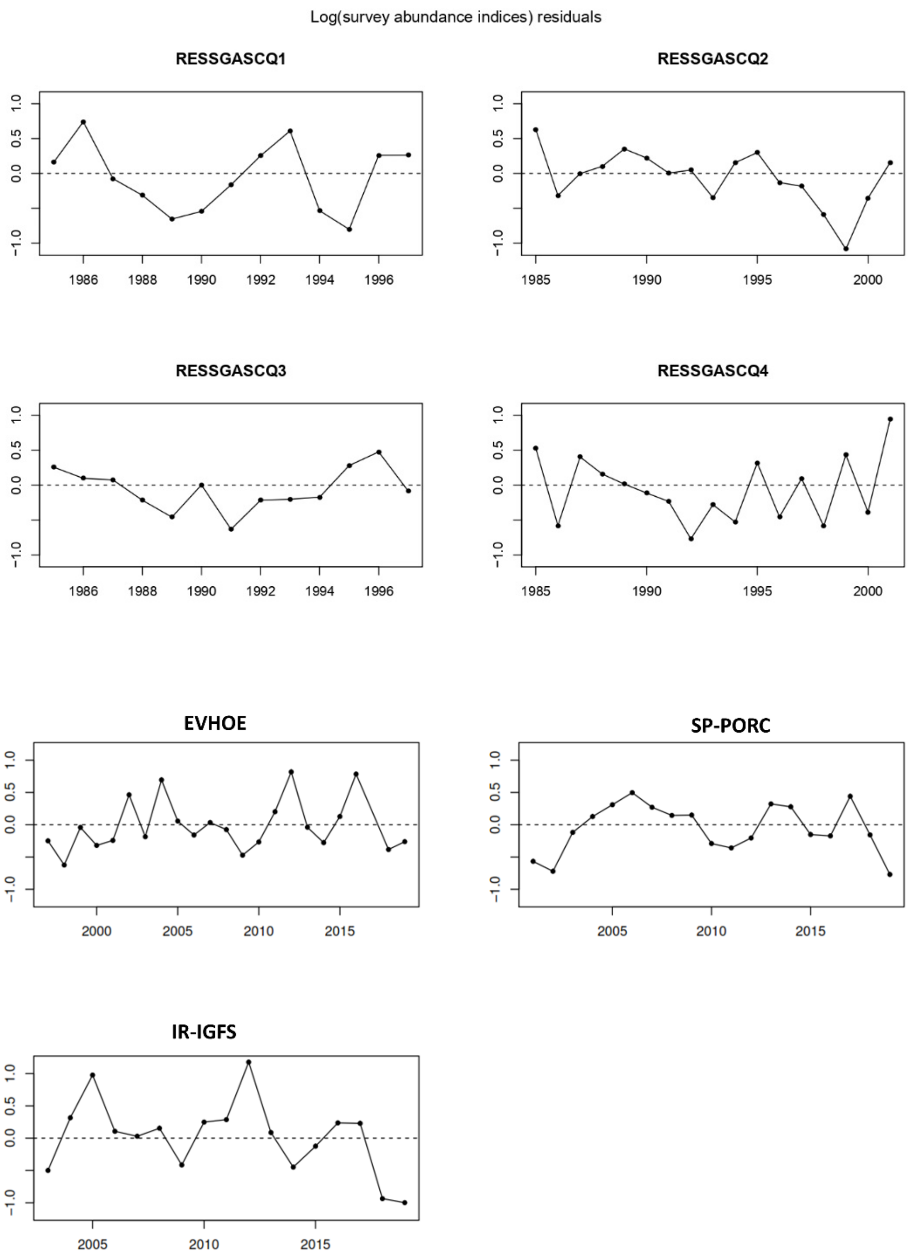

Figure 9.7. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Residuals of the fits to the surveys log(abundance indices). For RESSGASC, EVHOE, SP-PORC and IR-IGFS, fits are by quarter.

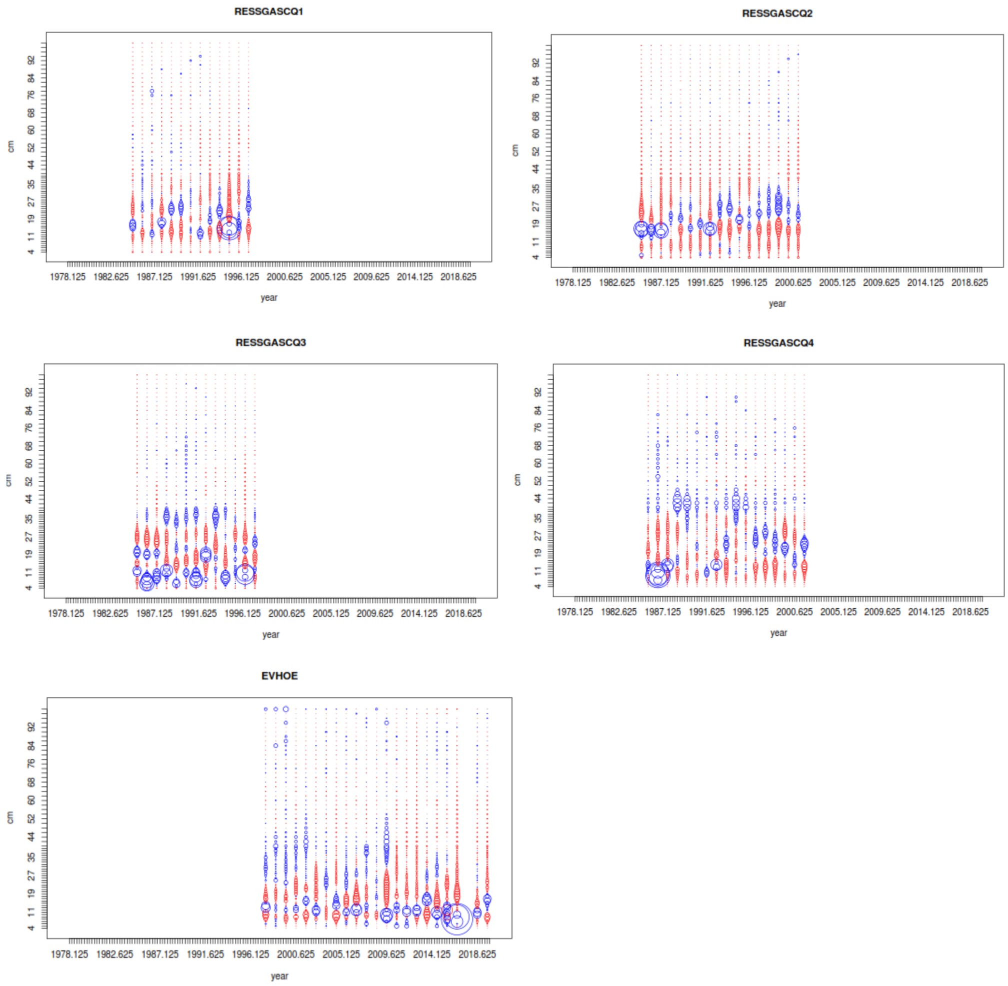

Figure 9.8. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Pearson residuals of the fit to the length distributions of the surveys abundance indices. For RESSGASC, fits are by quarter. Blue and red denote positive and negative residuals, respectively.

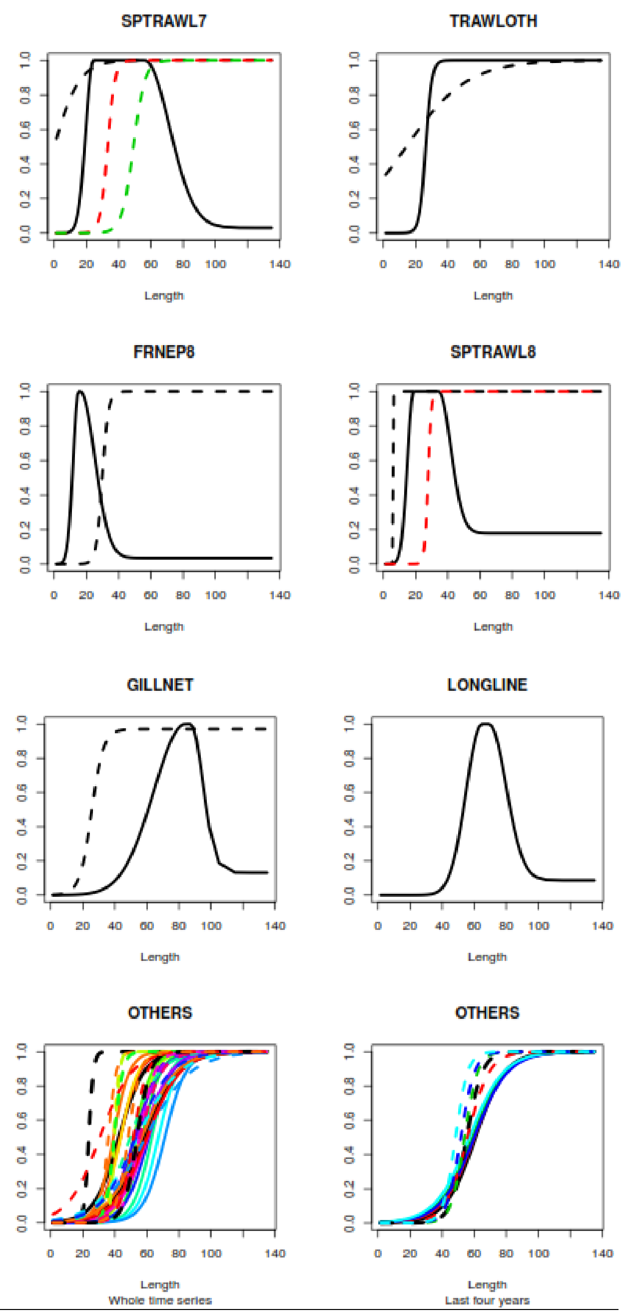

Figure 9.9. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Selection patterns (solid lines) and retention functions (dashed lines) at length by commercial fleet estimated by SS3. For SPTRAWL7, retention functions for 1978-1997, 1998-2009 and 2010-2013 are in black, red 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, 2015 (black), 2016 (red), 2017 (blue), 2018 (green) and 2019 (blue light).

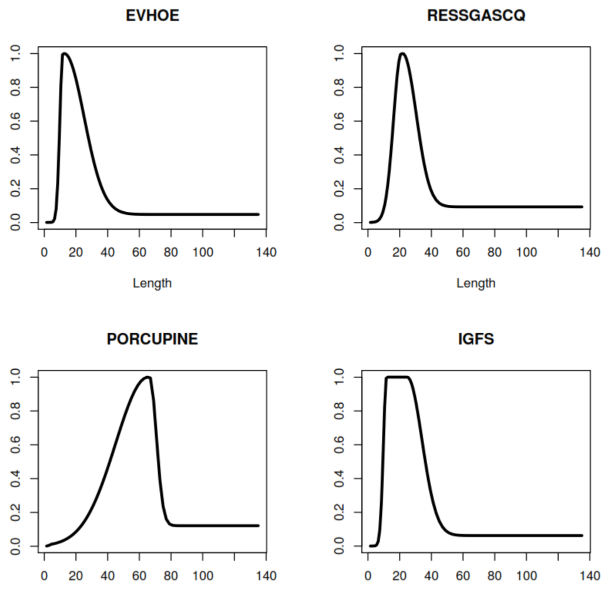

Figure 9.9. (continued). Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Selection patterns at length for surveys estimated by SS3.

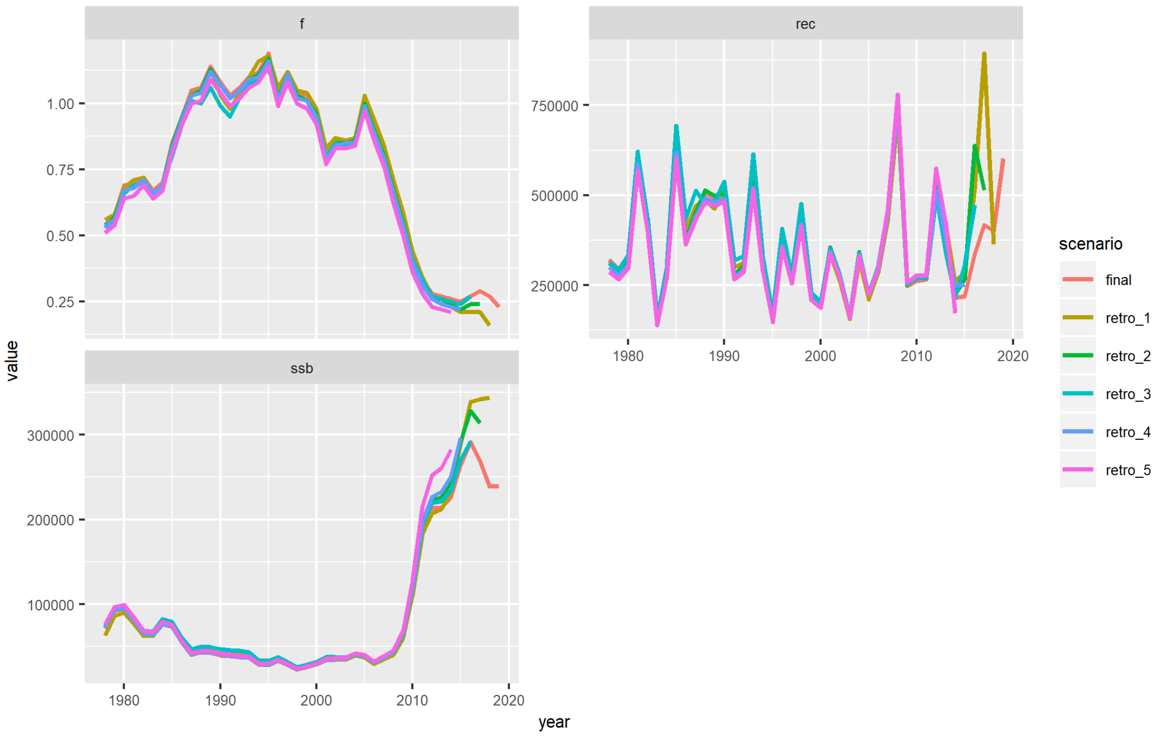

Figure 9.10. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Retrospective plot from SS3.

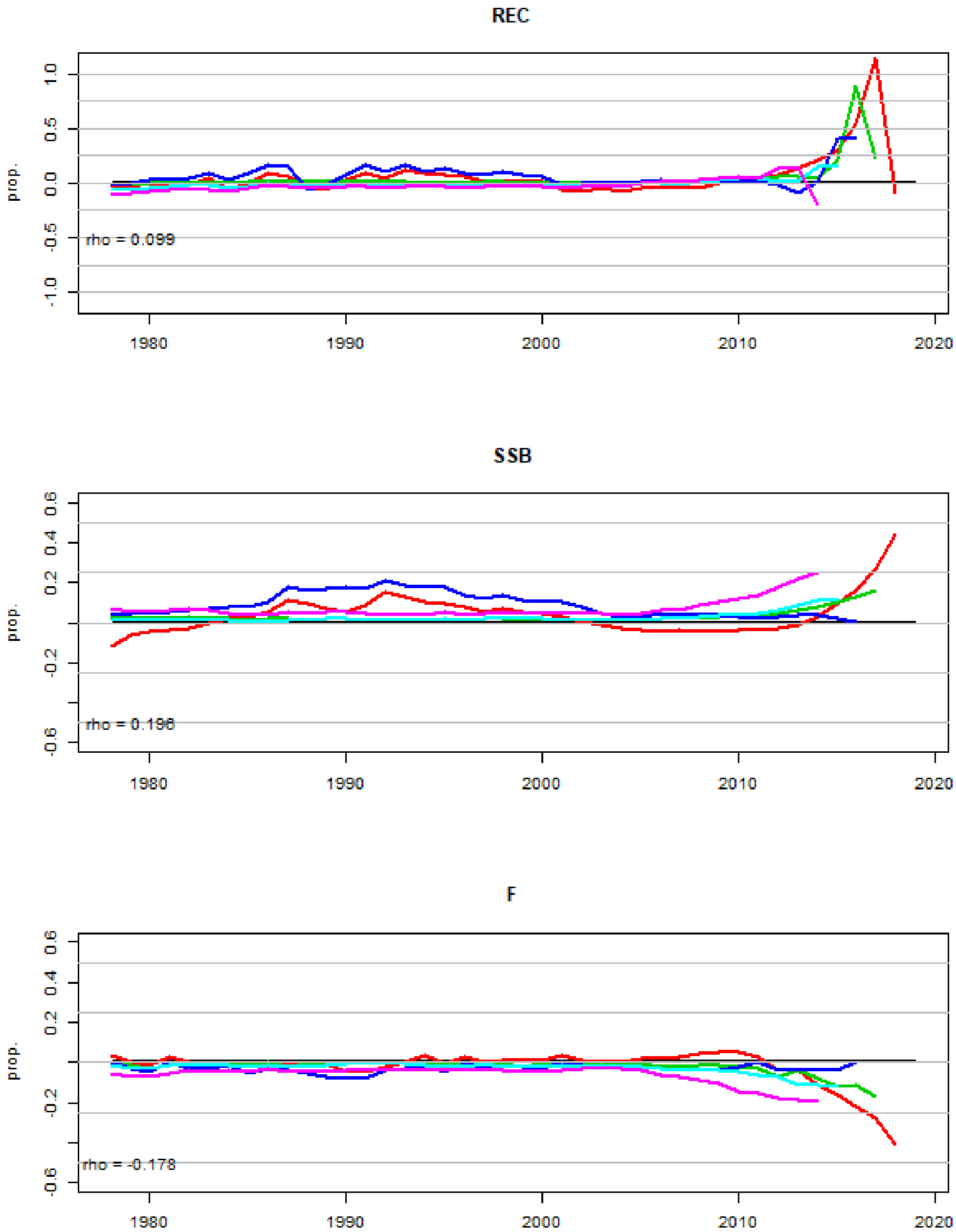

Figure 9.11. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Differences between time series in the retrospective analysis plot from SS3 for 2014-2019. The number in the bottom-left of the plot corresponds with the Mohn's rho.

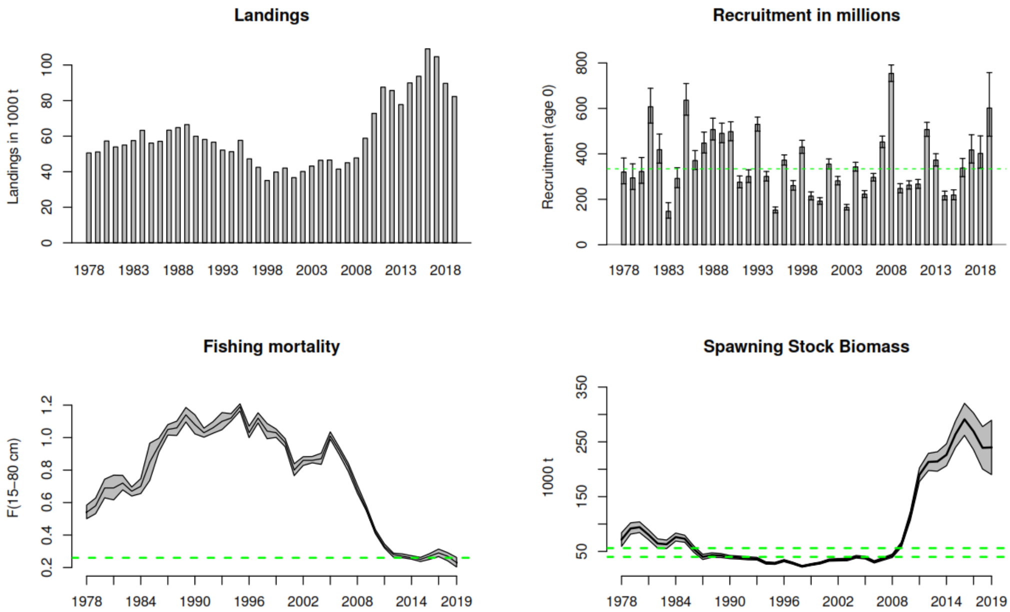

Figure 9.12. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Summary plot of stock trends. Green dashed lines correspond with geometric mean recruitment, F_{MSY} and, B_{lim} and B_{pa}.

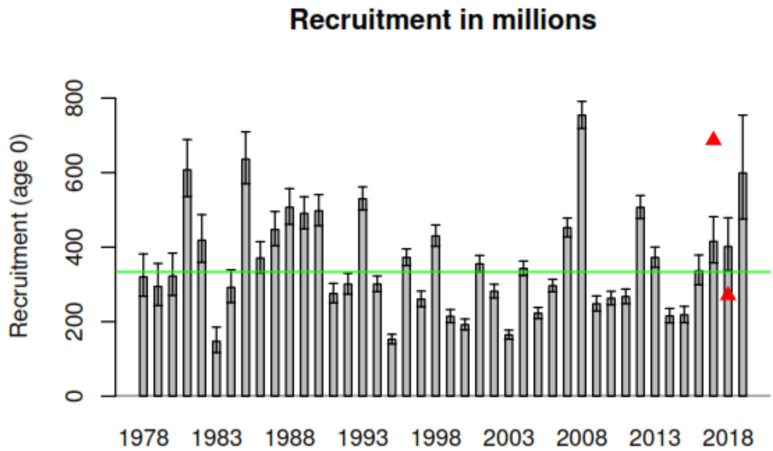

Figure 9.13. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Recruitment time-series with confidence intervals. The green line corresponds with the geometric mean from 1990 to 2017. The red triangles correspond with the recruitment estimated in 2019 working group by the model for 2017 and 2018, which were then replaced by the geometric mean in the projection.

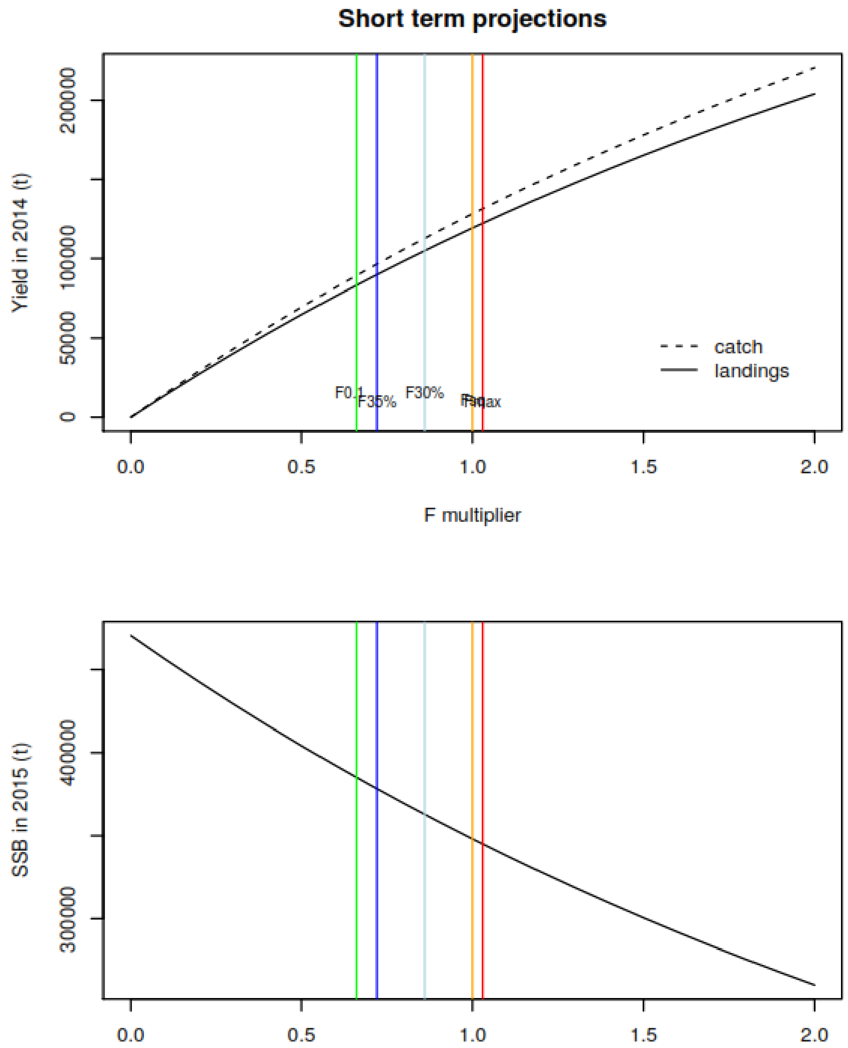

Figure 9.14. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Short-term projections

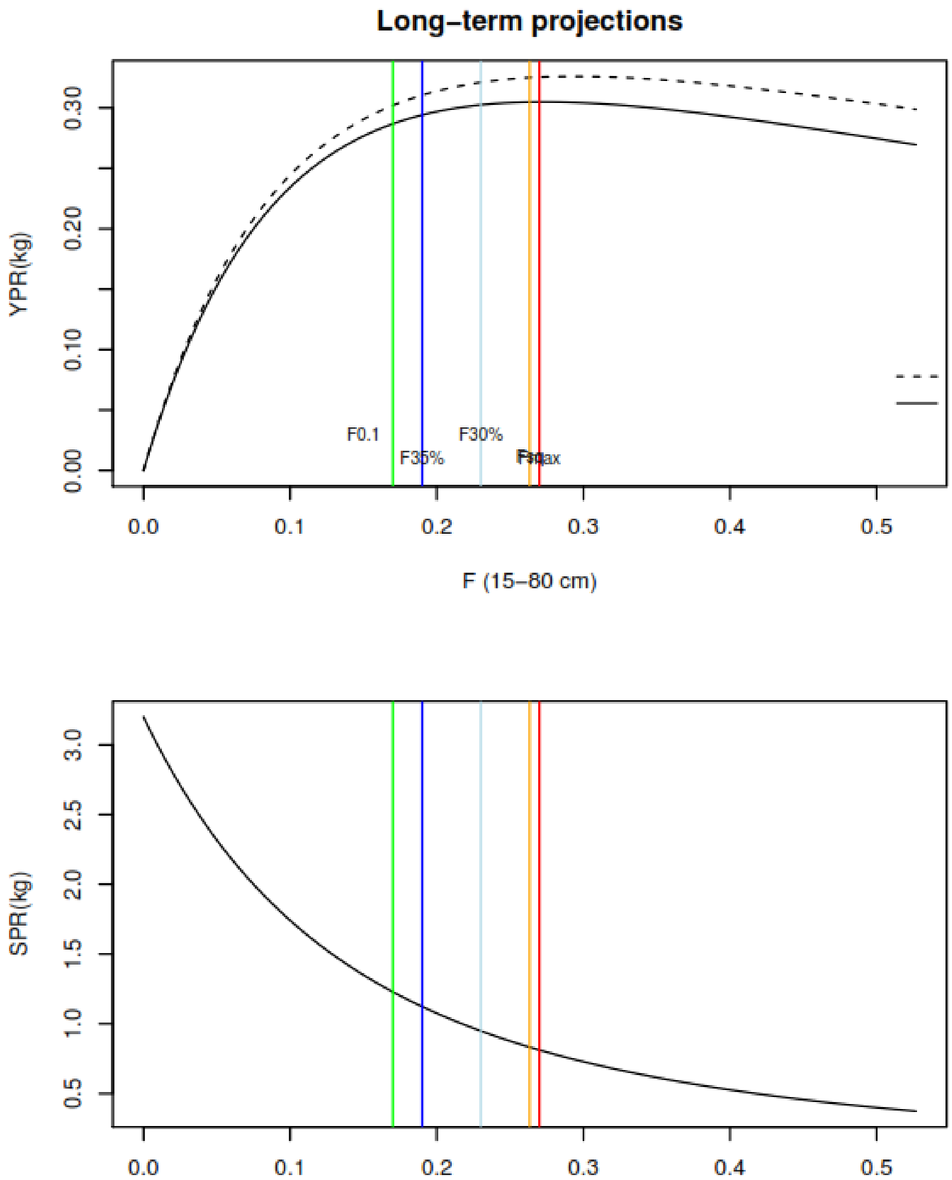

Figure 9.15. Hake in Division 3a, Subareas 4, 6 and 7 and Divisions 8a,b,d (northern stock). Equilibrium yield and SSB per recruit.

10 Southern Stock of Hake

10.1 General

The type of assessment is an "update" based on a previous benchmark assessment WKSOUTH (ICES, 2014). This year's assessment was updated with the 2019 data with no reviews of previous years' data. The model was rejected and a new advice based on category 3 was produced.

10.1.1 Fishery description

Fishery description is available in the Stock Annex.

10.1.2 ICES advice for 2020 and Management applicable to 2019 and 2020.

ICES Advice for 2020

ICES advised that when the EU multiannual plan (MAP, EU 2019) for Western Waters and adjacent waters is applied, catches in 2020 that correspond to the F ranges in the MAP are between 4 694 and 8 991 t. According to the MAP, catches higher than those corresponding to F_{MSY} (6 615 t) can only be taken under conditions specified in the MAP, whilst the entire range is considered precautionary when applying the ICES advice rule.

Management Applicable for 2018 and 2019

Hake is managed by a TAC, effort control and technical measures. The agreed TACs for Southern Hake in 2019 and 2020 were 9 258 t and 8 752 t, respectively.

Southern hake is included in the EU MAP 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 2016 with a *de minimis* exemption. During this year, ongoing studies to evaluate the *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 (seasonal or closed to some gears), 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. Also, every year until 2017, Portuguese Regulations determined the distribution of the Portuguese hake quota by individual vessels. 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

Southern hake catches by country and gear for the period 1972-2019, 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. Some Spanish discards in InterCatch were uploaded as zeroes when in fact these were "non-sampled". These were estimated based on the effort and catches from the same métiers. Spanish discards in InterCatch were estimated at 704 t but the value considered is 754 t.

Overall landings increased from 10 183 t in 2018 to 11 800 t in 2019. Portuguese official landings increased from 1 489 t, in 2018 to 1 915 t in 2019. Spanish official landings increased from 6 441 t in 2018 to 7 267 t in 2019. Non-reported landings increased from 2 193 t in 2018 to 2 612 t in 2019. Total discards in 2018 were 1 942 t and decreased to 1 061 t in 2019. Total catches were 12 125 t in 2018 and increased slightly to 12 861 t in 2019. The TAC for 2019 was 9 258 t which means that total catches exceeded the advised TAC.

Length distributions for 2019 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 slight increase from 32.3 cm in 2018 to 34.0 cm in 2019. Discards decreased in mean size from 24.2 cm in 2018 to 19.3 cm in 2019. Mean catch size slightly decreased from 29.3 cm to 28.7 in 2019.

10.2.2 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.

10.2.3 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 shown a general decreasing trend with figures above 35 cm before 2010 and decreasing afterwards. It has oscillated from 34.5 in 2016, to 30.3 cm in both 2017 and 2018 and 31.6 cm in 2019.

10.2.4 Abundance indices from surveys

Biomass, abundance and recruitment indices for the Portuguese and Spanish surveys, respectively, are presented in Table 10.3 and Table 10.4, 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, 2017c), which further ensures the use of the same methodology.

The Portuguese Autumn survey (PtGFS-WIBTS-Q4) was not performed in 2019. The time series showed variable abundance indices with a maximum in 1981 and a minimum in 1993 (the survey did not take place in 2012). Low values for biomass and abundance were observed in the early 2000s and then increased after 2004. Maximum historical values were observed in 2008-2010, 2013 and 2015. Values in 2016, 2017 and 2018 were 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 using 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 2009-2012 and 2015. The estimates from 2018 and 2019 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 show the same trends with a peak in 2015 followed by a decreasing trend afterwards. In 2019, the value from SpGFS-WIBTS-Q4 was slightly below the historical mean while that from the SpGFS-caut-WIBTS-Q4 was at its historical maximum.

For modelling purposes, length distribution calibration is made from the three surveys (SpGFS-WIBTS-Q4, SPGFS-caut-WIBTS-Q4 and PtGFS-WIBTS-Q4). The surveys used for trend calibration were only the SpGFS-WIBTS-Q4 and the PtGFS-WIBTS-Q4.

10.2.5 Commercial catch-effort data

Effort and respective landings series are collected from Portuguese logbooks maintained in DGRM and compiled by IPMA. For the Portuguese fleets, until 2011 most logbooks were filled in paper but have thereafter been progressively replaced by e-logbooks for those vessels covered by regulation (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 logbook data on landings and effort (modulated by additional fleet and catch characteristics), following the methods described in the stock annex and accepted by WKROUND (ICES, 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 the SP-CORUTR fleet effort until 2012. After 2012, effort was reported following the logbooks. The full LPUE series is presented in Figure 10.4 and Table 10.5. Changes in effort and landings estimation method prevented the use of SP-CORUTR data as a continuous series after 2012. 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 2019 LPUE (44.3 Kg/hour) is above the average and shows a small increase compared to 2018.

10.3 Assessment

The assessment was carried out using the GADGET model (length-age based) (Begley, 2005; Begley and Howell, 2004) as decided by WKSOUTH (ICES, 2014) and described in the Stock Annex.

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, achieving, at least, a local minimum.

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, with a possible exception of PtGFS-WIBTS-Q4 for lengths groups 4-19 cm and 19–34 cm, which appear to display some trends. This means that the abundance of these two length groups may 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. In 2018 and 2019, catches of larger individuals were less frequent in the Portuguese trawl fleet, the residuals for these years show two isolated negative values for the two indices P-TR (40–55 cm and 55-70) which 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) also shows quite consistent random residuals to the exception with the length group 55–70 cm, which shows positive residuals for 6 years (2007–2012).

In general, we can find some conflicting signals among different indices and length classes, such as the model underestimation of recent surveys values and model overestimation of recent CPUEs.

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 considered 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). 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 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 2019 was estimated to be relatively higher than in 2018.

Table 10.6 and Figure 10.9 present the 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 2004 with mean values around 70 million (ranging from 40 to 120 million); another between 2005 and 2009, with mean values of 123 million; since 2010 recruitment has been oscillating around 60 to 90 million individuals. Recruitment in 2019 was 78 893 thousands. 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 three years has been decreasing reaching 0.73 in 2017, 0.76 in 2018 and 0.74 in 2019. The SSB was very high at the beginning of the time series with values around 45 000 t, then decreased to a minimum of 5 706 t in 1998. Since then, biomass has been increasing, with a peak in 2011 (16 210 t) and remaining slightly below this figure in 2019 with 13 159 t.

Retrospective pattern for SSB, fishing mortality, yield and recruitment

Figure 10.10 presents the results of the retrospective assessments performed from 2019 to 2014. 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 corrected downwards, in contrast to F which shows a tendency to be corrected upwards. Mohn's rho index (Mohn, 1999) for the last 6 years were estimated for recruitment (-0.74), F (-0.35) and SSB (0.56). 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 highly affecting the reliability of the assessment and advice (ICES, 2019). For this reason, WGBIE did not accept this model to make projections and give advice. A correction of the model results based on the Mohn´s rho was hypothesized but there are no clear guidelines.

Exploratory runs

WD5 (Cerviño and Mendes, 2020 in this report) describes the work performed regarding the retrospective pattern in order to understand why it is happening and how it can be corrected. An analysis of plausible causes was first developed in ICES WKFORBIAS held at Woodshole, USA, 9-17 November 2019 (ICES, 2020) and has continued afterwards. A total of 54 scenarios were performed and the rho index was calculated for each scenario, spending more than 1 700 computation hours in the FinisTerrae-II equipment belonging to CESGA (Centro de Supercomputación de Galicia).

The approach consisted on exploring and testing alternative model configurations and their impact on hake retrospective pattern, quantified as a Mohn's rho index. This preliminary analysis can be complemented with other analyses and checks (convergence, likelihoods, residuals, etc) which can help to explain the sources of the retrospective pattern for this stock.

A preliminary series of runs were performed removing likelihood data. The model fits 19 likelihoods that can be grouped, as length distributions and abundance trends or as fisheries dependent or survey dependent data. Removing surveys trends improves the retrospective pattern to rho figures below 0.2. Two survey trends grouped in 3 length classes are used to calibrate the abundance. The length group between 20 and 35 cm was the most influential on the retrospective pattern. An analysis of survey and CPUE trends identified some conflicting signals among them which can also be seen in the residual plots (Figures 10.6a and b), which happen also inside data trends (e.g. P-TR or SpGFS-WIBTS-Q4), among length groups.

Other runs were performed with alternative settings. These include some scenarios addressing population dynamics uncertain parameters (growth and M), selectivity (alternative selection curves or year blocks with different parameters) and catchability dense-dependent. Among these scenarios only those with a reduced M (from 0.4 to 0.3) improves slightly the retro. However, this reduction was not enough to consider them as an alternative.

Scenarios where overcatch was simulated were also considered. Catch was increased from 10% to 50% by 10% after 2010. The reason to do it is two-fold: 1) around 2010 model diagnosis started to change, such as residuals or retrospective pattern, which was in the opposite direction in 2010 and 2) there were changes in the regulations and also in the way to estimate the catches used in the model. The results of these simulations regarding retrospective pattern improvement and likelihood values are presented in next table:

Cacth Increase	Rho SSB	Rho F	Rho Rec	Likelihood
0%	-0.45	0.31	-1.10	1242
10%	-0.34	0.25	-0.90	1229
20%	-0.23	0.19	-0.82	1195
30%	-0.15	0.13	-0.77	1182
40%	-0.08	0.08	-0.67	1173

All the indicators (rho's and Likelihood) improve consistently when catches increase. A deeper analysis identified that survey trends are the likelihood components that mostly contributed to reduce the total likelihood when adding more catches.

In most of the 54 scenarios there is a common pattern where the last two peels are those that mainly contribute to the retrospective pattern. Adding data for 2018 and 2019 increased the Rho values much more compared to previous additions. If we look at the residuals (Fig 10.6a and b), the most influential ones in this direction are the Pt-CPUE at length groups 40-55 and 55-70, which pushes the model abundance downwards.

Conclusion:

There are conflicting signals inside and among abundance trends, i.e. not all of them show the same trends. Adding catches in recent years help to reduce these conflicting signals. However, although the simulations include overcatch in recent years, alternative settings, such as an increase in M or outward stock migrations could probably achieve similar results. Is there any basis to support these alternative options? Natural mortality rose after 2005, when this stock started to recover although mainly affecting small individuals, below ~30 cm corresponding with ages 0 and 1. Migration outside Southern hake stock area has not been reported in tagging experiments. However, the separation between Northern and Southern stock was always considered lacking biological basis. Genetic studies also support this assertion.

The simulations performed did not allow setting an alternative model with an acceptable retrospective pattern. Some runs open the expectation to do it but further work is required.

10.4 Catch options (with cat 3)

10.4.1 Category 3 advice

Gadget model was not considered for projections and advice this year. The alternative is using the survey and CPUEs trends.

Figure 10.11 (left) shows the relative biomass index trend (divided by the mean) for 2 surveys (SpGFS-WIBTS-Q4and PtGFS-WIBTS-Q4) and 2 CPUEs (SP-CORUTR and P-TR LPUE). Although this data are noisy, there is a common pattern with values below historical mean at the beginning, an increase after 2004 until 2010 followed by a slightly decreasing trend although most of the values in recent years were still above the mean.

SpGFS-WIBTS-Q4 and P-TR LPUE are the only trend data used to make an index for Category 3 advice calculation that requires representative trends having, at least, the last 5 years available. SPGFS-caut-WIBTS-Q4 [1997 to 2019] was not used because of the small area coverage neither PtGFS-WIBTS-Q4 [1989 to 2018]) because the survey was not performed in 2019.

The index for stock size indicator (Figure 10.11, right) was calculated as the mean (years 1989-2019) of the two valid relative indices (SpGFS-WIBTS-Q4, in red and P-TR LPUE in blue). Stock size indicator (SSI) is quite variable with up and down behaviour although it shows an historical upward trend from values below historical mean in the beginning and above afterwards. It decreases in recent years reaching figures still above historical mean.

$SSI_y = ½ * [(SpGFS_y/mean(SpGFS) + P\text{-}TR_y/mean(P\text{-}TR)]$

Figure 10.12 shows the relative F trends estimated as yearly catch (C) divided by biomass yearly index (Ii). $F_{rel} = C / I$. The plot shows 3 trends (SP-NSGFS in red; PT-PGFS, in green and P-TR, in blue) although the mean corresponds to the same two trends used in the stock size indicator. The index shows high variability although an increases after 2004, peaking in 2008 and decreasing afterwards reaching figures below historical means in the last 4 years.

10.5 Biological reference points

Reference points estimated by WKMSYRef4 (ICES, 2017b) were based on GADGET, model no longer accepted for advice this year. MSY $B_{trigger}$ was set as B_{pa} by ACOM (ICES, 2017b).

Reference points

PA Reference points	Value	Rational
B_{lim}	8 000	Hockey stick breakpoint (8 000 t if rounded)
B_{pa}	11 100	B_{lim} * 1.4
F_{lim}	1.05	F corresponding to the slope of the hockey stick SSB-Rec relationship
F_{pa}	0.75	F_{lim} / 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 $B_{trigger}$	11 100	

A SPiCT model (Pedersen and Berg, 2017) was explored as an alternative to define reference points and the stock status which remained undefined under the new categorization of the stock. The model suffers from some inconsistencies among biomass indexes although most of the diagnostics were fine. The retrospective pattern is also problematic, specifically in the older peel (2014). Further work is required to solve these issues. Therefore, proxies for the reference points were undefined under the new categorization of the stock.

10.6 Comments on the assessment

The strong retrospective pattern was the cause of rejection of the GADGET model for projections and advice. Contradictory signals among abundance indices and stock productivity are the probable causes for these inconsistencies. Catch underestimation in recent years may explain the retrospective pattern that is reduced when catches increase. However, this reduced productivity can also be explained with natural mortality or migrations. Further work is required to figure out the real causes of the retrospective pattern.

Alternative models explored were not considered valid. Among the options discussed, only the category 3 assessments were considered suitable. The two indices considered cover most of the stock area (Portugal area and North of Spain), using catch dependent data (P-TR) and survey data (SpGFS-WIBTS-Q4) from 1989 to 2019.

Further work is required to explore alternative models like LBI (ICES, 2015), LB-SPR (Hordyk et al., 2015) or SPiCT to support new reference points for category 3 advice. Alternative data rich assessment methods, such as Stock Synthesis (SS, Merhot Jr. and Wetzel, 2013), should be explored for benchmark as soon as possible.

10.7 Management considerations

Southern hake is included in the Multiannual Management Plan for Western Waters (EU, 2019). This stock is caught in a mixed fishery together with megrims, anglerfish and other demersal species. Hake is a choke species in these fisheries.

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.

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Table 10.1. Southern hake 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

	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
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

	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
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
2019	0.78	1.65	1.12	0.43		1.81	1.49	0.75	7.27	1.114	0.801	0.307	1.92	0.01	2.61	1.06	11.80	12.9

Table 10.2. Southern hake stock - length compositions (thousands) in 2019 (without France landings (10 tonnes).

Length (cm) (4 to 100+ each 2)	Land	Disc	Catch
4	0	0	0
6	2	63	66
8	40	447	488
10	249	1228	1477
12	554	1807	2361
14	614	1555	2169
16	666	1262	1928
18	677	2511	3189
20	690	2245	2935
22	564	2949	3513
24	723	1999	2722
26	2342	921	3263
28	4368	221	4589
30	3869	113	3981
32	2971	47	3018
34	2627	4	2631
36	2151	1	2152
38	1709	1	1710
40	1186	0	1186
42	886	0	886
44	733	0	733
46	524	0	524
48	580	0	580
50	376	0	376
52	307	0	307
54	305	0	305
56	309	0	309

Length (cm) (4 to 100+ each 2)	Land	Disc	Catch
58	259	0	259
60	245	0	245
62	195	0	195
64	158	0	158
66	114	0	114
68	89	0	89
70	69	0	69
72	57	0	57
74	48	0	48
76	30	0	30
78	19	0	19
80	13	0	13
82	9	0	9
84	9	0	9
86	6	0	6
88	4	0	4
90	4	0	4
92	2	0	2
94	3	0	3
96	2	0	2
98	2	0	2
TOTAL	**31359**	**17374**	**48735**
Weight (000' tons)	**11,79**	**1,06**	**12,85**
SOP	**11,74**	**1,05**	**12,80**
SOP / NW	**1,00**	**1,01**	**1,00**
Mean length (cm)	**34,0**	**19,3**	**28,7**

Table 10.4. Southern hake 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

	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
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

	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
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	6.48	0.52	113	300.8	34.8	291	8.00	1.22	45	34.4	5.78	1.48	41	134.6
2019	5.71	0.39	113	166.1	18.4	151	8.03	1,17	43	364.4	5.13	0.90	46	109.7

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. Southern hake 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	41.8	3.1	44223
1990	749	17	44430	1138	39.3	3.0	28925
1991	501	12	40440	1245	35.4	4.2	35132
1992	589	15	38910	1325	33.1	2.6	40048
1993	514	12	44504	870	27.3	2.5	31825
1994	473	12	39589	789	33.2	3.4	23784
1995	831	20	41452	1026	41.9	3.7	24487
1996	722	20	35728	758	38.1	3.7	19875
1997	732	21	35211	897	44.6	4.7	20098
1998	895	27	32563	970	37.9	3.2	25599
1999	691	23	30232	1090	45.8	3.3	23826
2000	590	20	30102	1158	32.7	4.0	35422
2001	597	20	29923	1198	41.9	4.3	28582
2002	232	11	21823	965	41.2	2.8	23444
2003	274	15	18493	962	37.7	1.8	25552
2004	259	12	21112	799	37.6	1.7	21258
2005	330	16	20663	965	40.3	1.9	23919
2006	518	27	19264	908	37.7	2.5	24057
2007	621	29	21201	724	36.0	1.5	20081
2008	762	38	20212	936	43.3	1.8	21614
2009	640	40	16162	964	40.7	1.6	23707
2010	553	40	13744	727	40.7	1.7	17853
2011	538	47	11532	493	41.1	2.0	12003
2012	498	42	11887	814	48.9	1.8	16659
2013*	542	37	14736	812	46.2	1.7	17570
2014*	493	27	18060	661	45.2	1.8	14617
2015*	411	31	13309	763	59.5	1.7	12829
2016*	514	38	13718	752	44.9	1.3	16739
2017*	303	24	12449	575	42.1	1.3	13658
2018*				697	43.2	1.3	16130
2019*	572	45	12824	801	44.3	1.3	18078

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. Southern hake stock. Assessment summary.

Year	M (1-3)	SSB ('000 tonnes)	R (million)	Catch ('000 tonnes)	Landings ('000 tonnes)	Discards ('000 tonnes)
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	82.34	13.19	13.19	NA
1991	0.69	16.45	70.00	12.83	12.83	NA
1992	0.84	15.51	52.28	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	6.47	80.71	10.77	8.50	2.27
1998	0.94	5.70	57.97	9.36	7.68	1.68
1999	0.79	7.39	66.84	8.69	7.17	1.52
2000	0.89	8.65	70.34	9.74	7.90	1.83
2001	0.87	8.77	49.20	9.24	7.58	1.66
2002	0.83	9.13	70.93	8.18	6.69	1.49
2003	0.85	8.83	60.33	8.21	6.74	1.46
2004	0.75	8.75	78.25	7.86	6.94	0.91
2005	0.80	9.06	128.37	10.31	8.33	1.98
2006	0.92	10.33	96.41	14.08	10.82	3.26
2007	0.98	12.11	172.66	17.44	14.93	2.50
2008	0.95	11.85	116.28	19.11	16.80	2.31
2009	0.99	13.82	105.51	22.17	19.24	2.93

Year	M (1-3)	SSB ('000 tonnes)	R (million)	Catch ('000 tonnes)	Landings ('000 tonnes)	Discards ('000 tonnes)
2010	0.75	13.68	64.10	16.95	15.37	1.58
2011	0.87	16.21	85.60	19.01	17.06	1.95
2012	0.89	14.86	89.94	16.40	14.57	1.82
2013	0.78	12.62	67.24	13.91	11.35	2.55
2014	0.90	14.73	82.70	14.48	11.88	2.60
2015	0.85	12.24	92.04	13.84	11.55	2.29
2016	0.93	11.79	59.94	14.52	12.21	2.31
2017	0.73	11.95	66.85	10.78	9.10	1.68
2018	0.76	13.20	88.91	12.06	10.12	1.94
2019	0.74	13.16	78.89	12.86	11.79	1.06

Notes:

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.

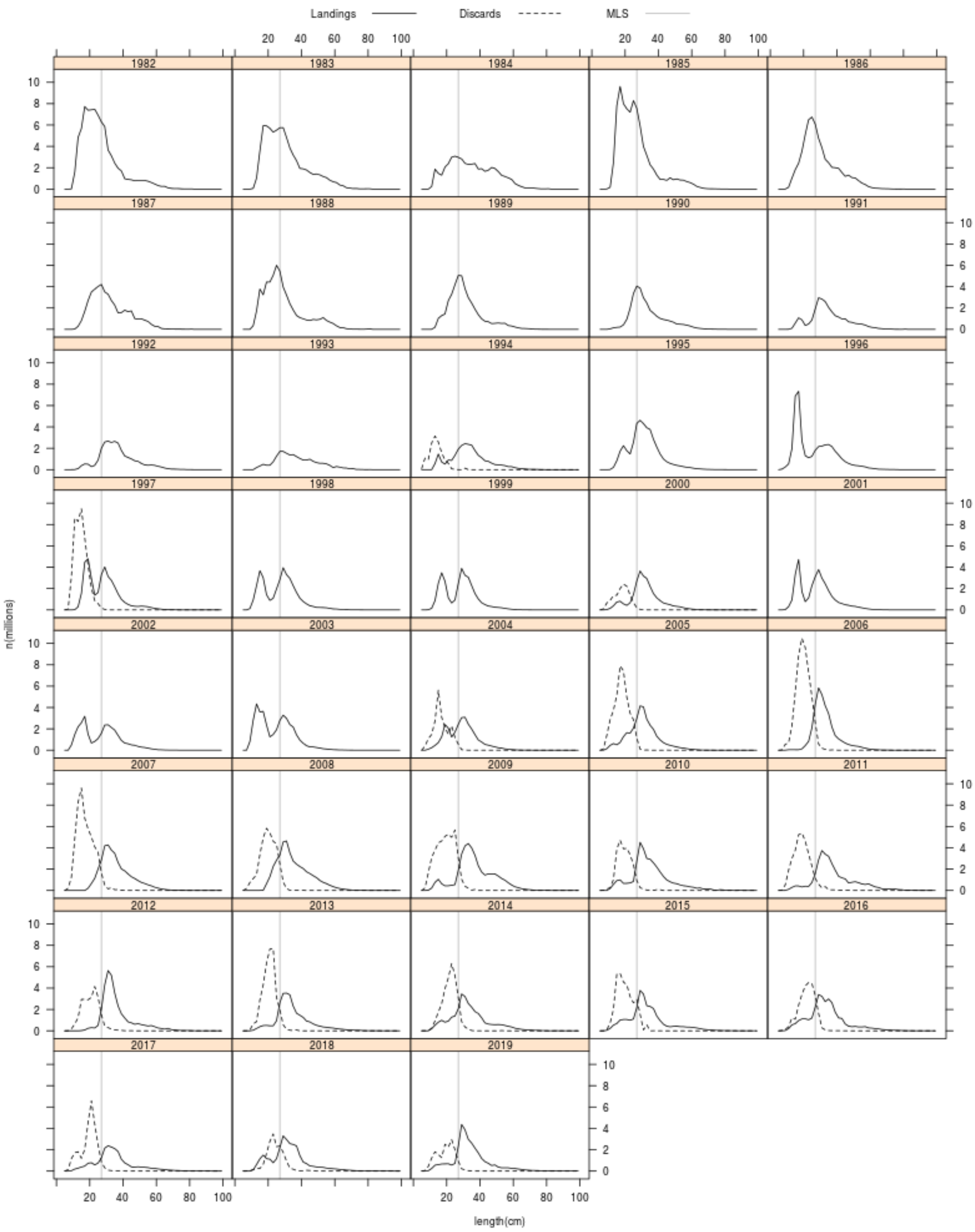


Figure 10.1. Length distribution of catches used in the assessment. Landings (1982-latest year) plus Cadiz landings from 1994–2004. Discards from 1992–latest year (dashed line). Minimum landing size (MLS) since 1992 at 27 cm. No French landings included (10 tonnes).

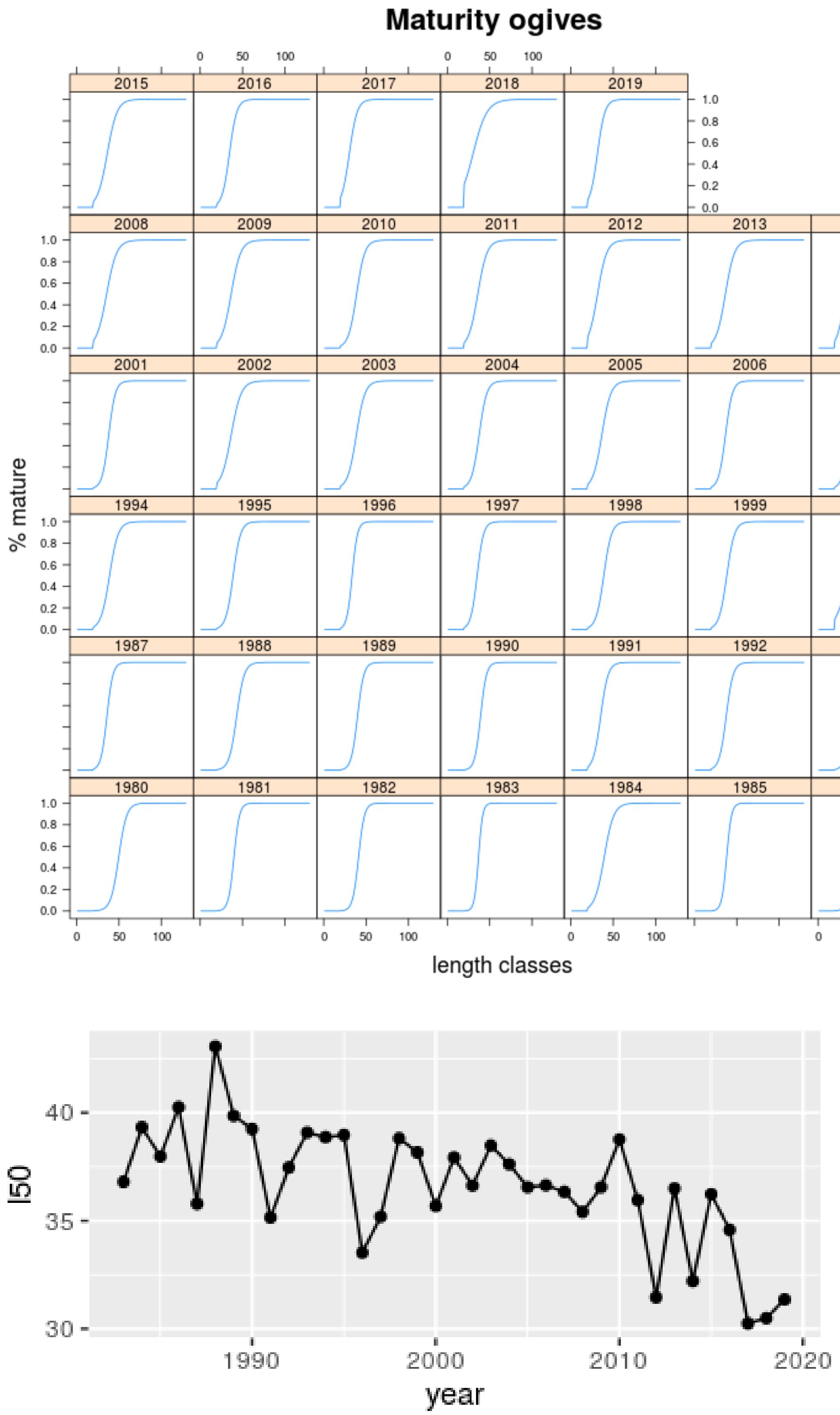


Figure 10.2. Maturity ogives from 1982 (upper plot) and L_{50} trend (lower plot).

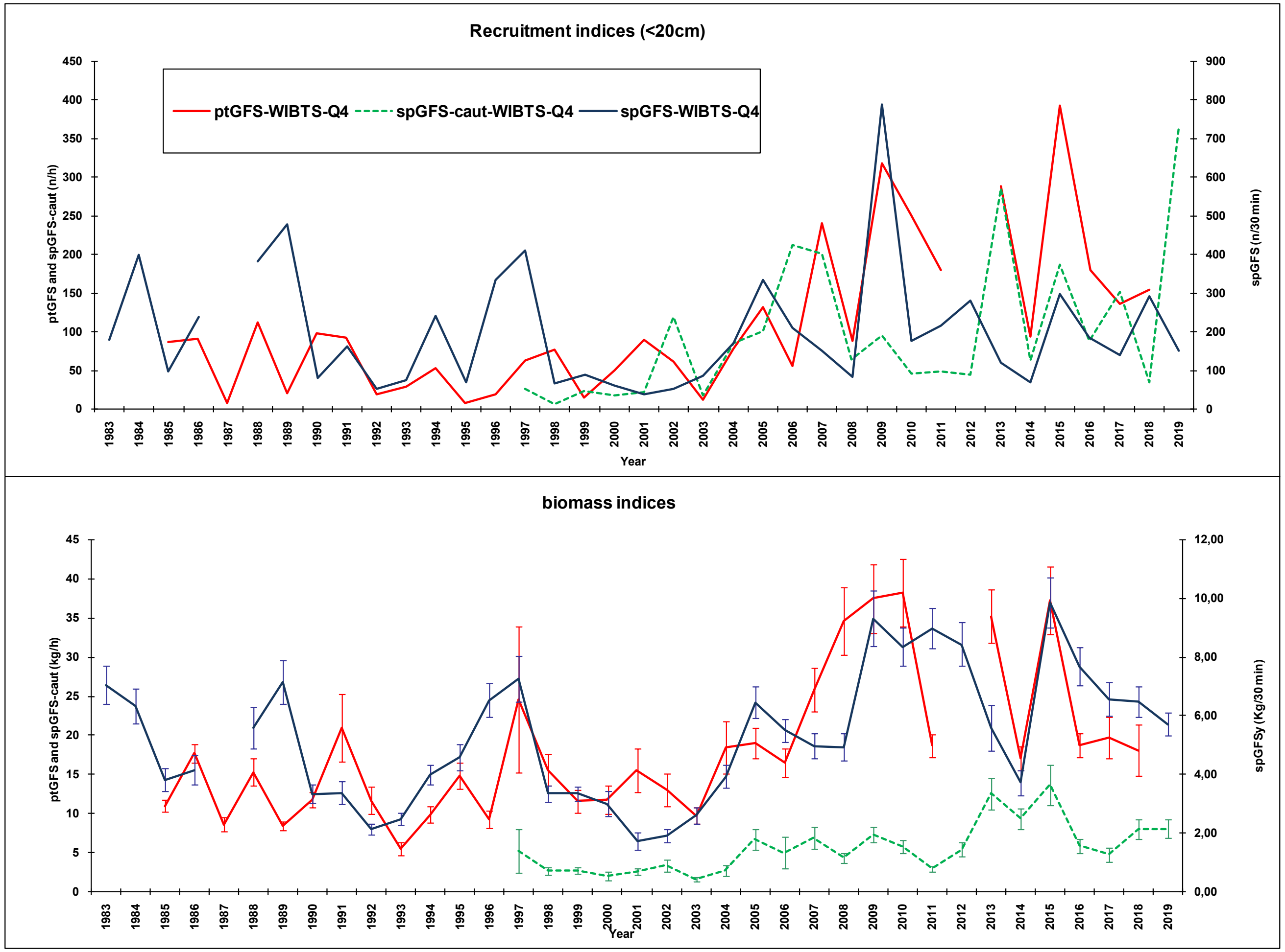


Figure 10.3. Southern hake stock. Recruitment and biomass Indices from groundfish surveys. Vertical bars = 90% CI.

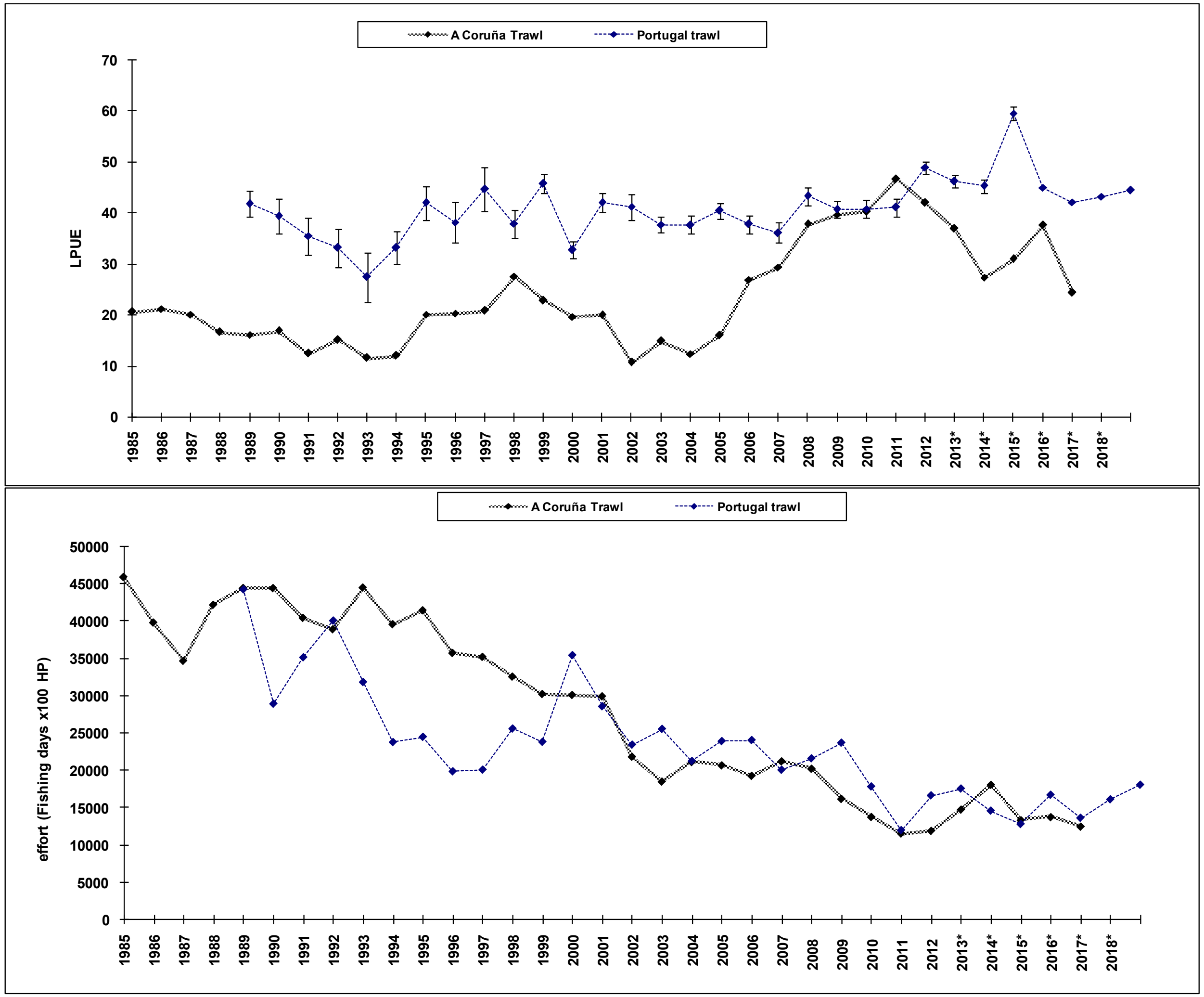


Figure 10.4. Hake southern stock- LPUE and fishing effort trends for trawl fleets. Vertical bars = 90% C

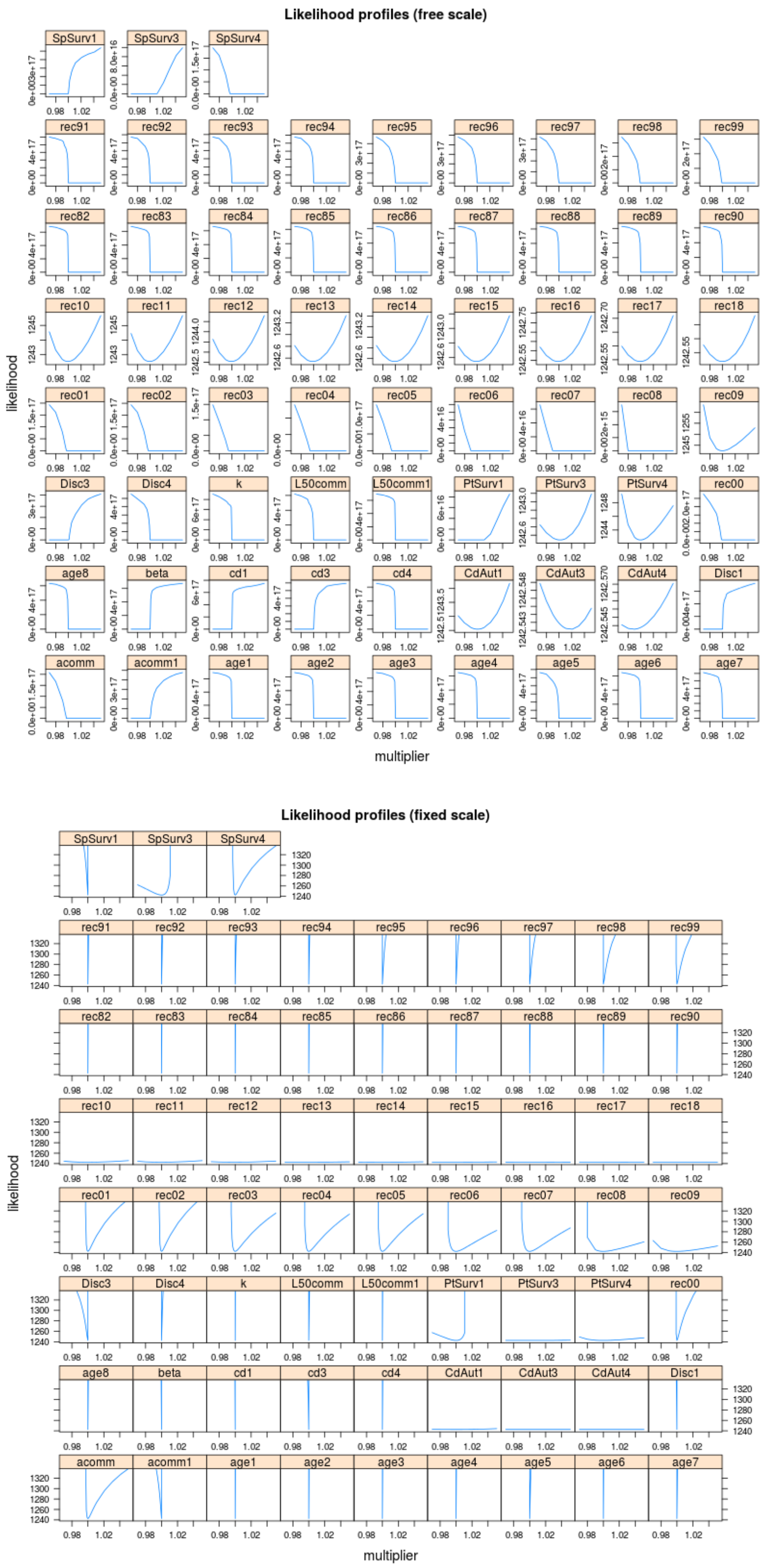


Figure 10.5. Gadget convergence with likelihood profiles. Free scale (upper panel) and fixed scale (lower panel).

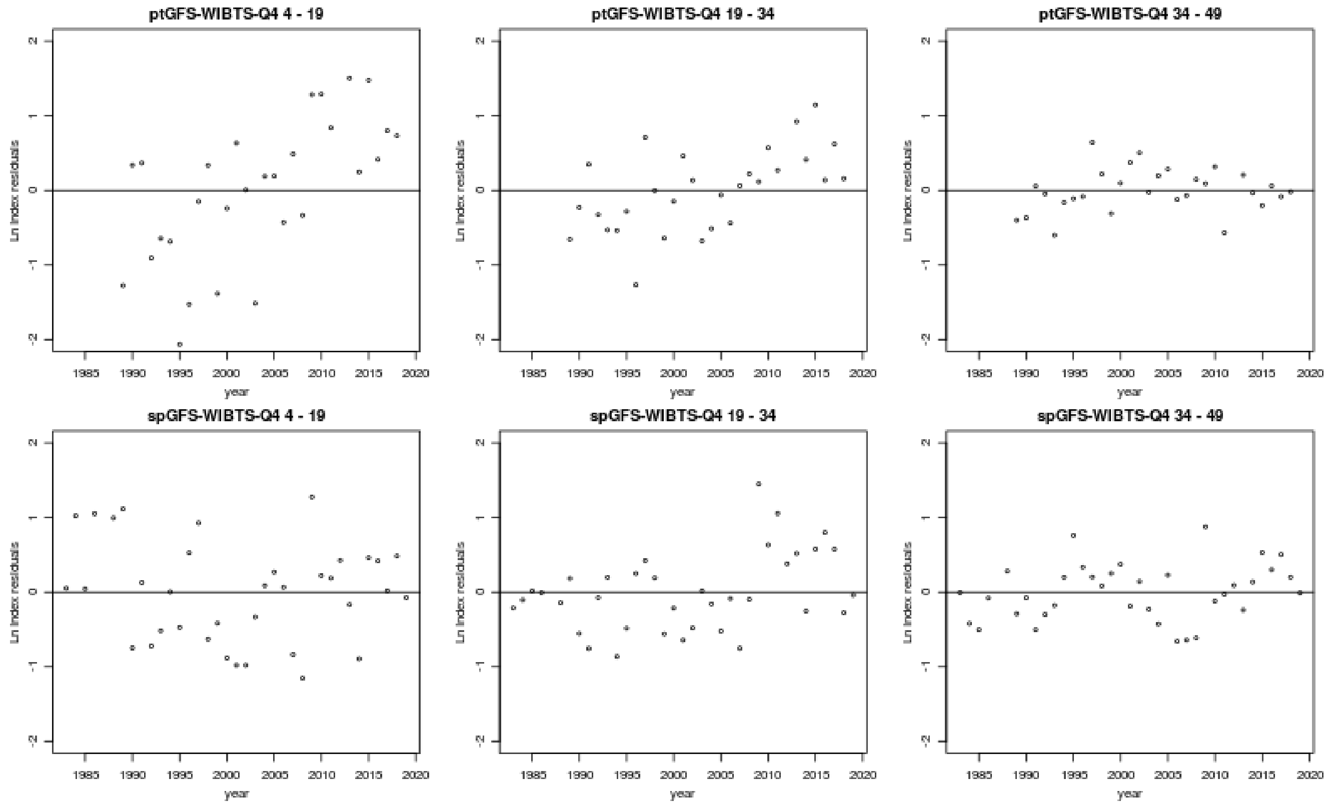
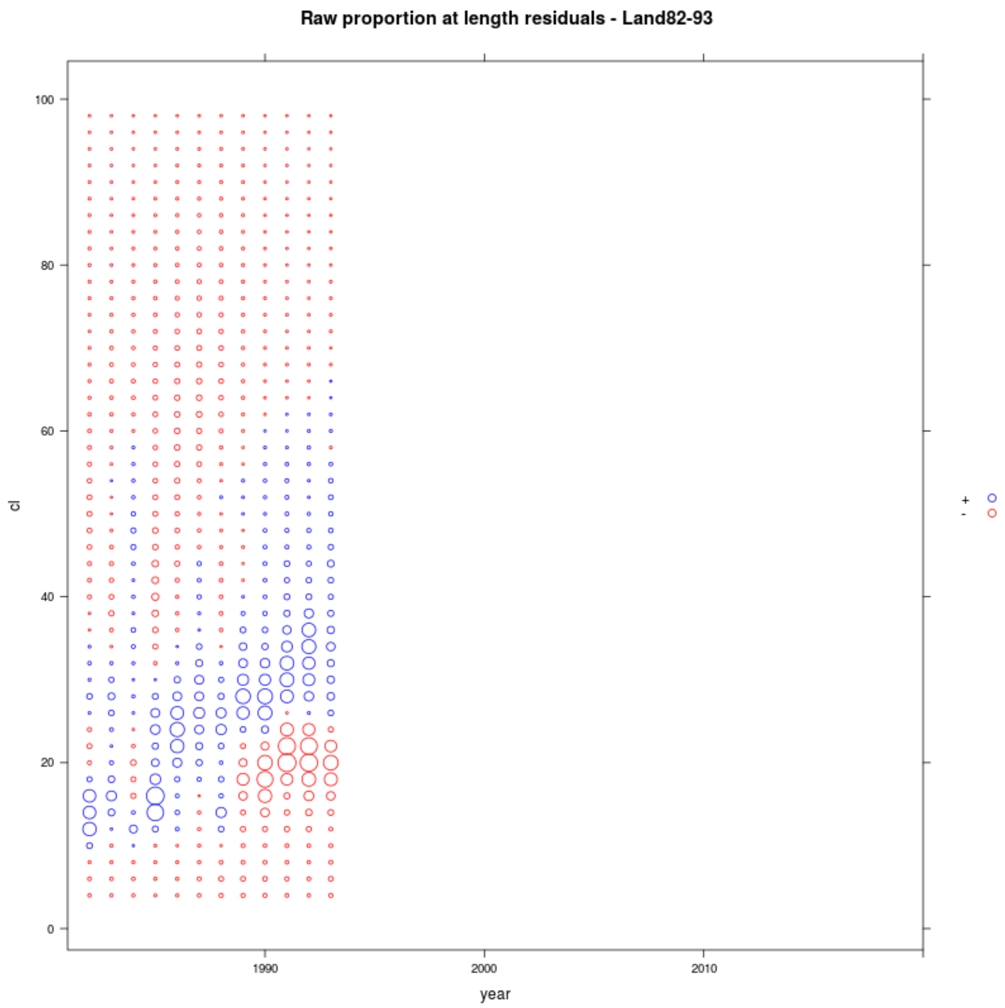


Figure 10.6a. Diagnostics residuals (from 10.6 a to b) and observed vs. expected length proportion (from 10.6c to 10.6i). (10.6 a). Survey residuals by 15 cm groups (4–19, 19–34, 34–49 cm).



x

Figure 10.6 c. Bubble plot for landings length distribution from 1982 to 1993.

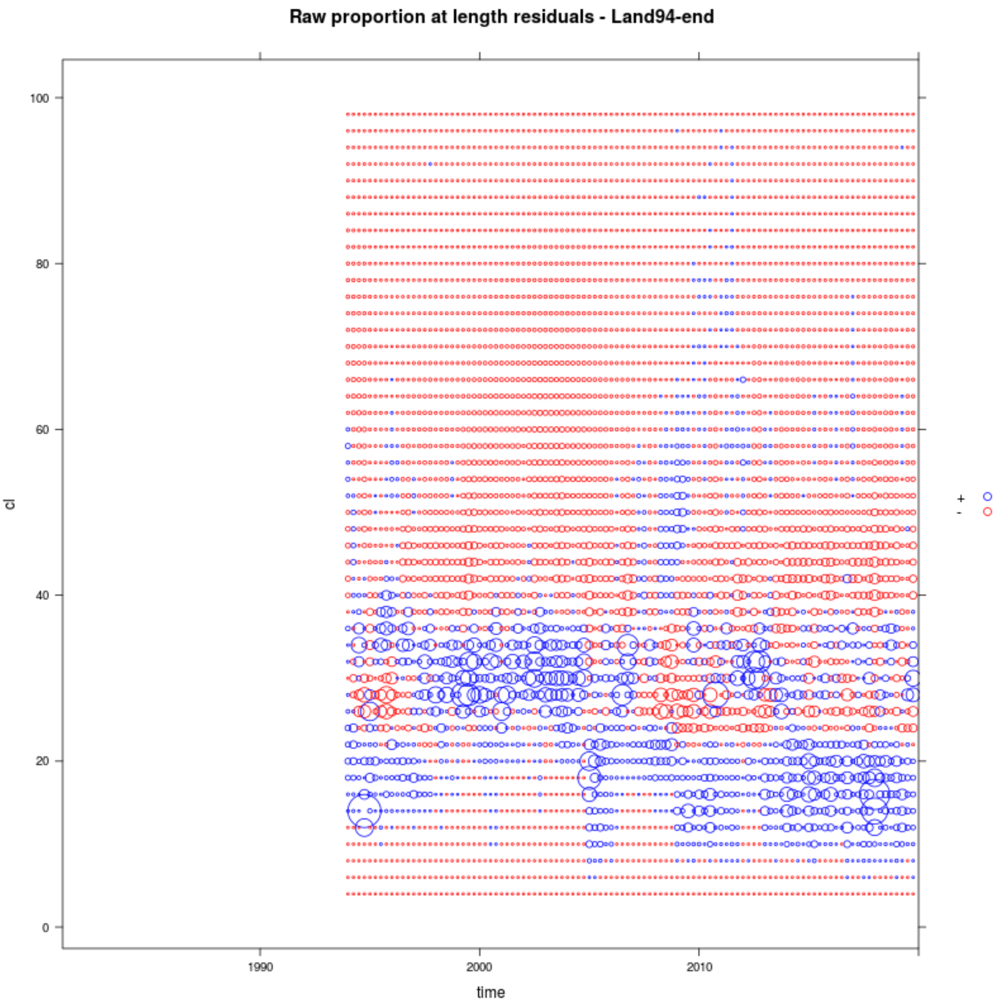


Figure 10.6d. Bubble plot for landings length distribution from 1994 to last year.

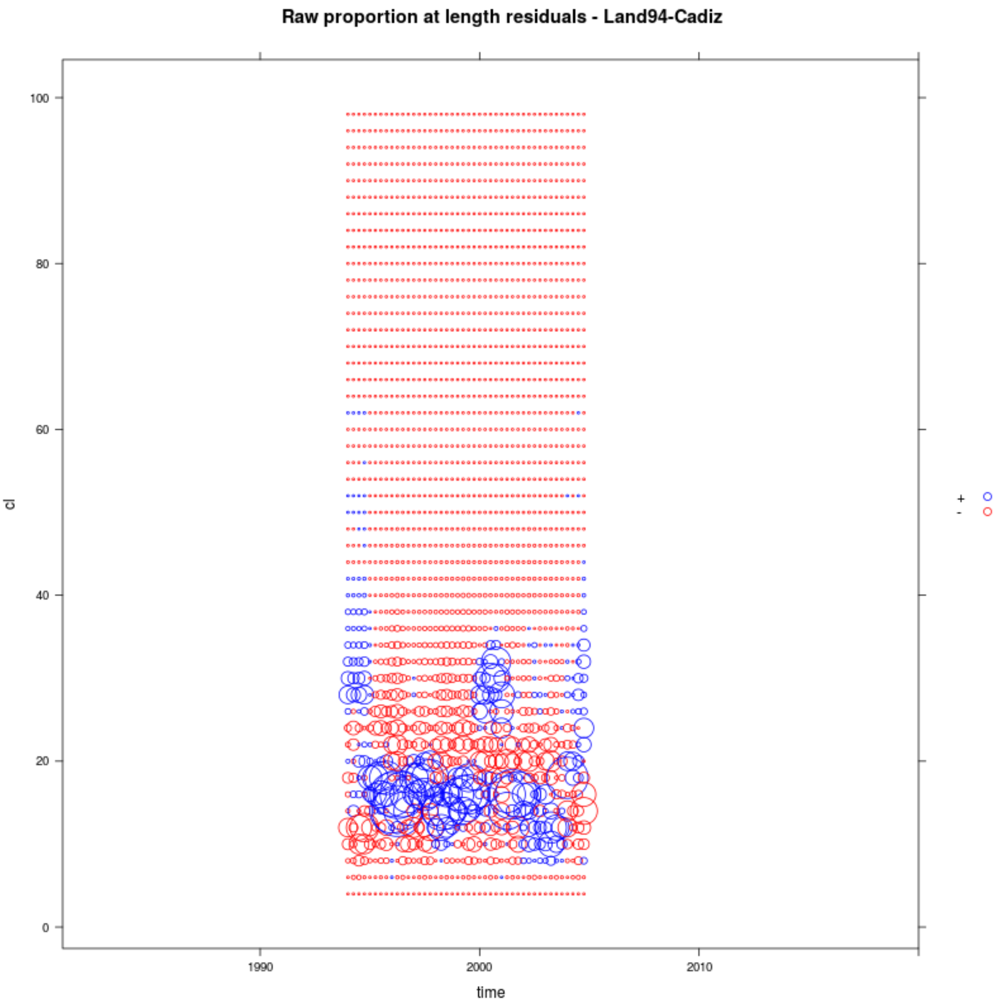


Figure 10.6e. Bubble plot for Cadiz landings length distribution from 1982 to 2004.

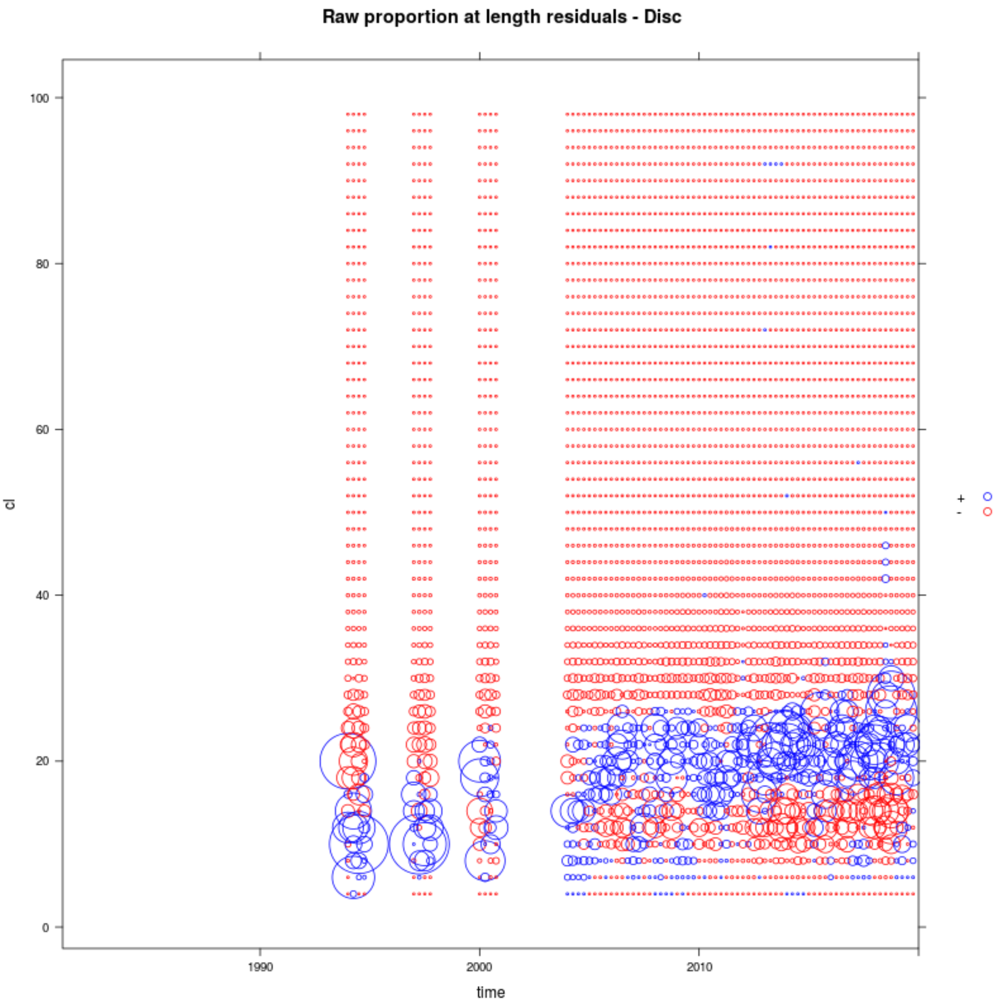


Figure 10.6f. Bubble plot for discards length distribution for years 1993, 1997, 1999, 2004-end.

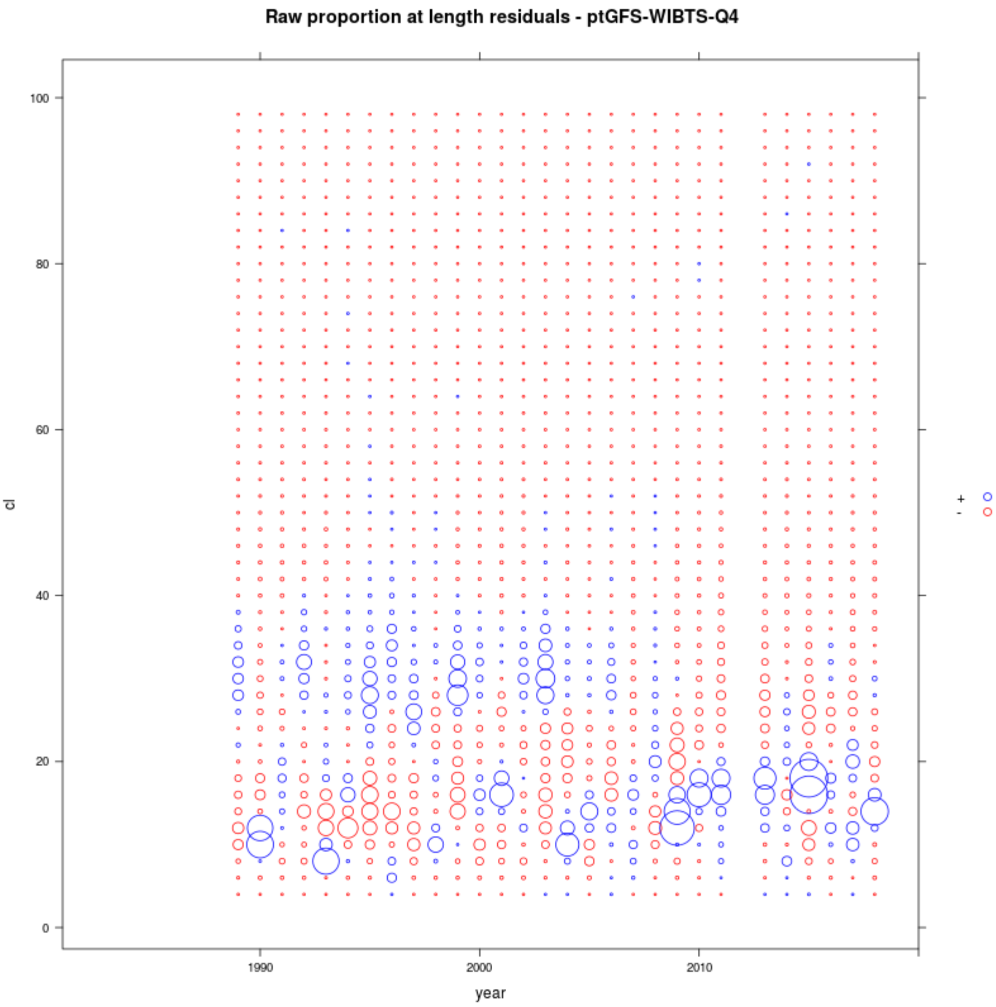


Figure 10.6g. Bubble plot for Portuguese demersal survey (ptGFS-WIBTS-Q4).

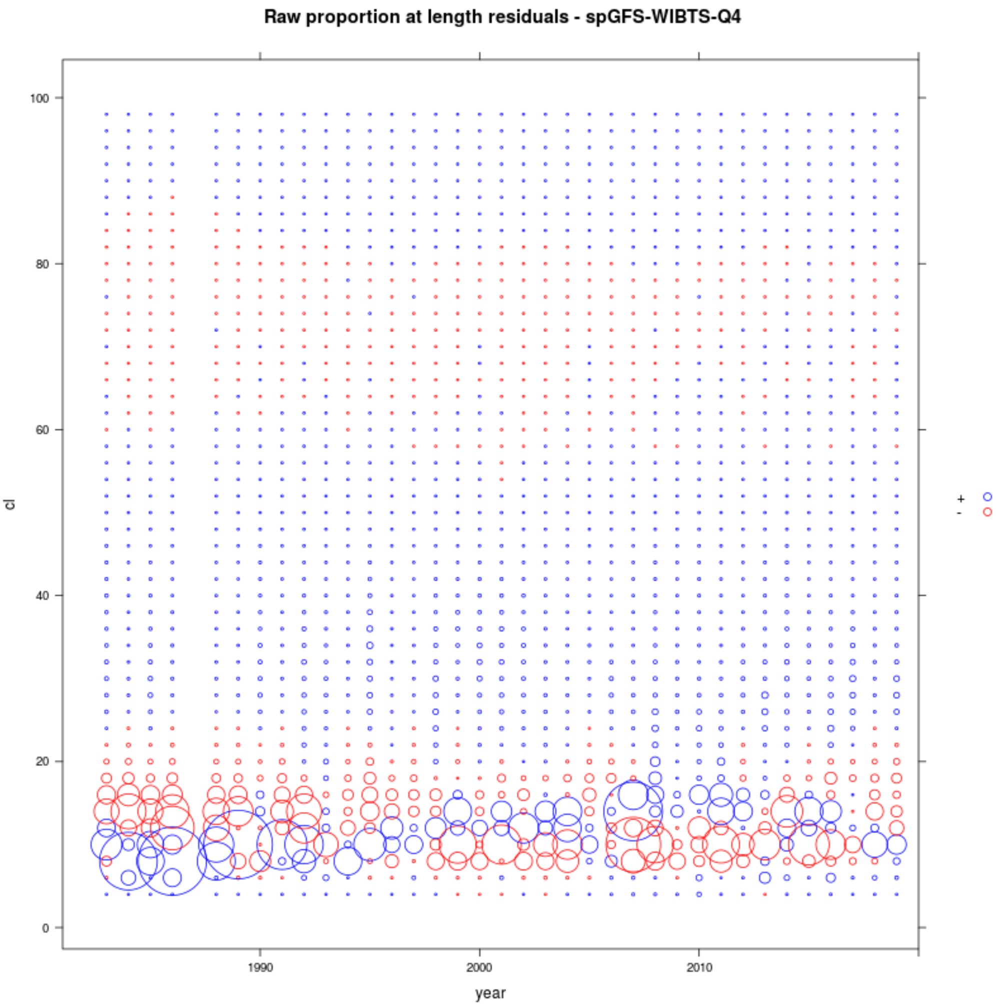


Figure 10.6 h. Bubble plot for North Spain demersal survey (spGFS-WIBTS-Q4).

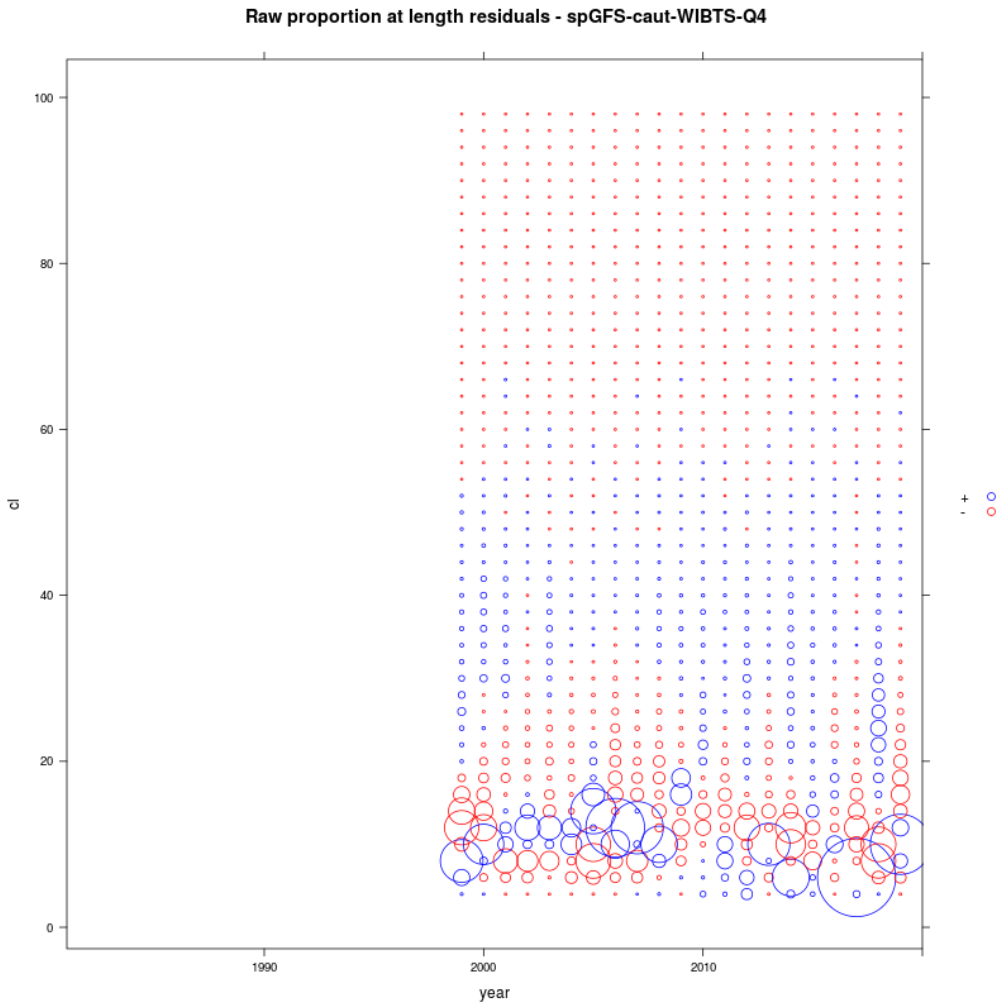


Figure 10.6i. Bubble plot for South Spain (Cadiz) demersal survey (spGFS-caut-WIBTS-Q4).

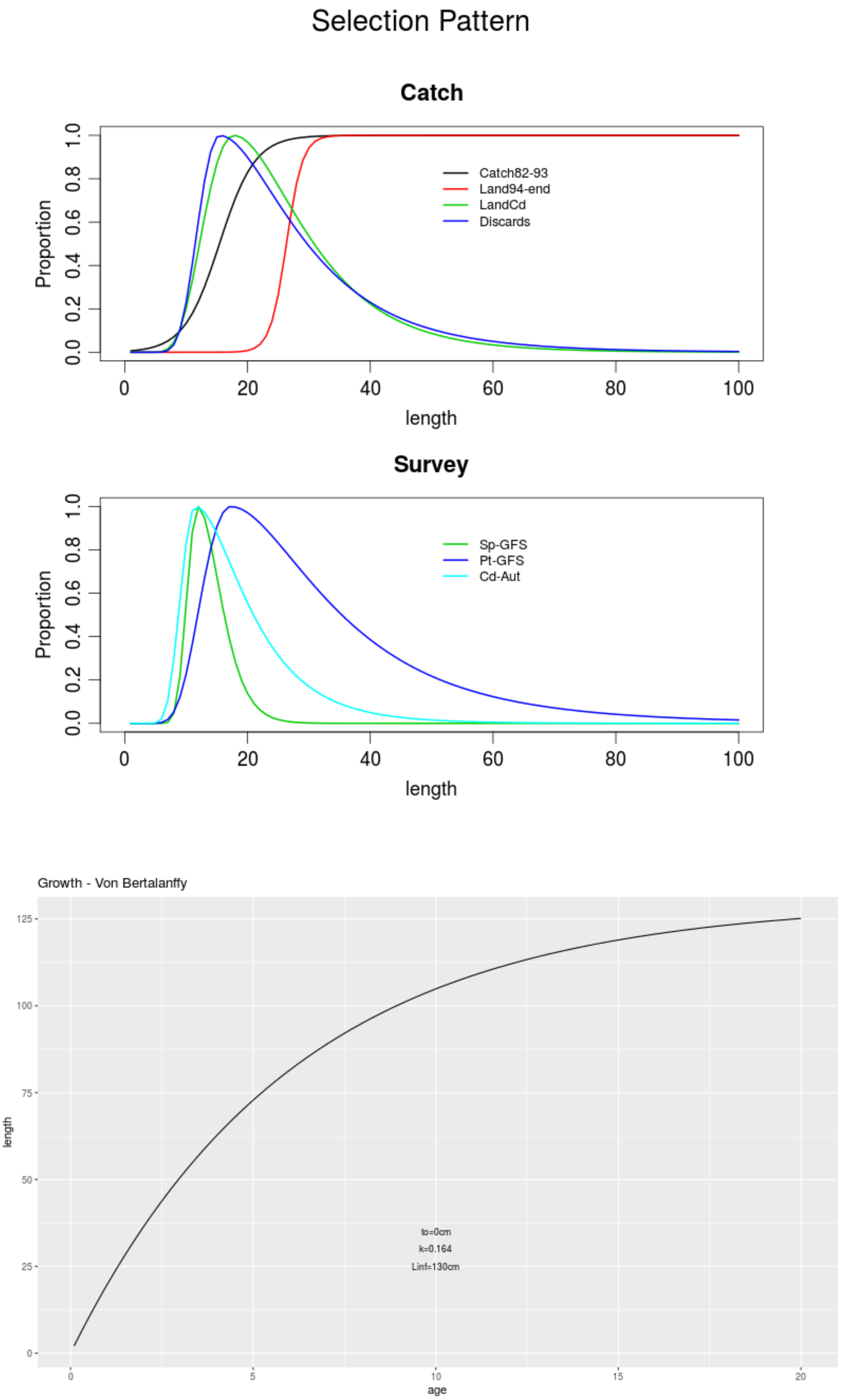


Figure 10.7. Selection pattern (upper panel) and von Bertalanffy growth with K parameter estimated by the model (lower panel).

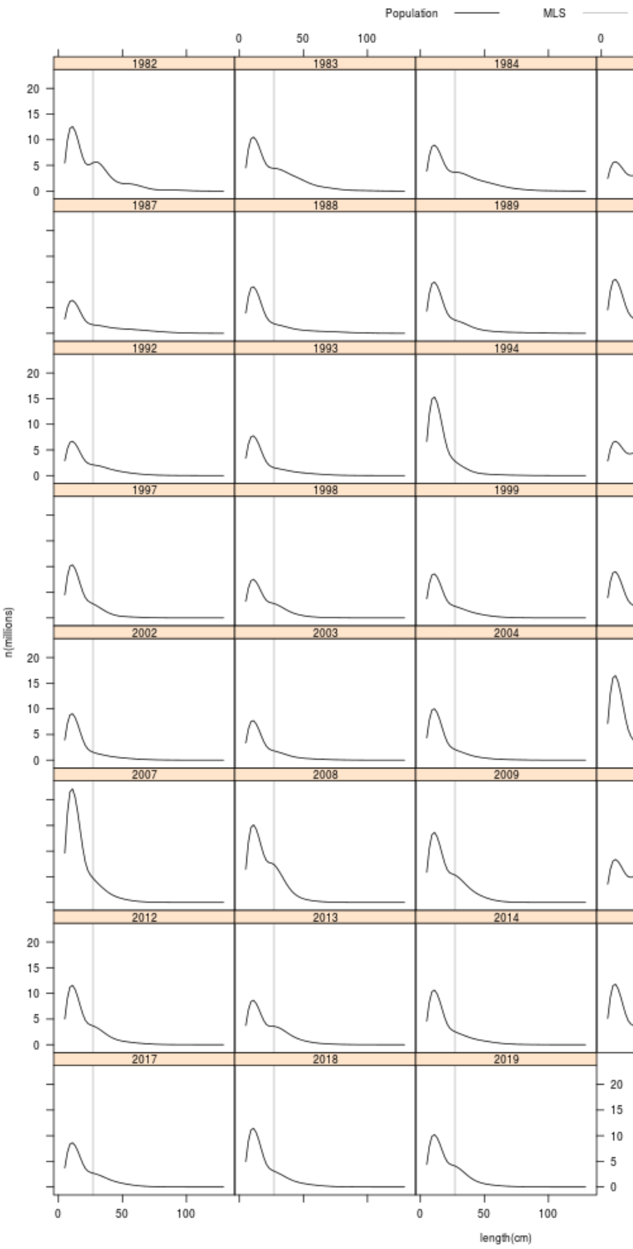


Figure 10.8. Population length distribution at the beginning of the 4th quarter.

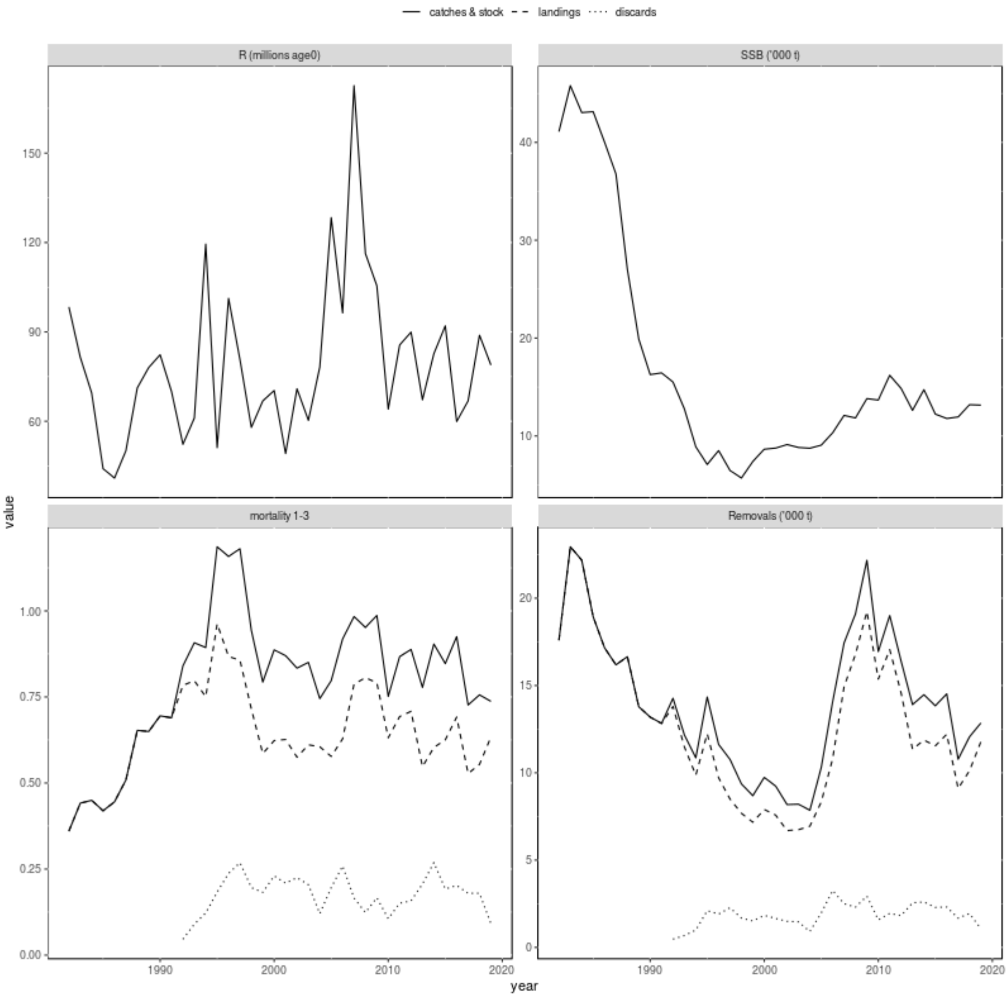


Figure 10.9. Summary plots. SSB and removals (catch, landings and discards). Fishing mortality (F) for ages 1–3.

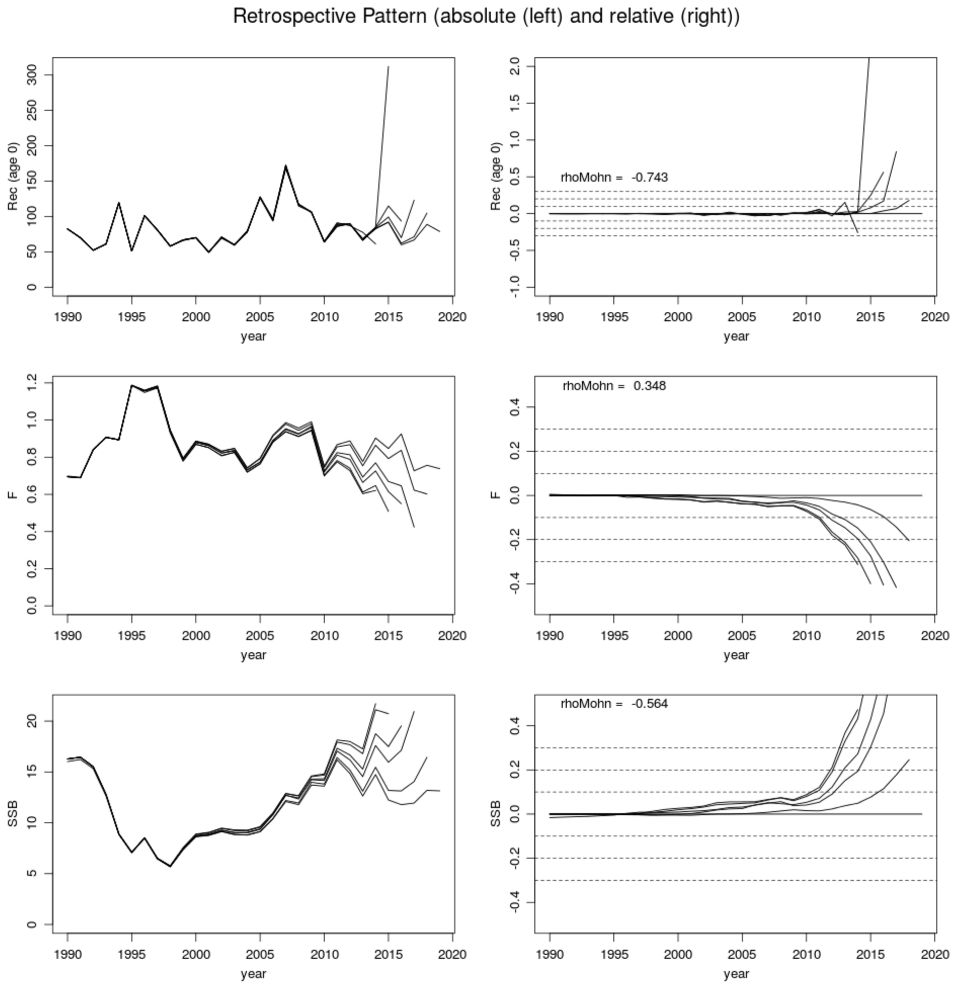


Figure 10.10. Retrospective plots (absolute and relative).

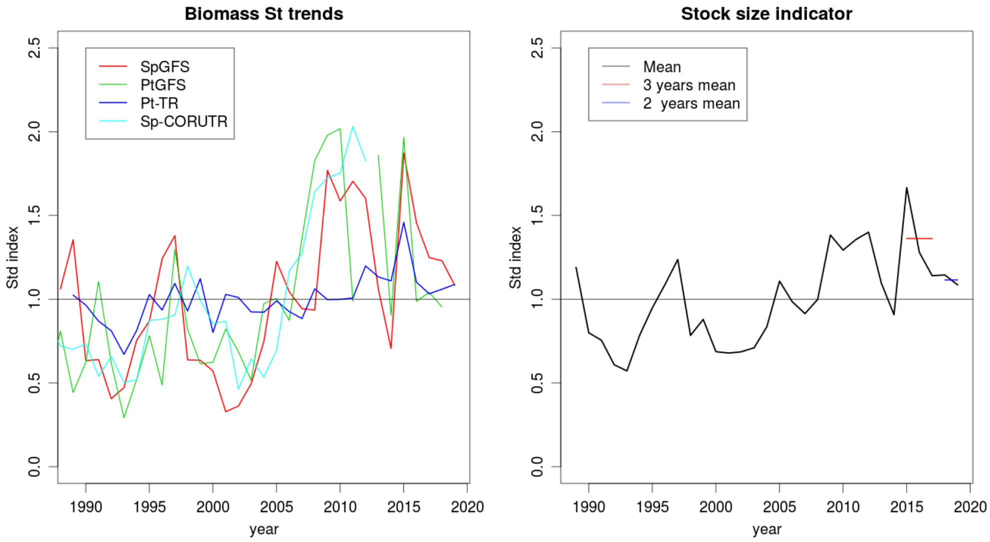


Figure 10.11. Stock size indicator plots. All biomass relative indices (left) and the mean of two indices, the P-TR (PtCPUE) and the SP-NSGFS (SpGFS), in black (right).

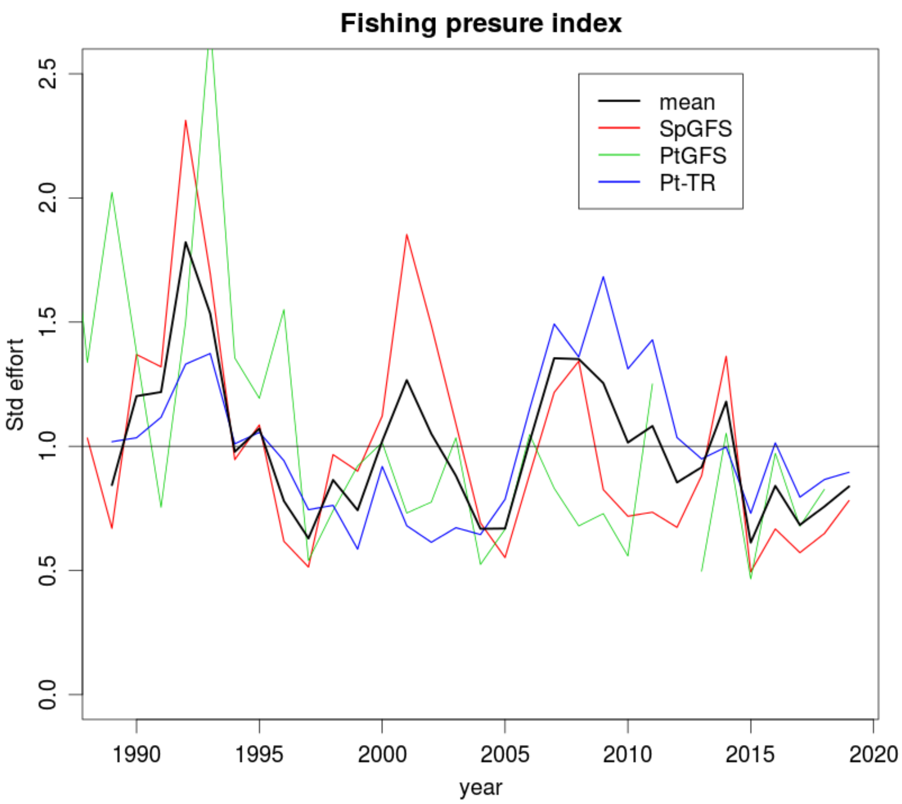


Figure 10.12. Fishing pressure indicators (Catch/Index) for relative (divided by their mean) trends (in colors) and the mean of P-TR (PtCPUE) and SP-NSGFS (SpGFS) (in black).

11 *Nephrops* in Divisions 8a,b - FU 23-24

Type of assessment: update assessment

Main changes from the last assessment during WGBIE in 2019 (ICES, 2019a):

No major change compared to the last year. In 2016, the stock was benchmarked (ICES, 2017a) 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 (ICES, 2012) when the stock was assessed by XSA model (Shepherd, 1999):

→ *Methodology for discard derivation (probabilistic approach replaced the proportional one).*

→ *Scientific time series was provided by an annual survey LANGOLF included in the tuning data but is no more conducted since 2014.*

ICES description: 8a,b

Functional Units: Bay of Biscay North (8a) – FU 23, Bay of Biscay South (8b) – 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 2020

For many years, advice for this stock was provided biennially. 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 the standard assessment method by the 2016 benchmark workshop WKNEP (ICES, 2017a). As consequence of that, the advice became yearly and the stock was upgraded to category 1. The latest advice provided in 2019 recommended "*…when the MSY approach is applied, catches in 2020 should be no more than 6573 tonnes*" corresponding to 3 886 tonnes of landings.

Management applicable for 2019 and 2020

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

2019

Species:	Norway lobster *Nephrops norvegicus*	Zone:	8a, 8b, 8d and 8e (NEP/8ABDE.)
Spain	233	Analytical TAC	
France	3 653		
Union	3 886		
TAC	3 886		

2020

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 2019 was 3 878 t against 3 899 t which was the TAC for years 2013-2016 before the validation of the UWTV survey as standard assessment method. TAC for 2017 was 4 160 t and 3 614 t for 2018 (ICES, 2019). For 2020, the TAC remained almost the same (3 886 t). In 2019, total nominal landings reached 2 154 t, close to the historically lowest level of 2018 (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 had significantly impacted the data used by the WG (see report WGHMM 2007; ICES, 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 replaced the 50 mm mesh size implemented in 1990-91. Technical regulations have also been introduced to reduce bycatch in the *Nephrops* fishery in the Bay of Biscay. In 2002, the European Commission established technical measures for the recovery Northern stock of European hake, under which the minimum codend mesh size (MMS) was raised from 70 to 100 mm in the hake box to reduce the high level of hake discarding by *Nephrops* trawlers in the Bay of Biscay (Commission Regulation (EC) No. 494/2002). 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 cited in paragraph 28 of the preamble of the European Regulation (EC) No. 43/2009, fixing the fishing opportunities for that year: "*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 VIIIa, VIIIb and VIIId.*"

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 8a and 8b 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 2018-2019). 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 landings sales over several days were taken by the producers' organisations at the aim of preventing any productivity excess and quota overshot.

Since the 1st January 2017, the use of a discarding quick chute system on-board has become compulsory. There has been an impact on the survival rate of discards which is currently considered higher (50%; Mérillet *et al.*, 2018) than the historical value of 30% (Charuau *et al.*, 1982). This new status was recently taken into account during the WK*Nephrops* in 2019 (ACOM, 2020) for future assessment and advice of the stock.

11.2 Data

11.2.1 Commercial catches and discards

Total catches, landings and discards, of *Nephrops* in division 8a,b for the period 1960-2019 are given in Table 11.1.

Throughout the mid-'60s, 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 '80s and the mid-'90s. An increase has been noticeable during the early 2000s. Landings remained stable between 2008 and 2009 (3 030 and 2 987 t, respectively) whereas they had decreased compared with previous years (3 176 t in 2007, 3 447 t in 2006 and 3 991 t in 2005). In 2010 and 2011, total landings increased (3 398 and 3 559 t, respectively), but in 2012 and 2013 a strong reduction of the landings occurred (2 520 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) due to the more constraining regulations cited above. In 2018, the historically lowest level of landings was observed (2 125 t) close to the 2019 value (2 154 t).

In 2005, when the Northern hake stock was under recovery plan, the use of dorsal mesh square panels became mandatory for the trawlers targeting *Nephrops* in the Bay of Biscay, as this area is known to be an important nursery for the hake stock. From the 1st April 2008 onwards, all vessels catching more than 50 kg of *Nephrops* per day should use at least one of the following selective devices: (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 (from Districts of South Brittany) have chosen to increase the codend mesh size whereas the ventral squared panel was adopted by a minority of trawlers (multi-purpose vessels mainly from harbours outside Brittany). Its implementation coincided with a peak of hake in weight and in proportion discarded which was followed by a slightly lower value of hake discarded proportion in 2006-2007. Similarly in 2008, *Nephrops* length distribution in discards remained unchanged despite the mandatory use of the above mentioned selective (Nikolic et al., 2015). The decrease in *Nephrops* discarded weight in recent years may be due to the decreasing fishing mortality imposed to the stock since 2006 and consequently resulted in lower catches (ICES, 2012a), rather than due to a change in selectivity.

Males usually predominate in the landings with the sex ratio, defined as number of females divided by total, fluctuating between 0.28 and 0.46 for the overall period 1987-2019 with the historically lowest value in 2017. In 2019, the sex ratio of landings was 0.34. The same predominance, although in a lesser degree, was observed for the removals (sex ratio in the range 0.35-0.49) which show a sex ratio of 0.39 in 2019. Females are less accessible in winter because of their burrowing behaviour during the egg-bearing period.

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 2000s (not routinely sampled) is about 1 543 t whereas discards estimate of the most recent sampled years (2003-2019) reached a higher level (1 933 t). This change in the amount of discards could be due to the restriction of individual quotas, the strength of some recruitments in mid-2000s 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 2019, the minimum level of discards since the European Union Data Collection Framework (DCF; Commission Regulations (EC) Nos. 1639/2001 and 199/2008) routinely plan has been observed (59 million individuals were estimated to have been discarded, corresponding to 634 t) and the discard rate moved downwards (38% against 58% in 2017 and 65% in 2018).

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 a quarterly basis. Since 2003, additional database of landings was also provided by sampling routinely performed on-board 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 on-board 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 presented in Tables 11.2 and 11.3, respectively.

In order to tackle the lack of landings data in 2017 Q1 and Q2, a simulation was performed (Quemar et al., 2018 – WD in ICES, 2018) generating missing sampling units at auction from those sampled on-board 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 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 2019 and the global sampling levels were more satisfactory than previously.

Discards

Discards data from onboard sampling are available for 1987, 1991 and 1998 and from 2003 onwards. 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 (ICES, 2012b) investigated the probabilistic (logistic) approach developed for the WGHMM since 2007, although it was not conclusive (Table 11.4; see Stock Annex).

Since 2003, discards have been estimated from catch sampling programmes onboard *Nephrops* trawlers (681 trips and 1 830 hauls have been sampled over 17 years). In spite of improvements in the agreement between logbook declarations and auction hall sales since mid-2000s, the quality of crossed information fluctuates between years. *e.g.* for years 2007-2019 the percentage of cross-validation item by item between logbooks and sales ranged from 69 to 90% with an improvement in the last period (85% for 2016, 88% in 2017, 90% in 2018, 88% in 2019). 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. Discards sampling from the southern part of the fishery was carried out only once in the past (2005), but the sampling plan is now routinely applied since 2010. The numbers of sampled units by quarter and for the whole year and those of discarded sampled *Nephrops* are given in Table 11.5.

The length distribution of landings, discards and catches from DCF sampling (from 2003 onwards) are presented in Tables 11.6.a-c and in Figure 11.1 (for LFDs from years 1987-2002: see Stock Annex). 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 2019 (same information for years 2014-2018 in Stock Annex).

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 Section 2 of this report and Stock Annex) occurred once a year in May and its sampling design was stratified based on the sedimentary structure. Therefore, as with regards to the investigations carried out during the IBP *Nephrops* in 2012 (ICES, 2012b), the abundance indices were included in the assessment during the WGHMM meetings in 2012 (ICES, 2012c) and 2013 (ICES, 2013) and during the WGBIE in 2014 (ICES, 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 ended in 2013.

UWTV survey (LANGOLF-TV)

A new experimental survey counting UWTV burrows, as is routinely operated for many *Nephrops* stocks in areas 6 and 7, has been conducted since 2014 on a yearly basis. This 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 research 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 anymore 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 2016-2019 allowed to cover the area contained in the outline of the Central Mud Bank not 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*. 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 (ICES, 2017a) 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 in order to accurately limit the actual outline of the stock accordingly to recommendations of the WGNEPS in 2016 (ICES, 2017b). In 2018 and 2019, 184 and 145 validated stations were respectively 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) and (+9%) in 2019 (4,113 billion).

The survey occurred in different seasons within year (September 2014, July 2015, May 2016, 2017 and 2019, end of April 2018) as it is constrained by the schedule time for UWTV Irish equipment and staff.

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 logbook 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 recent years, the lowest fishing effort for the whole period was observed. In 2019, the fishing effort slightly decreased compared to 2018 (-2%). The overall downwards trend in effort can be explained by the reduction 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 14.0 Kg/hour (Figure 11.7), with four peaks (1988, 2001, 2010, 2017). LPUE reached the historically highest level in the middle of the last decade (2015: 19.5 Kg/h; 2016: 19.7 Kg/h; 2017: 21.9 Kg/h), but declined in 2018 (-22% ; 17.0 Kg/h) and in a lesser degree in 2019 (-7%, 15.7 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 ‘90s, 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 (ICES, 2017a) 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 only provided in autumn. Details of this assessment performed in 2019 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 7.3%, 8.4% and 5.0% under survival rate of discards fixed at the historical value of 30%. In 2019, the minimum observed level of discards combined with the revised value of 50% for the survival rate provides a harvest rate of 3.1%, much below the MSY target (7.7%).

The summary from the 2019 assessment is provided below.

Variable	Value	Source	Notes
Abundance in TV assessment	4113.422	ICES (2019)	UWTV 2019 (May)
Mean weight in landings	24.861	ICES (2019)	Average 2016-2018
Mean weight in discards	11.611	ICES (2019)	Average 2016-2018
Discard rate (total)	59.43%	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)	50.69%	ICES (2019)	Average 2016-2018 (proportion by number), only applies in scenarios where discarding is allowed.

11.1 Catch options and prognosis

For 2020, 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 September 2020	ICES (2020)*	UWTV 2020 (initially planned for April/May 2020, the survey will be carried out in late July 2020 due to the COVID-19 disruption)
Mean weight in landings	23.820 g	ICES (2020)	Average 2017-2019
Mean weight in discards	10.990 g	ICES (2020)	Average 2017-2019
Discard rate (total)	53.57%	ICES (2020)	Average 2017-2019 (proportion by number)
Discard survival rate	50%	ICES (2020)	Only applies in scenarios where discarding is allowed.
Dead discard rate (total)	37.38%	ICES (2020)	Average 2017-2019 (proportion by number), only applies in scenarios where discarding is allowed.

*** This Working Group report, to be updated in October.**

11.4 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, 2016a, b). With the availability of UWTV surveys, ICES has now been able to assess this stock as category 1. 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, 2017a) is based on the average realised harvest rates of *Nephrops* 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. As, at the time of this report, WK*Nephrops* 2019 (report not yet available) was not conclusive on the aim of defining new reference points exclusively based on the SCA outputs and scenarios under F0.1 provide irrelevant results, the current reference value of HR=7.7% was kept.

11.5 Comments on the assessment

The French *Nephrops* trawlers onboard sampling programme avoids the use of "derived" data for missing years (13 years on 33). Since 2009, there has been a relevant improvement of the sampling design with many trips 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 survey on the whole Central Mud Bank of the Bay of Biscay as performed in 2016-2019. In addition to an unbiased spatial fishery information such as VMS, these results demonstrate the accurate knowledge on the stock area and its heterogeneous sedimentary structure.

11.6 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 supported 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 2016-2019 which was considered by the industry as a temporary status and not as a signal of a declining trend. Prior to the WG of the last year, the industry moderated conclusions about such a decrease and pointed out many additional regulations aiming to control productivity of *Nephrops* trawlers and to avoid quotas overshot. It was argued that this situation have already been 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 agree that it should be the consequence of a gradual modification of the sedimentary nature of this area from typical mud to more mixed one.

The industry stressed a point from a recent study (Mérillet *et al.*, 2018) suggesting a higher discard survival rate of 50% instead of the historical 30% used for the assessment of this stock. This upwards estimate was integrated as basis for future assessments and advice for the stock. The industry had concerns related to the actual realization of the UWTV survey in 2020 as the schedule plan was seriously impacted by the COVID-19 disruption. The survey is currently planned to be undertaken in the mid-summer 2020 owing to an efficient cooperation between Irish and French scientific teams and the results should be available for the autumn advice.

11.7 Management considerations

Some positive signals in the mid-2010s (increase of LPUEs, landings, removals) and relative stability of burrow indices from UWTV surveys 2014-2016 suggested a stock status within safety limits. However, the steep decrease of the UWTV indices in 2017 and a slighter increase in 2018 and 2019 values, combined with the historically lowest landings level in 2018 and 2019, suggest considering cautiously the current situation which will be examined after including the 2020 UWTV survey results.

11.8 References

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Table 11.1. ***Nephrops*** **in FUs 23-24 Bay of Biscay (8a,b) – Estimates of catches (t) by FU for 1960 – 2019.**

	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	*1571*	*	*3696*
2019	na	2065	89	na	2154	634	*	2789

(1) WG estimates (2) landings from VIIIa and VIIIb aggregated until 1974 (3) outside FU 23-24

Italic font: revised value between WGBIE 2019 and 2020 (from 1627 t to 1571 t)

Table 11.2. *Nephrops* in FUs 23-24 Bay of Biscay (8a,b). Quarterly and yearly numbers of units for the landings sampling program.

Year	Q1			Q2			Q3			Q4		
	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
2019	86	18	104	92	46	138	64	29	93	80	17	97
Total	505	152	657	589	373	962	555	362	917	604	117	721

Table 11.3. *Nephrops* in FUs 23-24 Bay of Biscay (8a,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	470	3461
2019	3669	635	4304	3770	1554	5324	2632	819	3451	3257	566	3823
Total	21831	5611	27442	26533	14833	41366	24578	12646	37224	26025	3931	29957

Table 11.4. *Nephrops* in FUs 23-24 Bay of Biscay (8a,b) – Derivation and estimation 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 (VIIIa,b). Quarterly and yearly discards from onboard sampling program.

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	9	29	8	3058	215
	total	70	186	39	16752	2572
2019	1	10	24	8	3366	367
	2	24	58	14	5610	1076
	3	16	42	9	4381	360
	4	8	20	5	2791	234
	total	58	144	36	16148	2037

Table 11.6.a Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) landings length distributions in 2003-2019

Landings CL mm/Y	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10																	
11																	
12																	
13																	
14																	
15					0												
16																	
17	20	7															
18	14		25	5	4	12								0	6		
19		14	27						1		5				18		
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	15
22	661	899	771	131	18	208	288	252	11	235	682	180	575	532	368	90	153
23	1614	2194	2588	227	48	322	473	386	111	334	1002	764	1121	772	1155	185	331
24	3966	5664	6511	822	188	721	1929	1238	515	1399	3162	1836	2523	1341	1787	410	1166
25	8164	10930	13678	2844	1201	2742	3670	3940	1803	3843	7873	4419	3478	3842	3845	1823	4325
26	13297	13998	17811	6376	5684	6319	8258	8499	4773	7875	13242	7910	6651	7285	9264	4362	8273
27	17614	16094	22006	12010	9439	10891	12759	14173	7520	11079	14926	12869	9702	12566	14413	6905	11811
28	18572	15350	21879	14647	13248	12640	15732	15390	8991	11920	13260	13788	14431	16617	14546	7753	12245
29	16843	14808	18027	14591	12516	12890	13524	15340	9602	11120	13397	14560	13726	18269	17209	9186	11409
30	17264	14143	15570	13690	12219	10726	13271	15736	8821	9636	10296	12662	13690	16596	16695	8812	10076
31	13345	12353	12634	11814	10698	9772	10859	12749	8253	8393	9137	11051	12456	16820	12979	8307	7377
32	11276	10322	9907	9694	9274	8845	9310	11366	6954	7414	7116	10354	12021	13096	12950	6417	6352
33	8253	8020	7800	8421	7859	7436	7086	8851	6175	6069	5558	6509	9882	12519	7752	7079	5178
34	6195	6298	6537	7112	6539	6425	5985	7140	5467	4505	4123	6657	7881	8416	7638	4991	4882
35	4653	4673	5100	5135	6529	5366	4568	5852	4541	3507	2783	4961	6122	6809	5052	3676	4423
36	3818	3308	3369	4104	4735	3867	3697	3626	4260	2649	1978	3264	5219	6474	4829	3537	2292
37	3075	2875	2597	3196	3839	3121	2565	3024	3648	1976	1472	2682	4511	4785	2620	2263	1749
38	2660	2098	2380	2662	2639	2398	1871	2247	3911	1563	998	1783	3311	3342	2005	1890	1189
39	2174	1683	1650	1956	2245	2043	1491	1630	3472	1314	936	1844	2726	2850	2176	1775	946
40	1936	1555	1628	1599	1711	1633	1190	1280	3296	1103	518	843	2676	1976	1294	1232	942
41	1423	1188	1154	1171	1227	1190	878	966	2740	878	438	669	1635	1394	1020	652	530
42	1403	889	953	990	1111	1015	742	742	2497	635	351	412	1284	1185	779	329	329
43	1054	774	842	741	710	805	540	560	2157	558	320	343	883	749	585	388	330
44	810	707	640	633	746	706	473	509	1762	536	249	234	637	658	471	319	129
45	808	613	605	595	518	536	396	442	1177	478	177	206	467	708	442	296	107
46	535	485	415	479	373	405	307	305	1024	441	181	159	236	368	271	153	79
47	456	388	353	440	311	361	262	290	858	378	88	151	216	332	261	86	80
48	339	313	339	382	257	294	245	237	656	381	98	87	149	230	143	80	46
49	206	318	288	319	237	262	196	204	557	212	74	72	200	195	100	51	30
50	253	306	276	287	190	228	156	160	501	160	46	63	108	123	126	68	36
51	170	214	176	246	163	201	115	135	383	132	37	58	68	83	53	32	27
52	150	152	184	201	138	116	110	120	296	128	32	24	46	88	96	36	24
53	120	111	142	137	140	121	98	97	198	96	24	42	33	56	37	21	13
54	80	90	104	156	115	95	63	95	271	93	17	18	29	59	49	18	11
55	57	47	109	137	79	73	75	79	152	58	15	11	26	23	38	10	5
56	23	86	69	117	60	67	54	75	132	46	8	5	15	21	24	8	2
57	47	49	58	134	70	41	31	67	98	48	22	10	18	7	12	6	1
58	22	27	43	134	45	40	48	47	105	52	3	8	5	7	12	11	3
59	10	32	41	85	33	19	23	48	79	33	12	3	3	8	6	1	2
60	8	10	19	115	33	23	14	42	48	22	3	2	3	5	7	3	0
61	5	5	28	40	23	7	8	30	39	15	8	1	0	3	2	1	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	0
64		8	8	18	10	6	3	16	12	8	0	0	1	1	2	72	
65		1	14	11	9	1	3	9	11	7	0		1	1	3	0	
66	1	1	6	10	1	0	2	3	11	3	0			1	1	0	
67		1	5	8	1		2	3	6	1		0			0	0	
68		2	4	7	3	0		4	7		0			0	0	0	
69	1		1	6	2		1	1	2	2							
70			2	4				1	2	0			0	1	1	0	
71	1		1	5		0		1	1					0	0		
72			1	5										0	1	0	
73				2	1										1		
74				4					1			1		0	1		
75			1	4						1		0	0	2	5	0	0
Total	**163771**	**154405**	**179758**	**128777**	**117273**	**115274**	**123504**	**138120**	**108011**	**101424**	**114853**	**121594**	**138920**	**161371**	**143502**	**83463**	**96919**
Weights	**3886**	**3571**	**3991**	**3447**	**3176**	**3030**	**2987**	**3398**	**3559**	**2520**	**2380**	**2807**	**3569**	**4091**	**3412**	**2125**	**2154**

Table 11.6.b Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) discards length distributions in 2003-2019.

Total Discards

CL mm/Y	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10	28				22		82								26		
11			94		171	38	135	2								23	8
12	70	363	413	70	202	98	79		237				75	76	54		8
13	294	1722	1085	234	122	235	177	97	596	532		28	184	76	111	47	110
14	636	3152	3190	1138	900	389	291	83	834	665	229	101	606	327	384	31	428
15	1198	5548	7287	3102	1288	189	1157	155	941	1425	870	281	1476	578	1228	533	583
16	3386	6784	13528	7810	2959	1027	2315	822	1230	4544	1313	1300	2354	569	1668	1029	606
17	5927	8836	15094	11655	3636	1832	3059	1333	2430	4737	4179	1647	3242	2717	3697	3499	741
18	8078	10161	19795	16139	4590	2626	4843	2309	3630	8066	3372	2808	5073	5207	4175	6531	1456
19	11506	17361	19522	25891	5244	6473	6485	3532	4546	8024	8730	3822	8084	9685	8517	7534	1951
20	12142	19250	22265	39742	8735	11444	12766	5692	7227	10125	9682	6457	9246	9420	13805	9555	3042
21	18597	25898	32409	54220	11585	15630	16772	7699	10393	12145	15281	9195	10952	12022	16601	13562	4330
22	21416	25210	35523	69870	17930	24730	18701	11689	15161	14034	20618	11284	11324	15704	16245	17648	6379
23	28429	26756	40041	70094	24086	27560	21693	13672	13837	12904	26287	15130	14109	18312	20400	20617	6817
24	26501	21343	36279	55408	30615	29638	24105	16963	15551	14889	21750	14000	16820	19435	21961	16825	8875
25	23211	20085	30222	52660	32917	28007	20736	14670	16545	10873	17823	18051	18746	22159	21886	18966	8383
26	17357	12006	19003	38812	27376	23127	14205	11852	10047	7747	10188	11947	15874	24994	21474	12621	6065
27	9680	6436	8498	20124	20567	10129	9188	8558	8127	4304	5439	8155	11931	17139	13660	8548	3506
28	6187	3487	4603	10263	10365	5893	5927	5986	3201	919	2824	5026	8056	11441	11298	5719	2625
29	2537	2115	1201	4188	4464	3225	3163	3360	2086	588	2146	2316	5771	10887	5361	3151	913
30	1605	1901	1600	2578	2868	1923	3261	1876	2011	680	945	1672	4714	5283	5464	1457	885
31	1326	1115	1417	1109	1316	925	1824	1274	1246	125	922	1263	2033	4343	3766	1135	517
32	574	735	526	592	737	454	839	716	492	200	684	1482	1745	2458	2470	513	181
33	313	503	296	544	484	421	671	350	265	13	365	384	812	3193	814	1014	183
34	261	385	553	411	537	1025	830	274	272	145	494	433	1108	1071	1132	744	146
35	176	424	260	230	265	206	332	242	174	24	233	125	147	874	1540	296	163
36	113	108	46	73	336	78	197	55	59	3	260	391	243	774	503	140	74
37	83	74	246	25	299	153	188	162	149	146	130	45	298	573	681	11	8
38	93	31	116	99	40	93	269	16	97	68	81	71	246	576	320	18	8
39	15	139	147		3	369	55	33	24		33	230	65	598	409	60	35
40	37	73	37	169	47		66	38	25	3		122	175	72	235	39	64
41	34	60	20		40		8	4				7	46	148	126	40	
42	4	12	31		20	53		4	157				508	186	139		8
43	14	13			11		38		4	4		152	199		202	20	
44		13					14	6					12		164		
45	13			36					5				56		38		
46								6					44	77			
47									6			7			23		
48							8				36						
49													23				
50					11												
51																	
52																	
53																	
54																	
55															23		
56																	
57																	
58						39											
59																	
60																	
61																	
62																	
63																	
64																	
65																	
66																	
67																	
68																	
69																	
70																	
71																	3
72																	
73																	
74																	
75																	
Total	**201841**	**222102**	**315346**	**487288**	**214788**	**198031**	**174480**	**113530**	**121603**	**117935**	**154914**	**117930**	**156400**	**200973**	**200600**	**151926**	**59102**
Weights	**1977**	**1932**	**2698**	**4544**	**2411**	**2123**	**1833**	**1275**	**1263**	**1012**	**1521**	**1326**	**1822**	**2531**	**2387**	**1571**	**634**

Table 11.6.c Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) catches length distributions in 2003-2019.

Total catches																	
CL mm/Y	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
10	28				22		82								26		
11			94		171	38	135	2								23	8
12	70	363	413	70	202	98	79		237				75	76	54		8
13	294	1722	1085	234	122	235	177	97	596	532		28	184	76	111	47	110
14	636	3152	3190	1138	900	389	291	83	834	665	229	101	606	327	384	31	428
15	1198	5548	7287	3102	1289	189	1157	155	941	1425	870	281	1476	578	1228	533	583
16	3386	6784	13528	7810	2959	1027	2315	822	1230	4544	1313	1300	2354	569	1668	1029	606
17	5947	8843	15094	11655	3636	1832	3059	1333	2430	4737	4179	1647	3242	2717	3697	3499	741
18	8092	10161	19820	16144	4593	2638	4843	2309	3630	8066	3372	2808	5073	5207	4181	6531	1456
19	11506	17376	19549	25891	5244	6473	6485	3532	4546	8024	8735	3822	8084	9685	8535	7534	1951
20	12229	19297	22348	39747	8738	11521	12803	5706	7249	10160	9713	6458	9262	9441	13829	9573	3042
21	18877	26146	32679	54289	11598	15820	16845	7775	10398	12170	15433	9269	11082	12160	16921	13668	4346
22	22077	26109	36293	70001	17948	24938	18989	11941	15171	14269	21300	11464	11899	16237	16613	17738	6531
23	30042	28950	42629	70322	24134	27882	22167	14058	13948	13238	27289	15894	15231	19084	21554	20802	7148
24	30467	27006	42790	56230	30803	30359	26034	18202	16065	16288	24913	15836	19343	20775	23747	17236	10041
25	31376	31015	43900	55504	34119	30750	24406	18610	18348	14716	25696	22470	22223	26001	25731	20789	12708
26	30654	26004	36814	45189	33060	29446	22463	20352	14820	15622	23430	19857	22526	32279	30738	16983	14338
27	27294	22530	30504	32134	30006	21020	21948	22730	15647	15383	20365	21024	21633	29705	28073	15453	15317
28	24759	18837	26482	24909	23613	18533	21659	21375	12191	12838	16084	18814	22487	28058	25844	13471	14869
29	19381	16923	19228	18779	16980	16115	16687	18700	11687	11708	15543	16876	19498	29156	22570	12337	12322
30	18868	16044	17170	16268	15087	12649	16531	17612	10832	10315	11241	14334	18403	21879	22159	10269	10961
31	14672	13469	14051	12923	12014	10697	12682	14024	9500	8518	10059	12314	14489	21163	16745	9442	7893
32	11849	11057	10433	10286	10011	9299	10150	12082	7447	7614	7801	11836	13766	15554	15419	6930	6533
33	8566	8523	8095	8965	8343	7857	7757	9201	6440	6082	5923	6892	10695	15712	8566	8093	5362
34	6456	6684	7090	7524	7076	7449	6815	7414	5739	4649	4617	7091	8990	9487	8770	5735	5028
35	4829	5097	5361	5366	6793	5573	4900	6094	4715	3531	3016	5087	6270	7683	6592	3972	4586
36	3931	3416	3415	4177	5071	3945	3894	3681	4319	2652	2237	3654	5462	7247	5332	3677	2366
37	3158	2949	2844	3221	4138	3273	2753	3186	3797	2122	1602	2727	4809	5358	3302	2274	1758
38	2752	2129	2496	2760	2679	2491	2139	2263	4007	1632	1079	1854	3556	3918	2325	1908	1197
39	2189	1822	1797	1956	2247	2412	1546	1662	3496	1314	968	2075	2791	3448	2585	1835	981
40	1973	1628	1665	1768	1758	1633	1257	1318	3321	1107	518	965	2851	2048	1529	1271	1006
41	1457	1248	1174	1171	1267	1190	886	971	2740	878	438	676	1681	1542	1146	691	530
42	1407	901	984	990	1130	1069	742	746	2654	635	351	412	1792	1370	918	329	337
43	1068	787	842	741	722	805	578	560	2161	563	320	495	1082	749	787	407	330
44	810	719	640	633	746	706	487	515	1762	536	249	234	649	658	636	319	129
45	821	613	605	631	518	536	396	442	1182	478	177	206	523	708	480	296	107
46	535	485	415	479	373	405	307	312	1024	441	181	159	280	445	271	153	79
47	456	388	353	440	311	361	262	290	865	378	88	158	216	332	284	86	80
48	339	313	339	382	257	294	254	237	656	381	134	87	149	230	143	80	46
49	206	318	288	319	237	262	196	204	557	212	74	72	223	195	100	51	30
50	253	306	276	287	201	228	156	160	501	160	46	63	108	123	126	68	36
51	170	214	176	246	163	201	115	135	383	132	37	58	68	83	53	32	27
52	150	152	184	201	138	116	110	120	296	128	32	24	46	88	96	36	24
53	120	111	142	137	140	121	98	97	198	96	24	42	33	56	37	21	13
54	80	90	104	156	115	95	63	95	271	93	17	18	29	59	49	18	11
55	57	47	109	137	79	73	75	79	152	58	15	11	26	23	61	10	5
56	23	86	69	117	60	67	54	75	132	46	8	5	15	21	24	8	2
57	47	49	58	134	70	41	31	67	98	48	22	10	18	7	12	6	1
58	22	27	43	134	45	80	48	47	105	52	3	8	5	7	12	11	3
59	10	32	41	85	33	19	23	48	79	33	12	3	3	8	6	1	2
60	8	10	19	115	33	23	14	42	48	22	3	2	3	5	7	3	0
61	5	5	28	40	23	7	8	30	39	15	8	1	0	3	2	1	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	0
64		8	8	18	10	6	3	16	12	8	0	0	1	1	2	72	
65		1	14	11	9	1	3	9	11	7	0		1	1	3	0	
66	1	1	6	10	1	0	2	3	11	3	0			1	1	0	
67		1	5	8	1		2	3	6	1		0			0	0	
68		2	4	7	3	0		4	7		0			0	0	0	
69	1		1	6	2		1	1	2	2							
70			2	4				1	2	0			0	1	1	0	
71	1		1	5		0		1	1					0	0		3
72			1	5										0	1	0	
73				2	1										1		
74				4					1			1		0	1		
75			1	4						1		0	0	2	5	0	0
Total	**365612**	**376507**	**495103**	**616065**	**332060**	**313305**	**297984**	**251649**	**229614**	**219358**	**269767**	**239523**	**295319**	**362344**	**344102**	**235390**	**156021**
Weights	**5863**	**5503**	**6689**	**7990**	**5587**	**5154**	**4820**	**4673**	**4822**	**3532**	**3900**	**4133**	**5391**	**6622**	**5799**	**3696**	**2789**

Table 11.7. Total number of burrows (10^6), densities (nb/m²) and CVs (%) by spatial stratum for the Bay of Biscay. From 2016-2019, rough sea bottom (noted as 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*) were included. Rough numbers of burrows with no correction by cumulative bias factor (equal to 1.24; WKNEP (ICES, 2017a).

	2016 (196 stations)				2017 (124 stations)			
	nb/m²	total terriers	CV (%)	%terriers	nb/m²	total terriers	CV (%)	%terriers
	0.320	**5167.67**	**7.84**		**0.259**	**4181.95**	**9.87**	
CB	0.258	654.41	19.84	12.66%	0.152	384.49	20.10	9.19%
CL	0.237	272.72	20.87	5.28%	0.262	302.03	14.76	7.22%
LI	0.283	1319.12	13.86	25.53%	0.210	978.48	14.75	23.40%
VS	0.839	531.18	17.92	10.28%	1.147	726.44	27.94	17.37%
VV	0.642	1728.09	14.52	33.44%	0.425	1142.76	19.82	27.33%
RO	0.148	662.15	29.61	12.81%	0.144	647.75	34.23	15.49%

	2018 (184 stations)				2019 (145 stations)			
	nb/m²	total terriers	CV (%)	%terriers	nb/m²	total terriers	CV (%)	%terriers
	0.291	**4696.84**	**8.30**		**0.316**	**5100.64**	**8.34**	
CB	0.259	656.93	19.56	13.99%	0.172	436.35	25.39	8.55%
CL	0.517	595.61	23.64	12.68%	0.403	464.82	43.28	9.11%
LI	0.228	1064.10	13.27	22.66%	0.292	1363.72	14.34	26.74%
VS	0.841	532.43	23.30	11.34%	0.586	370.94	21.46	7.27%
VV	0.492	1323.75	17.30	28.18%	0.661	1778.04	12.12	34.86%
RO	0.117	524.02	31.79	11.16%	0.153	686.77	28.17	13.46%

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 (ICES, 2017a).

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 (8a,b). Effort and LPUE values of commercial fleets.

	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
2019	338	216	15.66

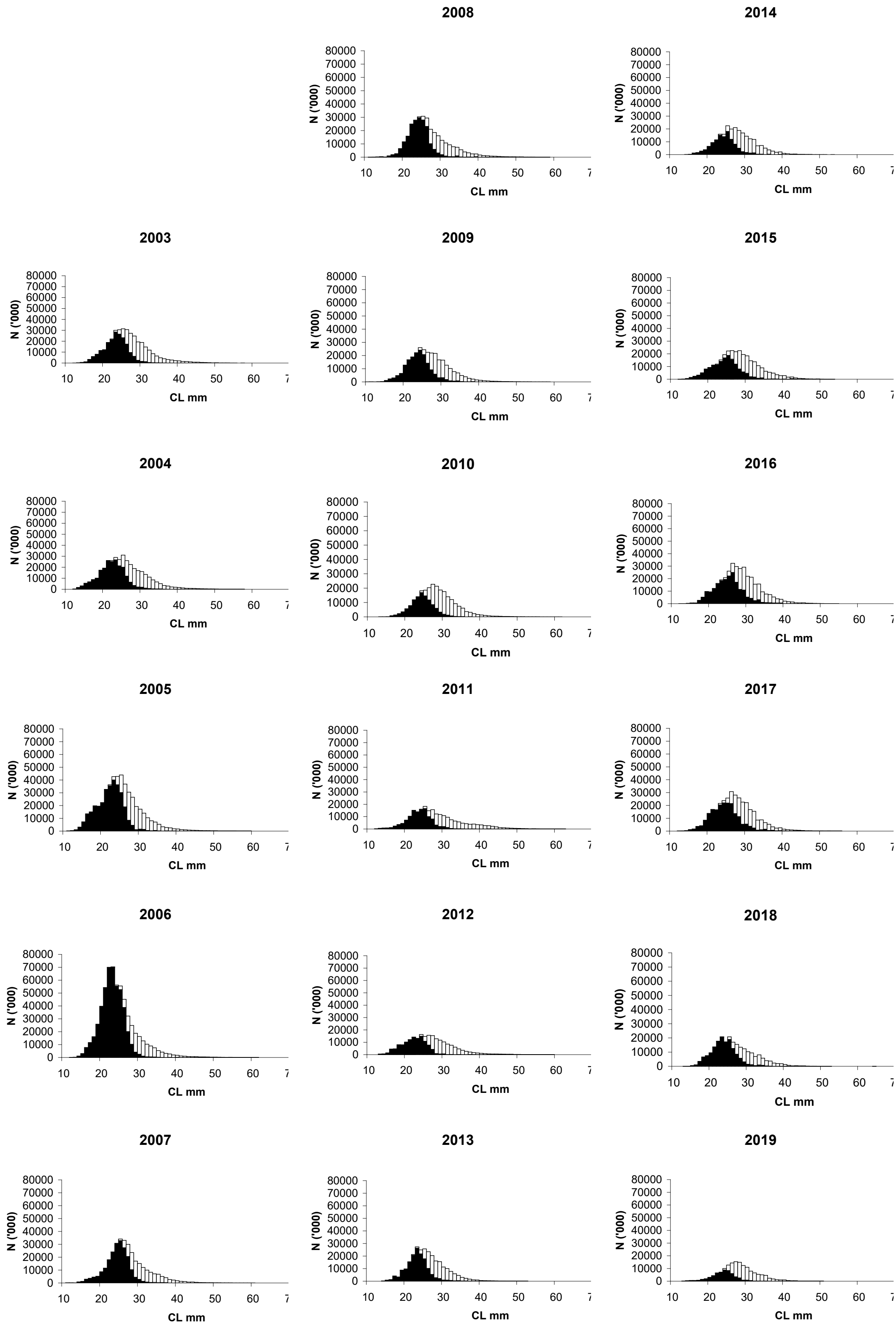


Figure 11.1. ***Nephrops*** **in FU23-24 Bay of Biscay (8a,b) catches (landings in white, discards in dark) from 2003-2019.**

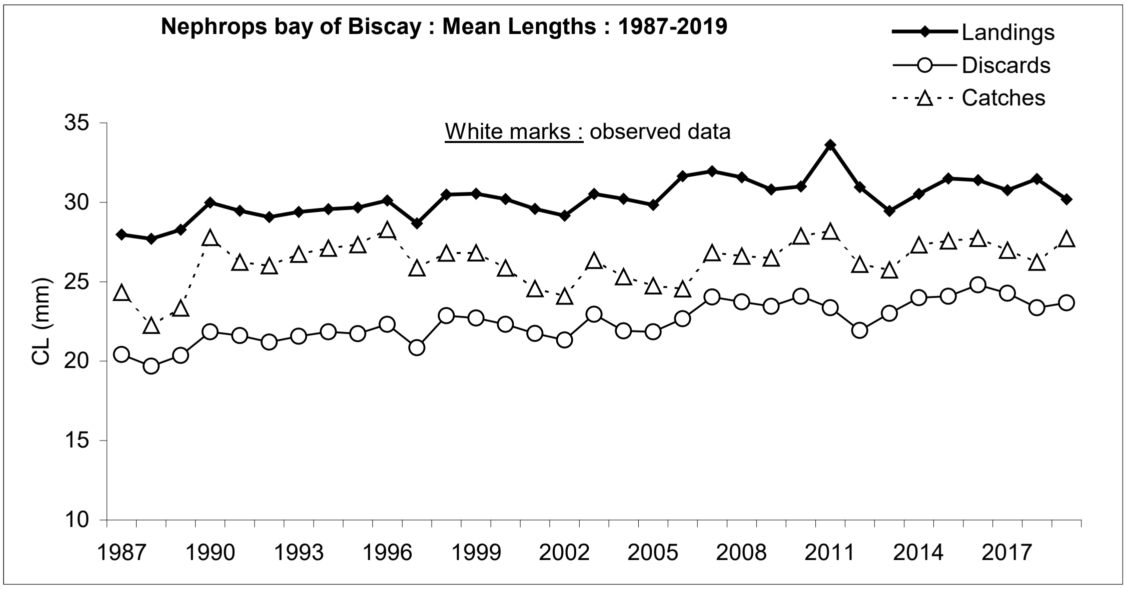
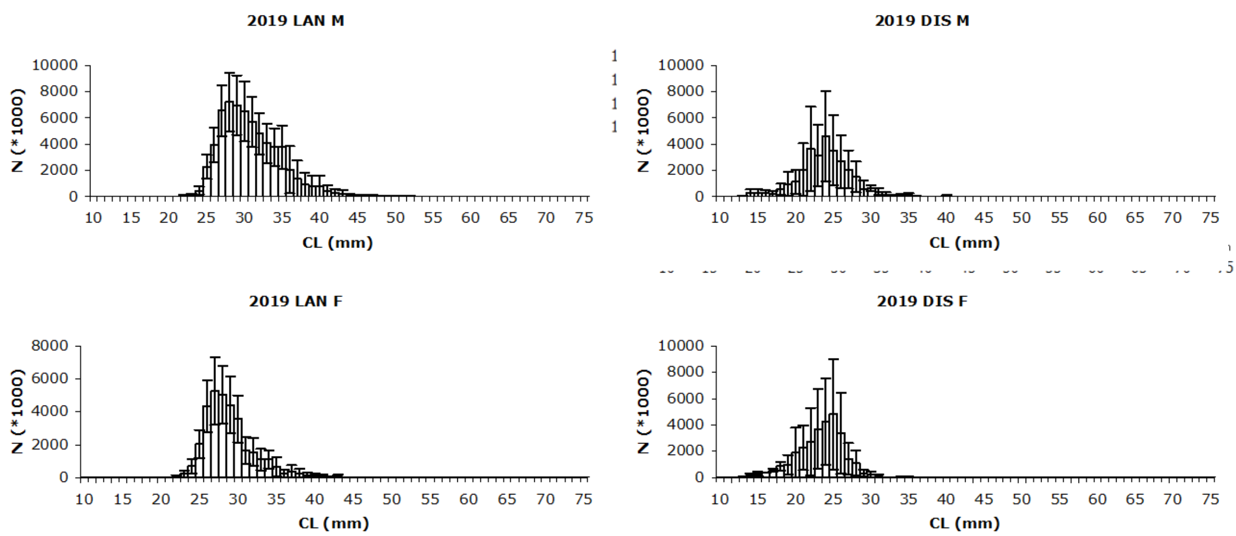


Figure 11.2. ***Nephrops*** **in FUs 23-24, Bay of Biscay (8.a-b). Mean length in landings, discards and catches.**



		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	20.4
2019	LAN	11.3	14.1
	DIS	18.2	19.5

Figure 11.3. ***Nephrops*** **in FU23-24 Bay of Biscay (8a-b). LFDs and confidence intervals for landings and discards in 2019 by sex.**

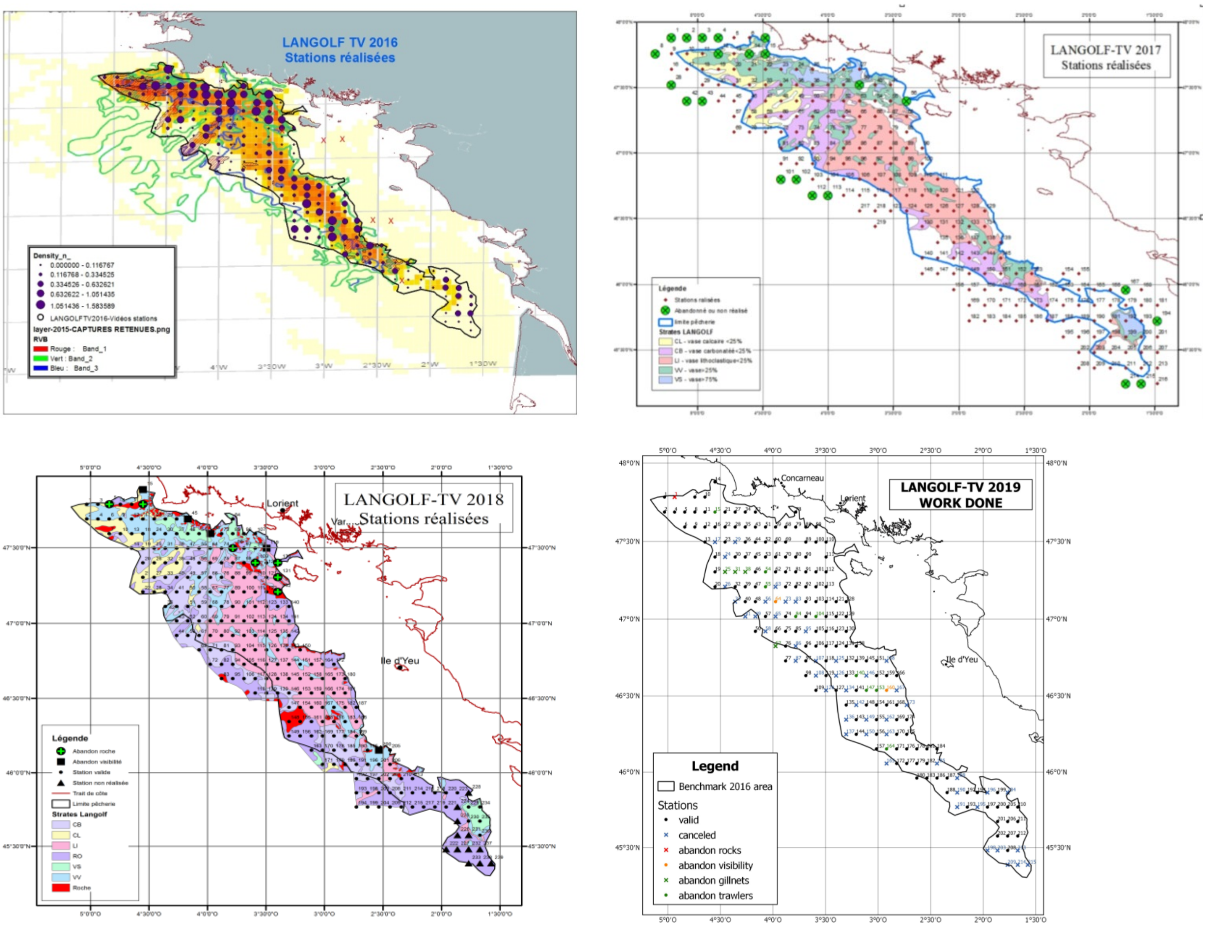
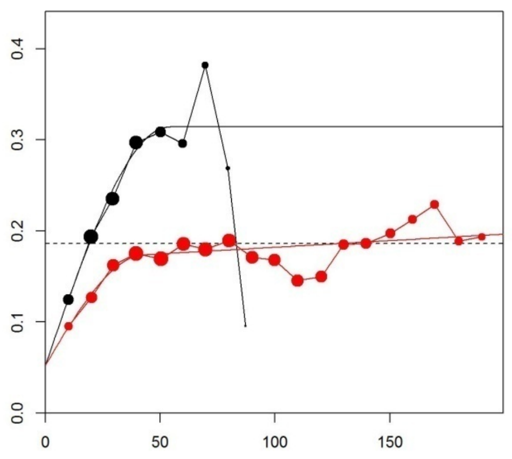


Figure 11.4. Systematic grids for the UWTV surveys 2016-2019 (for 2016 grid is combined with VMS data on rectangles of 3 min*3 min; source: National Fisheries Direction; compilation: SIH Ifremer).



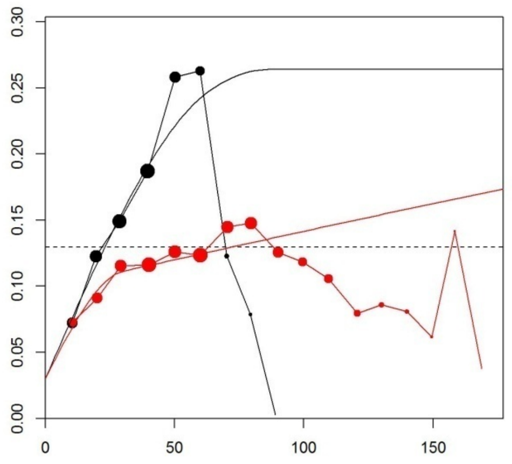


Figure 11.5. Experimental variograms (circles proportional to the number of pairs) and models (continuous curves) for the main anisotropic directions (red: NW->SE, black: SW->NE).

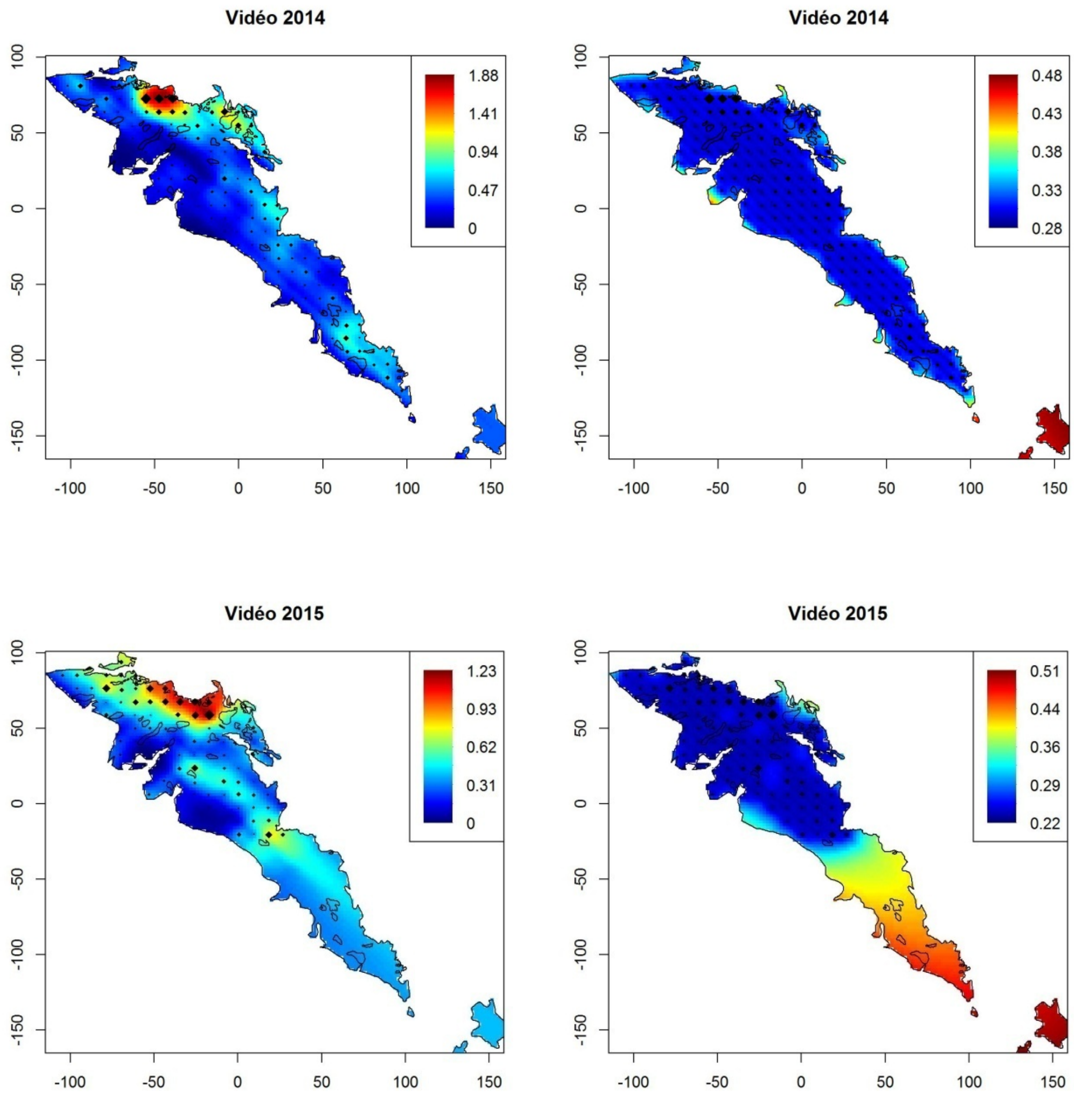


Figure 11.6. Estimation of the burrows densities nb/m² using ordinary kriging (left column) error of kriging (right column) in 2014 and 2015.

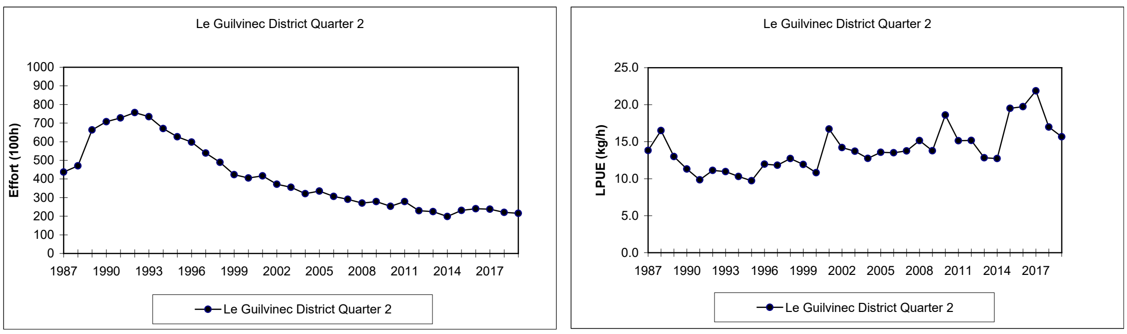


Figure 11.7. *Nephrops* in FUs 23-24 Bay of Biscay (8a,b). Effort and LPUE values for standardised commercial fleets.

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 contributes with 63% to the Spanish *Nephrops* landings from 8c, FU 31 with 25% and the other rectangles of 8c with the remaining 12% of landings (logbooks 2003-2016) (Figure 12.1).

12.1 FU 25 (North Galicia) *Nephrops*

12.1.1 General

Up to this date, the status of the FU 25 *Nephrops* stock is considered undesirable (ICES, 2016a) with extremely low biomass and zero catch advice was issued (ICES, 2017a).

12.1.2 Ecosystem aspects

See Stock Annex.

12.1.2.1 Fishery description

Nephrops is caught by the Spanish OTB_DEF_≥55, which is described as "Northern trawl" fleet in the section 2.1.2 of this report. See also Stock Annex.

12.1.2.2 Summary of ICES Advice for 2020 and management applicable to 2019 and 2020

ICES advice for 2020

The advice for this *Nephrops* stock is triennial and valid for 2020, 2021 and 2022.

ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2020, 2021 and 2022.

To protect the stock in these functional units, ICES advises that management should be implemented at the functional unit level.

Management applicable to 2019 and 2020

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, when the recovery plan was repealed (Regulation EU 2019/472). This plan was based on precautionary reference points for hake in 8c and 9a which are no longer appropriate.

A new Spanish regulation in 2011 established an Individual Transferable Quota system (ITQs) including *Nephrops* (ARM/3158/2011, BOE, 2011).

In 2016, a zero TAC was set for *Nephrops* in ICES Division 8c for 2017, 2018 and 2019. In 2019, this measure was reapplied for the years 2020, 2021 and 2022.

FU 25 *Nephrops* special quotas of 4.3 t in 2017, 2.0 t in 2018 and 2.0 t in 2019 were set in order to conduct an observers' programme (Sentinel fishery), supervised by the Spanish Oceanographic Institute (IEO) for obtaining a *Nephrops* abundance index.

12.1.3 Data

12.1.3.1 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, allowing geo-referencing 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.

Nephrops landings were reported by Spain. The time-series of the commercial landings (Table 12.1.1 and Figure 12.1.1) shows a clear declining trend. During the period of 1975-1978, landings were around 600 t. In the period 1979-1993, landings values fluctuated around 400 t. In the period 1993 to 1998, landings decreased by 62%. From 1998 to 2016 (the last year with non-zero *Nephrops* TAC), landings decreased from 103 to 13 t. It should be noted that 88% of *Nephrops* landings are from the statistical rectangle 16E1, 10% from 15E0 and 2% from 15E1 (source: logbooks 2003-2016).

In 2017, 2018 and 2019, although *Nephrops* TAC was zero, a special quota of 2 t each year was allowed for the FU 25 *Nephrops* Sentinel fishery (special onboard observers' programme in commercial fishing vessels to monitor the status of the stock in this FU). Details on the 2017, 2018 and 2019 Sentinel fisheries were presented in working documents to WGBIE (WD 10, Vila *et al*., 2018 in ICES, 2018b; WD 02, González Herraiz *et al*., 2019 in ICES, 2019; WD 7, González Herraiz *et al.*, 2020, in this report).

Information on landings, discards and length distributions was uploaded on InterCatch. *Nephrops* discards are negligible in FU 25. Estimates for 1994, 1997 and 1999 ranged from 0.4 to 2.4% of the catches by weight. However, since the *Nephrops* TAC is zero, discards recorded for 2018 and 2019 were 179 and 769 Kg, respectively.

VMS information

VMS data of trawl fleet operating in FU 25 for the period 2009-2018 provide some information about the spatial distribution of *Nephrops* catches in this FU before the zero-TAC (2009-2016) and for the trawl fleet and for the vessels engaged in the Sentinel fishery in the zero-TAC years (2017-2019) (Figures 12.1.2a-e). Logbook data were assigned to VMS pings by vessel, fishing day and statistical rectangle. About 22% of the VMS pings could not be identified in logbooks. Only 27% of the 2009-2016 VMS pings revealed the presence of *Nephrops*.

The evolution of the spatial landings distribution of *Nephrops* in the FU before the zero-TAC implementation could indicate a contraction of the stock.

Sentinel CPUE maps are represented in Figure 12.1.2.b (2017 and 2018) and in Figure 12.1.2.c (2019), in Kg/fishing day, considering all sentinel surveys hauls (directed and not directed to *Nephrops*) in order to compare them with the maps of the rest of the commercial fishing fleet activity. Regular commercial fleet catch is based on fishing days from logbooks, as data by haul are only available for trips with observers.

Sentinel maps in Figure 12.1.2.d (2017-2019) are represented in Kg/haul only for the hauls directed to *Nephops*, which were used for the Sentinels' *Nephrops* CPUE estimates. Some of the red points of the 2019 Sentinel map in Figure 12.1.2.c are not represented in Figure 12.1.2.d because they correspond to non directed hauls.

The 2017, 2018 and 2019 maps show that the area covered by the FU 25 *Nephrops* sentinel fishery is very small, compared with the area of *Nephrops* fishery in the past. It should be noted that this is a zone with high occurrence of *Nephrops* (Figures 12.1.2a,b, 2009-2016). The FU areas with low or no occurrence of *Nephrops* before the zero TAC implementation (Figures 12.1.2a,b, 2009-2016) were not explored by the Sentinel fishery (Figures 12.1.2b-d, 2017-2019).

12.1.3.2 Biological sampling

The biological sampling programme provides length frequencies by sex of *Nephrops* landings, sex ratio and mean sizes. The sampling levels are shown in Table 1.4.

Annual length compositions for males and females combined, mean size and mean weight in the landings time-series are presented in Tables 12.1.2a and b for the periods 1982–2019. Length frequency distributions for the period of 1982–2019 are presented in Figures 12.1.3a, b and c.

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 Pérez, 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 (Figure 12.1.4).

Mean sizes in landings show an increasing trend in the time-series for both sexes. The maximum value was recorded in 2009. Low mean sizes observed in 1983-1986, 1991 and 2013 may suggest recruitment failures from 1991 to 2013 (Figure 12.1.1). Mean carapace length in males was 40.3 and 38.7 mm CL for females in the 2019 FU 25 *Nephrops* Sentinel survey catch (landings + discards).

12.1.3.3 Commercial catch-effort data

Fishing effort and LPUE data are available for the bottom trawl fleet selling in the port of A Coruña (SP-CORUTR8c) from 1975 to 2019 (Table 12.1.3 and Figure 12.1.1). The method for estimating 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 ("Northern trawl" in Section 2.1.1) 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). Since then, only OTB_DEF_>55_0_0 (renamed SP-LCGOTBDEF according to Castro and Morlán, 2015) data were used for 8c *Nephrops*. The available A Coruña effort time series (Figure 12.1.1) shows a continuous decreasing trend up to 2011, when there was approximately 15% of the '70s effort. From 2012, the effort remained at low values with 824 trips in 2019. The 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, 2018c). From 1975 to 1992, LPUE fluctuated around 70 kg/trip. Since 1992, LPUE sharply decreased to about 6.6 Kg/trip in 2016. In 2017, 2018 and 2019 the *Nephrops* TAC was zero. 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 (source: logbooks 2006–2016).

In Portugal, CPUE of species with affinity for temperate waters (in opposition to tropical waters) decreased from 1992 to 2009, especially in the case of 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) (1983-2019): 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 every year in September to estimate hake recruitment and to collect information on the relative abundance of demersal species (see survey description in Section 2.2.1 of this report as Spanish IBTS survey in 3rd quarter). The survey hauls positions are the same each year.

In 2017, fishing industry presented to WGBIE a working document with CPUE indices for the years 2015 and 2016 in FU 25 estimated from catches and effort data of two trawl vessels based in the A Coruña port (Fernández *et al*., 2017 and Table 12.1.4).

An observers' program (FU 25 Sentinel survey) was authorized during August and September of 2017, 2018 and 2019 in order to obtain a *Nephrops* abundance index (see WD 10 by Vila *et al*., 2018 in ICES 2018b; WD 02 by González Herraiz *et al*., 2019 in ICES, 2019 and WD 07, by González Herraiz, 2020 in this report). Table 12.1.5 shows the *Nephrops* abundance indices (CPUE) estimated in 2017, 2018 and 2019 from this survey. *Nephrops* catch in 2019 by the Sentinel fishery was 2020 Kg of retained catch and 250 Kg of discards. Data of Sentinel fishery are included in the Spanish data uploaded to InterCatch. This CPUE time-series is still very short to identify abundance trends for *Nephrops*. It is also not clear if this information is representative of the whole FU 25 and if these could be used in the future since the fishery is carried out in a very restricted zone and *Nephrops* seem to be almost absent in the rest of the FU (Figure 12.1.2).

12.1.4 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, 2019). The assessment of FU 25 is triennial and the last assessment was in 2019. Therefore, the stock will not be assessed in 2020.

12.1.5 Biological references points

Proxies of MSY reference points were defined using the methods developed in WKLIFE V (ICES, 2015) and WKProxy in 2015 (ICES, 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.

12.1.6 Stakeholders information

The fishing industry presented a working document to WGBIE in 2017 with qualitative and quantitative information about *Nephrops*' fishery in FU25 (Fernández *et al*., 2017 in ICES, 2017b). The WG considered 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.

In April 2020, WGBIE received a letter from stakeholders (two Spanish fishing producers' organizations, OPP no. 31 and 07) regarding *Nephrops* in ICES Division 8c. This document was discussed in a subgroup meeting during the WG.

The document analysed market and sales notes data and the fisheries management measures of the last years in relation with 8c *Nephrops*. Those sources of data and the issues mentioned in the document, together with additional sources of data and any information relative to the 8c *Nephrops* stocks, are regularly taken into account each year to make an integral analysis of the status of the resource to elaborate a scientifically sound assessment. Therefore, no further potential actions can be taken by the WG with regards to the stakeholders' letter. There is no scheduled advice for these functional units this year.

12.1.7 Management Considerations

Nephrops is taken as by catch in the mixed bottom trawl fishery. In FU 25, 90% of the Spanish landings of *Nephrops* come 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 *Nephrops* landings from the North Galicia (FU 25) 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, 2018 and 2019, the *Nephrops* TAC was zero.

A recovery plan for 8c and 9a hake and *Nephrops* stocks (except FU 30) was implemented since 2006 (Council Regulation (EC) No 2166/2005) until March 2019 (EU, 2019), when this plan was repealed. The management objective was to rebuild the hake 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, BOE, 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 *Nephrops* abundance index (sentinel) was carried out in 2017 (see WD 10 by Vila et al., 2018 in ICES, 2018b). To do this, a special quota for *Nephrops* in FU 25 was authorized by the EU.

Spain requested again a sentinel fishery for *Nephrops* in FU 25 for 2018. An ICES Special Request Advice about the characteristics of the *Nephrops* sentinel fishery in FU 25 for 2018 was released in February 2018 (ICES, 2018a). ICES advised that, if a UWTV survey cannot be conducted, collecting of sentinel fishery CPUE data would require ten trips and no more than 1.7 t (ICES, 2018a). The observers' programme was repeated in 2018 (see WD 02 by González Herraiz *et al*., 2019 in ICES, 2019) and in 2019 (WD 07 by González Herraiz *et al*. 2020 in this report).

12.1.8 References

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Castro, J. and Morlán, R. 2015. Review of the Spanish commercial tuning indices used in the assessment of the southern stocks of hake and anglerfish, and FU25 of Norway lobster. WD 04. 8 pp. In ICES. 2015. Report of the Working Group for the Bay of Biscay and the Iberian waters Ecoregion (WGBIE), 04-10 May 2015, ICES HQ, Copenhagen, Denmark. ICES CM/ACOM: 11, 503 pp.

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Table 12.1.1. *Nephrops* FU25, North Galicia. Catch, 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*		2
2019	2*	1	3

(*) *Nephrops* TAC was zero in 8c (FU 25 & FU 31) in 2017, 2018 and 2019, but there was *Nephrops* Sentinel Fishery 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 of 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 2001–2019. * *Nephrops* TAC in 8c (FU 25 & FU 31) was zero in 2017, 2018 and 2019. Length distributions from FU 25 *Nephrops* Sentinel fishery for those years.**

Carapace length (mm)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*	2018*	2019*
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	0
26	19	5	2	7	8	3	5	1		0			9	0	1		0	0	0
27	20	14	3	12	13	9	4	3	0	2	0		0	1	1	0	0	0	0
28	79	30	2	26	25	15	8	4		2	1	2	10	1	3	0	0	0	0
29	125	43	5	28	25	18	11	6	0	2	2	1	2	1	2	2	0	0	0
30	112	105	14	46	43	25	19	10	1	9	2	2	13	3	18	6	0	0	0
31	129	102	26	45	56	39	36	10	1	9	3	3	2	2	11	5	0	0	0
32	288	198	36	60	66	55	44	15	1	18	3	3	3	2	14	8	1	0	1
33	319	181	51	71	87	69	69	13	3	20	5	3	5	5	25	12	1	0	2
34	302	272	66	70	83	62	75	16	4	27	13	2	6	7	26	16	2	1	2
35	265	308	85	91	98	85	90	25	5	34	25	4	20	12	47	31	2	1	3
36	243	259	110	98	102	88	101	31	6	30	21	4	9	16	26	26	3	2	4
37	285	236	123	101	88	87	105	37	9	34	23	5	10	13	22	23	3	3	5
38	238	185	147	98	92	80	101	35	10	26	63	3	7	13	22	33	3	3	5
39	192	129	130	81	69	67	86	37	10	23	45	1	16	11	12	20	3	2	4
40	212	186	129	96	81	64	90	47	12	20	78	8	12	13	16	30	3	2	4
41	115	99	81	78	61	59	73	44	12	23	61	4	8	9	11	16	3	2	3
42	150	117	79	63	52	49	63	38	11	23	50	3	6	8	12	10	3	3	3
43	103	67	65	57	47	44	59	35	12	24	52	1	16	8	10	10	2	2	2
44	98	109	52	39	36	32	46	29	14	22	34	3	7	7	10	6	2	2	2
45	68	78	46	44	34	30	42	23	13	21	24	3	8	4	6	6	1	1	1
46	35	65	57	35	26	26	37	22	11	22	17	1	8	5	5	3	1	1	1
47	22	34	42	26	20	18	30	20	14	22	13	1	2	4	5	3	1	1	1
48	24	35	37	23	14	17	22	16	9	17	15	0	5	2	3	2	1	1	1
49	18	23	27	16	13	11	16	14	8	14	17	2	3	2	3	2	1	1	0
50	18	24	27	19	11	14	18	10	8	13	12	0	2	2	2	2	0	0	0
51	16	34	20	13	7	9	11	11	6	11	7	1	2	1	2	1	0	0	0
52	10	18	16	12	8	8	8	9	6	8	7	0	2	1	2	1	0	1	0
53	15	13	11	9	6	7	7	8	7	9	4	1	2	2	2	1	0	0	0
54	4	4	9	7	5	4	4	6	5	7	7	0	2	1	1	1	0	0	0
55	7	9	6	6	5	4	3	6	6	7	6	1	1	1	1	1	0	0	0
56	5	6	5	5	3	9	3	4	4	4	5	0	1	1	1	0	0	0	0
57	0	5	7	4	3	4	2	5	3	5	4	0	1	0	0	0	0	0	0
58	1	9	4	4	3	2	2	4	3	3	4	0	1	1	0	0	0	0	0
59	1	4	5	3	2	1	1	3	3	2	1	0	1	0	0	0	0	0	0
60	1	2	2	2	2	1	1	2	3	3	3	0	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	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	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	0
68		0	1	1	1	0	0	1	1	1	2	0		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	0
71		0	1	2	0	6	0	0	1	0		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	38	32	47
Total weight (tonnes)	147	143	89	75	63	62	67	39	21	34	44	10	11	9	14	13	2	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	0.049
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	39.6

Table 12.1.3. *Nephrops* FU 25: North Galicia. Landings, fishing effort and LPUE from the fleet selling in A Coruña port.

Year	Landings (t)	Effort (trips)		LPUE (kg/trip)	
		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
2019	2*		824		0

* *Nephrops* TAC in 8c (FU 25 and FU 31) was zero in 2017, 2018 and 2019, but there was Nephrops Sentinel fishery 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 ICES, 2017b)	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 in 2017, 2018 and 2019.

Source	Year	Period	*Nephrops* directed hauls				*Nephrops* non-directed hauls*			
			CPUE (kg/hour)	s.d.	CV	n	CPUE (Kg/hour)	s.d.	CV	n
Observers on board Sentinel survey	2017	Aug-Sep	7.2	3.1	43%	54	0.5	0.8	163%	25
	2018	Aug-Sep	5.1	3.0	59%	66	0.8	1.7	213%	37
	2019	Aug-Sep	16.2	11.1	69%	22	0.0	0.0	-	25

***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*.**

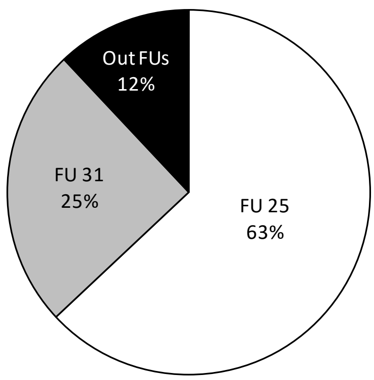

Figure 12.1. ICES Division 8c *Nephrops* landings by Functional Unit (FU) (2003-2016). *Nephrops* TAC in 8c was zero in 2017, 2018 and 2019.

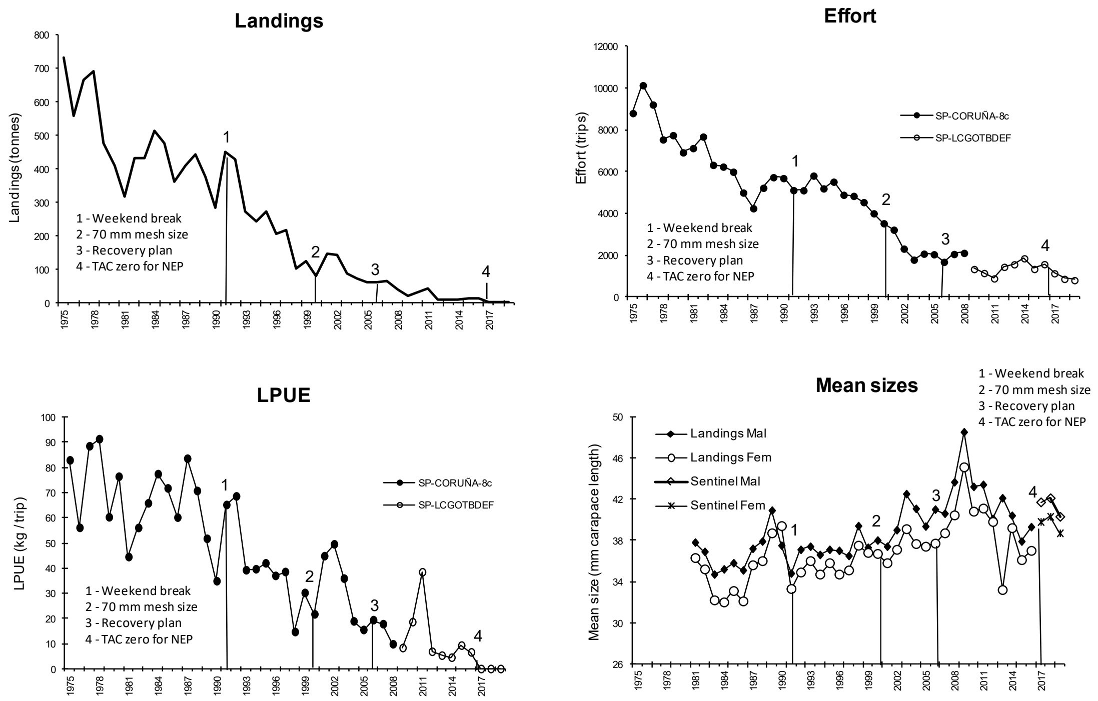

Figure 12.1.1. *Nephrops* FU 25, North Galicia. Long-term trends in landings, effort, LPUE and mean sizes. Landings and mean sizes from the FU. Effort and LPUE from the fleet selling in the A Coruña port. *Nephrops'* TAC in 8c (FU 25 and 31) was zero in 2017, 2018 and 2019. Mean sizes in these years were from the FU 25 *Nephrops* Sentinel fisheries.

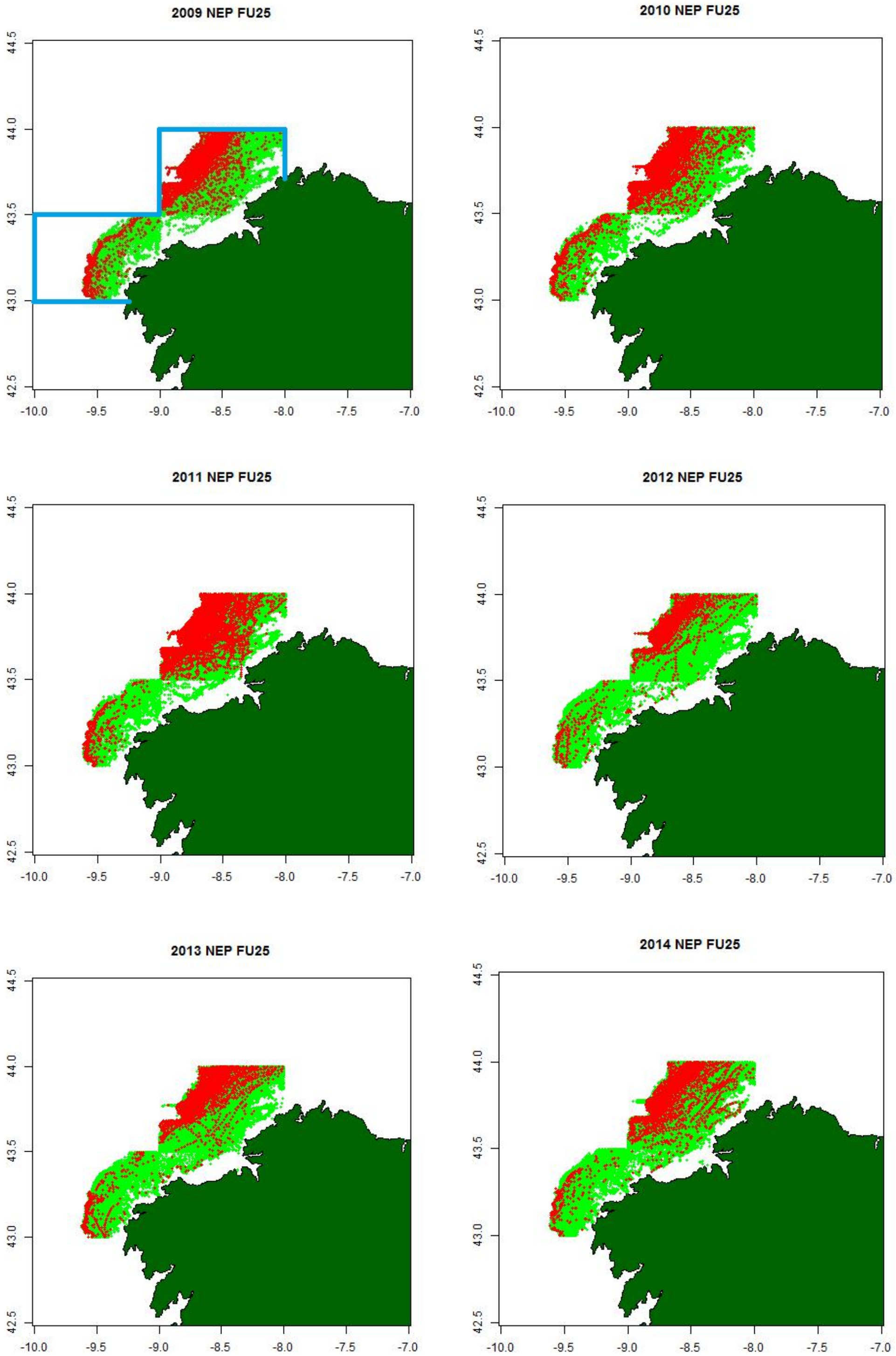

Figure 12.1.2a. FU25 North Galicia *Nephrops* LPUE (Kg/fishing day) distribution from commercial fleet activity. Red points: *Nephrops* LPUE > 0 Kg/fd, green points: *Nephrops* LPUE = 0 Kg/fd. Limits of the FU in blue in the 2009 map.

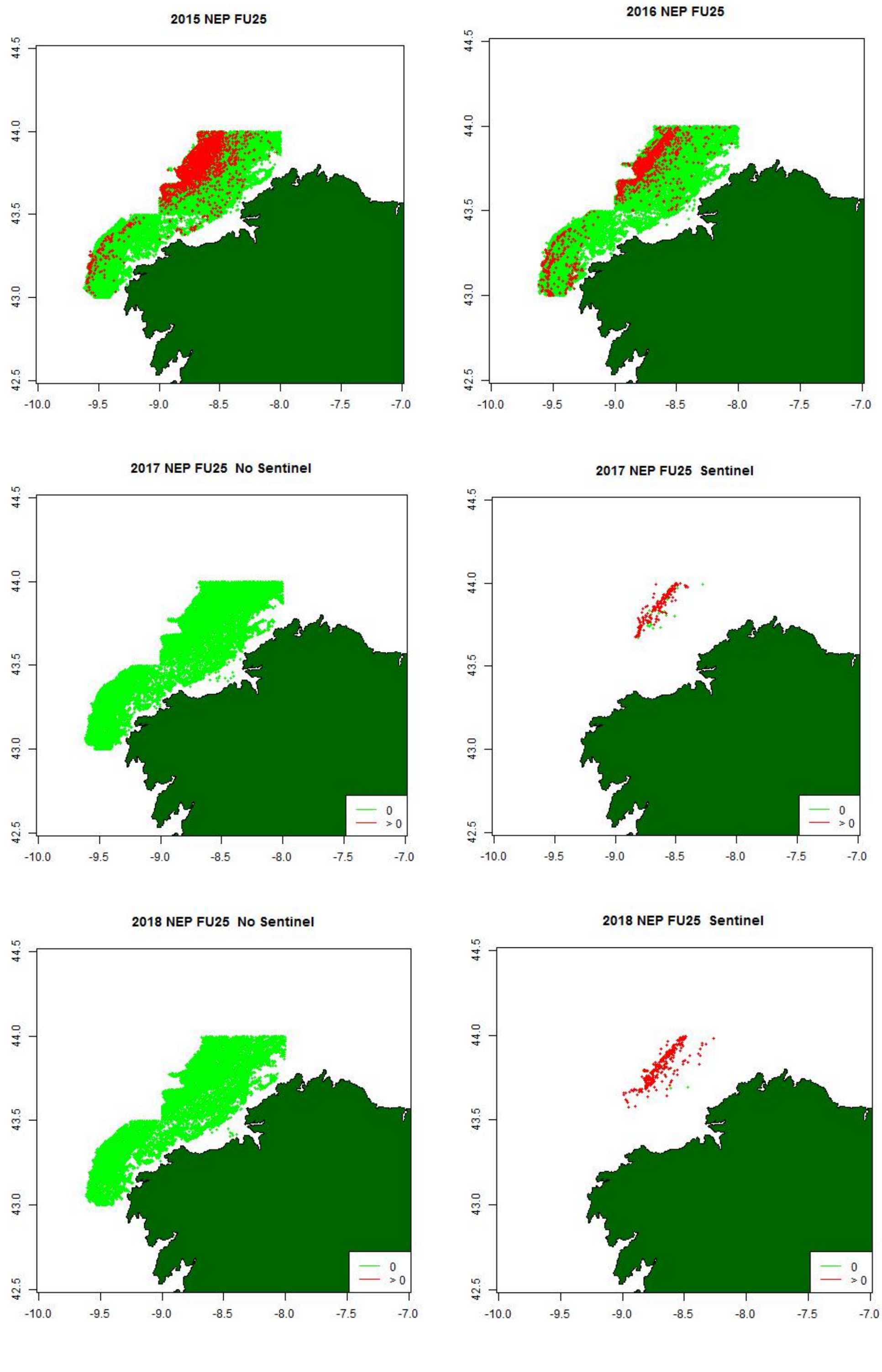

Figure 12.1.2b. FU25 North Galicia *Nephrops* LPUE (Kg/fishing day) distribution from commercial fleet activity (2015, 2016, 2017 and 2018 "no sentinel" maps) and from Sentinel fishery (2017 and 2018 "sentinel"). Red points: *Nephrops* LPUE > 0 Kg/fd, green points: *Nephrops* LPUE = 0 Kg/fd. Limits of the FU in blue in the 2009 map in Figure 12.1.2a.

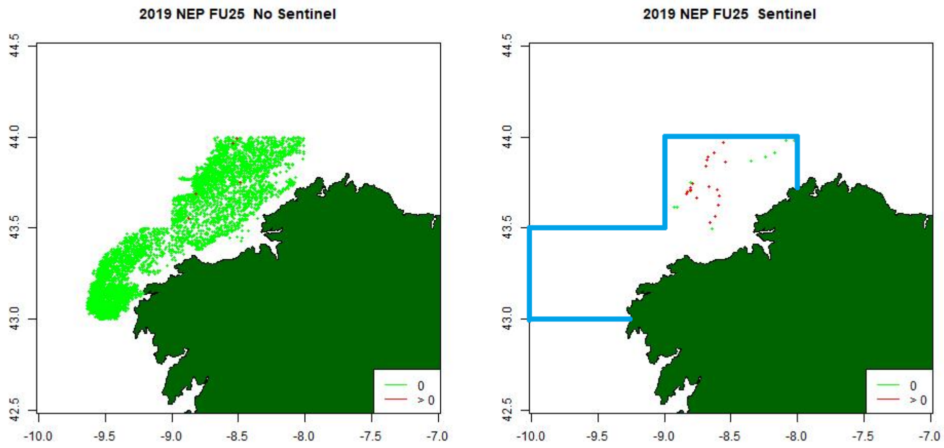

Figure 12.1.2c. FU25 North Galicia *Nephrops* LPUE (Kg/fishing day) distribution from commercial fleet activity ("no sentinel") and from Sentinel fishery ("sentinel"). Red points: *Nephrops* LPUE > 0 Kg/fd, green points: *Nephrops* LPUE = 0 Kg/fd. Limits of the FU in blue in the right panel map.

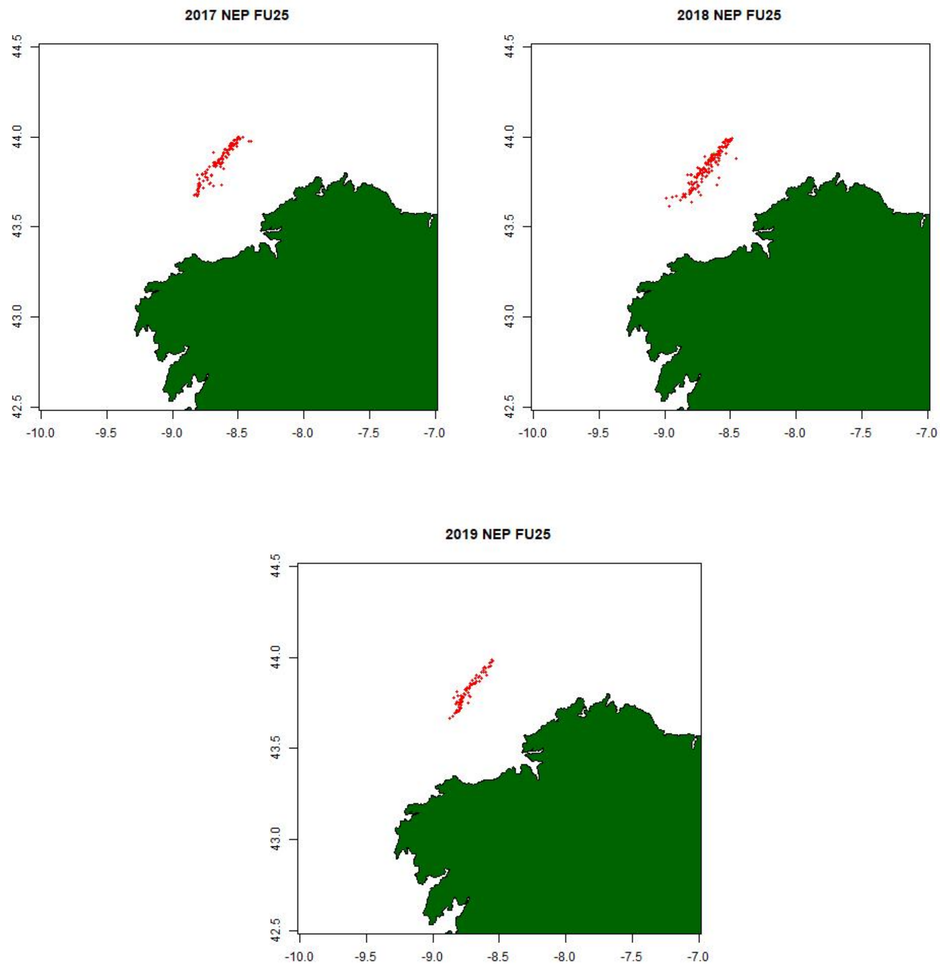

Figure 12.1.2d. FU25 North Galicia *Nephrops* LPUE (Kg/haul) distribution from Sentinel fishery ("sentinel"). Only *Nephrops* directed hauls. Red points: *Nephrops* LPUE > 0 Kg/haul, green points: *Nephrops* LPUE = 0 Kg/haul. Limits of the FU in blue in the 2009 map in Figure 12.1.2a.

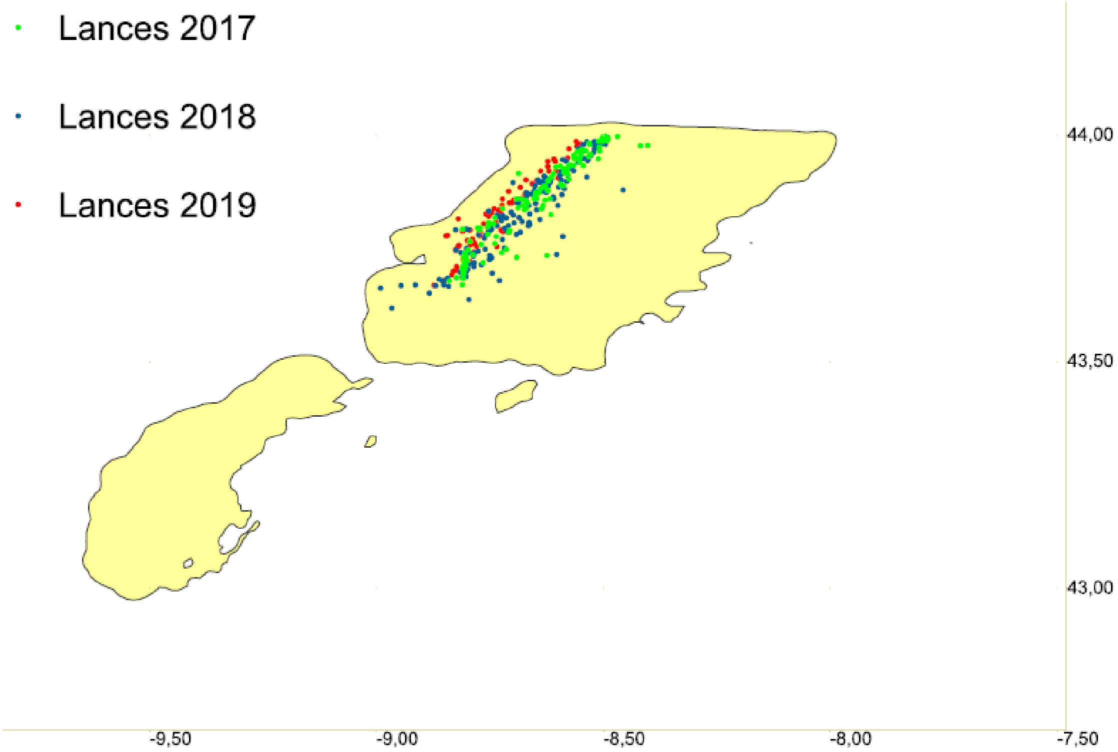

Figure 12.1.2e. FU25 North Galicia. Sentinel effort (hauls) distribution in 2017-2019. In yellow FU 25 *Nephrops* assessment area. Lances = hauls. Only hauls directed to *Nephrops*.

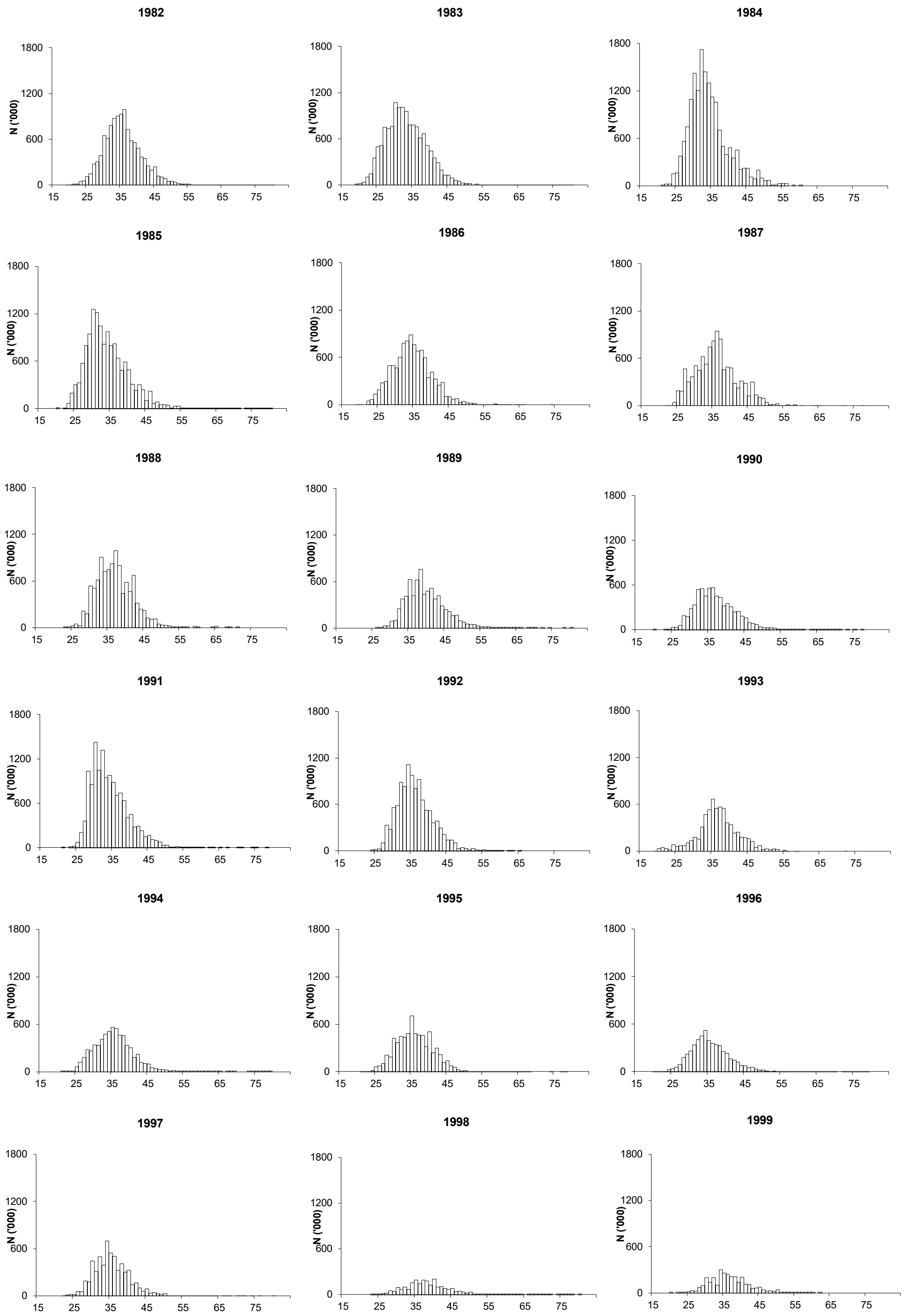

Figure 12.1.3a. ***Nephrops*** **FU 25, North Galicia. Length distributions of landings, 1982–1999. Maximum of Y-axis 1800 thousands. Carapace length in mm In X-axis.**

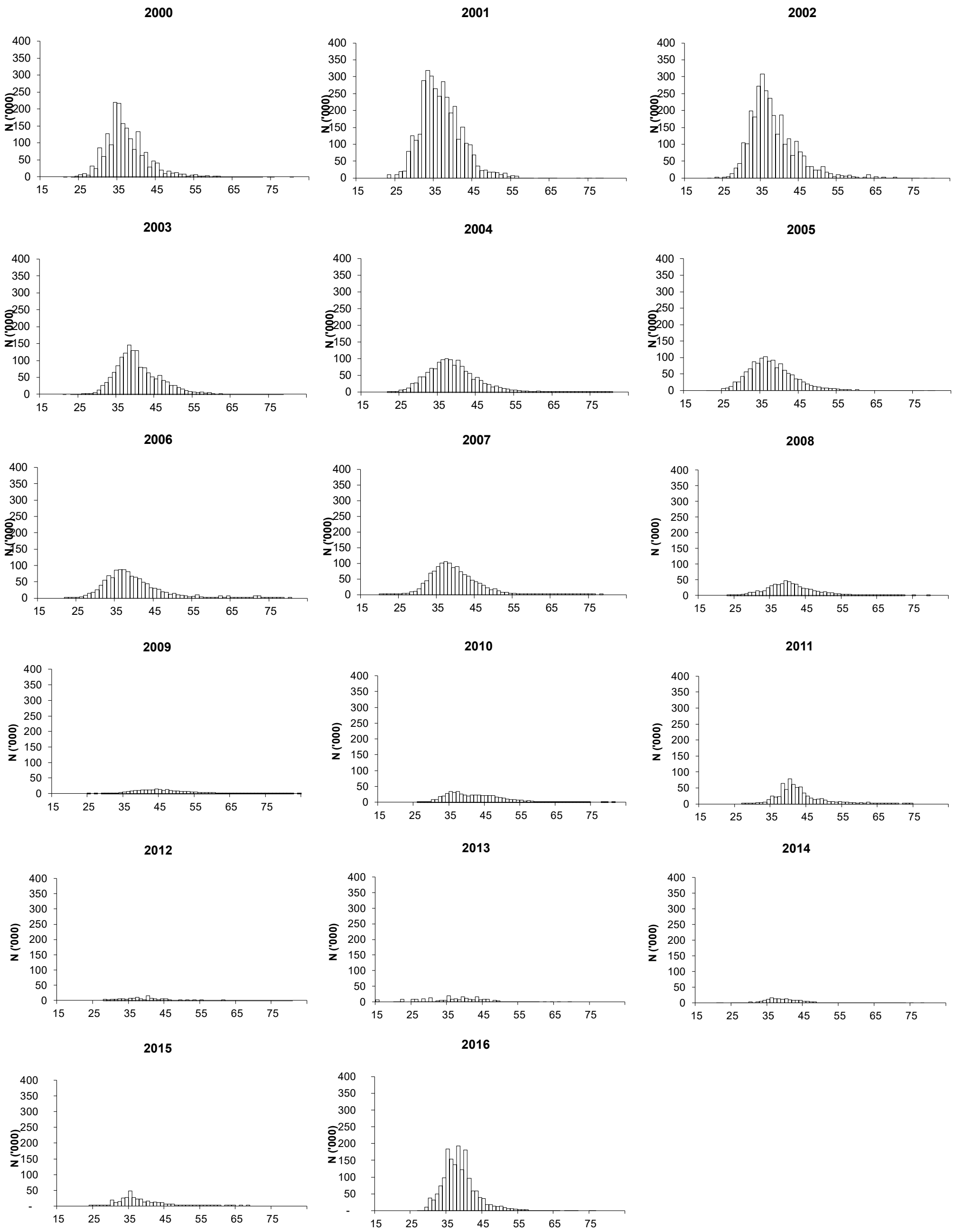

Figure 12.1.3b. *Nephrops* FU 25, North Galicia. Length distributions of landings, 2000–2016. Maximum of Y-axis 400 thousands (2001-2016). Carapace length in mm In X-axis.

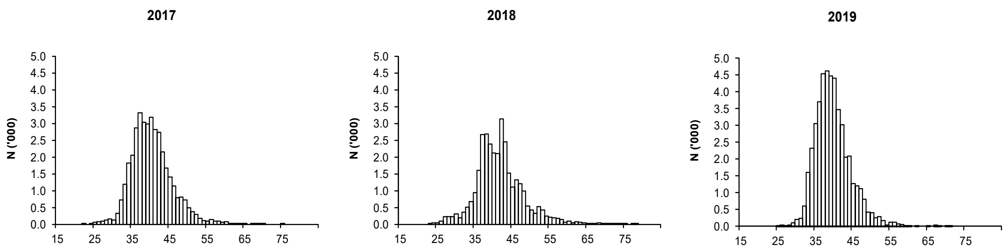

Figure 12.1.3c. *Nephrops* FU 25, North Galicia. *Nephrops'* TAC in 8c (FU 25 and FU 31) was zero in 2017, 2018 and 2019. Length distributions of landings for these years were from the FU 25 *Nephrops* Sentinel fishery. Maximum of Y-axis 5 thousands. Carapace length in mm In X-axis. Measured individuals: 7 266 (2017), 8 524 (2018) and 4 633 (2019).

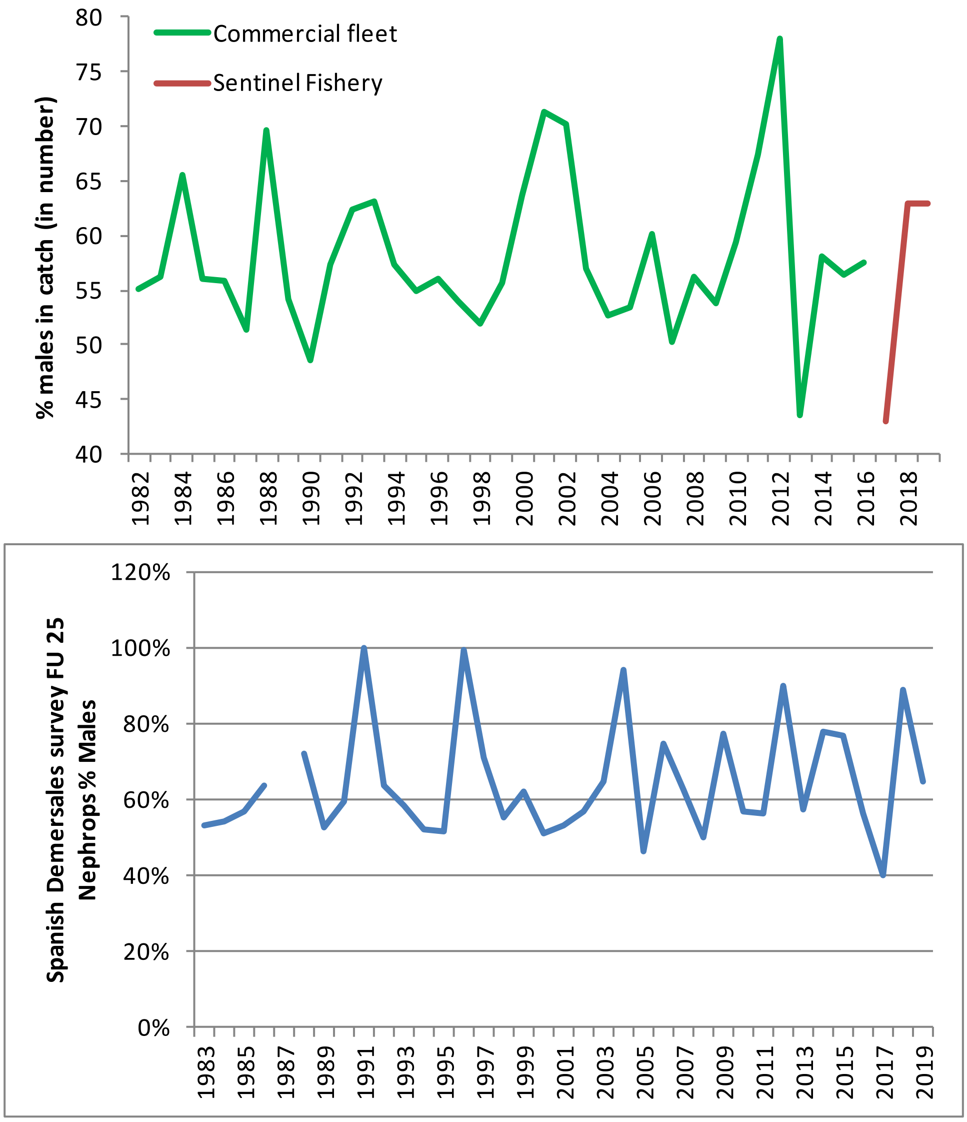

Figure 12.1.4. FU25 North Galicia *Nephrops*. Catches proportion of males in 1982–2019. Upper panel: Commercial fleet and Sentinel fishery. Lower panel: Spanish "Demersales" survey.

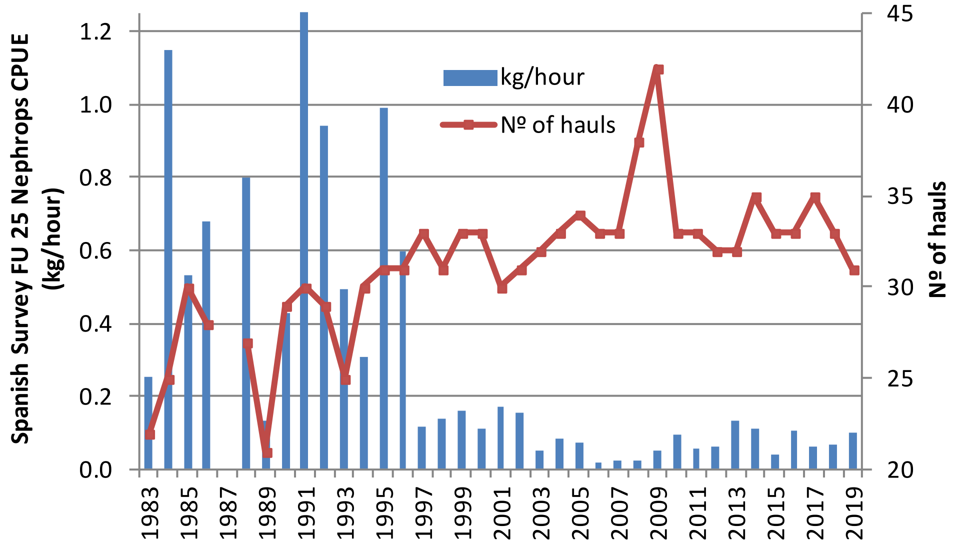

Figure 12.1.5. FU25 *Nephrops* CPUE (kg/hour) from Spanish "Demersales" trawl survey (SP-NSGFS) (1983-2019). No survey was carried out in 1987. Smaller gear in 1989. 1991 bar is not completely shown in the figure.

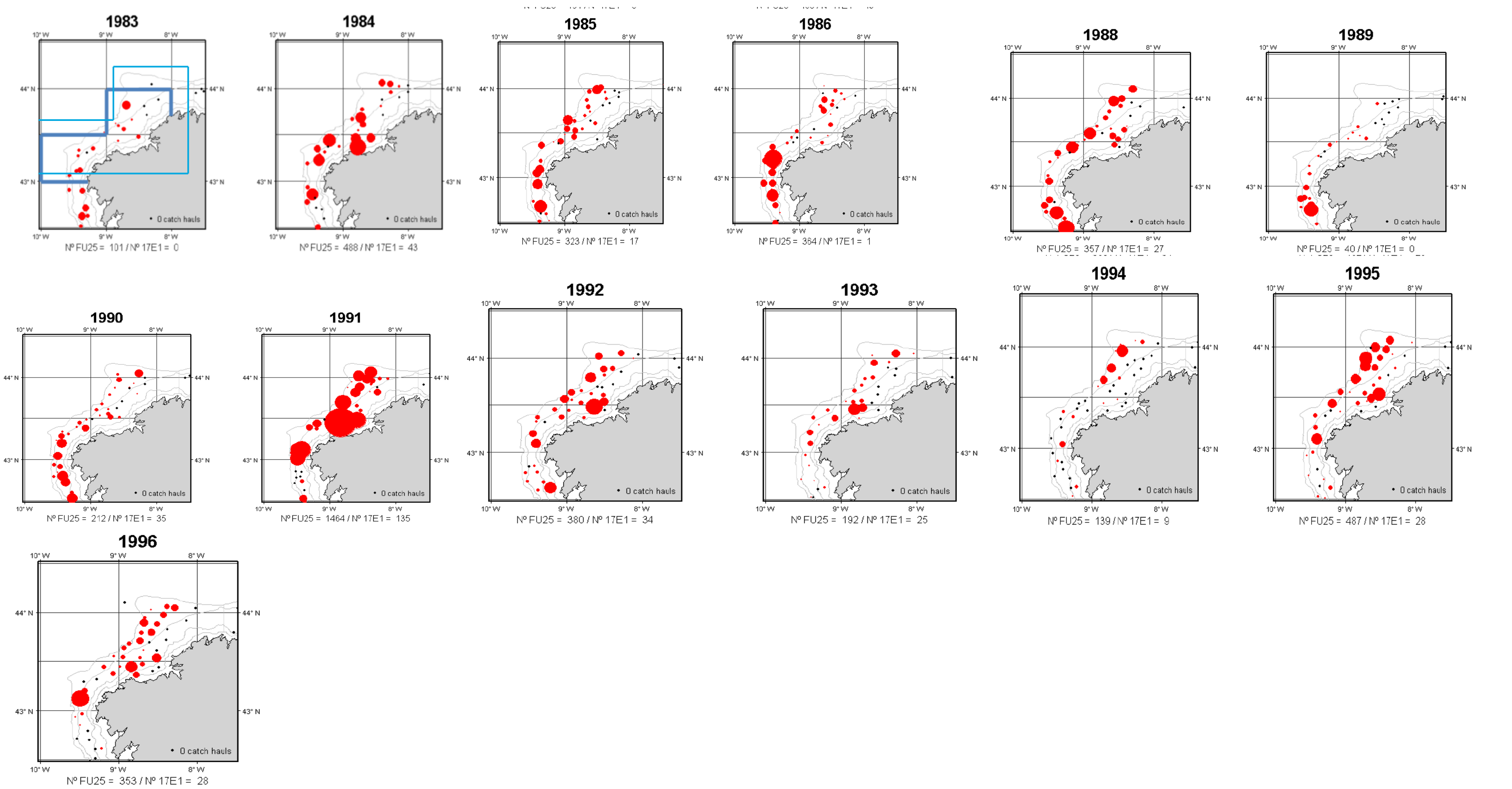

Figure 12.1.6a. FU25 *Nephrops* CPUE (Kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero kg of *Nephrops*/haul. Limits of FU 25 in blue in the 1983 map. No survey was carried out in 1987. Smaller gear in 1989. Period of high CPUEs (1983–1996).

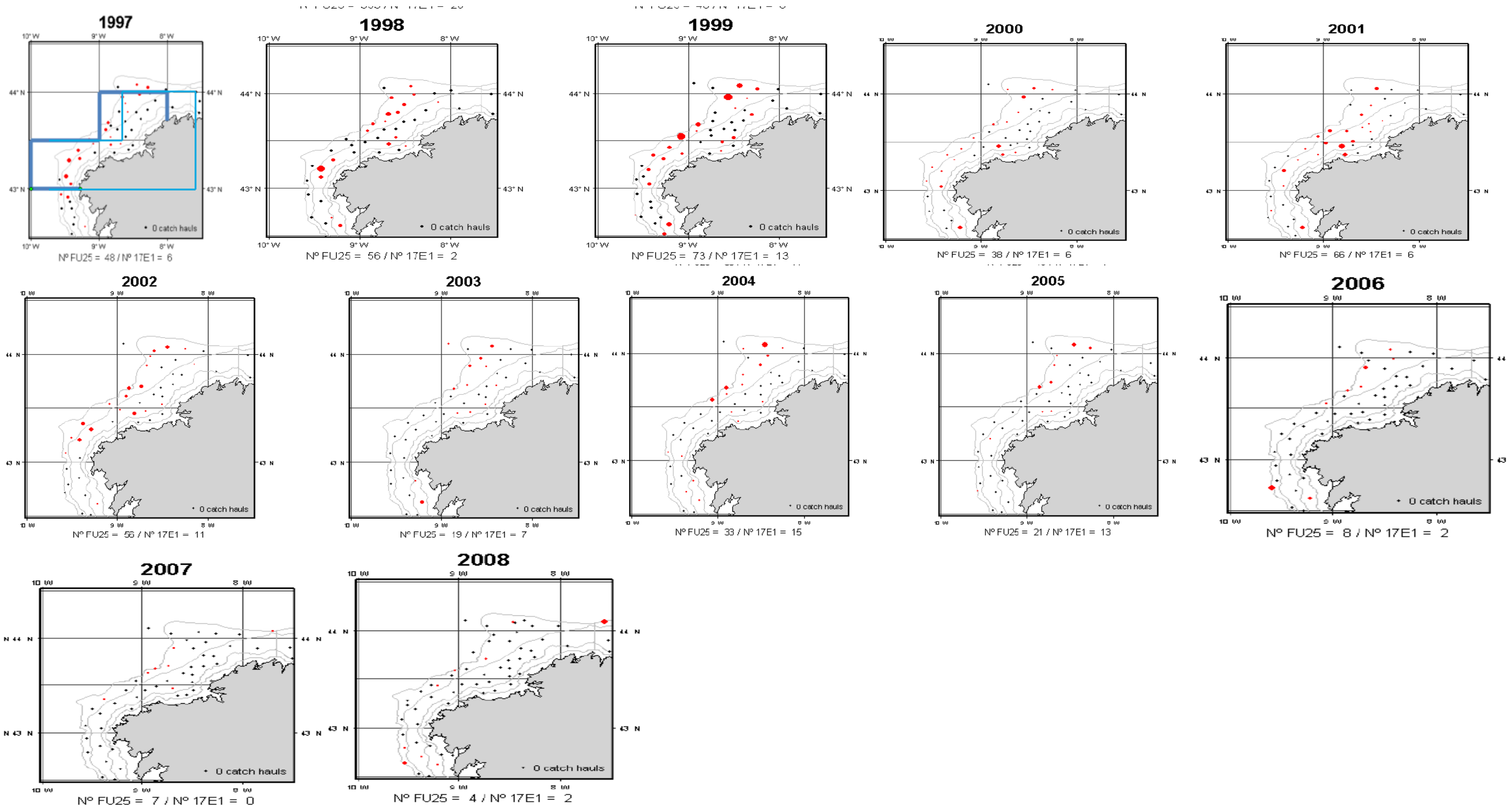

Figure 12.1.6b. FU25 *Nephrops* CPUE (Kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero kg of *Nephrops*/haul. Limits of FU 25 in blue in 1997. Period of low CPUEs (1997–2008).

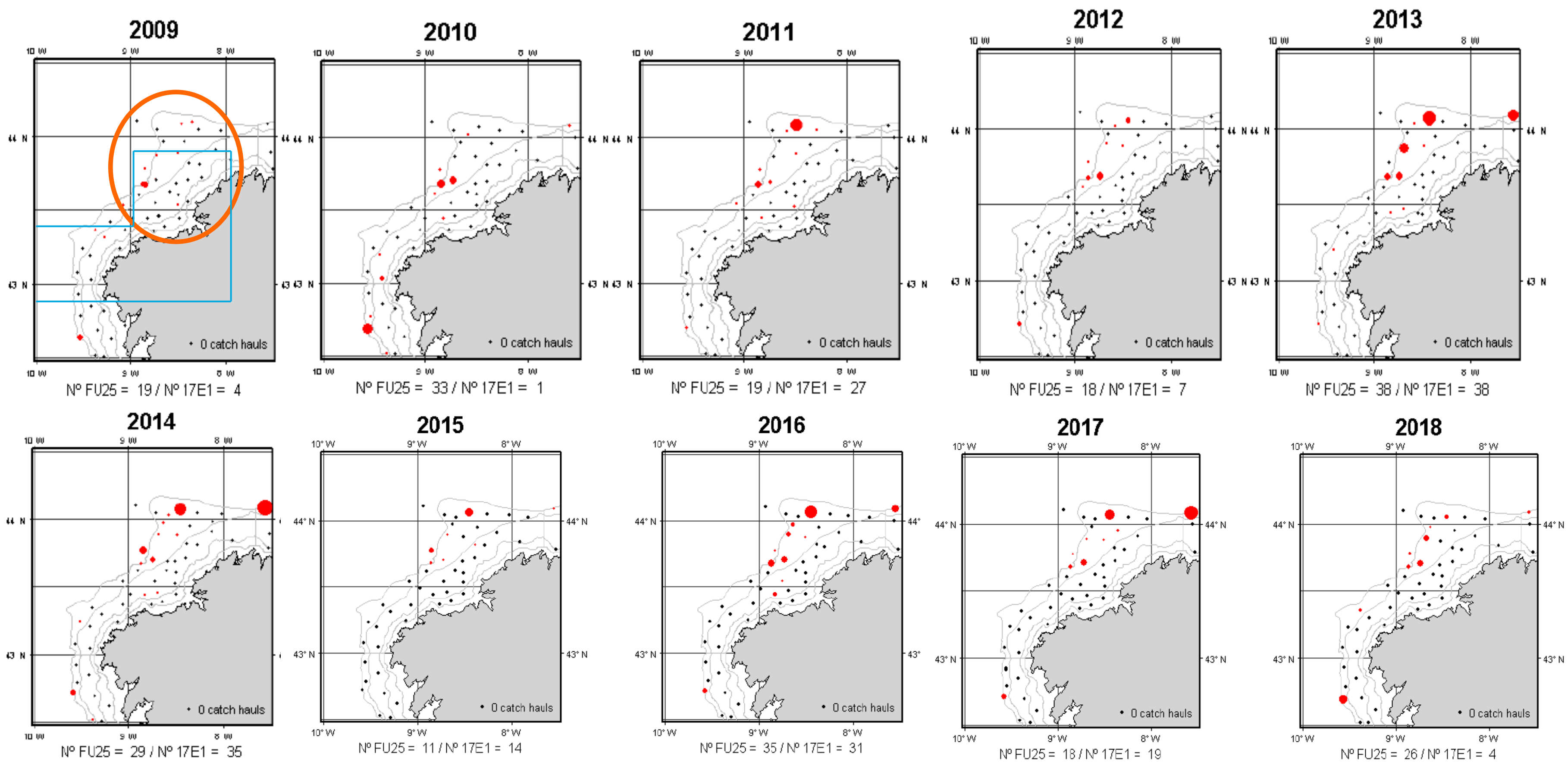

Figure 12.1.6c. FU25 *Nephrops* CPUE (Kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero kg of *Nephrops*/haul. Limits of FU 25 in blue in the 2009 map. Medium CPUEs in the rectangle 16E1 (inside FU 25) and 17E1 (outside FU) (2009–2018). Statistical rectangle 16E1 is indicated with an orange circle.

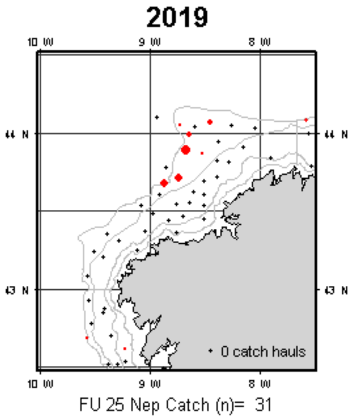

Figure 12.1.6d. FU25 *Nephrops* CPUE (Kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero Kg of *Nephrops*/haul. Limits of FU 25 in blue in the 2009 map in Figure 12.1.6c.

12.2 FU 31 (Cantabrian Sea) Nephrops

12.2.1 General

Up to this date, the status of the FU 31 *Nephrops* stock is considered undesirable (ICES, 2016a) with extremely low biomass and zero catch advice (ICES, 2017).

12.2.1.1 Ecosystem aspects

See Stock Annex.

12.2.1.2 Fishery description

FU 31 *Nephrops* is caught by the Spanish OTB_DEF_≥55, which is described as "Northern trawl" fleet in the Section 2.1.2 of this report. See also Stock annex.

12.2.1.3 Summary of ICES Advice for 2020 and management applicable to 2019 and 2020

ICES advice for 2020

The advice for this *Nephrops* stock is triennial and valid for 2020, 2021 and 2022.

ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2020, 2021, and 2022.

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 2019 and 2020

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) until March 2019, when the recovery plan was repealed (Regulation EU 2019/472). This plan was based on the precautionary reference points for 8c and 9a hake, which are considered 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 ICES Division 8c for 2017, 2018 and 2019. In 2019, this measure was set again for 2020, 2021 and 2022.

A FU 31 *Nephrops* special quota of 0.7 t for 2019 was established in order to carry out an observers' programme supervised by the Spanish Oceanographic Institute (IEO) for obtaining a *Nephrops* abundance index (Sentinel fishery).

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 sales notes are also combined with their respective logbooks, which allow geo-referencing 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 in 2019 based on logbooks data. The Spanish concurrent sampling is used to raise the FU 31 observed trips landings to total effort by metier since 2013. *Nephrops* landings from FU 31 were reported by Spain (Table 12.2.1 and Figure 12.2.1) and are available for the period 1983–2019. The highest landings were recorded in 1989 and 1990, 177 t and 174 t, respectively. Since 1996, landings have declined sharply from 129 t up to 3 t in 2016. About 39% of *Nephrops* landings in FU 31 comes from the statistical rectangle 16E7 (Basque Country), 36% from 16E4 (Asturias region), 18% from 16E6 (Cantabrian region) and 8% from 16E5 (logbooks 2003-2016).

In 2017, 2018 and 2019, *Nephrops* TAC was set at zero, landings were zero, but at least 814 Kg were obtained in the 2019 FU 31 Sentinel fishery, which had a special quota. More details are provided in the WD 08 (González Herraiz *et al.* in this report).

Information on landings, discards and length distributions were uploaded to InterCatch. *Nephrops* discards are negligible in FU 31, Nevertheless, since the *Nephrops* TAC is zero, estimated discards amount 31.4, 3.4 and 5.7 t in 2017, 2018 and 2019, respectively.

VMS information

VMS data from 2009-2018 from FU 31 trawl fleet (baca OTB_DEF≥55, jurelera OTB_MPD≥55 and pair trawlers PTB_MPD≥55) were used to provide some information about the *Nephrops* spatial catch distribution when TAC was higher than zero (Figure 12.2.2, 2009-2016). Figure 12.2.2, 2017-2018) shows the catch spatial distribution under zero TAC. Logbook data were assigned to VMS pings by vessel, fishing day and statistical rectangle. About 28% of the VMS pings could not be identified in logbooks while only 9% of the 2009-2016 VMS pings revealed the presence of *Nephrops*.

12.2.2.2 Biological sampling

The biological sampling programme provides the mean sizes of males and females in the landings from 1988 to 2016. This series shows an increasing trend (Figure 12.2.1). The highest values were recorded in 2009 (males 55.8 mm and females 45.9 mm CL). Decreases of mean sizes were observed in 1991, 2002, 2011 and 2015. The decline of mean sizes 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 are available for FU 31 in 2017 and 2018 because the *Nephrops* TAC was zero. The number of *Nephrops* individuals from the Spanish "Demersales" trawl survey was insufficient in 2017 and 2018 to provide a reliable mean length. Mean sizes of 45.4 mm carapace length (CL) in males and 41.4 mm CL in females were observed during the 2019 FU 31 Sentinel fishery. The sampling levels are showed in Table 1.4.

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 Pérez, 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 2019 FU 31 Sentinel fishery was 50%.

12.2.2.2 Commercial catch-effort data

The fishing effort and CPUE data series include bottom trawl fleets operating in the Cantabrian Sea selling in the harbours of Santander, Gijón and Avilés. In last years, the information from the different fleets is intermittent. A combined effort series that includes Santander, Avilés and Gijón from 2009 onwards is presented in Figure 12.2.1. In order to standardize the effort units, the unit considered for this series is the trip. All the available effort time series show decreasing trends from 1983-2016 (Figure 12.2.1). The increase in the use of other gears (HVO and pair trawl) resulted in the reduction of the baca trawl fleet effort, which captures 85% of *Nephrops* from FU 31. The combined Santander-Gijón-Avilés effort values decreased since 2014 (Figure 12.2.1). The effort in 2019 was 719 trips.

The Santander LPUE series shows fluctuations and a general downward trend (Figure 12.2.1) until 2013 (2.3 Kg/fishing days). The combined Santander-Gijón-Avilés LPUE series also shows a decreasing trend. The CPUE in 2016 was 4.3 Kg/trip. In 2017, 2018 and 2019 *Nephrops* TAC was zero in 8c (FU 25 and FU 31).

In Portugal, CPUE of 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) (1983-2019) decreased from 1992-1994 to 2010, increased until 2015 and fell since then (Figure 12.2.3). CPUE (Kg/haul) spatial distribution shows a decreasing trend of the yields until 2000 with a slight prevalence along the eastern area (Figure 12.2.4). 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 (see survey description in section 2.2.1 of this report as Spanish IBTS survey in 3rd quarter). The survey haul positions are the same each year.

The FU 31 fishing sector requested for a Sentinel fishery in that area in order to obtain a *Nephrops* abundance index. ICES delivered a Special Request Advice (ICES, 2019b) establishing the technical requirements and the Sentinel was carried out in July 2019 (see WD 08, by González Herraiz *et al*. 2020, in this report). The *Nephrops* CPUE obtained in this fishery was 7.1 Kg/hour. The *Nephrops* retained catch was at least 734.72 Kg and the *Nephrops* discards were 79 Kg. Sentinel data were included in the Spanish data uploaded to InterCatch.

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, 2019a). The assessment of FU 31 is triennial and the last assessment was in 2019. Therefore, no assessment will be provided in 2020.

12.2.4 Biological reference points

Proxies of MSY reference points were defined using the methods developed in WKLIFE V (ICES, 2015) and WKProxy in 2015 (ICES, 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 Stakeholders information

In April 2020, WGBIE received a letter from stakeholders (two Spanish fishing producers' organizations, OPP no. 31 and 07) regarding *Nephrops* in ICES Division 8c. This document was discussed in sub-group meeting during the WG.

The document analysed market and sales notes data and the fisheries management measures of the last years in relation with 8c *Nephrops*. Data sources and the issues mentioned in the document, together with additional data and any other information relative to the 8c *Nephrops* stocks, are regularly taken into account each year to make an integral analysis of the status of the resource to elaborate a scientifically sound assessment. Therefore, no further potential actions can be taken by the WG with regards to the stakeholders' letter. There is no scheduled advice for these functional units this year.

12.2.6 Management considerations

Nephrops is taken as by-catch in the mixed bottom trawl fishery. In FU 31, 85% of the Spanish *Nephrops* landings are 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 *Nephrops* landings 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 value. The TAC for *Nephrops* TAC was zero in 2017, 2018 and 2019.

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 (BOE, 2011, ARM/3158/2011). This new regulation established an Individual Transferable Quota system (ITQs) (including *Nephrops*).

A *Nephrops* Sentinel Fishery in FU 31 supervised by the IEO was carried out in 2019 to obtain a *Nephrops* abundance index (see WD 08, by González Herraiz *et al*., 2020, in this report). This fishery followed the technical requirements established by a specific ICES Special Request Advice (ICES, 2019b).

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 on a sentinel fishery for *Nephrops* in FU 31 for 2019 was released 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, 2019b).

12.2.7 References

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Table 12.2.1. Nephrops FU 31, 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
2019	1*	0	6	6

* Nephrops TAC was zero in 8c (FU 25 & FU 31) in 2017, 2018 and 2019, but in 2019 there was a *Nephrops* Sentinel fishery in FU 31.

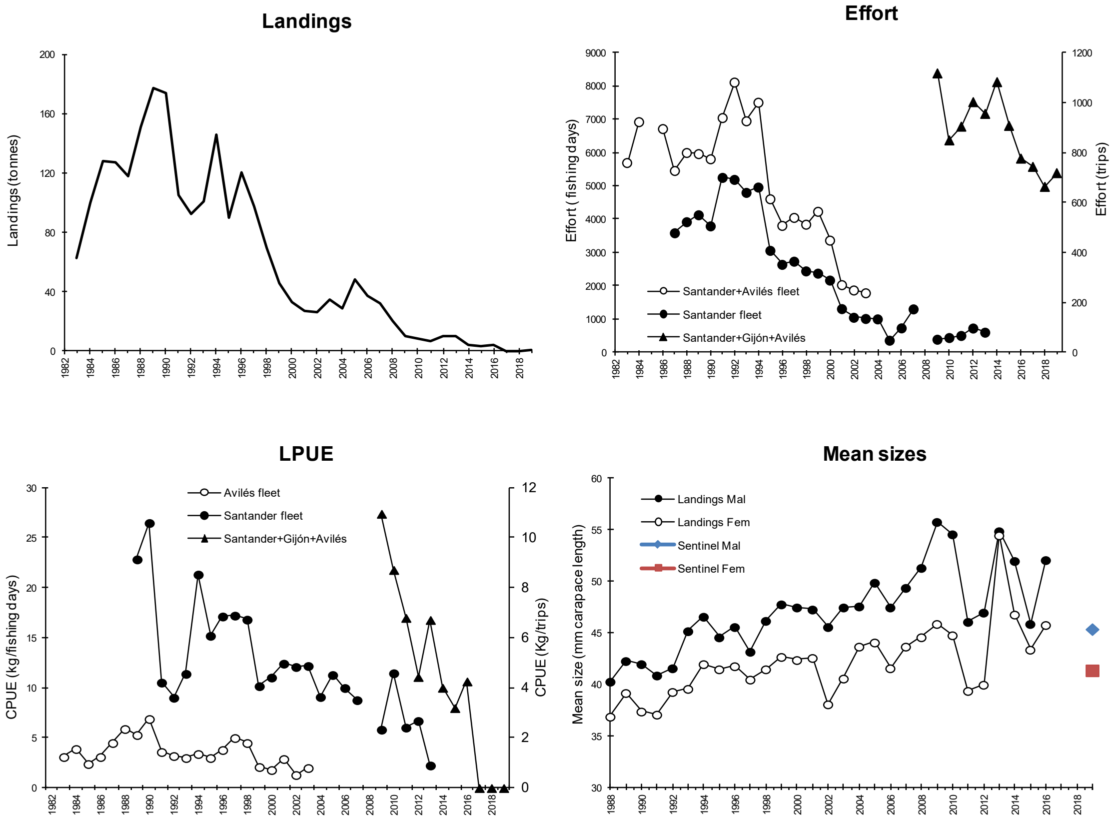

Figure 12.2.1. Nephrops FU 31, Cantabrian Sea. Long-term trends in landings, effort, LPUE and mean sizes. Effort and LPUE for the "bacas" (metier OTB_DEF≥55) selling in the ports of Santander, Gijón and Avilés. 8c Nephrops fishery (FUs 25 & 31) was closed in 2017 and 2018.

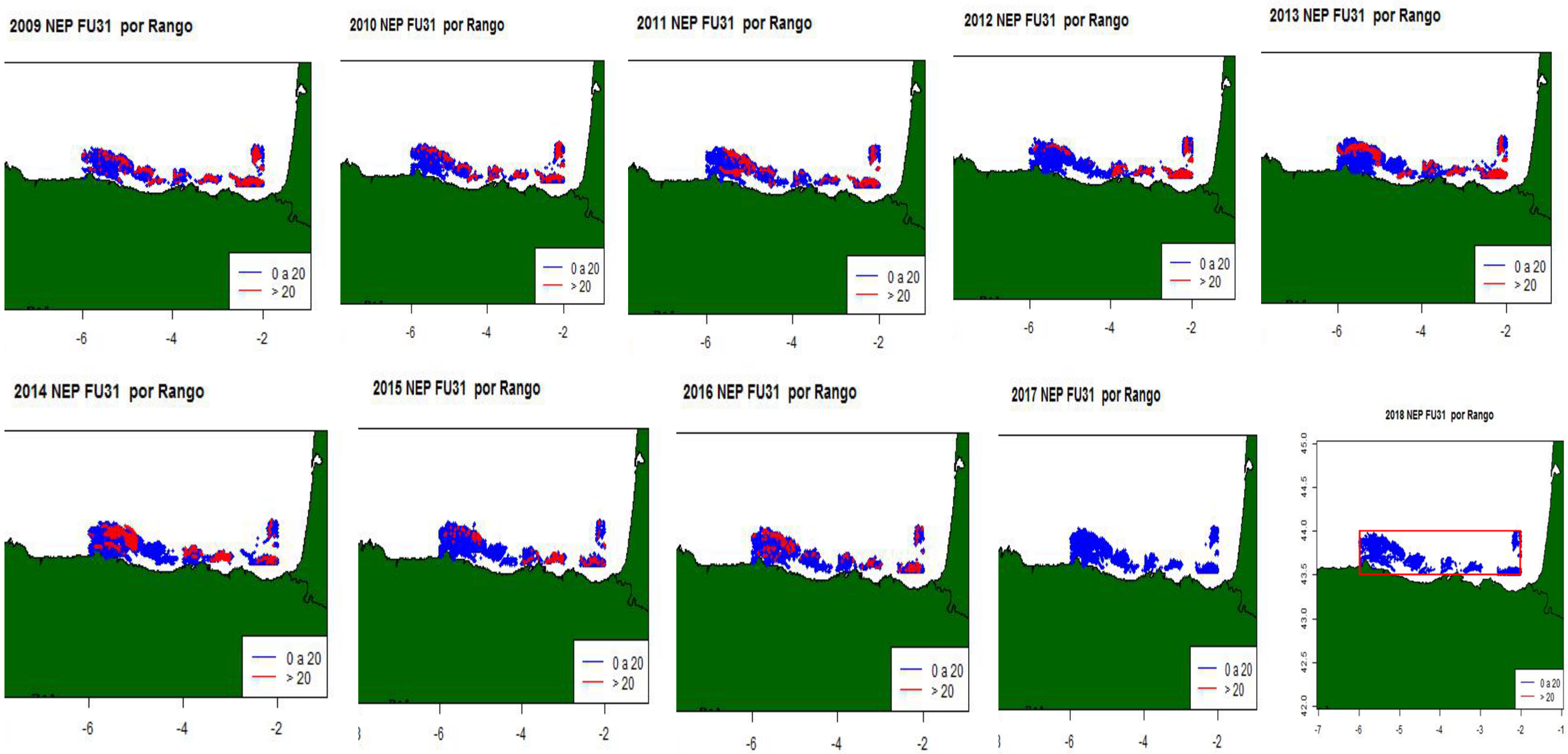

Figure 12.2.2a. FU 31 Cantabrian Sea. Distribution of FU 31 *Nephrops* LPUE (Kg/fishing day). FU 31 limits indicated in red in the 2018 map. Red points: *Nephrops* LPUE > 20 Kg/fd, blue: *Nephrops* LPUE ≤20 Kg/fd. *Nephrops* TAC in 8c (FUs 25 and 31) was zero in 2017, 2018 and 2019.

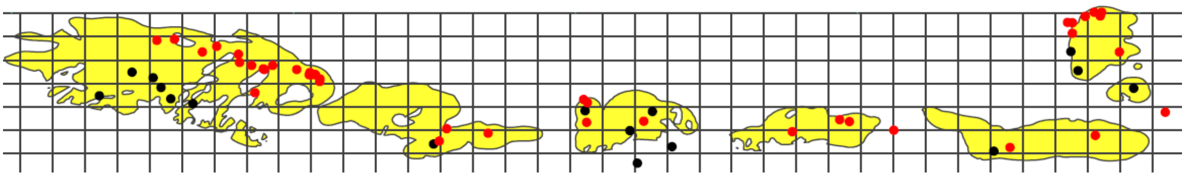

Figure 12.2.2b. FU 31 Cantabrian Sea. 2019 Sentinel effort distribution (hauls VMS points). Red points: hauls with *Nephrops* catch. Black points: hauls without *Nephrops* catch.

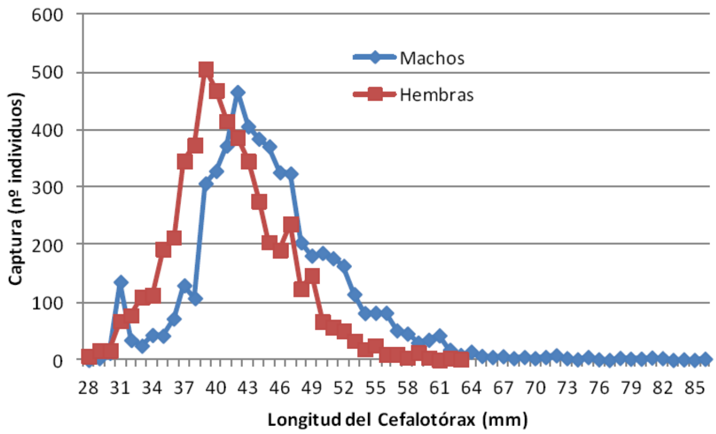

Figure 12.2.2c. FU 31 Cantabrian Sea. 2019 Sentinel length distribution. Red points: Females. Blue points: males.

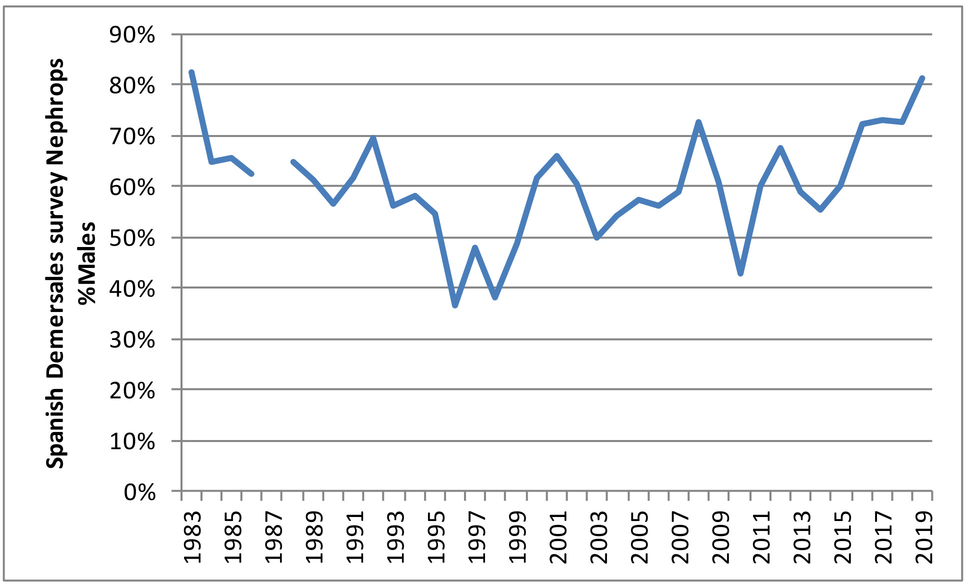

Figure 12.2.2d. FU 31 Cantabrian Sea. Catches proportion of males (1983–2019) from the Spanish "Demersales" trawl survey.

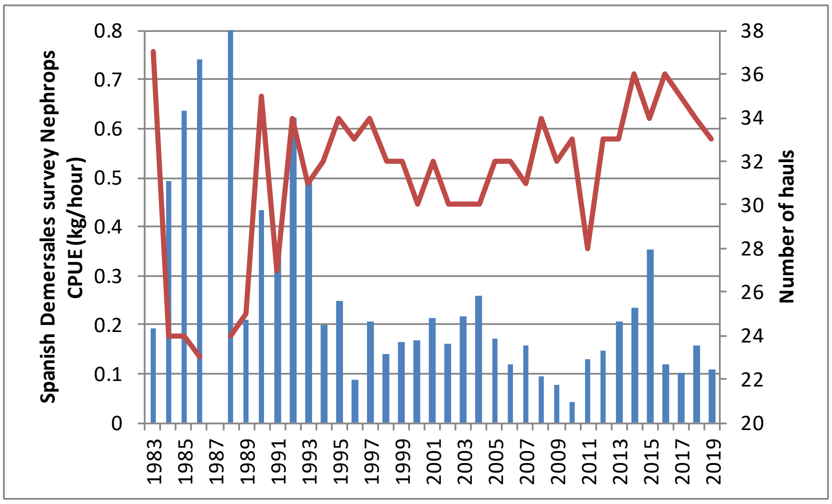

Figure 12.2.3. FU 31 *Nephrops* CPUE (Kg/hour) from Spanish "Demersales" trawl survey (SP-NSGFS) (1983-2019). Notes: 1) No survey was carried out in 1987; 2) 1988 bar not completely shown in the figure; 3) a smaller size gear, used in the 1989 survey, could have affected the *Nephrops* CPUE.

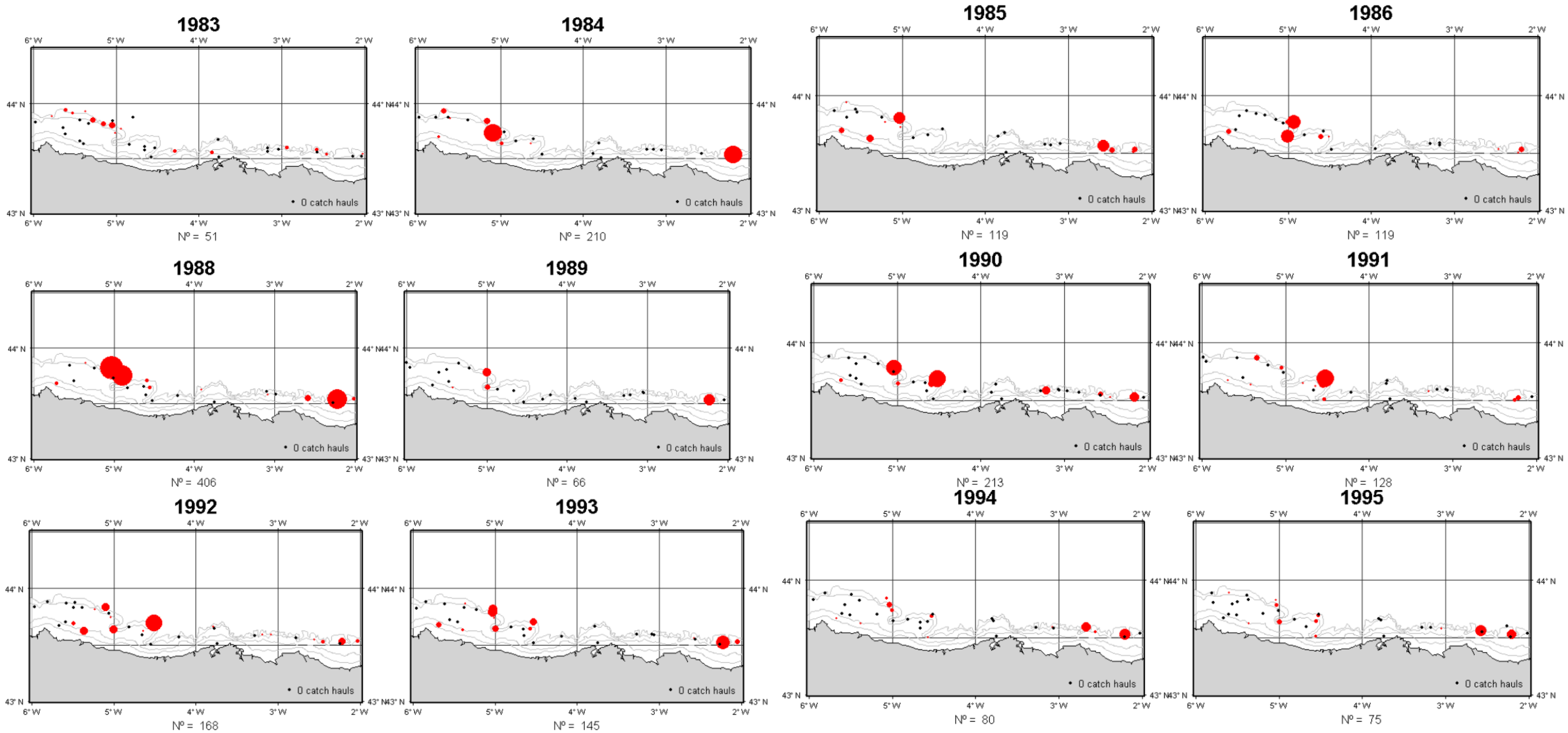

Figure 12.2.4a. FU 31 ***Nephrops*** **CPUE (Kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero kg of** ***Nephrops*** **by haul. No survey was carried out in 1987. The smaller size gear used in the 1989 survey may have affected the point estimates. Higher CPUEs period (1983–1995).**

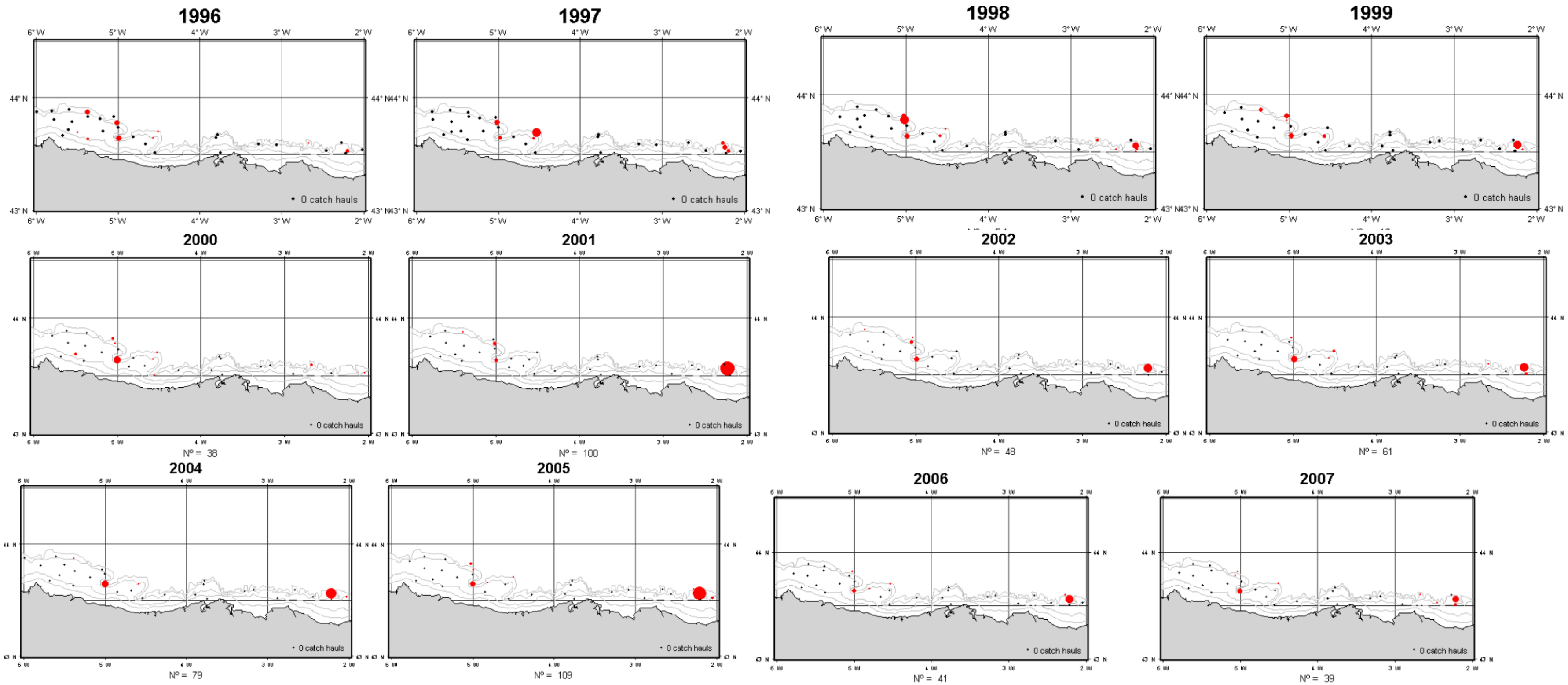

Figure 12.2.4b. **FU 31 *Nephrops* CPUE (Kg/haul) from Spanish “Demersales” trawl survey (SP-NSGFS). Black points: zero Kg of *Nephrops* by haul. Lower CPUEs, eastern patch prevalence.**

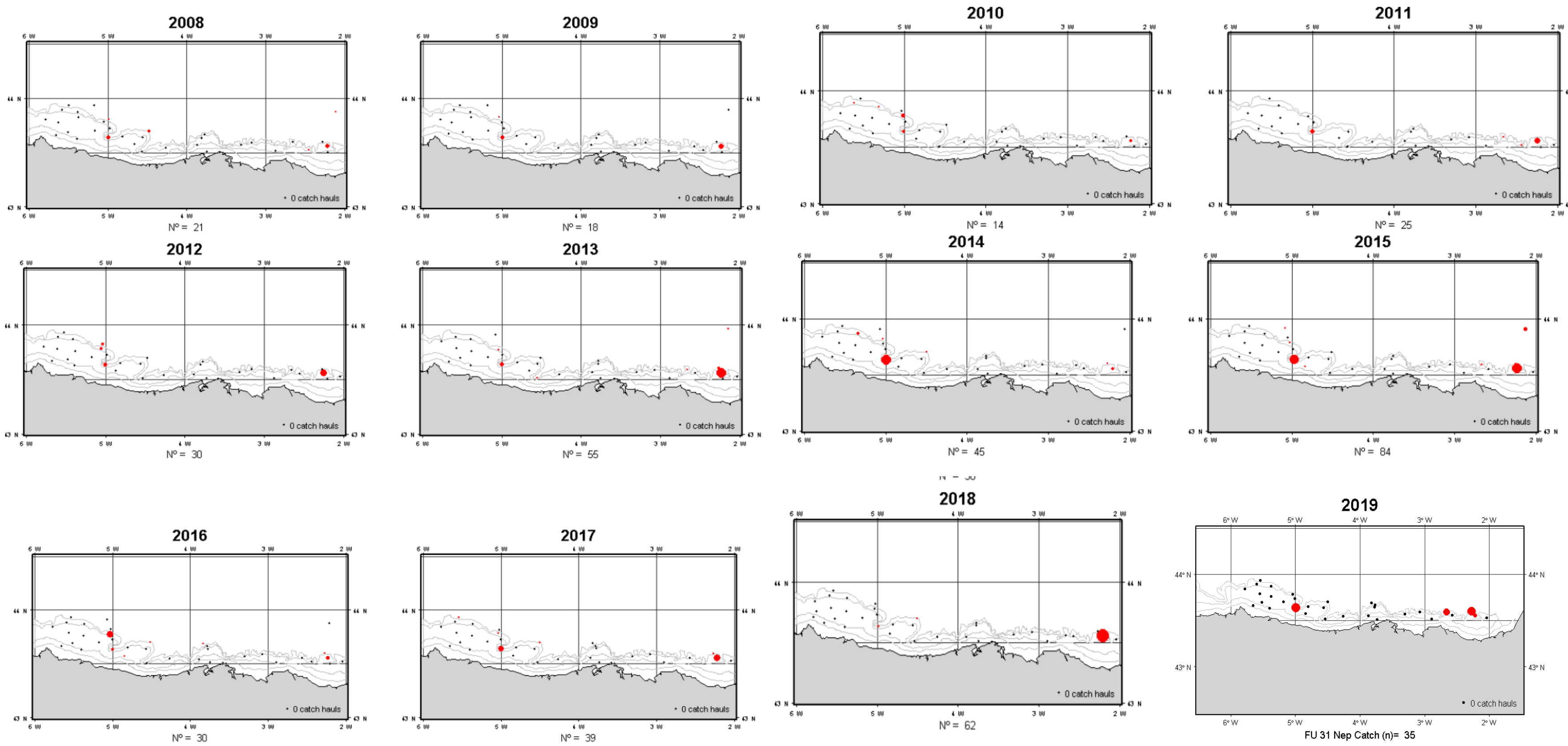

Figure 12.2.4c. **FU 31 *Nephrops* CPUE (Kg/haul) from Spanish "Demersales" trawl survey (SP-NSGFS). Black points: zero Kg of *Nephrops* by haul. Lower CPUEs.**

12.3 Summary for Division 8c

Atlantic *Nephrops* landings from the Iberian Peninsula (ICES divisions 8c and 9a) have been decreasing at about 93% since 1978 to 2014 (Figure 12.3.1). Separate 8c and 9a landings have different magnitude but offer the same evolution (Figure 12.3.2).

Division 8c includes Functional Unit (FU) 25, North Galicia, and FU 31, Cantabrian Sea (Figure 12.3.3). Division 9a 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 (Figures. 12.1.1, 12.2.1, 9a section). Since 1996, landings of the southern stocks (FU 28-29 and 30) have been increasing for some years (9a section), while northern stocks' (FUs 25, 31 and 26-27) landings continue to decrease (Figures. 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 for all of the Atlantic *Nephrops* stocks except in FU 30 (Gulf of Cádiz) between 1994 and 2005 (Figures 12.1.1, 12.2.1, 9a section).

Nephrops CPUEs are decreasing since the beginning of the time-series for the northern stocks (Figures 12.1.1, 12.2.1, 9a section) while values are quite stable for 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 (Regulation (EU) 2019/472). 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).

Considering only Division 8c, FU 25 provides about 63% of the Spanish *Nephrops* landings, FU 31 the 25% and 12% for the other rectangles in 8c (logbooks 2003-2016) (Table 12.3.1, Figure 12.1).

In Division 8c, 87% of *Nephrops* landings come 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 significantly low levels of landings from FU 25, FU 31 and rectangles outside the FUs coupled with the decreasing LPUE trends indicate that both stocks are in very poor condition. TAC in Division 8c was zero catch for 2017, 2018 and 2019. However, a special quota was authorized for FU25 in August and September 2017 and 2018 in order to collect some data for the estimation of 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 Pérez, 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 observed in 1998 and 2004 (Figure 12.3.4).

Decreases in mean length could be related with recruitment. In Division 8c, *Nephrops* mean length from SP-NSGFS showed an increasing trend from 1983 to 2008 (Figure 12.3.5). Atlantic Iberian Northern *Nephrops* stocks mean length show an increasing trend until 2009-2011 (Figures 12.1.1, 12.2.1). Both the landings and CPUE decreased in the fisheries. The decreasing fishing mortality (F) together with an increase in mean size could be related with global processes (*e.g.* Teixeira *et al.*, 2014). The resilience of the different stocks to these processes could be related with their different population/fishery characteristics (fishing pressure, stock density and size, etc.) and local/punctual events (*Nephrops* larvae mortality, etc.).

12.4 References

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Teixeira, C.M., Gamito, R., Leitão, F., Cabral, H.N., Erzini, K. and Costa, M.J. 2014. Trends in landings of fish species potentially affected by climate changes in Portuguese fisheries. Regional Environmental Change 14 (2): 657-669. https://doi.org/10.1007/s10113-013-0524-5

Table 12.3.1. *Nephrops* in Division 8c. Landings and discards (tonnes). *Nephrops* TAC in 8c was zero in 2017, 2018 and 2019.

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	0	3	0	4	10
2019*	2*	1	1*	6	0	3	12

* *Nephrops* TAC was zero in 8c (FU 25 & FU 31) in 2017, 2018 and 2019, but there were *Nephrops* Sentinel Fisheries in FU 25 and FU 31.

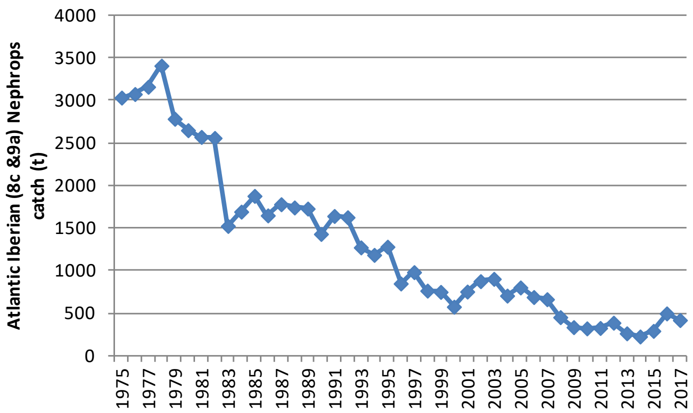

Figure 12.3.1. Atlantic Iberian (8c+9a) *Nephrops* landings (t), 1975–2017.

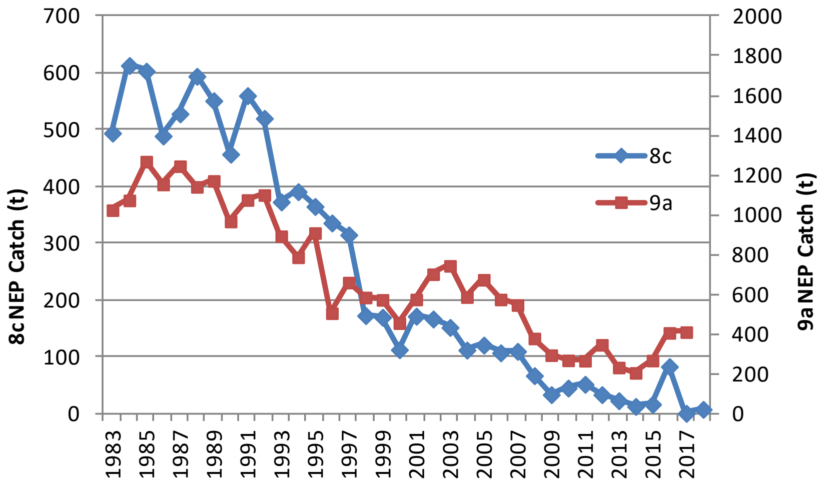

Figure 12.3.2. 8c and 9a *Nephrops* landings (t), 1983–2018.

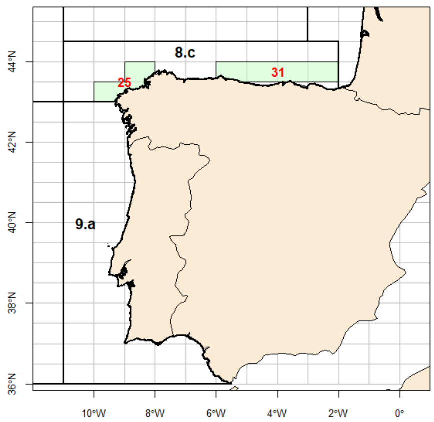

Figure 12.3.3. *Nephrops* in Division 8c: FU 25 (North Galicia) and FU 31 (Cantabrian Sea).

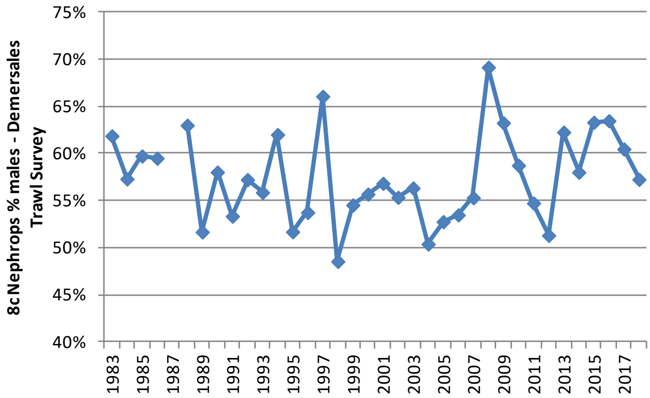

Figure 12.3.4. *Nephrops* in Division 8c. Percentage of males from the whole Spanish "Demersales" Trawl Survey (SP-NSGFS) (1983-2018).

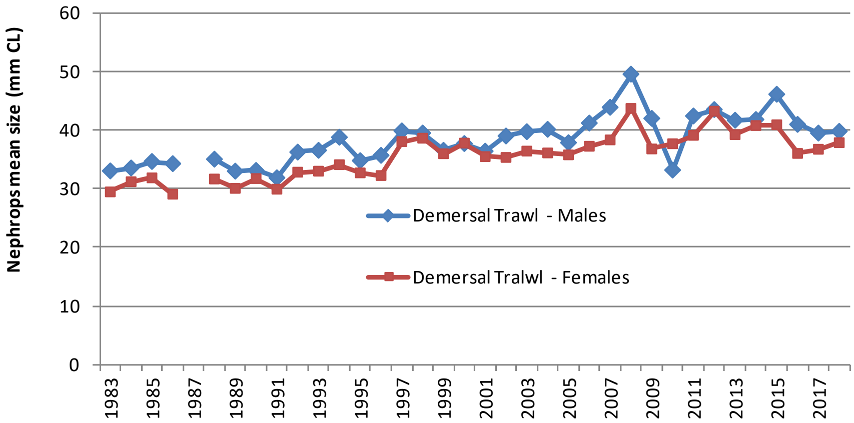

Fig. 12.3.5. *Nephrops* in Division 8c. Mean sizes from the whole Spanish "Demersales" Trawl Survey (SP-NSGFS) (1983-2018).

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

13.1.1.2 Fishery description

See Stock Annex

13.1.2 ICES Advice for 2020 and management applicable to 2019 and 2020

ICES advice for 2020

The advice for these *Nephrops* stocks is triennial and valid for 2020, 2021 and 2022.

For *Nephrops* in FUs 26-27, ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2020, 2021 and 2022.

To ensure that the stock in FUs 26 and 27 is exploited sustainably, ICES advises that management should be implemented at the functional unit level.

Management applicable to 2019 and 2020

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 was 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 was based on precautionary reference points for southern hake that are no longer appropriate.

In March 2019, the European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (Parliament and Council Regulation (EU) 2019/472) and repealed the previous recovery plan. This plan applies to demersal stocks including *Nephrops* in FU 26-27 in ICES divisions 9a.

In order to further reduce F on *Nephrops* stocks in this Division, seasonal fishing restrictions were introduced in the trawl and creel fishery in 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 401 t for 2019 and 386 t for 2020, respectively, of which no more than 6 % may be taken in FUs 26 and 27 and no more than 120 t in 2019 and 77 t in 2020 may be taken in FU30. In 2019, the maximum number of fishing days per vessel was fixed at 129 days for Spanish vessels and at 113 days for Portuguese vessels for 2019 (Annex II A of Council

Regulation no 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 regime. In the current Management Plan for Western Waters, applied to 2020 onwards, no effort limitations were established.

A Fishing Plan for the Northwest Cantabrian ground was established in 2013 (AAA/1307/2013, BOE, 2013) and modified in 2014 (AAA/417/2014, BOE, 2014). These regulations establish a quota assignment system for several stocks (including *Nephrops*) by vessel.

1.1.1 Data

1.1.1.1 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 bycatch although it is a very valuable species.

Considering the whole 1975-2019 time series of landings, for both FUs and countries combined, two periods can be distinguished (Figure 13.1.9.1). 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 and below 10 t in 2012. Landings were minimal since that date.

Table 13.1.9.1 shows total landings in FU26-27 by FU and country for the time-series. Information on discards was sent to the WG through InterCatch although no discards are recorded in these FUs. Differences between landings in both FUs diminished, recording FU 27 higher landings since 2005 despite remaining stable at low level. In 2019, landings increased in relation to the previous years and a total of 6 t were estimated, being taken 84% in FU 27 mainly by the Portuguese fleet.

Along the time series, landings by the Spanish fleets are mostly from FU 26, together with smaller quantities taken from FU 27. Yet, prior to 1996, no distinction was made between these two FUs, and, therefore they were considered together. Overall, landings recorded in both FUs decreased in the time series (from a maximum of 359 t in 1997 in FU 26 and 68 t in FU 27 to a minimum of near 0 t in both FUs in recent years). Since 2005 onwards, landings from both FUs were of the same order of magnitude.

Total Portuguese landings from FU 27 have decreased from almost 100 t in 1988 to 17 t in 1996. In 1997-2004 period, landings decreased to a mean value of 7 t but a slight increase was observed from 2005 to 2009 (mean value of 11 t). From 2010 onwards, landings decreased to the lowest values in the time series (ranging from 0 to 4 t).

1.1.1.2 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 13.1.9.1). 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. No length frequencies distributions for both sexes were available in 2017 and 2018. In 2019, the mean length in both sexes was higher than in the previous data available: 46.9 mm for males and 40.6 mm for females. Annual length compositions for males and females combined, mean size and mean weight in landings for the period 1988-2019 are given in Table 13.1.9.2 and Figures 13.1.9.2a and 13.1.9.2b.

13.1.3.3 Commercial catch-effort data

Fishing effort and LPUE estimates are available for Marin trawl fleet (SP-MATR) for the period 1990-2019 (Table 13.1.9.3; Figure 13.1.9.1). The overall trend for the effort and LPUE of SP-MATR time series is decreasing. Fishing effort remained at a very low level since 2010 (mean value 447 Kg/trip). LPUE series shows the same, so the commercial index was very low since 2012 and lower than 1 Kg/trip since 2014, indicating that the abundance in these FUs is very poor. In 2019, fishing effort was 383 trips and LPUE 0.3 Kg/trip.

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 13.1.9.1 for complementary information.

13.1.4 Biomass index from surveys

The SP-NSGFS-Q4 IBTS 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 designed 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 the whole area surveyed and not by FU, for this reason it was never explored by this WG. Now the *Nephrops* survey index is estimated for the total ICES statistical rectangles in FU 26 (West Galicia) and expressed as the mean biomass or abundance per haul (mean Kg/haul and mean number of individuals per haul) (Table 13.1.9.4 and Figure 13.1.9.3).

The survey index shows an increasing trend from 1985 to 1991 (Figure 13.1.9.3), when the highest value was recorded (0.72 Kg/30min.). In 1994, the abundance decreased up to 0.06 Kg/30min. The abundance increased in 2001 (0.22 Kg/30min.) and afterwards the index remained at very low level. The mean value in the 2001-2019 period was 0.03 Kg/haul and in 2019, with 0.02 Kg/haul in 2019.

Marin Fishing Industry (OPROMAR, Productores de Pesca Fresca del Puerto y la Ría de Marín) promoted a survey onboard a commercial vessel in order to estimate *Nephrops* abundance index in FU 26 with an observer onboard and the supervision of IEO. The survey was conducted from 24th July to 29th August 2019, following a systematic sampling over a 5x5 nm grid. Detailed results obtained in this survey (GALNEP-19) are shown in a Working Document presented during this WGBIE 2020 (WD 09 – Vila *et al.*, 2020). The survey index from GALNEP-19 with 95% confidence interval was 0.74±0.58 Kg/h (0.06 Kg/Kw day). Figure 13.1.9.4 shows the *Nephrops* biomass index distribution in FU26. *Nephrops represented* only 1.04% of the total retained catch and discard rate was zero. There were only 7 *Nephrops* positive hauls (18%) of a total of 39 hauls carried out. The spatial analysis of the survey index indicates that *Nephrops* is concentrated in a small area on the Northwest half within the original distribution area in FU 26 (Figure 13.1.9.4). The mean length was 39.9 mm CL for females and 43.9 mm CL for males.

13.1.5 Assessment

No assessment has been carried out this year as the last advice is for 2020, 2021 and 2022. Nevertheless, 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 V (ICES, 2015), WKProxy (ICES, 2016) and WGBIE 2019 (ICES, 2019). $F_{0.1}$, taken as proxy of F_{MSY}, from length–based analysis was estimated using the Mean-Length Z method. The period 1988-2016 was used since length composition for 2017 and 2018 was not available. The proxy of F_{MSY} resulted in 0.16 for both sexes combined. No update of this proxy has been carried out in 2020. 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 (Parliament and Council Regulation (EU) 2019/472). This plan applies to demersal stocks including *Nephrops* in FU 26-27 in ICES division 9a.

A Fishing Plan for the Cantabrian and Northwest fishing grounds was established in 2013 (AAA/1307/2013, BOE, 2013) and modified in 2014 (AAA/417/2014, BOE, 2014). These regulations establish a quota assignment system for several stocks (including *Nephrops*) by vessel.

Unwanted catches from *Nephrops* are regulated by the discard plan for demersal fisheries in South-Western waters for the period 2019-2021 (Council Regulation (EC) No 2018/2033, replaced by the Council Regulation (EU) No 2019/2237), under which they are exempted from the landing obligation based on this species' high survival rates. This exemption applies to all catches of Norway lobster from ICES subareas 8 and 9 with bottom trawls, and the discards shall be released whole, immediately and in the area where they were caught.

13.1.8 References

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Table 13.1.9.1.*Nephrops* FU 26-27, West Galicia and North Portugal. Landings in tonnes by Functional Units and country.

	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
2019	1	1	4	6

**Prior 1996, landings of Spain recorded in FU 26 include catches in FU 27

Table 13.1.9.2. Nephrops FU 26-27, West Galicia and North Portugal. Length compositions, mean weight (Kg) and mean size (CL, mm) in landings for the 1988-2019 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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

(to be continued in next page)

Table 13.1.9.2. *Nephrops* FU 26-27, West Galicia and North Portugal. Length compositions, mean weight (Kg) and mean size (CL, mm) in landings for the 1988-2019 period. Data not available in 2017 and 2018. (continued from previous page).

Lenght (mm)	2013	2014	2015	2016	2017	2018	2019
12	0						
13	0						
14	0						
15	0						
16	0						
17	0						
18	0						
19	0						
20	0						
21	0						
22	1						
23	0						
24	0	1					
25	0	2	0	1			0
26	0	1	0	0			0
27	0	1	0	0			0
28	0	2	0	1			0
29	0	2	0	2			0
30	1	4	0	4			2
31	1	1	0	0			1
32	1	1	0	2			1
33	1	0	1	2			1
34	1	5	1	3			3
35	1	5	2	5			2
36	1	2	1	2			3
37	1	3	1	2			3
38	1	1	1	3			2
39	1	2	1	2			3
40	1	4	3	5			4
41	1	1	1	1			3
42	1	1	1	2			2
43	1	1	2	1			6
44	0	3	1	3			3
45	0	3	1	6			5
46	0	1	0	1			2
47	0	1	0	3			3
48	1	1	0	2			3
49	0	1	0	2			3
50	0	2	0	3			3
51	0	0	0	1			1
52	0	0	0	1			1
53	0	0	0	1			2
54	0	1	0	1			1
55	0	1	0	2			1
56	0	0	0	0			1
57	0	0	0	0			0
58	0	1	0	0			1
59	0	0	0	0			1
60	0	1	0	1			1
61	0	0	0	1			0
62	0	0	0	0			1
63	0	0	0	0			1
64	0	0	0	0			0
65	0	0	0	0			0
66	0	0	0	0			0
67	0	0	0	0			0
68	0	0	0	0			0
69	0	0	0	0			0
70	0	0	0	1			0
71	0	0	0	0			0
72	0	0	0	0			0
73	0	0	0	0			0
74	0	0	0	0			0
75	0	0	0	0			0
76	0	0	0				0
77	0	0	0				0
78	0	0	0				0
79	0	0					
80	0						
81	0						
82	0						
83	0						
84	0						
Total number (thousand)	20	60	23	69			72
Total weight (t)	3	4	2	5			5
Mean weight (kg)	0.081	0.059	0.087	0.077			0.065
CL Mean length (mm)	35.8	39.4	42.0	42.2			45.0

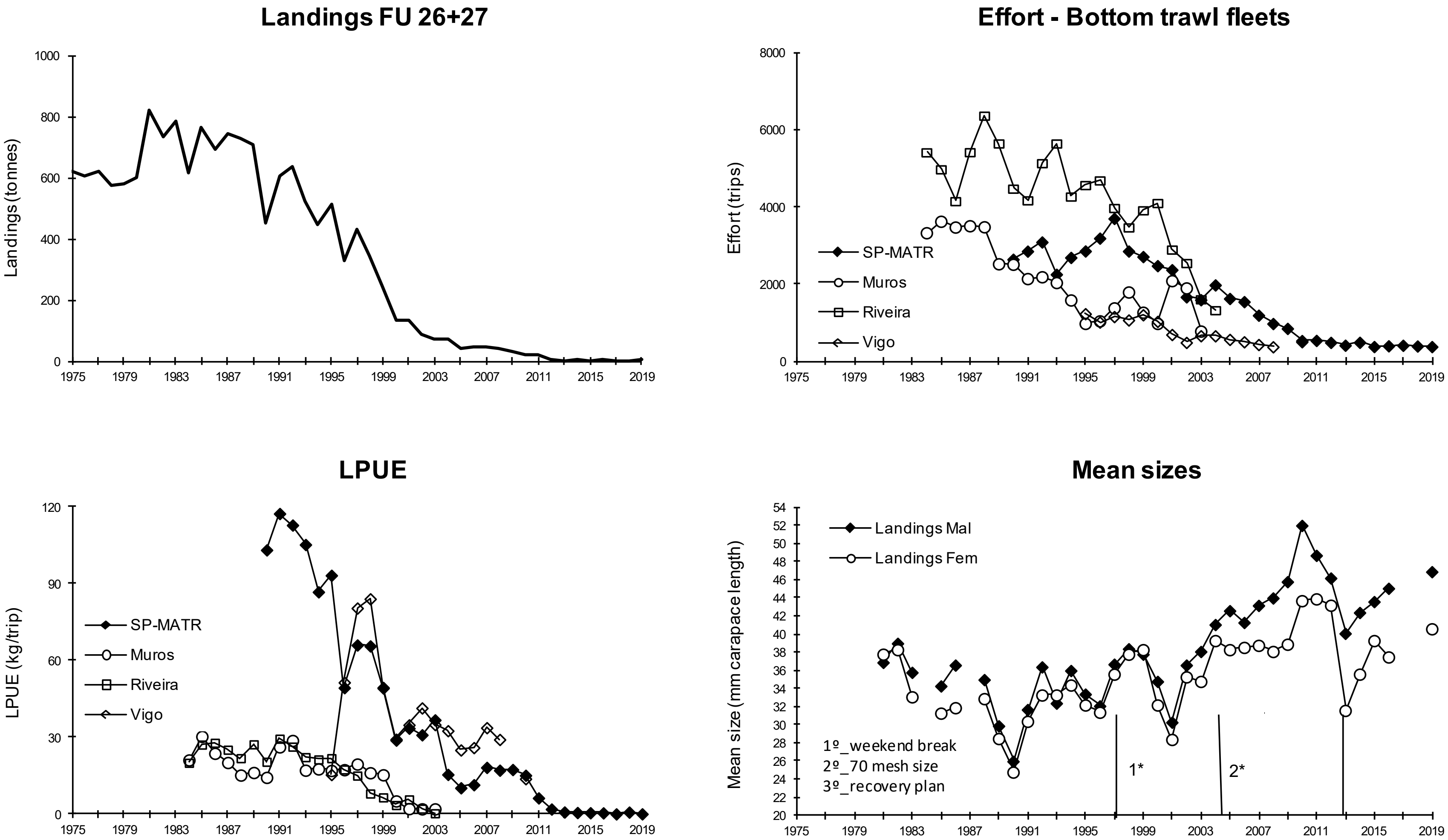
Table 13.1.9.3. ***Nephrops*** **FU 26-27, West Galicia and North Portugal. Fishing effort and LPUE for SP-MATR fleet.**

		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
2019	<1	383	0.3

Table 13.1.9.4. *Nephrops* FU 26–27, West Galicia and North Portugal: Biomass and abundance index from Spanish bottom trawl survey (SP-NSGFS-Q4 IBTS)) in statistical rectangles included in FU 26.

	SP-NSGFS survey index in FU 26 (14E0, 13E0, 13E1*)			
	Nº Hauls	Nº Hauls with Nephrops catch	Kg/30'	Nº Indv./30'
1983	13	10	0.43	17.46
1984	16	8	0.22	9.44
1985	18	13	0.15	9.67
1986	17	14	0.55	24.41
1987*				
1988	17	12	0.68	28.24
1989	17	16	0.45	21.24
1990	18	14	0.59	22.22
1991	19	7	0.72	27.37
1992	21	14	0.37	14.67
1993	19	10	0.13	5.05
1994	18	5	0.06	1.56
1995	19	9	0.27	10.37
1996	19	8	0.06	2.47
1997	20	8	0.07	1.25
1998	20	5	0.09	1.35
1999	22	10	0.14	3.32
2000	17	7	0.07	1.41
2001	21	8	0.22	6.05
2002	19	4	0.02	0.32
2003	18	3	0.04	0.50
2004	18	5	0.02	0.44
2005	20	2	0.01	0.15
2006	20	6	0.04	0.85
2007	18	3	0.01	0.17
2008	25	7	0.03	0.48
2009	23	2	0.02	0.39
2010	20	5	0.08	1.55
2011	20	3	0.01	0.20
2012	19	1	0.01	0.16
2013	20	5	0.04	0.35
2014	20	2	0.02	0.30
2015	21	2	0.01	0.19
2016	19	4	0.03	0.58
2017	20	2	0.02	0.45
2018	19	2	0.04	0.89
2019	21	3	0.02	0.29

* No survey was carried out in 1987.



1* -weekend break in West Galicia, 2*- 70 mm mesh size, 3*-recovery plan

Figure 13.1.9.1. *Nephrops* FU 26–27, West Galicia and North Portugal. Long-term trends in landings, effort and mean sizes.

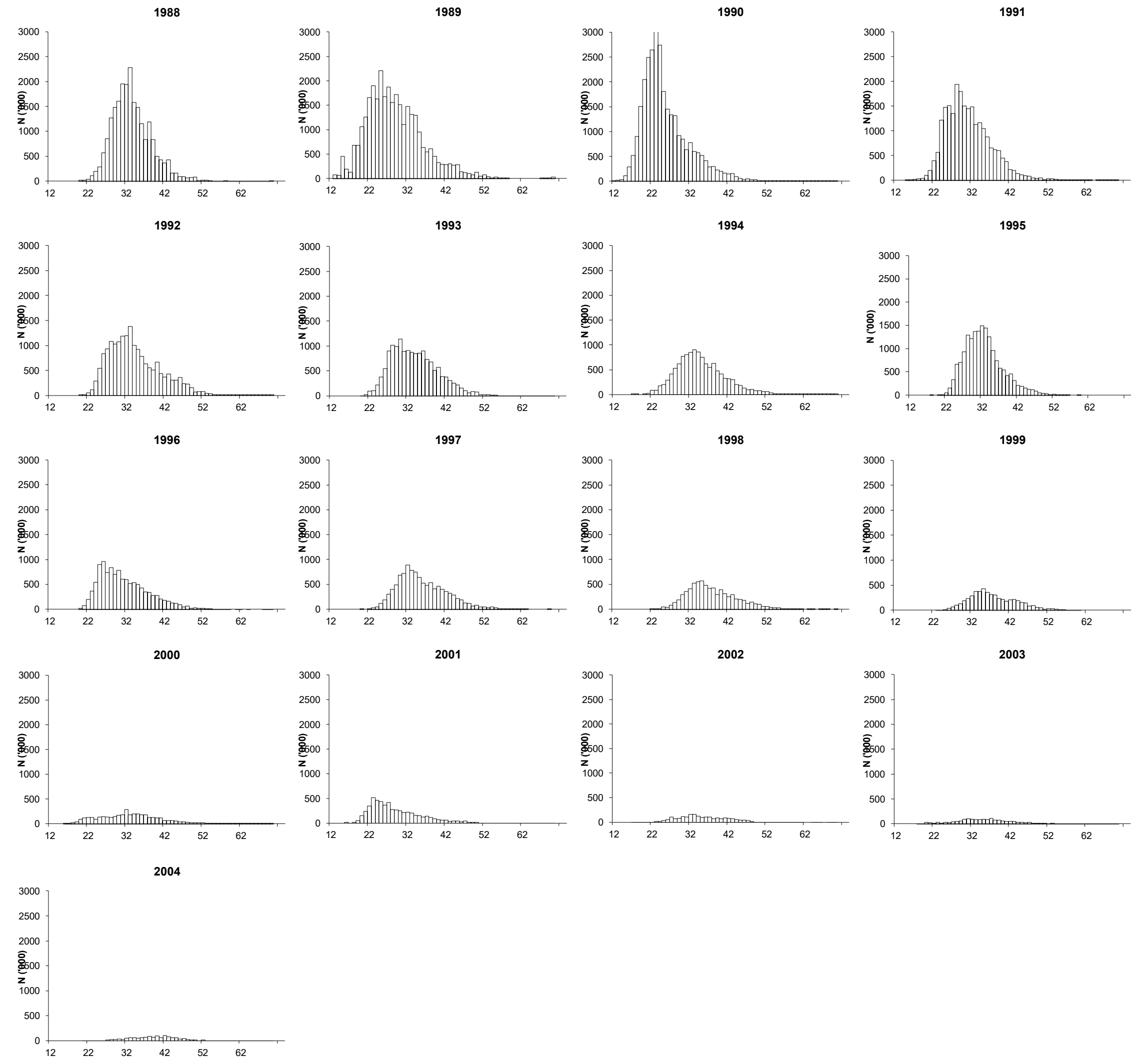


Figure 13.1.9.2a. ***Nephrops*** **FU 26–27. West Galicia and North Portugal. Length distributions in landings for the 1988–2004 period.**

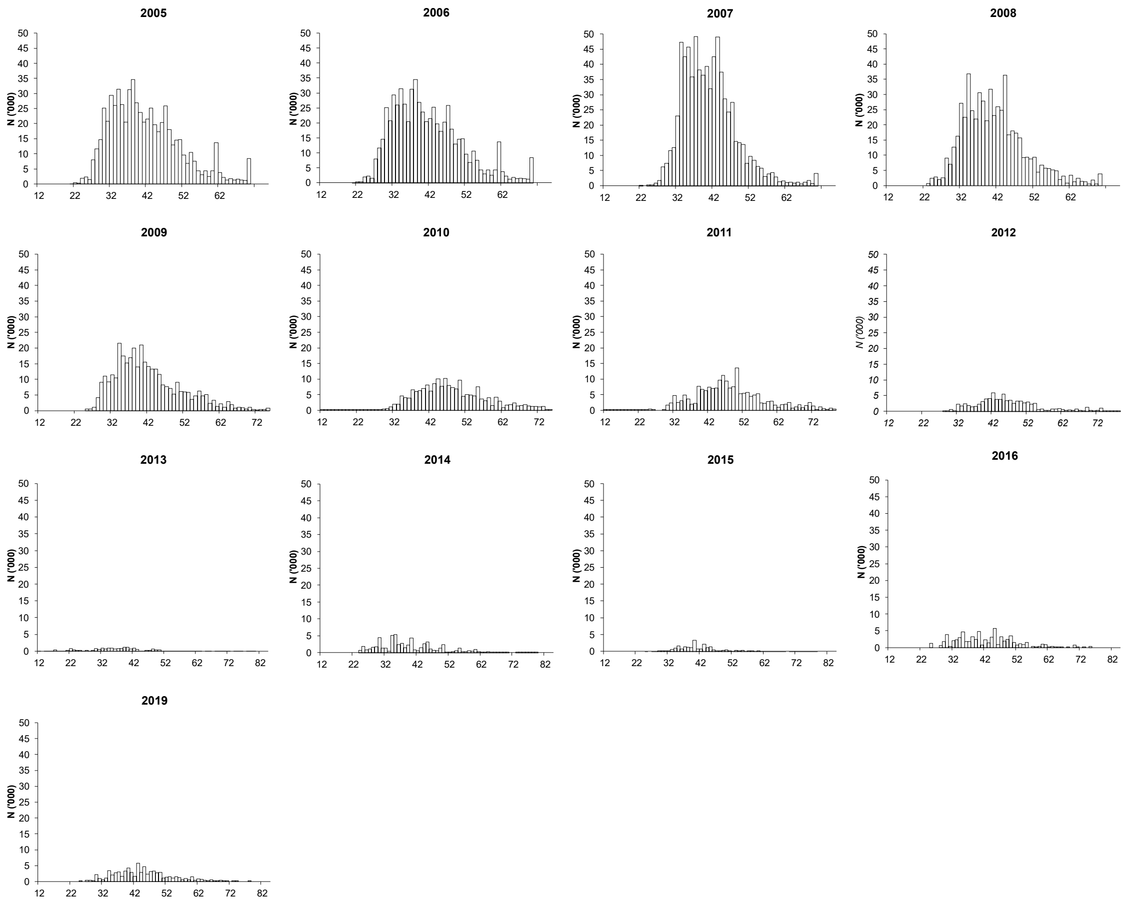


Figure 13.1.9.2b. ***Nephrops*** **FU26–27. West Galicia and North Portugal. Length distributions in landings for the 2005–2019 period. Data not available for 2017 and 2018.**

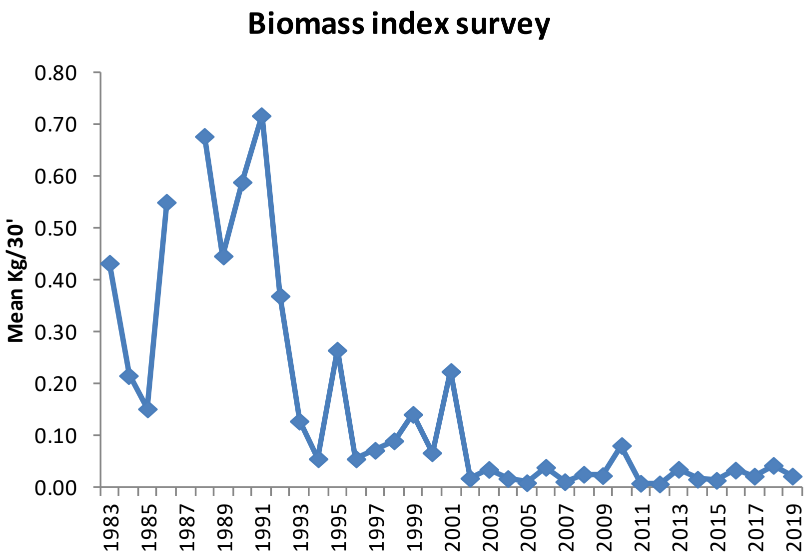


Figure 13.1.9.3. ***Nephrops*** **FU 26–27. West Galicia and North Portugal. Biomass index from Spanish bottom trawl survey (SP-NSGFS-Q4 IBTS) in statistical rectangles included in FU26. No data available for 1987.**

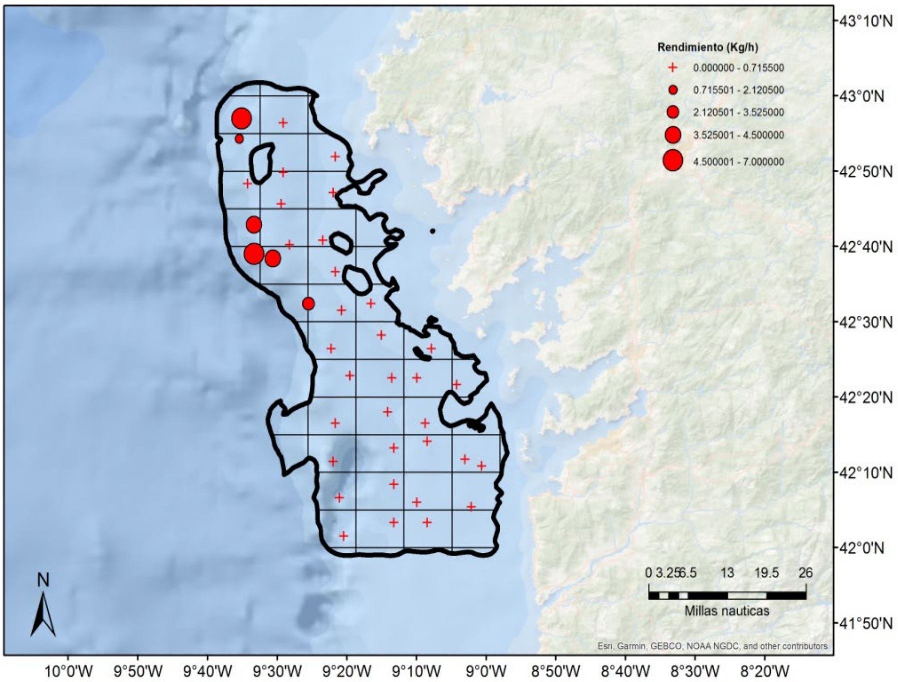


Figure 13.1.9.4. ***Nephrops* FU 26–27. West Galicia and North Portugal. *Nephrops* biomass spatial distribution from GAL-NEP_19 survey in FU26.**
x

13.2 FU 28 - 29 (SW and S Portugal)

13.2.1 General

13.2.1.1 Ecosystem aspects

See the Stock Annex

13.2.1.2 Fishery description

See the Stock Annex (in Annex L of WG report)

13.2.1.3 ICES Advice for 2020 and Management applicable for 2019 and 2020

ICES Advice for 2020

The advice for these stocks is biennial and valid for 2020 and 2021. Based on the ICES approach for data-limited stocks, ICES advised that catches in 2020 for FUs 28 and 29 should be no more than 309 t.

To ensure that the stock in FUs 28 and 29 is exploited sustainably, ICES advises that management should be implemented at the functional unit level.

Management applicable for 2019 and 2020

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). ICES has not evaluated the recovery plan for *Nephrops* in relation to the precautionary approach. This plan was based on precautionary reference points for southern hake that are no longer appropriate.

In order to further reduce F on *Nephrops* stocks in Division 9.a, 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)

The TAC set for the whole Division 9.a was 401 and 386 t for 2019 and 2020, respectively, of which no more than 6 % may be taken in FUs 26 and 27; and no more than 120 t in 2019 and 77 t in 2020 may be taken in FU 30. In 2019, 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 and 109 days for French vessels (Annex IIA of Council Regulation (EU) 2019/124). The number of fishing days included in this regulation is not applicable to the Gulf of Cadiz (FU 30), which has a different effort management regime.

A new Management Plan for Western Waters (EU, 2019) was established in 2019 for demersal species including *Nephrops* in these FUs. In the current Management Plan for Western Waters, applied to 2020 onwards, no effort limitations were established.

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 then 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 from FUs 28-29.

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 2018 and 2019 were 1.3:1 and 0.9:1, 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 2019 was at the same level as in previous years, in the months when the Norway lobster fishing was open. The sampling data were 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 small size individuals. 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 an 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.

In 2019, the survey was not conducted due to issues external to IPMA.

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 1994-2019 (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 into 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 to 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 exceeding the 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 the model used has not changed, 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 2008-2019, 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 2019.

The advice is based on the standardized commercial CPUE and effort trends. According to the ICES data-limited approach, this stock is classified as 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 showed an increasing trend in 2014–2018 (Figure 13.2.3).

Length-based indicators (LBI), defined at WKLIFE V (ICES, 2015), 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; Gedamke and Hoenig, 2006) and Then, Hoenig & Gedamke (THoG; Then, 2014) 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 a better fit and a lower AIC. For the last period, fishing mortality was estimated at 0.17 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 or 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 (ICES, 2017) using the methods developed in WKLIFE V 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).

In November 2019, a Workshop on Methodologies for *Nephrops* Reference Points was held in Lisbon to evaluate reference point estimation methods for stocks with UWTV surveys and to evaluate the utility of other modelling frameworks to assess and provide reference points for *Nephrops* stocks. Besides the Length-Based Indicators and Mean Length Z models (WKLIFE V, ICES, 2015) already used in the assessment of this stock, other approaches as Separable Cohort Analysis (*SCA* R package, version 1.2.0; Bell, 2019), Separable Length Cohort Analysis (SLCA – *nepref* R package, version 0.2.2; Dobby, 2019), Length-based Stock Potential Ratio (LBSPR, Hordyk et al, 2015) and Surplus Production in Continuous Time (SPiCT, Pedersen and Berg, 2017) were tested.

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 by 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.

Unwanted catches from *Nephrops* are regulated by the discard plan for demersal fisheries in South-Western waters for the period 2019-2021 (Council Regulation (EC) No 2018/2033, replaced by the Council Regulation (EU) No 2019/2237), under which they are exempted from the landing obligation based on the species' high survival rates. This exemption applies to all catches of Norway lobster from ICES subareas 8 and 9 with bottom trawls, and all discards shall be released, immediately and in the area where they were caught.

13.2.6 References

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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			
	Spain	Spain	Portugal			Total
	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
1999			5	206	211	211
2000			4	197	201	201

	FU 28+29 SW+S Portugal					
Year	28***	29		28+29		Total
	Spain	Spain		Portugal		
	Trawl	Trawl	Artisanal	Trawl	Total	
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
2019**		**31**	**8**	**245**	**253**	**284**

** Preliminary values

*** Spanish landings from FU28 included in FU29

Table 13.2.2.a. FU 28-29 - Length Composition of *Nephrops* males (1984-2019).

Landings (thousands)														
Length/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 (1984-2019) (continued).

Landings	(thousands)													
Length/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 (1984-2019) (continued).

Landings (thousands)								
Length/Year	2012	2013	2014	2015	2016	2017	2018	2019
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	22
26	37	6	7	3		23	89	4
27	47	27	15	8		68	162	38
28	37	25	12	10		109	201	19
29	143	55	35	27	10	149	241	63
30	158	84	36	71	27	324	321	114
31	248	82	49	112	51	293	382	142
32	573	217	120	138	36	345	433	144
33	329	109	47	96	75	207	281	106
34	436	276	119	162	166	277	334	138
35	356	155	144	263	128	295	387	268
36	248	191	119	202	173	138	146	108
37	211	145	108	191	155	145	191	144
38	206	216	144	179	240	82	89	134
39	126	95	129	125	300	71	116	97
40	112	162	160	139	247	114	128	187
41	114	113	90	117	179	86	69	110
42	140	171	129	142	185	101	112	162
43	79	64	58	85	182	64	45	95
44	87	89	104	127	222	94	82	132
45	52	42	59	92	187	108	64	157
46	46	81	59	62	211	75	23	64
47	47	89	83	61	129	53	42	55
48	30	67	26	28	157	18	26	27
49	32	53	36	48	92	32	33	22
50	19	59	25	58	69	41	53	73
51	17	37	32	56	58	27	47	30
52	33	47	64	70	26	46	57	39
53	22	18	25	45	34	38	34	29
54	32	36	44	48	52	46	54	36
55	15	16	24	60	41	38	45	43
56	24	20	20	43	51	30	30	30
57	20	15	20	27	36	22	33	38
58	7	12	10	14	45	5	19	12
59	7	8	9	16	38	12	18	19
60	4	10	7	10	30	10	15	12
61	9	7	4	4	21	4	10	8
62	3	1	12	4	10	5	8	3
63	2	4	3	3	14	2	3	1
64	2	3	8	3	10	2	4	6
65	1	1	2	1	9	2	9	7
66	3	2	3	2	6	3	5	8
67	3	1	2	1	4	2	5	6
68	3	1	1	0	4	1	2	3
69	1		1	0	8	1	3	5
70	3	1	1	0	3	1	4	5
71	1		1	0	3	1	0	2
72	3	0	1		2	0	2	2
73	1		1		0	0	0	3
74	1		1		0	0	0	3
75	1		0		0	0	3	3
76	0			0			0	1
77	0				0		0	0
78					0	0	0	
79	0				0		0	
80							0	
81								
82								
83								
Total	4170	2928	2217	2959	3725	3632	4693	2979
Landings (t)	149	132	114	147	166	139	169	150

Table 13.2.2.b. FU 28-29 - Length Composition of *Nephrops* females (1984-2019).

Landings	(thousands)														
Length/Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
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	2
23	66	21	7	31	28	135	15	69	38	21	2		0	0	4
24	79	102	118	270	153	258	38	173	164	41	22	2	11	20	15
25	228	205	104	357	163	197	138	198	203	191	73		13	20	25
26	272	284	186	684	220	282	140	436	361	111	92	1	35	102	74
27	345	491	359	902	429	326	247	418	448	235	134	0	37	77	91
28	431	523	322	1421	471	231	345	598	597	413	170	6	36	152	148
29	443	672	419	1253	516	285	491	590	514	523	269	31	45	178	114
30	422	588	381	928	499	317	575	771	599	775	326	104	50	199	199
31	487	593	418	948	482	501	639	414	736	752	427	182	95	394	168
32	485	653	700	946	766	306	859	807	617	824	558	322	198	502	376
33	613	415	406	227	527	314	596	375	430	449	283	251	53	163	116
34	618	467	654	774	813	511	734	310	369	359	353	641	209	278	298
35	562	563	447	447	460	435	519	284	287	194	246	674	184	150	112
36	469	329	316	386	489	274	243	130	267	203	237	811	142	135	166
37	505	353	400	223	206	318	189	108	333	154	147	692	267	129	171
38	383	284	330	269	265	285	207	135	251	100	128	348	151	39	48
39	274	142	211	146	288	148	216	74	176	150	66	194	67	35	59
40	171	119	80	119	132	131	230	131	147	110	114	344	120	21	89
41	58	106	55	65	128	149	73	39	68	108	77	361	63	31	64
42	50	36	133	54	43	127	210	62	69	95	73	165	111	18	84
43	30	27	21	40	28	109	58	82	26	43	23	64	29	2	34
44	17	13	47	147	27	91	77	6	46	42	43	88	90	18	71
45	14	11	27	84	19	27	41	21	40	34	13	54	36	8	22
46	7	6	5	40	14	38	31	45	25	37	11	13	15	4	28
47	5	3	3	26	9	24	16	7	12	29	7	18	23	3	23
48	4	1		71	11	29	7	15	18	15	4	15	8	2	6
49	1	0	3	17	4	9	1	17	17	23	4	1	6	7	6
50	1	0		2	6	3	1	2	32	8	17	1	2	1	6
51	0	0	3	4	3	7	2	4	4	5	0			1	2
52	1			5	5	8	1		5	6	1	1	0	1	1
53	2			2	3	1			9	6	0			0	0
54				4	1	1			1	1			1	0	1
55				0	1	1			6	2					
56				3	0	2		5	14	5					0
57				0	0	1			4	1			0		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	2621
Landings (t)	169	156	150	232	171	151	174	134	165	145	97	174	67	62	72

Table 13.2.2.b. FU 28-29 - Length Composition of *Nephrops* females (1984-2019) (continued).

Landings	(thousands)													
Length/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 (1984-2019) (continued).

Landings	(thousands)							
Length/Year	2012	2013	2014	2015	2016	2017	2018	2019
17								
18								
19				0				
20								
21	7				4			
22		3	1		4		19	
23		7	1	0	1		4	9
24	5	7	3		2	13	66	19
25	8	18	10	5	19	91	150	21
26	17	7	10	7	19	23	87	48
27	40	36	17	13	46	100	110	107
28	51	33	23	23	44	134	125	73
29	130	59	60	39	57	169	203	68
30	164	119	80	85	219	464	351	306
31	330	129	99	143	149	290	260	149
32	397	290	203	208	307	462	327	314
33	195	194	105	146	214	290	247	210
34	297	278	202	167	325	353	235	264
35	165	232	188	303	362	365	381	265
36	138	166	153	203	193	196	138	215
37	98	199	151	162	203	142	149	246
38	76	206	148	171	125	81	78	151
39	46	61	121	136	112	105	75	160
40	46	67	145	134	130	108	89	172
41	37	41	66	104	82	56	51	64
42	35	65	90	87	112	72	94	93
43	33	9	27	54	59	55	33	51
44	27	13	40	58	48	53	35	69
45	10	9	17	56	25	45	38	58
46	10	11	17	36	28	36	15	34
47	11	13	18	16	14	21	22	17
48	5	7	5	8	3	14	9	7
49	6	5	7	8	5	7	14	4
50	6	5	4	8	14	7	16	11
51	6	1	3	7	4	7	12	1
52	9	5	4	9	8	6	13	2
53	5	1	3	6	0	5	7	1
54	5	3	8	12	2	4	6	3
55	2	1	3	12	2	3	4	2
56	1	1	6	10	1	1	6	1
57	3	2	2	4	0	1	5	0
58	2	0		1	0	0	5	0
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	3217
Landings (t)	65	66	66	85	88	102	94	95

Table 13.2.3. SW and S Portugal (FUs 28-29): Effort and CPUE of Portuguese trawlers, 1994–2019.

Year	No. of trawlers	CPUE (t/vessel)	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	98 083	1.6
1999	26	8.1	91 415	2.3
2000	27	7.4	124 963	1.6
2001	33	8.2	89 749	3.0
2002	31	11.5	75 734	4.7
2003	32	10.5	58 182	6.4
2004	23	15.0	87 069	4.3
2005	25	15.3	69 379	5.6
2006	25	11.0	51 644	5.6
2007	26	10.5	56 068	5.2
2008	27	7.0	45 365	4.9
2009	27	4.9	34 700	4.3
2010	25	5.2	33 695	4.4
2011	26	4.5	39 175	3.8
2012	21	10.2	49 107	4.7
2013	24	8.2	41 450	5.1
2014	24	7.5	36 923	5.0
2015	22	10.5	48 576	4.8
2016	22	11.5	43 436	6.0
2017	22	11.0	51 238	5.4
2018	24	11.0	43 827	6.2
2019*	25	9.8	42 528	5.9

* provisional; ** standardized CPUE

Table 13.2.4. SW and S Portugal (FUs 28-29): *Nephrops* CPUEs (kg/hour) in research trawl surveys, 1994–2019.

Year	Demersal surveys CPUE (kg/hour) Summer	Demersal surveys CPUE (kg/hour) Autumn	Demersal surveys CPUE (kg/hour) Winter	Crustacean surveys Month and year of survey	Crustacean surveys CPUE (kg/hour)
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
2019	ns	ns	ns	ns	ns

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, 1994–2019.

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
2019	40.7	35.5	ns	ns	ns	ns	ns	ns	ns	ns
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			118651	153886		
year	21	27087	118630	126799	< 2.2e-16	17.6%
month	11	3786	118619	123014	< 2.2e-16	2.5%
depth.class2	2	3071	118617	119942	< 2.2e-16	2.0%
catdps	1	2054	118616	117888	< 2.2e-16	1.3%
cat_pnep	1	41264	118615	76624	< 2.2e-16	26.8%
catPRT2	2	1745	118613	74879	< 2.2e-16	1.1%
Total	**38**	**79007**				**51.3%**

AIC: 450335

Table 13.2.7. Length-based indicators for *Nephrops* males and females in FU 28-29.

Sex	Year	Conservation				Optimizing Yield	MSY
		L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{max5\%}/L_{inf}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
		>1	>1	>0.8	>30%	~1 (>0.9)	≥1
Males	2017	1.02	1.11	0.82	0.08	0.81	0.97
	2018	0.95	1.07	0.85	0.09	0.79	0.98
	2019	1.02	1.11	0.89	0.12	0.88	1.05
Females	2017	0.97	1.02	0.73	0.02	0.81	0.92
	2018	0.90	1.02	0.78	0.03	0.81	0.96
	2019	0.97	1.08	0.72	0.01	0.84	0.95

Table 13.2.8. Results from the application of the Mean Length Z approach.

		Males	Females
	Input:		
	LFD period	1984-2019	1984-2019
	Effort series	1998-2019	1998-2019
	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 =	0.47	0.29
	F* =	0.17	0.09
THoG	q estimate =	0.005	0.001
	q estimate* =	0.023	0.010
	M estimate =	0.43	0.26
	F_{2019} estimate =	0.02	0.01
	F_{2019} estimate* =	0.10	0.10
Y/R	F_{MSY} proxy: $F_{0.1}$ =	0.23	0.24

* indicates estimates with external fixed M

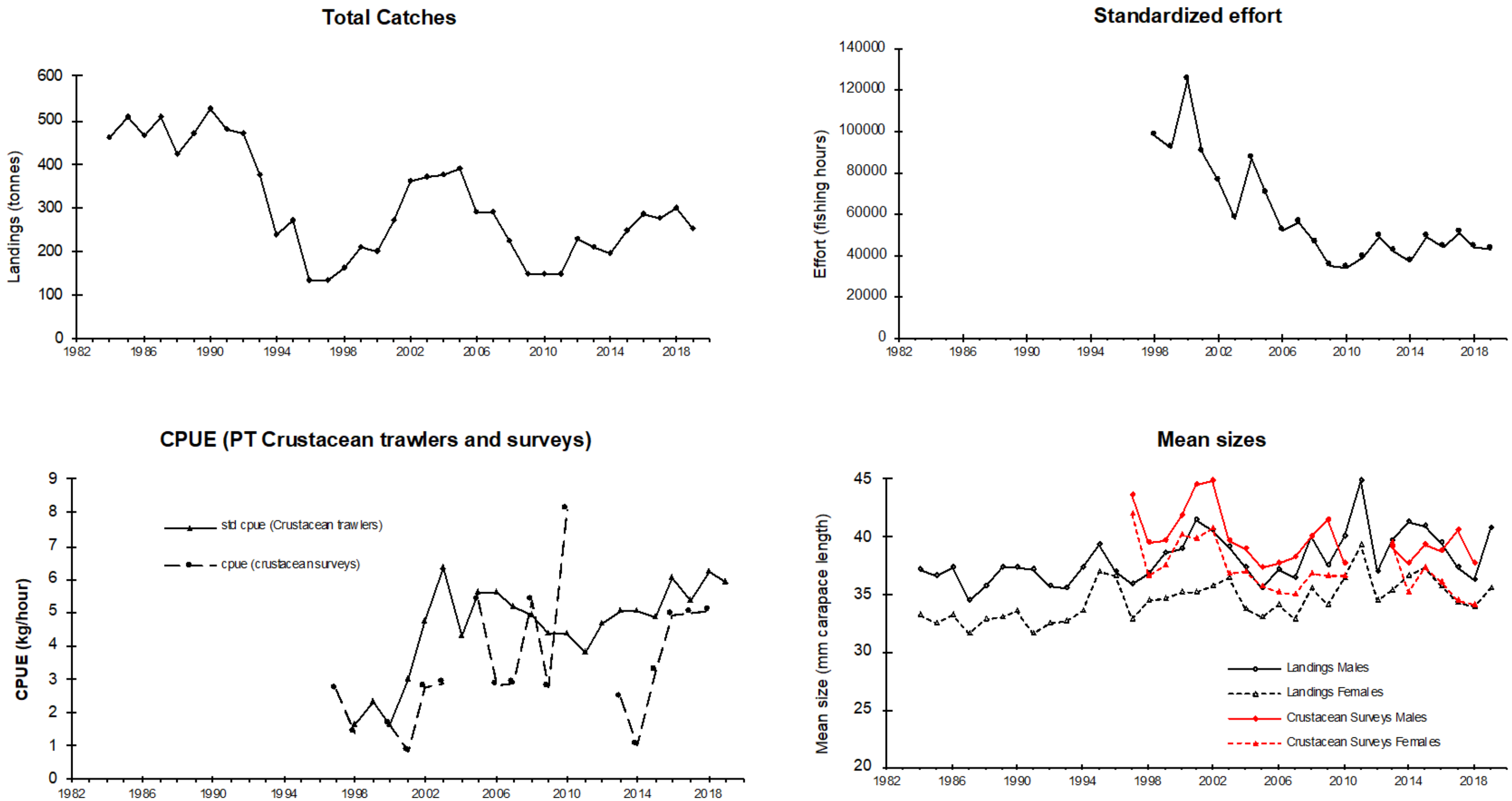


Figure 13.2.1. SW and S Portugal (FU 28+29): landings, effort, biomass indices and mean sizes of *Nephrops* in Portuguese landings and surveys. Note: Values of CPUEs and effort updated with the new CPUE standardization.

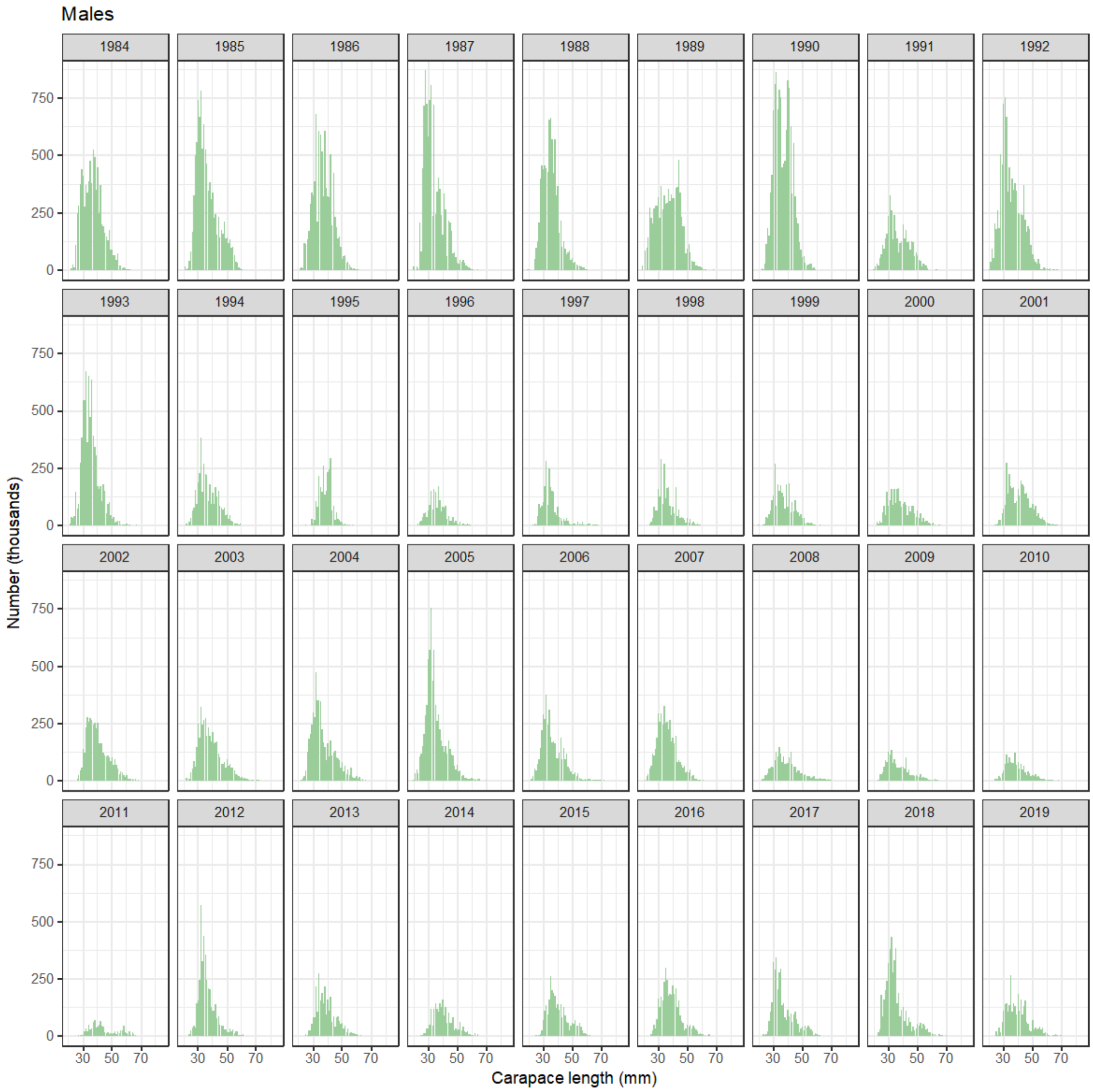


Figure 13.2.2.a. **SW and S Portugal (FU 28-29) male length distributions for the period 1984–2019.**

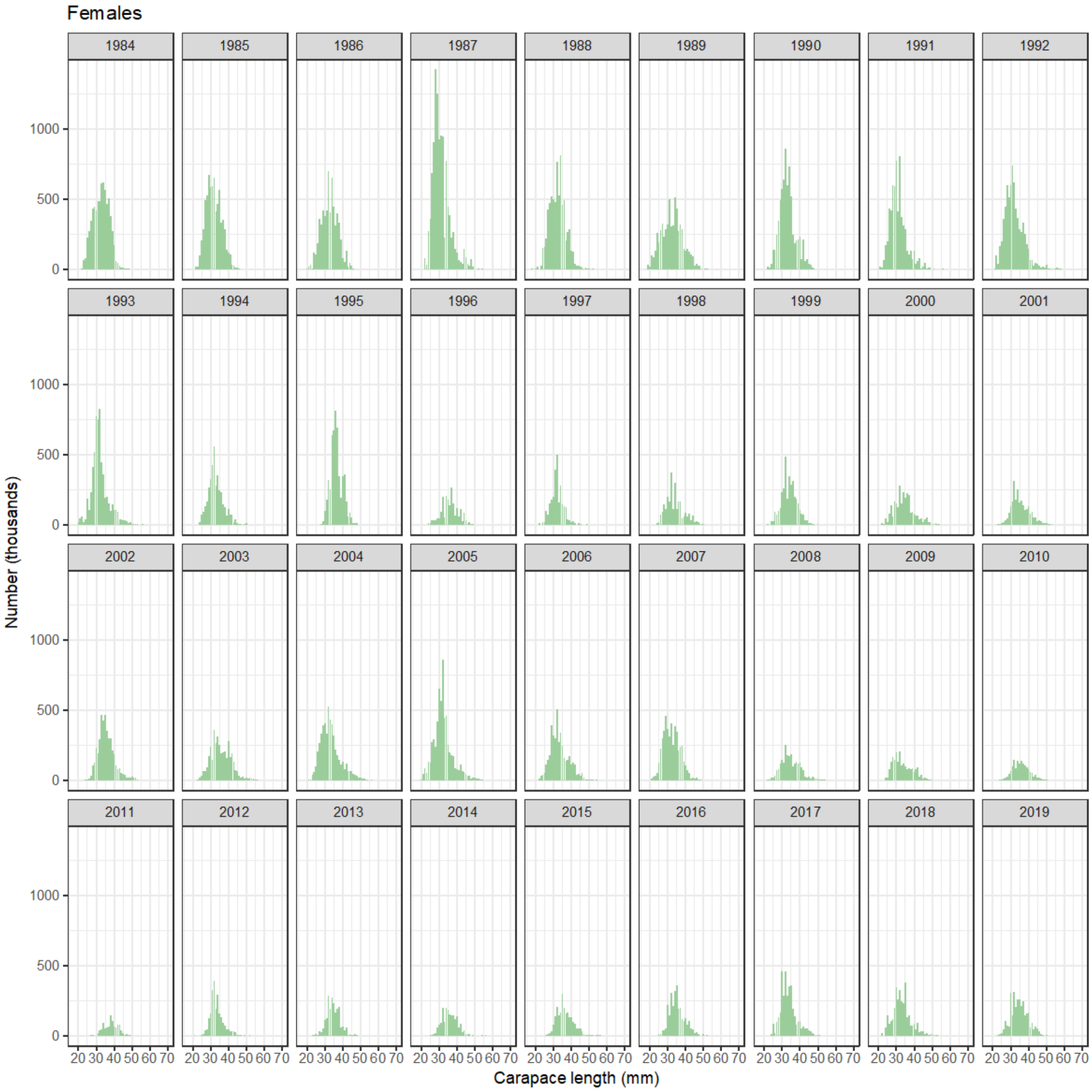
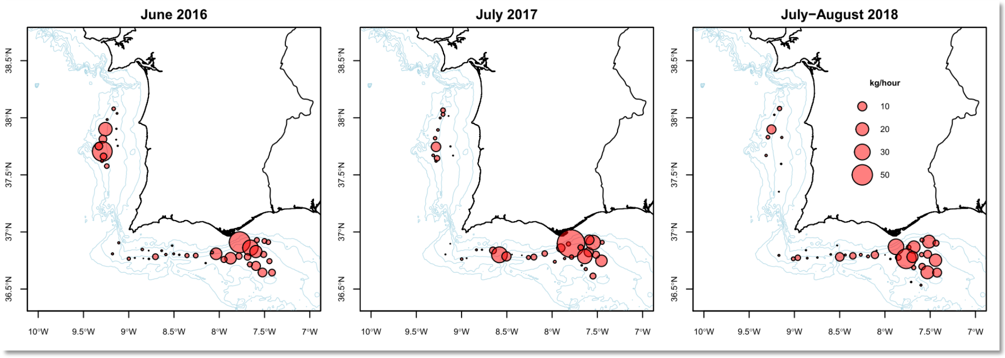


Figure 13.2.2.b. SW and S Portugal (FU 28-29) female length distributions for the period 1984–2019.



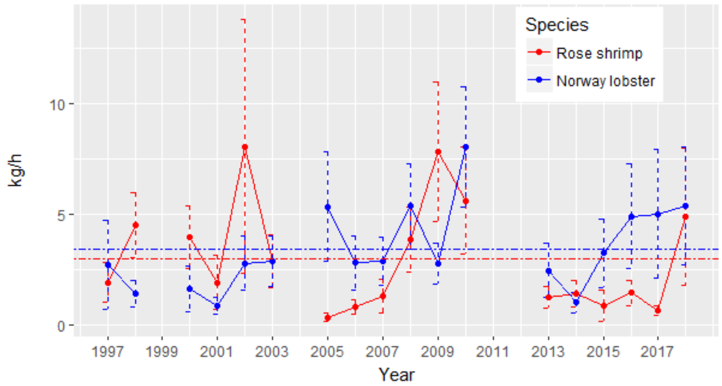


Figure 13.2.3. Spatial distribution of Norway lobster biomass survey index in the period 2016–2018 (upper panel) and stratified mean biomass time series with 95% confidence interval of Norway lobster and deepwater rose shrimp (lower panel).

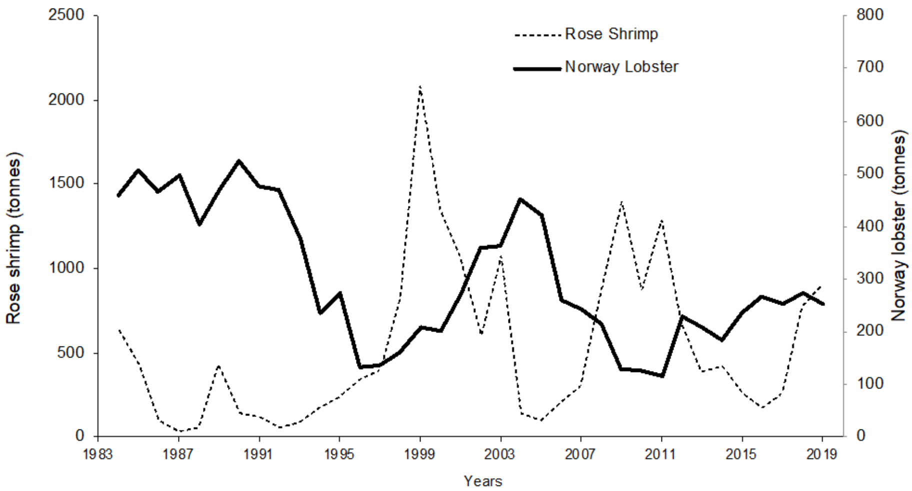


Figure 13.2.4 FUs 28-29: Landings of the two main target species of the Crustacean Fishery in the period 1984–2019.

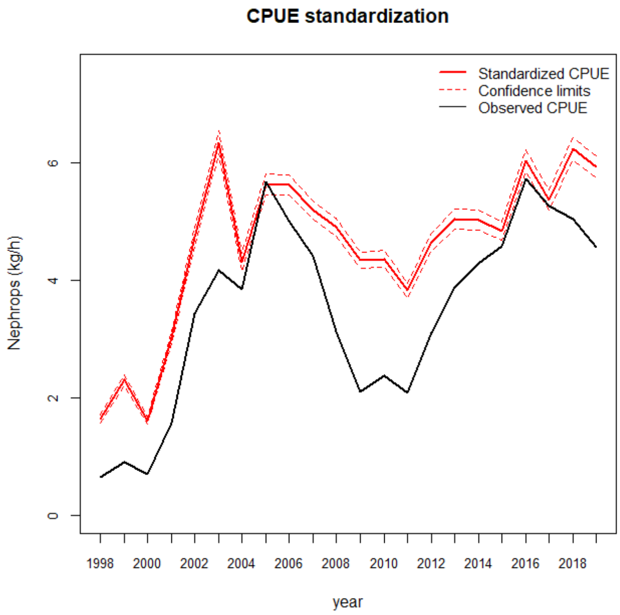


Figure 13.2.5. Comparison of standardized and observed *Nephrops* CPUE.

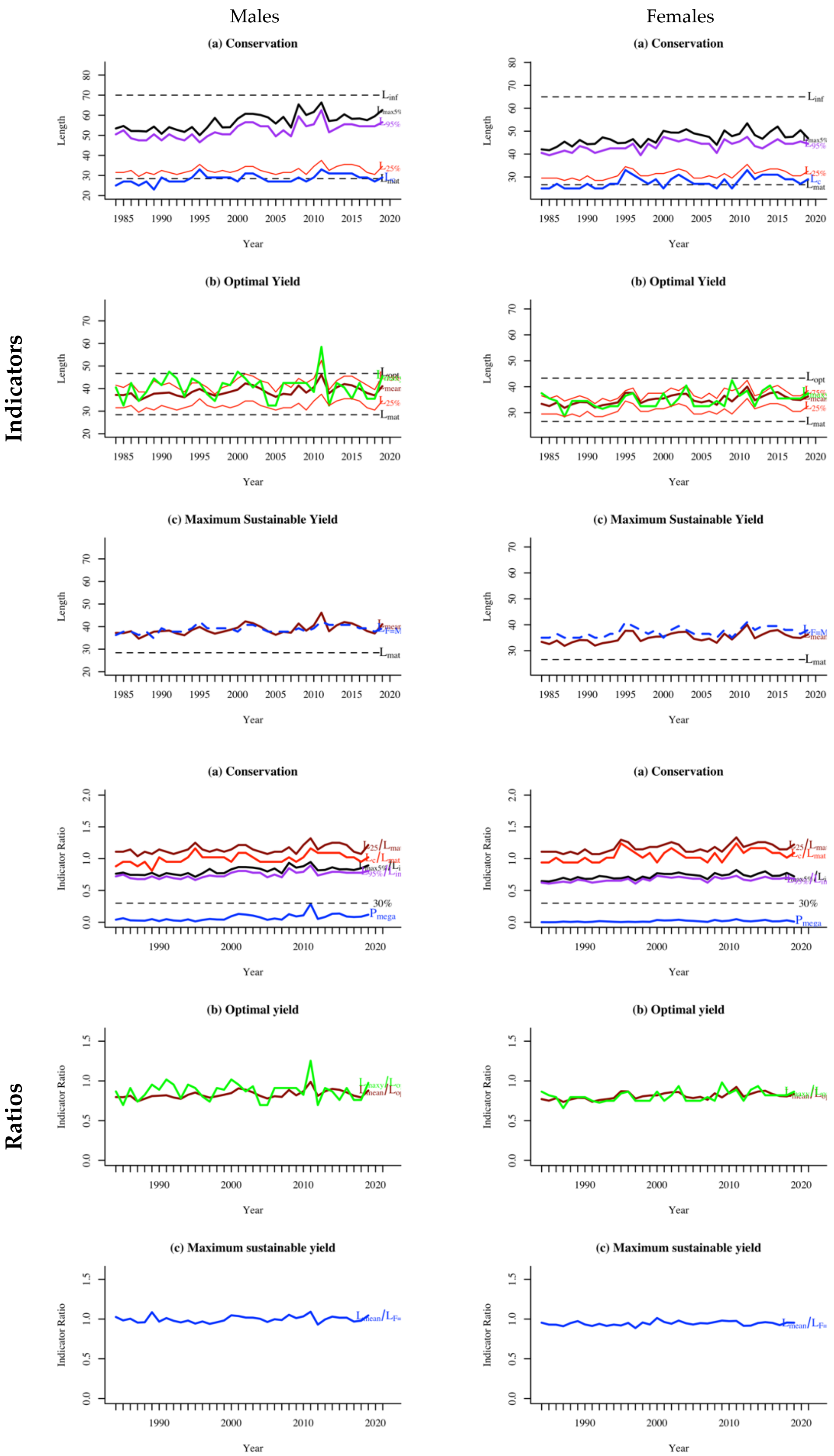


Figure 13.2.6. Length-based indicators (upper panel) and ratios (lower panel) for *Nephrops* males (left) and females (right) in FUs 28-29.

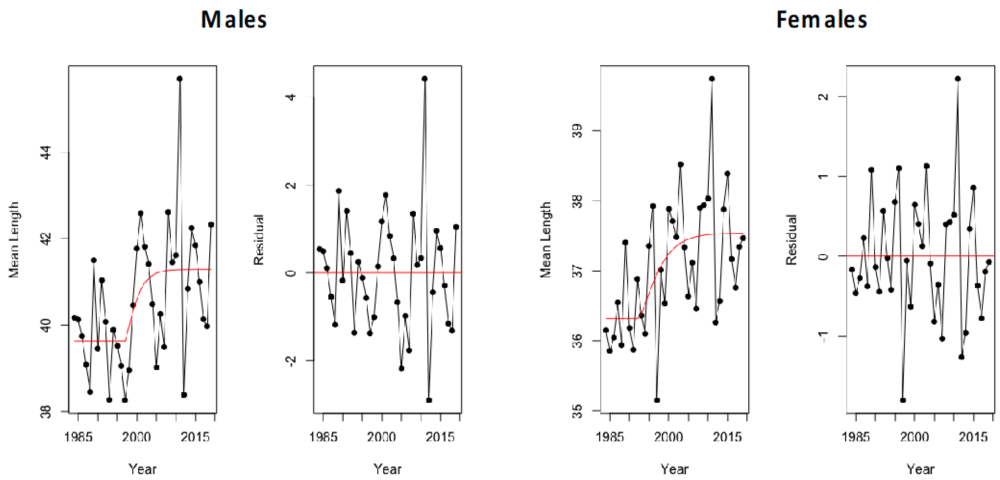


Figure 13.2.7. ***Nephrops*** **FU 28-29. Gedamke & Hoenig Mean Length Z model diagnostics.**

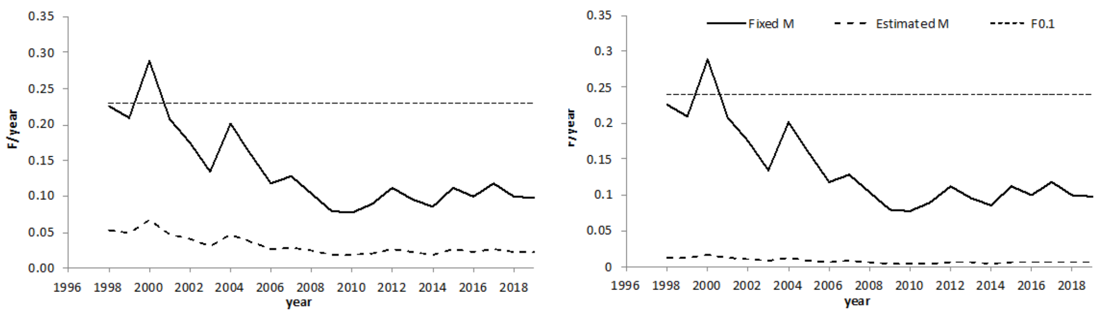


Figure 13.2.8. ***Nephrops*** **FU 28-29. Fishing mortality from THoG model using an external fixed M or an M estimated by the model. Left panel: males, right panel: females.**

13.3 *Nephrops* in FU 30 (Gulf of Cadiz)

Nephrops FU 30 was benchmarked by WKNEP 2016 (ICES, 2017a). A UWTV Survey based Approach was considered appropriated for providing scientific advice on the stock abundance in this FU. However, stock specific MSY harvest rate could not be derived. The basis of advice for this stock follows a category 3. When the stock specific MSY reference points could be estimated, *Nephrops* FU 30 will meet the requirements for category 1 assessment.

13.3.1 General

13.3.1.1 Ecosystem aspects

See Stock Annex

13.3.1.2 Fishery description

See Stock Annex

13.3.2 ICES Advice for 2020 and Management applicable for 2019 and 2020

ICES Advice for 2020

ICES advises that when the precautionary approach is applied, catches in 2020 should be no more than 77 t.

To ensure that the stock in FU 30 is exploited sustainably, management should be implemented at the functional unit level

Management applicable for 2019 and 2020

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.

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 401 t for 2019 and 386 t for 2020**,** of which no more than 6 % may be taken in FUs 26 and 27 and no more than 120 t in 2019 and 77 t in 2020 may be taken in FU 30. The maximum number of fishing days per vessel was fixed at 129 days for Spanish vessels and at 113 days for Portuguese vessels for 2019 (Annex IIA of Council Regulations no. 2019/124). The number of fishing days included in this regulation is not applicable to the Gulf of Cadiz (FU 30), which has a different effort management regime.

A modification of the Fishing Plan for the Gulf of Cadiz was established in 2014 (AAA/1710/2014). This new regulation establishes an assignment of *Nephrops* quotas by vessel. A closed season in autumn for the bottom trawl fleet of the Gulf of Cadiz is implemented since 2004. Since 2018, this closed season is from 16 September to 31 October (APM/453/2018).

13.3.3 Data

13.3.3.1 Commercial catch and discard

Landings in this FU are reported by Spain and, in 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 are 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 the WGHMM meeting in 2010 (ICES, 2010), *Nephrops* landings in Ayamonte port were incorporated in the Gulf of Cadiz landings time series, as well as, directed effort and LPUE from 2002 (Tables 13.3.8.1 and 13.3.8.5). *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 but sharply declined to 147 t in 2014, which is more than 50% drop. After a new increase in 2005 (246 t), landings trend declined up to 120 t in 2008. In 2008-2012, landings remained relatively stable at around 100 t. Landings declined again in 2013-2015 up to a mean value of 22 t. Since the quota in 2012 was exceeded, the European Commission applied a sanction to be paid within 3 years, 2013-2015 (Figure 13.3.8.1). The TAC was limiting the fishery during this period. Moreover, the *Nephrops* fishery was closed in 2013 and vessels could only go *Nephrops* fishing for only a few days during the summer and the winter. Total estimated landings increased in 2016 and 2017

(124 t and 140 t, respectively), representing almost six times the landings observed in 2013-2015. Landings estimations were 75 t, representing 46% less than the previous year (Figure 13.3.1). In 2019, landings slightly decreased, recording a total of 65 t. Estimates since 2016 are considered the best information available. A modification of the regulation implemented for the Spanish Administration for the Gulf of Cadiz grounds in 2014 (Orden AAA/1710/2014) established the assignment of *Nephrops* quotas by vessel. This regulation may have caused unreported *Nephrops* landings in recent years. The highest value of non reported landings was recorded in 2017. In 2019, the non reported landings were lower than 10% of the official landings, and were considered as zero.

Information on discards was submitted to the WG through InterCatch. Discard rate of *Nephrops* in this fishery fluctuates annually but is always very low or zero and thus, discards are considered negligible (Table 13.3.8.2). In 2019, the percentage discarded was 1.6%, lower than in the last two years. The mean carapace length of the discarded fraction was also lower than that observed in previous years (21.4 mm). Figure 13.3.8.2 shows the estimated length frequency distributions of the discarded and retained *Nephrops* by trip for the annual discarding program (2005-2019).

13.3.3.2 Biological sampling

The sampling level for the species is given in Table 1.4.

Figure 13.3.8.3 shows the annual landings length distribution for males, females and both sexes combined during the period 2001-2019. The length composition of landings was considered biased for the period of 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, making information 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 not sufficient to cover *Nephrops* catches, whereas, when the directed *Nephrops* sampling were carried out in harbours during the past, the length distribution of landings were covered for all months. This fact could reduce the consistency of the catch length distribution data. The number of samples between 2013 and 2015 was influenced by the EU sanction in this period coupled with the closure of *Nephrops* fishery in 2013. The sampling effort has been increasing since the summer of 2016 due to the additional *Nephrops* directed sampling in order to improve the quality of the commercial length distributions. In 2019, sampling level decreased in the third quarter and was zero during the fourth quarter. This fact could have some impact in the annual estimation of the sex-ratio, the mean length and the mean weight in landings. Summer is the main *Nephrops* fishing season, when females are out from their burrows for reproduction, making them more accessible to the fishery. So, sex-ratio and mean weigth might be affected by the sampling effort distribution along the year.

Mean size of males and females in *Nephrops* landings in 2001-2019 are shown in Figure 13.3.8.1. 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 higher than for males, the opposite of what should be expected. It could be due to sampling problems. This fact was investigated in collaboration with the observers. The number of samples and the number of individuals sampled were low in both years which 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 was implemented. The mean sizes remained relatively stable in 2016-2018. Thus, the average for that period was 32.0 mm CL in males and 30 mm in females (31.1 mm for combined sexes). Length frequency distribution shows an increase of small size individuals in 2017 and 2018 (see Figure 13.3.8.3). In 2019, mean sizes increased, mainly in males (36.9 mm CL in males, 31.9 mm CL in females and 35.0 mm CL for combined sexes).

The proportion of males in the sex-ratio of the landings is shown in Figure 13.3.8.4. The proportion of males remained stable, around 50%, since 2009 despite an increase of males observed in 2017 and 2019 (representing 60% and 65% of the landings, respectively).

13.3.3.3 Mean weight in landings

The mean weights in landings are shown, for the whole time-series, in Figure 13.3.8.5. Since 2009, an increasing trend of the mean weight was observed. In 2013, it declined but remained stable to about 31 g until 2015 (period affected by the sanction and TAC limitation). In 2016, a decline in the mean weight in landings was observed again then remained stable in 2017 and 2018, reaching a mean value of 23.4 g during these last three years. The mean weight increased up to 32.4 g in 2019. The low level of sampling when females are more accessible to the *Nephrops* fishery could have caused an increment in the mean weight of the annual landings as males tend to be larger and heavier than females.

13.3.3.4 Abundance indices from surveys

Trawl survey

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 13.3.8.3.

The overall abundance index trend decreased from 1993 to 1998 and remained stable from 1999 to 2009 despite occurrence of strong fluctuations in some years. The lowest values in the time-series were recorded in 2004 and 2012. In 2010, the deeper strata (500-700 m) were not sampled due to a reduction in the number of fishing days, as a consequence of the adverse weather conditions. Therefore, only the abundance index for the strata 200-500 m is available for 2010 (Table 13.3.8.3) and its value is similar to the corresponding strata in previous years. The abundance index increased significantly in 2013 and 2014 (Table 13.3.8.3). The survey index has fluctuated since 2015 then declined in 2017 and 2018. Results in 2019, show an increase of the abundance survey index (Figure 13.3.8.6). It should be noted that this survey is not specifically directed to *Nephrops* and is not carried out during the main *Nephrops* fishing season.

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 13.3.8.7. In 2015 and 2016, an increase of smaller individuals was observed. The mean size for both sexes increased in 2017 while remaining relatively stable in 2018 and 2019 (~36 mm CL in males and ~30 mm CL in females). The *Nephrops* mean sizes time-series for males, females and combined sexes obtained in these surveys are shown in Figure 13.3.8.8. No apparent trends are observed. The mean size ranged between 28.3 and 32.7 mm CL for females and 31.9 and 42.9 mm CL for males.

UWTV surveys

An exploratory *Nephrops* UWTV survey on the Gulf of Cadiz fishing grounds (ISUNEPCA) within the framework of a project supported by Biodiversity Foundation (Spanish Ministry of Agriculture, Food and Environment) and European Fisheries Fund (EFF) was carried out in 2014 (Vila *et al*., 2014). This survey was considered exploratory in 2014 and, currently, five UWTV surveys are available (2015 to 2019).

The ISUNEPCA surveys are based on a randomized isometric grid design with stations spaced at 4 nm. The methods used during the surveys are according to WKNEPHTV (ICES, 2007), WKNEPHBID (ICES, 2008), and SGNEPS (ICES, 2012) and WGNEPS (ICES, 2020). 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, 2017a). WKNEP 2016 concluded that the UWTV survey in FU 30 is appropriate for providing scientific advice on stock abundance.

The highest mean burrow density (adjusted to the cumulative bias) was obtained in 2017 (0.13 burrows/m^2). This value slightly decreased in 2018 (0.12 burrows/m^2) but it has continued to decline in 2019 (0.04 burrows/m^2), the lowest value of the time-series (Table 13.3.8.4).

The final modelled density surfaces for the time-series (2015–2019) are shown as heat maps and bubble plots in Figure 13.3.8.9. 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 this increased in 2017 (CV=8.7%). In 2018, geostatistic abundance estimate 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* distribution area, where the commercial bottom trawl operates, shows an increase in relation to 2017. In 2019, the geostatistical abundance estimate was 113 millions of burrows, representing a 65% less than the previous year (Table 13.3.8.4). The CV was 9.7%, higher than the previous year.

The total number of TV stations was increased up to 65 in 2017 and raised to 70 in 2018 and 2019. However, the stations used in the geostatistical abundance estimate were 62, 60 and 65, respectively. Deviation of the planned stations is usually due to the poor visibility related to recent fishing activity in some stations or due the uncertainty generated by the presence of other crustaceans' burrows.

In 2019, many technical problems occurred in the UWTV survey, which were related to the communication between the sledge and the desk unit by the vessel coaxial cable. This resulted in a reduction of the effective survey time. So, the planned stations had to be prioritized. In the shallowest edge, besides the very poor visibility, the available VMS data from the *Nephrops* directed trips and the bottom trawl survey series (SP-GCGFS-Q1_IBTS) indicate a very low density which generates a high uncertainty in the *Nephrops* burrows identification. Additional information obtained from the beam trawl hauls carried out in 2017-2019 period indicated absence of *Nephrops* in the hauls at depths lower than 200 m. Therefore, it was decided to sacrifice the 12 stations located at lower depths, which were considered *Nephrops* zero density stations although including them in the geostatistical analysis (Figure 13.3.8.9). A working document detailing the results obtained from ISUNEPCA UWTV survey in 2019 has been presented during the WGBIE 2020 (Vila *et al*., 2020, WD 10 in this report).

The final modeled density surfaces in the ISUNEPCA UWTV surveys time series (2015-2019) are shown as heat maps and bubble plots in Figure 13.3.8.9.

Data compiled during ISUNEPCA UWTV survey series suggest that the survey area is probably smaller than the current area and therefore, it should be reviewed during the next benchmark. New and more accurate information is available for this issue. The Andalucian Regional Government has installed its own vessel monitoring system on vessels using GPRS/GSM (Global System for Mobile Communications), a cellular network technology that send data on vessel positions and speed every three minutes instead of two hours in the traditional VMS. Additionally, information obtained from beam trawl and sediment samples obtained in the ISUNEPCA UWTV survey during 2017-2019 periods, as well as, the sea bed morphology and backscatter analysis could also be very useful in order to redefine the survey area in FU 30.

13.3.3.5 Commercial catch and effort data

Figure 13.3.8.1 and Table 13.3.8.5 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 which land 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 (4 336 fishing days). After that, the effort declined up to 2008 (73%) remaining relatively stable during the 2009–2012 period. As a consequence of the sanction in 2012, the effort dropped (mean value 283 fishing days) in 2013-2015. Fishing effort increased since 2016 up to 658 fishing days then remained stable in 2019 (675 fishing days) (Figure 13.3.8.1).

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) in the time-series. LPUE then increased until 2008 to around 60% higher. In the following years, the LPUE declined to 50 Kg/fishing day in 2009 (about 30% less with respect to 2008) and to 45.5 Kg/fishing day in 2010. The increased abundance of rose shrimp in 2008 is believed to have led to a change in the fishery objectives, as rose shrimp achieves a higher market value and caught in shallower fishing grounds (90-380 m) which are 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, the commercial abundance index showed an increasing trend up to 2016. The commercial index declined in 2017 and remained relatively stable in 2018 compared to the previous year. In 2019, commercial LPUE increases 57% in relation to the previous year (Figure 13.3.8.1). LPUE in the period 2013-2015 must be taken with caution as during this period a penalty for exceeding the quota in 2012 was applied, which increases the uncertainty associated to the LPUE index. Moreover, the assignment of *Nephrops* quotas by vessel implemented in 2014 might have caused unreported landings and contributed to increase the uncertainties around the commercial index estimate since this date. On the other hand, LPUE was estimated using the official landings (reported landings) and not the total landings estimated by the WG since 2016.

13.3.4 Assessment

This stock was benchmarked in October 2016 (ICES, 2017a). The assessment is based on UWTV survey trends according to category 3 for *Nephrops* stocks, using the procedure defined in the stock annex.

13.3.5 Catch options

Table 13.3.8.6 shows the UWTV abundance, estimates of mean weight and HR for the period 2017 – 2019. 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*	Availability in October not confirmed	ICES (2020)**	UWTV survey 2020
Mean weight in landing	32.45 g	ICES (2020)	Average 2017-2019
Mean weight in discards		ICES (2020)	Not relevant
Discard proportion	0%	ICES (2020)	Negligible
Discard survival rate		ICES (2020)	Not relevant
Dead discard rate	0%	ICES (2020)	Negligible

* UWTV survey 2020 not confirmed due coronavirus disruption

** This WG report will be updated in October after the UWTV survey

The prediction of landings for the FU 30, using the procedure agreed upon at WKNEP 2016 (ICES, 2017a) and outlined in the Stock Annex, is usually made on the basis of the UWTV survey estimated abundance obtained in the advice year and is presented in October for the provision of advice. During WGBIE 2020, it was not possible to confirm if the 2020 UWTV survey in FU30 (scheduled for the period 29th May to 10th June) could be conducted due to the suspension of most services and activities in most EU Member States since the beginning of spring. In light of the overall corona virus uncertainties, state and territory governments have different restrictions and lockdown exit plans which currently render unpredictable and complicated any future organisation or reorganisation of planned scientific surveys.

13.3.6 Biological reference points

F_{MSY} proxy ($F_{0.1}$) derived from the SCA (Separable Cohort Analysis; Pope and Shepherd 1982) model during WKNEP 2016 (ICES, 2017a), corresponds to a harvest rate of 9.5% but this resulted in recommended catches much higher than values historically observed. WKNEP 2016 decided to derive the harvest rate (HR) from historical catches of this stock and from the exploitation in similar stocks as an interim solution, until a more consolidated basis for generating advice from UWTV survey abundance estimates can be developed (ICES, 2017a). Taken into account the *Nephrops* FU 30 fishery history, HR was estimated ranging between 1.5% in 2010-2012 and 4% when landings achieved the highest value (2003). Recent 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 despite the absence of a current transition scheme definition. As the UWTV survey approach was just recently initiated for the FU 30, caution should be taken in 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 the absence of stock-specific MSY harvest rate in *Nephrops* FU 30 (due to poor fits in length-frequency model analyses), normally used for calculating F_{MSY} for category 1 in *Nephrops* stocks, that the basis of advice for this stock should follow the category 4 approach for Norway lobster stocks and not category 1. ADGNEP recommended that when stock-specific MSY reference points can be estimated, *Nephrops* FU 30 will meet the requirements for category 1 assessment.

The WGBIE 2017 supported the proposal of a specific workshop before the 2018 WGs assessment (ICES, 2017b). The WK*Nephrops* was finally carried out in November 2019 (Report not yet available). Different models were applied to *Nephrops* in FU30 during WKNephrops. Some of them are methods developed for data-limited stocks as Length-Based Indicators (LBI) or Mean Length-Z at WKLIFE V (ICES, 2015) while others are used for calculating MSY Reference Points for Category 1 *Nephrops* stocks, such Separable Cohort Analysis (*SCA* R package, version 1.2.0, Bell,

2019) and Separable Length Cohort Analysis (SLCA – *nepref* R package, version 0.2.2, Dobby, 2019) (Leocádio et al, 2018). SCA model gave FU 30 stock estimates far below those estimated from the UWTV survey. Factors as the uncertainties around natural mortality and growth parameters can affect the shape of the catch-at-length distribution and can produce different magnitudes of stock abundance. On the other hand, the abundance from UWTV input value in the model for FU 30 seems be very sensitive, where lower UWTV survey input resulted to a model with a better fit. Some explorations runs were carried out using SLCA but the resulting HRs were also very high.

To conclude, MSY reference point could not be derived properly for FU 30 during the WK*Nephrops* in 2019. Other methods need to be explored in order to obtain specific FU 30 MSY reference points and upgrade this *Nephrops* stock to category 1.

Estimates from Length Based Indicators (LBI) and Mean Length-Z method were updated during the WK*Nephrops* in 2019.

Table 13.3.8.7 shows the status of the conservation of the stock from LBI. In 2019, 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 in the catch. The optimizing yield (L_{mean}/L_{opt}) is below the desirable value of 0.9, i.e. catch is below the theoretical length L_{opt}. MSY indicator is lower than 1, so fishing is above F_{MSY}.

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 for the mean length-based Z estimator models, Gedamke & Hoenig (G&H, Gedamke and Hoenig, 2006) and Then, Hoenig & Gedamke (THoG, Then 2014), are summarized in Table 13.3.8.8. Figures 13.3.8.10 and 13.3.8.11 show the model diagnostics for G&H model and the F series estimated by the THoG model.

The results based on the G&H model indicate that the stock is exploited at a level above the F_{MSY} proxy. However, results from THoG model indicate that females are exploited below the F_{MSY} proxy while males are exploited above and provide much lower estimates for F values. THoG model could only be used with a fixed M as input and should not be used to estimate the M value as the model tends not only to overestimate the resulting M value but also provides negative q and F values.

13.3.7 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, the *Nephrops* fishery was closed for most of the year because the quota in 2012 was exceeded and the European Commission applied a sanction to be paid in 3 years time.

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 considered no longer appropriate. By derogation, a different method for effort management was applied to the Gulf of Cadiz. A multiannual management plan (MAP) for the Western Waters was published by the European Parliament and the Council (EU, 2019). This plan applies to demersal stocks including *Nephrops* in FU 30 in ICES Division 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 established a closed fishing season of 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 the 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 the last Fishing Plan for the Gulf of Cadiz was established (AAA/1710/2014, modified by AAA/1406/2016). This new regulation establishes the assignment of *Nephrops* quotas by fishing vessel. The Fishing Plan for the Gulf of Cadiz (APM/453/2018) changes the closed season for the bottom trawl fleet to the period from 16 September to 31 October.

Several 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 controls the days and time when the Gulf of Cadiz bottom trawl fleet can enter or leave the 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, and a more restricted time period in other months. This fishing flexibility during 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.

Unwanted catches from *Nephrops* are regulated by the discard plan for the demersal fisheries in South-Western waters for the period 2019-2021 (Council Regulation (EC) No 2018/2033, replaced by the Council Regulation (EU) No 2019/2237), under which they are exempted from the landing obligation based on the species' high survival rates. This exemption applies to all catches of Norway lobster from ICES subareas 8 and 9 with bottom trawls, with the immediate release of all discards in the area where they were caught.

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Table 13.3.8.1. *Nephrops* FU 30, 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
2019	65	0	0	65

** Ayamonte landings are included since 2002

Table 13.3.8.2. ***Nephrops* FU 30, Gulf of Cadiz: Mean carapace length of the discarded and retained fraction of *Nephrops*, and percentage of discarded (2005-2019) 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	2.9	7.6
2019	21.4	35.6	1.6	7.2

Table 13.3.8.3. ***Nephrops* FU 30, 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 13.3.8.4. *Nephrops* FU 30, Gulf of Cadiz. Summary table of results from the 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
2019	65	0.0377	3000	3000	113	9.7

Table 13.3.8.5. *Nephrops* FU 30, Gulf of Cadiz. Total landings and landings, LPUE and effort of 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	76	31	47.1	658
2019	65	50	73.7	675

*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 13.3.8.6. *Nephrops* FU 30, 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
2019	1.99	0	1.99	113	21	1.8	32.5	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

Table 13.3.8.7. *Nephrops* FU 30, Gulf of Cadiz. Length-Based Indicator (LBI) analysis results for both sexes.

MALES

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%} / L_{mat}$	$L_{max\,5} / L_{inf}$	P_{mega}	L_{mean} / L_{opt}	$L_{mean} / L_{F=M}$
2017	0.95	1.02	0.66	0.01	0.78	0.94
2018	0.95	1.02	0.66	0.01	0.78	0.94
2019	1.09	1.16	0.72	0.04	0.85	0.95

FEMALES

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%} / L_{mat}$	$L_{max\,5} / L_{inf}$	P_{mega}	L_{mean} / L_{opt}	$L_{mean} / L_{F=M}$
2017	1.02	1.02	0.60	0.00	0.74	0.86
2018	1.02	1.02	0.62	0.01	0.75	0.88
2019	1.17	1.17	0.61	0.00	0.79	0.85

Table 13.3.8.8. Results from the Mean-Length Z approach analysis.

	Males	Females
Input:		
LFD period	2009-2019	2009-2019
Effort series	2009-2019	2009-2019
W~L relationship		
a =	0.000845	0.001873
b =	2.953452	2.726119
External M*	0.3	0.2

Method	Results		
	Parameter	Males	Females
Gedamke & Hoenig	Z =	1.05	0.91
	F* =	0.75	0.71
THoG	q estimate =		
	q estimate* =	0.77	0.11
	M estimate =		
	F_{2019} estimate =		
	F_{2019} estimate* =	0.52	0.07
Y/R	F_{MSY} proxy: $F_{0.1}$ =	0.24	0.19
	F/F_{MSY} =	3.11	3.76

*Indicate estimates with external fixed M

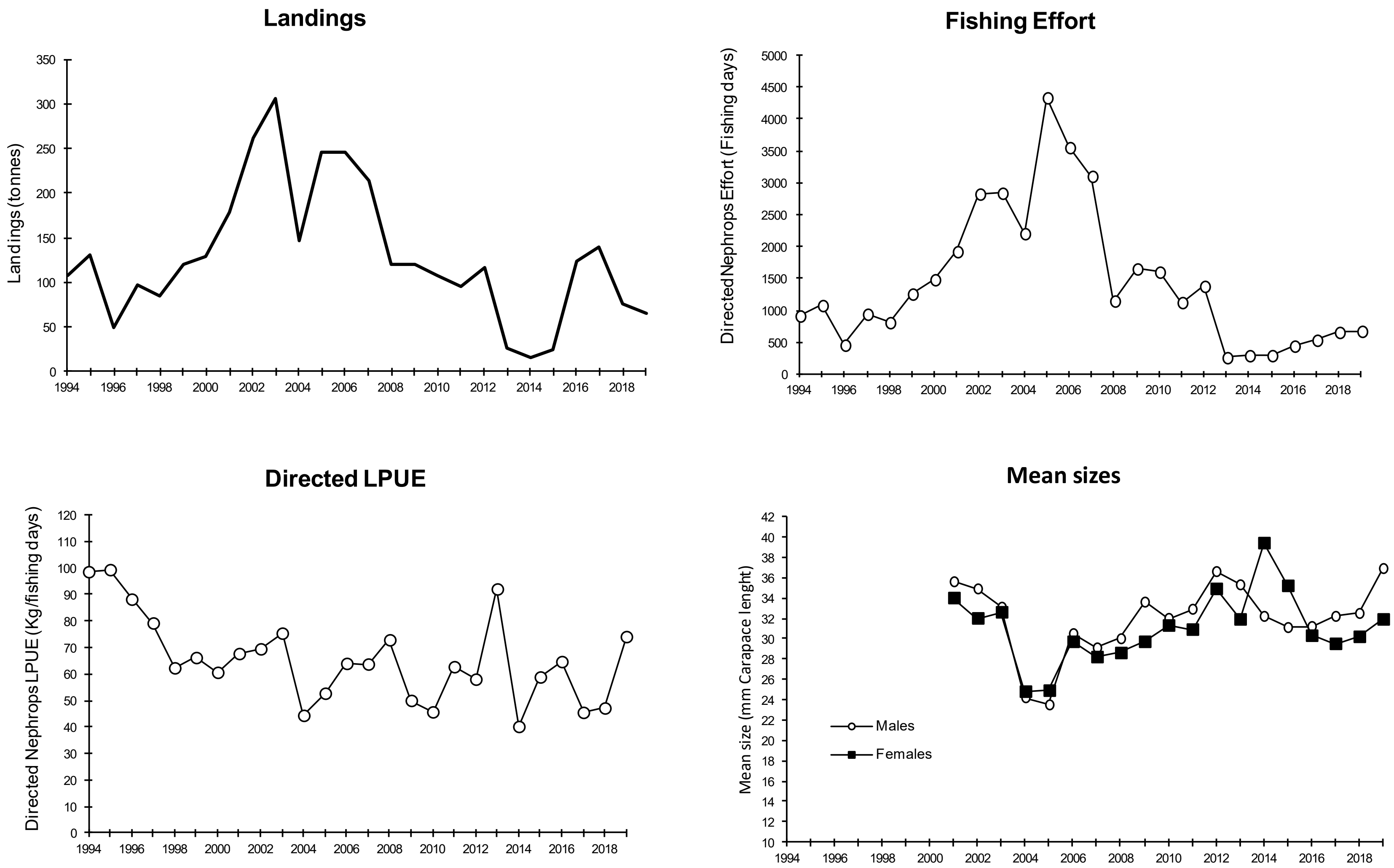


Figure 13.3.8.1. *Nephrops* FU 30, Gulf of Cadiz. Long-term trends in the landings, *Nephrops* directed effort and LPUE and mean sizes.

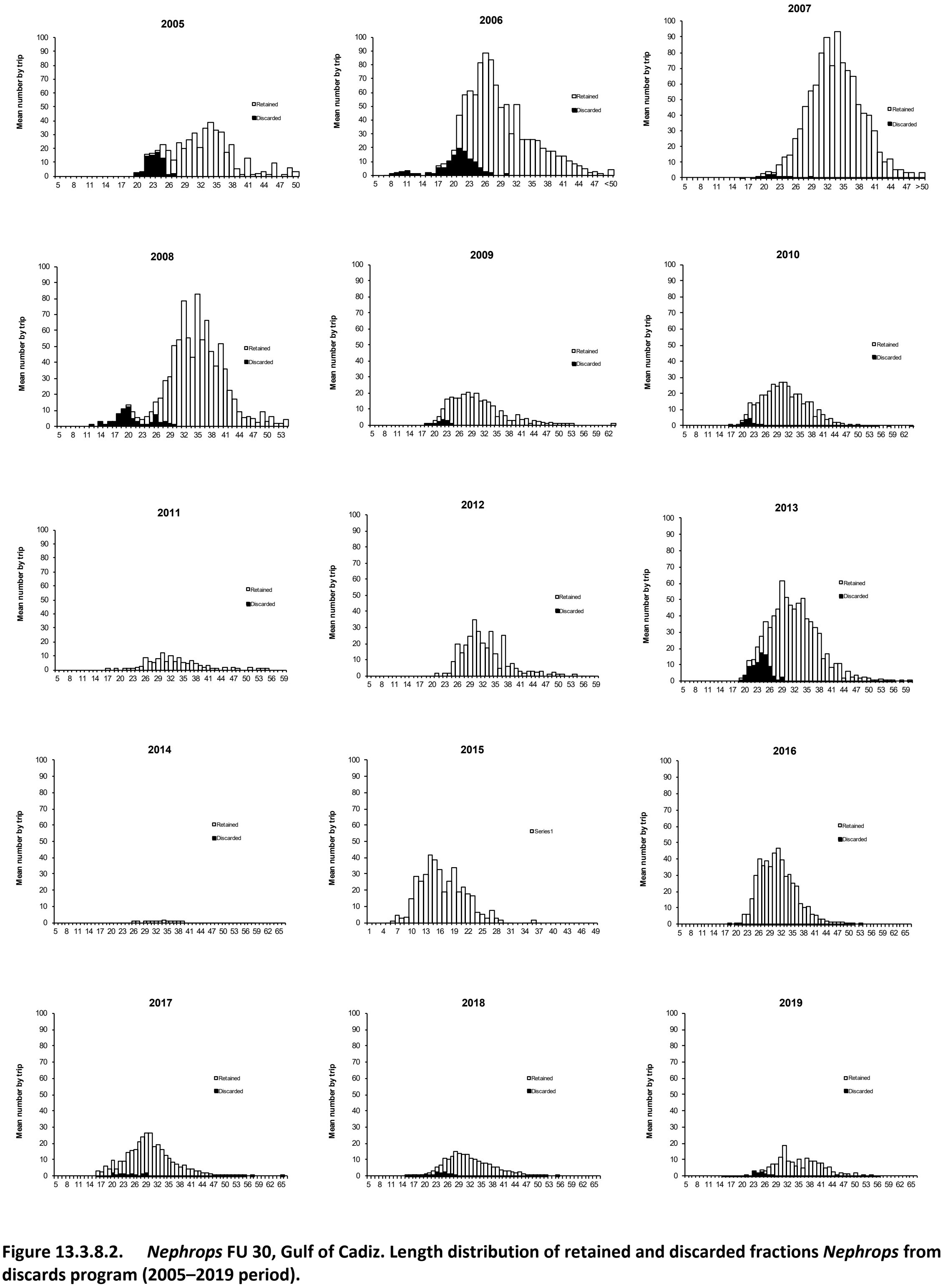


Figure 13.3.8.2. ***Nephrops*** **FU 30, Gulf of Cadiz. Length distribution of retained and discarded fractions** ***Nephrops*** **from discards program (2005–2019 period).**

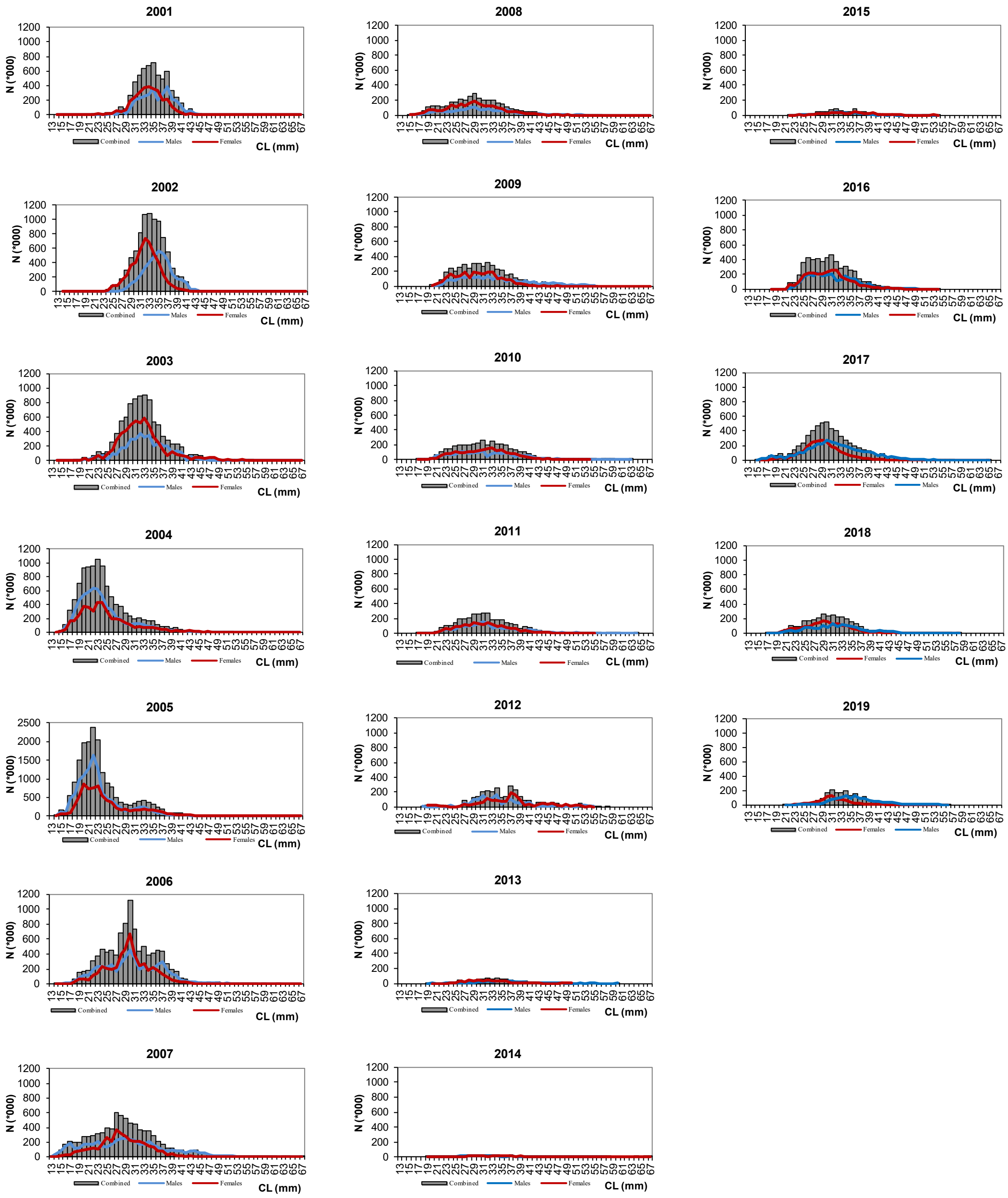


Figure 13.3.8.3. *Nephrops* FU 30, Gulf of Cadiz. Length distributions of landings for the period 2001–2019.

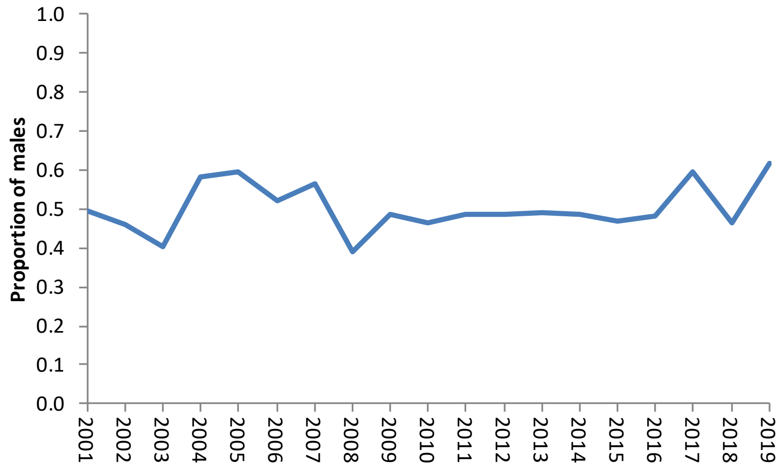


Figure 13.3.8.4. ***Nephrops*** **in FU 30, Gulf of Cadiz. Proportion of males in landings for the time-series.**

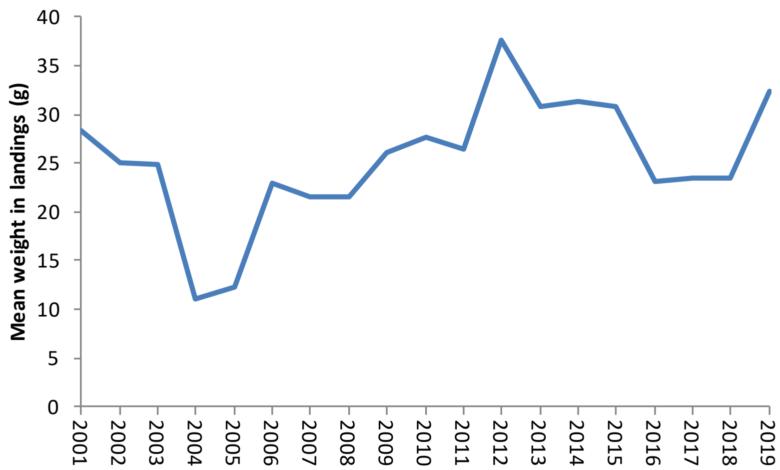
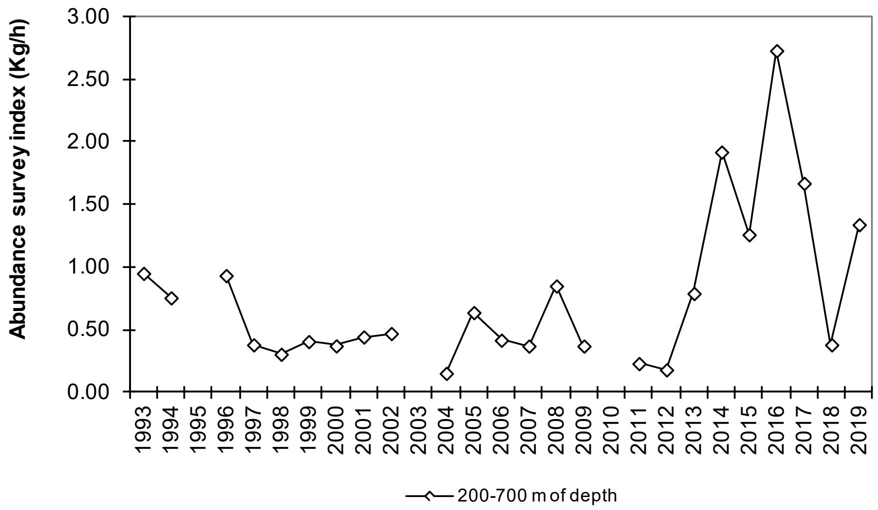


Figure 13.3.8.5. ***Nephrops*** **in FU 30, Gulf of Cadiz.Time-series of the mean weight trend in commercial landings.**



* 1995 and 2010: strata 500-700 m no sampled

** 2003: no survey

Figure 13.3.8.6. *Nephrops* FU 30, Gulf of Cadiz, Abundance index from Spanish bottom trawl spring surveys (SP-GCGFS-Q1).

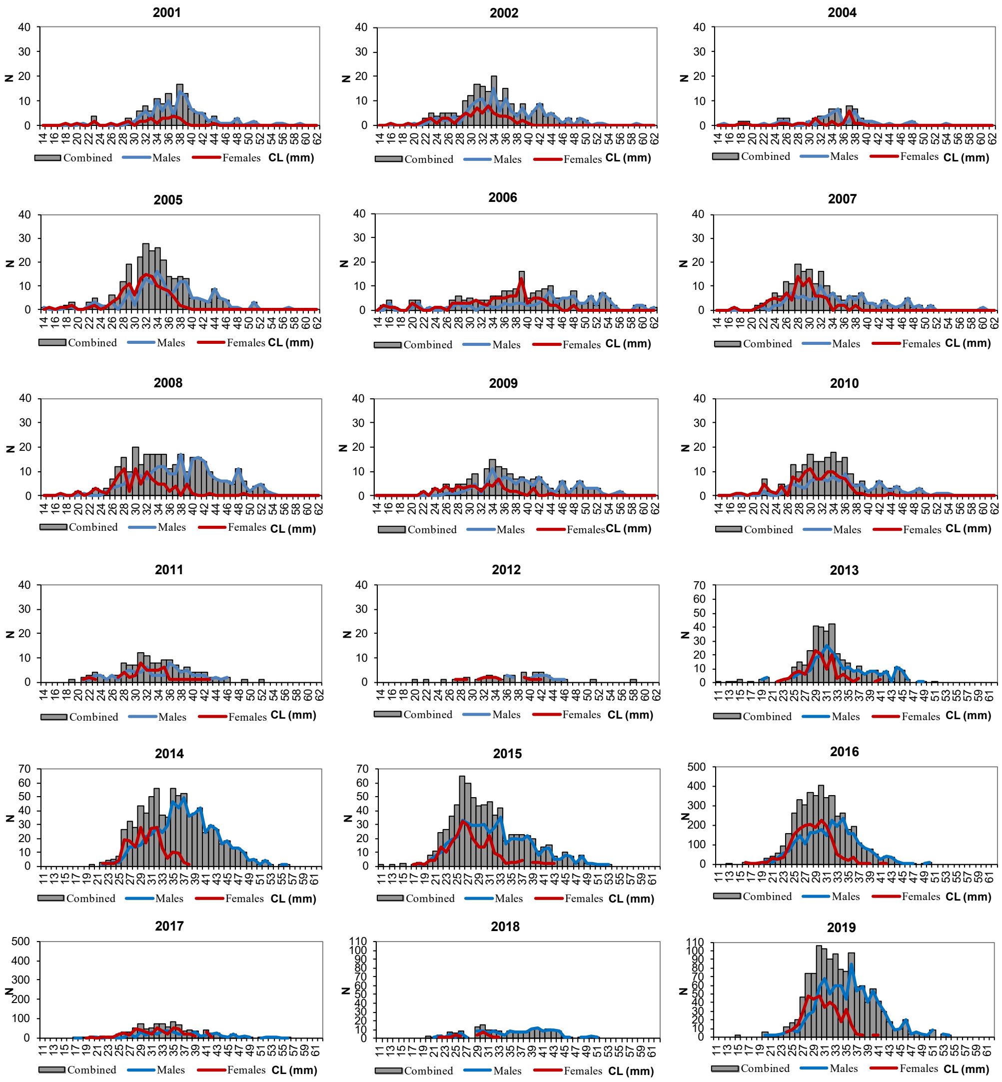


Figure 13.3.8.7. ***Nephrops*** **FU30, Gulf of Cadiz. Length distributions from Spanish bottom trawl surveys (SP-SPNGFS-Q1) for the 2001–2019 period.**

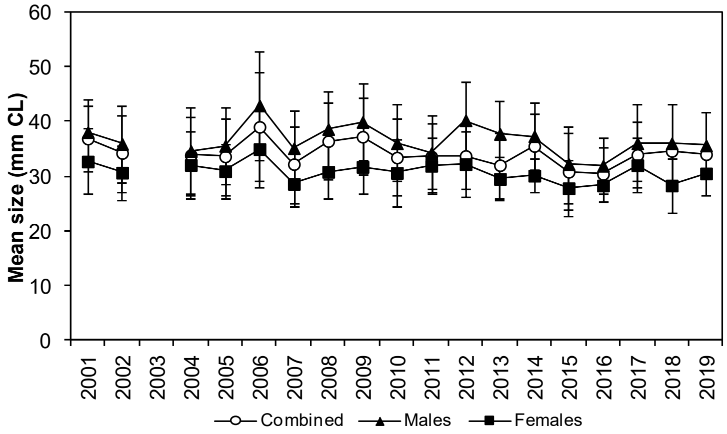


Figure 13.3.8.8. ***Nephrops*** **FU30, Gulf of Cadiz. Mean size in spring bottom trawl surveys (SP-GCGFS-Q1) for the period 2001–2019.**

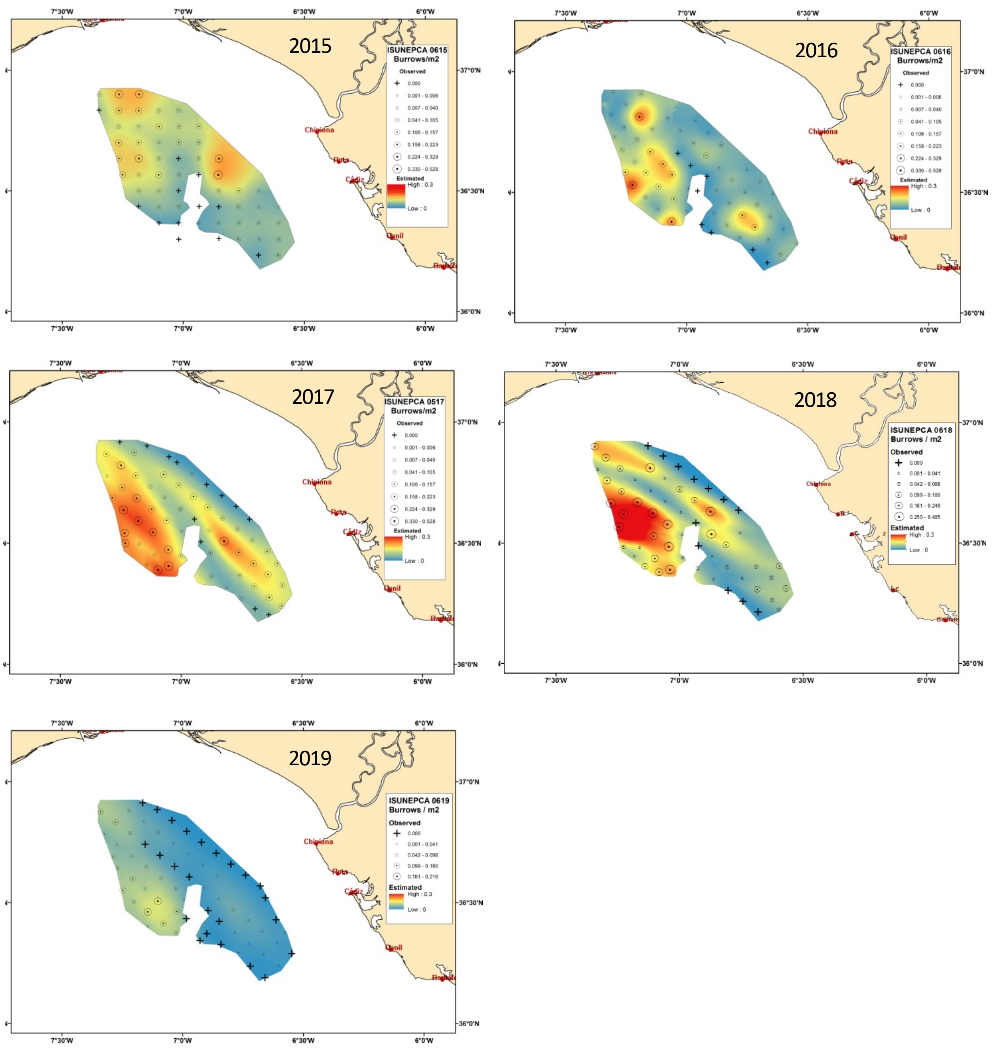


Figure 13.3.8.9. ***Nephrops*** **FU 30, Gulf of Cadiz. Contour plots of the krigged density estimates for the ISUNEPCA UWTV surveys time-series (2015–2019).**

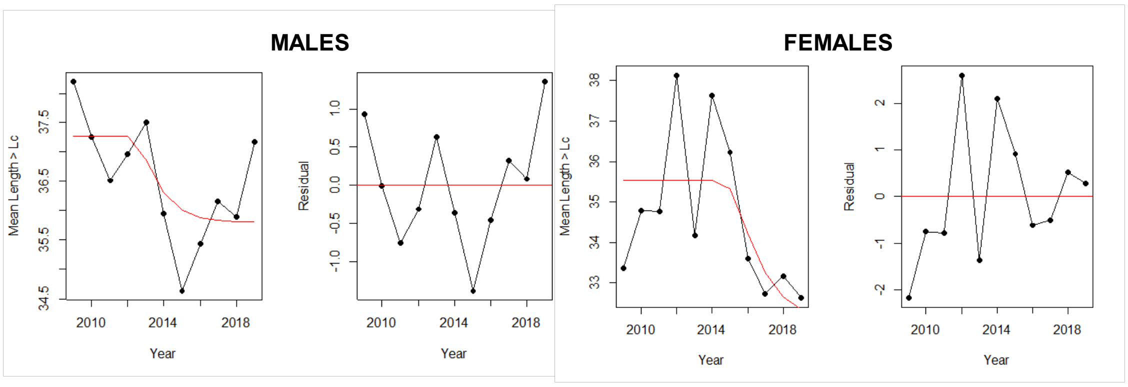


Figure 13.3.8.10. ***Nephrops*** **FU 30, Gulf of Cadiz. Mean Length Z (Gedamke & Hoenig, 2006) model diagnostics**

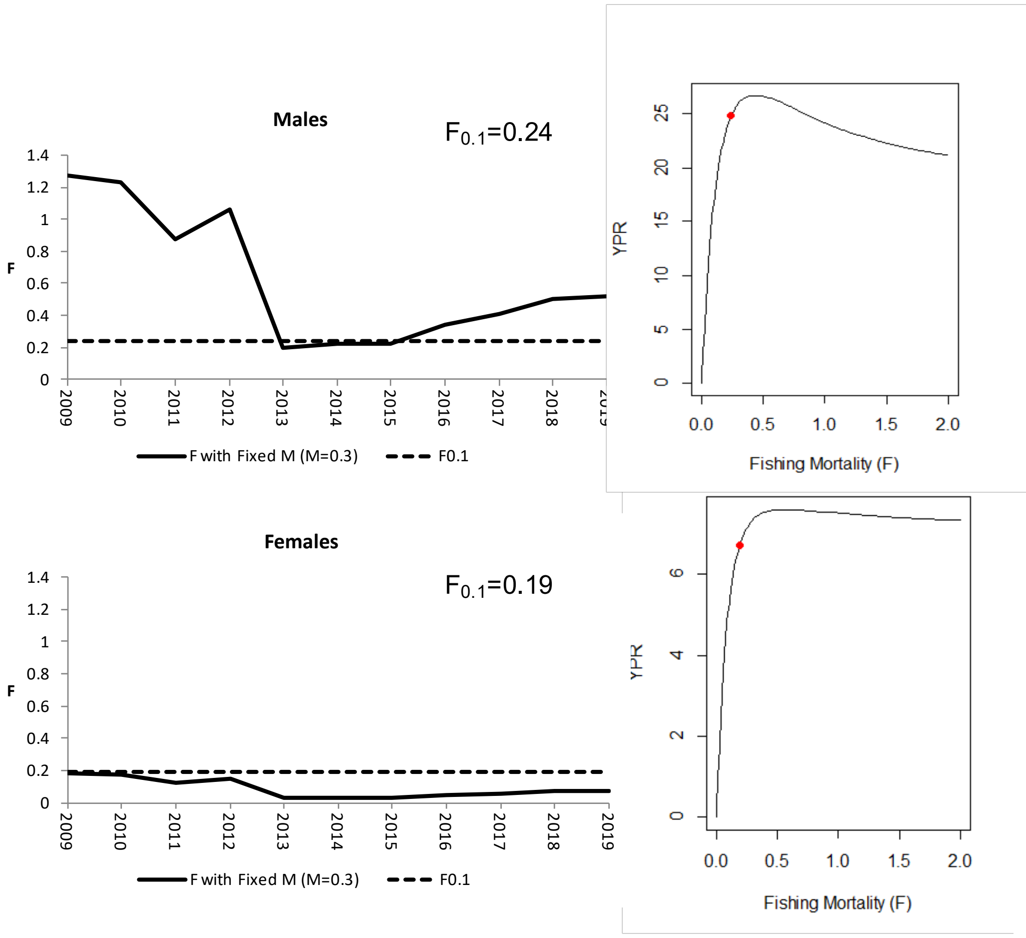


Figure 13.3.8.11. ***Nephrops*** **FU 30, Gulf of Cadiz. Fishing mortality from THoG model using an external fixed M and Yield-per-Recruit curve.**

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 2017/2018 (ICES, 2018a) and IBP Bass 2018 (ICES, 2018b).

Data revisions: 2018 French data, resubmitted by France, have been used for this assessment

Working Group issues: 2019 age-length key introduced bias in the last year of the retrospective analysis due to age reader change, already observed and discussed in WGBIE 2019 (ICES, 2019a).

14.1 General

14.1.1 Stock definition and ecosystem aspects

See Stock Annex.

14.1.2 Fishery description

Seabass in the Bay of Biscay is mainly targeted by France with more than 95.6% of the international landings in 2019 (Table 14.1). Spain is responsible for about 4.4% of the catches in 2019. A more detailed description of the fishery is available in the Stock Annex.

Table 14.1: Summary of official and ICES commercial landings data in tonnes. 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

1998	0	1261	0	27	0	1288	2231
1999	0	2081	0	11	0	2092	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	167	2	3487	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	2536	0	311	0	2848	2575
2012	1	2325	0	204	5	2535	2549
2013	0	2504	0	156	0	2660	2685
2014	0	2926	0	89	0	3015	2991
2015	0	2216	0	71	0	2287	2264
2016	0	2121	0	85	0	2206	2252
2017	0	2146	0	72	0	2218	2295
2018	0	2204	0	84	0	2288	2316
2019	0	2090	0	97	0	2187	2227

For France, line fisheries (handlines and longlines) take place all year round (especially in quarters 3 and 4), while nets, pelagic and bottom trawl fisheries take place from November to April, the period when pre-spawning and spawning seabass aggregate to reproduce. In 2019, nets represent 33.3% of the landings of the area, lines 33.8%, bottom trawl 20.7%, and pelagic trawl 7.2%.

In 2019, total landings decreased slightly compared to 2018. An increase was observed for liners and other gears, and a decrease for netters, pelagic trawlers and bottom trawlers (Figure 14.1). Note that netters are very dependent on weather conditions (2014 was an exceptional year).

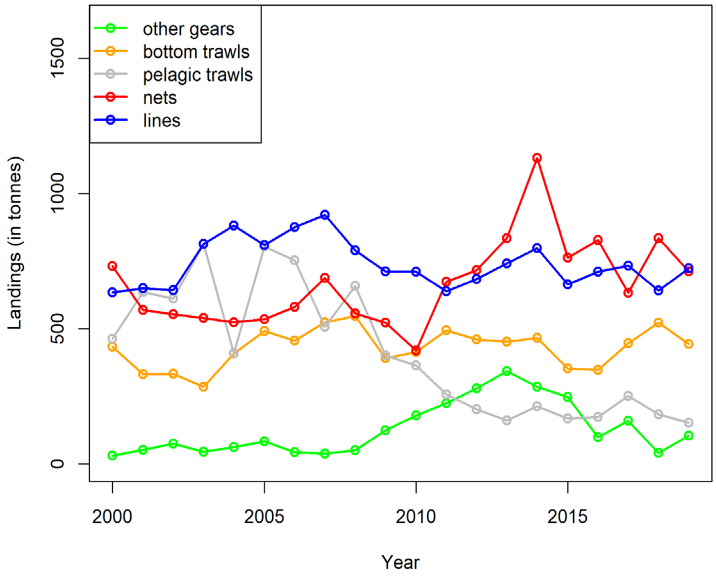


Figure 14.1: French landings per gear.

14.1.3 Summary of ICES advice for 2020 and management

14.1.3.1 ICES advice for 2020

This was the second time that ICES has provided advice for this stock based on a category 1 assessment. ICES advises that when the EU multiannual plan for Western waters and adjacent waters is applied (MAP; European Parliament and Council Regulation (EU) 2019/472), catches in 2020 that correspond to the F ranges in the MAP 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, while the entire range is considered precautionary when applying the ICES advice rule (ICES, 2019b).

14.1.3.2 Management

Commercial and recreational fisheries at EU level

Seabass in the Bay of Biscay is not subject to EU TACs and quotas, however seabass is ruled by an EU multiannual plan since 2019 (EU, 2019). It aims to ensure that stocks, in particular seabass stocks, are exploited sustainably and that the decisions on fishing opportunities are based on the most up-to-date scientific information. It allows a certain flexibility in setting fishing opportunities, by defining the target fishing mortality as a range of values, which would result in MSY in the long term (F_{MSY}), and would be based on the best available scientific advice. The plan does not include quantified reference points for fishing mortality or biomass levels, which are instead provided by the latest scientific advice available, and used by the Council when fixing fishing opportunities. In addition to the ranges of F_{MSY}, the plan introduces safeguard measures based on biomass levels, in order to restore the stocks when they fall below safe biological limits. Where recreational fishing mortality has a significant impact on a stock managed on the basis of MSY (which is the case of seabass stocks), the Council should be able to set non-discriminatory limits for recreational fishers. The Council should use transparent and objective criteria when setting such limits. Where appropriate, Member States should make the necessary and proportionate arrangements for monitoring and data collection in order to make a reliable estimate of effective levels of recreational catches.

Commercial fishery at national level

Since 2012, a national professional quota system for seabass fishing licences, defined and implemented by the Committees for Maritime Fisheries and Fish Farming (CNPMEM, 2020), has regulated French professional catches of the species, both for the Bay of Biscay (Divisions 8abd) and the Northern stocks (Divisions 4bc, 7a and 7d-h).

In 2017, the framework for seabass fishing activities in the Bay of Biscay was supplemented by the French introduction of a specific national administrative scheme for the management of professional fisheries. Since then, various measures have been applied to French professional vessels in the area:

- Fixing the minimum fishing size for seabass at 38 cm then to 40 cm since February 2020;
- Overall annual limit on landed catches in the Bay of Biscay, which is re-assessed each year in line with ICES recommendations on fishing opportunities for this stock. This level was set at 2 490 t in 2017 and then successively reduced to 2 241 , 2 150 and 2 052 t between 2018 and 2020;
- Implementation of production monitoring throughout the year (monthly during spring and summer, and biweekly during winter and autumn) which can be reinforced if necessary.

In 2018, the professional system was radically overhauled and replaced by a more restrictive licensing system, governing seabass fishing in the Bay of Biscay. Strengthened in 2019 and again in 2020, this latest national licensing system aims to limit effort and adjust fishing capacity by taking into account, on one hand, the great diversity of fishing practices and strategies and, on the other hand, the administrative measures governing the fishery, in particular the annual overall limit on authorised catches. It shall apply to all French professional fishing vessels operating in the Bay of Biscay. Since 2019, this annual scheme provides for the following measures:

- The requirement to hold a licence to allow shipowner couples to fish seabass in the area beyond a certain quantity, especially for trade groups which are the most productive (hook, net, bottom trawl and Danish seine, and pelagic trawl). This licence is divided into two categories ("Targeted fishing" and "Bycatch"). It is subjected to quotas by métier and by category;
- The fixing of individual seabass catch limits for both licence and non-license holders. These limits are either on an annual or monthly basis, at different levels according to the profession(s) practised and, where applicable, according to the category of licence ;
- The contribution to the monitoring of the individual production of licensed vessels.

In 2019, under the administrative arrangements, French vessels were subject to an overall annual limit on seabass catches in the Bay of Biscay at 2 150 t. During the same year, each production unit under the occupational scheme is subject to an individual annual catch limit as presented in Table 14.2.

On the basis of the estimated consumption of the overall ceiling at the beginning of September, in mid-November and the projections at the end of the year, the initial individual monthly catch limits set for 2019 had to be adjusted twice during the year. These individual monthly catch limits are presented in Table 14.3. In addition, the following specific limits have been added:

- In October and November, an individual limit of 50 Kg of seabass per vessel and per trip, up to a maximum of 50 Kg per day
- In December, an individual limit of 250 Kg of seabass per vessel per trip, except for vessels holding a seabass licence for pelagic trawling as "Targeted fishing".

A total fishing closure in the Bay of Biscay took place on 28 December 2019 due to the overall annual ceiling for 2019 being deemed to be exhausted. These measures have inevitably influenced seabass fishing yields, especially in the last quarter of 2019.

Table 14.2: Individual annual limits (t/year) for seabass landings in the Bay of Biscay for holders and non-holders of the national license in 2019.

Individual annual limits (t/year)	Lines and handlines	Nets	Bottom trawlers and seiners	Pelagic trawlers
Non seabass license holder 2019	1	1	3	4
Seabass license holder 2019 – accessory fishing	6	6	6	--
Seabass license holder 2019 – targeted fishing	20	12	15	15

Fleet vessels fishing with purse seines in the Bay of Biscay have been authorized to land a maximum of 41 t of seabass in 2019. Finally, vessels fishing the stock using any other gears than those mentioned above have been authorised to land individually up to a maximum of 1 t in 2019.

Table 14.3: Individual periodic limits for seabass in the Bay of Biscay for holders and non-holders of the national license in 2019.

<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 rowspan="2">Non seabass license holder 2019</td><td>January to September</td><td>0.40</td><td>0.40</td><td>1.00</td><td>1.00</td></tr>
<tr><td>December</td><td>0.30</td><td>0.30</td><td>0.75</td><td>0.75</td></tr>
<tr><td rowspan="3">Seabass license holder 2019 – accessory fishing</td><td>January to March</td><td rowspan="2">2.00</td><td>2.00</td><td rowspan="2">2.00</td><td rowspan="3">-.°°-</td></tr>
<tr><td>April to September</td><td>1.00</td></tr>
<tr><td>December</td><td>1.50</td><td>1.50</td><td>1.50</td></tr>
<tr><td rowspan="3">Seabass license holder 2019 – targeted fishing</td><td>January to March</td><td>3.00</td><td>3.00</td><td>3.00</td><td>6.00</td></tr>
<tr><td>April to September</td><td>6.00</td><td>2.00</td><td>4.00</td><td>4.00</td></tr>
<tr><td>December</td><td>2.25</td><td>2.25</td><td>2.25</td><td>3.00</td></tr>
</table>

Vessels holding a seabass licence and exercising several trades in 2019 were subjected to the "rule of non-accumulation of catch ceilings". This rule prohibits accumulating the annual or periodic limits to which these vessels would have been entitled. The most favourable ceiling is used in this case.

Recreational fishery at the national level

A series of management measures have been implemented for 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.
- A 2-fish bag limit has been implemented in 2020.

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 time series was reconstructed using the three main available sources (Figure 14.2):

1. Official statistics recorded in the Fishstat database (FAO, 2020) since around the mid-1980s (total landings).
2. French landings for 2000-2019 from a separate analysis of logbook and auction data by IFREMER (SACROIS methodology; Demaneche et al., 2010) which is used to answer the ICES annual InterCatch data call. Landings are available by métier.
3. Spanish landings for 2007-2011 from sale notes and for 2012-2018 from InterCatch statistics.

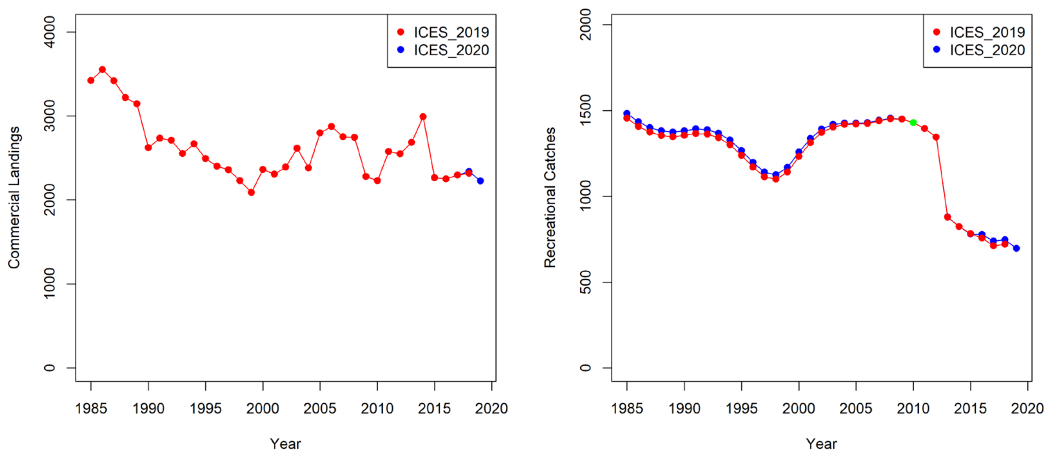


Figure 14.2: Commercial landings and recreational removals used in the 2018 and 2019 assessments. Weights are in tonnes.

This year, the 2018 revised French data were re-submitted by France and have been used for the assessment. This data revision was minor (Figure 14.2) and did not affect the result of the assessment (see hereafter).

Discarding of seabass by commercial fisheries can occur when fishing takes place in areas where caught individuals are smaller than the minimum landing size. For France, discards rates are low (Table 14.4). In 2019, the total discards percentage was estimated at 5.89% of the total French commercial catches, corresponding to an amount of 183 t. For Spain, observer data from Spanish vessels fishing in area 8, have shown that no seabass was discarded in 2003 (no information on discards in 2019 was available for this WG). Thus, for 2019, total catches were estimated by adding the total discards (183 t), the commercial landings (2 227 t) and the recreational removals (697 t). Discards are considered negligible and are not included in the stock assessment, despite the availability of this information. As it was observed that discards increased during the last 3 years of the series, landings predictions (from the assessment) were raised to provide catch advice (Vigneau and Girardin, 2020).

Table 14.4: Estimated seabass discards of French vessels fishing in the Bay of Biscay. Weights are in tonnes.

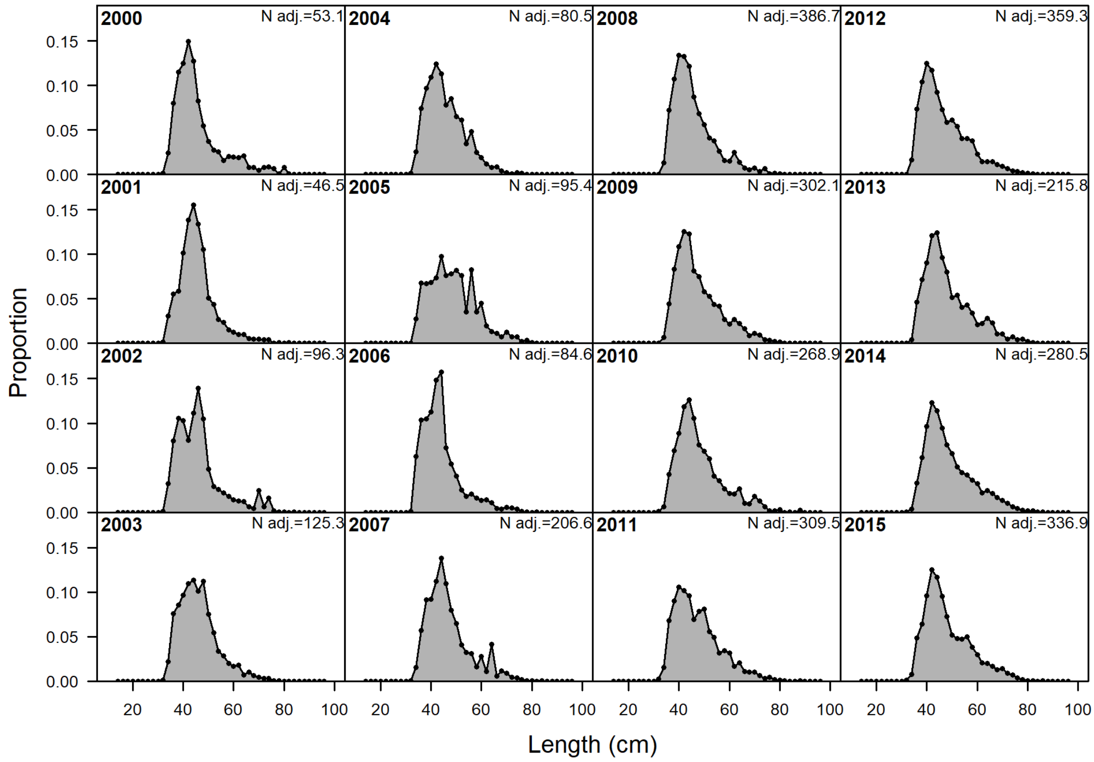
Year	Commercial discards	Total catches	% discards
2015	68	3114	2.18
2016	65	3095	2.10
2017	196	3231	6.07
2018	155	3240	4.78
2019	183	3107	5.89

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 seabass landings length compositions covers sampling at sea and on-shore. Data are available from 2000 onwards. French length compositions for 8.a-b, across time, all gear combined, are presented in Figure 14.3.



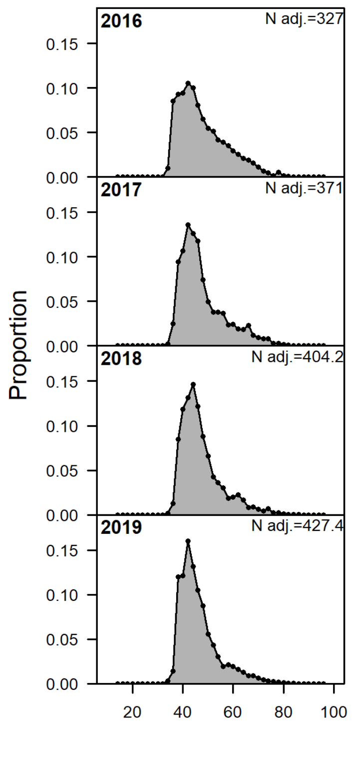


Figure 14.3: Length composition of all French fleet combined from 2000 onwards.

WGBIE was made aware of an issue with the sampling level in Q1 and Q2 of 2017 from France (Quemar et al., 2018 – WD12) in WGBIE 2018 (ICES, 2018c). Because of the lack of market sampling for length (biological and on-board samplings were unaffected), efforts were made to fill the deficiency in the number of samples by using simulation techniques. Both simulated and actual data were uploaded to InterCatch making it impossible to distinguish true samples from simulated ones. The simulation was based on commercial landings market categories (Figure 14.4).

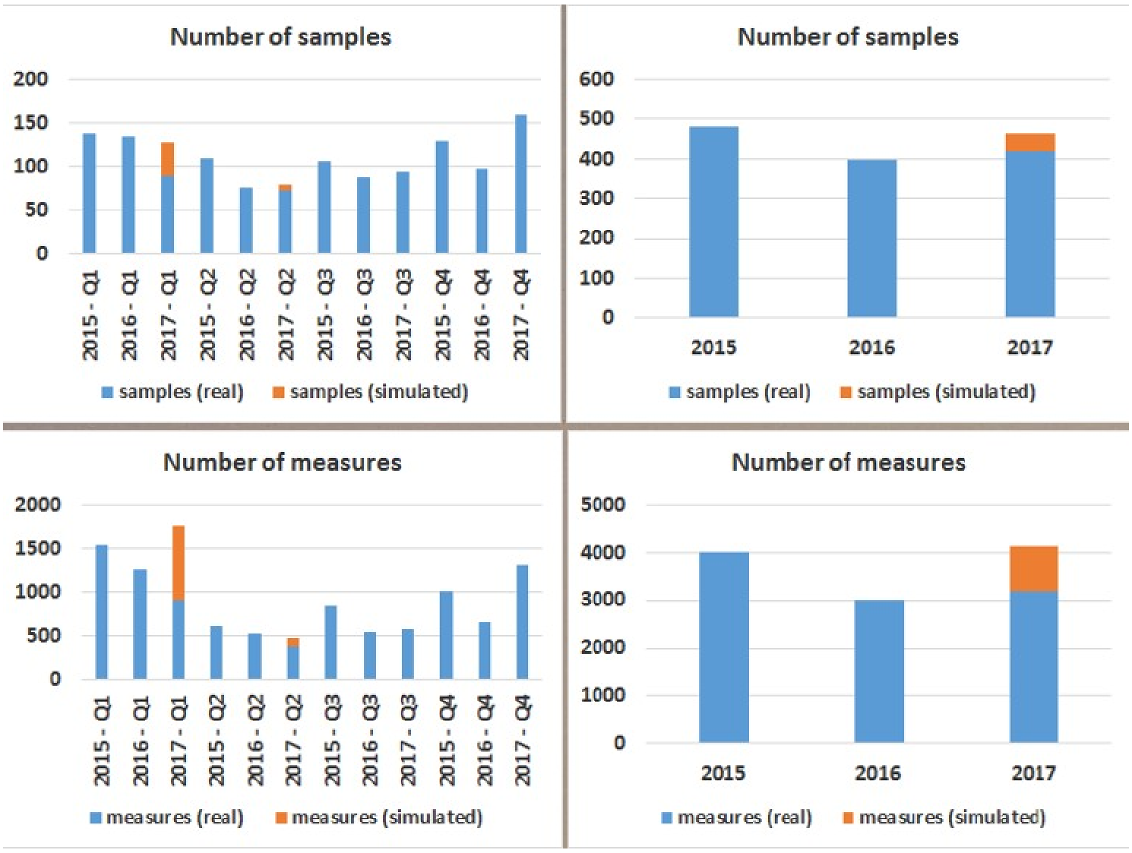


Figure 14.4: Numbers of seabass samples (trips) and measurements (fish) of observed and simulated data in the French sampling scheme in 2017 compared to previous years.

The French sampling programme for seabass age compositions is based on age-length keys (ALKs) with fixed allocation. For the 8.a-b area, the information is available only from 2008. This year, as in 2018, it was observed that the 2019 ALK showed a pattern inconsistent with the historical data (Figure 14.5). The observed bias was related to a change in age readers (Table 14.5). The group decided again not to include the age-at-length data, as the retrospective analysis showed that the year 2019 was offset compared to the other retrospective runs (see hereafter). A working document should be prepared on how to account for age readers bias in the assessment, and proposed changes should be reviewed likely at a (inter)benchmark.

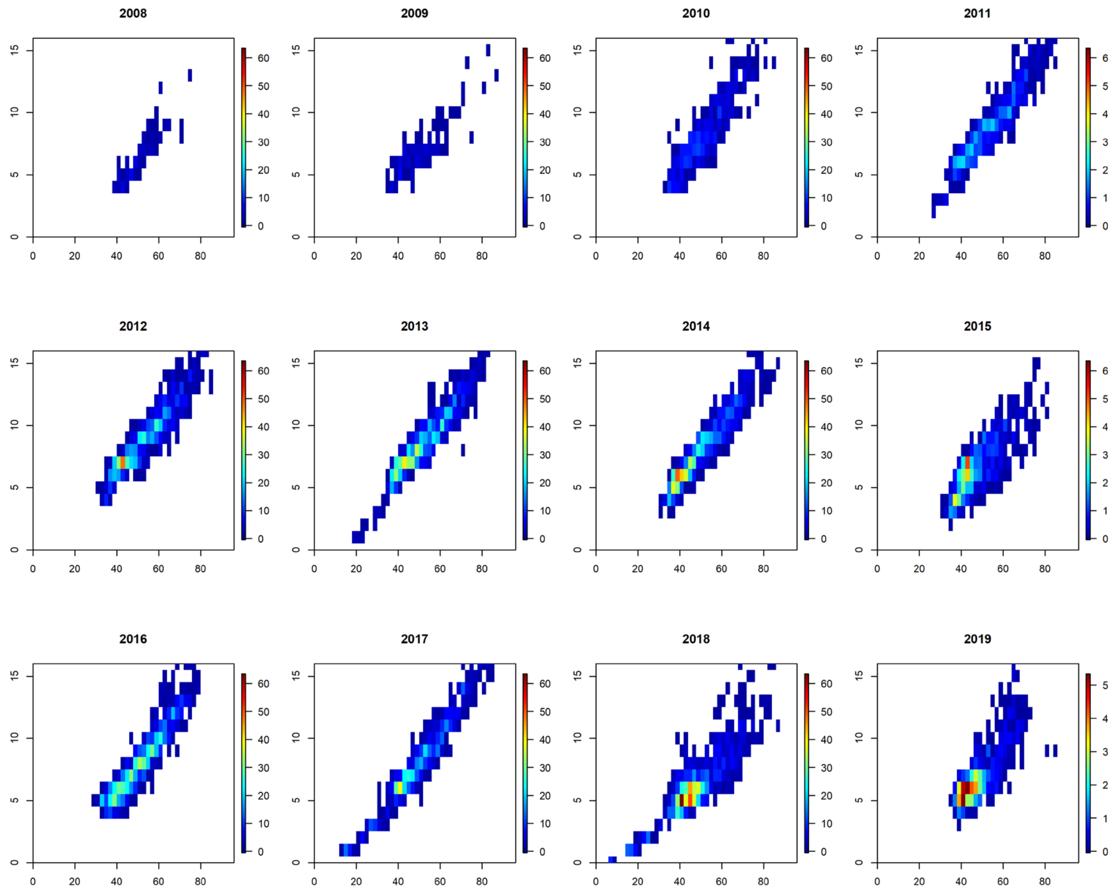


Figure 14.5: Age-at-length keys over years 2008-2019.

Table 14.5: Age readers proportion over years 2008-2019

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	

Year	Age readers			
	JH	KS	RE	SM
2019			100	

14.2.2.2 Recreational fishery

The full description of the recreational catches is presented in the Stock Annex.

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. IBPBass (ICES, 2014) considered more plausible to treat the 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 (ICES, 2018a) to apply a constant recreational fishing mortality over time considering the same approach used for the Northern stock. Total retained recreational catches were iteratively adjusted to obtain a constant recreational F over all years, which was derived using the catch value of 1 430 t estimated in 2010. The implementation of the 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 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 a new multiplier value was estimated at 0.647. In 2020, the multiplier relative to the implementation of a 2-fish bag limit is estimated at 0.584. The latter value was considered when performing 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	1482	3420
1986	1435	3549
1987	1401	3417
1988	1382	3217
1989	1374	3144
1990	1382	2621
1991	1393	2734
1992	1389	2709
1993	1368	2552

Year	Recreational removals	Commercial landings
1994	1328	2668
1995	1266	2492
1996	1198	2402
1997	1140	2358
1998	1126	2231
1999	1169	2091
2000	1258	2362
2001	1336	2306
2002	1391	2392
2003	1419	2616
2004	1426	2380
2005	1427	2796
2006	1430	2875
2007	1443	2751
2008	1454	2745
2009	1450	2278
2010	1430	2229
2011	1394	2575
2012	1346	2549
2013	880	2685
2014	824	2991
2015	782	2264
2016	778	2252
2017	740	2295
2018	747	2338
2019	697	2227

After the benchmark in 2018 (ICES, 2018a), a further survey has been conducted in France that provided estimates of seabass recreational catches in the Bay of Biscay. However, this survey has different associated uncertainty and bias than the one of 2010. It is not obvious how well to combine the data for use in the assessment and would represent a significant departure from the current approach. Hence, this should be done as part of the next benchmark and peer-reviewed to ensure its robustness. As a result, the current approach will continued to be used until the next benchmark and recreational catches included on the issue list.

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 (ICES, 2018a). This estimate was based on a published German study (Lewin et al., 2018).

Recreational length compositions

The estimate of removals was recalculated for the 2010 reference year as the sum of the 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 a WD from Hyder et al. (2018) and illustrated in Figure 14.6.

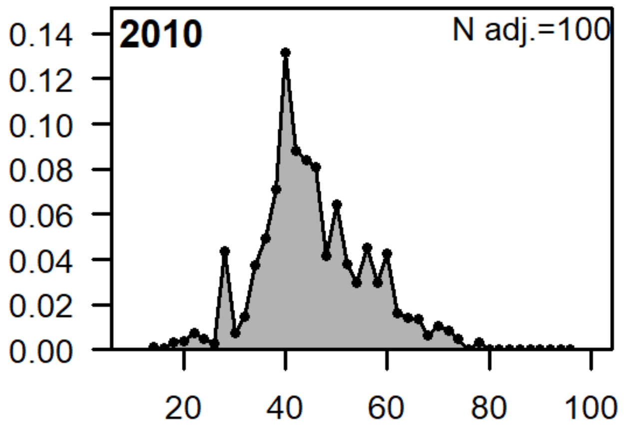


Figure 14.6. Length composition for the recreational fishery. Data available only for the year 2010.

14.2.3 Abundance indices from surveys

Currently, there is no survey providing relative indices of adult or juvenile seabass abundance over time. A French study was undertaken in 2013-2018 to explore the possibility of creating recruitment indices in estuarine waters. The obtained results were good and promising, but financial support is needed to be routinely carried out (Le Goff et al., 2017). Abundance indices have been calculated for years 2016, 2017, 2018 and 2019 in the Loire estuary and 2019 in the Gironde estuary. Further surveys are planned for the year 2020. However, it was not possible to confirm during this WG meeting if all the planned surveys can be conducted due to this year pandemic uncertainties. A project proposal was submitted to FEAMP[1] for the years 2019-2021 which included samplings in the Gironde estuary in order to get two abundance indices for the bss.27.8ab stock. The ultimate objective would be to make the study sustainable through DCF, from 2022 onwards.

[1] *Le Fond Européen pour les Affaires Maritimes et la* Pêche (FEAMP) or the European Maritime and Fisheries Fund is a European Union fund for fisheries and the maritime environment. It is thus an instrument of European fisheries policy which grants financial aid to this sector in order to help it adapt to changing needs.

14.2.4 Commercial landing-effort data

A full description of the LPUE and estimation methods are presented in the Stock Annex and in a WD by 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 stock in the Bay of Biscay. There are no scientific surveys providing sufficient data on adult seabass to develop an abundance index for the area. Hence, IFREMER investigated the potential of 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 (ICES, 2018a). This index was 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. C. Christman, MCC Statistical Consulting, Gainesville, Florida, USA) before WKBASS 2018. The reviewer recommended the use of the new LPUE index 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 2019 data are presented in Figure 14.7.

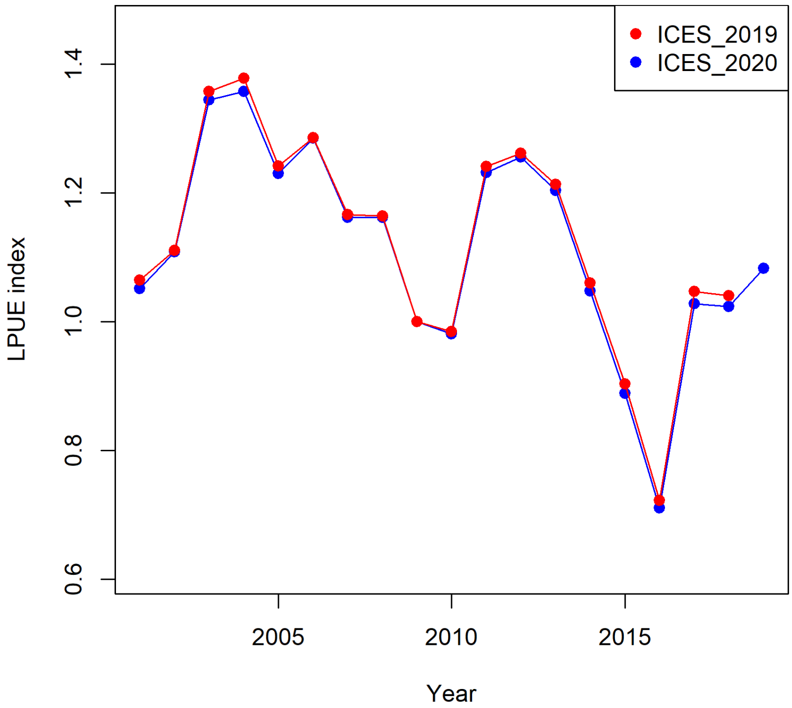


Figure 14.7. Comparison of the LPUE index used in the 2019 and 2020 assessments.

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 during the years 2014-2015 along the coasts of France in area 8.a-b (Drogou *et al.*, 2018). The von Bertalanffy model parameters were estimated using an absolute error model minimising $\sum(obs - exp)^2$ in the lengths-at-age data used. L_{inf} was fixed to 80.4 cm (Bertignac, 1987). The standard deviation could be described by a 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 not used (K is re-estimated by the assessment model).

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)

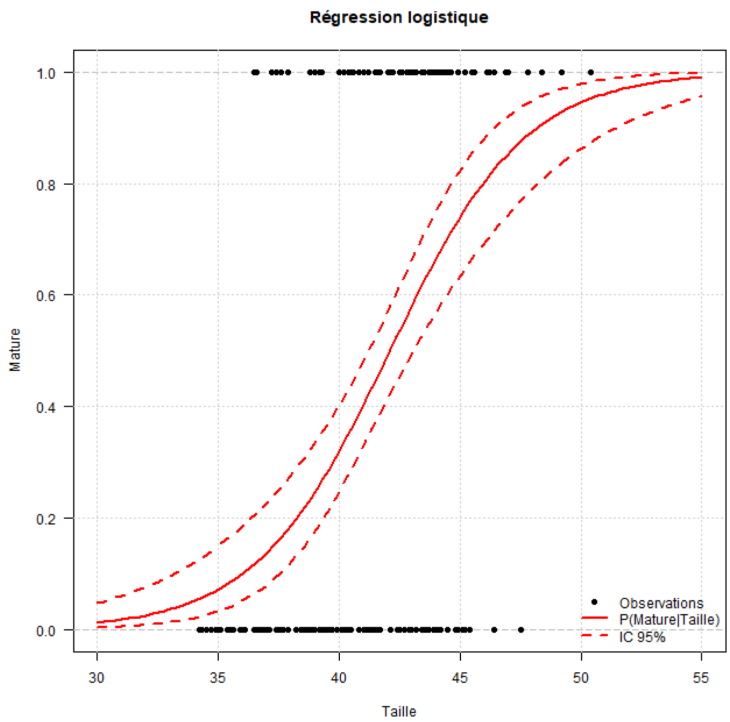


Figure 14.8. Maturity ogive for the Bay of Biscay seabass stock.

14.2.5.3 Natural mortality

WKBASS 2017/2018 (ICES, 2018a) proposed to use the same value for both the Northern and the Bay of Biscay seabass stocks and set the natural mortality to M = 0.24, the value predicted by Then et al. (2015) t_{max} method which is considered more robust than inferences from any single study.

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 the LPUE abundance index. Figure 14.9 presents selectivity functions by fleet estimated by the model. The inclusion of the 2019 data did not change the selectivity pattern and its modelling.

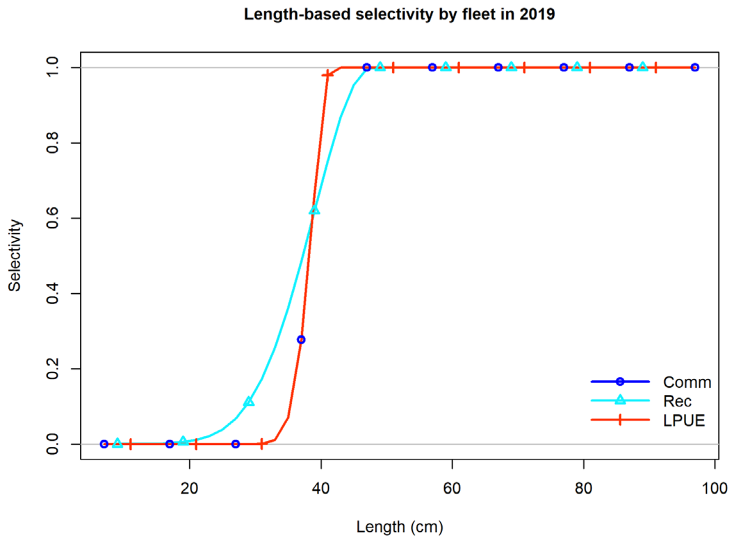


Figure 14.9. Selection patterns at length by commercial and recreational fleets estimated by SS3. Selection pattern for the LPUE abundance index was assumed to follow the one from the commercial fleet.

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.

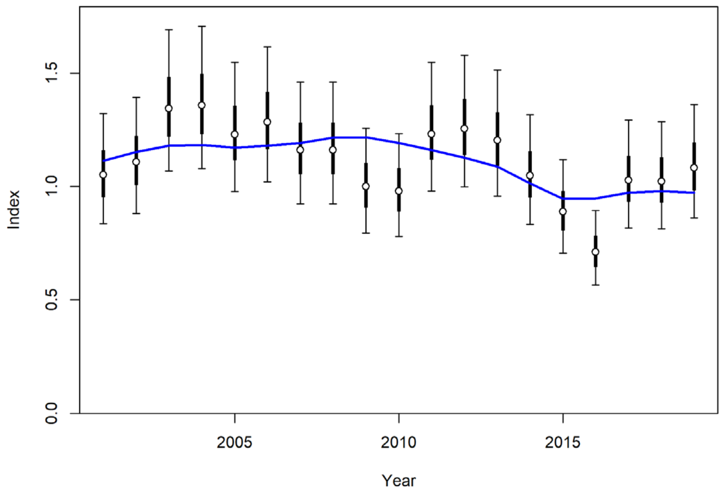
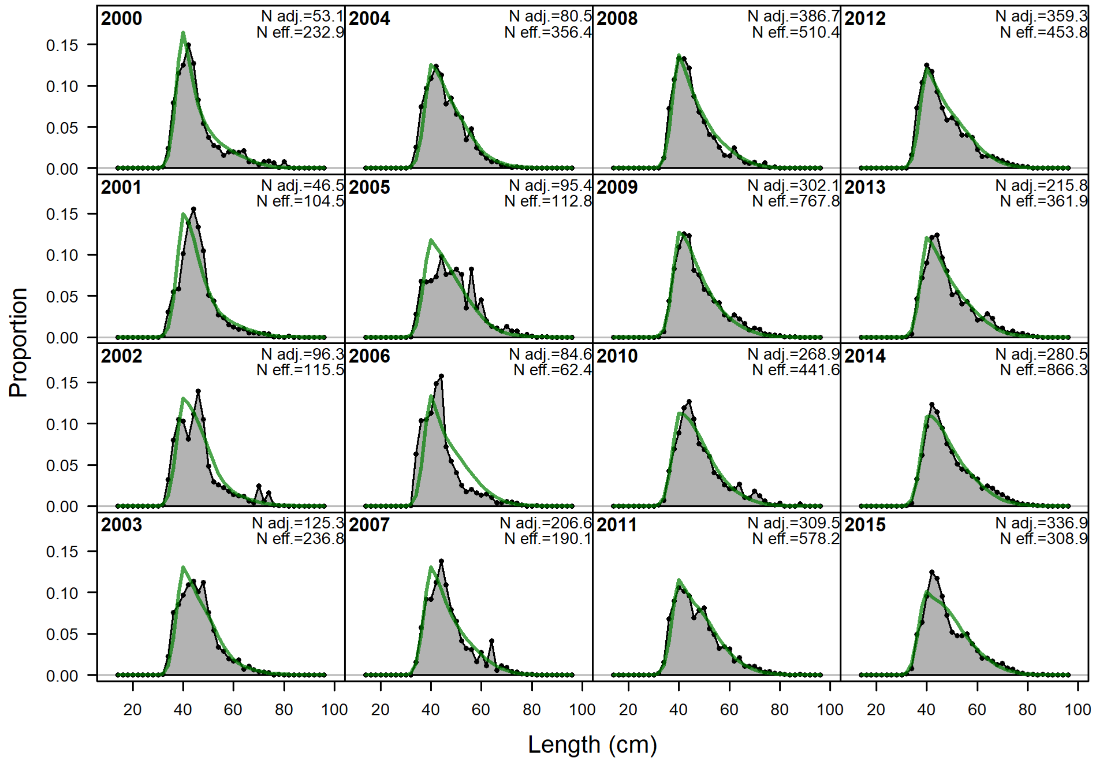


Figure 14.10. Fit to the LPUE abundance index.

Model fit for the commercial and recreational length composition data was good (Figures 14.11 and 14.12).



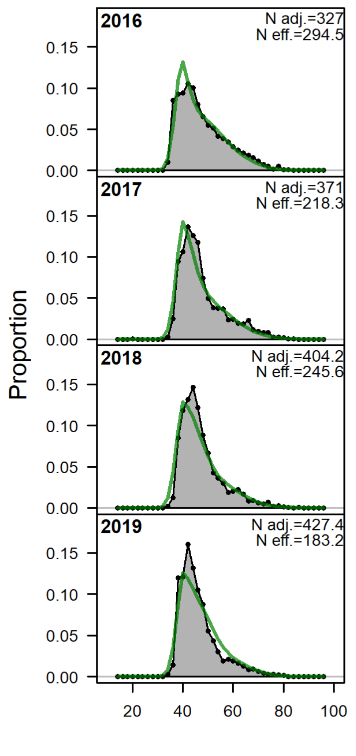


Figure 14.11. Fit to the commercial fishery length composition data.

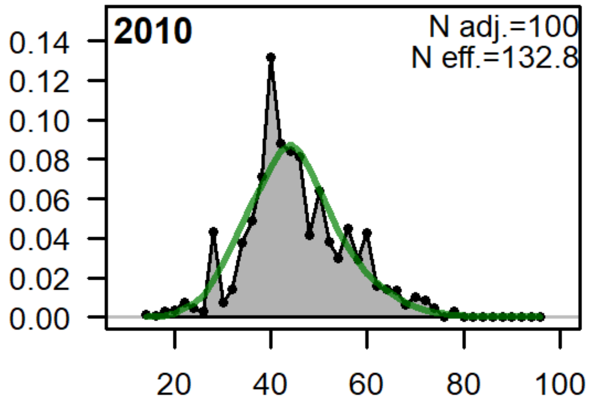
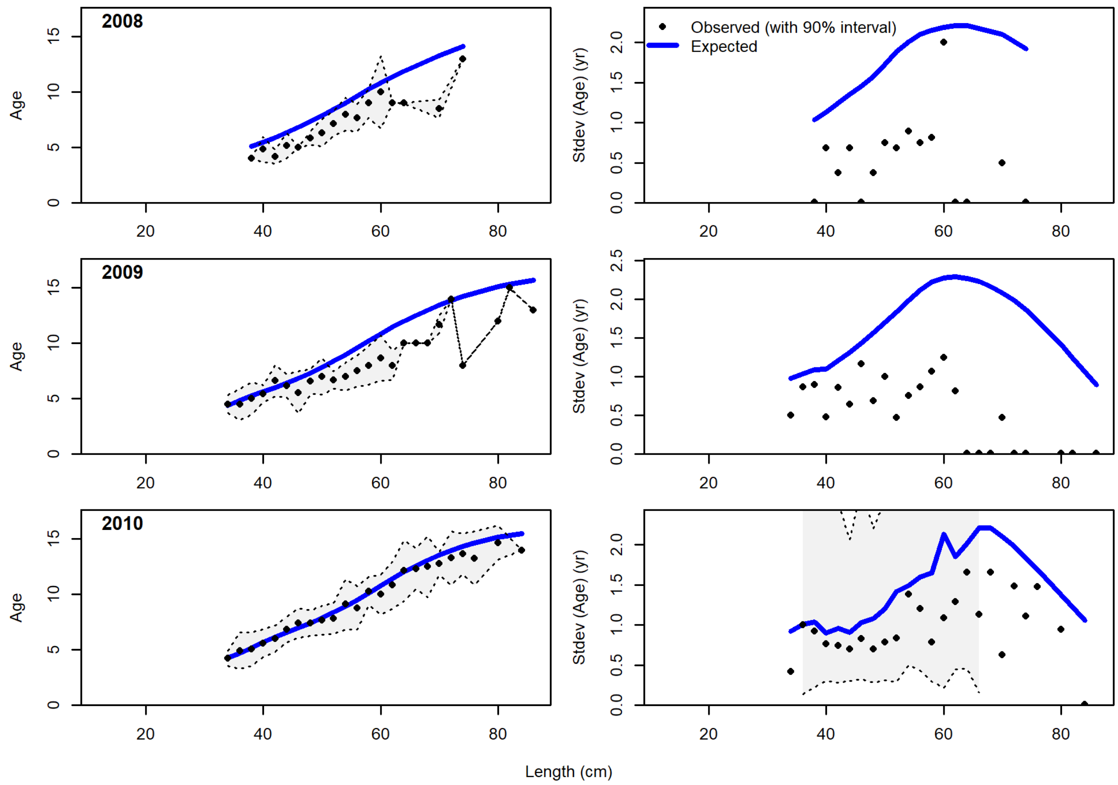
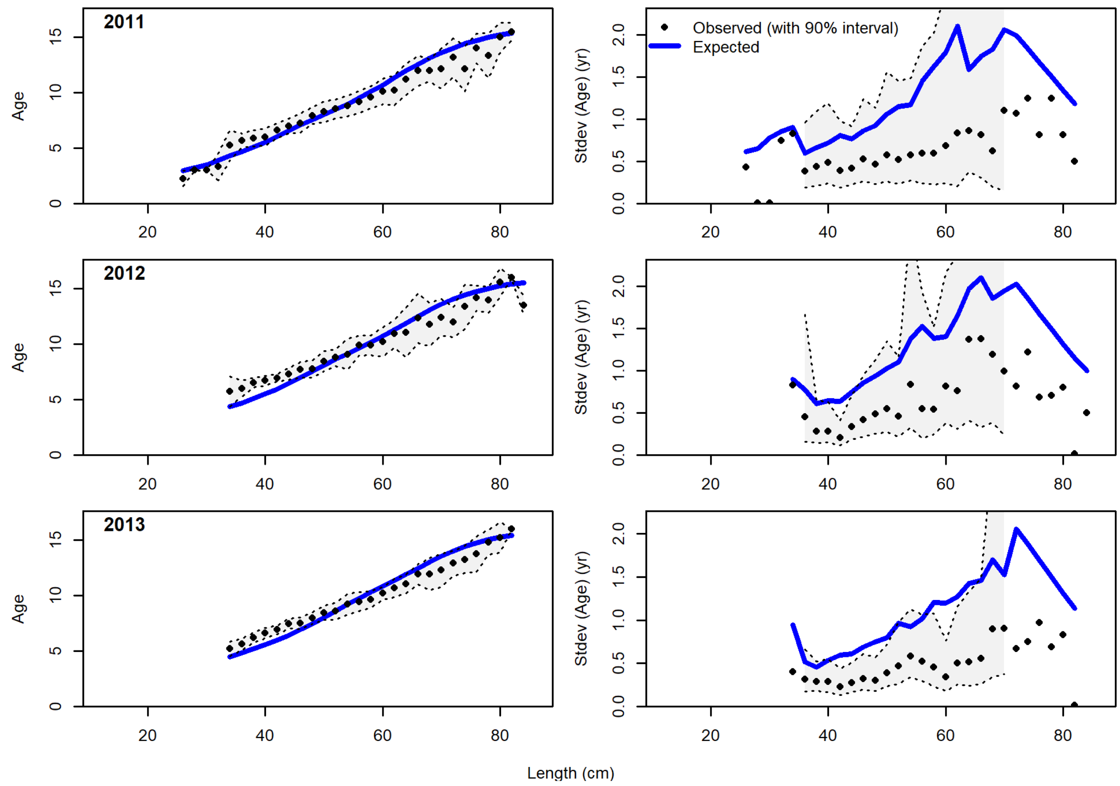


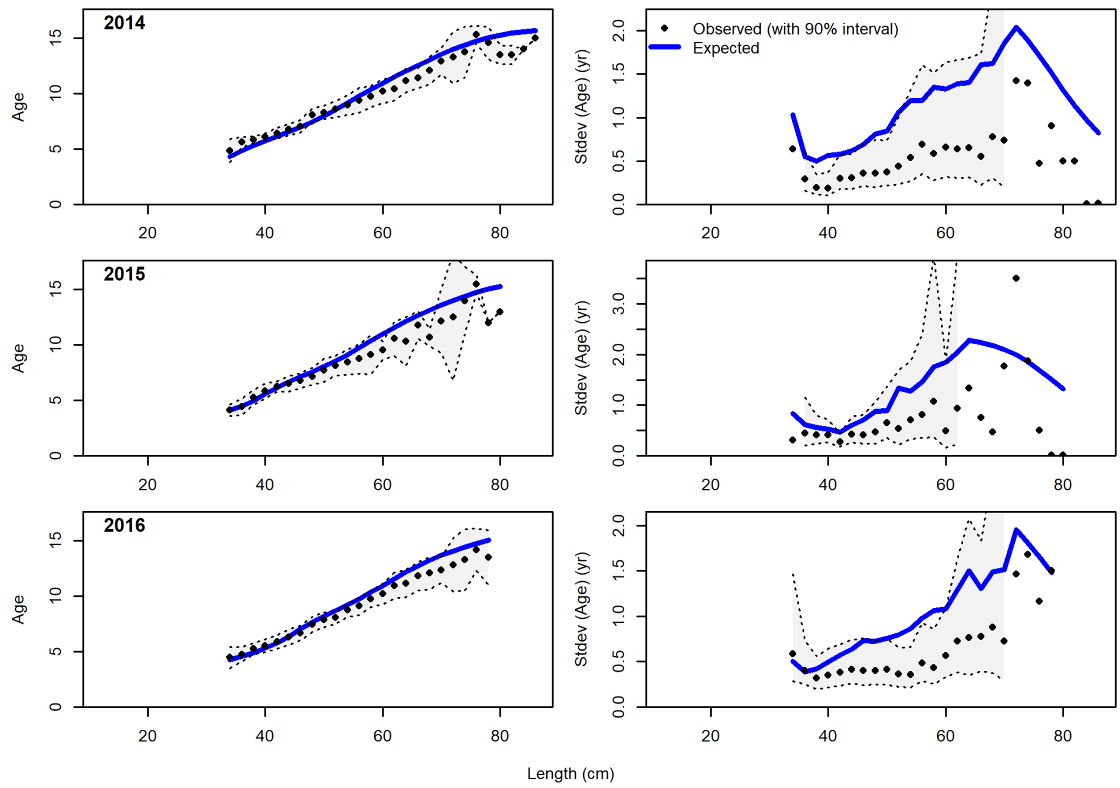
Figure 14.12. Fit to recreational fishery length composition data.

Model fit for the aggregated fishery age-at-length composition data were good in average, but poor in standard deviation (Figures 14.13 and 14.14). The 2018 and 2019 age-at-length data were not included in the assessment, as they showed a pattern incoherent with the historical data. The retrospective analysis (see below) was poor when these data were included.





2011
2012
2013
Age
Stdev (Age) (yr)
Observed (with 90% interval)
Expected
Length (cm)



2014
2015
2016
Age
Stdev (Age) (yr)
Observed (with 90% interval)
Expected
Length (cm)

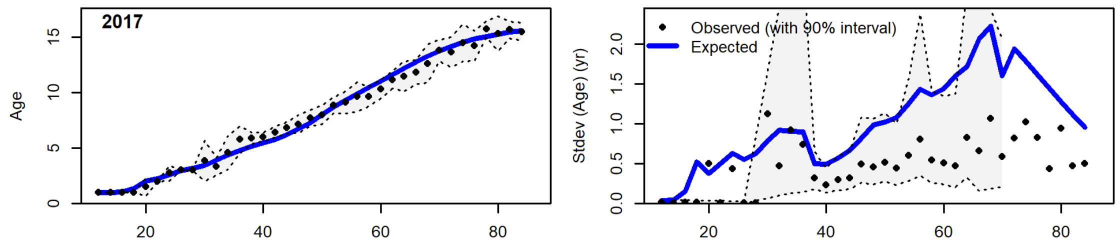


Figure 14.13. Fit to conditional age-at-length for commercial fishery.

The fit was poor for the first 2 age-at-length keys for years 2008 and 2009 when sampling size during these years was considered low.

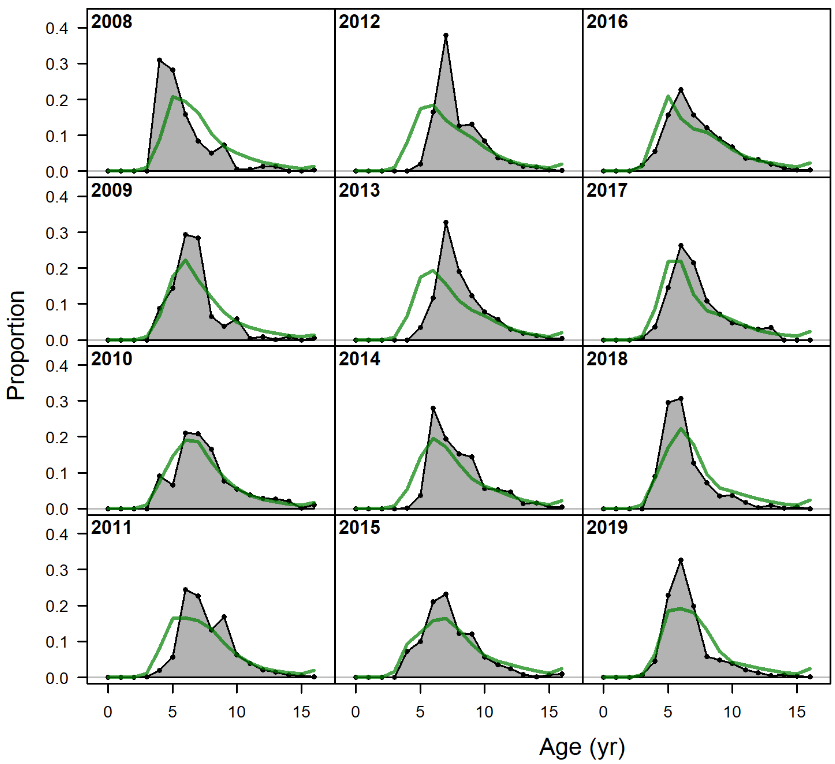


Figure 14.14. Observations and model predictions for age composition.

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 discrepancy 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 analyses were conducted (Figures 14.15 and 14.16). When excluding the 2019 ALK (Figure 14.15), recruitment, SSB and F series showed some variability, however, the stock trend is rather robust. In the last 5 years, SSB is stable at around 20 000 t showing a decreasing trend, while F is below 0.15 and fluctuating without a trend. Recruitment was poorly estimated in recent years and showed high variability.

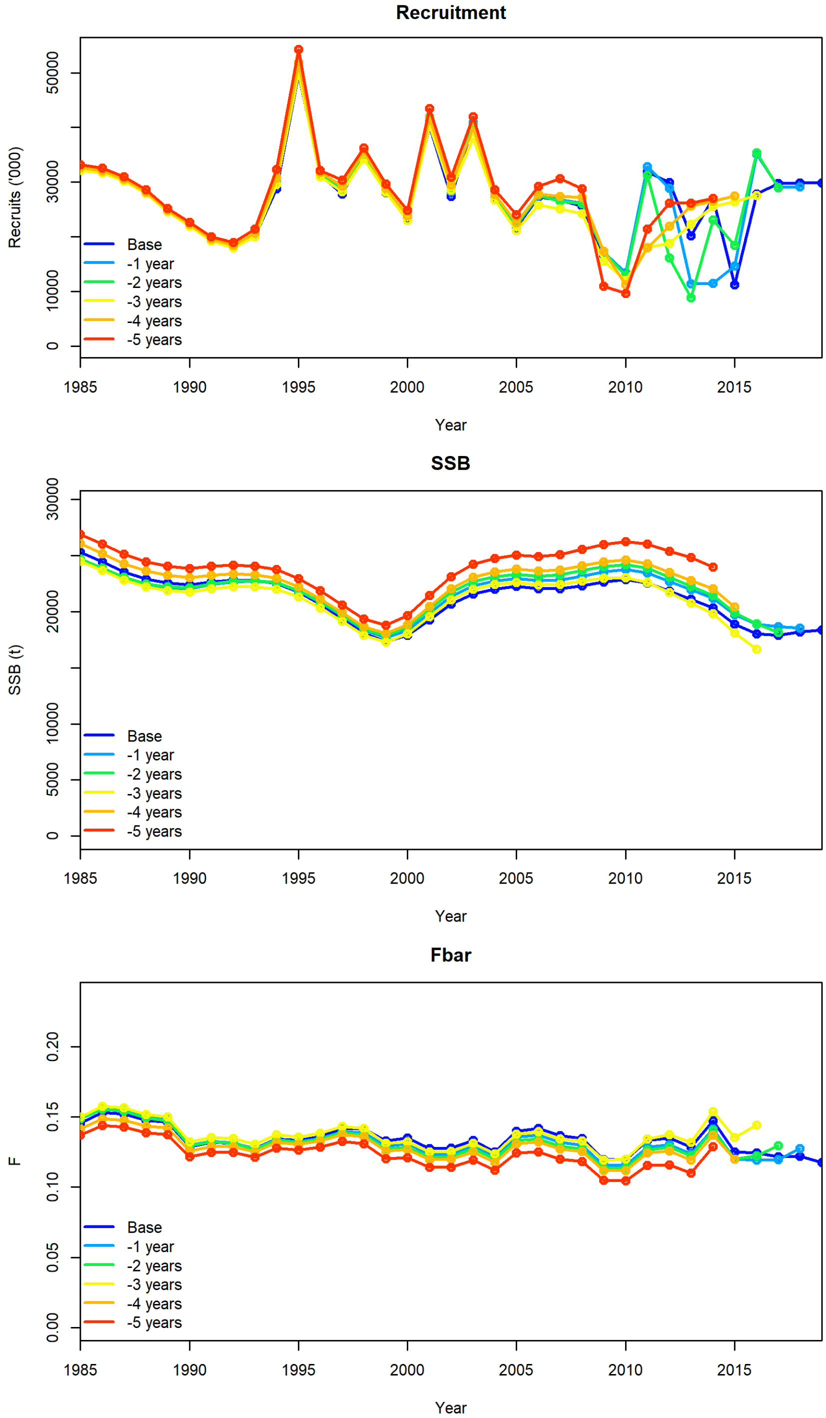


Figure 14.15. Retrospective plot without the 2019 age-at-length key (i.e. with the model used for the assessment).

When including the 2019 ALK (Figure 14.16), 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 are quantified by the poor values of Mohn's rho (see Table 14.7). Assessment including 2019 ALK may not be in adequacy with the current biological reference points. Consequently 2019 ALK was not included in the assessment model.

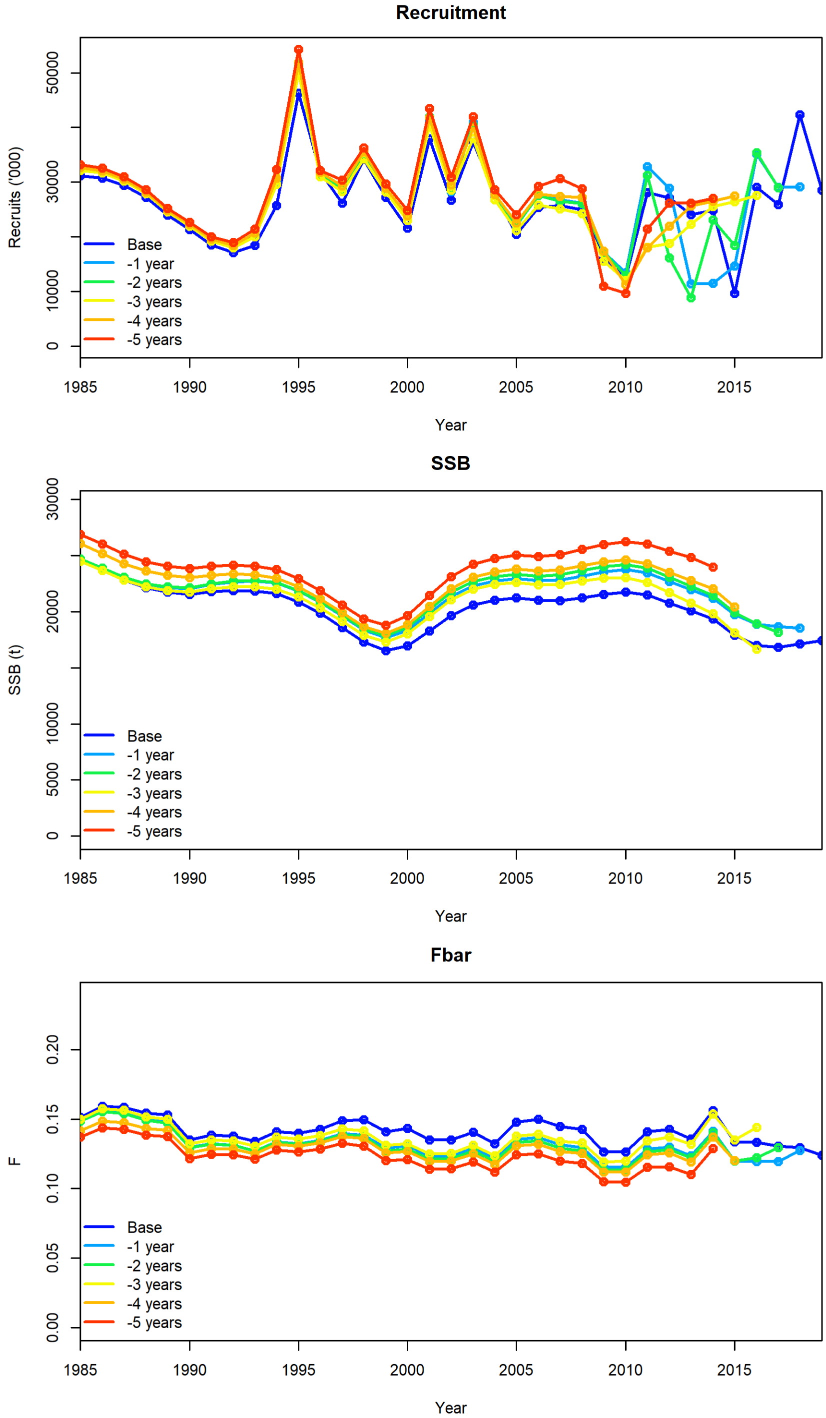


Figure 14.16. Retrospective plot with the 2019 age-at-length key (i.e. with a model not used for the assessment).

Table 14.7. Mohn's rho values for both retrospective analysis.

without 2019 ALK			with 2019 ALK		
SSB	Rec	Fbar	SSB	Rec	Fbar
0.043	0.280	0.020	0.105	0.339	-0.045

Figure 14.17 shows a comparison between the 2020 assessment with and without the 2019 ALK and the last year ICES assessment for seabass in the Bay of Biscay area. The chosen assessment for 2020 (i.e. that without 2019 ALK) is in line with last year ICES assessment.

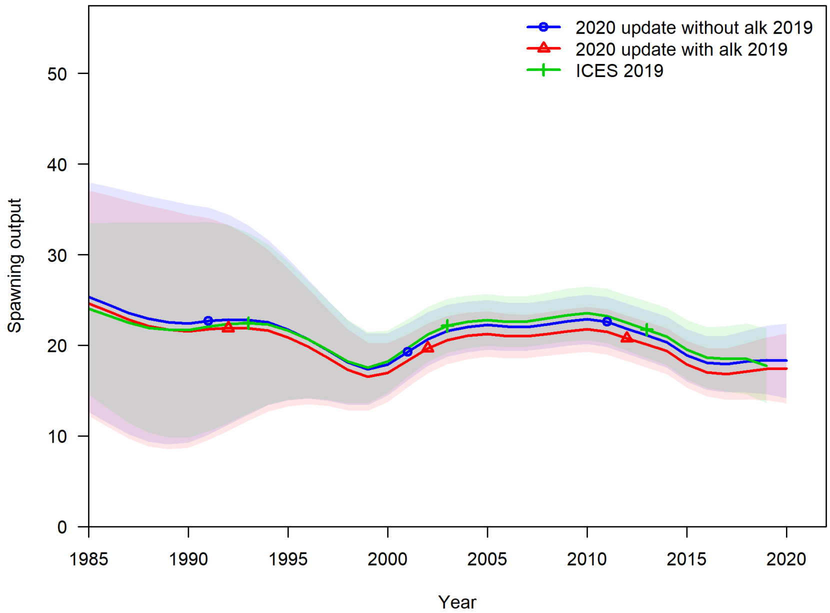


Figure 14.17. Comparison between the 2020 assessment with and without the 2019 age-length key and last year ICES assessment for seabass in the Bay of Biscay area.

14.4 Historic trends in biomass, fishing mortality and recruitment

Assessment summary from SS3 is given in Figure 14.18. The recruitment series was variable around ~30 million individuals per year. Recruitment below average was observed for years 2009 and 2014. The SSB fluctuated around 20 000 t. A low SSB was observed just before the 2000s then a high value was observed around year 2010. Since then, a decreasing trend was observed. Average F computed for ages 4 - 15 showed a stable trend over the whole time series.

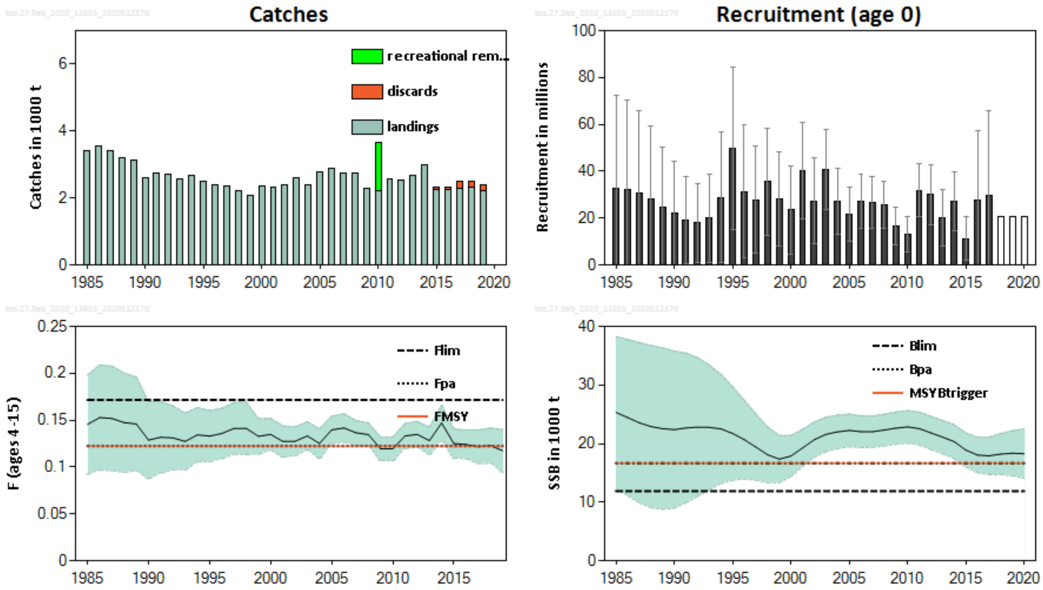


Figure 14.18. Summary of the stock assessment (weights in thousand tonnes). Commercial landings (with discards included for the years 2016, 2017, 2018 and 2019), and recreational removals (only presented for 2010 when the data are available), including 5% mortality of released fish. Fishing mortality 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 2019, F is below F_{MSY} (Table 14.8). SSB is above MSY $B_{trigger}$ 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				
		2017	2018	2019			2018	2019	2020	
Maximum sustainable yield	F_{MSY}	✔	✖	✔	Appropriate	MSY $B_{trigger}$	✔	✔	✔	Above trigger
Precautionary approach	F_{pa},F_{lim}	✔	○	✔	Harvested sustainably	B_{pa},B_{lim}	✔	✔	✔	Full reproductive capacity
Management plan	F_{MGT}	–	–	–	Not applicable	B_{MGT}	–	–	–	Not applicable

Table 14.9 presents the assessment summary provided by SS3.

Table 14.9. Assessment summary. All weights are in tonnes.

Year	Recruitment Age 0 thousands	High	Low	SSB tonnes	High	Low	Commerical landings tonnes	Recreational removals tonnes	F Ages 4-15
1985	32821	72502	0	25326	38268	12384	3420	1482	0.146
1986	32224	70564	0	24449	37786	11112	3549	1435	0.153
1987	30621	66056	0	23563	37239	9888	3417	1401	0.152
1988	28129	59442	0	22911	36748	9074	3217	1382	0.148
1989	24550	50500	0	22560	36319	8801	3144	1374	0.146
1990	21912	44026	0	22389	35793	8985	2621	1382	0.129
1991	19176	37627	724	22679	35456	9902	2734	1393	0.132
1992	18034	34899	1169	22823	34661	10986	2709	1389	0.131
1993	20061	38920	1202	22782	33430	12134	2552	1368	0.127
1994	28829	56714	944	22523	31844	13202	2668	1328	0.134
1995	49829	84422	15236	21743	29709	13777	2492	1266	0.133
1996	31323	59555	3091	20691	27404	13978	2402	1198	0.136
1997	27830	50639	5022	19404	25042	13767	2358	1140	0.141
1998	35492	58465	12519	18098	22850	13346	2231	1126	0.141
1999	28094	48337	7850	17363	21398	13328	2091	1169	0.133

Year	Recruitment Age 0 thousands	High	Low	SSB tonnes	High	Low	Commerical landings tonnes	Recreational removals tonnes	F Ages 4-15
2000	23530	42400	4661	17886	21393	14378	2362	1258	0.135
2001	40217	60780	19653	19271	22451	16091	2306	1336	0.127
2002	27352	45781	8923	20680	23696	17663	2392	1391	0.128
2003	40700	57690	23710	21590	24517	18662	2616	1419	0.133
2004	27262	41267	13258	22023	24879	19167	2380	1426	0.125
2005	21645	33381	9908	22262	25048	19475	2796	1427	0.140
2006	27261	38905	15617	22042	24756	19327	2875	1430	0.142
2007	26657	37633	15680	22038	24714	19362	2751	1443	0.137
2008	25619	35580	15659	22316	25019	19613	2745	1454	0.135
2009	16652	24766	8537	22641	25393	19889	2278	1450	0.120
2010	13276	20768	5784	22864	25651	20077	2229	1430	0.120
2011	31900	43198	20601	22576	25383	19770	2575	1394	0.133
2012	29974	42611	17337	21840	24663	19017	2549	1346	0.135
2013	20219	32173	8266	21109	23954	18264	2685	880	0.128
2014	27030	39517	14542	20355	23239	17472	2991	824	0.147
2015	11173	20480	1867	18900	21830	15970	2264	782	0.125

Year	Recruitment Age 0 thousands	High	Low	SSB tonnes	High	Low	Commerical landings tonnes	Recreational removals tonnes	F Ages 4-15
2016	27817	57233	0	18058	21069	15047	2252	778	0.124
2017	29794	65761	0	17929	21129	14728	2295	740	0.122
2018	20650	NA	NA	18232	21731	14734	2338	747	0.123
2019	20650	NA	NA	18369	22213	14524	2227	697	0.118
2020	20650	NA	NA	18294	22494	14093			
Average	26638	47654	7629	21127	27199	15055	2615	1242	0.134

14.5 Biological reference points

IBP Bass (ICES, 2018b) set the biological reference points to be used for this stock. Table 14.10 compiles the biological reference points computed for type 6 stock-recruitment relationship as agreed during the inter-benchmark IBP Bass.

Table 14.10. Biological reference points agreed by IBP Bass (ICES, 2018b) for use in the ICES advice. All weights are in tonnes.

Framework	Reference Point	Value	Basis
MSY approach	MSY $B_{trigger}$	16688 t	B_{pa}
	F_{MSY}	0.123	F that maximizes median long-term yield in stochastic simulations under constant F exploitation; constrained by the requirement that $F_{MSY} = F_{pa}$
Precautionary approach	B_{lim}	11920 t	B_{pa} / exp(CV * 1.645)
	B_{pa}	16688 t	Lowest observed SSB
	F_{lim}	0.172	F that, In equilibrium gives a 50% probability of SSB>B_{lim}
	F_{pa}	0.123	$F_{pa} = F_{lim}$ / exp(CV * 1.645)
Management plan	SSB_{mgt}	Not defined	
	F_{mgt}	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 2015. During WGBIE 2020, it has been agreed to add one more year (2015) for the GM calculation, as the youngest age caught by the fishery is 4 years old. For the short-term projection, F-at-age averaged over the last 3 years (2017-2019) and scaled to the 2019 value was used for commercial and recreational fleets (Table 14.11).

Table 14.11. Forecast inputs table.

Ages	N@age	Weight@age	Prop.mature@age	Commerical F	Commerical mean weight	Recreational F	Recreational mean weight	Natural mortal-ity
0	20 650	0.0039	0.0000	0.000	0.0091	0.000	0.0091	0.24
1	16 244	0.0197	0.0000	0.000	0.0442	0.000	0.0512	0.24
2	12 777	0.0773	0.0002	0.000	0.2841	0.001	0.1500	0.24
3	14 491	0.1806	0.0030	0.000	0.4546	0.004	0.2977	0.24
4	10 600	0.3277	0.0296	0.014	0.5959	0.010	0.4811	0.24
5	3 266	0.5128	0.1599	0.056	0.7309	0.018	0.6842	0.24
6	5 752	0.7281	0.4198	0.086	0.8994	0.025	0.8972	0.24
7	3 012	0.9656	0.6734	0.097	1.1122	0.029	1.1228	0.24
8	3 075	1.2174	0.8354	0.099	1.3549	0.030	1.3641	0.24
9	2 241	1.4770	0.9197	0.100	1.6110	0.031	1.6165	0.24
10	635	1.7386	0.9602	0.100	1.8698	0.031	1.8728	0.24
11	537	1.9974	0.9794	0.100	2.1252	0.031	2.1268	0.24
12	556	2.2499	0.9888	0.100	2.3731	0.031	2.3740	0.24
13	390	2.4933	0.9936	0.100	2.6111	0.031	2.6116	0.24
14	271	2.7256	0.9961	0.100	2.8373	0.031	2.8376	0.24
15	147	2.9456	0.9975	0.100	3.0507	0.031	3.0508	0.24
16	454	3.5051	0.9984	0.100	3.5602	0.031	3.5602	0.24

Age 0,1,2 over-written as follows:

2020 yc -> 2020 age 0 replaced by 2008-2015 LTGM (20650thousand);

2019 yc -> 2020 age 1 from SS3 survivor estimate at-age 1, 2020 * LTGM / SS3 estimate of age 0 in 2018;

2018 yc -> 2020 age 2 from SS3 survivor estimate at-age 2, 2020 * LTGM / SS3 estimate of age 0 in 2017.

The total landings forecasted for 2020 are 2736 t, with 2 125 t for the commercial landings and 612 t for the recreational fishery. SSB 2021 is forecasted at 17 147 t, i.e. above MSY $B_{trigger}$ (Table 14.12).

Table 14.12. The basis for the catch scenarios.

Variable	Value
F ages 4-15 (2020)	Commercial fishery F = 0.088, Recreational fishery F = 0.025 Total F = 0.113
SSB (2021)	17 147 t
Rage0 (2018,2019,2020)	20 650 thousands
Total catch (2020)	2 736 t
Wanted commercial catch (2020)	2 125 t
Unwanted commercial catch (2020)	4.2 %
Recreational Catch (2020)	612 t

Following the ICES advice rules, when the MSY approach is applied, total catch (commercial and recreational removals) in 2021 should be no more than 3 108 t (Table 14.13).

Table 14.13. Catch options table.

Basis	Total catches	Commerical landings	Recreational removals	Commercial discards	Total Fbar	Commercial Fbar	Recreational Fbar	SSB 2022	SSB change	Advice change
$F=F_{MSY}$	3108	2316	667	125	0.123	0.096	0.027	16 997	-0.90	22.7
F=0	0	0	0	0	0.000	0.000	0.000	19 267	12.4	-100.0
$F=F_{pa}$	3108	2316	667	125	0.123	0.096	0.027	16 997	-0.90	22.7
$F=F_{lim}$	4252	3167	913	172	0.172	0.134	0.038	16 169	-5.70	67.9
SSB_2022 = B_{lim}	10257	7630	2213	414	0.474	0.370	0.104	11 920	-30.5	304.9
SSB_2022 = B_{pa}	3534	2632	759	143	0.140	0.110	0.031	16 688	-2.70	39.5
SSB_2022 = MSY $B_{trigger}$	3534	2632	759	143	0.140	0.110	0.031	16 688	-2.70	39.5
$F=F_{2019}$	2870	2138	616	116	0.113	0.088	0.025	17 169	0.10	13.3
$F=F_{MSY\ lower}$	2966	2210	637	120	0.117	0.091	0.026	17 100	-0.30	23.2
$F=F_{MSY\ upper}$	3771	2809	810	152	0.151	0.118	0.033	16 517	-3.70	22.6

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 below average for years 2009 and 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.

14.8 Considerations for a benchmark

This assessment relies on a short data time series: length composition time series started in 2000; age-at-length time series started 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 smoothened because of ageing errors (Laurec and Drogou, 2012). A French study has been undertaken in 2013-2018 to explore the possibility of creating recruitment indices in estuarine waters. The survey delivered good results, but it needs economic support to be routinely carried out (Le Goff et al., 2017). Annual abundance indices have been calculated for years 2016, 2017, 2018 and 2019 in the Loire estuary. Another survey is planned for this year. A study has been proposed to FEAMP for years 2019-2021, which will include the Gironde estuary in order to get 2 abundance indices for the stock bss.27.8ab. The final objective would be to make the study sustainable through DCF from 2022 after including 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 in abundance trends 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 the ongoing tagging and genetic research programs.
5. Studies are needed to investigate the accuracy/bias in ageing and errors due to historical 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. Further survey has been conducted in France following the WKBASS in 2018 which provide estimates of recreational catches of seabass for the Bay of Biscay (ICES, 2018a). However, this

survey has different associated uncertainty and bias than the one in 2010. A methodology should be investigated on how to best integrate these data for use in the assessment and should be peer-reviewed to ensure its robustness.

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).

14.9 Management considerations

Seabass are 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 migration 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 implemented, 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 a significant decline of biomass, similar to what occurred in the Northern areas.

The behaviour of seabass, forming predictable aggregations for spawning in winter and moving inshore to feed at other times of the year increase the stock 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 limits to control the fishery, there can be risks to increase landings as observed in 2014. 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 indicates that resource sharing is an important issue for management consideration.

14.10 Information from stakeholders

Since 2017, the French commercial fishing activities in the Bay of Biscay (ICES Divisions 8.a-b and d) have been subjected to national management measures aiming at limiting both seabass fishing effort and capacity of the fishery at levels compatible with the ICES recommendations. These especially concern annual and periodic limitations of seabass fishing opportunities, at the level of both the whole fishery and individual vessels (CNPMEM, 2020).

14.11 References

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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 2020 and 2021 should be no more than 502 t. All commercial catches are assumed to be landed. Recreational catches cannot be quantified; therefore, total catches cannot be calculated.

The perception of the stock didn’t change in 2020. The advice will not be reopened.

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). Stock identity has not been changed (ICES, 2017a), but research on population structure are under progress.

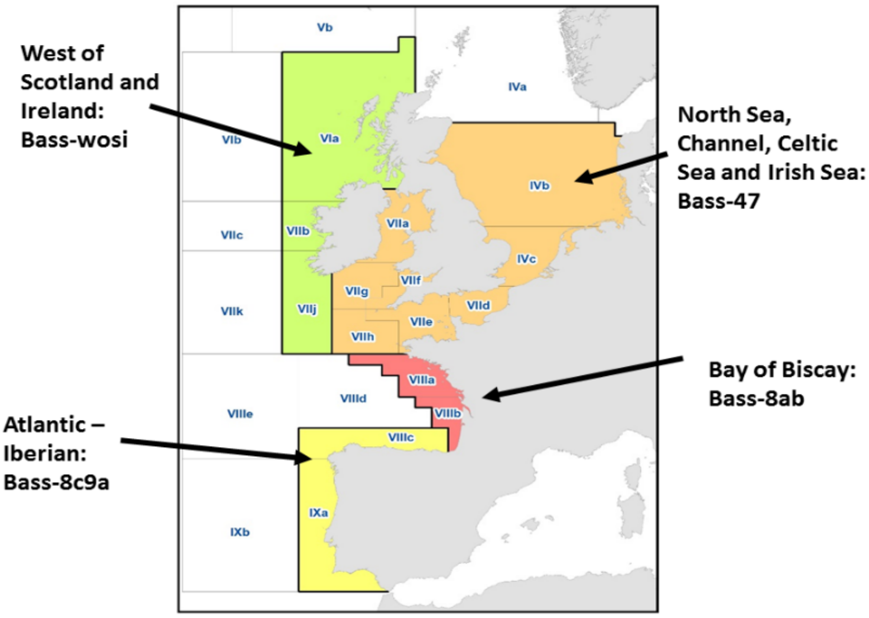

Figure 15.1. Current stock definitions for seabass.

15.2.2 Management applicable to 2017

Seabass is not subject to EU TACs and quotas. Under the EU regulation, the minimum landing size (MLS) of seabass in the Northeast Atlantic is 36 cm total length. A variety of national restrictions on commercial seabass fishing is 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 management measures are known at present in 8c, 9a.

15.2.4 Management applicable to 2019

A multiannual management plan (MAP) has been published for the Western Waters (European Parliament and Council Regulation (EU) 2019/472). 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 (FAO, 2020) since around the mid-1970s.
- ii) Spanish landings for 2007-2011 from sales 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 represented 788 t in 2019 (source: InterCatch). A peak of landings was observed in the early ‘90s and in 2013, reaching more than 1000 t, and the lowest landings (637 t) have been observed in 2004. Seabass fisheries in this area are mainly artisanal (Table 15.2). Landings from Portugal are only from the 9a area, while the Spanish landings are distributed between the two zones 8c and 9a (186 t and 187 t in 2019, respectively). Landings per country are given in Figure 15.1. Landings split by country, gear and area are given in Table 15.2.

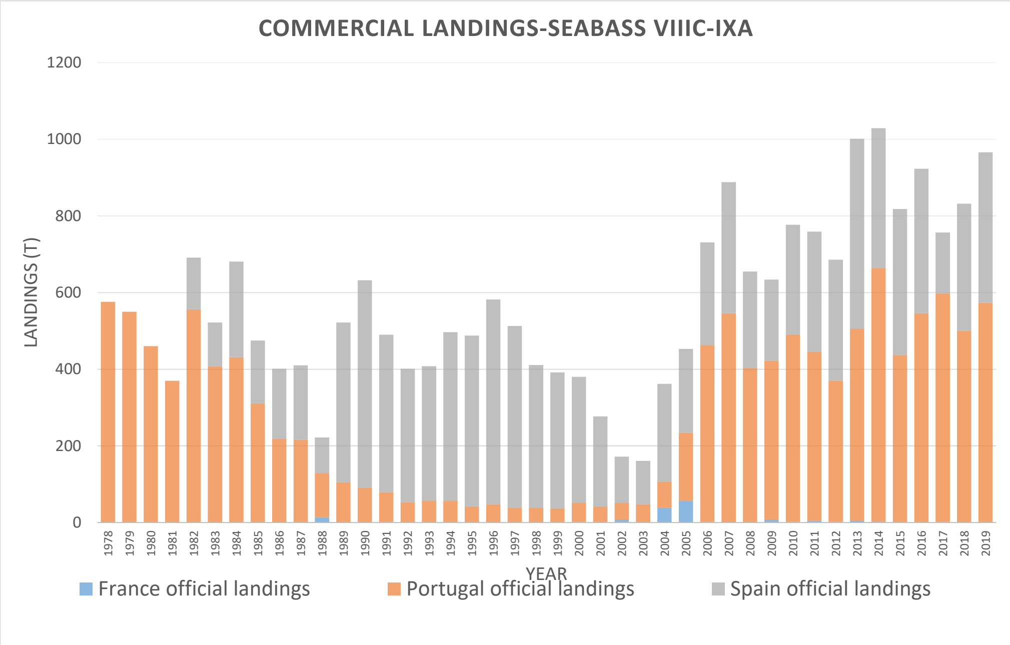

Figure 15.1. Commercial landings per country in area 27.7.9a and 27.7.8c (source: InterCatch).

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 (Figure 15.2) and for Spanish fleet in 2017-2018 (Figure 15.3).

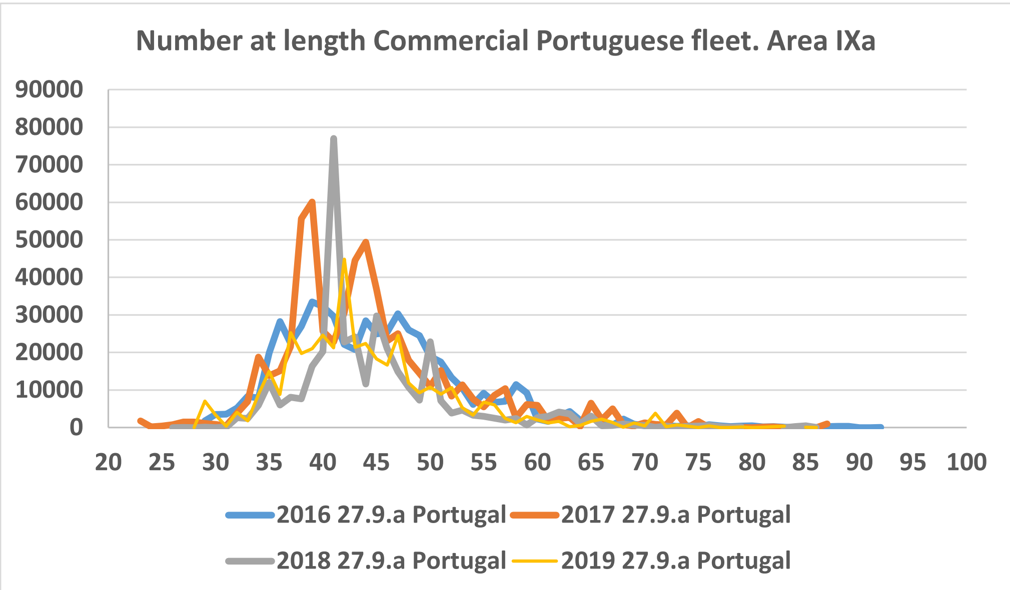

Figure 15.2 : Commercial length composition in 2016-2018 for Portuguese fleet landings (source: InterCatch).

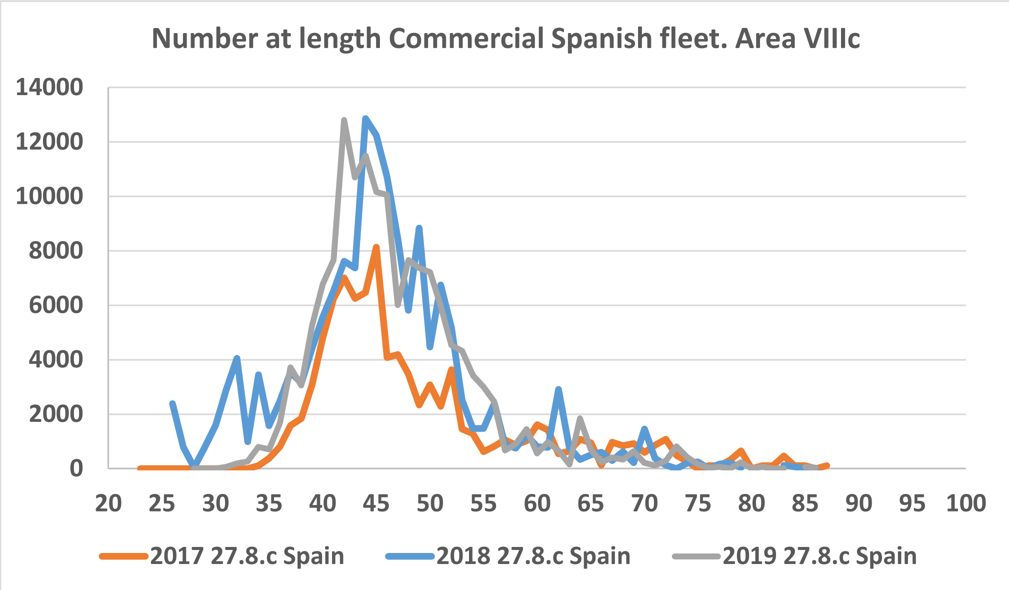

Figure 15.3: Commercial length composition in 2017-2018 for Spanish fleet landings (source: InterCatch).

15.3.3 Commercial discards

Portugal: Seabass discards are recorded by the DCF onboard sampling program. The Portuguese onboard sampling is not covering the Seabass fishing area. No discards are observed.

Spain: No seabass discards were observed for any métier in 2003-2019.

15.3.4 Effort

Some effort data are available (source: InterCatch) for Spanish fleet from 2013 and for Portuguese fleet from 2015, showing a global decrease over time (Figure 15.4). Note that Spanish effort in 2018 (double counted in InterCatch in 2018) has been revised in 2019.

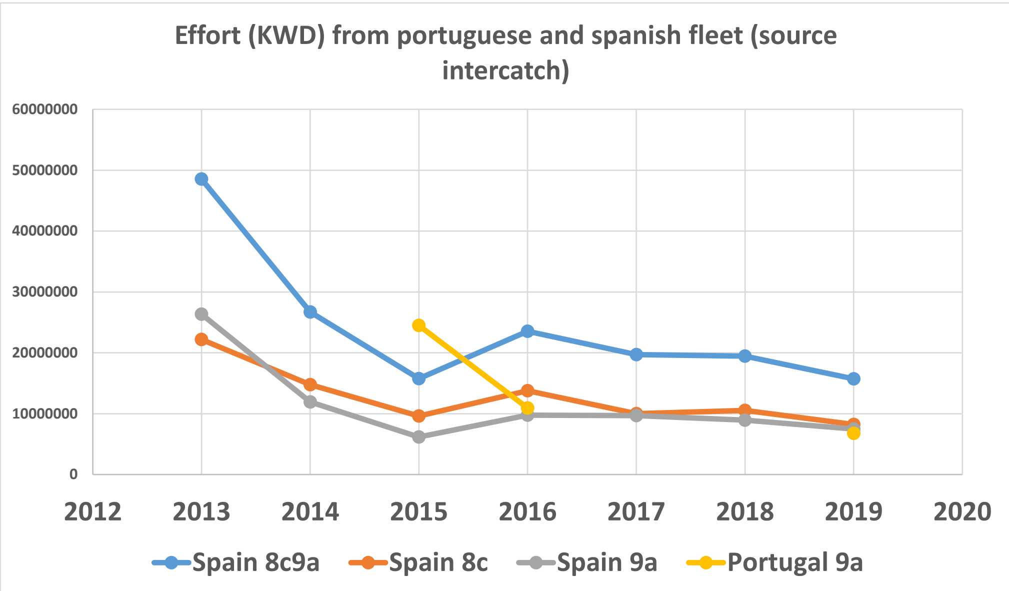

Figure 15.4: Effort (KWD) for Spanish and Portuguese fleets in 8c 9a area (source: InterCatch).

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 (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 analyzed. 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 on 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 emphasized 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) reached 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 for 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 for data-limited stocks, ICES advised 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 advised 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 advised 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 did not make sense for the WG group in 2018 due to the very old period considered for the calculations, the relative 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 (in opposition to the other northern stock). The mean of the three years' catches (2014-2016) applying the buffer (20% less) and 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

In 2019, the WG encouraged the documentation of the seabass data quality for the Iberian waters, and studies to better understand the stock dynamics and movements between the current stock areas (ICES, 2019). 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 logbook of French commercial vessels (>10m and <10m), allowed the assessment of this stock using the ICES framework for category 3 stocks (ICES, 2012a). The French LPUE was applied as an 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 been prepared at WGBIE 2017 in order to get material from Spain and Portugal and do an assessment of the 8c9a stock using an LPUE index calculated using the French methodology (ICES, 2017a). 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 (Regulation (EU) 2019/472). This plan applies to demersal stocks including seabass in ICES divisions 8c and 9a.

15.7 References

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ICES. 2012b. Report of the Working Group on Assessment of New MoU Species (WGNEW), 5–9 March 2012, ICES CM 2012/ACOM:20. 258 pp.

ICES. 2012c. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2012/ACOM: 23. 55 pp.

ICES. 2017a. Report of the Working Group for the Bay of Biscay and the Iberian waters Ecoregion (WGBIE) 4-11 May 2017 ICES HQ, Cadiz, Spain. ICES CM/ACOM: 12, 552 pp.

ICES. 2017b. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). Azores, Portugal. ICES CM 2017/EOSG: 20; 2017

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.

ICES. 2019. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. 1:31. 692 pp. http://doi.org/10.17895/ices.pub.5299.

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

Table 15.1: Seabass in the 9 and 8c areas. ICES and official landings (tonnes).

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

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

*** 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 the 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.

	Source : intercatch	landings 2016	landings 2017	landings 2018	landings 2019
Portugal	total IXa	565	598	366	415
	MIS_MIS_0_0_0	565	598	366	412.3
	OTB				0.52
	PS_SPF_0_0_0				2
	total VIIIc	0	0	0	0
	Total Portugal	565	598	366	415
	Source : intercatch	landings 2016	landings 2017	landings 2018	landings 2019
Spain	total IXa	165	171	168	187
	GNS_DEF_60-79_0_0	8	8	12.1	52.3
	GNS_DEF_80-99_0_0	0	0	0.04	0
	GTR_DEF_60-79_0_0	50	45	33.7	25.88
	LHM_DEF_0_0_0	3	3	3.38	0
	LLS_DEF_0_0_0	86	85	76.61	83.82
	MIS_MIS_0_0_0_HC	12	3	2.2	7.51
	OTB_DEF_>=55_0_0	0	0	0.08	0
	OTB_MCD_>=55_0_0	0	0	0.33	0
	PS_SPF_0_0_0	6	25.03	39.38	17.47
	total VIIIc	215	183	182	186
	GNS_DEF_>=100_0_0	0	0	0.04	0
	GNS_DEF_60-79_0_0	7	11	12.82048	37.4
	GNS_DEF_80-99_0_0	3	1	3.81	2.3
	GTR_DEF_60-79_0_0	38	26	26.76525	12.6
	LHM_DEF_0_0_0	2	0	1.02	0.03
	LHM_SPF_0_0_0			0.18	0
	LLS_DEF_0_0_0	139	130	115.19584	120.03
	MIS_MIS_0_0_0	0	3		0.95
	MIS_MIS_0_0_0_HC	3		1.85	0
	OTB_DEF_>=55_0_0	0	0.29	0.343	0.23
	OTB_MPD_>=55_0_0	1	0.25	0.49	0.05
	PS_SPF_0_0_0	21	12.81	19.5689	12.35
	PTB_MPD_>=55_0_0	0		0.3763	0.05
	total Ixa+VIIIc	380	353.86	350	373

16 Plaice in Subarea 8 and Division 9a

Plaice (*Pleuronectes platessa*) is 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, 2018 and 2019 catches, which were in the order of 11%, 2%, 5%, 2% and 5% of the French catches for 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, FR-EVHOE, only caught 43 plaice in division 8 during its entire time series (1997-2018). 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 can be 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 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 assessment

ICES 2016 Advice (Published 30 June 2015): ICES advises that when the precautionary approach is applied, wanted catch should be no more than 194 t 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 t. 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.

[1] The term ”wanted catch” is used to describe the fish that would be landed in the absence of the EU landing obligation.

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.

ICES 2020 and 2021 Advice (Published 28 June 2019)
ICES advises that when the precautionary approach is applied, wanted catches in each of the years 2020 and 2021 should be no more than 155 t. ICES cannot quantify the corresponding total catches. The stock status relative to reference points remains unknown. The precautionary buffer was not applied in 2017 (for the 2018 and 2019 advice) and is therefore applied this year.

16.1.2 Current assessment

The advice for this stock is biennial. In this WG, the stock catch data were updated. As the perception of the stock status hasn't change, no advice will be issued this year.

16.2 Reference

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68, 42 pp.

Table 16.1. Plaice in Subarea VIII and Division IXa. 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
2019**	0	94	36	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	2019
Discards	France	Nets	-	10.00	3.00	4.00	2.00	2.00
		Other	-	2.00	0	0	0	0
		Trawl	-	4.00	0	1.00	1.00	0
	Spain	Nets	0	-	-	-	0	-
		Trawl	0	-	-	-	0	-
	Portugal	Trawl		0*	0*	0*	0	-
Discards Total			0	15.00	3.00	5.00	3.00	2.00
Landings	Belgium	Other	1.00	2.00	1.00	1.00	-	0.40
	France	Nets	42.00	46.00	48.00	42.00	41.00	38.00
		Other	38.00	21.00	12.00	24.00	6.00	7.00
		Trawl	82.00	74.00	62.00	33.00	44.00	49.00
	Portugal	Other	47.00	44.00	47.00	33.00	39.00	36.00
	Spain	Nets	4.00	3.00	3.00	1.00	2.00	2.00
		Other	1.00	1.00	1.00	0	0	0.20
		Trawl	1.00	1.00	1.00	1.00	1.00	0.06
Landings Total			**217.00**	**193.00**	**174.00**	**135.00**	**133.00**	**133.00**
Catch Total			**217.00**	**208.00**	**177.00**	**140.00**	**136.00**	**2.00**
Official Landings			**220.00**	**193.00**	**173.00**	**134.00**	**133.00****	**133.00****

*** Not available in InterCatch, submitted to AC**

**** Official provisional statistics from ICES website http://data.ices.dk/rec12/downloadData.aspx**

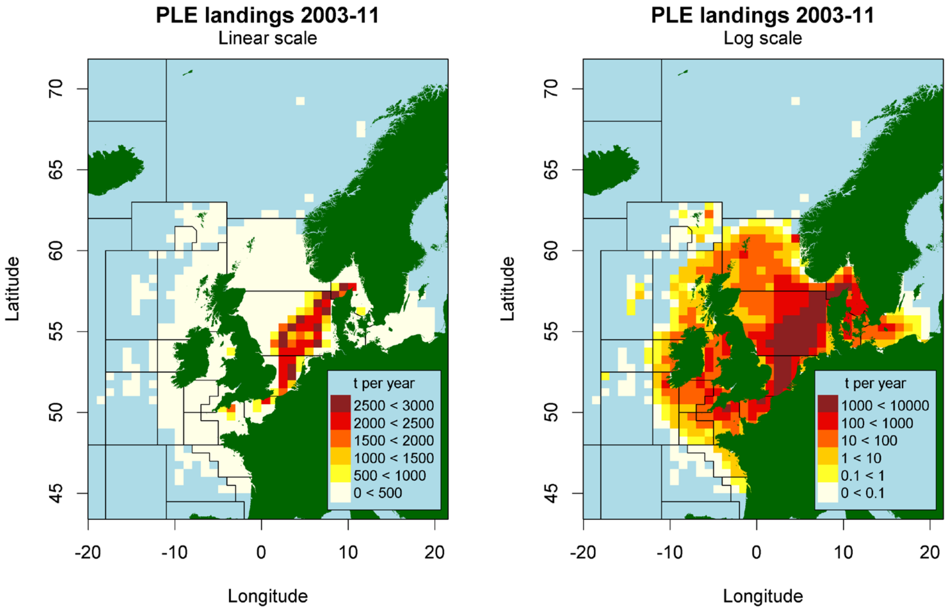

Figure 16.1. International landings of plaice by statistical rectangle from 2003-2011.

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 a 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 and discards for 2018 were updated with the information uploaded to InterCatch.

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 2020 and 2021 and management for 2019 and 2020

ICES advice for 2020 and 2021:

In 2019, ICES advised that when the precautionary approach is applied, commercial catches should be no more than 1131 t in each of the years 2020 and 2021.

Management applicable for 2019 and 2020:

Pollack is managed under a TAC that was set at 1995 t for 2019 and at 1944 t for 2020. 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 2020 were as follows:

Species:	Pollack *Pollachius pollachius*	**Zone:**	8a, 8b, 8d and 8e (POL/8ABDE.)
Spain	252	Precautionary TAC	
France	1 230		
Union	1 482		
TAC	1 482		

Species:	Pollack *Pollachius pollachius*	Zone:	8c (POL/08C.)
Spain	187	Precautionary TAC	
France	21		
Union	208		
TAC	208		

Species:	Pollack *Pollachius pollachius*	Zone:	9 and 10; Union waters of CECAF 34.1.1 (POL/9/3411)
Spain	246 (1)	Precautionary TAC	
Portugal	8 (1) (2)		
Union	254 (1)		
TAC	254 (1)		

The reported landings of pol.27.89a in 2019 were 78% 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 are provided in the Stock Annex. There is some mixing in Portuguese markets with whiting (*Merlangius merlangus*) due to the use of common names. This resulted in most pollack landings being recorded as whiting from 2004 onwards. Sampling data since 2012 indicate that Portuguese landings of whiting and pollack from 9a consisted of 2% whiting and 98% pollack (EC, 2015, Audit Mission Report PT-2015-C2-07-A, Executive Summary). The updated landing estimates 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 landing 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 métier from 2000 to 2014 is available from ROMELIGO project (Léauté et al., 2018 - WD 05 in ICES, 2018a), and these 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 1 479 and 2 313 t since 2000, without a clear trend. Pollack landings increased from 1 481 t in 2017 to 1 562 t in 2019, which is an increase of 5%. The TAC for 2019 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 5 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 while Spanish netters discards are considered negligible (less than 0.5% of catch). French netters and liners discarded about 1.2% and 1.6% of their catches in 2019, respectively.

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 in the working document by Léauté *et al*. (2018). 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 from 2005 to 2018 and it represents an average of 7.5% of the total landings of the stock. Landings of this fleet have fluctuated between 54 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 (Fs), 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. A new methodology, based on a conditional decision tree, has been developed to select the information from fleet FR-GNS >90mm-8a-2s from logbook records (Caill-Milly et al., 2020 - WD11 in this report). This methodology has been proposed for updating the abundance index every year.

17.3 Exploration of data-limited methods for assessing pol.27.8.9a

17.3.1 Exploration of length-based methods

Pollack in ICES subarea 8 and division 9a is considered a Data-Limited Stock and classified by ICES as a category 5.2 stock. The insufficient data for this stock prevented from performing an analytical assessment with a traditional model. Three length-based approaches were tested for assessing the status of pollack stock: Length-Based Indicators (LBI), Length Based Spawning Potential Ratio (LBSPR), and Length-based Integrated Mixed Effects (LIME).

A set of length compositions of commercial landings, annual and gear-combined, for the period 2010-2019 was considered for three length-based approaches (Figure 17.3). The life-history parameters used as input data in the models and their source are presented in Table 17.5.

LBI are a set of length-based indicators representing the conservation of large and immature individuals, optimal yield and maximum sustainable yield that were defined at WKLIFE V (ICES, 2015). The main assumptions of the LBI methods are that the fishing gear selectivity is asymptotic and the population is in equilibrium: constant selection, fishing mortality and recruitment over time. Analyses were conducted using the R script *utilities.R* available at the ICES github repository: https://github.com/ices-tools-dev/LBIndicator_shiny. The results of the model are given in Table 17.6 and Figure 17.4. The conservation parameters for immature individuals (L_c/L_{mat} , $L_{25\%}/L_{mat}$) were only green during 2011-2013, indicating that first length of catch is below L_{mat} and that fishery captures more than 25% of individuals below maturity size (L_{50}=42 cm). Large individuals constitute a small part of the landings (P_{mega} < 0.13). The optimizing yield indicator (L_{mean}/L_{opt}) has been below the desirable values of 0.9, indicating that the fish caught may be too small. The MSY indicator ($L_{mean}/L_{(F=M)}$) was > 1 in 2017 and 2018, but in 2019 it decreased to 0.97. There is no strong evidence of important overexploitation. The time series of indicators and indicator ratios (Figure 17.4) show that the levels of conservation and maximum sustainable yield indicators have been relatively stable throughout the last ten years.

LBSPR model uses the characteristics of two life-history ratios: M/K and L_{50}/L_{∞}, to analyse the shape of adult length-frequency distributions and to estimate the selectivity ogive, relative fishing pressure (F/M) applied to stocks, and the resulting spawning potential ratio (SPR). SPR is defined as the proportion of the unfished reproductive potential left at any given level of fishing pressure (Hordyk et al., 2015). SPR is 100% in an unexploited stock, and 0% in a stock with no spawning. LBSPR model relies on many assumptions being some of them: the assumption of equilibrium conditions, that the length composition is representative of the exploited population, and a logistic-type selectivity. The length-structured version of the LBSPR model, using growth-type-groups (GTG) to account for size-based selectivity, was applied for pollack stock. The analyses were conducted using the R package LBSPR *v*0.1.5 (Hordyk, 2019). The LBSPR smooth results indicated that SPR values were below the SPR 30-40% range in all years (Figure 17.5) and, therefore, can be considered to be below proxies that would be consistent with high long-term yields. Except in 2015 and 2017, the F/M ratios were above F/M = 1, which implies an exploitation above F_{MSY} (Table 17.7). In 2019, the raw F/M was 1.03, slightly above the proxy for F_{MSY}.

LIME model relaxes the equilibrium assumptions of LBSPR method, accounting for both the time-varying recruitment and fishing mortality while assuming constant selectivity for the whole time series (Rudd and Thorson, 2018). Length data and biological information are used to estimate F rates and SPR. LIME has the same data-requirements as LBSPR plus an assumed uncertainty for recruitment and fishing mortality. The LIME analysis was performed using the R package LIME *v*2.1.3. (Rudd, 2017). LIME model fits a unique selectivity ogive for the whole time series, and for pollack L_{50} and L_{95} were estimated at 39 and 50 cm, respectively (Table 17.8). LIME estimated SPR in 2019 to have been 0.32, but with high uncertainty (95% CI: 0.03-0.61). Fishing mortality estimates were above $F_{40\%}$ reference point (0.25) for the whole time series, indicating that the pollack stock has been overfished (Figure 17.6).

The three model results indicated that pollack stock was slightly overexploited in 2019 (F > Ftarget) and the SPR is below the SPR target. There is a high uncertainty in the estimation of stock status using these models and, due to their sensitive to input parameters, more sensitivity analyses should be conducted.

The conclusion of this exploration was that the length-based methods constitute a good starting point to assess the stock status of pollack. Sensitivity analyses should be conducted to evaluate the impact of input parameters in the results.

17.3.2 First approach of using SPiCT to assess pol.27.8.9a

A SPiCT model (Surplus Production model in Continuous Time; Pedersen and Berg, 2017) has been fitted for pol.27.8.9a. Different scenarios were tested based on abundance indices series selected, time period considered and the model options of fixing model parameters and the definition of priors.

Landings data come from different sources (International databases, ICES database and ROMELIGO project data) and have been collected for the stock assessment of pol.27.8.9a (Table 17.9). Three time series of commercial index were compiled. The series "FR-GNS>90-2s" (French Gillnets with mesh size > 90 mm, operating in North Bay of Biscay during the second semester) was provided by ROMELIGO project for the years 2005-2018 to the WGBIE in 2019 (ICES, 2019), and the series "GAL-GN-60-79_8c" (Galician Gillnets with mesh size 60-79 operating in 8c) and "GAL-GN-60-79_9ª" (Galician Gillnets with mesh size 60-79 operating in 9a) are available for the period 2000-2016 in published information (Alonso-Fernández et al., 2019).

The SPiCT model is based on the generalized surplus production model, known as the Pella-Tomlinson model, where the shape of the production curve may deviate from the symmetric form. A detailed description of the SPiCT model and all the options available can be found in Pedersen and Berg (2017). The analyses were performed using the R package spict *v.1.2.8* available at https://github.com/DTUAqua/spict

Three different scenarios were explored:

scenario 1. Including the 3 CPUE indices available (Figure 17.8).

scenario 2. Only with the time series of FR.GN.90.2s index.

scenario 3. Data restricted to the 2005-2018 period.

The model didn't converge under scenarios 1 and 3. Different priors and options were tested, but it was not possible to get a convergence. Scenario 1 was performed as a trial, as we knew that the two "GAL-GN_60_79" were abundance indices (ind/haul) and SPiCT requires biomass indices. The two time series were discarded to be used as indices. In the case of scenario 3, with a short-time period, the absence of contrast in fishery evolution prevented proper convergence.

Under scenario 2, the model converged and the main estimates were considered as realistic values (Figure 17.9). The uncertainty around the reference points is high (Figure 17.9, grey boxes). The relative values of F and B have narrower confidence intervals. Few sensitivity analysis trials of input values didn't converge. The overall trend of F/F_{MSY} decreased since 1986, and was estimated below 1 since 2008. Also, the B/B_{MSY} is above 1 since 2007.

The implementation showed that the best model was the scenario using the landing series 1986-2018 and the abundance index FR-GNS>90-2s 2005-2018. Although the uncertainty around the parameters and reference points is high, the estimates of K, r, F and B are realistic, thus, indicating that SPiCT could be a good option for assessing this stock.

17.4 Current assessment

Latest assessment was performed in 2019 (ICES, 2019). ICES advised that commercial landings should be no more than 1 131 t in each of the years 2020 and 2021.

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. As the data for this year do not change the perception of state of the stock, the advice will not be reopened.

17.5 Management plans

No management plan is known for pol.27.89a.

17.6 References

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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 2019, were derived from the InterCatch database.

	Bay of Biscay (Subarea 8)				Atlantic Iberian waters (Division 9.a)				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	1513	0	1513
2019	0	174	1189	0	143	57	1562	0	1562

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 2019, were derived from the InterCatch database.

	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	684	78	405	54	134	120	6	32	0.8
2019	683	76	387	43	152	162	3	55	1.8

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 2019, were derived from the InterCatch database.

	France			Spain			Portugal
Year	Nets	Trawl	Lines	Lines	Nets	Trawl	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	0
2016	83.1	5.4	4.3	0	0.4	0	0
2017	18.6	0	0	0	0	0	0
2018	38.7	0	0	0	0	2.8	0
2019	8.2	0	6.1	0	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

Table 17.5. Pollack in Subarea 8 and Division 9a. Life-history information used in the three length-based models explored. Values and source are indicated.

Parameter	symbol	value	source	LBI	LBSPR	LIME
Length-frequency data	LD		Annual, gear-combined			
Length were 50% of the fish are mature	L_{50} (cm)	42.3	Alonso *et al.*, 2013			
Length were 95% of the fish are mature	L_{95} (cm)	58	Alonso *et al.*, 2013			
von Bertalanffy growth parameter	K	0.182	Alemany, 2017			
Von Bertalanffy asymptotic Length	L_{∞}	92.8	Alemany, 2017			
Theoretical age at length=0	t_0 (years)	-0.935	Alemany, 2017			
Length-weight relationship parameter a	a	$1.09e^{-5}$	Leauté *et al.*, 2018			
Length-weight relationship parameter b	b	3.0044	Leauté *et al.*, 2018			
Natural Mortality (fixed)	M ($year^{-1}$)	0.32	M-metanalysis			
M/K invariant	M/K	1.8	M/K			
Coefficient of variation of von Bertalanffy asymptotic l	CV L_{inf}	0.1	Assumed			
Steepness	h	0.7	Assumed			
Recruitment deviation	σ_R	0.4	Assumed			
Fishing mortality deviation	σ_F	0.1	Assumed			

Table 17.6. Pollack in Subarea 8 and Division 9a. LBI results. Output table with indications of status compared to reference points for pol.27.8.9a. Green cell: indicator suggests that the stock is in a desirable state relative to the reference; red cell: negative state.

	Conservation				Optimizing yield	MSY
Year	Lc/Lmat	L25/Lmat	Lmax5/Linf	Pmega	Lmean/Lopt	Lmean/LFeM
2010	0.80	0.80	0.72	0.03	0.69	0.89
2011	1.18	1.18	0.80	0.07	0.94	0.95
2012	1.18	1.18	0.80	0.11	0.98	0.99
2013	1.09	1.09	0.79	0.12	0.92	0.98
2014	0.80	0.99	0.77	0.10	0.86	1.10
2015	0.71	0.80	0.74	0.04	0.72	0.99
2016	0.80	0.90	0.71	0.03	0.74	0.94
2017	0.80	0.90	0.80	0.09	0.82	1.04
2018	0.80	0.99	0.82	0.11	0.89	1.14
2019	0.80	0.80	0.76	0.04	0.76	0.97

Table 17.7. Pollack in Subarea 8 and Division 9a. LBSPR annual raw estimates of selectivity (SL_{50}, SL_{95}), fishing pressure (F/M) and spawning potential ratio (SPR).

Year	SL50	SL95	FM	SPR
2010	31.5	33.4	2.00	0.12
2011	50.3	61.7	2.42	0.26
2012	52.0	64.9	1.87	0.32
2013	44.6	52.9	1.34	0.31
2014	62.7	88.9	4.25	0.27
2015	26.9	31.9	0.96	0.24
2016	35.0	40.1	1.93	0.14
2017	34.9	49.8	0.90	0.31
2018	54.5	78.9	1.93	0.32
2019	30.5	35.3	1.03	0.24

Table 17.8. Pollack in Subarea 8 and Division 9a. LIME total estimates of selectivity (SL_{50}, SL_{95}), fishing pressure ($F/F_{40\%}$) and spawning potential ratio (SPR).

Year	SL50 (cm)	SL95 (cm)	F/F40%	SPR
2010	39.1	49.9	1.24	0.34
2011	39.1	49.9	1.33	0.32
2012	39.1	49.9	1.55	0.29
2013	39.1	49.9	1.70	0.27
2014	39.1	49.9	1.71	0.26
2015	39.1	49.9	1.46	0.30
2016	39.1	49.9	1.34	0.32
2017	39.1	49.9	1.29	0.33
2018	39.1	49.9	1.35	0.32
2019	39.1	49.9	1.35	0.32

Table 17.9. Pollack in Subarea 8 and Division 9a. Input data available for pollack to perform SPiCT. *Landings in 1999 were estimated.

Year	Landings (tonnes)	FR-GNS>90-2s (kg/fishing sequence)	% Stock Landings	GAL-GN-60-79_8c (ind/haul)	GAL-GN60-79_9a (ind/haul)
1986	2806				
1987	2918				
1988	2582				
1989	1973				
1990	1900				
1991	2168				
1992	1958				
1993	1513				
1994	1955				
1995	1679				
1996	1354				
1997	1378				
1998	1165				
1999	1322				
2000	1479			1.98	0.89
2001	1746			0.95	0.55
2002	1972			0.95	0.41
2003	1663			2.18	1.09
2004	1726			1.36	0.55
2005	1986	115	5.3	2.32	1.02
2006	2126	66	2.5	1.36	1.36
2007	1847	129	6.7	0.55	0.48
2008	2313	129	6.2	0.89	0.55
2009	1812	124	6.2	0.89	0.27
2010	1682	108	5.5	1.23	1.09
2011	2032	197	7.7	0.55	0.00
2012	1520	174	10.7	0.55	0.00
2013	1811	157	8.9	1.43	0.82
2014	1959	150	9.1	1.09	0.55
2015	1610	144	10.4	0.82	0.14
2016	1661	121	9.0	0.61	1.64
2017	1481	122	9.2		
2018	1512	112	7.4		

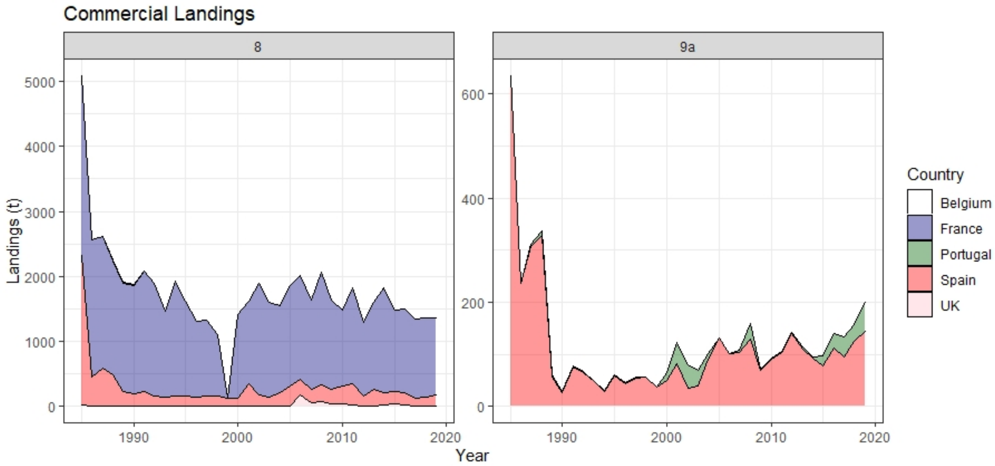

Figure 17.1. Pollack in Subarea 8 and Division 9a. Commercial landings by country in Subarea 8 and Division 9a. French data is missing for 1999.

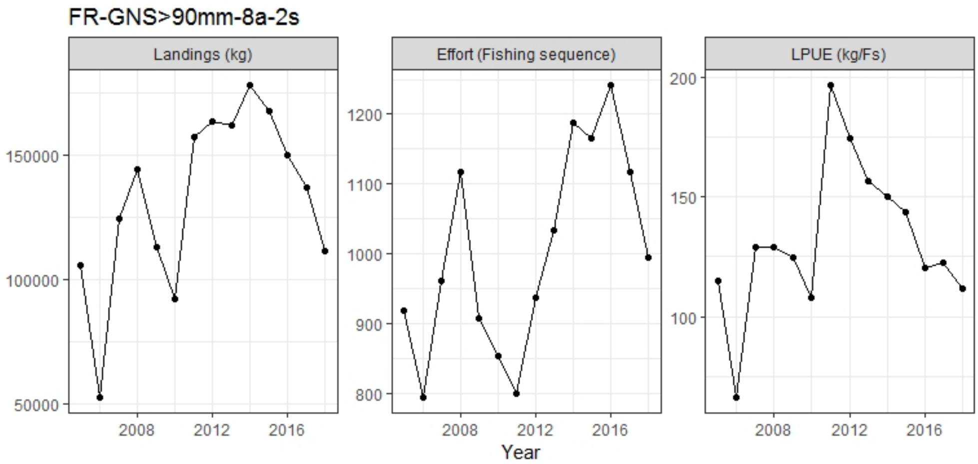

Figure 17.2. Pollack in Subarea 8 and Division 9a. Landings, effort and LPUE for commercial fleet FR-GNS>90mm-8a-2s.

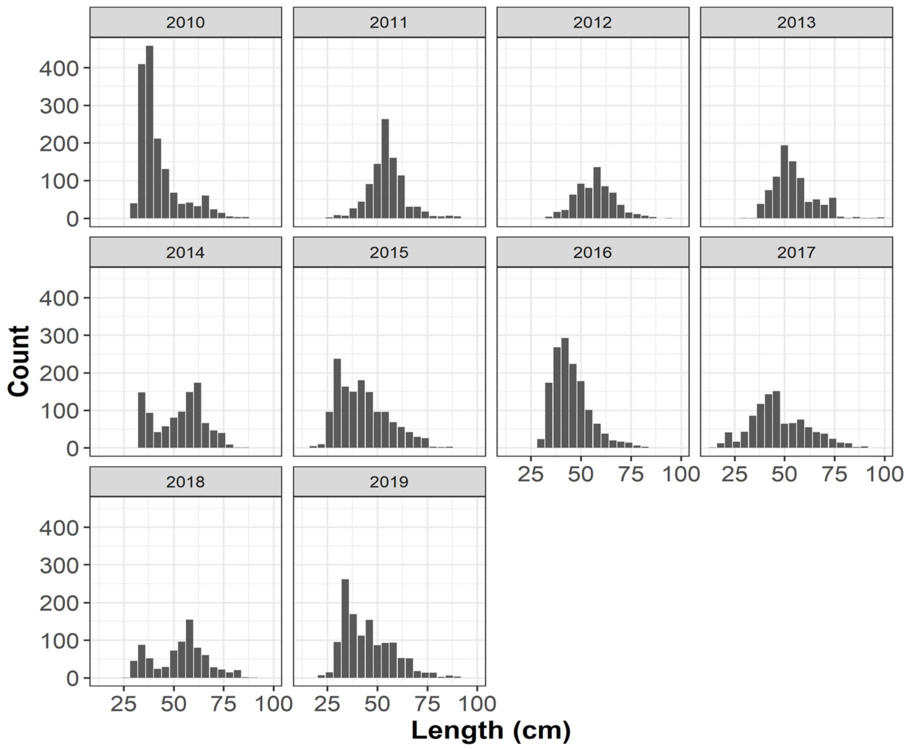

Figure 17.3. Pollack in Subarea 8 and Division 9a. Length composition of landings (all gear combined) for the period 2010-2019.

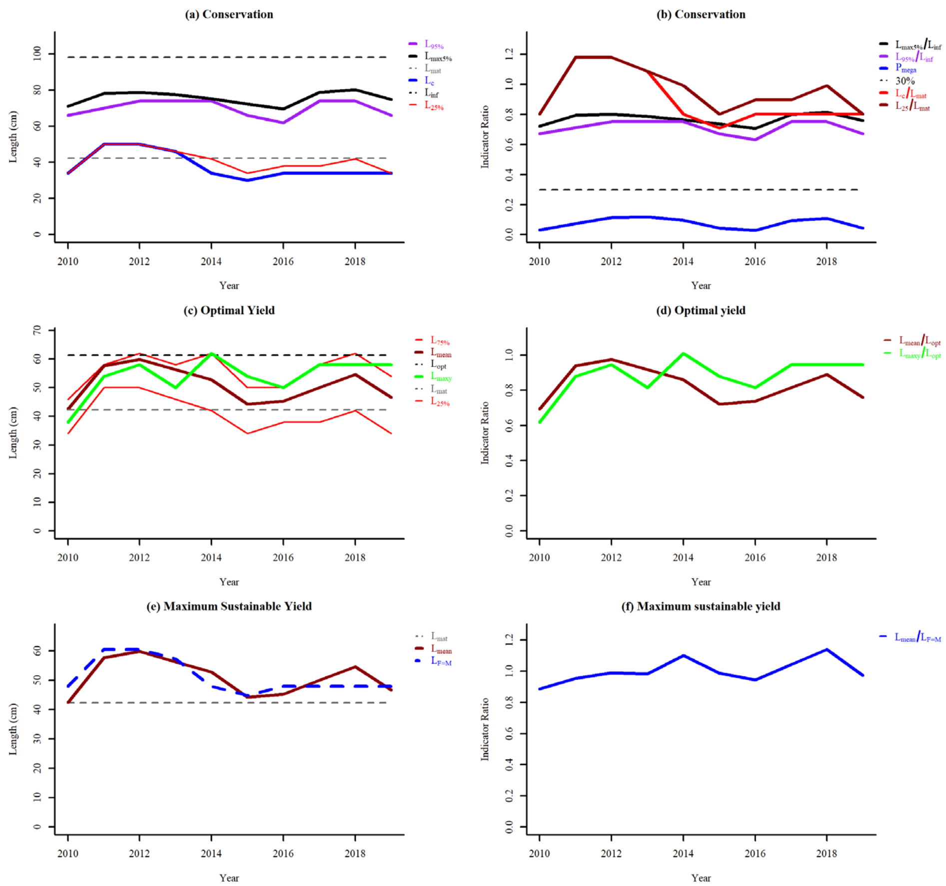

Figure 17.4. Pollack in Subarea 8 and Division 9a. LBI results. Time series indicators (left side) and indicators ratios (right side).

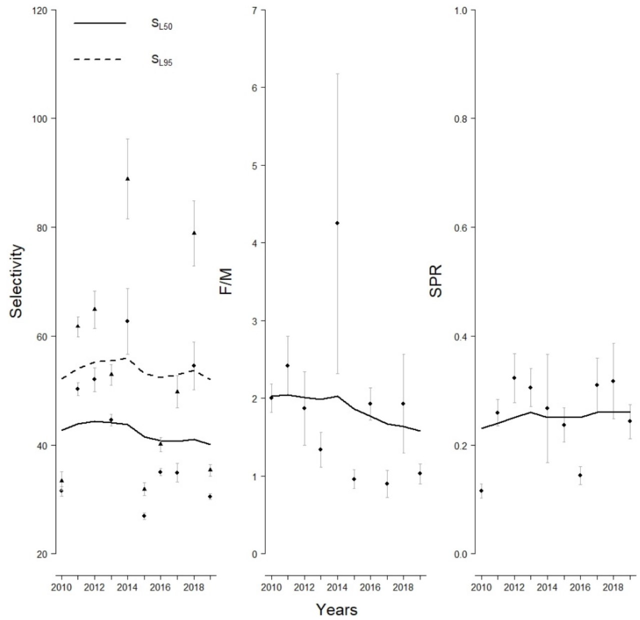

Figure 17.5. Pollack in Subarea 8 and Division 9a. LBSPR results. Lengths at 50% and 95% of annual selectivity to the fishery, and proxies in terms of F/M and SPR. Annual raw estimates (+standard deviation) for F/M and SPR are represented by points (+bars), and the smooth fit for the time series by lines.

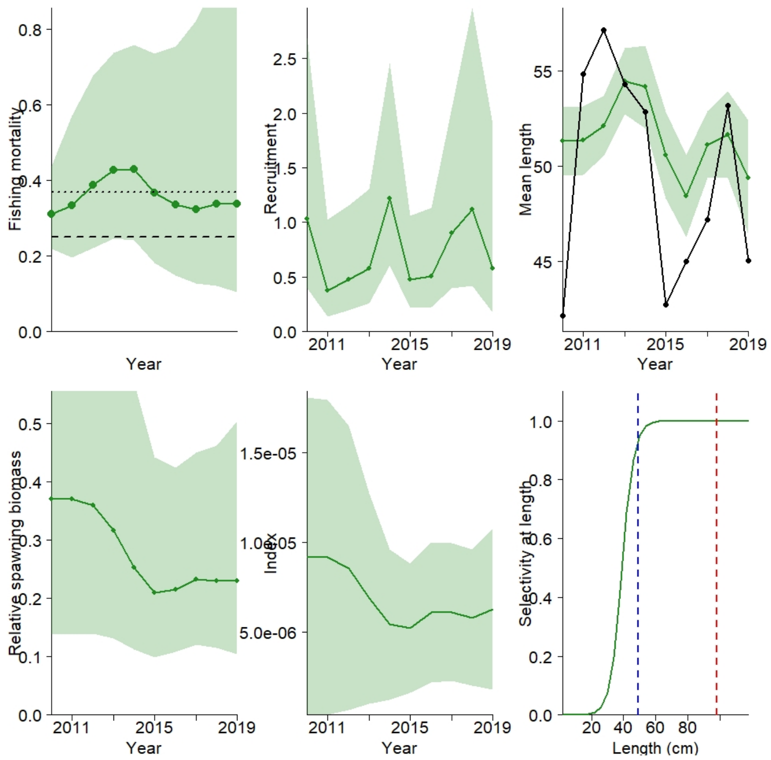

Figure 17.6. Pollack in Subarea 8 and Division 9a. LIME results. Upper row, from left to the right: a) estimates of anual fishing mortality rates (green line) with the reference points $F_{30\%}$ (black dotted line) and $F_{40\%}$ (black dashed line); b) estimates of recruitment; c) mean length of catches (black line) and estimated mean-length of catches (green line). Lower

row, from left to the right: d) relative spawning biomass; e) Index time series and f) total selectivity curve, with L_{inf} (dashed red line) and mean length of catches (dashed blue line).

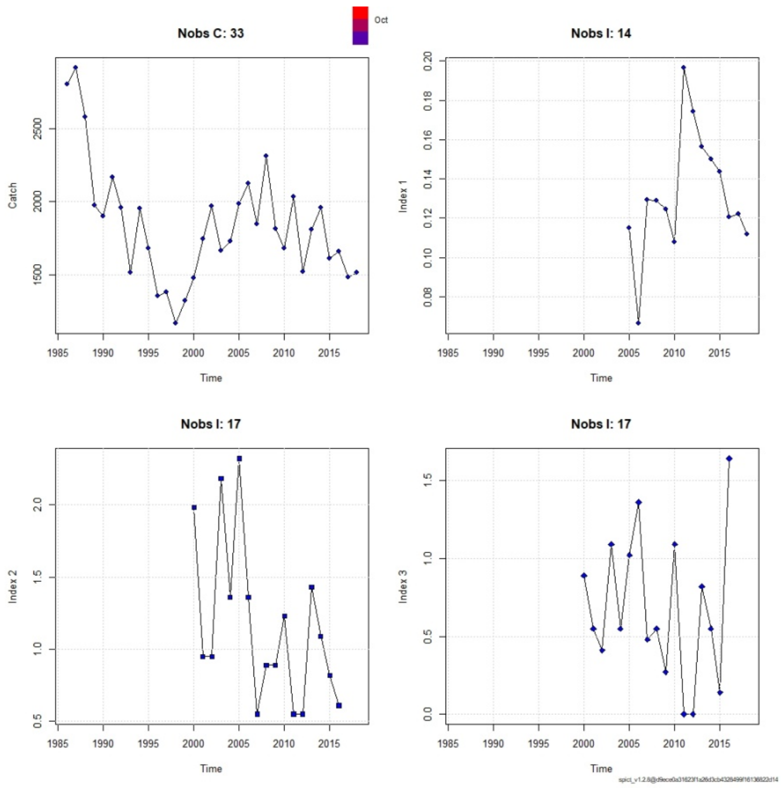

Figure 17.7. Pollack in Subarea 8 and Division 9a. Input data of SPiCT model.

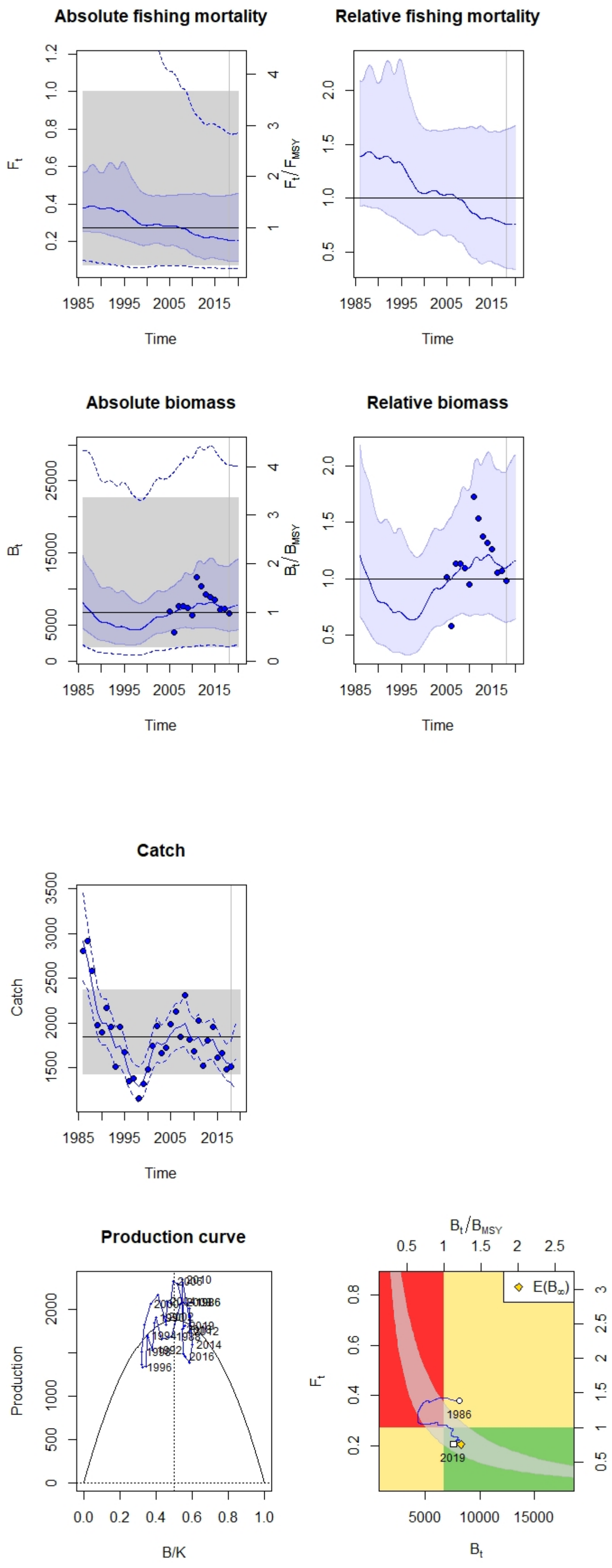

Figure 17.8. Pollack in Subarea 8 and Division 9a. SPiCT results for scenario 2.

18 Whiting in Subarea 8 and Division 9a

Type of assessment in 2019: LBI

Data revision in 2020: InterCatch data were compiled for 2018.

18.1 General

18.1.1 Summary of ICES advice for 2019, 2020 and 2021

ICES advises that when the precautionary approach is applied, catches in each of the years 2019, 2020, and 2021 should be no more than 2 276 t.

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 and was applied again in 2018 as the stock size was unknown in relation to reference points.

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 18.1). There are concerns about the reliability of the French data from 2008-2009, which appear to be incomplete. There is some mixing in Portuguese markets with pollack due to the 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 (EC, 2015, Audit Mission Report PT-2015-C2-07-A, Executive Summary); whiting landed by Portuguese vessels makes up an insignificant amount of the total whiting landings in this area.

18.2.2 Commercial catches and discards

InterCatch data from 2016-2018 were processed in 2019 to compute discards estimates (ICES, 2019). In 2020, 2019 InterCatch data were processed to compute landings and 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 18.2.1, landings with associated data (same strata) represent respectively 70, 72 and 88% for 2018, 2017 and 2016, this percentage decreased to 49% in 2018.

Raised and total discards between 2016 and 2019 are presented in Table 18.2.2.

18.2.3 Length structure of commercial catches

For landings, 41, 46, 44 and 63% of the landings (in volume) had a length structure associated in 2019, 2018, 2017 and 2016, respectively.

For discards, the percentage of the total discards (after raising) with a length distribution provided are 30, 44, 43 and 60% in 2019, 2018, 2017 and 2016, respectively. See Tables 18.2.3-6 for details.

Length distribution of landings and discards before and after raising are shown in Figures 18.2.1.1-4. Final distributions (pink dots) are similar to the sampled (provided) distribution, showing the limited impact of the raising procedures on length compositions.

The length distributions of the landings are truncated below 27cm due to the Minimum Conservation Reference Size set at 27 cm in this area.

18.2.4 Survey data

Whiting are present in the French EVHOE-WIBTS-Q4 survey from the Bay of Biscay. In 2017, the WG investigated if this survey could provide an index of recruitment and/or biomass (ICES, 2017). 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 18.2.2.1 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 18.2.2.2; 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 the whole 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 (ICES 2012).

This species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula (Figure 18.2.2.3). It is not clear whether this is a separate stock from a biological point of view.

18.2.5 Length-based indicators

Length-based indicators were not updated in 2020.

18.3 Issues List

- No discard information is provided for the areas 8c and 9a.
- Very little information is available about stock distribution.
- Surveys should be investigated furter to check for data availability.

18.4 References

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68, 42 pp.

ICES. 2017. Report of the Working Group for the Bay of Biscay and Iberian waters Ecoregion (WGBIE), 4-11 May 2017, Cadiz, Spain. ICES CM 2017/ACOM: 12., 552 pp.

ICES. 2018. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. 1:31. 692 pp. http://doi.org/10.17895/ices.pub.5299.

Table 18.1. Whiting in Subarea 8 and Division 9a. Official landings in tonnes (*2018/19 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	Unallocated	ICES est mates
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	1871	18	20	1909	16	1925
2018*	2	1519	14	19	1554	11	1565
2019*	1	1349		13	1363	33	1396

Table 18.2.1. 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%
2019	49%

Table 18.2.2. Whiting landings and discards after raising procedures (in tonnes).

Year	Landings (Imported)	Discards (Imported)	Discards (raised)	Total Discards	Overall DR
2016	2525.00	828.40	98.38	926.78	0.268
2017	1925.00	617.60	320.20	937.80	0.328
2018	1565.00	376.00	279.50	655.50	0.295
2019	1396.00	243.90	291.20	535.10	0.280

Table 18.2.3. Whiting, Summary of the structures provided in 2019 (Imported_Data refer to data imported to InterCatch, 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	826	59
Landings	Imported_Data	Sampled_Distribution	570.1	41
Discards	Raised_Discards	Estimated_Distribution	291.2	54
Discards	Imported_Data	Sampled_Distribution	163.2	30
Discards	Imported_Data	Estimated_Distribution	80.77	15

Table 18.2.4. Whiting, Summary of the structures provided in 2018 (Imported_Data refer to data imported to InterCatch, 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 18.2.5. Whiting, Summary of the structures provided in 2017 (Imported_Data refer to data imported to InterCatch, 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 18.2.6. Whiting, Summary of the structures provided in 2016 (Imported_Data refer to data imported to InterCatch, 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 18.2. Whiting in Subarea 8 and Division 9a. Landings submitted to InterCatch (tonnes).

Catch cat	Country	Gear	2014	2015	2016	2017	2018	2019
Landings	France	Lines	0*	539.00	807.00	675.00	468.00	434.50
		Nets	113.00*	234.00	418.00	281.00	284.00	239.19
		Other	561.00*	412.00	491.00	182.00	248.00	267.80
		Trawl	465.00*	955.00	736.00	748.00	521.00	424.51
	Portugal	Other	0	31.00**	0	15.00	13.00	15.22
		Trawl	0	2.00**	0	1.00	2.00	<1
	Spain	Other	1.00	0	1.00	1.00	1.00	1.30
		Trawl	53.00	55.00	71.00	20.00	26.00	11.98
	Other	Other	1.00	2.00	1.00	2.00	2.00	1.00
	Total	Land	1194.00	2231.00**	2525.00	1925.00	1565.00	1396.00
ICES best estimate of the landings			1651.00	2199.00	2525.00	1925.00	1565.00	1396.00
Discards	Total	Dis	-	1060.00	828.00	618.00	376.00	535.00

*** Probably incomplete (official landings: 1 579 t).**

**** No correction for whiting/pollack species misidentification.**

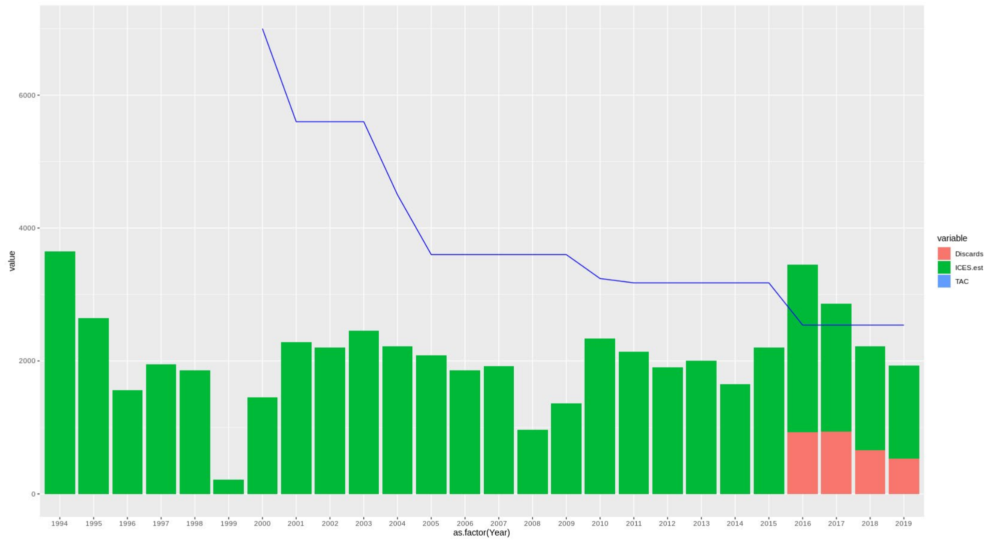

Figure 19.1. Wanted/unwanted catches and TAC (blue line).

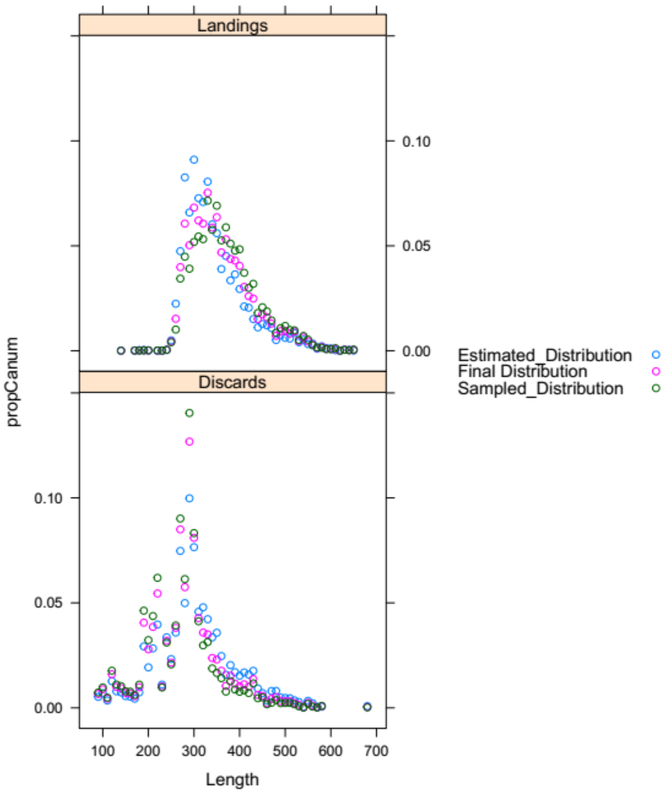

Figure 18.2.1.1. Length distribution of landings (top) and discards for 2016.

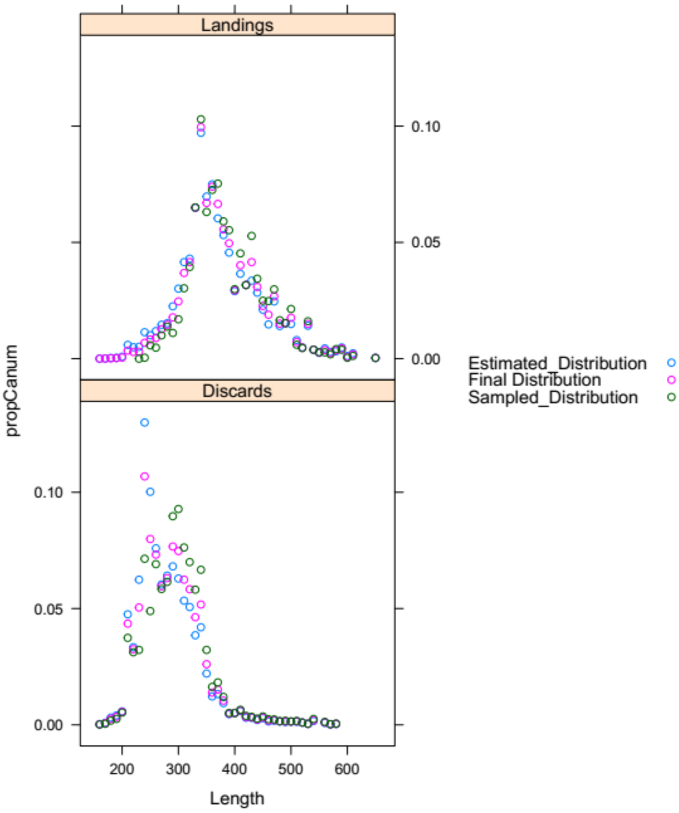

Figure 18.2.1.2. Length distribution of landings (top) and discards for 2017.

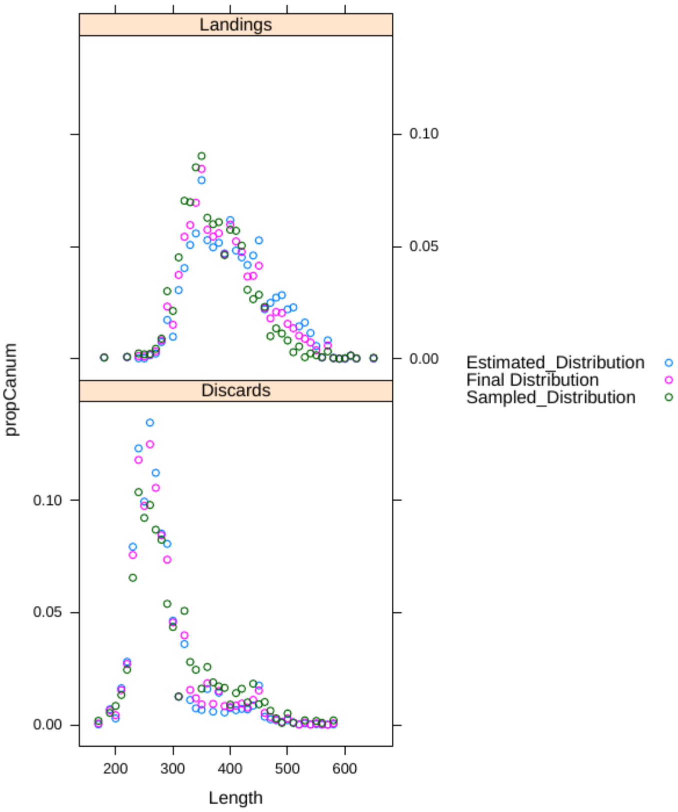

Figure 18.2.1.3. Length distribution of landings (top) and discards for 2018.

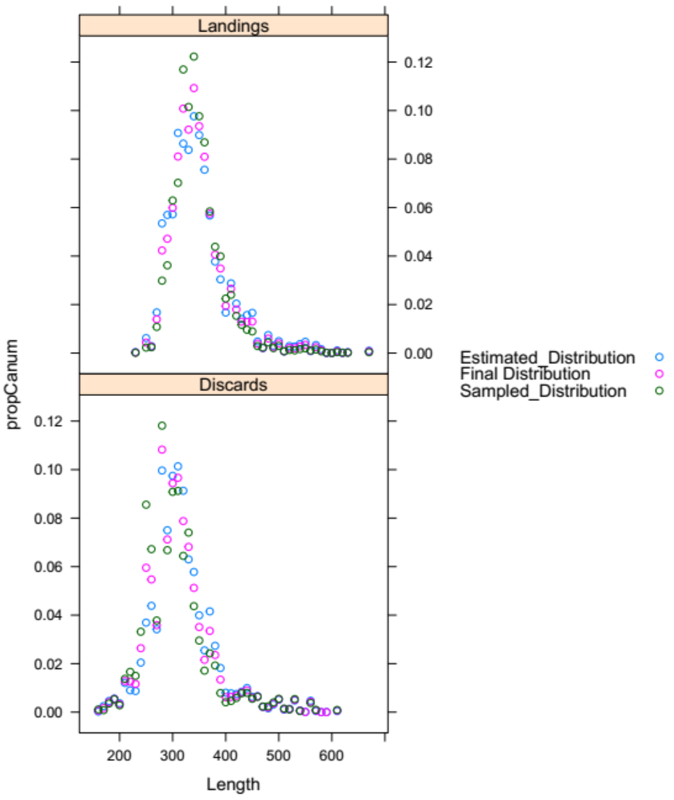

Figure 18.2.1.4. Length distribution of landings (top) and discards for 2018.

Figure 18.2.2.1. EVHOE-WIBTS-Q4 survey indices of recruitment (left) and biomass (right).

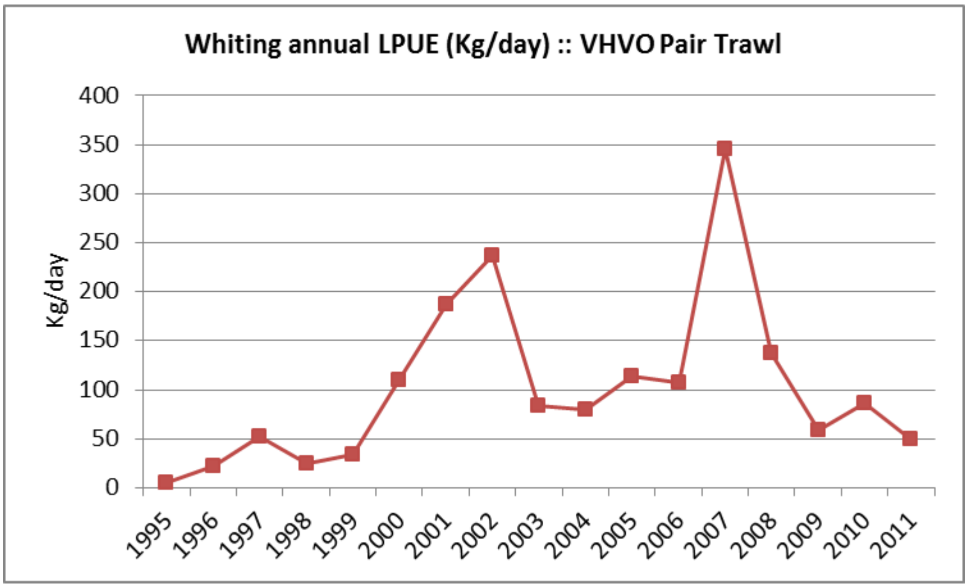

Figure 18.2.2.2. Time series of whiting landings per unit of effort (LPUEs in Kg/day), for Basque pair bottom trawl fleet fishing in Divisions VIIIa,b,d, in the period 1995-2011.

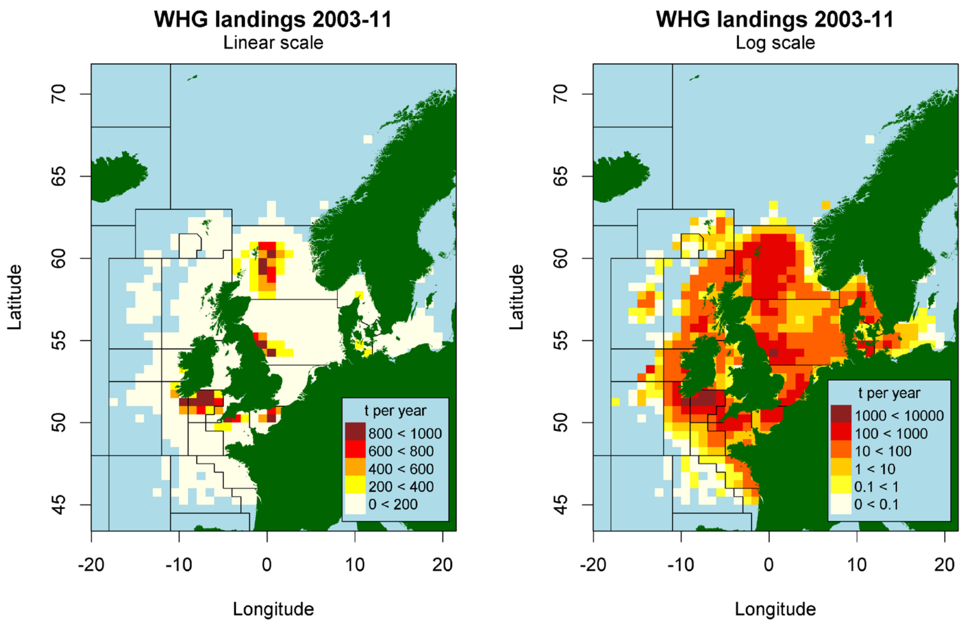

Figure 18.2.2.3. Whiting, spatial distribution of landings.

Annex 1: List of participants

Name	Country
Esther Abad	Spain
Luke Batts	Ireland
Santiago Cerviño	Spain
Mickaël Drogou	France
Spyros Fifas	France
Dorleta Garcia	Spain
Hans Gerritsen	Ireland
Isabel González Herraiz	Spain
Ane Iriondo	Spain
Eoghan Kelly	Ireland
Jean-Baptise Lecomte	France
Hugo Mendes	Portugal
Teresa Moura	Portugal
M. Grazia Pennino	Spain
Bárbara Pereira	Portugal
Lisa Readdy	United Kingdom
Naiara Rodriguez-Ezpeleta	Spain
Paz Sampedro	Spain
Cristina Silva (Co-chair)	Portugal
Agurtzane Urtizberea Ijurco	Spain
Youen Vermard	France
Yolanda Vila	Spain
Ching-Maria Villanueva (Co-chair)	France
Mathieu Woillez	France

Annex 2: Resolutions

WGBIE– Working Group for the Bay of Biscay and Iberian waters Ecoregion

2019/2/FRSG08 The **Working Group for the Bay of Biscay and Iberian waters Ecoregion** (WGBIE), chaired by Ching Villanueva (France) and Cristina Silva (Portugal), will meet by correspondence, 6–13 May 2020 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 on the dates specified in the 2020 ICES data call.

WGBIE will report by 27 May for the attention of ACOM.

Only experts appointed by national Delegates or appointed in consultation with the national Delegates of the expert's country can attend this Expert Group

Due to the COVID-19 disruption that started early 2020, ACOM drafted a "spring 2020 approach" for recurring fishing opportunities advice. The generic Terms of Reference have been adjusted as described in the letter to ICES chairs below.

Chairs of Expert Groups

Our Ref: C.4.e/MDC/mo 13 March 2020

Subject: **Spring 2020 approach to advice production**

Dear Expert Group Chair,

I am writing this letter to keep you up to date about the approach of ACOM to the COVID-19 disruption. Many of our institutes now have travel bans and/or working from home policies. ACOM has developed a "spring 2020 approach" to this year's spring advice season. This letter covers the recurrent fishing opportunities advice. Any special request processes and non-fisheries advice will be dealt with separately. The expert groups effected are listed in Annex 1.

ACOM is encouraging all expert groups to keep working, and stick broadly to the time line, but clearly this needs to be through virtual meetings. ICES secretariat will support your efforts and make WebEx available. They will also produce a broad training document on WebEx. We know that the use of virtual meetings will result in an increased burden on the Chairs and members of the expert groups, therefore we have made changes to the generic terms of reference (see Annex 2 below) categorizing them as high, medium and low priority for this year's work. We also suggest that the expert group works virtually through smaller subgroups, and only hold larger virtual meetings when necessary.

The requesters of advice have been informed that there will be disruption/change to the delivery of advice for the spring 2020 season.

ACOM will also change the way that ICES gives advice for the spring 2020 season. There will be three types of advice:

- **Standard advice** sheet (the advice sheet following the January 2020 guidelines)
- **Abbreviated advice** sheet (a shortened advice sheet)
- **Rollover advice** (the same advice as in 2019)

ICES CIEM
International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer
H. C. Andersens Boulevard 44-46, 1553 Copenhagen V, Denmark
+45 33 38 67 00
info@ices.dk | www.ices.dk

The choice of which type of advice to apply to a stock is based on criteria determined by ACOM:

a. **Standard advice** - stocks with 2020 benchmarked methods
b. **Abbreviated advice** – most stocks, including management plan and MSY advice stocks, and some Cat 3 stocks. The abbreviated advice will contain the advice of the headline advice, catch scenario tables, plots and automated tables (last years' advice will be added as an annex to each sheet). The guidance for abbreviated advice is being written now and you should receive it in a few days.
c. **Rollover advice** – same as 2019 advice. This will be provided for stocks in the following categories:
    - zero TAC has been advised in recent years and no change likely,
    - category 3 or greater roll over advice, except if due to be reviewed in 2020
    - long lived stable stocks, with no strong trends in dynamics in recent years
    - some non-standard stocks (e.g. North Atlantic salmon)

We need to consult both you and the requesters of advice about which type of advice to apply to each stock. Today the ACOM criteria are being used by the secretariat to allocate advice types to stocks. This is the first version. We would like you to consider this list and comment if you think that the allocation needs changing. Please remember that the abbreviated advice is being developed to help your processes and also the ACOM processes during the disruption. The list of allocated advice type for each stock will hopefully be sent to you today or Monday. Please reply with your comments by 19th March so that we can start the dialogue with requesters. ACOM hopes that we could have a definitive list by 25th March. (This is too late for HAWG, so we suggest that HAWG use the list compiled in cooperation with Secretariat expecting requesters of advice to agree).

ACOM is recommending that for North Sea stocks with re-opening of advice in the autumn, the stock assessments be carried out in the spring but not the forecasts (postponed until early autumn). The advice would be delivered in the autumn of 2020.

You will shortly receive the first version of the **list of advice types allocated to stocks** and the **guidelines for abbreviated advice**. Please respond by 19th March with your comments on the first version of the list.
Your professional officer has been briefed about these changes. The changes are designed to reduce both expert group and ACOM workload. Lotte, your professional officer, the ACOM leadership and the FRSG Chair are available for further explanation.

Best regards

Mark

Mark Dickey-Collas
ACOM Chair

Annex 1. Expert groups associated with 2020 spring advice season

Herring Assessment Working Group for the Area South of 62°N
Working Group on North Atlantic Salmon*
Assessment Working Group on Baltic Salmon and Trout*
Baltic Fisheries Assessment Working Group
Arctic Fisheries Working Group
Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak
North-Western Working Group
Working Group on the Biology and Assessment of Deep-sea Fisheries Resources
Working Group for the Bay of Biscay and the Iberian Waters Ecoregion
Working Group for the Celtic Seas Ecoregion
Working Group on Southern Horse Mackerel, Anchovy, and Sardine
Working Group on Elasmobranch Fishes

* These groups already have different approaches.

Annex 2. Spring 2020 adapted generic terms of reference. [Agreed by ACOM 12 March 2020]

In light of the disruptions caused by COVID-19 in 2020, the generic terms of reference for the FRSG stock assessment groups have been re-prioritised. This applies to expert groups that feed into the spring advice season process[1]. ACOM is encouraging expert groups to use virtual meetings (e.g. WebEx) and subgroups to deliver the high priority terms of reference. See letter from the ACOM Chair to expert groups.

High Priority for spring 2020 advice season

c) Conduct an assessment on the stock(s) to be addressed in 2020 using the method (analytical, forecast or trends indicators) as described in the stock annex and produce a brief report of the work carried out regarding the stock, summarising where the item is relevant. **Check the list of the stocks to be done in detail and those to roll over.**
   i) Input data and examination of data quality;
   ii) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;
   iii) For relevant stocks (i.e., all stocks with catches in the NEAFC Regulatory Area) estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in 2019.
   v) The developments in spawning stock biomass, total stock biomass, fishing mortality, catches (wanted and unwanted landings and discards) using the method described in the stock annex;
   vi) The state of the stocks against relevant reference points;
   vii) Catch scenarios for next year(s) for the stocks for which ICES has been requested to provide advice on fishing opportunities;
   viii) Historical and analytical performance of the assessment and catch options with a succinct description of quality issues with these. For the analytical performance of category 1 and 2 age-structured assessment, report the mean Mohn's rho (assessment retrospective (bias) analysis) values for R, SSB and F. The WG report should include a plot of this retrospective analysis. The values should be calculated in accordance with the "Guidance for completing ToR viii) of the Generic ToRs for Regional and Species Working Groups - Retrospective bias in assessment" and reported using the ICES application for this purpose.

d) Produce a first draft of the advice on the stocks under considerations according to ACOM guidelines. Check list to confirm whether the stock requires a concise advice sheet or a traditional advice sheet.

f) Prepare the data calls for the next year update assessment and for planned data evaluation workshops;

j) Audit all data and methods used to produce stock assessments and projections.

[1] These do not apply to Assessment Working Group on Baltic Salmon and Trout and Working Group on North Atlantic Salmon.

Medium Priority for spring 2020 advice season

a) Consider and comment on Ecosystem and Fisheries overviews where available;

b) For the aim of providing input for the Fisheries Overviews, consider and comment for the fisheries relevant to the working group on:
   i) descriptions of ecosystem impacts of fisheries
   ii) descriptions of developments and recent changes to the fisheries
   iii) mixed fisheries considerations, and
   iv) emerging issues of relevance for the management of the fisheries;

e) Review progress on benchmark processes of relevance to the Expert Group; High for application;

Low Priority for spring 2020 advice season

c iv) Estimate MSY proxy reference points for the category 3 and 4 stocks

g) Identify research needs of relevance for the work of the Expert Group.

h) Review and update information regarding operational issues and research priorities and the Fisheries Resources Steering Group SharePoint site.

i) Take 15 minutes, and fill a line in the audit spread sheet 'Monitor and alert for changes in ecosystem/fisheries productivity'; for stocks with less information that do not fit into this approach (e.g. higher categories >3) briefly note in the report where and how productivity, species interactions, habitat and distributional changes, including those related to climate-change, have been considered in the advice. ACOM would encourage expert groups to carry out this term of reference later in the year through a webex.

Annex 3: List of stock annex edits

The table below provides an overview of the WGBIE Stock Annexes. Stock Annexes for other stocks are available on the ICES website Library under, 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.

	Title	Name
1	bss.27.8ab_SA	Sea bass (*Dicentrarchus labrax*) in division 8ab (Bay of Biscay)
2	mon.27.78abd_SA	Stock Annex for White anglerfish (*Lophius piscatorius*) in divisions 7.b–k, 8.a–b, and 8.d (southern Celtic Seas, Bay of Biscay)
3	nep-8abde_SA	Bay of Biscay *Nephrops* (FU 23-24)
4	nep-30_SA	Norway lobster (*Nephrops norvegicus*) in Division 9.a, Functional Unit 30 (Atlantic Iberian waters East and Gulf of Cadiz)
5	nep-2627_SA	Norway lobster (*Nephrops norvegicus*) in Division 9.a, functional units 26–27 (Atlantic Iberian waters East, western Galicia, and northern Portugal)
6	sol-8c9a_SA	Sole (*Solea spp*.) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)

Annex 4: Audit reports

Working Group: WGBIE **Stock Name: ank.27.78ab**

Date: 15/05/2020
Auditors: Paz Sampedro and Yolanda Vila

General

- This stock was benchmarked in 2018.
- A combined abundance index from surveys IGFS-WIBTS-Q4 and EVHOE-WIBTS-Q4 is used as basis for the advice. This combined index is used to perform the assessment following the 3-over-2 rule according to category 3 stocks.
- New biomass reference point proxies (MSY $B_{trigger\ proxy}$, $B_{pa\ proxy}$ and $B_{lim\ proxy}$) are estimated in WGBIE2020.

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. A spatiotemporal model (VAST) was used to estimate the index value for 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 estimated below F_{MSY} and 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 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.

Technical comments

Although the VAST model provided nearly identical biomass values to the original survey index for the whole series, following the recommendation of ADG2019 only the abundance value for 2017 was used for the assessment. In 2019, the combined index used in the assessment registered the highest biomass of their time series. The index is estimated to have increased (3-over-2 rule) by 88% and thus the uncertainty cap was applied.

The F/F_{MSY} proxy is based on mean-length Z analysis and the biomass reference points proxies are estimated based on biomass index used for the assessment. The approach to derive the biomass reference points proxies follow the identification of the category of a stock-recruitment, based on recruit and biomass combined indices, and the application of the guidelines for an improved 3-over-2 rule from WKLIFE IX in 2019 (ICES, 2019).

The assessment follows the Stock Annex except for using the VAST-modelled value index in 2017.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? Yes.

Is the assessment according to the stock annex description? Yes.

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? The management plan has been agreed to by relevant parties and ICES has evaluated the multiannual management in a single stock basis.

Have the data been used as specified in the stock annex? Yes.

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes.

Is there any **major** reason to deviate from the standard procedure for this stock? No.

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes.

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE Stock Name: ank.27.8c9a

Date: 21/05/2020
Auditors: Lisa Readdy and Hans Gerritsen

General

- This stock is managed under a combined species TAC with *Lophius piscatorius*.
- The last benchmarked conducted was in 2018 and a stochastic production model in continuous-time (SPiCT) was accepted as indicative of trends, and classified within the category 3.2, with proxy reference points using SPiCT results.
- Mohn's rho does not indicate strong retrospective pattern.
- The stock shows fishing pressure to be below proxy F_{MSY} and SSB to be above proxy MSY $B_{trigger}$.
- The uncertainty cap was not applied as the index ratio is between 0.8 and 1.2.
- The precautionary buffer has never been applied; as the stock status and fishing pressure are appropriate a buffer was not applied this year.

For single stock summary sheet advice:

9) **Assessment type:** Update
10) **Assessment**: Analytical assessment; results used only for trends analysis.
11) **Forecast**: Not presented. ICES advice follows the rules for data limited stocks, category 3.2.0 and uses the 2 over 3 harvest control rule applied to the modelled SSB time series output.
12) **Assessment model:** Trends based assessment using SPiCT and 2 over 3 harvest control rule for fishing opportunities. Tuned by 3 commercial indices, with one of indices (SPCORTR8c) ending in 2012.
13) **Data issues:**
    a. The data are as described in the stock annex.
    b. Landings for 2018 from France was revised and unallocated/non reported landings were presented for 2019 and used in the assessment.
14) **Consistency**: The assessment was consistent with last year's assessment even with the inclusion of 2019 data and an update of landings for 2018 from France. Comparison of 2019 and 2020 assessment diagnostics shows similar results.
15) **Stock status:** Stock biomass was above MSY $B_{trigger}$ proxy (0.5×B_{MSY} proxy) over the whole time series; F has been below F_{MSY} proxy for the last 20 years.
16) **Management Plan**: There is one management plan for this stock but ICES advice is according to the precautionary approach as the stock classified as 3.2.0 under the data-limited approach.
    - The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters applies to this stock. The plan specifies conditions for setting fishing opportunities depending on stock status and making use of the F_{MSY} range for the stock.

General comments

This was a well-documented, well ordered and considered section. It was easy to follow and interpret.

Technical comments

Similar to last year's assessment, one of the autocorrelation diagnostic plots for the index show significance at the first lag. The report suggests that this is considered not meaningful, but a better explanation of why this is of no concern is needed especially if the assessment is to be considered as a category 1 assessment.

Conclusions

The assessment was performed according to the stock annex. The group discussed the possibility of putting this stock forward as a case study for a workshop to look at biomass production models as category 1 assessments.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: bss.27.8ab**

Date: 16/05/2020
Auditors: Agurtzane Urtizberea and Eoghan Kelly

General

The assessment model SS3 overestimates the length-at-age distribution of 2018 and 2019. In 2018 and 2019, otoliths were read by a new person without any analysis comparing possible bias in readings between the new and the previous readers. This could be the reason for the differences in the estimates of the 2018 ALK in comparison to the previous years and therefore, it was decided not to consider the 2018 and 2019 ALKs in the assessment for the second consecutive year.

For single stock summary sheet advice:

1) **Assessment type:** Update
2) **Assessment**: Analytical assessment
3) **Forecast**: presented
4) **Assessment model**: Stock Synthesis 3 model with commercial landings and recreational removals, the length frequencies of both as input data and French commercial LPUE series as tuning index.
5) **Data issues:** French data for 2018 were revised but had no major impact on the assessment.
6) **Consistency:** This is the third time that ICES has provided an advice based on analytical assessment for this stock.
7) **Stock status**: F has fluctuated around FMSY since 2000 and is now just below F_{MSY}. B> MSY $B_{trigger}$. Recruitment is variable over time and the lowest values in the time series have occurred in the recent period. The recruitment of the last 3 years is assumed the value of the geometric mean calculated from 2008-2015 (4 years before last year). The stock annex was also updated this year.
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 8ab.

General comments

The report and the advice are well written. However, some comments in order to improve the advice and the report were included in the text and communicated to the stock coordinator.

Technical comments

- The main issue in the assessment is the differences in the ALK due to a different otolith reader. A WD is needed to explain and quantify the differences between the age estimations in order to include them in the assessment model.
- It was agreed during the WGBIE 2020 meeting that the value of the recruitment of the last 3 years should be from 2008 until 4 years before the last year of data, because the youngest fish catch are 4 years old. Otherwise, the assessment is done according to the revised stock annex.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

- Yes

Is the assessment according to the stock annex description?

- The reference points of the stock annex are not updated.

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

- 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 8ab.

Have the data been used as specified in the stock annex?

- Yes, except for the ALK of the last 2 years due to a bias identified from the change of otolith age readers and thus are not used in the assessment model.

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

- Yes

Is there any **major** reason to deviate from the standard procedure for this stock?

- It was decided by the WG since WGBIE 2019 not to include the ALK estimates of 2018 and 2019, due to the possible bias from a change of otolith readers and considering the impact of this bias to the assessment and retrospective pattern.

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

- Yes

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: bss.27.8c9a**

Date: 20/05/2020
Auditor: Maria Grazia Pennino

General

- The seabass stock 8c9a is considered as a data-limited stock and it is classified as category 5.2 stock (ICES, 2012).
- The landings statistics do not show any remarkable changes. The available scientific data for the stock is not sufficient to evaluate the stock status.

For single stock summary sheet advice:

9) **Assessment type:** Update
10) **Assessment**: Not presented
11) **Forecast**: Not presented
12) **Assessment model**: According to ICES Guidance, if the precautionary approach buffer has been applied in 2017 or later (assessment conducted in 2017 providing advice for 2018), then it should not be applied in 2019.
13) **Data issues:** All commercial catches are assumed to be landed. Recreational catches cannot be quantified; there-fore, total catches cannot be calculated.
14) **Consistency:** No assessment was presented for this stock
15) **Stock status**: The perception of the stock didn't change in 2020.
16) **Management Plan**: A multiannual management plan (MAP) has been published for the Western Waters (European Parliament and Council Regulation (EU) 2019/472). This plan applies to demersal stocks including seabass in ICES divisions 8c and 9a.

General comments

The report is well written. Some comments have been made in order to improve the report which were included in the text and communicated to the stock coordinator.

Technical comments

Assessment and advice have been carried out following ICES procedures.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? Yes

Is the assessment according to the stock annex description? Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? Yes

Have the data been used as specified in the stock annex? Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Not applicable

Is there any **major** reason to deviate from the standard procedure for this stock? None

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Not applicable as no advice was requested for this stock this year

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: hke.27.3a46-8abd**

Date: 20/05/2020
Auditors: Hans Gerritsen and Mathieu Woillez

General

Comments on the report section:

- Management for 2019 and 2020, last paragraph: "ICES, according to the MSY framework, proposed a decrease in the 2020 TAC advice of a 26% from 142 240 t to 104 763. The agreed TAC, was higher than the advice (112 903 t) to limit the inter-annual variability in TAC to a 20%."
- 2.1, last para: "It is remarkable the case of gillnetters which did not discard before 2012 and since that year they have had high level of discards." – the values in the table for gillnetters before 2012 are NA, that suggests there was no data available. If the discards were actually observed to be zero, the table should have zeros.
- 2.1, last para "Nevertheless, in 2019 this fleet was not sampled in the second and fourth quarters so there could be a potential under-estimation of discards." – I would say: "so the values in the table are an under-estimate. However, the model estimates discards for these missing quarters."
- 9.2.2 "The sampling level is given in Table 1.3." – I think it is table 1.4 now.
- 9.2.5.1. "The model is not very sensitive to discard volume"
- Fig 9.9. I am always worried when I see those selection curves that go down so much for larger fish. It seems to me that there is scope for the model to 'hide' a lot of biomass that is not available to the fisheries because they can't catch it. I had a look at the observed catch length freq distributions and the model estimated population LFDs and tried to plot the mean length of the biomass (so it's like the mean length but weighted by biomass): sum(length * frequency * weigh-at-length) / sum(frequency * weight-at-length). I don't think I did it right but it would a nice way to see if the model has created a lot of cryptic biomass or not:

- 9.2.6 – Retrospective. "The inclusion of new data impacted the recruitment estimates in the whole time series without any trend" - would not say that is the case in recent years; it only impacts the recruitment estimate going back 3 or 4 years, not the full time-series
- Figure 9.12 – it would be nice to see the confidence intervals in this fig.
- Figure 9.13 – this figure is not cited in the main text.
- Table 9.6 – This catch option table does not match the catch options in the advice. E.g. Fcatch=0.263 is close to F_{MSY} and gives a catch of 128 267 t, the advice value is much lower for F_{MSY}=0.26 (catch of 98 657 t). Also some of the intermediate year assumptions are different (SSB 20/21, Catch).

- 9.6 Management considerations – with the northward expansion of the stock, I presume the Norwegian catches have become more important. It would be nice to see a line here saying something that the ices catch advice is for the whole stock but the sum of the TACs are only for EU member states. Still not sure how the Norwegians agree their share of the catch but this should be accounted for when setting the EU TAC.

Comments on the draft advice sheet

None.

For single stock summary sheet advice:

17) **Assessment type:** Update/SALY
18) **Assessment**: Analytical assessment
19) **Forecast**: Presented
20) **Assessment model:** SS3 – tuning by 4 surveys
21) **Data issues:** No major issues
22) **Consistency**: Assessment has been accepted every year since the last benchmark in 2014.
23) **Stock status:** B>>B_{lim}; F around F_{MSY} in recent years. R uncertain in recent years; varies without trend.
24) **Management Plan**: MAP; hake recovery plan is not active

General comments

See comments on report section above.

The report is well documented and clearly written.

Technical comments

The assessment and forecast were done following the stock annex with the exception of the replacement of the last two years of estimated recruitment with the GM. This is documented in the report.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? Yes

Is the assessment according to the stock annex description? Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? EU MAP – Norway is not part of this. MSY approach has been evaluated as precautionary when the reference points were defined.

Have the data been used as specified in the stock annex? Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes- deviations are explained

Is there any **major** reason to deviate from the standard procedure for this stock? Not a major reason but WGBIE considered it sensible to deviate slightly from the SA by replacing recent recruitment in the forecast.

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? It appears to be a valid basis for the advice. My main concern is the failure of the fishery to catch the TAC in recent years. There can be many reasons for this but it appears to happen for all major countries now whereas before the full quota were taken. This could be a sign that the assessment is too optimistic about the absolute level of biomass.

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: hke.27.8c9a**

Date: 18/05/2020
Auditors: Teresa Moura and Youen Vermard

General

- There is a strong retrospective bias in the assessment carried out with de GADGET model (benchmarked in 2014) associated to contradictory signals among biomass indexes and stock productivity. This strong bias has been documented in past assessments.
- Major work was carried out by the stock coordinator to understand the causes for the retrospective pattern (also in the scope of WKFORBIAS; ICES, 2020).
- A correction to the model results based on the Mohn´s rho was hypothesized but there are no clear guidelines and the application to Gadget model is unknown.
- The Mohn´s rho values were considered unacceptable for forecast and the assessment was conducted following a category 3 approach, using one commercial LPUE and one survey index.
- Relative F trends were estimated as the yearly catch divided by biomass yearly index.
- Uncertainty cap was not applied.
- The precautionary buffer was applied following ICES guidelines for 2020
- A new benchmark for this stock is urgent.

For single stock summary sheet advice:

17) **Assessment type:** Update
18) **Assessment**: - Analytical assessment (rejected)
    - Category 3 assessment
19) **Forecast**: not presented
20) **Assessment model**: - GADGET – catches+2 commercial LPUE + 3 research surveys (rejected)
    - Category 3 assessment (1 survey index+ 1 commercial LPUE)
21) **Data issues:** Data available as described in stock annex.
22) **Consistency**: The assessment with the GADGET model was rejected (see above). A trend-based assessment was carried out under category 3 (first year).
23) **Stock status**: No reference points for category 3 are available for this stock. (Gadget assessment: SSB> MSY $B_{trigger}$; F > F_{MSY})
24) **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.

General comments

Report is well documented, presenting the results from the analyses, conclusions and justifications for the change in the assessment. Advice sheet will be revised by the ICES secretariat as a category 3 stock.

Technical comments

Assessment based on biomass trends (cat. 3).
A new benchmark for this stock is urgent.

Conclusions

The new assessment has been performed correctly following ICES guidelines for category 3.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

T

Working Group: WGBIE **Stock Name: ldb.27.7b-k8abd**

Date: 18/05/2020
Auditor: Mathieu Woillez and Agurtzane Urtizberea

General

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 (the main country in the fishery) data for most of the time-series (data submitted only for the last 3 years).

For single stock summary sheet advice:

25) **Assessment type:** No assessment (ICES category 5 stock)
26) **Assessment**: No assessment
27) **Forecast**: No forecast
28) **Assessment model**: Length-based indicators and mean length Z explored on Spanish Porcupine survey data
29) **Data issues:** Missing Spanish data for most of the time-series. Data submitted only for the last 3 years.
30) **Consistency**: No comment
31) **Stock status**: Not provided
32) **Management Plan**: None

General comments

The report is well written.

Technical comments

None

Conclusions

No assessment has been performed.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

- Yes

Is the assessment according to the stock annex description?

- Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

- Not applicable

Have the data been used as specified in the stock annex?

- Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

- Not applicable

Is there any **major** reason to deviate from the standard procedure for this stock?

- Short time series for Spanish data to evaluate stock status as required by the commission

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

- Not applicable

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: mgb.27.8c9a**

Date: 20/05/2020
Auditors: Santiago Cerviño and Isabel González Herraiz

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
  - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
  - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

25) **Assessment type:** Update
26) **Assessment**: Analytical assessment
27) **Forecast**: Presented
28) **Assessment model:** XSA + 1 survey and 2 LPUEs
29) **Data issues:** No issues
30) **Consistency**: Accepted for the second consecutive year. Retrospective pattern
31) **Stock status:** SSB2020 > B_{pa} = MSY $B_{trigger}$. F_{pa} > F_{MSY} > F_{2019}
32) **Management Plan:** EU multiannual plan (MAP) for Western waters.

General comments

This was a well-documented, well ordered and considered section. It was easy to follow and interpret. The update and projections were performed following stock annex. Some identified typographical errors or inconsistencies in the text and tables but these were already corrected.

Technical comments

- Data used according with stock annex.
- The assessment was done according with the stock annex.
- Recruitment 2019-21 was replaced for short term projections to historical mean ($GM_{1990-2018}$).
- Exploitation patter was set as the mean of last 5 years and F 2020 was set as mean F (years 2017-2019).
- SSB has increased in recent years to the current maximum value and is well above B_{pa} (= MSY $B_{trigger}$).
- Fishing mortality (F) has decreased in the last years to historical minimum followed by a slight increase during the last year but is still below F_{MSY}.
- Retrospective pattern shows a tendency to reduce SSB estimates and increase F. This year the SSB reduction and F increase was higher than previous years.

Conclusions

The assessment has been performed correctly given a valid basis for the advice. The data, the assessment and the forecast was developed according to the stock annex description.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: meg.27.7b-k8abd**

Date: 18/05/2020
Auditors: Esther Abad and Spyros Fifas

General

- Category 1 stock since the 2016 benchmark workshop.
- This stock was assessed and projections were performed without no particular issues.
- Retrospective analysis does not indicate a strong pattern although it is noticeable that SSB is revised downwards year by year as well as F_{bar} is revised upwards.
- The assessment results show an increasing trend in SSB and a decreasing F trend, being below F_{MSY}.

For single stock summary sheet advice:

33) **Assessment type:** Update
34) **Assessment**: Analytical assessment
35) **Forecast**: Presented; the advice for this stock follows the ICES rules for category 1 stocks.
36) **Assessment model:** Statistical catch-at-age – tuning by 3 commercial indices and 2 surveys.
37) **Data issues:** Data available as described in the stock annex.
38) **Consistency**: Results are consistent with last year's assessment and the assessment was accepted.
39) **Stock status:** Fishing pressure on the stock is below F_{MSY} and spawning stock size is above MSY $B_{trigger}$.
40) **Management Plan**: The European Parliament and the Council have published a multiannual 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 section is well documented and written. Some minor issues were reported and corrected.

- Inputs 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 recruitment in 2017.
- Recruitment 2020 was replaced for short-term projections to historical mean ($GM_{1984-2017}$).
- F *status quo* is unscaled and set as a mean F (years 2017-2019).

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? Yes

Is the assessment according to the stock annex description? Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex? Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes

Is there any **major** reason to deviate from the standard procedure for this stock? No

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: meg.27.8c9a**

Date: 13/5/2020
Auditors: Ane Iriondo and Jean-Baptiste Lecomte

General

- Category 1 stock since the 2016 benchmark workshop.
- This stock was assessed and projections were performed without no particular issues.
- This year, there is a retrospective pattern.
- The assessment has been performed correctly according to the stock annex.

For single stock summary sheet advice:

33) **Assessment type:** Update
34) **Assessment**: Analytical assessment
35) **Forecast**: Presented. The advice for this stock follows the ICES rules for category 1 stocks.
36) **Assessment model**: XSA + 1 survey and 2 LPUEs
37) **Data issues:**
    a. The data are as described in Stock Annex.
    b. No special data issues are described.
38) **Consistency**: The assessment was accepted for the second consecutive year.
39) **Stock status**: Stock biomass has been above MSY $B_{trigger}$ since 2016; F has been decreasing and is below F_{MSY} in 2019.
40) **Management Plan**: A multiannual plan for demersal stocks (which includes this stock) and their fisheries in the Western Waters and adjacent waters was 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 section was well structured, properly documented and it is easy to follow. We detected no inconsistencies in the text or in tables or figures. The data, assessment and forecast were used/realized according to the Stock Annex.

Technical comments

- Good recruitments in 2015, 2016 and 2017 which was followed by a decrease in 2018. A slight increase was observed in 2019.
- Recruitment 2020 was replaced by the historical geometrical mean ($GM_{1998-2017}$) for short-term projections.
- F_{2020} was set as average F (years 2017-2019)
- SSB has been increasing in recent years and above MSY $B_{trigger}$.
- Fishing mortality (F) has decreased in the last years and it is below F_{MSY} in 2019.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? Yes.

Is the assessment according to the stock annex description? Yes.

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? The management plan has been agreed to by relevant parties and ICES has evaluated the multiannual management in a single stock basis.

Have the data been used as specified in the stock annex? Yes.

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes.

Is there any **major** reason to deviate from the standard procedure for this stock? No.

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes.

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: mgb.27.8c9a**

Date: 20/05/2020
Auditors: Santiago Cerviño and Isabel González Herraiz

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
  - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
  - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

41) **Assessment type:** Update
42) **Assessment**: Analytical assessment
43) **Forecast**: Presented
44) **Assessment model:** XSA + 1 survey and 2 LPUEs
45) **Data issues:** No issues
46) **Consistency**: Accepted for the second consecutive year. Retrospective pattern
47) **Stock status:** SSB2020 > B_{pa} = MSY $B_{trigger}$. F_{pa} > F_{MSY} > F_{2019}
48) **Management Plan:** EU multiannual plan (MAP) for Western waters.

General comments

This was a well-documented, well ordered and considered section. It was easy to follow and interpret. The update and projections were performed following stock annex. Some identified typographical errors or inconsistencies in the text and tables but these were already corrected.

Technical comments

- Data used according with stock annex.
- The assessment was done according with the stock annex.
- Recruitment 2019-21 was replaced for short term projections to historical mean ($GM_{1990-2018}$).
- Exploitation patter was set as the mean of last 5 years and F 2020 was set as mean F (years 2017-2019).
- SSB has increased in recent years to the current maximum value and is well above B_{pa} (= MSY $B_{trigger}$).
- Fishing mortality (F) has decreased in the last years to historical minimum followed by a slight increase during the last year but is still below F_{MSY}.
- Retrospective pattern shows a tendency to reduce SSB estimates and increase F. This year the SSB reduction and F increase was higher than previous years.

Conclusions

The assessment has been performed correctly given a valid basis for the advice. The data, the assessment and the forecast was developed according to the stock annex description.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: mon.27.8c9a**

Date: 14/05/2020
Auditor: Mickael Drogou and Eoghan Kelly

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.
- There was a moderate increase in recruitment in 2019 after being low from 2015-18. SSB continues to increase and F is at the lowest values of the series. Retrospective analysis showed that SSB was overestimated last year while F was slightly underestimated.
- A Coruña-fleet and Cedeira-fleet abundance indices (SPCORTR8C) from 2013 to 2019 were not included in the assessment.
- French landings for 2018 were reviewed this year.

For single stock summary sheet advice:

41) **Assessment type:** Update
42) **Assessment**: Analytical assessment
43) **Forecast**: Presented
44) **Assessment model**: Stock Synthesis 3 (SS3)
45) **Data issues:** Time series of commercial index SPCORTR8C are incomplete.
46) **Consistency**: The assessment is consistent, it passed through a benchmark with minor changes, and has been accepted for stock status and forecast.
47) **Stock status**: The spawning-stock biomass (SSB) has been increasing since 1994 and has been above MSY $B_{trigger}$ since 2005. Fishing mortality (F) has been below F_{MSY} since 2010. Recruitment (R) has been low in recent years although there was a moderate increase in 2019.
48) **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.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

- Yes

Is the assessment according to the stock annex description?

- Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

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

Have the data been used as specified in the stock annex?

- Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

- Yes

Is there any **major** reason to deviate from the standard procedure for this stock?

- No

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

- Yes

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE Stock Name: mon.27.78ab

Date: 15/05/2020
Auditor: Dorleta Garcia and Mickael Drogou

General

This year the fishing mortality (F) has been rescaled to the last year due to the observed decreasing trend. This option is explained in the stocks annex.

For single stock summary sheet advice:

49) **Assessment type:** Update
50) **Assessment**: Analytical assessment
51) **Forecast**: Presented
52) **Assessment model**: a4a – tuning by 1 combined index
53) **Data issues:** Data compilation to conduct the assessment has been carried out following the stock annex. Some minor revisions of the 2018 French data have been made and submitted to the WG this year. However, the impact in the assessment of this stock was negligible. A correction in the data raising procedure has also been made but had no significant effect in the results.
54) **Consistency:** The assessment is consistent with the two previous years' assessments.
55) **Stock status**: For the second consecutive year, $F<F_{MSY}$ while SSB is above $B_{trigger}$ and, during the recent years, is at its highest historical level.
56) **Management Plan**: The stock is included in the multiannual management plan of north western waters.

General comments

The report was well documented and ordered. It was easy to follow and interpret. There was a revision of the historical catches due to a change in the way the catches were raised.

Technical comments

The assessment has been carried out following the stocks annex and the data used seem correct. However, some comments for improvement includes:

- At the beginning of the report, the ICES advice should correspond with what was given for 2021 and not with the one produced last year for 2020.
- Data description detailing the issue with the uploaded simulated French Q1 and Q2 data that occurred 2 years ago has already been discussed in previous reports and could be removed in this year's report.
- Legend of figure 3.2.4a and its corresponding texts in the report indicate 'in terms of abundance' but this should be 'in terms of numbers of individuals'. I find the words 'in terms of abundance' a bit strange.
- In the report, the author indicated in the legends of figures 3.2.5. and 3.2.7c that "the cohorts can be consistently followed up to ages 6 and 7", which are not always clear. However, this seems contradictory to what is written in 3.2.7 which states the recommendations for the next benchmark, one of the concerns highlighted included "the retrospective pattern and the apparent loss of cohort tracking after age 4 or 5".
- The legends of figures 3.2.8a and b indicate "internal and external consistencies of the survey indices", respectively. However, it is not clear what these consistencies mean?
- In figure 3.2.10, it could be more informative to plot selectivity and fishing mortality levels separately, where on one plot the selectivity-at-age which is considered constant

every year and in another plot the fishing mortality level that changes annually since the configuration of the model corresponds to separable models.

- Under the final update section of the report, in the end phrase of the first sentence of the 5th paragraph, "and continues to rise" is redundant.
- The third sentence of the same paragraph, "This is because in a separable assessment the F-pattern of the entire time series is adjusted with each new year of data", add 'at-age' to the "F-pattern".
- The estimated F_{MSY} in 2018 was 0.36 or 0.26? 0.36 seems too high in comparison with the rest.
- Under the biological reference points section of the report, the first sentence of the second paragraph which states, "This year a WD was presented where a base case is developed under similar assumptions as a4a and with similar results", is not clear and not well understood.
- The values used in the STF do not appear in the report: Rec GM and SSB in 2021, catch in 2020.
- In the advice sheet: The table with the STF assumptions indicates the F as the "average selection pattern" which does not make sense in this case because the model is separable in selectivity and fishing mortality level, so the selection pattern should be constant all along the time series.
- The catch options table should include F_{lim} and SSB (2022) = B_{pa}.
- In the advice table: The comparison in % with the advice, the previous year's advice is missing in the notes.
- In the historical advice and catches, a note should be added indicating that the total catches has been corrected.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? *Yes*

Is the assessment according to the stock annex description? *Yes*

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? *ICES has evaluated the multiannual management plan of the stock in a single stocks basis.*

Have the data been used as specified in the stock annex? *Yes*

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? *Yes*

Is there any **major** reason to deviate from the standard procedure for this stock? *No*

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? *Yes*

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: nep.fu.25**

Date: 19/05/2020
Auditor: Spyros Fifas

General

- The stock is classified as DLS category 3.1.4 and assessed with LPUE trends.
- The advice for this stock is triennial and the last assessment was made in 2019.
- The stock biomass is extremely low and zero catch is advised (ICES, 2019).
- A sentinel fishery of almost 2 t was allowed in August-September in 2017-2019, supervised by a scientific institute (IEO) aiming to obtain an abundance index.

For single stock summary sheet advice:

49) **Assessment type:** Update
50) **Assessment**: ICES framework for category 3 stocks
51) **Forecast**: No forecast; zero catch are recommended
52) **Assessment model:** Assessment of LPUE trends
53) **Data issues:** (i) Data from the sentinel fishery 2017-2019 (CPUE and LFDs); (ii) VMS information 2009-2018; (iii) Demersal trawl survey (SP-NSGFS, years 1983-2018); (iv) Discarded quantities in 2018 and 2019 (those quantities previously close to zero increased since zero TAC has been applied); (v) percentage of males in landings (years 1981-2010). The data are well described.
54) **Consistency**: Assessment consistent accordingly to available information
55) **Stock status** Very low level, no possible to currently define reference points.
56) **Management Plan**: 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 hake 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.

General comments

Report well structured.

Technical comments

No specific point to raise.

Conclusions

The assessment has been performed properly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? Yes

Is the assessment according to the stock annex description? Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? No

Have the data been used as specified in the stock annex? Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes, the assessment and recruitment analyses were performed but no STF as this is a DLS category 3 stock.

Is there any **major** reason to deviate from the standard procedure for this stock? No
Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? No advice this year

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: nep.fu.30**

Date: xx/xx/2020
Auditor:

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
  - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
  - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

57) **Assessment type:** Update/SALY
58) **Assessment**: analytical /trends / not presented
59) **Forecast**: Presented or not presented. Additional information, if any
60) **Assessment model**: model use, tuning indices, surveys
61) **Data issues:** are the data available as described in stock annex or have there been any issues with specific data / new data ?
62) **Consistency:** Last yr assess rejected – this accepted, the view of the RG was that last yrs assess should have been accepted
63) **Stock status**: Catches, F, SSB and Rec. *B<Blim for a while, Flim<F<Fpa, R uncertain, seem to be high recent years*
64) **Management Plan**: If any. E.g., Agreed 2006: SSB above 35 000 t within 10 years and to reduce fishing mortality to 0.27. The main elements in the plan are a 10% annual reduction in F and a 15% constrain on TAC change between years. Plan is **not** evaluated by ICES

General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret…. etc

Technical comments

(Include comments on points where the draft report contains errors, is unclear and if the assessment is done according to the stock annex)

Conclusions

The assessment has been performed correctly.

(If needed describe if relevant what extra things need to be done for a correct final assessment)

(Include suggestions for future benchmarks, and things to be done before ADG)

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: nep.fu.31**

Date: 19/05/2020
Auditor: Sypros Fifas

General

- The stock is classified as DLS category 3.1.4 and assessed with LPUE trends.
- The advice for this stock is triennial and valid for the period 2020-2022.
- The stock abundance is extremely low and zero catch is advised.
- A special quota of 0.7 t for 2019 was established in order to carry an observers` programme supervised by the Spanish Oceanographic Institute (IEO) for obtaining a *Nephrops* abundance index (Sentinel fishery).

For single stock summary sheet advice:

57) **Assessment type:** Update
58) **Assessment**: ICES framework for category 3 stocks
59) **Forecast**: No forecast; zero catch recommended
60) **Assessment model:** Assessment of LPUE trends
61) **Data issues:** (i) Information on discards (negligible in this FU); (ii) VMS data of the trawl fleet providing spatial information of *Nephrops* landings; (iii) Time series available owing to the Spanish demersal trawl survey (SP-NSGFS) although not mainly targeting *Nephrops*.
62) **Consistency**: Assessment is consistent to the available information
63) **Stock status:** Very low level, no possible to currently define reference points.
64) **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

Report well structured.

Technical comments

No specific point to comment

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? Yes

Is the assessment according to the stock annex description? Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? No

Have the data been used as specified in the stock annex? Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes, the assessment and recruitment analyses were performed but no forecast as the stock is considered as DLS category 3.

Is there any **major** reason to deviate from the standard procedure for this stock? No
Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: nep.fu.2324**

Date: xx/xx/2020
Auditor:

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
    - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
    - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

65) **Assessment type:** Update/SALY
66) **Assessment**: analytical /trends / not presented
67) **Forecast**: Presented or not presented. Additional information, if any
68) **Assessment model**: model use, tuning indices, surveys
69) **Data issues:** are the data available as described in stock annex or have there been any issues with specific data / new data ?
70) **Consistency:** Last yr assess rejected – this accepted, the view of the RG was that last yrs assess should have been accepted
71) **Stock status**: Catches, F, SSB and Rec. *B<Blim for a while, Flim<F<Fpa, R uncertain, seem to be high recent years*
72) **Management Plan**: If any. E.g., Agreed 2006: SSB above 35 000 t within 10 years and to reduce fishing mortality to 0.27. The main elements in the plan are a 10% annual reduction in F and a 15% constrain on TAC change between years. Plan is **not** evaluated by ICES

General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret…. etc

Technical comments

(Include comments on points where the draft report contains errors, is unclear and if the assessment is done according to the stock annex)

Conclusions

The assessment has been performed correctly.

(If needed describe if relevant what extra things need to be done for a correct final assessment)

(Include suggestions for future benchmarks, and things to be done before ADG)

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: nep.fu.2627**

Date: xx/0x/2020
Auditor: Barbara Pereira

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
  - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
  - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

73) **Assessment type:** Update/SALY
74) **Assessment**: analytical /trends / not presented
75) **Forecast**: Presented or not presented. Additional information, if any
76) **Assessment model**: model use, tuning indices, surveys
77) **Data issues:** are the data available as described in stock annex or have there been any issues with specific data / new data ?
78) **Consistency:** Last yr assess rejected – this accepted, the view of the RG was that last yrs assess should have been accepted
79) **Stock status**: Catches, F, SSB and Rec. *B<Blim for a while, Flim<F<Fpa, R uncertain, seem to be high recent years*
80) **Management Plan**: If any. E.g., Agreed 2006: SSB above 35 000 t within 10 years and to reduce fishing mortality to 0.27. The main elements in the plan are a 10% annual reduction in F and a 15% constrain on TAC change between years. Plan is **not** evaluated by ICES

General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret…. etc

Technical comments

(Include comments on points where the draft report contains errors, is unclear and if the assessment is done according to the stock annex)

Conclusions

The assessment has been performed correctly.

(If needed describe if relevant what extra things need to be done for a correct final assessment)

(Include suggestions for future benchmarks, and things to be done before ADG)

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: nep.fu.2829**

Date: xx/0x/2020
Auditor: Yolanda Vila

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
  - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
  - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

81) **Assessment type:** Update/SALY
82) **Assessment**: analytical /trends / not presented
83) **Forecast**: Presented or not presented. Additional information, if any
84) **Assessment model**: model use, tuning indices, surveys
85) **Data issues:** are the data available as described in stock annex or have there been any issues with specific data / new data ?
86) **Consistency:** Last yr assess rejected – this accepted, the view of the RG was that last yrs assess should have been accepted
87) **Stock status**: Catches, F, SSB and Rec. *B<Blim for a while, Flim<F<Fpa, R uncertain, seem to be high recent years*
88) **Management Plan**: If any. E.g., Agreed 2006: SSB above 35 000 t within 10 years and to reduce fishing mortality to 0.27. The main elements in the plan are a 10% annual reduction in F and a 15% constrain on TAC change between years. Plan is **not** evaluated by ICES

General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret…. etc

Technical comments

(Include comments on points where the draft report contains errors, is unclear and if the assessment is done according to the stock annex)

Conclusions

The assessment has been performed correctly.

(If needed describe if relevant what extra things need to be done for a correct final assessment)

(Include suggestions for future benchmarks, and things to be done before ADG)

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: nep.fu.2829**

Date: 29/06/2020
Auditor: Yolanda Vila

General

- The advice for this stock is biennial
- Last advice was carried out in 2019
- The standardized commercial CPUE is used as index of biomass

For single stock summary sheet advice:

89) **Assessment type:** No advice in 2020
90) **Assessment**: Category 3 assessment.
91) **Forecast**: Not presented.
92) **Assessment model**: Mean Length Z method, as defined in WKLIFE-V (ICES, 2015) and WKProxy (ICES, 2016)
93) **Data issues:** All data are available. No survey was conducted in 2019.
94) **Consistency:** Data are consistent with time series.
95) **Stock status**: The stock has been exploited at a level below the F_{MSY} proxy. New data do not change the perception of the stock.
96) **Management Plan**: A recovery plan for Southern hake and Iberian *Nephrops* was agreed by the EU in 2006 (Council Regulation (EC) 2166/2005). The aim of the recovery plan is to rebuild the stocks within ten years, with a reduction in F of 10% relative to the previous year and the TAC set accordingly. The same regulation introduced a seasonal ban from May to August for the trawl and trap fishery for *Nephrops* in a box (geographic area) located in FU 28. ICES has not evaluated this recovery plan. This plan is based on precautionary reference points for southern hake that are no longer appropriate.
    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). In the current Management Plan for Western Waters, applied to 2020 onwards, no effort limitations were established

General comments

The report is well written, easy to follow and interpret

Technical comments

The stock data were updated with the new information from 2019. No new advice for these stocks has been given in 2020. The advice is planned for 2021.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? Yes

Is the assessment according to the stock annex description? Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? Not applicable

Have the data been used as specified in the stock annex? Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Only the annual assessment for category stock was performed this year as indicated in the stock annex.

Is there any **major** reason to deviate from the standard procedure for this stock? No

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Not applicable

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: ple.27.89a**

Date: xx/0x/2020
Auditor: Youen Vermard

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
  - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
  - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

97) **Assessment type:** Update/SALY
98) **Assessment**: analytical /trends / not presented
99) **Forecast**: Presented or not presented. Additional information, if any
100) **Assessment model**: model use, tuning indices, surveys
101) **Data issues:** are the data available as described in stock annex or have there been any issues with specific data / new data ?
102) **Consistency:** Last yr assess rejected – this accepted, the view of the RG was that last yrs assess should have been accepted
103) **Stock status**: Catches, F, SSB and Rec. *B<Blim for a while, Flim<F<Fpa, R uncertain, seem to be high recent years*
104) **Management Plan**: If any. E.g., Agreed 2006: SSB above 35 000 t within 10 years and to reduce fishing mortality to 0.27. The main elements in the plan are a 10% annual reduction in F and a 15% constrain on TAC change between years. Plan is **not** evaluated by ICES

General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret…. etc

Technical comments

(Include comments on points where the draft report contains errors, is unclear and if the assessment is done according to the stock annex)

Conclusions

The assessment has been performed correctly.

(If needed describe if relevant what extra things need to be done for a correct final assessment)

(Include suggestions for future benchmarks, and things to be done before ADG)

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: pol.27.89a**

Date: 26/05/2020
Auditor: Jean-Baptiste Lecomte

General

- The Bay of Biscay and Atlantic Iberian Waters pollack stock is considered as a data-limited stock and it is classified as category 5.2 stock (ICES, 2012).
- Exploration of data-limited methods with length-based methods and a first attempt for stock assessment using SPiCT were presented. Results show high uncertainties with both type of models due to lack of sufficient data.
- 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.
- No management plan is known for pol.27.89a.

For single stock summary sheet advice:

65) **Assessment type:** Update
66) **Assessment**: Not presented
67) **Forecast**: Not presented
68) **Assessment model:** First approach of using the SPiCT model, but with high uncertainty
69) **Data issues:** Lack of sufficient data. French data and discards for 2018 were updated from InterCactch.
70) **Consistency**: No assessment was presented for this species.
71) **Stock status:** The available scientific data for the stock are not sufficient to evaluate its abundance and exploitation status.
72) **Management Plan**: There is no management plan implemented for this stock.

General comments

The report is well written. Some comments have been made in order to improve the report which were included in the text and communicated to the stock coordinator.

Technical comments

Assessment and advice have been carried out following ICES procedures.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? Yes

Is the assessment according to the stock annex description? Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? Not concerned

Have the data been used as specified in the stock annex? Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Not concerned

Is there any **major** reason to deviate from the standard procedure for this stock? No

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: sol.27.8ab**

Date: ??/05/2020
Auditor: Maria Grazia Pennino and Lisa Readdy

General

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:

73) **Assessment type:** Update

74) **Assessment**: The assessment was carried out using FLXSA and has been included in the TAF environment. The assessment includes 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) and one scientific beam trawl survey ORHAGO. It is worth noting an important decrease of the FR-BB-IN-Q4 and ORHAGO indices in 2019 for the age 3.

    In this year's assessment the retrospective analyses showed that recruitment estimates from 2012 where not well estimated by the model although Mohn's rho was estimated to be 22%. As with previous years the group discussed the step change in recruitment and agreed that for the forecast a reduced time series is used for the GM recruitment. This is a deviation from the stock annex. The GM was selected based on incorporating a period where recruitment is well estimated but within the time period of lower recruitment to 2017 (as in the stock annex). The GM of recruitment was therefore calculated over 2004:2017.

75) **Forecast**: Forecast input parameters are provided in the table 7.10, management option outputs are also given. They are compatible with previous years' investigations since the interim benchmark 2013. With the exception of the GM recruitment used in the forecast, the forecast follows the stock annex.

    This year F was scaled to the final F (F status quo) rather than a catch constraint as catches since 2015 have been below the TAC and the intermediate year catch based on an F constraint gives catches below the 2020 TAC. Presented; the advice for this stock follows the ICES rules for category 1 stocks. Category 1 stock since the 2016 benchmark workshop.

76) **Assessment model:** XSA using the FL R library environment

77) **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. 2018 French data has been resubmitted by France and used for this assessment. Compared to last year's assessment, there is only very limited change in ORAGHO survey CPUE.

78) **Consistency**: Results are consistent and the assessment and forecast were accepted.

79) **Stock status:** The assessment indicates that after SSB decreased to below MSY $B_{trigger}$ in 2003, SSB increased above MSY $B_{trigger}$ and although variable remains above or at MSY $B_{trigger}$. An increase of SBB is predicted by the short-term prediction in 2020 and 2021.Fishing mortality has been estimated above FMSY over the time series with the exception of 2017 and historically in 1984-85. Recruitment although variable has been declining over the time series and is now estimated to be the lowest level of the time series in 2019.

80) **Management Plan**: There are two management plans and ICES advice is according to the EU multiannual plan (MAP):

- The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters applies to this stock. The plan specifies conditions for setting fishing opportunities depending on stock status and making use of the FMSY range for the stock.
- 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.

General comments

No significant criticism overall.

Technical comments

Given the GM recruitment deviation from the stock annex and if taken forward and accepted by ADG and ACOM then the stock annex should be updated to reflect this change, otherwise an IBP should be conducted to review the appropriateness of this deviation from the stock annex.

Conclusions

The assessment has been performed according to the stock annex with the exception of a change in the geometric mean recruitment for the forecast. The assessment and forecast is in agreement with previous years investigations.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: sol.27.8c9a**

Date: xx/0x/2020
Auditor: Mickael Drogou

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
  - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
  - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

105) **Assessment type:** Update/SALY
106) **Assessment**: analytical /trends / not presented
107) **Forecast**: Presented or not presented. Additional information, if any
108) **Assessment model**: model use, tuning indices, surveys
109) **Data issues:** are the data available as described in stock annex or have there been any issues with specific data / new data ?
110) **Consistency:** Last yr assess rejected – this accepted, the view of the RG was that last yrs assess should have been accepted
111) **Stock status**: Catches, F, SSB and Rec. *B<Blim for a while, Flim<F<Fpa, R uncertain, seem to be high recent years*
112) **Management Plan**: If any. E.g., Agreed 2006: SSB above 35 000 t within 10 years and to reduce fishing mortality to 0.27. The main elements in the plan are a 10% annual reduction in F and a 15% constrain on TAC change between years. Plan is **not** evaluated by ICES

General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret…. etc

Technical comments

(Include comments on points where the draft report contains errors, is unclear and if the assessment is done according to the stock annex)

Conclusions

The assessment has been performed correctly.

(If needed describe if relevant what extra things need to be done for a correct final assessment)

(Include suggestions for future benchmarks, and things to be done before ADG)

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Working Group: WGBIE **Stock Name: whg.27.89a**

Date: xx/0x/2020
Auditor: Paz Sampedro

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
  - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
  - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

113) **Assessment type:** Update/SALY
114) **Assessment**: analytical /trends / not presented
115) **Forecast**: Presented or not presented. Additional information, if any
116) **Assessment model**: model use, tuning indices, surveys
117) **Data issues:** are the data available as described in stock annex or have there been any issues with specific data / new data ?
118) **Consistency:** Last yr assess rejected – this accepted, the view of the RG was that last yrs assess should have been accepted
119) **Stock status**: Catches, F, SSB and Rec. *B<Blim for a while, Flim<F<Fpa, R uncertain, seem to be high recent years*
120) **Management Plan**: If any. E.g., Agreed 2006: SSB above 35 000 t within 10 years and to reduce fishing mortality to 0.27. The main elements in the plan are a 10% annual reduction in F and a 15% constrain on TAC change between years. Plan is **not** evaluated by ICES

General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret…. etc

Technical comments

(Include comments on points where the draft report contains errors, is unclear and if the assessment is done according to the stock annex)

Conclusions

The assessment has been performed correctly.

(If needed describe if relevant what extra things need to be done for a correct final assessment)

(Include suggestions for future benchmarks, and things to be done before ADG)

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Annex 5: Working Documents

Summaries of Working Documents

WD01: Population structure of white anglerfish (*Lophius piscatorius*) within the North Atlantic Ocean

I. Aguirre, N. Díaz-Arce, I. Mendibil, I. Pereda, I. Coscia, A. Urtizberea, A. Zanzi, J.Th. Martinsohn and N. Rodríguez-Ezpeleta

Population connectivity among white anglerfish (*Lophius piscatorius*) remains uncertain. Here, using thousands of genome-wide genetic markers, we have shown that the white anglerfish within the Atlantic is part of a single panmictic population. Yet, we have also revealed existence of mislabelling, i.e. black anglerfish identified as white anglerfish and hybridization between both species. Our results have important implications for the assessment of *Lophius piscatorius* stocks.

WD02: Stage-based assessment models for black and white anglerfish in areas 7b-k, 8abd

L. Batts, C. Minto, H. Gerritsen and D. Brophy

Stage-based assessment models offer an alternative middle ground between data-poor and data-rich models. Two well-known stage-based assessment models are applied to the black and white anglerfish stocks in areas 7,8abd. The white anglerfish stock is assessed analytically and therefore there is an established model against which the stage-based models could be compared to. The black anglerfish has no agreed analytical assessment. The two models are Catch-Survey Analysis (CSA) and a biomass based model developed by Schnute. The CSA results for white anglerfish showed very similar absolute estimates and trends for F and SSB, while the Schnute model had similar trends but different absolute values. For black anglerfish, the CSA model appeared to have a better fit but both models could be credible alternatives to the current basis for the advice.

WD03: Preliminary alternative stock assessment model with Stock Synthesis for white anglerfish in divisions 7, 8 abd

A. Urtizberea, D. García, A. Iriondo and M. Santurtún

A4a is the model used in the assessment of white anglerfish in the Division 7,8abd. The model is based on age, but due to some aging problems there is not age data, and therefore, the data are transformed from length to age outside the model with a growth pattern estimated from a cohort analysis from survey and commercial data. The assessment model has also some retrospective pattern that should be analyzed, even though the Mohn's rho are within the accepted ranges. Therefore, in order to solve those issues, in this study we use stock synthesis to develop first a base case with similar assumptions and results to the assessment of 2019 and considering the results of a sensitivity analysis, after a reference case was developed with a better retrospective pattern of SSB and F.

WD04: French Nourdem project: Seabass survey in estuarian waters

M. Drougou

The Nourdem project aims to complement the individual Solent, both in the northern zone and in the Bay of Biscay, and firstly proposes to define the campaigns to be carried out in the nurseries of 3 major French estuaries of the Seine, the Loire and of the Gironde. This definition must be based on all the knowledge acquired during the preparatory phase that constituted the Bargip project / *Nourriceries2* action: the sampling protocol is now finalized, and all the equipment and methods acquired / developed (2 identical GOV trawls of 12 m of back rope, navigation and mapping system for practicable trains, measurement / weighing systems / tools, multi-parameter probes, databases and tools for producing abundance indicators) can be used.

The project report published in 2019 detailed the sampling surveys carried out using the GOV "Bargip" trawl between 03 and 10 July 2018 in the Loire estuary and between 01 and 08 August in the Seine estuary in order to produce 2018 abundance indices for bass juveniles and other fish species which is used in the assessment of the seabass stocks.

WD05: Southern hake retrospective analysis

S. Cerviño and H. Mendes

The WD describes the work performed regarding the southern hake retrospective pattern in order to understand why is happening and how can be correct it. The approach consisted on exploring and testing alternative model configurations and their impact on hake retrospective pattern, quantified as a Mohn's rho index, which is complemented with convergence, likelihoods or residual analysis. A total of 54 runs were performed and analyzed. Some of them reduced the retrospective patter helping to understand their plausible causes and reject hypothesis about other causes. There are conflicting signals inside and among abundance trends, i.e. not all of them show the same trends. Adding catches in recent years help to reduce these conflicting signals and also the retro. However, although the simulations include overcatch in recent years, alternative setting such as an increase in M or also migrations out of the stock could probably achieve similar results. The simulations performed did not allow setting an alternative model with an acceptable retrospective pattern. Some runs open the expectation to do it but further work is required before that works.

WD06: Preliminary results of a4a assessment model for megrim (*L. whiffiagonis*) in ICES Divisions 7b-k and 8a,b,d

A. Iriondo, A. Urtizberea, S. Sanchez, D. García and M. Santurtún

Megrim (*L. whiffiagonis*) is assessed in ICES WGBIE with a Bayesian catch-at-age model considered as a full analytical assessment since 2016. The model is very complex and time consuming so a change to a more standardized model is proposed to ease the implementation and shorten the iteration times, so a4a model is implemented. The a4a model is feasible and input data for the assessment were formatted as FLR objects of catch, biological data and tuning indices. Results show very similar in trends and absolute values, therefore a change to this more standardized model a4a is proposed for the northern megrim to ease the implementation and shorten the iteration times from the previous Bayesian model.

WD07: *Nephrops* Sentinel Fishery in Functional Unit 25 (North Galicia) 2017-2019

I. González Herraiz, F. J. Gómez Suárez, C. Fariña, J. Rodríguez and I. Salinas

After the establishment of the TAC zero for *Nephrops* in division 8c, a *Nephrops* Sentinel Fishery was authorized in FU 25 in 2017, 2018 and 2019. Sentinel is carried out by two commercial vessels with observer on board each year in August and September. In these three years, a total of 231 hauls were made. The global *Nephrops* CPUE average in this period was 5.3 Kg/hour. If we take into account only the hauls directed to *Nephrops* (142), CPUE in each year were 7.2, 5.1 and 16.2 Kg/hour. In 2019 *Nephrops* mean sizes were 40.3 mm CL for males and 38.7 for females. The percentage of *Nephrops* in the catch in the directed hauls oscillated between 12 and 32% in these three years. The concentration of the Sentinel in a small part of the stock area raises doubts about the representativeness of its results.

WD08: *Nephrops* Sentinel Fishery in Functional Unit 31 (Cantabrian Sea) 2019

I. González Herraiz, F. J. Gómez Suárez, C. Fariña, J. Rodríguez and I. Salinas

After the establishment of the TAC zero for *Nephrops* in division 8c, a *Nephrops* Sentinel Fishery was authorized in FU 31 in 2019. Sentinel was carried out by two commercial vessels with observer on board in July. 28 hauls were planned proportionally along the seven *Nephrops* patches of the functional unit. 16 hauls were carried out, obtaining a CPUE average of 7.1 Kg/hour. *Nephrops* mean sizes were 45.4 mm CL for males and 41.4 for females. The percentage of males was 50%. The number of fishing days with *Nephrops* catches ≥ to the 10% of the total catch in FU 31 has decreased 95% between 2005 and 2014.

WD09: *Nephrops* abundance index estimation from GALNEP19 Survey in FU26 (West Galicia, ICES Division 9a)

Y. Vila, I. Salinas and F. J. Gómez

Marin Fishing Industry (OPROMAR, Productores de Pesca Fresca del Puerto y la Ría de Marín) promoted a survey onboard a commercial vessel in order to estimate a *Nephrops* abundance index in FU26 with an observer onboard and the supervision of IEO. GALNEP_19 survey was conducted from 24th July to 29th August 2019, following a systematic sampling over a 5x5 nm grid. Area survey was established on the base on the VMS analysis together the bottom trawl logbooks in the 2009-2017 period. Additionally, sediment composition was taken account and gravel and rocky bottoms were eliminated in the area delimited by VMS. Survey was carried by an unique commercial vessel (27.9 m Length, 109.17 GRT, 430 HP & 70 mm mesh size). The main objectives of GALNEP_19 survey were to estimate: the *Nephrops* abundance index, the discard rate and the size composition for both sexes in this FU. *Nephrops* total catches were 58 kg, representing only 1.04% of the total retained catch. Discard rate was zero. Survey index was 0.74 Kg/h (0.06 Kg/Kw day) with 95% confident of 0.58. Hauls positive in *Nephrops* were only 7 of a total of 39 hauls carried out during the survey, representing 18%. Spatial analysis of the survey index shows *Nephrops* is concentrated in a small area on the Northwest half within the original distribution area in FU26. The mean length was 39.9 mm CL in females and 43.9 mm CL in males. Sex-ratio was estimated in almost 50%.

WD10: ISUNEPCA2019 UWTV Survey on the Gulf of Cadiz *Nephrops* Grounds (FU30 and some stations in FU29) and catch options for 2020 in FU30

Y. Vila, C. Burgos and C. Farias

This WD details the results of the sixth underwater television survey on the Gulf of Cadiz *Nephrops* grounds (FU 30). The survey is considered multi-disciplinary in nature, collecting UWTV, CTD, beam trawl and dredges information. A total 69 UWTV stations were planned in a randomized 4 nm isometric grid but only 65 UWTV stations were used in the geo-statistical. The mean burrow density observed in 2019, adjusted for cumulative correction factor, was 0.04 burrows/m^2. The final krigged abundance estimate was 113 million burrows with a CV of 9.7%. The 2019 abundance estimate was 65% lower than in 2018. Additionally, 6 UWTV stations were conducted in FU29 (South Portugal) close to the Spanish border with FU30 in order to explore if both FUs could correspond to the same population. Mean burrow density was 0.05 burrows/m2, which is comparable to mean burrow density in Spanish stations close to the border. Other information related to the ecosystem is also presented.

WD11: Update of pollack abundance indices from professional fishing data (2016-2018)

N. Caill-Milly and M. Lissardy and N. Bru

The ROMELIGO project included a proposal of abundance indicators for pol-89a stock using professional fishing data. The methodology is based on the selection of a sample of representative vessels grouped in a cluster with the same technical characteristics, taking into account their LPUE for specified period and area. The analysis was conducted on an historical dataset from 2005 to 2015. To be able to update it, a conditional decision tree was used to find rules to assign any new vessels to one of the predefined GNS clusters. Then, the trends of LPUE on the overall period were considered: for the past three years, the LPUEs display low levels compared to the whole series while the highest levels were observed between 2011 and 2015. No management measure likely to affect the indicators was identified by professionals. At this time no new element leads to discuss the relevance of this GNS indicator but attention should be paid to its use alone (linked to the possible various uses of the gear).

WD12: Exploration of length-based data-limited assessments for pollack in Bay of Biscay and Atlantic Iberian Waters

P. Sampedro

Pollack in ICES subarea 8 and division 9a is considered a Data-Limited Stock and classified by ICES in category 5.2. The insufficient data for this stock prevented to perform an analytical assessment with a traditional model. Three length-based approaches were tested for assessing the status of pollack stock: Length-Based Indicators, Length Based Spawning Potential Ratio, and Length-based Integrated Mixed Effects. The three model results indicated that pollack stock was slightly overexploited in 2019 ($F > F_{target}$) and the SPR is below the SPR target. There is a high uncertainty in the estimation of stock status using these models and, due to their sensitivity to input parameters, more sensitivity analysis should be conducted.

WD13: A first approach to stock assessment of pollack in ICES Divisions 8 and 9a using SPiCT

P. Sampedro

A SPiCT model has been fitted for Pollack stock in ICES area 8 and division 9a (pol.27.8.9a). Different scenarios were tested based on abundance indices series selected, time period considered, and the model's options of fixing model parameters and the definition of priors. The implementation showed that the best model was for scenario using the landing series 1986-2018 and the abundance index FR-GNS>902s 2005-2019. Although the uncertainty around the parameters and reference points is high, the estimates of K, r, F and B are realistic indicating that SPiCT could be a good option for assessing this stock.

WD14: Improving abundance index for Sol8c9a stock assessment model calibration.

M.G. Pennino

The common sole (*Solea solea*) is a species with a biological bathymetric range between 0 and 200 meters in the Iberian Atlantic waters (ICES divisions 8c9a). The annual scientific trawl survey that collects data for demersal species in this area only covers partially this bathymetric range and the resultant abundance indexes are consequently underestimated. In addition, habitat variables, (i.e., bathymetry), can influence these estimates as well as the species spatio-temporal variability. Alternatively, standardized CPUEs (catch per unit effort) derived from fishery-dependent data can be used as a proxy of the species abundance. In this study two different spatio-temporal abundances indices were computed and the impacts on the common sole evaluation using the stock assessment model SPiCT (Stochastic surplus Production model in Continuous Time) were analyzed. Both abundance indices were produced using Bayesian hierarchical spatio-temporal models, considering bathymetry as an environmental variable and testing three different spatio-temporal structures (i.e. opportunistic, progressive and persistent) to categorize the spatio-temporal behaviour of the sole. Results are preliminary and need to be improved but they are a first approximation for this species/stock assessment.

WD15: Update of whiting abundance indices from professional fishing data (2016-2018)

N. Caill-Milly, M. Lissardy and N. Bru

The ROMELIGO project included a proposal of abundance indicators for whg-89a stock using professional fishing data. The methodology is based on the selection of a sample of representative vessels grouped in a cluster with the same technical characteristics, taking into account their LPUE for specified period and area. The analysis was conducted on an historical dataset from 2010 to 2015. To be able to update it, a conditional decision tree was used to find rules to assign any new vessels to one of the predefined OTB clusters. Then, the trends of LPUE on the overall period were considered. In recent years, the north shows low levels, but the decrease is not significant over the whole period (Pearson test). For the south, no trend emerges. Professionals identified two management measures likely to affect the indicators. After analysis, they did not impact the trends of the series. Due to the characteristics of the southern indicator, the possibility of retaining only the northern one in future years is raised.

WD16: What is the effect of including the North Sea International Bottom Trawl Survey data on the assessment of the Northern European hake stock?

J. Horrill, L. Clarke and D. Garcia

The current assessment model for the Northern European hake stock is developed to include data from the two North Sea International Bottom Trawl Surveys (NS-IBTS). The inclusion of these surveys results in a substantial increase in estimates of spawning stock biomass (SSB), which implies that the current assessment method, which does not include surveys covering the full range of the stock, could be under-estimating the current status of the stock. We therefore recommend that WGBIE considers the inclusion of these surveys, and also other IBTS surveys carried out in 27.6.a in the stock assessment model at the next benchmark.

WD17: Maturity-at-age estimates for Irish Demersal Stocks in 6.a and 7.b-k between 2004-2019

S.-J. Moore and H. Gerritsen

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.

WD18: Information on Soleidae species landings from mainland Portugal

D. Dinis, C. Maia, I. Figueiredo and A. Moreno

The WD summarizes the information on Portuguese Soleidae species landings for the period 2017-2019. The document presents the landing statistics for different landing ports and the evaluation of species misidentification based on DCF/PNAB biological sampling.

Preliminary alternative stock assessment model with stock synthesis for white anglerfish in Divisions 7, 8 abd

Authors: Agurtzane Urtizberea, Dorleta García, Ane Iriondo, Marina Santurtún

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INTRODUCTION

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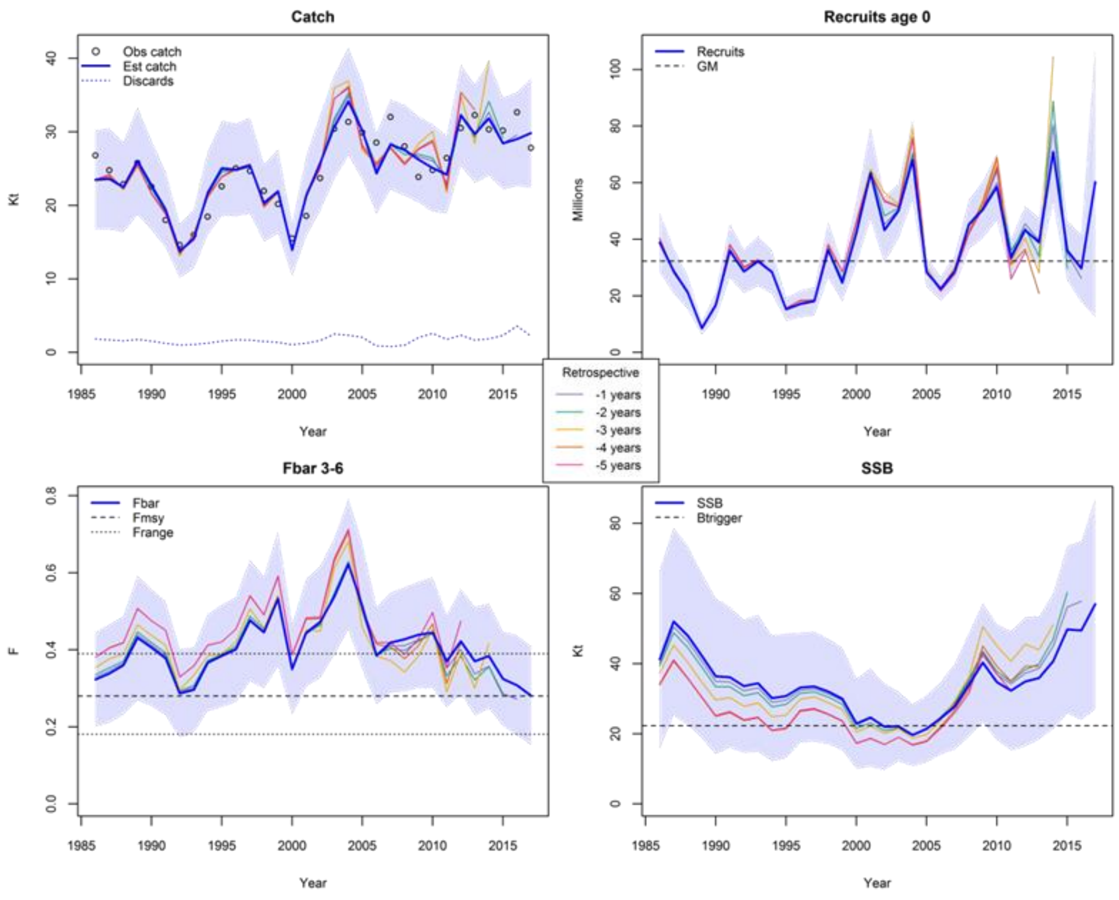
- In 2007 not assessment due to the deficiencies in data:
  - Not discards data available
  - Aging problems
- In 2018, WKANGLER, a4a was aproved as stock assessment model, with a previous conversión from length to growth:
  - Discards data available from 2003
  - Growth estimates following cohorts from survey and comercial length frequency data (Batts and Gerritsen 2019).

Main issues

- The main issues of the model are that:
  - The conversión from length to age is done outside of the a4a model.
  - The retrospective pattern at the beginning and at the end of the time series to be improved, even though the values are within the recommended values:

Rec	-0.106
SSB	0.136
F	0.0106



From a4a to ss3

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- Data
  - Catch data are used as retained (agregated landings and discards as in a4a), with seasonal resolution. Historical data from 7ª Division are taken from oficial data and they are anual. Thus, 7ª data by season are estimated considering the proportion of total catch by season.
  - Survey data: FR-IE-IBTS, FR-EVHOE (1997-2003),SP-Porc, Irish monkfish survey
  - Commercial fleet and survey’s length Frequency distribution with seasonal resolution.

From a4a to ss3

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Building a reference case in ss3

1. Develop in ss3 a model the most similar posible to the assessment model (AsMod), called base case (BC) the model.

2. Sensitivity analysis with the base case.

3. Develop a reference case (RC).

4. Compare the results with the a4a model.

5. Analyse the retrospective pattern of the (RC)

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1-Base case settings

- From 1986 to 2018.
- Seasonal.
- Age from 0 to 30
- One comercial fleet
- Indices: IR-FR-IBTS joint index, SP-Porc index, Irish monkfish survey

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1- Base case settings

- Growth:

  Linear until age 1 and afterwards Von Bertalanffy growth with the same parameterization as in the AsMod: Linf=171, K=0.1075.

- Recruitment:

  In season 4, month December (sigmar=0.6).

- Selectivities:

  Double normal to the comercial fleet, IR-FR-IBTS joint index and SP-Porc. Logistic to the monkfish survey.

Sensitivity analysis

- Recruitment, Base case: 1 recruitment season: season 4
  - 4 recruitment seasons:1, 2, 3 and 4
  - 3 recruitment seasons:1,2 and 4
  - 2 recruitment seasons: 1 and 4
  - 1 recrutiment season: in season 4, assuming different months 10, 11 or 12.
- Growth: Base case, *K* the same as in the a4a model for all ages.
  - 4 different K-s until age 4 assumed fixed with the same value as in AsMod and after estimated by the model at age 4, age 5 and age 6 and older.
  - Let estimate to the model Lmax.

*In red the choices for the Rerference case (RC)

Sensitivity analysis

- Growth: Base case, *K* the same as in the a4a model for all ages.
- 4 different *K*-s until age 4 assumed fixed with the same value as in AsMod and after estimated by the model at age 4, age 5 and age 6 and older.
- Let estimate to the model Lmax.

*In red the choices for the Rerference case (RC)

Sensitivity analysis

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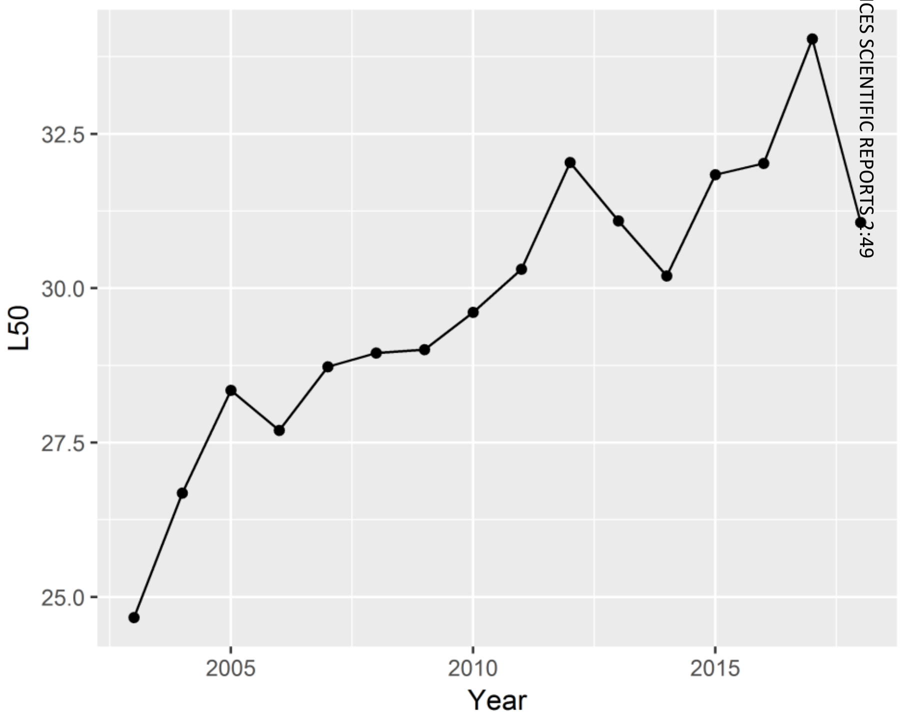
- Selectivity: Base case, 1 time block 2002-2018.

\- 2 time blocks: 2002-2010,2011-2018 due to the trend on L50 value of discarded fish.

- Surveys: Base case, Downweighting to 0 FR-EVHOE survey (from 1997-2003)

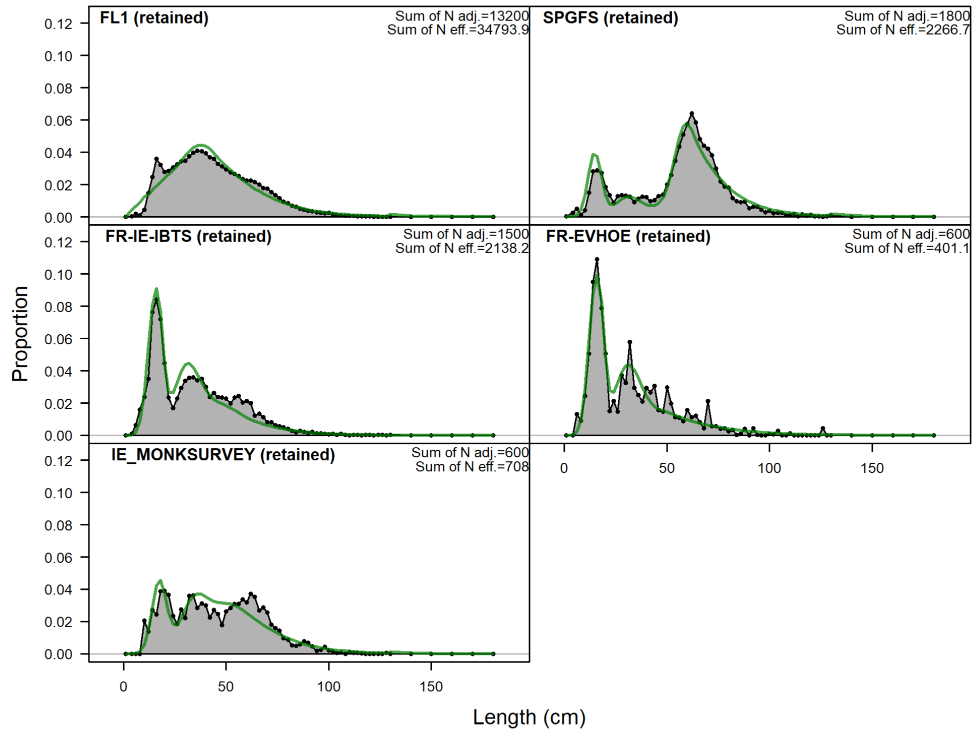
\- 4 indices: include FR-EVHOE survey data from 1997 to 2003 with a mirror in the selectivity of the joint index.



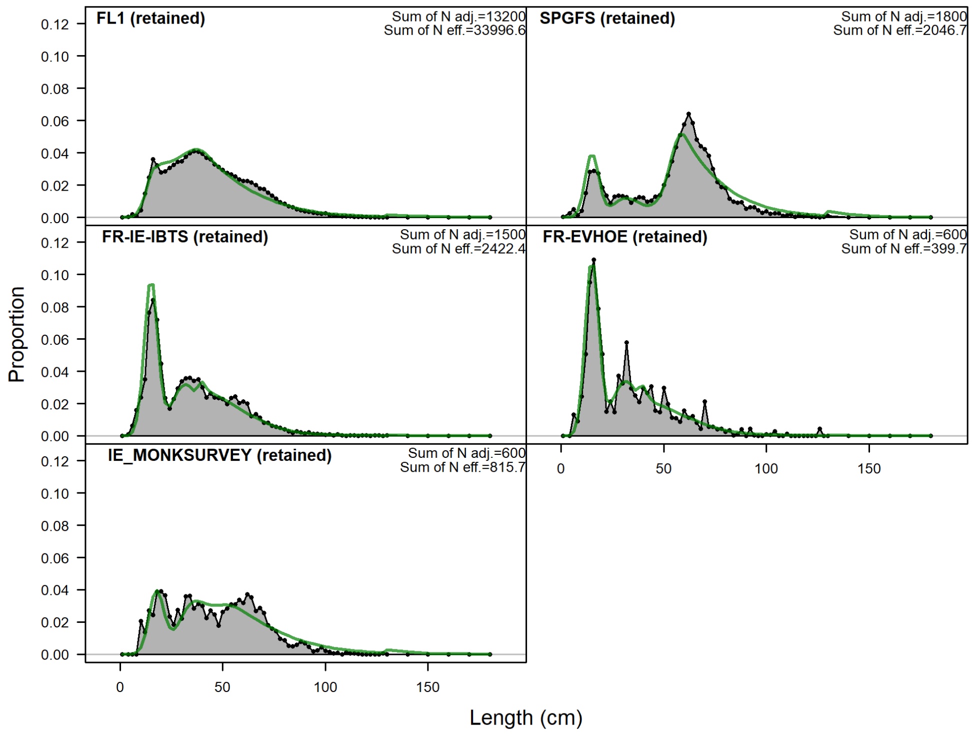
*In red the choices for the Rerference case (RC)

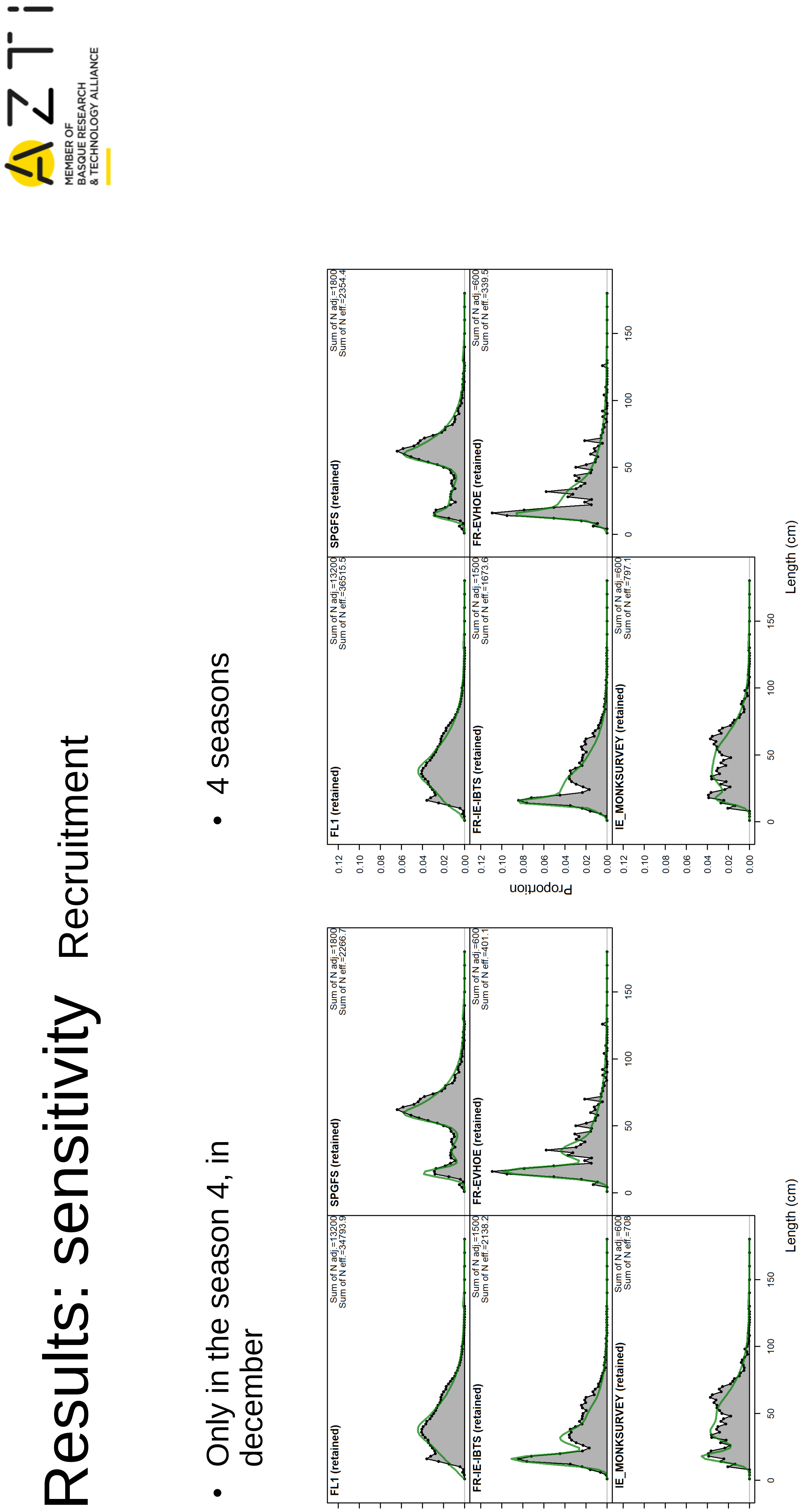
Results: sensitivity selectivity- time blocks

- Base case:one time block compare to two time blocks



- Base case: with two time blocks





Results: sensitivity Recruitment
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• Only in the season 4, in december
• 4 seasons
FL1 (retained)
SPGFS (retained)
FR-IE-IBTS (retained)
FR-EVHOE (retained)
IE_MONKSURVEY (retained)
Sum of N adj.=13200
Sum of N eff.=34793.9
Sum of N adj.=1800
Sum of N eff.=2266.7
Sum of N adj.=1500
Sum of N eff.=2138.2
Sum of N adj.=600
Sum of N eff.=401.1
Sum of N adj.=600
Sum of N eff.=708
Sum of N adj.=13200
Sum of N eff.=36515.5
Sum of N adj.=1800
Sum of N eff.=2354.4
Sum of N adj.=1500
Sum of N eff.=1673.6
Sum of N adj.=600
Sum of N eff.=339.5
Sum of N adj.=600
Sum of N eff.=797.1
Proportion
Length (cm)

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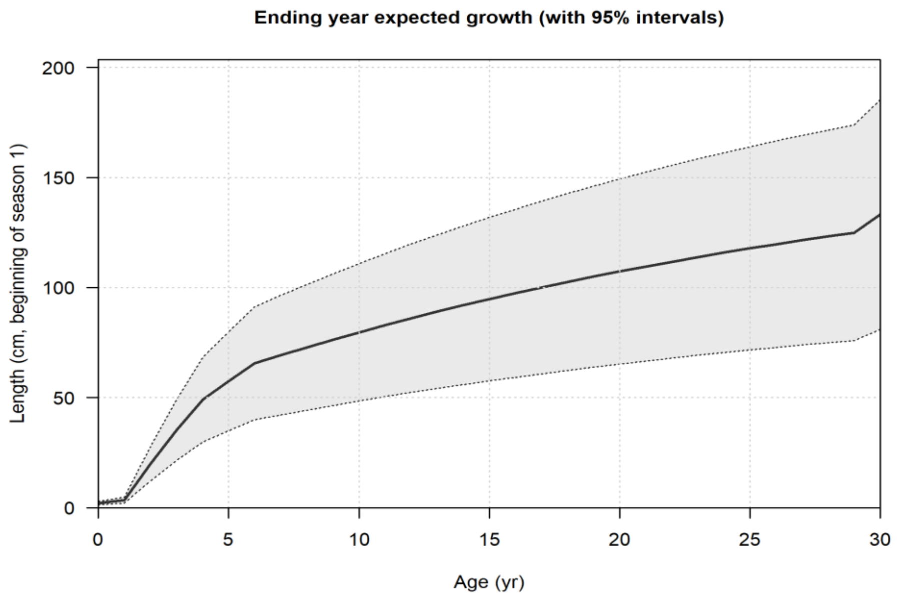
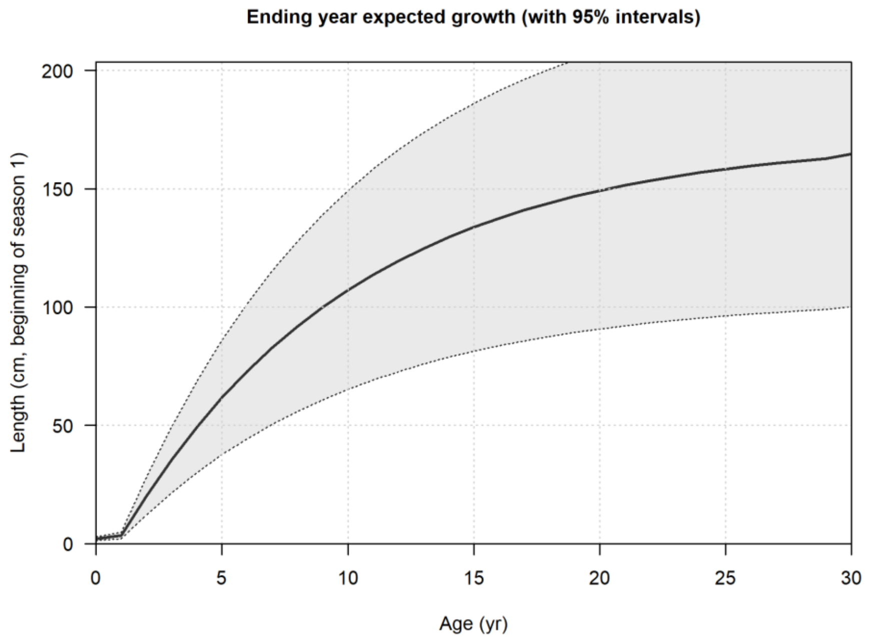
Results: Reference case Growth

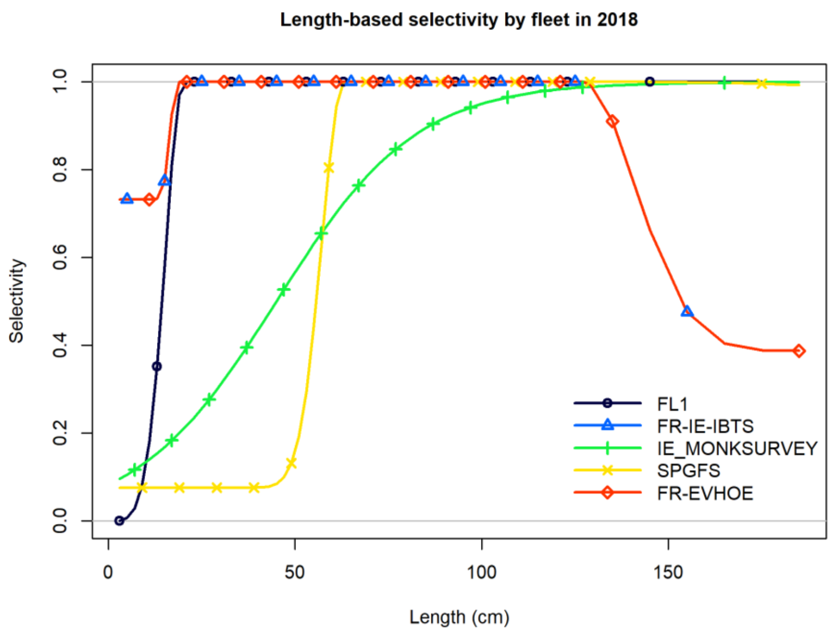
RC:4k and recmonth=12

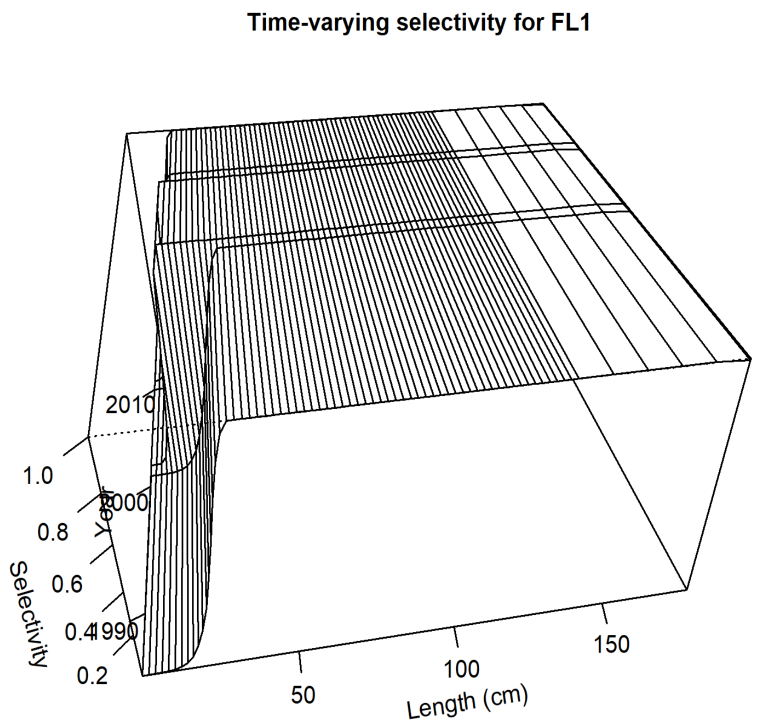


BC: 1k and recmonth=12



Results: Reference case - Selectivity





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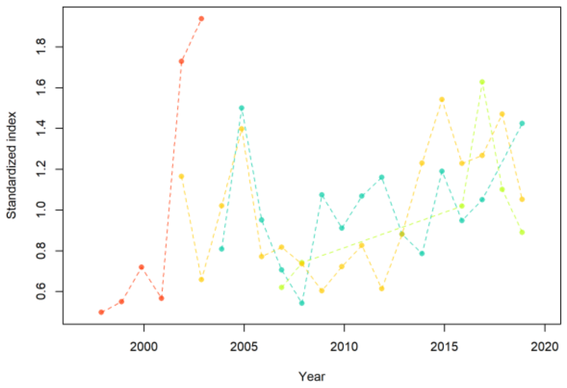
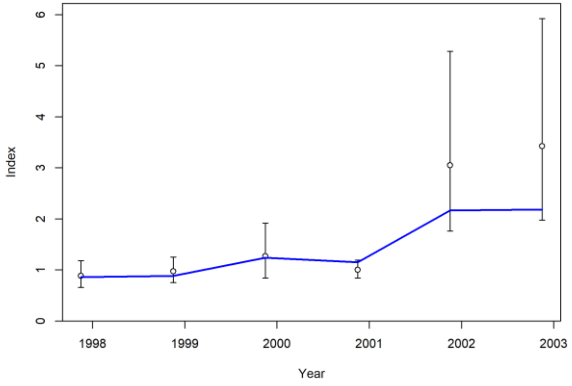
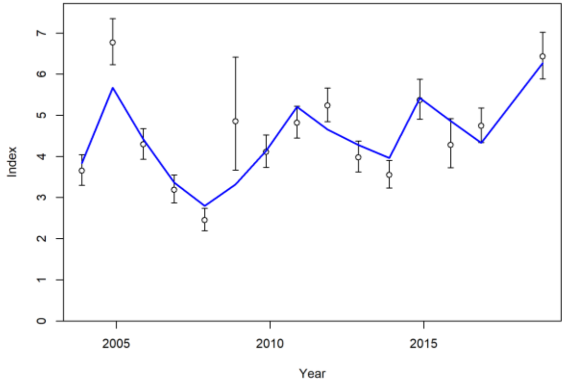
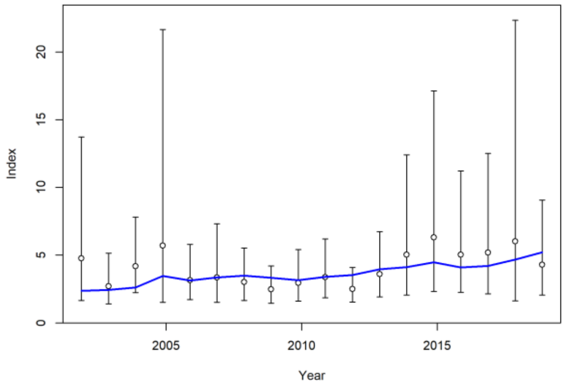
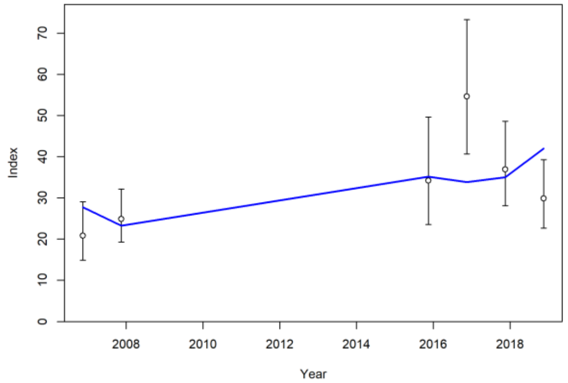
Results: Reference case - Indices











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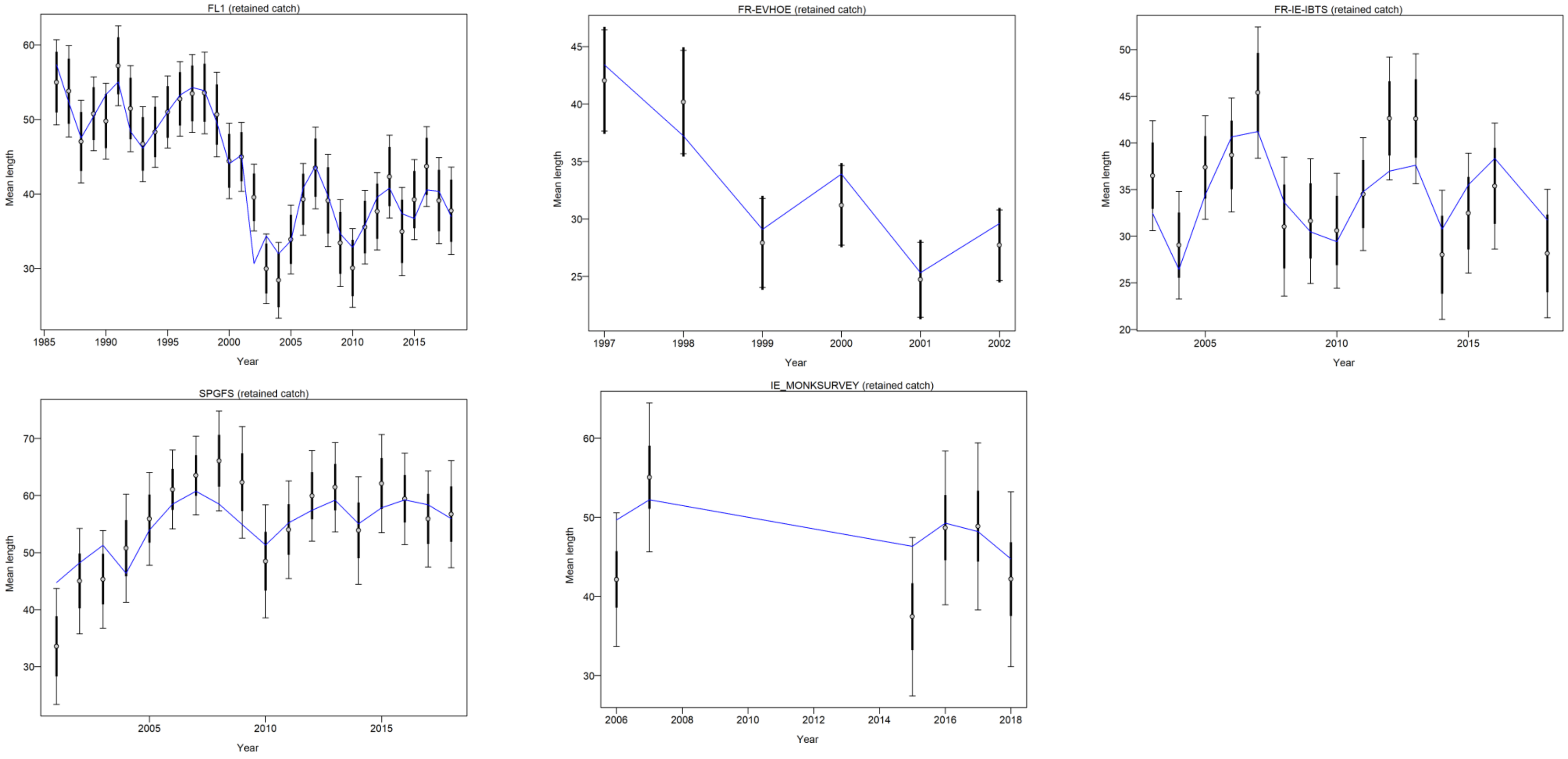
Results: Reference case - Mean size



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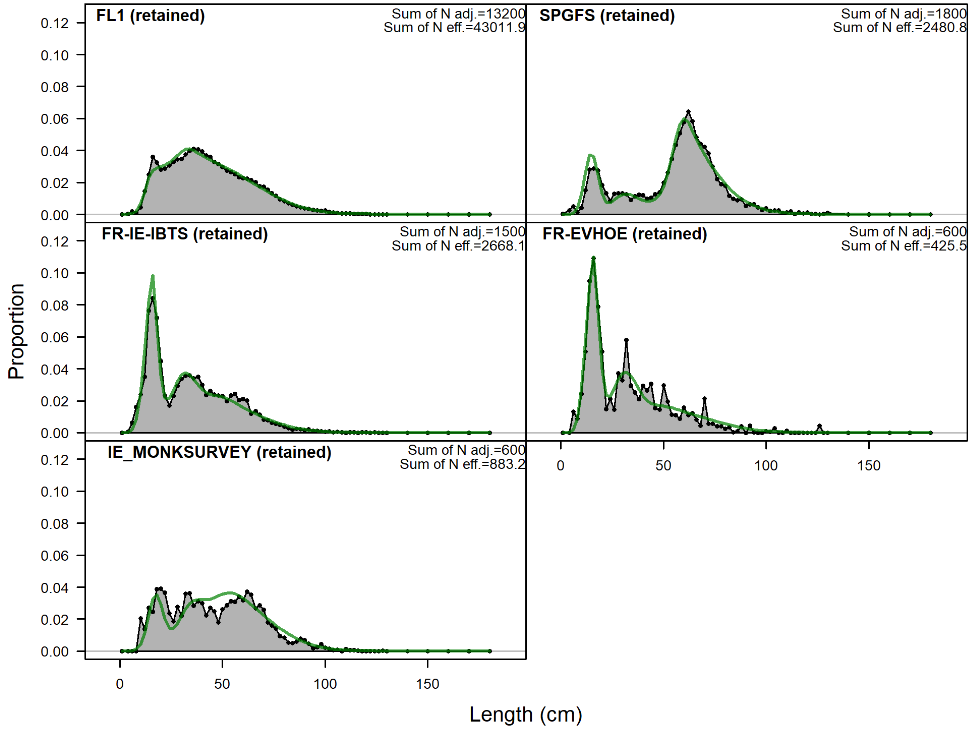
Results: Reference case - Agregated LF



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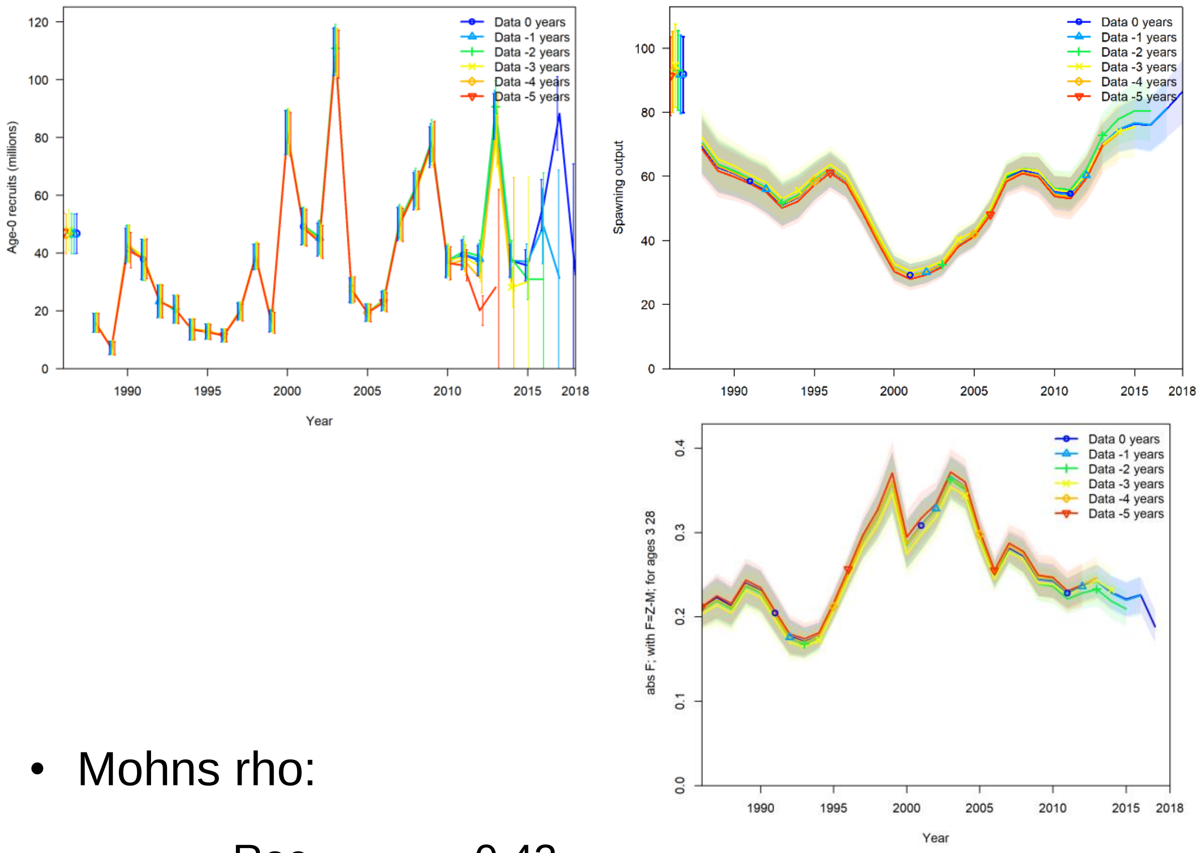
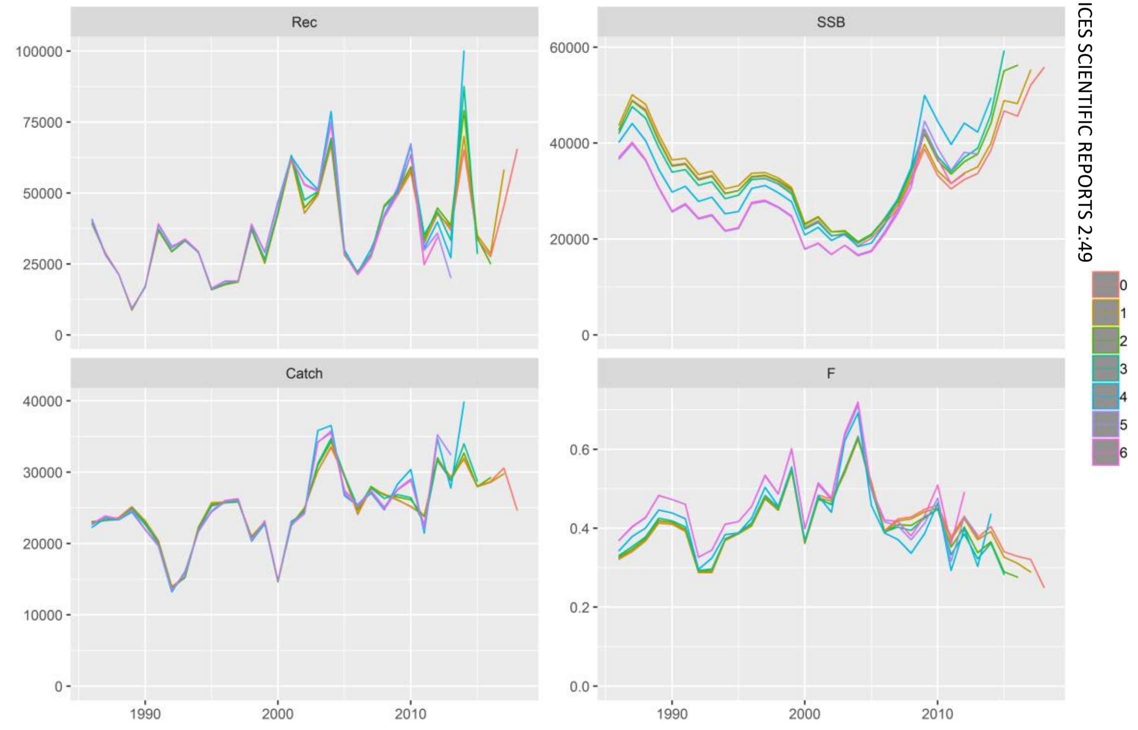
Retrospective pattern RC and AsMod



- Mohns rho:

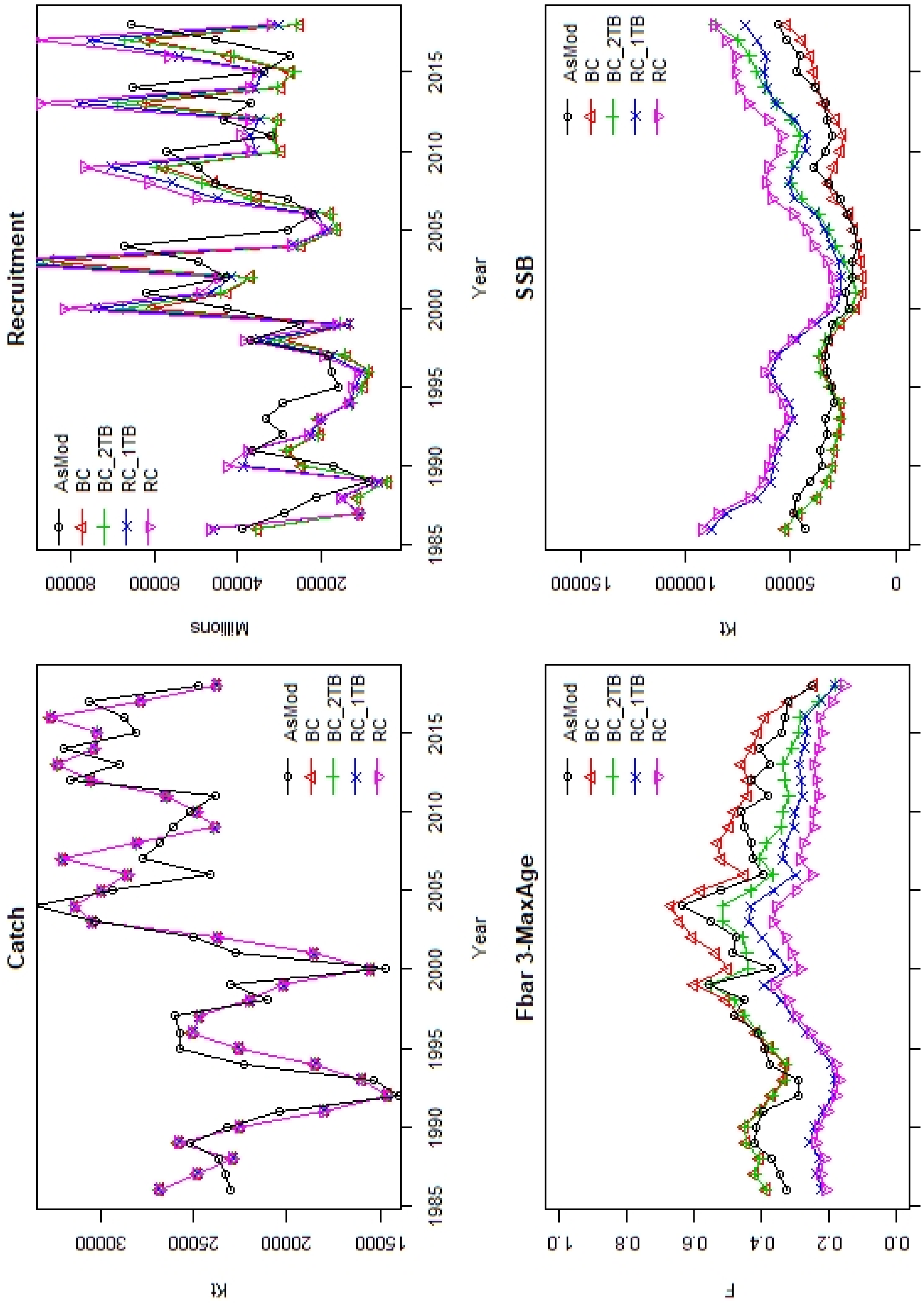
Rec	0.42
SSB	0.0053
F	0.0057



- Mohns rho:

Rec	-0.106
SSB	0.136
F	0.0106

Comparison


Catch
Recruitment
Fbar 3-MaxAge
SSB
AsMod
BC
BC_2TB
RC_1TB
RC
Year
Kt
Millions
F

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Discussion

- Reference Case:
  - The best fit comes from assuming recruitment in season 4, however, studies on GSI also suggest recruitment happens in season 2.
  - 2 time blocks improves the fit of the agregated length frequency across time of the comercial fleet and of the IR-FR-IBTS joint index.
  - Different growth rates could be due to differencies in growth between sex and differences and as consequence also in selectivity.
  - Mohn’s rho is improved but not the one of recruitment, this could be explained due to the lack of stock recruitment relationship and the big variability between years.

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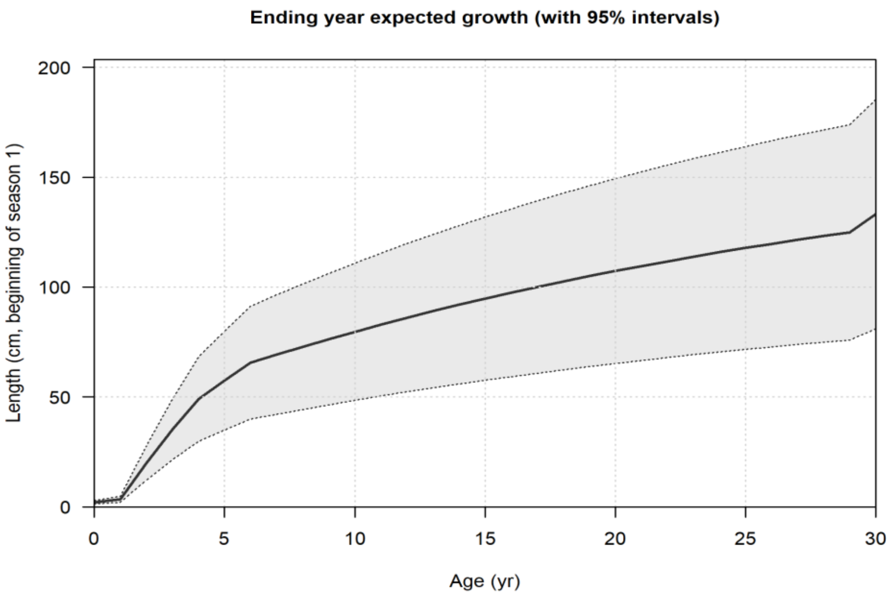
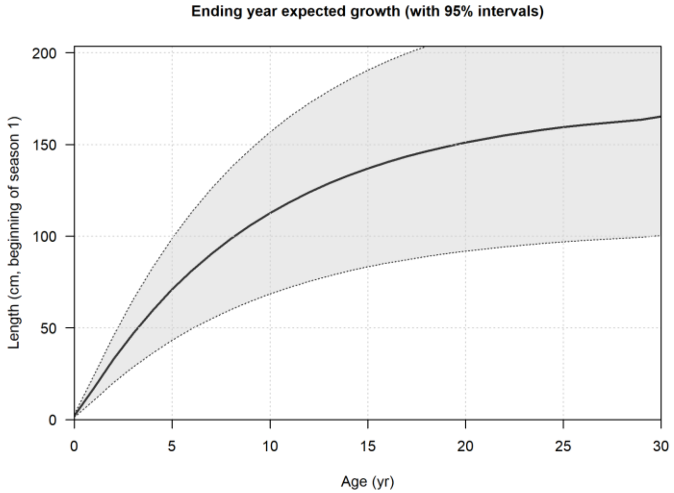
Results: Reference case (growth)

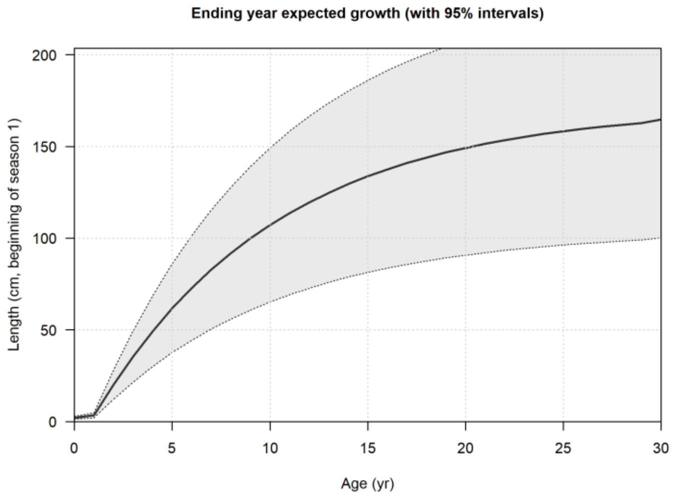
RC:3k and recmonth=12



BC: 1k and recmonth=12



1k and recmonth=1



WD for ICES WGBIE 2020

Stage-based assessment models for black and white anglerfish in areas 7b-k, 8abd

Luke Batts, Cóilín Minto, Hans Gerritsen and Deirdre Brophy

May 5, 2020

1 Introduction

Stage-based assessment models offer an alternative middle ground between aggregate and compositional models (Hilborn and Walters, 1992; Li *et al.*, 2019). Two well known but theoretically different approaches to stage-based assessment models are: biomass-based delay-difference models, first described by Deriso (1980) and developed by Schnute (1985, 1987); Fournier and Doonan (1987); and numbers-based depletion models, the most well-known of which is the Catch-Survey Analysis (CSA) (Collie and Sissenwine, 1983; Smith and Addison, 2003). Here we compare parameter estimation of these distinct approaches.

Schnute (1987) describes a size-based delay-difference model linking population size structure and mean weights. In the most simple form this consists of two stages of biomass (recruits and previously exploited biomass) and assumed deterministic growth of all individuals in the exploited stock. The model also offers flexibility for alternative processes to estimating total biomass from different assumptions regarding the relative importance of recruitment and previously exploited biomass.

CSA is a relatively simple two-stage model (numbers of recruits and post-recruits), which has changed somewhat from the original model first described in Collie and Sissenwine (1983). The most recent version can be found in the NOAA Fisheries Integrated Toolbox (FIT), where population dynamics centre on Baranov's catch equation and estimation is through maximum likelihood.

We implemented both Schnute (1987) and CSA within the "TMB" framework in R, taking advantage of automatic differentiation of the likelihood for optimisation. The assessments' capabilities in accurately modelling both *Lophius piscatorius* and *Lophius budegassa* stocks in the Celtic Sea and Northern Bay of Biscay were investigated.

2 Methods

2.1 Data

Data for the white-bellied anglerfish stock in ICES areas 7.b-k, 8.a-b and 8.d was collated from the 2019 ICES stock assessment. This consisted of catch data and three survey indices that cover the anglerfish stock; a combined index of the French EVHOE survey (Q4) and Irish Groundfish survey (IGFS, Q4) spanning 2003-2018, Spanish Porcupine Groundfish survey (SP-PORC, Q3/Q4) spanning 2001-2018, Irish Anglerfish and Megrim Survey (IAMS, Q1) in years 2007-2008 and 2016-2018 .

Data for the black-bellied anglerfish stock in ICES areas 7.b-k, 8.a-b and 8.d was collated from the 2020 ICES stock assessment. This consisted of catch data and two survey indices that cover the anglerfish stock; a combined index of the French EVHOE survey (Q4) and Irish Groundfish survey (IGFS, Q4) spanning 2003-2019 and the Irish Anglerfish and Megrim Survey (IAMS, Q1) in years 2007-2008 and 2016-2019 .

2.2 key assumptions and things of note

- Both models assume all stages are fully selected, although this can be relaxed in CSA within the input if external data on selectivity is available (but was not done so here).
- For both species of anglerfish the number of ages to which each survey indices is trimmed to is quite specific for the a4a assessments, i.e. ages 0-2 for IBTS combined survey, 1-5 for IAMS and 2-6 for SP-PORC. Schnute and CSA do not allow for this subtlety, although CSA does allow indices to be classified as "recruit", "post-recruit" or "whole" population indices. Schnute inputs are only entire biomass indices.
- For both assessments and species the natural mortality was not estimated and was fixed at 0.25, as is the case for the age-based assessments. There is ongoing work on whether these assessments can estimate natural mortality under certain conditions.
- Recruits and previously exploited biomass/post-recruits were crudely split by length; white-bellied anglerfish recruits were $\leq$ 25cm, black-bellied recruits were $\leq$ 15cm (Figure 1).

2.2.1 Schnute

- By using of a time series of mean weights within the model Schnute (1987) provides a model framework where the entire biomass of the population can be calculated either solely from the recruitment biomass, solely from the previously-exploited population biomass or both. All runs presented here were with Schnute version 2, where biomass in a given year is computed from the previously exploited biomass. This version has the advantage that no estimation of stock-recruitment parameters is necessary.
- Recruitment biomass at each time step is calculated through a relationship between mean weights and biomass of each stage.

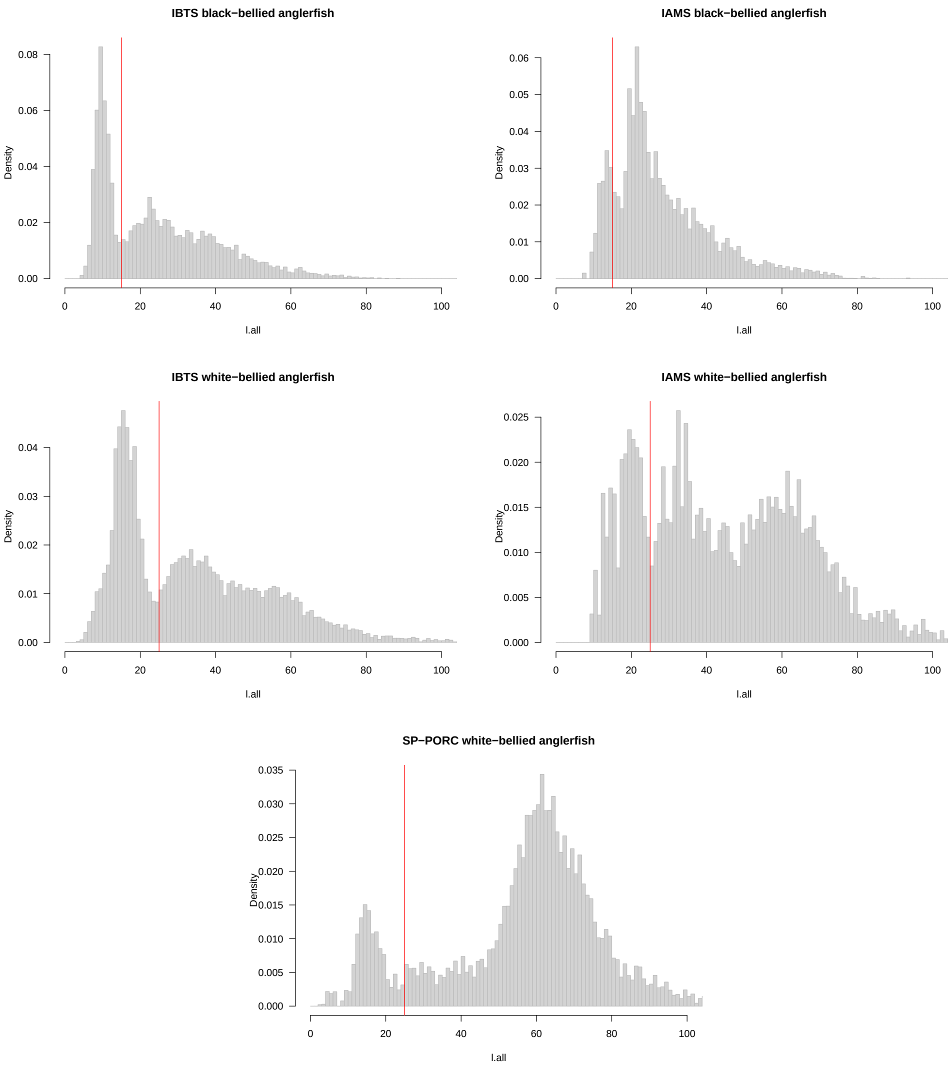


Figure 1: Length distributions of survey data aggregated over years. Red line indicates where cut off length was decided upon for each species

2.2.2 CSA

- In order to mimic the conditions of the a4a assessments as much as possible IAMS and SP-PORC (for white-bellied) were only input as post-recruit indices. CSA requires at least one survey to be split into recruits and post-recruits, IBTS combined survey provided these two indices.
- Recruitment numbers at each time step are latent states/parameters estimated within the model.

3 Results

3.1 white-bellied anglerfish

3.1.1 Schnute model fit

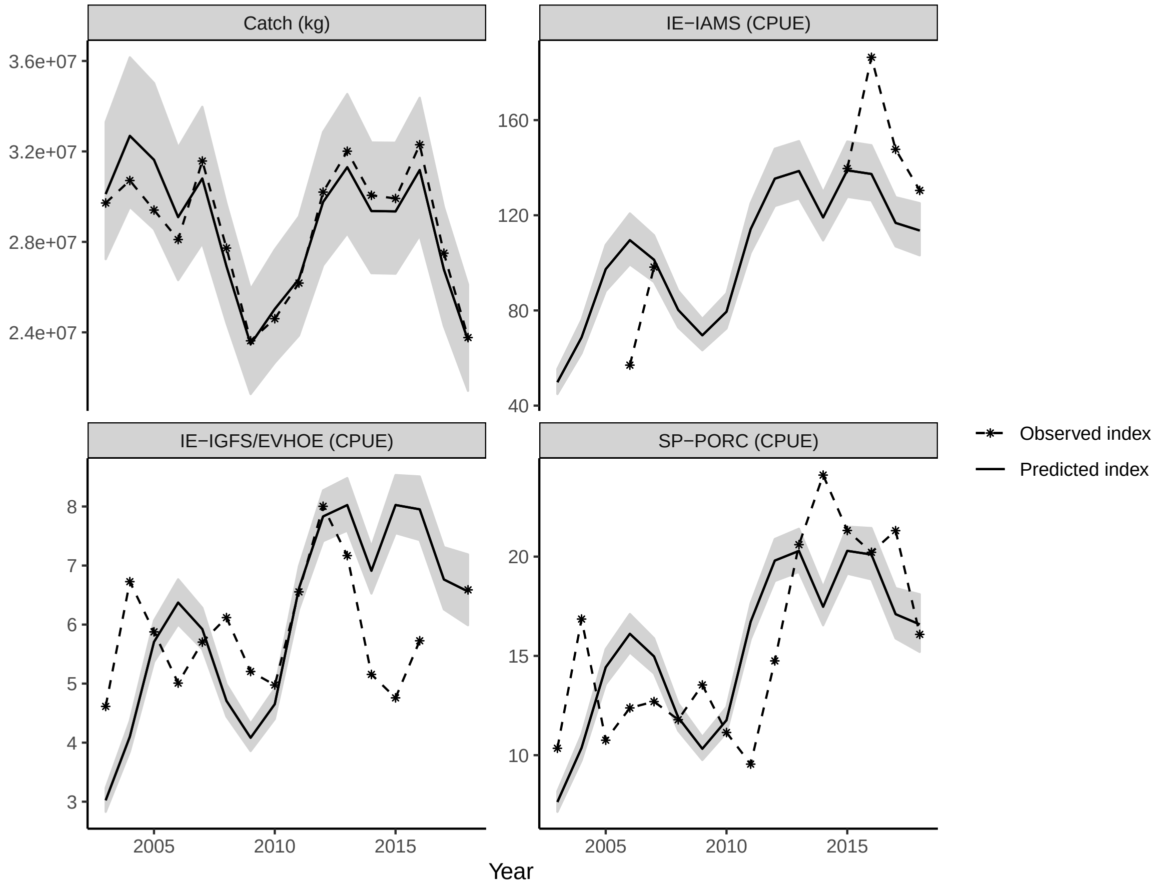


Figure 2: Model fits of observations in catch (kg) and survey indices (CPUE = kg per unit effort) compared to predicted values and their uncertainty for white-bellied anglerfish. Surveys are the combined index for the Irish groundfish and French EVHOE surveys (IE-IGFS/EVHOE), the Irish monkfish and megrim survey (IE-IAMS) and the Spanish Porcupine bank survey (SP-PORC). Shaded grey area is 2*standard error of the predicted values of the catch/indices.

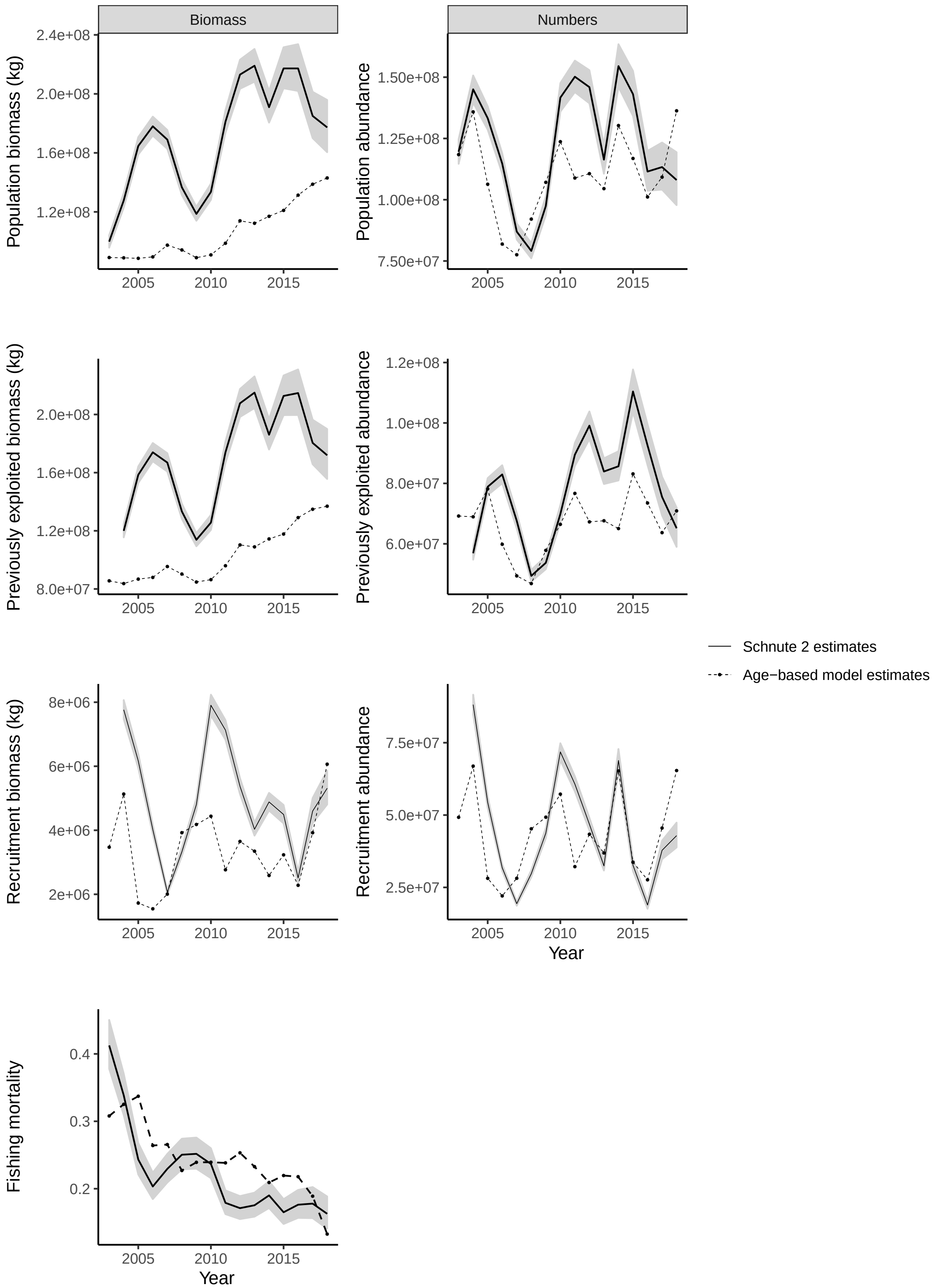


Figure 3: Comparison of the Schnute assessment and a4a assessment estimated values for white-bellied anglerfish. Total biomass and numbers, previously-exploited biomass and numbers, recruitment biomass and numbers, and fishing mortality are shown. Shaded grey area is 2*standard error of the estimated time series.

3.1.2 CSA model fit

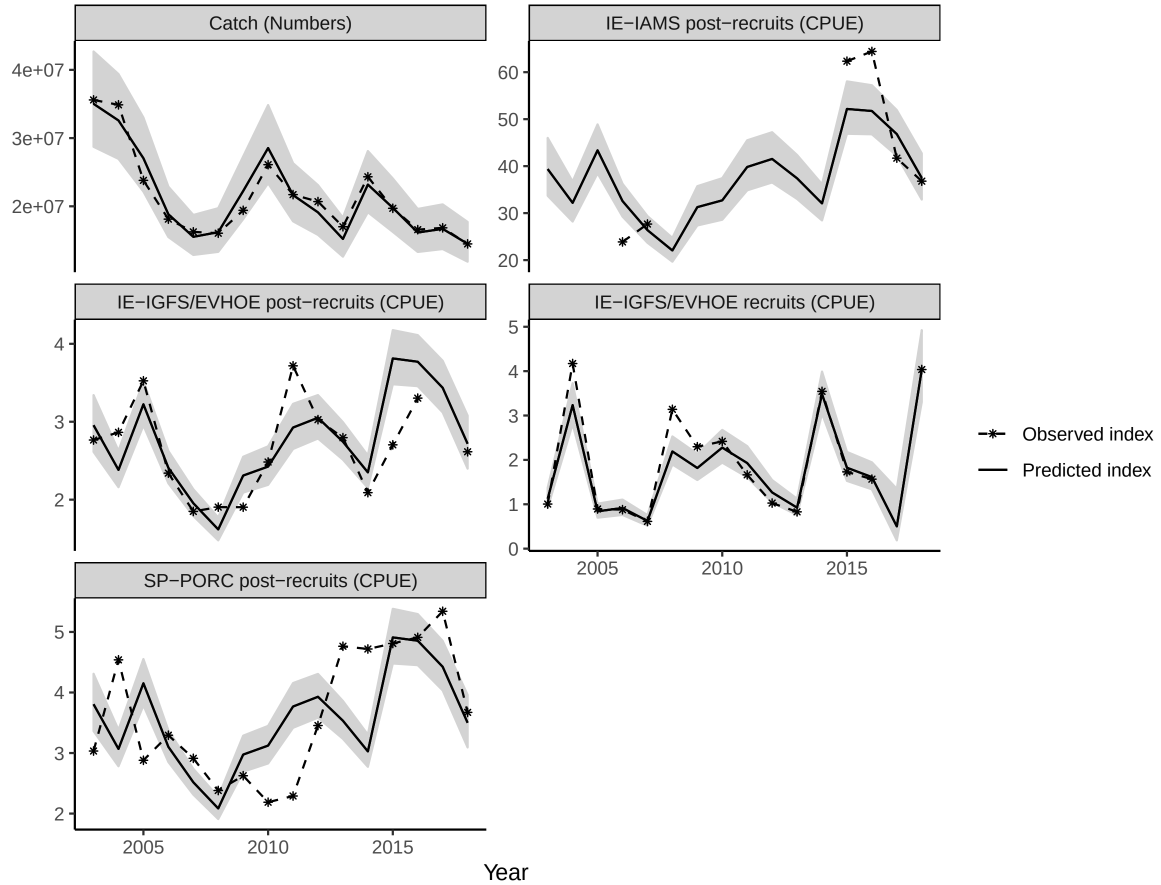


Figure 4: Model fits of observations in catch (numbers) and survey indices (CPUE = numbers per unit effort) compared to predicted values and their uncertainty for white-bellied anglerfish. Surveys are the combined index for the Irish groundfish and French EVHOE surveys (IE-IGFS/EVHOE), the Irish monkfish and megrim survey (IE-IAMS) and the Spanish Porcupine bank survey (SP-PORC). Shaded grey area is 2*standard error of the predicted values of the catch/indices.

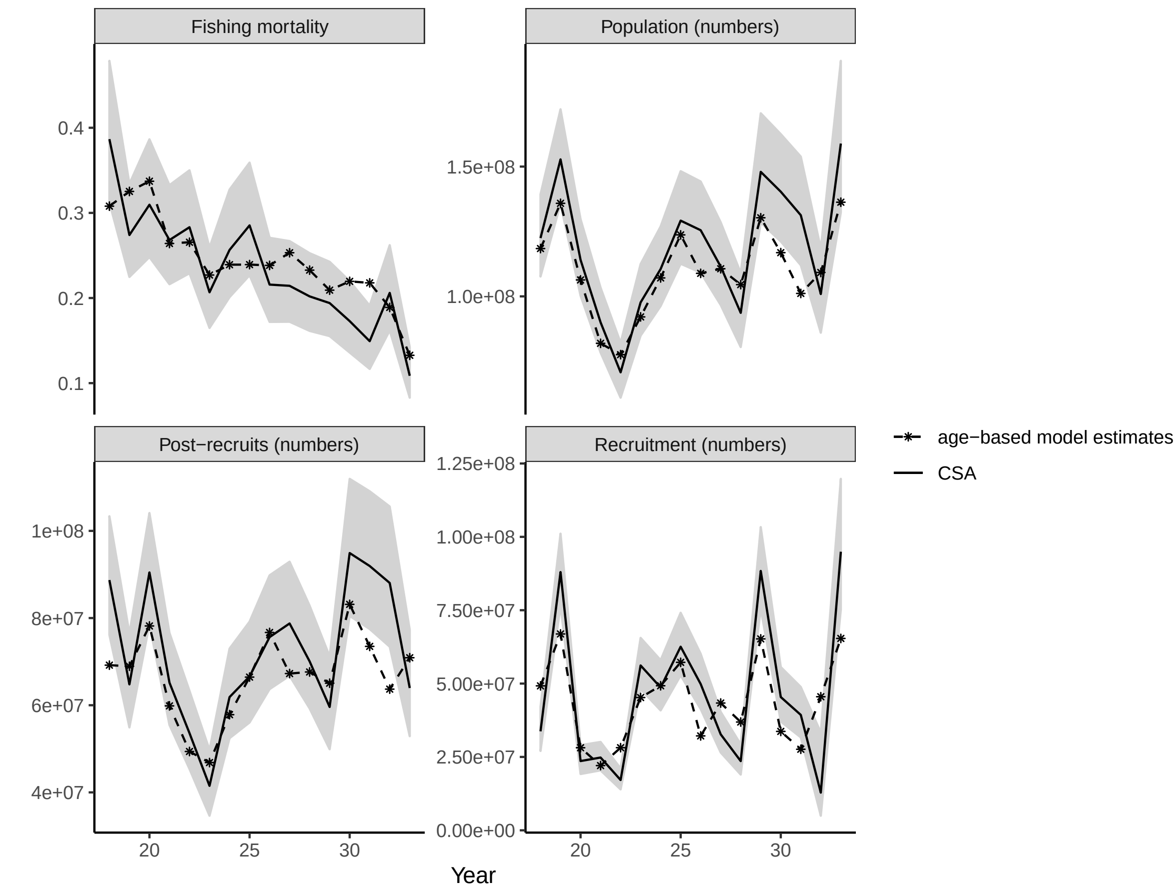


Figure 5: Comparison of the CSA assessment and a4a assessment estimated values for white-bellied anglerfish. Fishing mortality, total numbers, post-recruit numbers and recruitment numbers are shown. Shaded grey area is 2*standard error of the estimated time series.

3.2 Black-bellied anglerfish

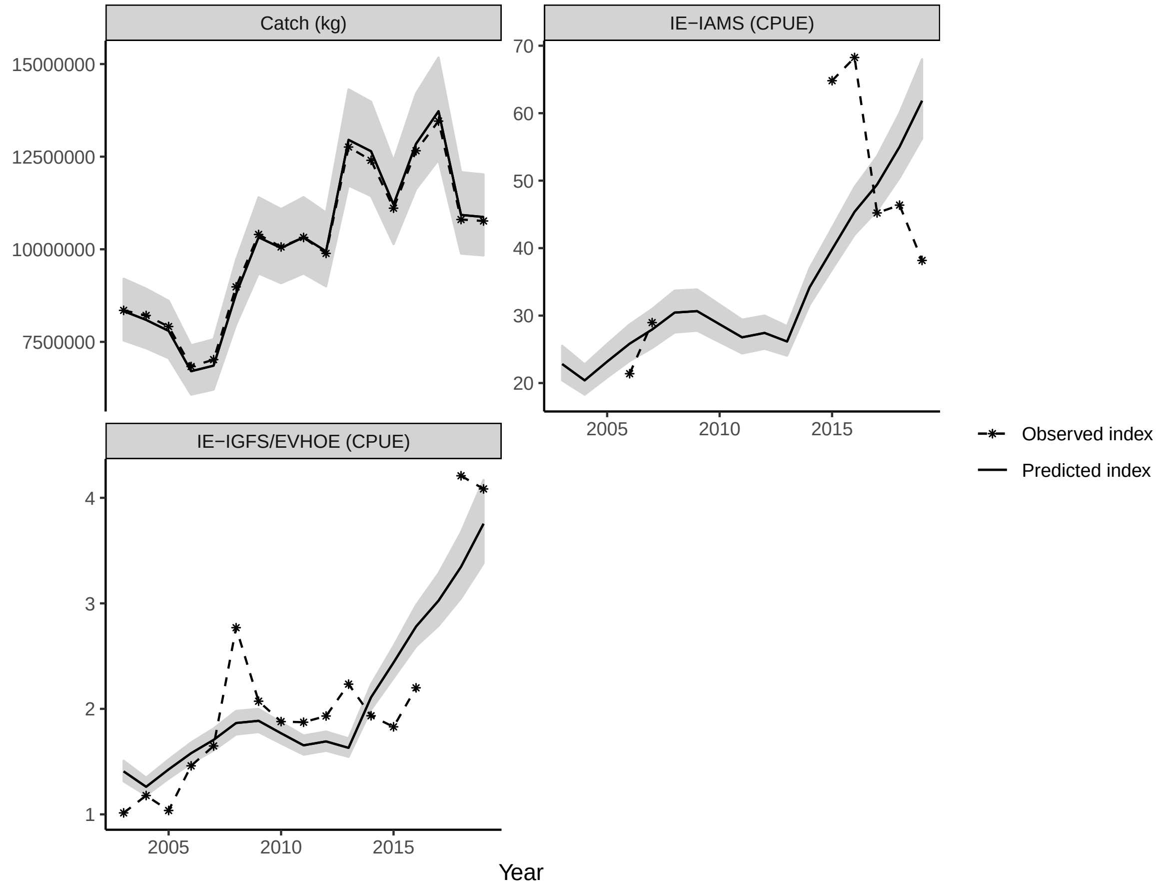


Figure 6: Model fits of observations in catch (kg) and survey indices (CPUE = kg per unit effort) compared to predicted values and their uncertainty for black-bellied anglerfish. Surveys are the combined index for the Irish groundfish and French EVHOE surveys (IE-IGFS/EVHOE) and the Irish monkfish and megrim survey (IE-IAMS) . Shaded grey area is 2*standard error of the predicted values of the catch/indices.

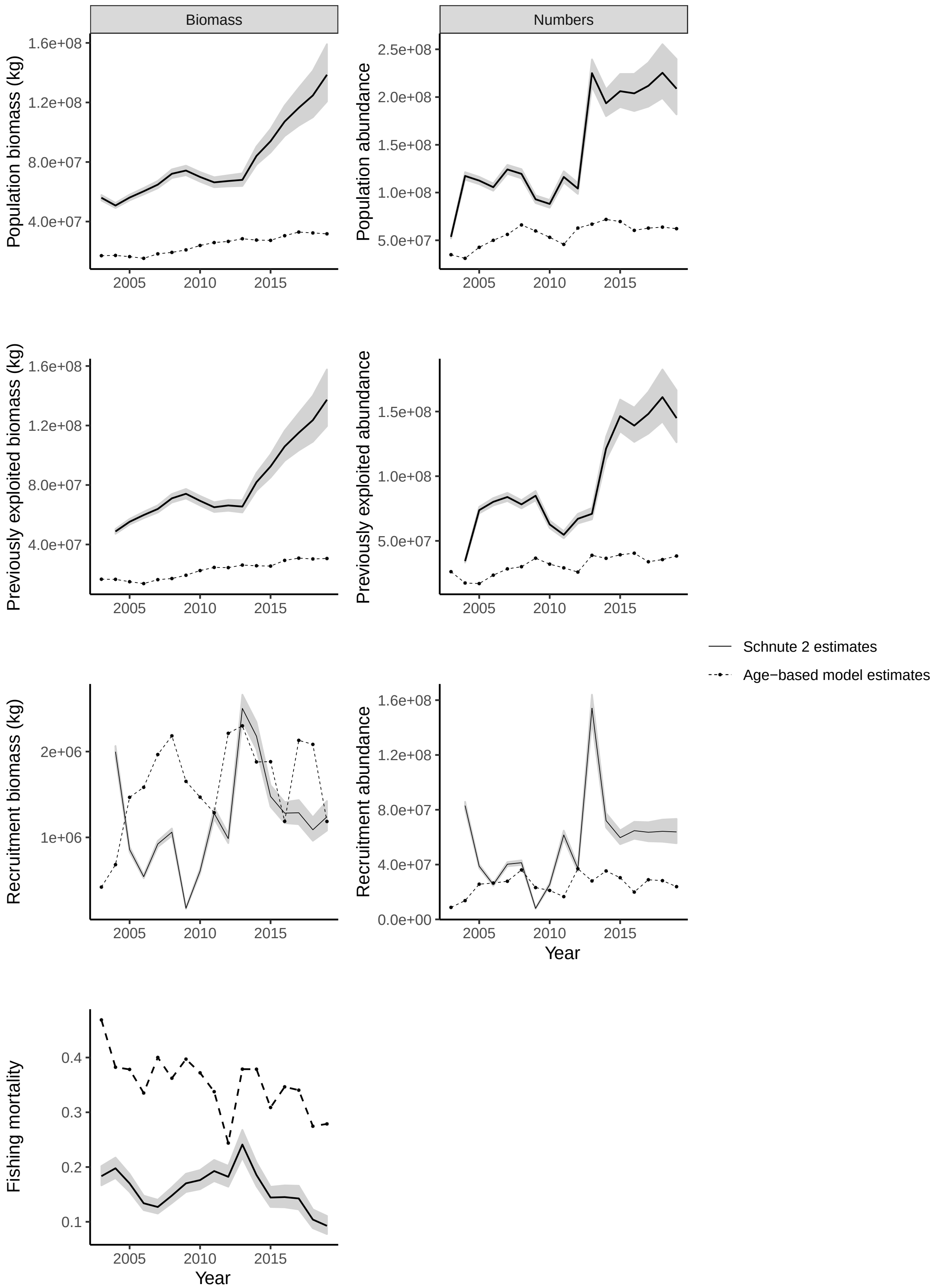


Figure 7: Comparison of the Schnute assessment and a4a assessment estimated values for black-bellied anglerfish. Total biomass and numbers, previously-exploited biomass and numbers, recruitment biomass and numbers, and fishing mortality are shown. Shaded grey area is 2*standard error of the estimated time series.

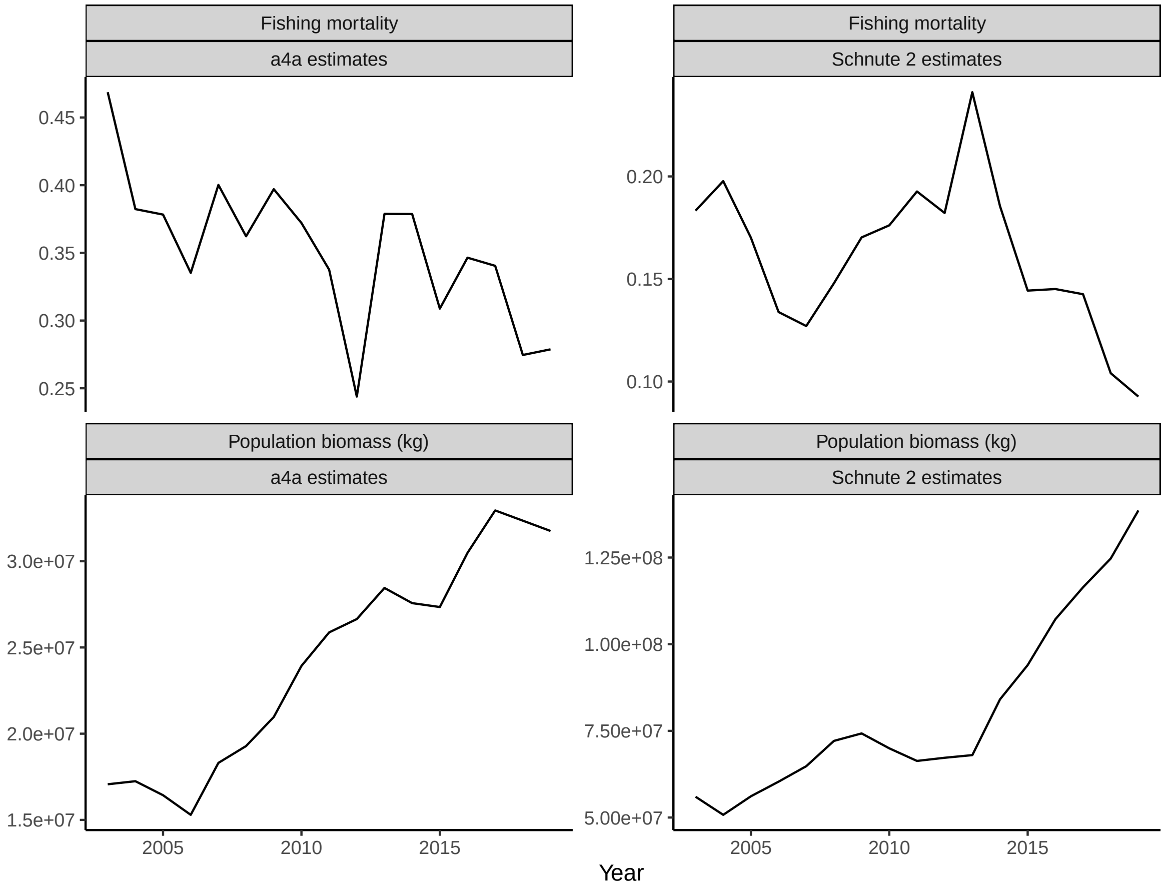


Figure 8: Comparison of the Schnute assessment and a4a assessment estimated values for black-bellied anglerfish. Total biomass and fishing mortality for each assessment are shown individually. Shaded grey area is 2*standard error of the estimated time series.

3.2.1 CSA model fit

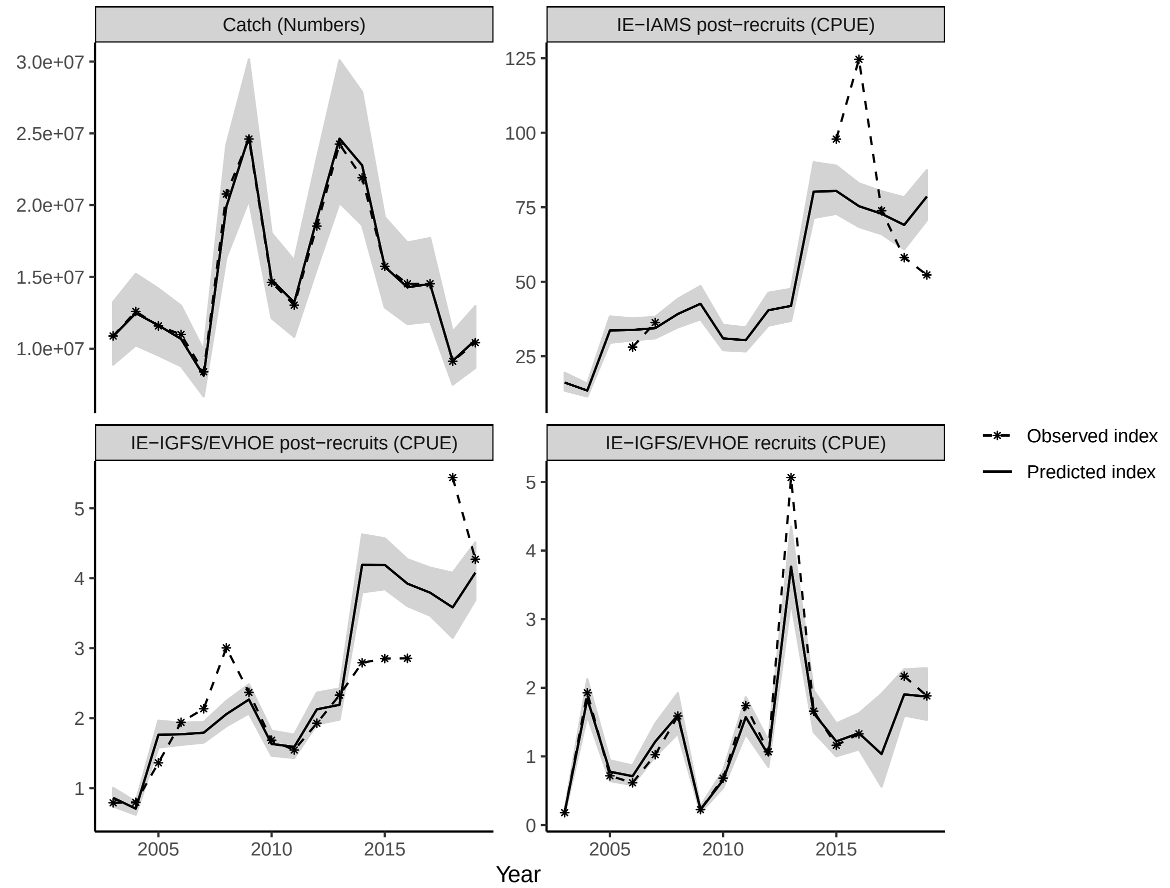


Figure 9: Model fits of observations in catch (numbers) and survey indices (CPUE = numbers per unit effort) compared to predicted values and their uncertainty for black-bellied anglerfish. Surveys are the combined index for the Irish groundfish and French EVHOE surveys (IE-IGFS/EVHOE) and the Irish monkfish and megrim survey (IE-IAMS) . Shaded grey area is 2*standard error of the predicted values of the catch/indices.

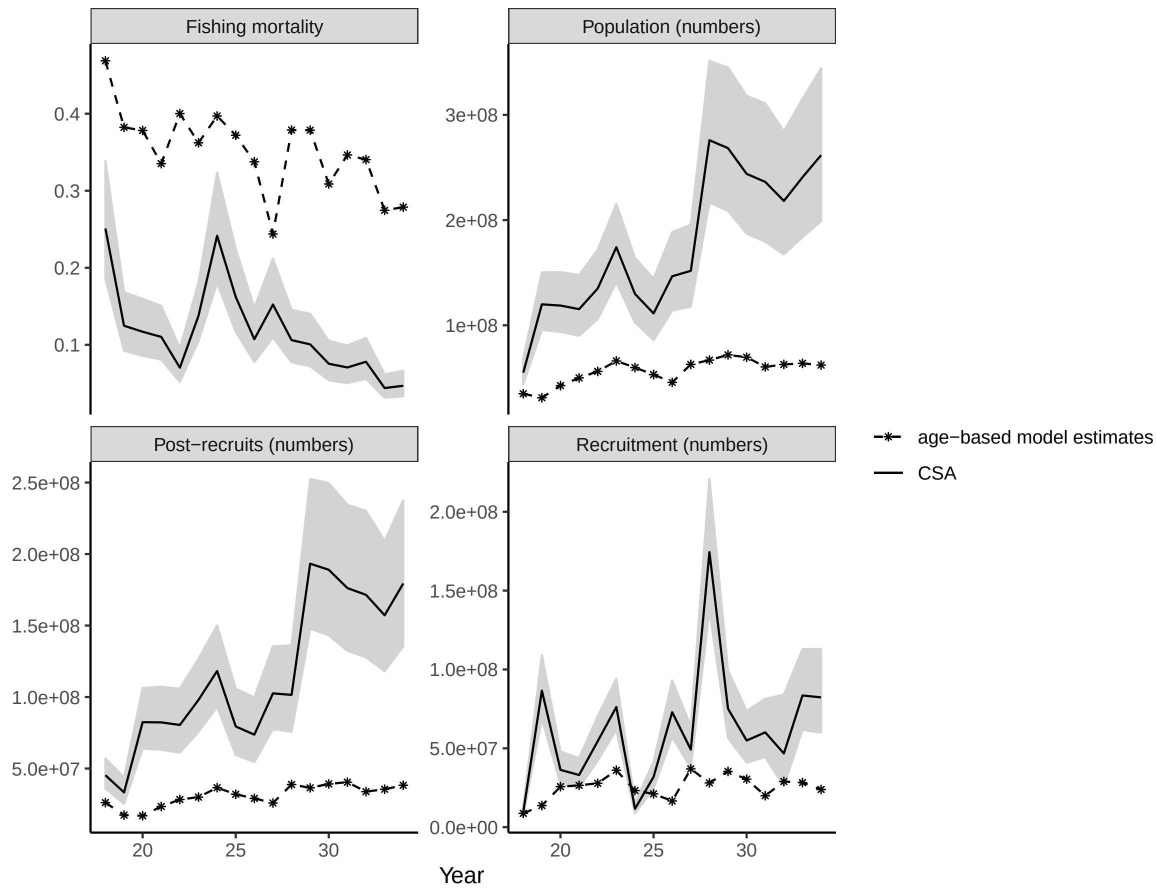


Figure 10: Comparison of the CSA assessment and a4a assessment estimated values for black-bellied anglerfish. Fishing mortality, total numbers, post-recruit numbers and recruitment numbers are shown. Shaded grey area is 2*standard error of the estimated time series.

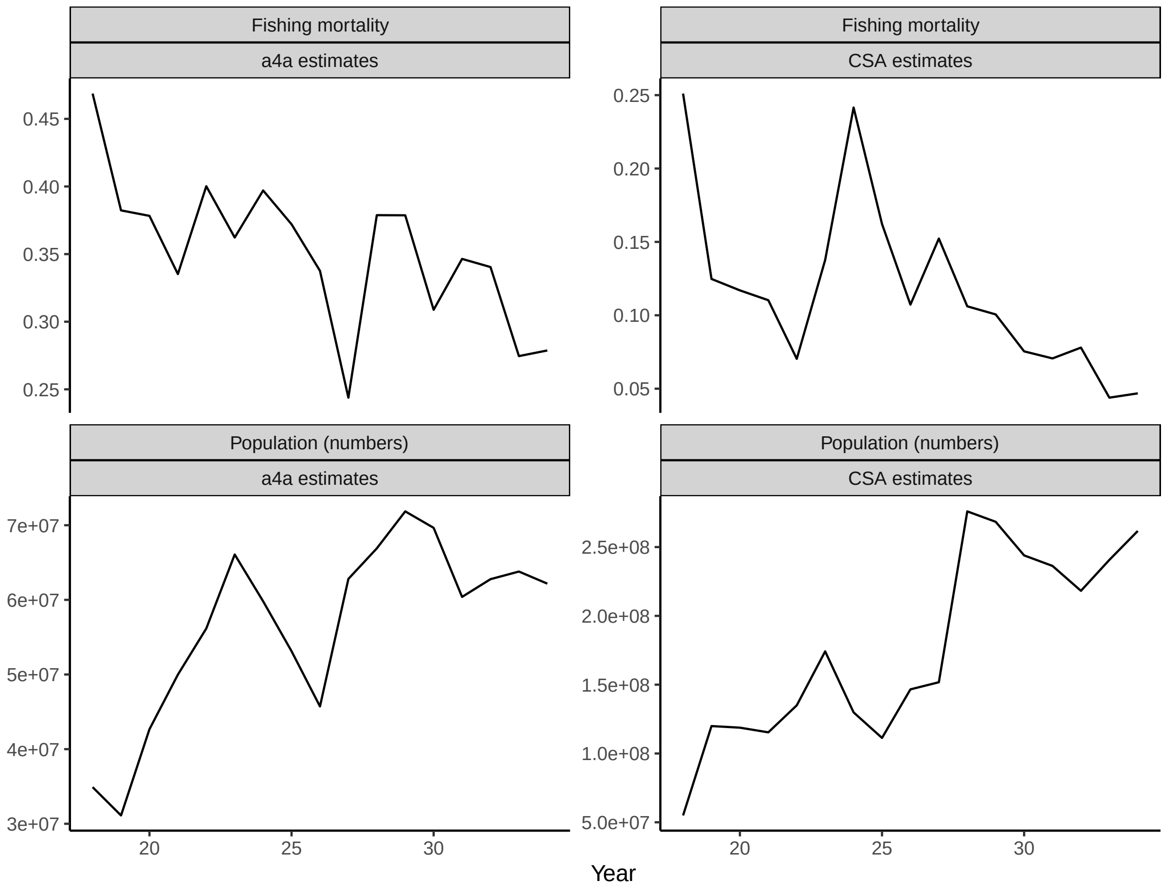


Figure 11: Comparison of the CSA assessment and a4a assessment estimated values for black-bellied anglerfish. Fishing mortality and total numbers for each assessment are shown. Shaded grey area is 2*standard error of the estimated time series.

4 Key points and discussion

4.1 Performance

- The Schnute model fits reasonably closely to both the white-bellied and black-bellied anglerfish catch/survey indices. However the CSA fit for white-bellied anglerfish is better in terms of closeness of fit.
- The CSA assessment also out performs the Schnute assessment for white-bellied anglerfish in terms of closeness to the age-based assessment estimates, however the Schnute assessment is not that far off, particularly when the biomass estimates are divided by their relevant mean weights to give numbers in the population. This discrepancy between biomass estimated in Schnute and biomass estimated in the age-based assessment may be due to differences in mean weights or differences in numbers of older fish.
- Both assessments gave similar results for the black-bellied anglerfish, estimating biomass/numbers at quite different absolute values to the a4a assessment. However, the overall trend in estimated time series was similar.

4.2 Survey class and selectivity

- It is worth considering that the Schnute model only takes entire biomass indices, whereas CSA can take total numbers, post-recruit and recruit indices. a4a is even more specific in its tailoring of indices for the assessment. Schnute still performs reasonably well even though significantly less information is given to the model and trends are very different between total biomass and recruit/post-recruit/age range specific indices. CSA performs very well and this is likely due to its flexibility in fitting to different stages.
- Selectivity is also a key consideration. Both assessments performed assume each stage is fully selected within the fishery (although differences can be entered as an input in CSA). Within the a4a assessment difference in selectivity can be taken into account within the model. We know that neither species is fully selected, particularly black-bellied anglerfish as the recruits at age 0 are somewhat smaller than white -bellied anglerfish recruits. This is likely to have an effect on the estimates from each of the assessments but particularly black-bellied anglerfish.
- CSA is a simpler model than a4a but still has the flexibility to emulate estimated values from a tailored age-based model, despite relaxed assumptions around selectivity in white-bellied anglerfish.
- Selectivity may be more of an issue for black-bellied anglerfish. Preliminary results (not shown in WD) indicate that if fish less than 15cm are removed from the data completely and $15cm \geq$ recruits $\leq 30cm$, the Schnute model gives similar similar absolute estimates to the a4a assessment.

4.3 Overall

- Currently both these assessment do not include process error but in the future this could be incorporated.
- Forecasting from these assessments would be possible. Both assessments give yearly recruits to which a S-R model could be fitted or average taken. Yearly fishing mortality is estimated within both assessments.
- These simpler stage based assessments offer a credible alternative to more complex models. Taking into account the caveats discussed above, both stage-based methods perform surprisingly well considering the simpler model framework and are likely to be less influenced by ageing/growth uncertainty.

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WORKING DOCUMENT

ICES WGBIE 2020

PRELIMINARY ALTERNATIVE STOCK ASSESSMENT MODEL WITH STOCK SYNTHESIS FOR WHITE ANGLERFISH IN DIVISIONS 7, 8 abd

by

Agurtzane Urtizberea, Dorleta García, Ane Iriondo, Marina Santurtún

Abstract

A4a is the model used in the assessment of white anglerfish in the Division 7,8 abd. The model is based on age, but due to some aging problems there is not age data, and therefore, the data are transformed from length to age outside the model with a growth pattern estimated from a cohort analysis from survey and commercial data. The assessment model has also some retrospective pattern that should be studied, eventhough the mohn's rho are within the accepted ranges. Therefore, in order to solve those issues, in this study we use stock synthesis to develop first a base case with similar assumptions and results to the assessment of 2019 and after, considering the results of the sensitivity analysis, a reference case with a better retrospective pattern of SSB and F.

1 Introduction

In 2007, there was not an accepted assessment for *Lophius piscatorius* due to the deficiencies on input data, especially on discards data and aging problems. In 2018, during the benchmark (WKANGLER 2018), discards data were collected since 2003 and a4a model (Millar and Jardim) was analysed and accepted for assessment. A4a model is based on age, so in the case of anglerfish data based on length has to be transform into ages. Growth was estimated with a length frequency analysis presented during the benchmark (WD04 WKANGLER 2018-Batts and Gerritsen, 2018). But the retrospective pattern shown during WGBIE, suggests that the model should be revised to improve it. However, the estimated Mohn's Rho values were within the acceptable range values, so the absolute values were lower than 0.2 (for Recruitment -0.106, for *SSB* 0.136 and for *F* 0.0106). 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 the estimated. The estimated recruitment in 2017 is highly uncertain because there was no recruitment index available for 2017. 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 their confidence intervals.

In this study, we use the last version of stock synthesis v3.30 (NOAA Fisheries Toolbox, 2011). This model is also age-structured; but the length data are transformed into ages within the model. This model is a highly flexible statistical model framework which allows the building of simple to complex models using a mix of data compositions available. We develop a base case model with ss3 the most similar possible to the assessment model. After we did some sensitivity analysis and based on those results is built the reference case, the model that better fits the data considering the knowledge we have apriori.

2 Data

The data used are the same to the data used in the ICES assessment of 2018 before the transformation to age. We use catch data as in the a4a model, the model is defined with only one fleet and the discards and landings are aggregated and treated as retained, but with seasonal resolution. The length frequency data of commercial fleet are with seasonal resolution, but the available catch data is annual, because the catch data in the Division 7a is annual, however, the catches are very low in that area, around 1.5% of total catches. So, we use the proportion of the catches per season without considering the 7a data, and we apply those proportions to total catches, also including the catches in Division 7a.

3 Model

The reference case (RC) was built first starting from a base case model with the most similar parameterization to the assessments from 2018 and 2019 (AsMod) and afterwards the base case was modified based on the results of a sensitivity analysis. The estimate of growth used in the BC is the same as in the AsMod, which was estimated following a cohort analysis using commercial length frequency data and survey data (WD04, WKANGLER- Batts and Gerritsen, 2018).

Sensitivity analysis on the base case:

Below is listed the sensitivity analysis done during the process:

Growth: Base case, *K* is the same as in the a4a model for all ages.

Modifications to the base case:

- 4 different *K*-s until age 4 assumed fixed with the same value as in AsMod and after estimated by the model at age 4, age 5 and age 6 or older.
- Let estimate to the model the maximum length, *Lmax*.

Recruitment: Base case, recruitment season in season 4, month December.

Modifications to the reference model:

- 4 recruitment seasons:1, 2, 3 and 4
- 3 recruitment seasons:2, 3 and 4
- 2 recruitment seasons: 2 and 4
- 1 recrutiment season: in season 4, assuming different months 10, 11 or 12.

Time blocks in selectivity: Base case, 1 time block 2002-2018.

Modifications to the base case:

- 2-time blocks: 2002-2010,2011-2018 due to the trend on *L50* value of discarded fish (Figure 1).

Surveys: Base case, Down weighting to 0 FR-EVHOE survey.

Modifications to the base case:

- 4 indices: FR-EVHOE survey data from 1997 to 2003, FR-IE-IBTS joint index, Irish monkfish survey and Spanish Groundfish Survey.

Reference case (RC):

In the RC as well as in AsMod, only one fleet is defined, and the catches are assumed retained. The main differences between both models are:

- The model is seasonal, with recruitment only happening in season 4, in December.

- The growth rate rate (*K*) until age 1 is linear and afterwards follows Von Bertalanffy growth curve with the same *K* as in the Mod2108 until age 4, and afterwards the model estimates another 3 different *K*-s, at age 4, 5 and 6 or older.
- The selectivity of the fleet and of the surveys is assumed a double normal function, but for monkfish survey logistic. All the parameters for selectivity are estimated based on length.
- The selectivity of the fleet changes in 2 periods: 2-time blocks are defined in 2002 the beginning of discards data and in 2010 due to the increase in median size of discards (*L50*) from 2002 to 2018 (Figure 1).
- In addition of the same indices as in AsMod (the FR-IE-IBTS joint index, the Irish monkfish survey and the Spanish Groundfish Survey in the Porcupine bank SP-Porc) the FR-EVHOE survey data from 1997 to 2003 with a mirror selectivity of the joint index is also considered.

4 Results

Sensitivity Analysis

The length at age of the BC (Figure 2) where growth is linear until age 1,shows that the length at age 1 is close to 18 cm, this value is very close to the estimates by Batts et al. (2019). The highest selectivity on the smallest is estimated for the joint index and FR-EVHOE survey, with dome shaped where the selectivity of the largest is lower than for other surveys but not 0. For the commercial fleet as well as for the monkfish survey and SP-Porc the selectivity is logistic. But this model does not fit well the distribution of the largest fish and neither the distribution of the indices (Figure 2).

When the model estimates the maximum length, the estimated value is 133 cm, this value is very low in comparison to the value used in the BC 171 cm and the estimates by other studies (Batts et. al. 2019) and the fits of the aggregated length frequency are very similar to the BC. However, when we give the possibility to the model to estimate growth with more than one stanza, then the model estimate that *K* at age 4 is 0.6 times lower than in the BC (0.1075), at age 5 is similar to the growth at age 4 (1.06) and at age 6 decreases again, 0.48 times lower than the growth at age 5. The aggregated size frequency across time of this model fits better the distribution of the largest fish of the commercial fleet but also of the surveys (Figure 3).

The BC model but with recruitment in the 4 seasons, estimates that around 50% of the recruitment comes from the 4rth season (Figure 4), but this model does not fit well the aggregated length distribution of the FR-IE-IBTS joint index and neither the FR-EVHOE survey (Figure 4). In addition, many of the parameters have quite high gradient and this could mean some instability in the model. The model shows the same diagnostic problems when 2 or 3 seasons are assumed. When recruitment happens only in season 4 (BC), then there is not big difference on the month chosen for recruitment, the only change is the length at age 1, and in the estimated growth parameters. So we chose December based on the results of Quincoces et al. (1998b) where is shown that most of the female matured were in June and December, and because in addition it fits better the length at age 1 estimated by other studies.

When 2-time blocks are included, the selectivity of the smallest changes following the discards data, the mean size of the discards increases (Figure 5). The fit of the length composition of the commercial fleet and of the FR-IE-IBTS Joint Index is improved (Figure 5).

Including the first years of FR-EVHOE survey does not change much the estimated parameters or the fits of other surveys, but it improves the fit of the FR-EVHOE survey and also the retrospective pattern of the model. If FR-EVHOE is not included in the model then the Mohn's Rho values are: 0.024 for SSB, -0.011 for F and -0.42 for Recruitment.

Reference Case:

Table 1 shows the results of the parameters for RC with the fixed values and the estimated ones. The estimated parameters are not limited by the boundaries and all the gradients of the parameters have an absolute value lower than 0.001. Table 2 shows the total likelihood and the likelihood of each component.

The model estimates that growth decreases at age 4 0.64 times the growth rate until age 4 (K=0.1075), after at age 5 the growth follows with similar values (1.06 higher thant growth at age 4) and after at age 6 decreases again 0.48 times lower (Table 1, Figure 6). At age 30 is when fish older than 30 are aggregated, the model estimates a little jump in the mean growth at this age (Figure 6).

The model estimates logistic selectivity for commercial fleet, with a change in the selectivity of the smallest in 2003 when discards data starts, and with another change in 2008 where the minimum size of the fish discarded increases (Figure 7).

The fitted values of the indices are within the observed range for most of the observed values with very few exceptions (Figure 8) and the fitted mean size are within the observed size range for the fleet and for all of the indices (Figure 9). The aggregated size distribution fit quite well the observed values, although the monkfish survey fitted values seemed a bit biased, which could be due to the few data available of this survey (Figure 10).

Retrospective pattern is calculated (Figure 11) and the estimated Mohn´s Rho values are improved in comparison to the estimates in 2019 for *SSB* and *F*, 0.0053 and 0.0058 respectively, but not for recruitment, with a very high value of 0.42.

5 Discussion

Comparing the results of the RC and BC with the assessment results from 2019

The catch values are the same to the observed values for all the ss3 models analysed here but in the case of AsMod there are some differences between the fitted and the observed values (Figure 12). In AsMod as well as in the ss3 models the *Fbar* is estimated between age 3 and the maximum age considered in the model. The F values as well as the SSB values are very similar in the AsMod and BC, even though the BC model considers a time block with a change in selectivity since 2002. The model without any time block did not converge, and therefore the model with one-time block was chosen as BC. But if the model considers a second time block then the differences with the AsMod increases since around 2002 when the increase of SSB is bigger. However, the differences are bigger in comparison to the RC where the virgin biomass has a bigger value than in the other models. So, the lower growth of the largest fish suggests a higher value of virgin biomass of the stock. Thus, the main differences between AsMod and the RC, are due to the second time block and the slower growth of the largest fish.

There are some differences in recruitment (Figure 12), this could be because in the RC and the BC assume different times of recruitment in comparison to AsMod: in RC and BC the recruitment happens in December, while in the AsModel, the recruitment happens in the beginning of the year, and that could explain the one year delay in the recruitment pattern of the RC or BC models.

The model that better fits the data is the RC, where the growth has more than one stanza and selectivity is treated with two different time blocks. The differences on the selectivity with time block could be explained with differences in discards data with time. Discards data are available since 2003 and the *L50* of the discards data has change from 20 to 32 cm. This could be possibly due to the implementation of the 500 g minimum market size since 1998.

The decrease in growth rate at age where the fish is matured or close to be matured, could be explained with an increase in the investment of energy into maturity instead of growth. In addition, the age at which 50% of fish are matured is different for males (52 cm) and females (73 cm) (Quincoces et al. 1998b) around age 4 and 6 (Figure 2). So, the differences in growth with age estimated by the model, it could be explained with differences in growth with sex and with differences in selectivity of sex and size. Commercial data on the ratio of sex with size could help to explain these issues and to choose the most appropriate model.

The retrospective pattern is better in the RC with lower Mohn's Rho values for *SSB* and *F* (0.00534 for SSB, -0.0057 for F) than in the AsMod (for *SSB* 0.136 and for *F* 0.0106), and both models give values within the recommended values, but in the case of recruitment the Mohn's Rho values of the RC are worst (-0.42 RC and -0.106 AsMod). This could be due to the no stock recruitment relationship and the high recruitment variability from year to year. So, the retrospective pattern of the recruitment should be analysed to improve the model.

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7 Tables

Table 1: The fixed and estimated parameters values, ranges, standard deviation and gradients when the parameter is estimated on the RC.

	Value	Active_Cnt	Phase	Min	Max	Init	Used	Status	Parm_StDev	Gradient
NatM_p_1_Fem_GP_1	0.25	NA	-3	0.01	0.5	0.25	0.25	NA	NA	NA
L_at_Amin_Fem_GP_1	18.5476	1	2	15	35	28.7452	28.7452	OK	0.108532	-8.11E-06
L_at_Amax_Fem_GP_1	171	NA	-4	90	200	171	171	NA	NA	NA
VonBert_K_young_Fem_GP_1	0.1075	NA	-4	0.05	0.35	0.1075	0.1075	NA	NA	NA
Age_K_mult_Fem_GP_1_a_4	0.651321	2	4	0.05	2	0.5	0.5	OK	0.0615131	-2.41E-05
Age_K_mult_Fem_GP_1_a_5	1.06445	3	4	0.05	3	0.5	0.5	OK	0.228815	-1.33E-05
Age_K_mult_Fem_GP_1_a_6	0.482834	4	4	0.05	3	1.8	1.8	OK	0.0943382	-9.60E-06
CV_young_Fem_GP_1	0.2	NA	-3	0.005	0.5	0.2	0.2	NA	NA	NA
CV_old_Fem_GP_1	0.2	NA	-3	0.005	0.5	0.2	0.2	NA	NA	NA
Wtlen_1_Fem_GP_1	2.70E-05	NA	-3	-1	1	2.70E-05	2.70E-05	NA	NA	NA
Wtlen_2_Fem_GP_1	2.839	NA	-3	2	4	2.839	2.839	NA	NA	NA
Mat50%_Fem_GP_1	61.84	NA	-3	40	70	61.84	61.84	NA	NA	NA
Mat_slope_Fem_GP_1	-0.1001	NA	-3	-1	1	-0.1001	-0.1001	NA	NA	NA
Eggs/kg_inter_Fem_GP_1	1	NA	-3	-3	3	1	1	NA	NA	NA
Eggs/kg_slope_wt_Fem_GP_1	0	NA	-3	-3	3	0	0	NA	NA	NA
RecrDist_GP_1	0	NA	-3	-3	3	0	0	NA	NA	NA
RecrDist_Area_1	0	NA	-3	-3	3	0	0	NA	NA	NA
RecrDist_month_12	-0.795307	5	1	-5	20	-0.82	-0.82	OK	24731.2	-1.11E-07
CohortGrowDev	1	NA	-1	0.1	10	1	1	NA	NA	NA
FracFemale_GP_1	0.5	NA	-99	1.00E-06	0.999999	0.5	0.5	NA	NA	NA
SR_LN(R0)	9.01087	6	1	1.5	16	12.2	12.2	OK	0.149401	-0.0002413
SR_BH_steep	0.999	NA	-1	0.2	0.999	0.999	0.999	NA	NA	NA
SR_sigmaR	0.6	NA	-4	0.1	2	0.6	0.6	NA	NA	NA

SR_regime	1.66655	7	4	-5	5	0	0	OK	0.177522	-0.0001286
SR_autocorr	0	NA	-99	0	0	0	0	NA	NA	NA
Main_InitAge_10	-0.314452	8	2	-5	5	0	0	act	0.539448	3.25E-06
Main_InitAge_9	-0.240969	9	2	-5	5	0	0	act	0.553461	3.32E-06
Main_InitAge_8	-0.124976	10	2	-5	5	0	0	act	0.578578	2.11E-06
Main_InitAge_7	0.0472717	11	2	-5	5	0	0	act	0.626134	3.11E-06
Main_InitAge_6	0.254434	12	2	-5	5	0	0	act	0.719331	1.69E-06
Main_InitAge_5	2.07658	13	2	-5	5	0	0	act	0.251462	-6.99E-06
Main_InitAge_4	-0.350871	14	2	-5	5	0	0	act	0.521112	3.03E-06
Main_InitAge_3	0.137924	15	2	-5	5	0	0	act	0.299518	3.63E-06
Main_InitAge_2	0.79688	16	2	-5	5	0	0	act	0.191141	8.04E-07
Main_InitAge_1	1.53374	17	2	-5	5	0	0	act	0.166662	-8.96E-07
Main_RecrDev_1986	0.252292	18	2	-5	5	0	0	act	0.0898816	-5.37E-06
Main_RecrDev_1987	-1.18422	19	2	-5	5	0	0	act	0.177163	1.40E-06
Main_RecrDev_1988	-0.832888	20	2	-5	5	0	0	act	0.116682	1.69E-06
Main_RecrDev_1989	-1.63178	21	2	-5	5	0	0	act	0.173289	2.13E-06
Main_RecrDev_1990	0.154858	22	2	-5	5	0	0	act	0.0883187	-6.38E-06
Main_RecrDev_1991	0.0403355	23	2	-5	5	0	0	act	0.106945	-5.13E-06
Main_RecrDev_1992	-0.443295	24	2	-5	5	0	0	act	0.134434	-2.59E-06
Main_RecrDev_1993	-0.569635	25	2	-5	5	0	0	act	0.131443	7.40E-07
Main_RecrDev_1994	-0.987185	26	2	-5	5	0	0	act	0.143312	8.03E-07
Main_RecrDev_1995	-1.05012	27	2	-5	5	0	0	act	0.116626	-1.98E-06
Main_RecrDev_1996	-1.1573	28	2	-5	5	0	0	act	0.111107	5.34E-07
Main_RecrDev_1997	-0.613901	29	2	-5	5	0	0	act	0.0919344	9.32E-07
Main_RecrDev_1998	0.0827647	30	2	-5	5	0	0	act	0.0776118	-1.33E-05
Main_RecrDev_1999	-0.746885	31	2	-5	5	0	0	act	0.124224	-2.00E-06
Main_RecrDev_2000	0.791402	32	2	-5	5	0	0	act	0.0711237	-7.95E-06
Main_RecrDev_2001	0.296789	33	2	-5	5	0	0	act	0.0820349	-2.79E-06

Main_RecrDev_2002	0.211322	34	2	-5	5	0	0	act	0.0811093	-1.66E-06
Main_RecrDev_2003	1.10563	35	2	-5	5	0	0	act	0.0632626	-6.24E-06
Main_RecrDev_2004	-0.291686	36	2	-5	5	0	0	act	0.0930556	-1.47E-07
Main_RecrDev_2005	-0.630783	37	2	-5	5	0	0	act	0.0930259	2.34E-06
Main_RecrDev_2006	-0.441663	38	2	-5	5	0	0	act	0.0867823	4.40E-06
Main_RecrDev_2007	0.320043	39	2	-5	5	0	0	act	0.0754835	8.94E-07
Main_RecrDev_2008	0.526357	40	2	-5	5	0	0	act	0.0720416	1.79E-06
Main_RecrDev_2009	0.749418	41	2	-5	5	0	0	act	0.0677552	2.56E-07
Main_RecrDev_2010	0.0148297	42	2	-5	5	0	0	act	0.0884457	8.85E-07
Main_RecrDev_2011	0.0809446	43	2	-5	5	0	0	act	0.0815099	2.34E-06
Main_RecrDev_2012	0.031923	44	2	-5	5	0	0	act	0.0849935	3.89E-06
Main_RecrDev_2013	0.878276	45	2	-5	5	0	0	act	0.0665005	1.49E-06
Main_RecrDev_2014	0.0261961	46	2	-5	5	0	0	act	0.090138	3.14E-06
Main_RecrDev_2015	-0.0176251	47	2	-5	5	0	0	act	0.0888	2.19E-06
Main_RecrDev_2016	0.441491	48	2	-5	5	0	0	act	0.0900903	3.21E-06
Main_RecrDev_2017	0.894148	49	2	-5	5	0	0	act	0.0863474	4.46E-06
Main_RecrDev_2018	-0.115623	50	2	-5	5	0	0	act	0.592613	3.64E-06
ForeRecr_2019	0	51	5	-5	5	0	0	act	0.6	0
Impl_err_2019	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
LnQ_base_FR-IE-IBTS(2)	-9.92027	52	1	-15	-5	-11.6287	-11.6287	OK	0.0335694	-1.11E-05
LnQ_base_IE_MONKSURVEY(3)	-7.02869	53	1	-15	-5	-11.6287	-11.6287	OK	0.0716514	-2.76E-08
LnQ_base_SPGFS(4)	-8.6599	54	1	-15	-5	-11.6287	-11.6287	OK	0.0955939	-8.50E-07
LnQ_base_FR-EVHOE(5)	-11.6166	55	1	-15	-5	-11.6287	-11.6287	OK	10011.5	-1.07E-07
Size_DblN_peak_FL1(1)	37.2392	56	2	6	70	15	15	OK	0.651281	-8.01E-06
Size_DblN_top_logit_FL1(1)	3	NA	-3	-20	20	3	3	NA	NA	NA

Size_DblN_ascend_se_FL1(1)	4.75654		57	3	-5	10	2	2	OK	0.0804768	9.11E-06
Size_DblN_descend_se_FL1(1)	14.847		58	3	-5	30	7	7	OK	95.816	1.10E-08
Size_DblN_start_logit_FL1(1)	-9.85227		59	3	-30	5	-3.5	-3.5	OK	9.62859	-1.09E-08
Size_DblN_end_logit_FL1(1)	5	NA		-2	-20	20	5	5	NA	NA	NA
Size_DblN_peak_FR-IE-IBTS(2)	18.4067		60	2	2	40	3.96	3.96	OK	1.2811	8.03E-07
Size_DblN_top_logit_FR-IE-IBTS(2)	0.64145		61	3	-5	5	-2	-2	OK	0.516973	-1.09E-07
Size_DblN_ascend_se_FR-IE-IBTS(2)	1.82745		62	3	-5	8	5	5	OK	1.02527	-1.33E-07
Size_DblN_descend_se_FR-IE-IBTS(2)	6	NA		-3	2	15	6	6	NA	NA	NA
Size_DblN_start_logit_FR-IE-IBTS(2)	1.00481		63	2	-15	5	-4	-4	OK	0.302297	-4.60E-07
Size_DblN_end_logit_FR-IE-IBTS(2)	-0.46	NA		-2	5	5	-0.46	-0.46	NA	NA	NA
Size_inflection_IE_MONKSURVEY(3)	45	NA		-2	3	100	45	45	NA	NA	NA
Size_95%width_IE_MONKSURVEY(3)	55.09	NA		-2	-5	100	55.09	55.09	NA	NA	NA
Size_DblN_peak_SPGFS(4)	63.1013		64	2	6	70	61.61	61.61	OK	0.405236	2.79E-07
Size_DblN_top_logit_SPGFS(4)	0.297283		65	3	-20	20	3	3	OK	14.7015	-9.06E-09
Size_DblN_ascend_se_SPGFS(4)	4.26	NA		-3	-5	10	4.26	4.26	NA	NA	NA
Size_DblN_descend_se_SPGFS(4)	14.8466		66	3	-5	30	7	7	OK	95.8341	3.28E-09
Size_DblN_start_logit_SPGFS(4)	-2.50726		67	3	-30	5	-3.5	-3.5	OK	0.0684612	1.78E-06
Size_DblN_end_logit_SPGFS(4)	5	NA		-2	-20	20	5	5	NA	NA	NA
minage@sel=1_FL1(1)	1	NA		-3	0.1	1	1	1	NA	NA	NA
maxage@sel=1_FL1(1)	40	NA		-3	40	40	40	40	NA	NA	NA
Size_DblN_peak_FL1(1)_BLK1repl_2002	16.3835		68	2	6	70	15	15	OK	0.440473	-2.67E-06
Size_DblN_peak_FL1(1)_BLK1repl_2011	20.2412		69	2	6	100	15	15	OK	0.604245	-1.76E-06
Size_DblN_ascend_se_FL1(1)_BLK1repl_2002	2.79611		70	3	-5	10	2	2	OK	0.188186	7.50E-07
Size_DblN_ascend_se_FL1(1)_BLK1repl_2011	3.92083		71	3	-5	20	2	2	OK	0.137923	2.99E-07

Table 2: Likelihoods of the base case (BC) with one time block and two time blocks and the same for the RC.

	BC	BC_2TB	RC_1TB	RC
TOTAL	3271.01	3019.16	3034.39	2679.14
Catch	4.95E-13	3.44E-13	1.61E-13	1.25E-13
Equil_catch	0	0	0	0
Survey	-24.2454	-30.8425	-38.8608	-35.5431
Length_comp	3266.13	3020.11	3062.83	2704.95
Recruitment	29.068	29.7783	10.3691	9.69429
InitEQ_Regime	0	0	0	0
Forecast_Recruitment	0	0	0	0
Parm_priors	0.0534853	0.110125	0.043034	0.0337429
Parm_softbounds	0.00304037	0.00682711	0.0140626	0.00350138
Parm_devs	0	0	0	0
Crash_Pen	0	0	0	0

8 Figures

Figure 1: Time series of discards data with the median size.

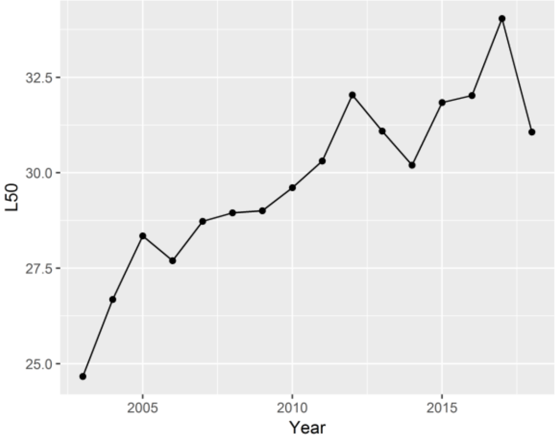
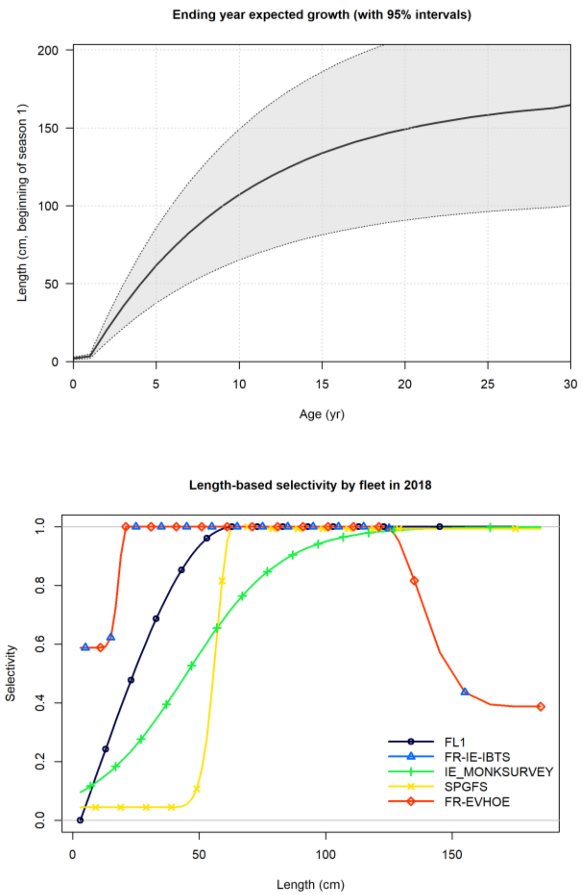


Figure 2: Left figure shows the length at age at the end of the year of the BC, the selectivity of the commercial fleet and surveys and the right figure the aggregated size across time in the BC.



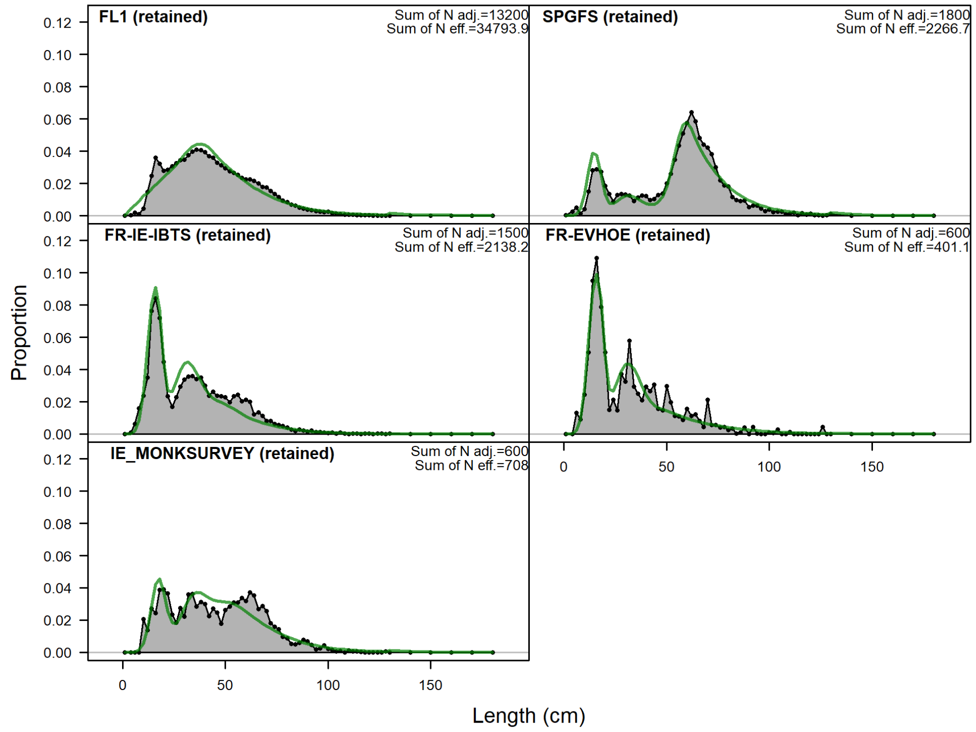


Figure 3: The length at age at the end of the year and the length frequency distribution aggregated across time simulated with the BC but letting the model to estimate growth at age 4, 5 and 6 or older.

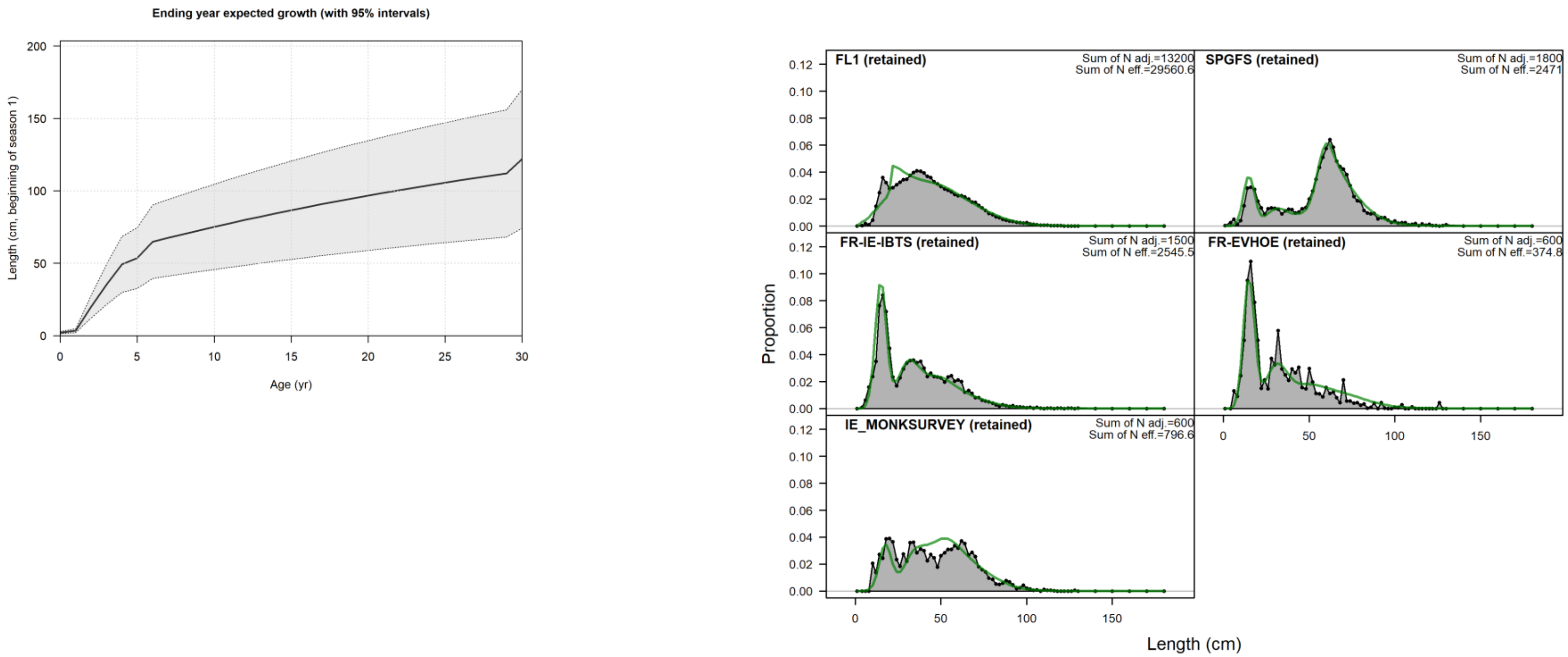


Figure 4: The recruitment per season and the percentage with the model assuming recruitment every season. On the right aggregated size frequency distribution with the same model BC with recruitment every season.

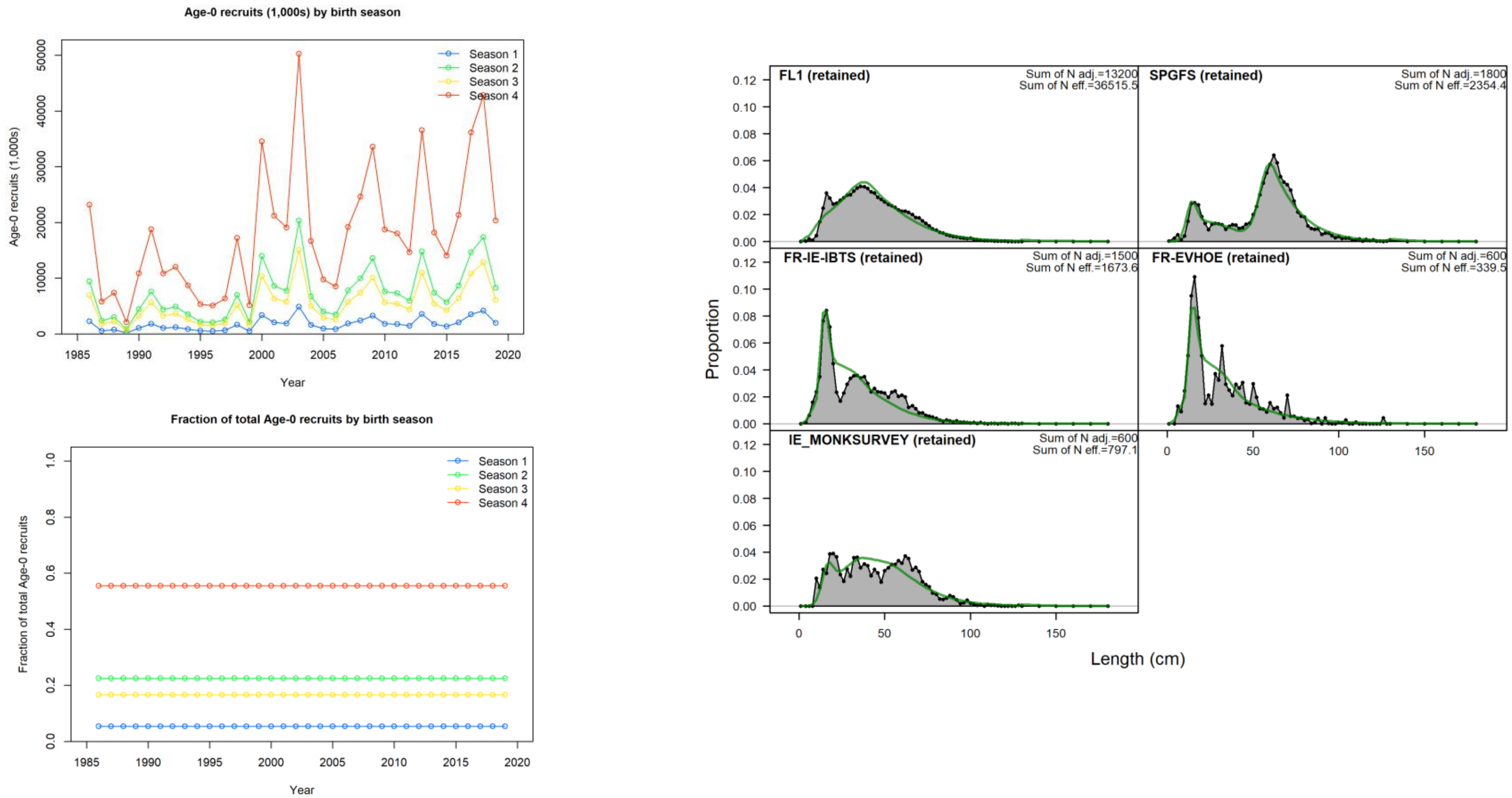
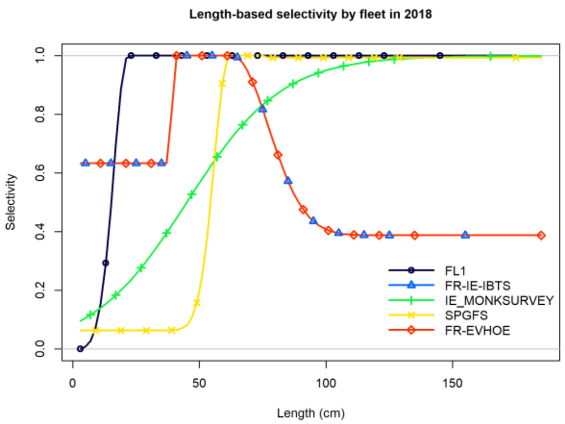
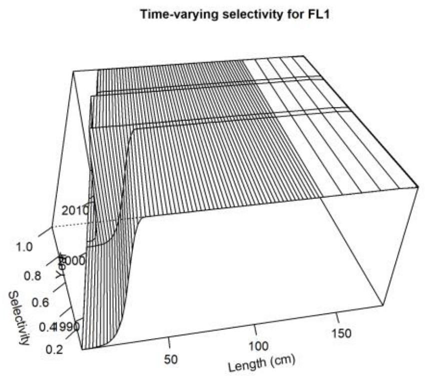


Figure 5: Aggregated size frequency distribution assuming 2 time blocks.





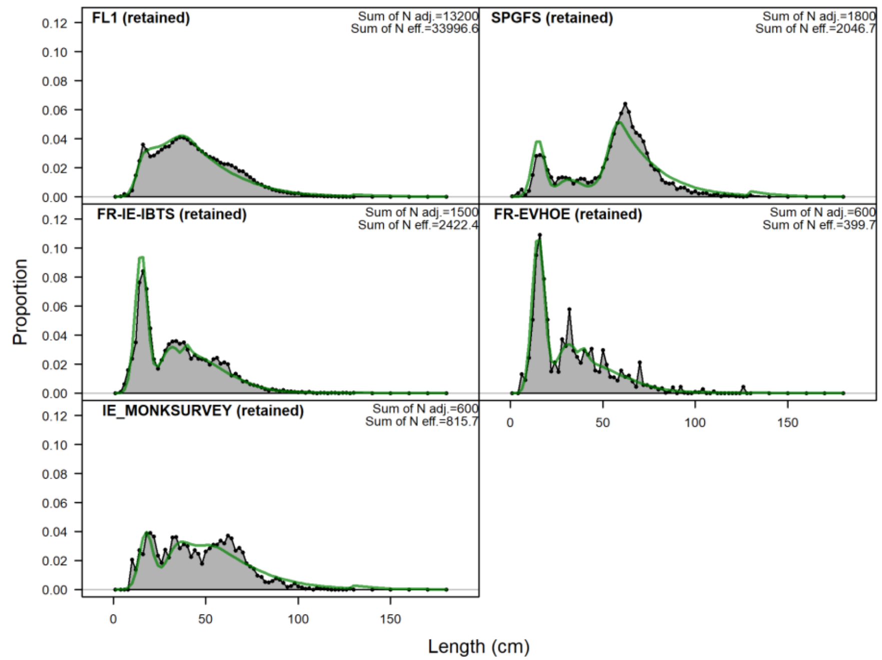


Figure 6: The mean length at age and confidence interval in the beginning of the season and year in the ending year of the model.

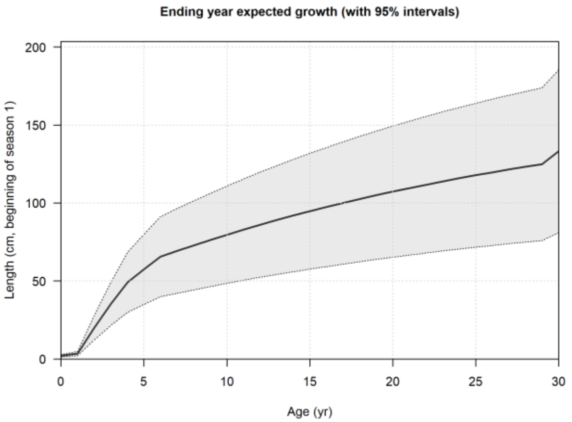


Figure 7: a) Selectivity at length for the fleet and indices b) the change of selectivity with time of the fleet.

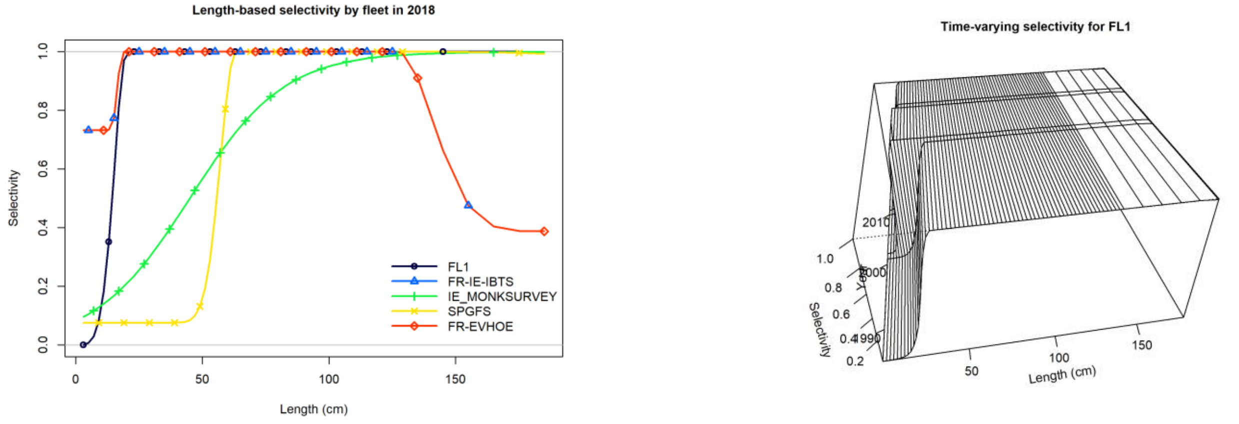


Figure 8: a) The standardized indices and the residuals of the indices: FR-EVHOE survey (red dots and line in figure a and comparison with the fitted values in figure b), FR-IE-IBTS joint index (yellow in figure a and comparison with the fitted values in figure b)), SP-Porc Survey (green dots and line in figure a and comparison with the fitted values in figure d)), Irish monkfish survey (light green in figure a and comparison with the fitted values in figure e).

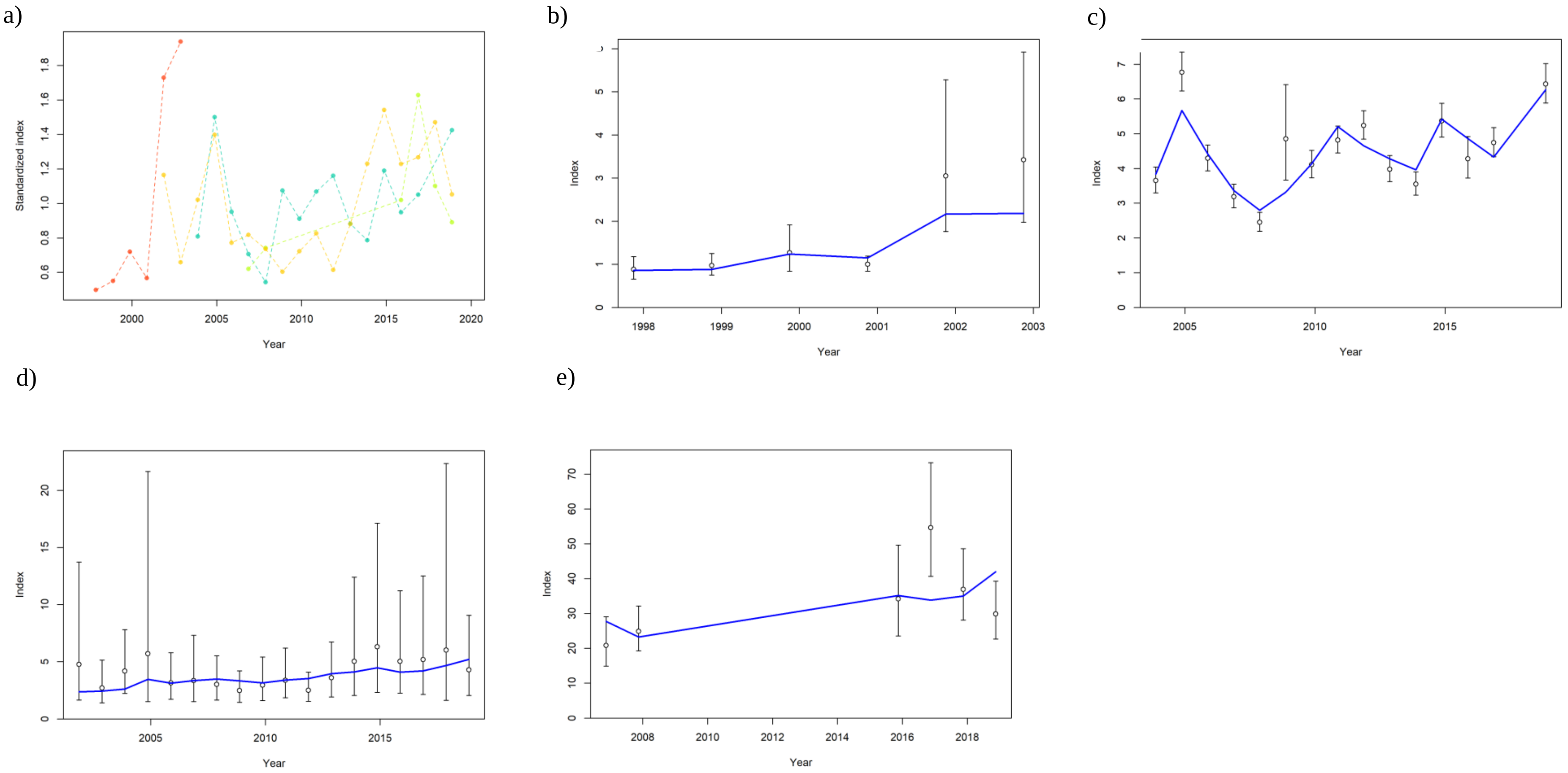


Figure 9: Time series of size for the fleet and for each of the survey observed values in black and the fitted in blue.

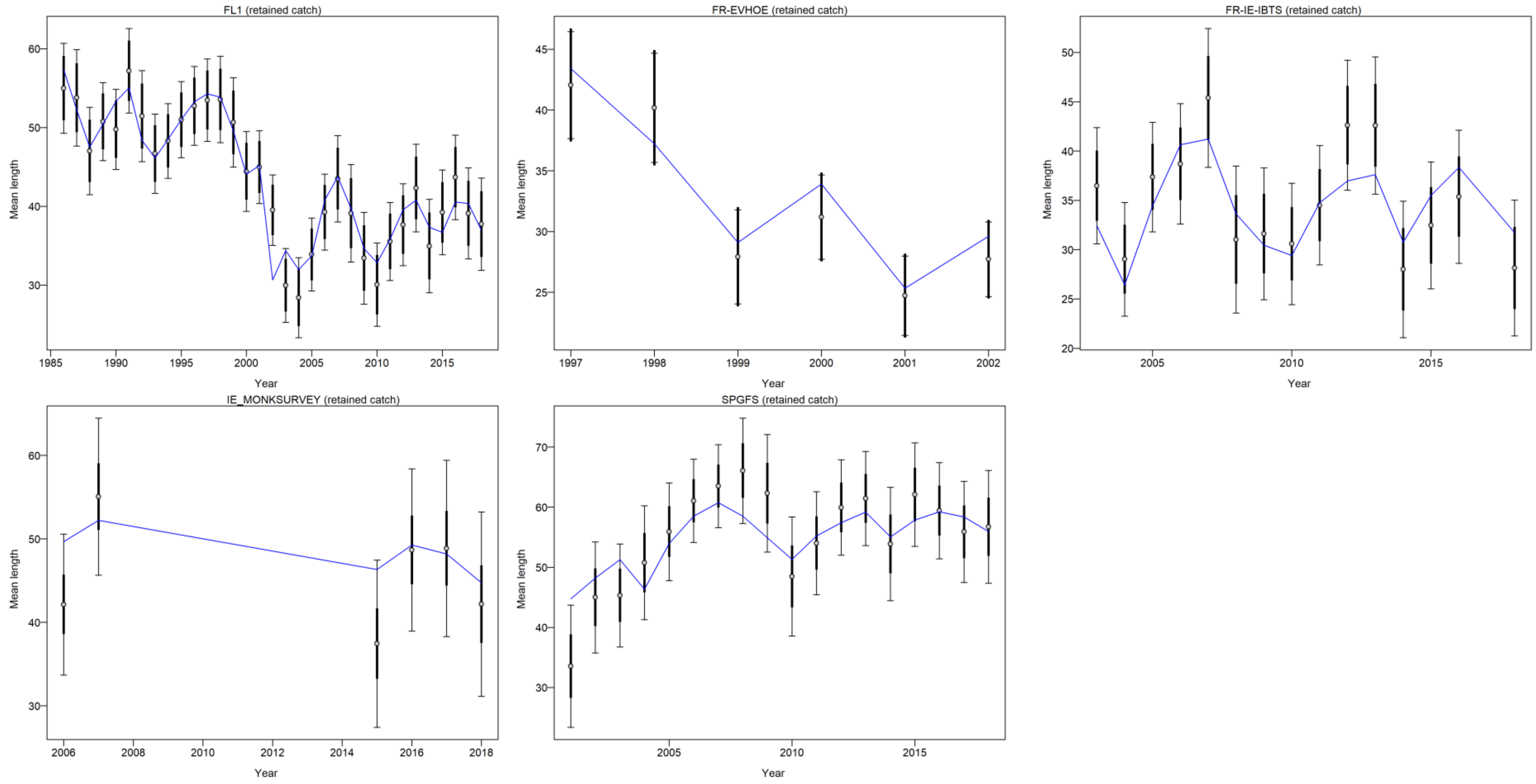


Figure 10: Aggregated size distribution for the fleet and indices of the RC.

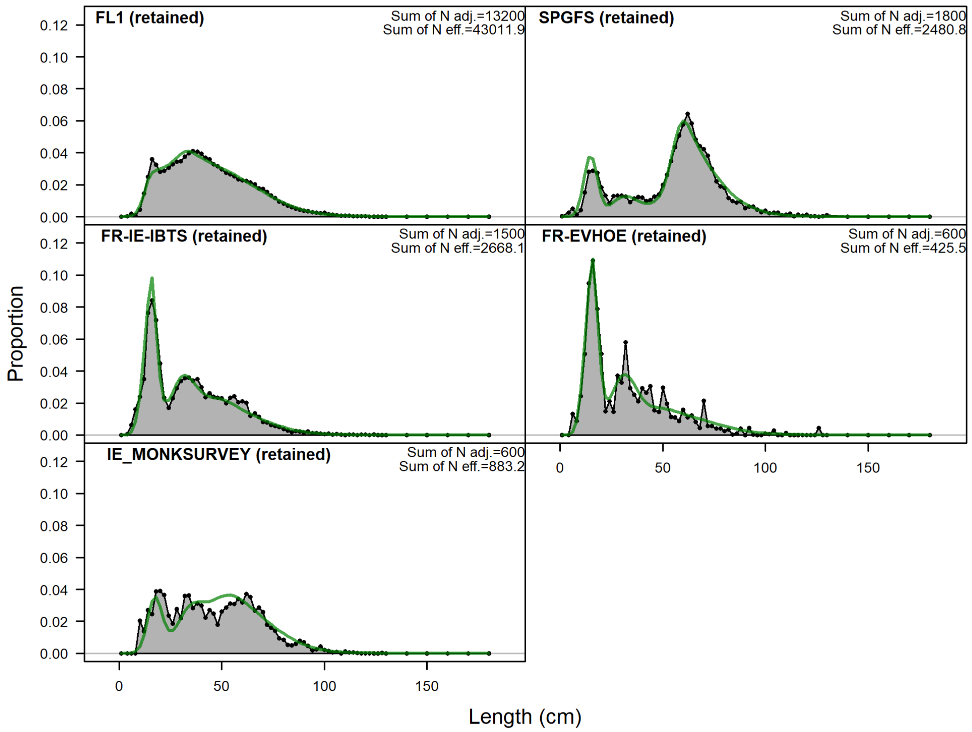


Figure 11: Retrospective pattern of RC.

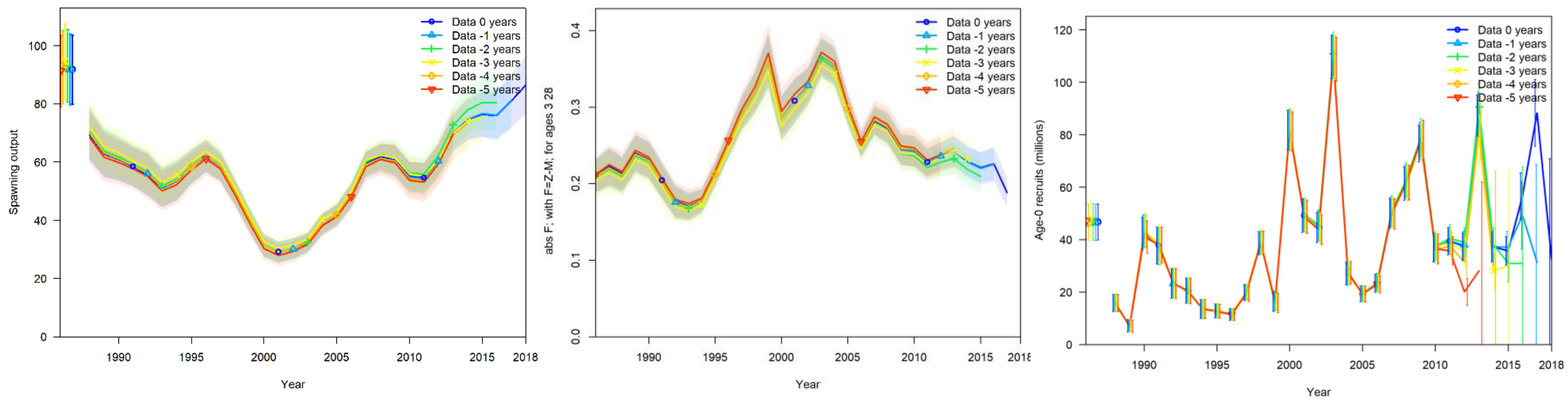
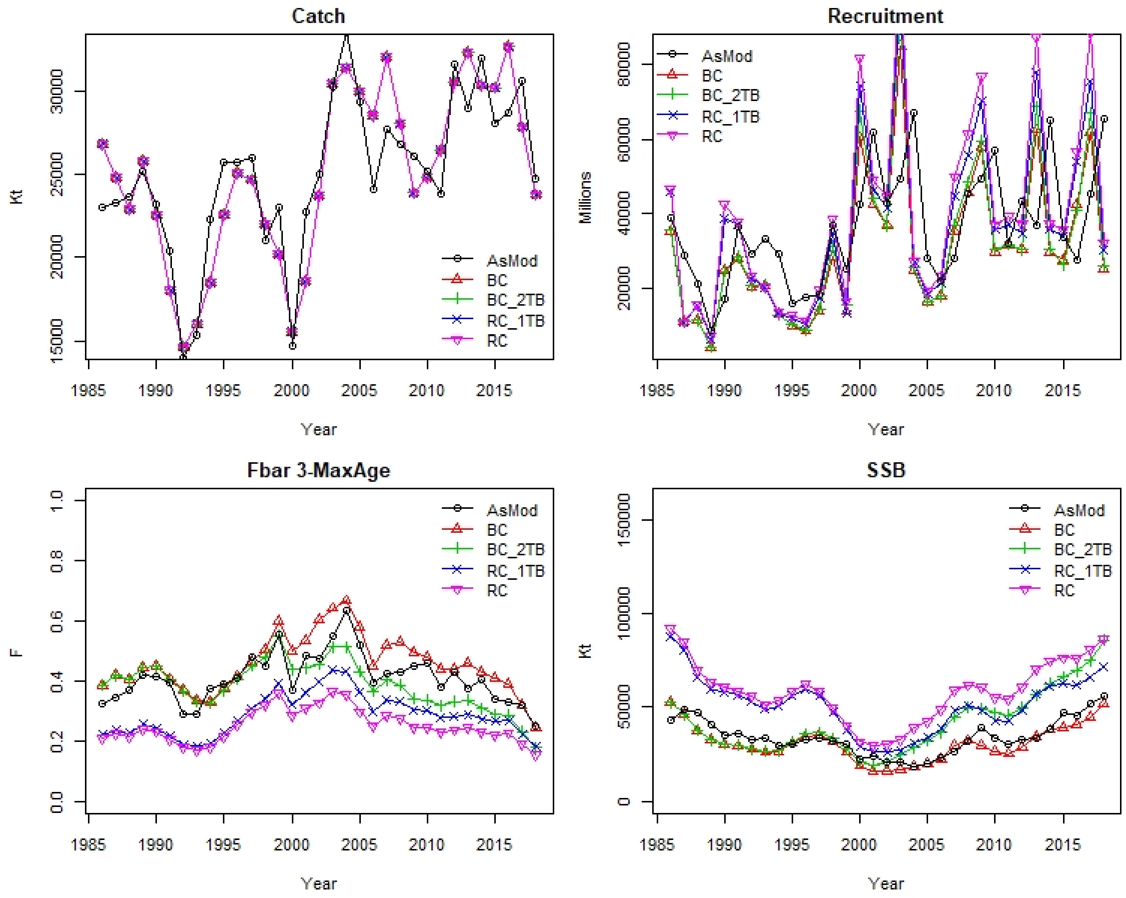


Figure 12: Comparison of the results with the AsMod the BC, the BC with one time block and two tieme blocks and RC with 1 time block and 2 time blocks.



Southern Hake Retrospective Analysis (WD-5. ICES WGBIE 2020)

Santiago Cerviño (IEO), santiago.cervino@ieo.es
Hugo Mendes (IPMA), hmendes@ipma.pt

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Contents

Introduction

Southern hake stock assessment model is a length-based model developed in GADGET (https://github.com/Hafro/gadget) and the latest assessment report is available in www.ices.dk (WGBIE 2019 Report). Gadget is a forwards age-length projection model. Quarterly from 1982 to 2018 with 0 to 15+ ages and 1 to 130 length classess.

The retrospective pattern was not an issue when this model was first implemented in 2010. However the magnitude of this retrospective pattern evaluated as Monh's Rho indices have increased in recent years moving from figures around 0.2 in recent years and raised to around 0.4 last assessment year (see Tab 1 and Fig 1).

Table 1. Rho figures in last 4 years including updated 2020 run

Name	Rho SSB	Rho F
Final Run 2017	-0.28	0.23
Final Run 2018	-0.3	0.24
Final Run 2019	-0.45	0.31
Updated Run 2020	-0.56	0.35

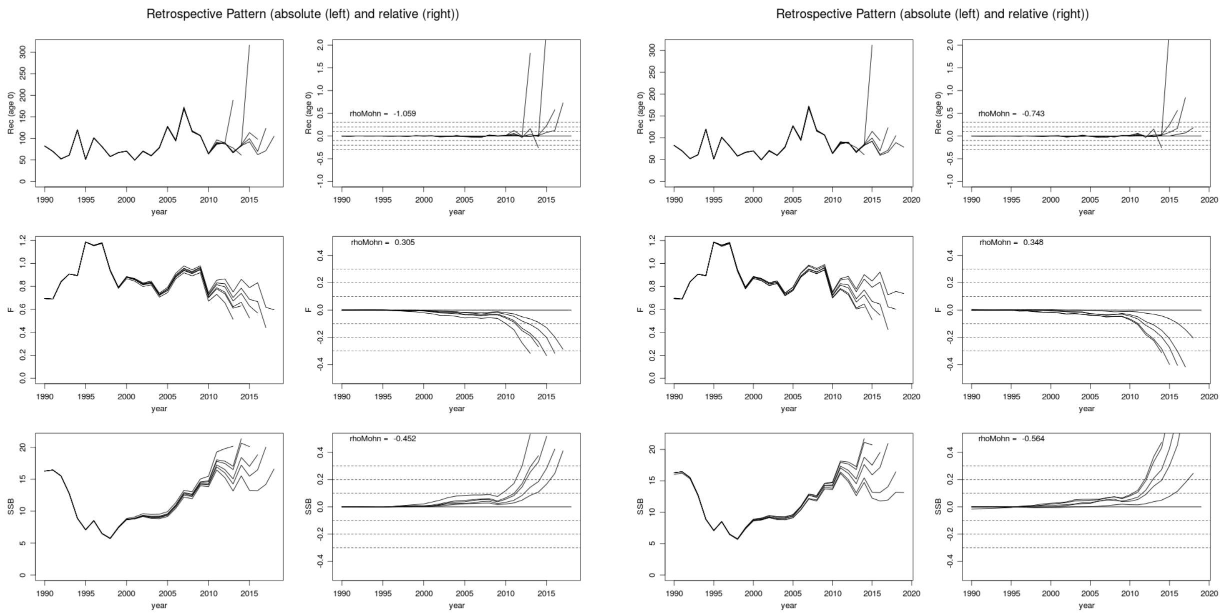


Figure 1. ICES WGBIE 2019 hake retrospective plot with Mohn's Rho figures

An analysis of plausible causes was first developed in ICES WKFORBIAS (Woodshole. USA. 9-17 Nov 2019). The approach consisted on exploring and testing alternative model configurations and their impact on hake retrospective pattern, quantified as a Mohn's rho index. Furthermore, this preliminary analysis can complement the others analysis and checks (convergence, likelihoods, residuals, etc) that can help to explain the sources of the retrospective pattern for this stock. Results suggested that catch underestimation after 2010 is the most probably cause. Although alternative explanations such as an increase of natural mortality or migration out of the area could also produce similar retrospective pattern.

The work initiated in WKFORBIAS was continued with additional scenarios and tests. A total of 53 scenarios were performed and the Rho index was calculated to any of them spending more than 1630 computation hours in the FinisTerrae-II equipment belonging to CESGA (Centro de Supercomputación de Galicia).

Scenarios analysis

Preliminary analysis include scenarios type "one data type out". First blocks of likelihood data types, afterwards running the modes without each likelihood data. Afterwards some scenarios addresing population dynamics uncertain parameters (growth and M), selectivity and catchability were also performed, and finally scenarios were overcatch was simulated and also scenarios were the first years of the time series were removed. In summary, the

- Biological realistic alternatives to growth and M.
- Selectivity realistic alternatives
- Catchability realistic alternatives
- Overcatch scenarios.
- Cut first years

Likelihood data out

Two different approaches have been applyed: first leaving appart big groups of data with similar characteristics (time trends data, length distribution data, fisheries dependent data or survey data) and second, depending on the results, leaving appart small groups or individual likelihoods data each time. The aim of this is to identify whether a specific data type is driving the retro pattern.

Leaving appart big groups of likelihood data

The hake GADGET model uses likelihood data that can be categorized in two different ways. Depending on the sampling origin, the data can be **catch-dependent**, i.e. quarterly length distribution data for landings and discards (with some gaps) and yearly LPUEs for two different fleets (with some gaps two) or **survey-dependent**; there are 3 different demersal surveys performed in 3 different areas covering the whole stock distribution providing hake data on yearly length distribution and abundance indices. On the other side, depending on the model dimension (time and size) we have two groups of likelihood data: **length distribution** data from catch and surveys and **time trends** from surveys and LPUEs. All these data are contributing to 19 likelihood functions, each one with an external weight. The total likelihood is the sum of these 19 product of weight * likelihood. Next plot shows the relative contribution of each likelihoods component to the total likelihood in the Southern hake ICES model.

Table 2. Gadget model Likelihood components

Description	period	area	Likelihood component
Landings -Length distribution	1994–lastYear	Iberia	Land1.ldist
Landings - Length distribution	1982–1993	Iberia	Land.ldist
Landings – Cadiz Length distr.	1994–lastYear	Gulf of Cadiz	cdLand.ldist
Spanish GFS- Length distribution	1982–lastYear	North Spain	SpDem.ldist
Port. GFS - Length distribution	1989–lastYear	Portugal	PtDem.ldist
Cadiz GFS- Length distribution	1990–lastYear	Gulf of Cadiz	CdAut.ldist
Discards - Length distribution	1994,98,99,2004–lastYear	Iberia	Disc.ldist
Sp GFS Abund: 4-19cm	1982–lastYear	North Spain	SpIndex15cm.1
Sp GFS Abund: 20-35cm	1982–lastYear	North Spain	SpIndex15cm.2
Sp GFS Abund: 36-51cm	1982–lastYear	North Spain	SpIndex15cm.3
Pt. GFS: 4-19 cm	1989–lastYear	Portugal	PtIndex15cm.1
Pt. GFS: 20-35cm	1989–lastYear	Portugal	PtIndex15cm.2
Pt. GFS: 36-51cm	1989–lastYear	Portugal	PtIndex15cm.3
Sp LPUE: 25-39 cm	1994–2012	North Spain	Spcpue15cm.1
Sp LPUE: 40-54cm	1994–2012	North Spain	Spcpue15cm.2
Sp, LPUE: 55-70cm	1994–2012	North Spain	Spcpue15cm.3
Pt. Stand. LPUE:25-39cm	1989–lastYear	Portugal	Ptcpue15cm.1
Pt. Stand. LPUE:40-54cm	1989–lastYear	Portugal	Ptcpue15cm.2
Pt. Stand. LPUE:55-70cm	1989–lastYear	Portugal	Ptcpue15cm.3

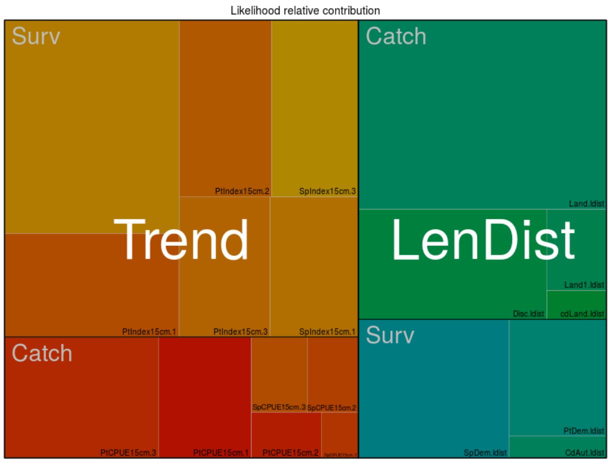


Fig 2. Relative contribution of the 19 likelihoods to the global fit. These are grouped in catch vs. survey dependent and length distribution vs time trends.

A preliminary retrospective analysis are performed deleting each one of these group of data. These are the 4 model names:

- **NoCatch**: without catch length distribution and LPUES data.
- **NoSurvey**: without survey length distribution and abundance indices data.
- **NoLength**: without length distribution from catch and surveys.
- **NoTrends**: without abundance indices (LPUEs and survey indices)

Summary table for

Description	Rho SSB	Rho F	Rho Rec	Comment
WGBIE19 Final Run	-.45	.31	-1.1	
No catch data	0.56	-1.5	0.2	NO CONVERGENCE. Parallel retro
No Survey data	**-0.18**	**0.17**	0.5	**F and SSB Reduction <0.2!**
No Length Dist data	0.33	-0.8	-0.2	NO CONVERGENCE. Parallel retro
No Time Trends data	**0.35**	**-1.3**	0.68	**OPOSITE PATTERN!!!**. Rare retro in period 2000-2005

There are some convergence problems. **However, the elimination of survey data (length distribution and time trends) reduce it below 0.2**. To follow this clue, some additional scenarios were run to identify the specific origin of this Rho value. To carry on with this, some additional scenarios were developed. In this case, to avoid convergence problems caused by leaving a group of relevant likelihoods together, the likelihoods were removed one by one or in small groups. This new analysis focused the problem in survey scenarios too.

Leaving appart Survey likelihood datae

The NoSurvey scenario was the one suggested that this data can be the cause of the observed retro. To continue this clue some additional runs were performed. NOSurvey likelihood data includes length distribution data and time trends data for two surveys split in 3 15 cm length groups from 5 to 50 cm

Description	Rho SSB	Rho F	Rho Rec	Comment
No Survey Ld	-0.49	0.32	-1.1	
No Survey Tr	-0.18	0.17	0.35	

Description	Rho SSB	Rho F	Rho Rec	Comment
No Survey Tr 5-20	-0.46	0.3	-1.8	
No Survey Tr 20 35	-0.18	0.17	-0.47	**HERE IT IS!!!!**
No Survey Tr 35-50	-1.1	0.5	-0.75	

When the Survey trend is given apart, the SSB Rho is reduced from -0.45 to -0.18 and F from 0.31 to 0.17. The same results are getting when we leave apart the length group of 20-35 cm. This preliminary analysis focuses the problem on the survey trend (lengths 20 to 35) data. However surveys are the more confident source of information because the well controlled sampling process. Furthermore, the length clash between 20 and 35 cm are well represented in both surveys. It is difficult to think that this data source is the cause of the problem, thought it is clearly affecting the pattern. Additional runs can be performed to indentify whether the PtSurvey or the SpSurvey data are causing this problem showed that is the combination of both. When we leave apart only one the Rho is quite less reduced.

Biological (growth and natural mortality)

Rationale: Current model included M=0.4 for all ages; Linf=130; k and **beta** (dispersion parameter) are model estimated. Biological studies show that there are alternatives to this "best model" approach decided in last benchmark.

The following scenarios were explored - **M 0.3.** M = 0.3 for all ages. Initially K was estimated but the K and M are higly correlated and k was bounded at 0.1. The models was re estimated keeping k=0.17, that was the value estimated with M=0.4 model. - **M 0.3 Ages 0-1.** The same as previous but Mage0=1 and Mage1=0.6 (based on predation) - **M 0.3 Ages 0-1 M9plus.** The same as previous but M increases for ages older than 9 based on senescence. - **Linf100K17M28.** Median figures from an hierarchical bayesian analysis based on hake (12 spp data) life history invariants. - **beta10DeltaL10.** Beta is currently model estimated driven to quite low figures. Correction of growth dispersion to reduce the model estimated dispersion.

Description	Rho SSB	Rho F	Rho Rec	Comment
M 0.3	-0.29	0.24	-0.81	Slight reduction of Retro
M 0.3 Ages 0-1	-0.32	0.26	-0.88	No clear retro pattern. Convergence?
M 0.3 Ages 0-1 M9plus	-0.32	0.23	-0.91	Slight retro reduction. Increased before 2000.
Linf100K17M28	-0.29	0.27	-0.91	Slight retro reduction
beta10DeltaL10	-0.47	0.32	-0.65	Similar than base model

In general, alternative "realistic" biological parameters **improve only slightly the retrospective pattern**. However an M around 0.3 could contribute, at least partially, to the solve the problem.

Selection alternatives (changing fishery process)

Rationale: Current selection for recent years include separate landings (logistic from 1994 to now) and and discards (asymetric normal from 1994 to now). Other "fleets" are separated in the past. The scenarios explored are related with alternative selections for fleets in recent years using dome shaped instead of logistic.

- **Sel Change 2005**. Current landing "fleet" is split in two periods: 1994-04 and 2005-now.
- **Dome shaped (estim end)**. Current landing "fleets" with logistic selections are changed to dome shaped selection.

- **Dome shape (cte end)**. Current landing "fleets" with logistic selections are changed to dome shaped selection fixing the parameter that defines the right part function.

Description	Rho SSB	Rho F	Rho Rec	Comment
Sel Change 2005	-0.47	0.23	-1.1	Retro converge in 2005 but get wider before
Dome shape (estim end)	0.9	-4	0.35	Weird but interesting. Convergence problems. But a thread to follow.
Dome shape (cte end)	-0.48	0.29	-1	Wider retro in past. Pivot point around 2010

The first and third scenarios do not change substantially the base case. However the second one, that do not converge in some peels can help to future tests.

Catchability process

Rationale: Current catchability models are linear in log scale. However there are reasons to think that some dense-dependent process can be in act. For instance, in the periods of large abundance (2005-2010) the density increases outside the survey area. The scenarios explored are the following:

- **surveys 2 params**. The two surveys are now modeled with dense-dependent catchability
- **Pt CPUE 2 params**. The two CPUEs are now modeled with dense-dependent catchability

Description	Rho SSB	Rho F	Rho Rec	Comment
surveys 2 params	-0.84	0.42	-0.53	Worst than Base. Slight improve in recruitment.
Pt CPUE 2 params	-0.62	0.37	-0.98	Worst than Base

Overcatch scenarios

Rationale: Current catches used in the Southern hake stock assessment model are not the official ones but estimated. The sampled vessels catch and effort are used to raise each metier catch to total effort. The reason to set 2010 as the year to increase the catch are twofold: (1) estimation system changed after 2010, now is not dependent on the fishing sector collaboration; there were important changes in the regulation (e.g. share of quotas by vessel) and increased of inspection which resulted in a weaker collaboration; on the other side (2) there are more diagnostics showing that something happened after 2010, such as a increased of the retrospective pattern or some survey residuals that start to raise. To test the impact of catch overestimation on the retrospective pattern some scenarios were run with overshoting after 2010 of 10%, 20%, 30% and 40%. the results are presented in the following table.

Description	Rho SSB	Rho F	Rho Rec	Likelihood
0%	-.45	.31	-1.1	1242
10%	-0.34	0.25	-0.9	1229
20%	-0.23	0.19	-0.82	1195
30%	-0.15	0.13	-0.77	1182
40%	-0.08	0.08	-0.67	1173

Results are quite consistent since all the indicators used show the same continuous behavior: the Rho's SSB decreases with increased overcatch, the same for Rho F and Rhos recruitment and also for the likelihood, i.e. an increase of catches after 2010 gives a good Rho value with a better model fit.

Which likelihood figures are contributing more to this likelihood decrease? The following table summarise how change each likelihood component.

Lik	0%	10%	20%	30%	40%	50%
Len dist	100%	101%	100%	100%	100%	100%
SP Survey	100%	97%	95%	92%	90%	91%
PT Survey	100%	96%	92%	89%	87%	83%
SP CPUE	100%	97%	95%	93%	89%	93%
PT CPUE	100%	93%	97%	97%	96%	97%
Total	100%	96%	95%	93%	91%	90%

In general we see that the inclusion of additional catch does not affect the quality of the fit of the length distribution but those of the survey trends. This mean that adding catches after 2010 helps to explain better the whole likelihood data, although specifically the trends data for all, surveys and CPUEs.

Time series cut

Rationale: The initial time series (1982-93) of Spanish catches and length distribution in the Northern area were estimated in the 90s. There were not a records of catches by stock area since the fleet was allowed to catch in both areas. The bigger vessels were catching more frequently in the North, even though there were some missing that required stock assignment. IEO and AZTI scientist reviewed that data and made an assignment by stock. This work was critical in the 90s since this information was required to do both assessments. However the time series is now larger and an assessment can be developed without this information. In fact WKFORBIAS recommended to this kind of exercised when information is less reliable.
A GADGET run from 1994 to 2019 was performed. Retro plot and Rho figures were calculated in two different ways. First using the last assessment year estimated parameters for all the peels and second, using different starting figures to each peel. Results are presented in next figure.

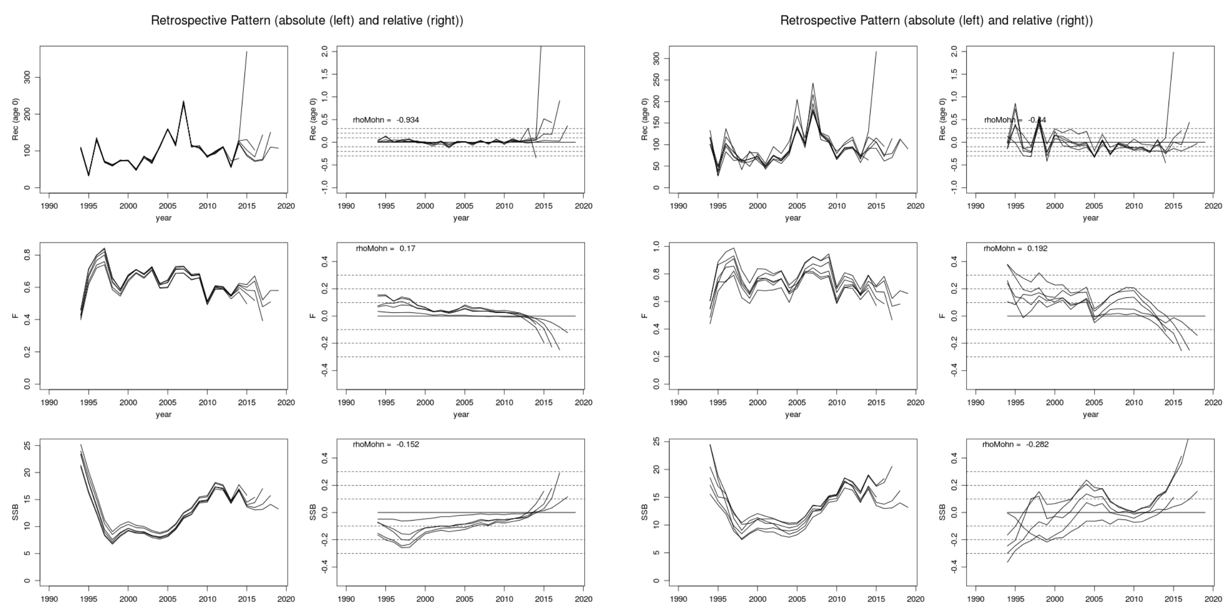
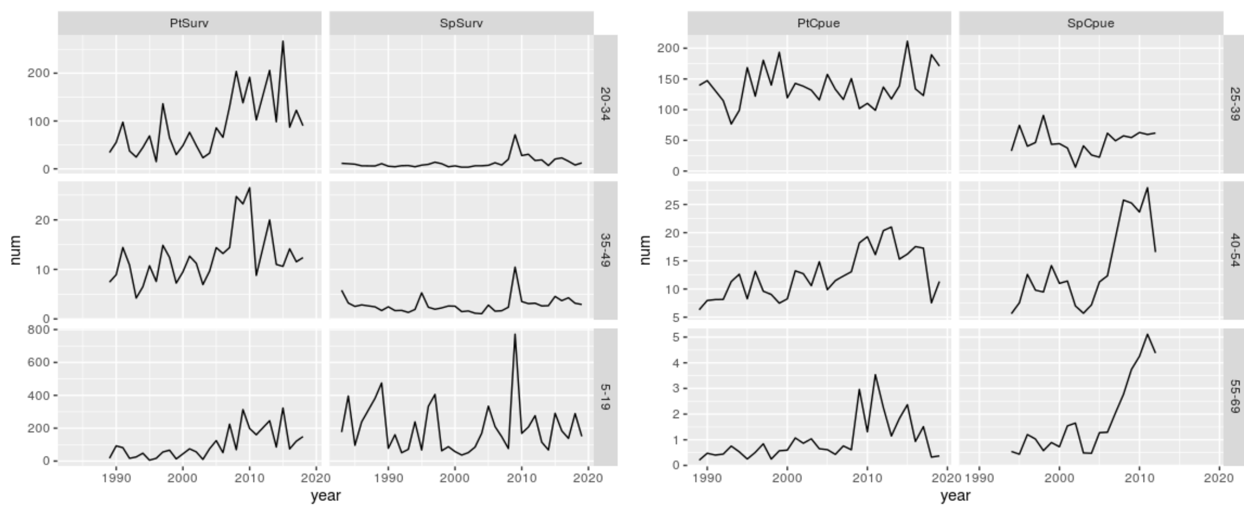


Figure shows the retrospective plot with peels estimated starting with same parameters (Left) and peels with different parameters (Right). In general we can see that the Retrospective pattern improves. However there is an issue with the convergence, that gets worse. Next table shows the Rho figures for these two runs and final (2019) and updated (2020) runs.

Name	Rho SSB	Rho F
Run 94 =param	-0.15	0.17
Run 94 != param	-0.26	0.19
Final Run 2019	-0.45	0.31
Updated Run 2020	-0.56	0.35

Discussion

Two possible explanations for the retro have been identified: Contradictory signals in abundance index trends and Catch underestimation. And both could be linked. Next plot shows the raw abundance trend data used to calibrate the GADGET model. These are updated to 2019.



Contradictory signals source inside the same index or among indices. Examples in the same index are SPSurv, with recruits (length 4-19 cm) without a clear trend, mainly noise, although upcoming classes (lengths 20-55) showing an increase after 2005. Something similar happens with PtCPUE, with length group (25-49 cm) increasing after 2010 and although upcoming classes (lengths 50-79 cm) show a decrease after 2010. Conflict signals among different indices can be seen, for instance, between PtSurvey (20-34), increasing after 2005, and PtCPUE (25-39), without this increase; also between SpSurvey (4-19), with no clear trend, and PtSurv (4-19) increasing after 2005; also the strong decrease of abundance after 2010 in PtCPUE (40-54 and 55-69) that is not seen in any other index.

These data conflicts affect the model fit as can be seen in the 2019 model residuals. Furthermore, when adding new data each year, the new model fit can give more credibility to a different index affecting the population abundance through the index catchability and its trends. If this change in index dominance is consistent in time it can produce a retrospective pattern. What it is observed in the change in population biomasas (SSB) estimated by GADGET is that the population increase in 2005-10 is not reproduced in the recent GADGET models, i.e. the index showing this change are having less contribution in recent models.

An additional source of mortality after 2010 produces a reduction of the retrospective pattern but also improves the quality of most of the indices fit, reducing also to total likelihood. However, although the scenario simulated implements an increase in catches, a similar result could be obtained with an increase of natural mortality or even with an increase of migrations out of the stock. Although an increase on catches can happen there is not alternative information to run the model. Natural mortality depends on their predators that are mainly hake (cannibalism) and common dolphins. The available information stomach contents although partial, it shows an increase of hake in hake diet after 2004, when the increase of hake abundance was first observed. Information on migrations out of the stock are also scarce. Tagging in Spain have not got success in recoveries and tagging n France, although successful in recoveries do not provide information on migrations out of Iberian peninsula. However there are some non-direct information that can help. These are the genetic studies showing that both stocks are quite connected and also the recent raise in abundance in the North stock, although none of these process implies necesarially migration from South to North.

A common pattern in all (most) the runs performed is that the retro get worse in last two years. Some additional data are supporting a decrease in abundance in last 2 years!!

Among the scenarios developed we found there were other things that help to reduce the retrospective pattern. First the reduction of natural mortality from 0.4 to 0.3 (with different M structures), although in any case Rho figures were reduced bellow rule of thumb (0.2). It also worked the cut of the time series starting in 1994 instead of the usual 1982. In this case there is a clear issue with the convergence that requires additional work to solve it. The reason for this can be that now the conflicting calibration indices are more in play. Furthermore, such a change would require a re estimation of the weights for all likelihoods, thick that was not tested.

Conclusions and further work

The main goal of this work was to explore the causes of the strong retrospective pattern with the aim of produce an alternative model to give advice to 2021 catches. Although this target was not achived, we better understan now of the potential causes producing the retrospective patter. HOwever there are still some options that can be tested in a short time.

- The option to increase mortality: fishing, natural (or even migration) do not seem reliable given the lack of external information to support any plausible alternative.
- Whether convergence problems are caused by conflicting signals inside calibration indices, it can be explored some alternatives such as changing CPUEs-at-legth with biomass CPUEs.
- Short time series combined (or not) with a lower M (= 0.3) could work in terms of retrospective pattern. However it requires a re-estimation of likelihood weights and probably dealing with convergence problems. This makes difficult to estimate the time needed to do it.

However it depends on the time available in the WGBIE but also whether we are able to go for a inter-becnhmark with this uncertain options.

Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE)

(by correspondence, 6–13 May 2020)

Preliminary results of a4a assessment model for megrim (*L. whiffiagonis*) in ICES Divisions 7b-k and 8a,b,d

by

Ane Iriondo[1], Agurtzane Urtizberea, Sonia Sanchez, Dorleta García and Marina Santurtún

AZTI. Txatxarramendi Ugartea z/g. E-48395 Sukarrieta - BIZKAIA (Spain)

[1]Corresponding author: airiondo@azti.es

1 Introduction

Megrim *(L. whiffiagonis)* is assessed in ICES Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) with a Bayesian catch-at-age model considered as a full analytical assessment since 2016[1i].

During WGBIE 2019, as it is yearly presented, an issue list was drafted for this stock in order to improve the assessment for next years. The identified issues are listed in the table below:

Issue	**Problem/Aim**	**Work needed / possible direction of solution**	**Data needed to be able to do this: are these available / where should these come from?**
Tuning series	France: No update of LPUEs data series are provided to the group from 2008 onwards.	Provide LPUE data from France for different bottom trawl fleet from 2008 onwards.	IFREMER to provide FU LPUE data series reviewed.
Biological Parameters	Old maturity ogive	Update the maturity ogive. Statistical method review.	Update the new maturity ogive, as presented in WD 07 in this report.
Assessment method	The Bayesian SCA model was ad-hoc implemented to solve the lack of discard data from France. After IBP Megrim 2016 discard from France where provided, so the problem disappeared. Therefore, a change to a more standardized model is proposed to ease the implementation and shorten the iteration times.	Intersessional work should be done to try different models.	Data are already available.
Landing Obligation	Impact of LO on model settings and data arrangement		

[1] ICES. 2016a. Inter-Benchmark Protocol Workshop Megrim (Lepidorhombus whiffiagonis) in divisions 7.b–k and 8.a, 8.b, and 8.d (West and Southwest of Ireland, Bay of Biscay) (IBP Megrim 2016), July 2015–March 2016, by correspondence. ICES CM 2016/ACOM:32. 124 pp. https://doi.org/10.17895/ices.pub.5352

Therefore, one of the issues to be solved is related to the assessment method:
"The Bayesian SCA model was ad-hoc implemented to solve the lack of discard data from France. After IBP, Megrim 2016 discard from France were provided, so the problem disappeared. Therefore, a change to a more standardized model is proposed to ease the implementation and shorten the iteration times."

2 Material and methods

The A4a statistical catch at age model has been developed as part of the Assessment For All (a4a) initiative of the European Commission Joint Research Centre. The model is implemented in R software (http://www.r-project.org/) and uses FLR (http://www.flr-project.org/) and ADMB (http://www.admb-project.org/). For a more detailed description, see: http://www.flr-project.org/doc/Statistical_catch_at_age_models_in_FLa4a.html

2.1 Data and data exploration

For applying the a4s stock assessment, all the input data for the assessment were converted to the appropriate format and these were were included in this two files: inputMegrim78As.RData (catch and biologica data) and MegIndices.RData (information on tuning indices).

Input data for the assessment were formatted as FLR objects. Firstly, catch and biological information (landings and discards, in numbers-at-age and mean weight-at-age, mean-weigts at age in the stock, natural mortality, maturiry and proportions of mortality before spawning) were converted to FLStock object.

```
stock <- FLStock(catch.n =catches.n, landings.n= landings.n, discards.n=discards.n,
              catch.wt=catches.wt,landings.wt=landings.wt,   discards.wt=discards.wt,
              stock.wt=stock.wt, catch= catches,landings=landings, discards=discards,
               m=m, mat=mat, harvest.spwn=harvest.spwn,m.spwn=m.spwn)
```

Next, tuning índices data were formatted based on FLR data format for indices, generating an FLIndices object which consist of a list of FLIndex objects, one for each of the five tuning fleets:

```
tun <- FLIndices(Tun1,Tun2,Tun3,Tun4,Tun5)
```

Data exploration was done based on the script: **3.meg_Dataexploration.Rmd** were a file is generated with all the exploratory data analysis. Figure 1 shows details on catch and and tuning fleets data are used for the assessment.

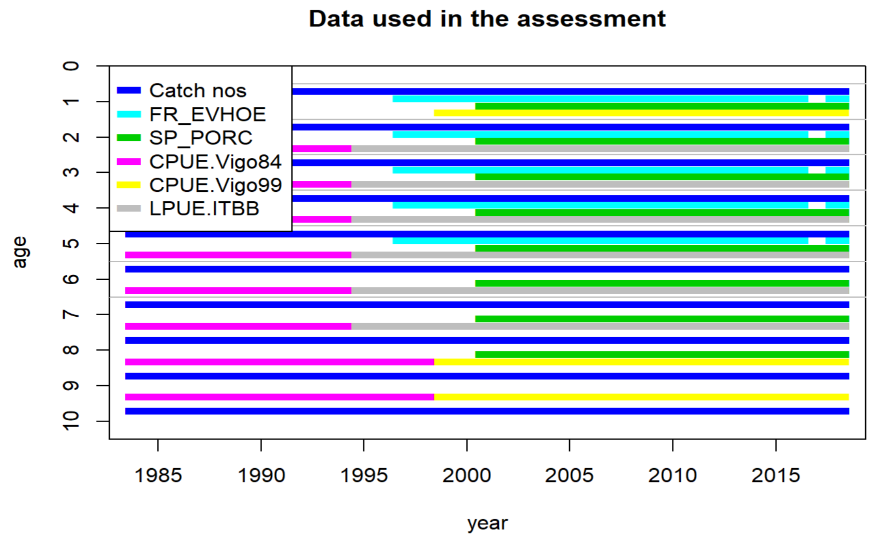


Figure 1. Year and age ranges for the input data for the assessment (catch data and and 5 tuning fleets).

Table 1. Year and age ranges for the input data for the assessment (catch data and and 5 tuning fleets).

DATA	YEARS	AGES	NOTES
Catches	1984-2018	1-10	
Survey EVHOE	1997-2018	1-5	French IBTS survey index in 7 and 8; Catch in numbers per hour;L. whiffiagonnis (ages 1-5, 1997-2018)
Survey PORCUPINE	2001-2018	1-8	Spanish IBTS Porcupine survey; Cpue in numbers per 30min; L. whiffiagonnis (ages 1-8, 2001-2018)
Commercial VIGO 84	1984-1998	2-9	Spanish demersal trawlers (Vigo) in subarea 7 from 1984-1998; L. whiffiagonnis (ages 2-9, 1984-1998)
Commercial VIGO 99	1999-2018	1-9	Spanish demersal trawlers (Vigo) in subarea 7 from 1999-2018; L. whiffiagonnis (ages 1-9, 1999-2018)
Commercial IRTBB	1995-2018	2-7	Irish beam trawlers; unit Standardised to N0/10SqKm; L. whiffiagonnis (ages 2-7, 1995-2018)

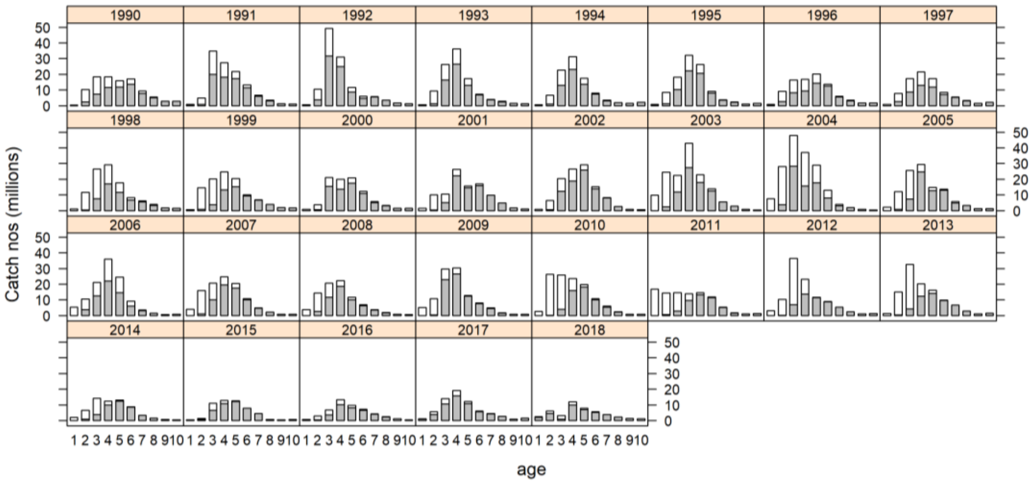


Figure 2. Catch numbers at age: landings (grey), discards (white).

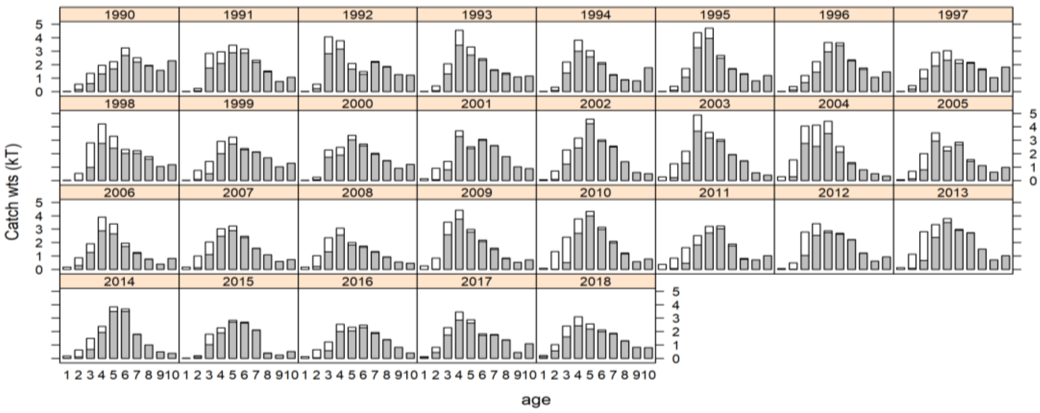


Figure 3. Catch weight at age: landings (grey), discards (white).

Buble plots to show catches , grey is below average, white is above average and cohort tracking in tuning fleets.

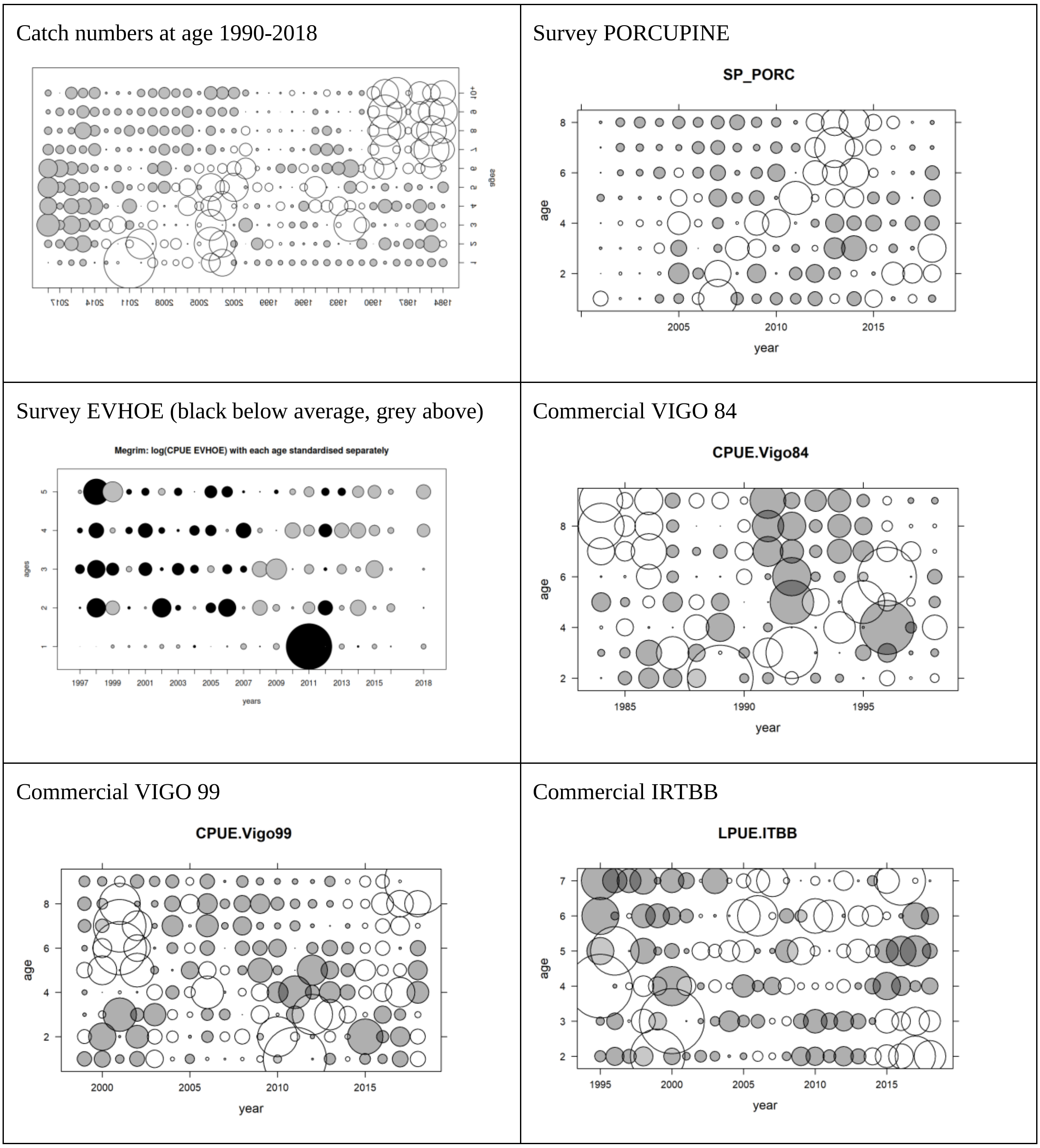


Figure 4. Catch numbers at age and 5 tuning fleets used (2 surveys and 3 commercial fleets).

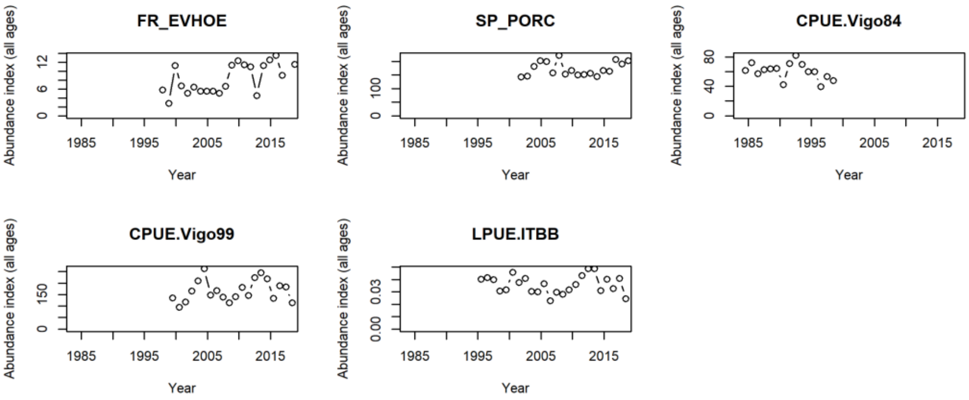


Figure 5. Abundance indices for all ages.

Standardised CPUE by cohort of the tunig fleets to analize the internal consistency of ages. Despite SP-Porcu survey shows a bit of consistency, in general all are a bit noisy.

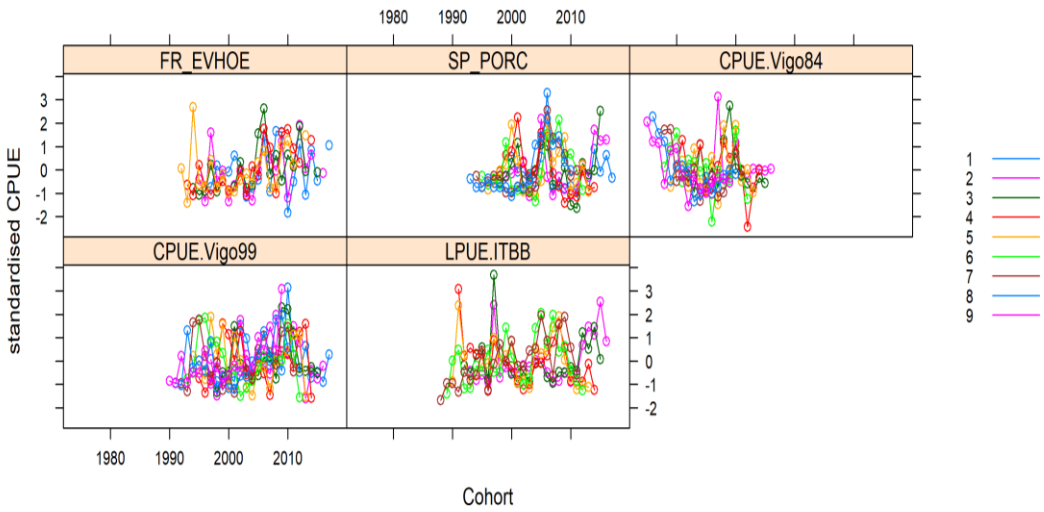


Figure 6. Standardised CPUE by cohort of the tuning fleets by ages.

Standardised CPUE by cohort of the tunig fleets to analize the internal consistency of tuning fleets, in general all are a bit noisy.

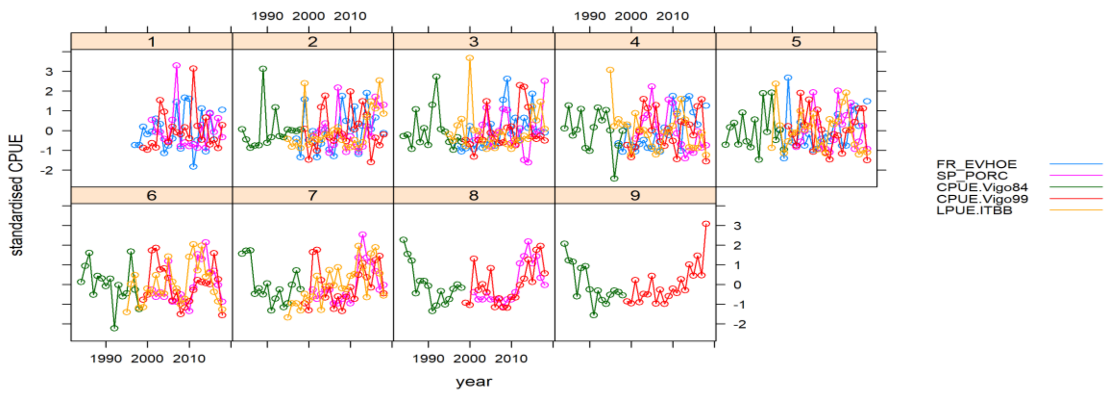


Figure 7. Standardised CPUE by cohort of the tunig fleets by fleet.

The log-ratios of the catch and tuning data can give an indication of the selectivity pattern of the fleets and surveys.

Log ratio of the catch data. This pattern suggest a relatively flat-topped selection. A logistic selectivity may be appropriate.

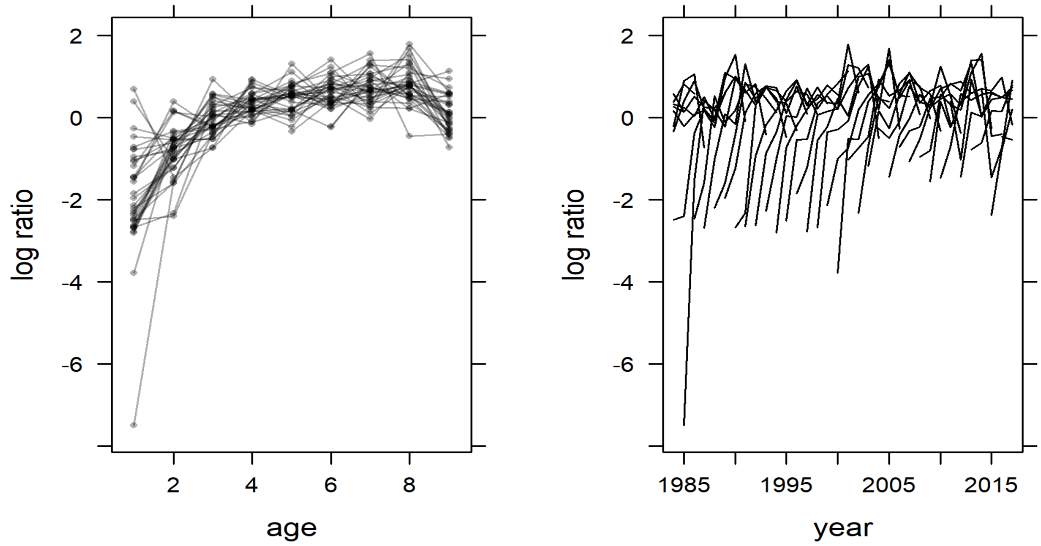


Figure 8. Log ratio of the catch data by ages (left panel) and by year (right panel).

Log-ratios of tuning fleet data are shown in the figure below. For LPUE.ITBB, SP-PORC, CPUE.Vigo84. CPUE.Vigo99 a logistic curve may be appropriate. For FR-EVHOE survey a ‘flat’ catchability model may be also appropriate (i.e. same q for all years).

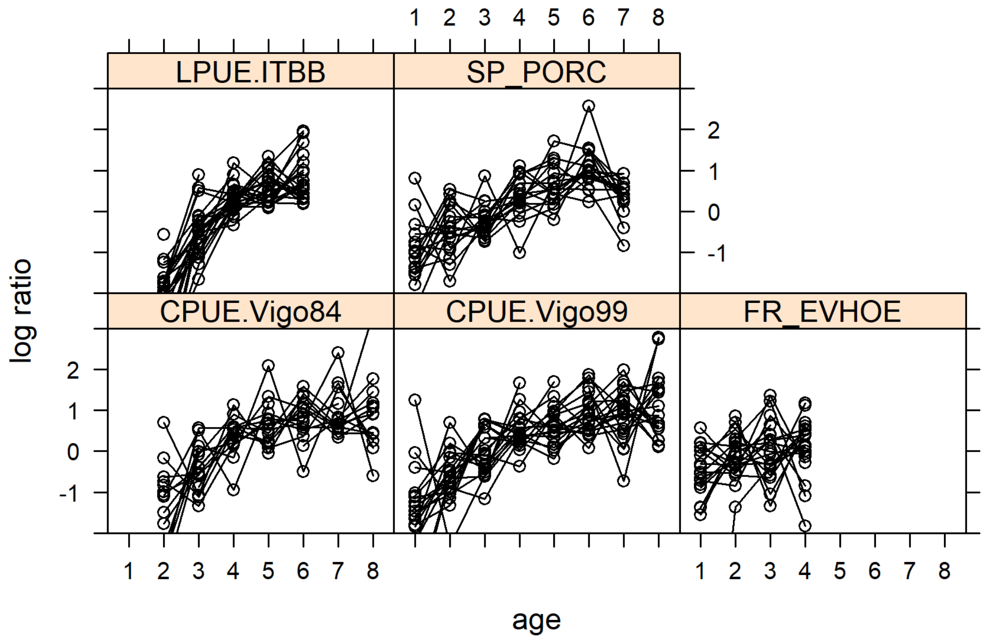


Figure 9. Log-ratios of tuning fleet data for LPUE.ITBB, SP-PORC, CPUE.Vigo84. CPUE.Vigo99 and FR-EVHOE.

3 Exploratory assessment

Based on the exploratory analysis of the input data, the following assessments are proposed:

- RUN 1: BASE CASE: the same settings used in the WGBIE 2019 for the Bayesian model.
- RUN 2: Flat Q for EVOHE Fit alternative models (different input data or models)

Table 2. Catchability models for the different runs for each of the tuning indices.

DATA	RUN 1: BASE CASE q mod	RUN 2: q mod
Survey EVHOE	I(1/(1 + exp(-age)))	-1 (flat q: the same for all ages)
Survey PORCUPINE	I(1/(1 + exp(-age)))	I(1/(1 + exp(-age)))
Commercial VIGO 84	I(1/(1 + exp(-age)))	I(1/(1 + exp(-age)))
Commercial VIGO 99	I(1/(1 + exp(-age)))	I(1/(1 + exp(-age)))
Commercial IRTBB	I(1/(1 + exp(-age)))	I(1/(1 + exp(-age)))

3.1 Run 1: BASE CASE

An initial assessment was conducted using all fleets and the following submodels for the different processes:

- fmod (F at age): a formula object depicting the model for log fishing mortality at age.

```
fmod <- ~factor(replace(age,age>9,9)) + factor(year)
```

- srmod (model for recruitment): a formula object depicting the model for log recruitment

```
srmod <- ~factor(year) #this stock-recruitment model (srmod) is 'free'; i.e.
there is no restriction on the estimated recruitment, based on the SSB.
```

- qmod (catchability at age): a list of formula objects depicting the models for log survey catchability at age.

```
#the order for megrim tuning fleet is: "FR_EVHOE" ,"SP-PORC", VIGO84, VIGO99,
IRTBB.
qmod <- list(~I(1/(1 + exp(-age))),~I(1/(1 + exp(-age))),~I(1/(1 + exp(-
age))),~I(1/(1 + exp(-age))),~I(1/(1 + exp(-age))))# logistic function for all
tuning fleets
```

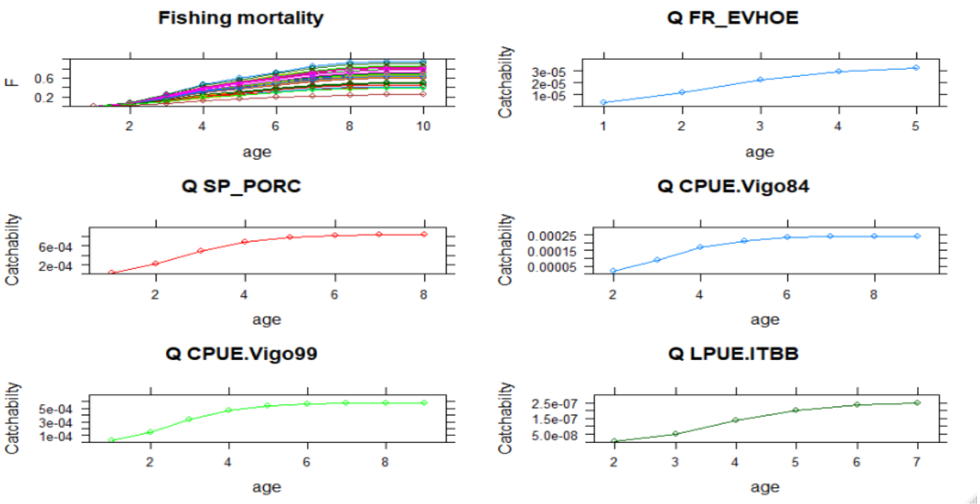


Figure 10. Catchability models used in the Base Case run.

```
fit1 <- sca(stock,tun.sel,fmodel=fmod,qmodel=qmod,srmodel=srmod)

submodels(fit1)

fmodel: ~factor(replace(age, age > 9, 9)) + factor(year)
        srmodel: ~factor(year)
        n1model: ~s(age, k = 3)
qmodel:
           FR_EVHOE:     ~I(1/(1 + exp(-age)))
           SP_PORC:      ~I(1/(1 + exp(-age)))
           CPUE.Vigo84: ~I(1/(1 + exp(-age)))
           CPUE.Vigo99: ~I(1/(1 + exp(-age)))
           LPUE.ITBB:    ~I(1/(1 + exp(-age)))
vmodel:
           catch:        ~s(age, k = 3)
           FR_EVHOE:     ~1
           SP_PORC:      ~1
           CPUE.Vigo84: ~1
           CPUE.Vigo99: ~1
           LPUE.ITBB:    ~1
```

3.1.1 Results: Base Case

In the initial exploratory run using logistic curve for catchability (qmod) for all fleets.

Figure 11. Stock summary results for recruis, SSB, catch and fishing mortality in the Base Case.

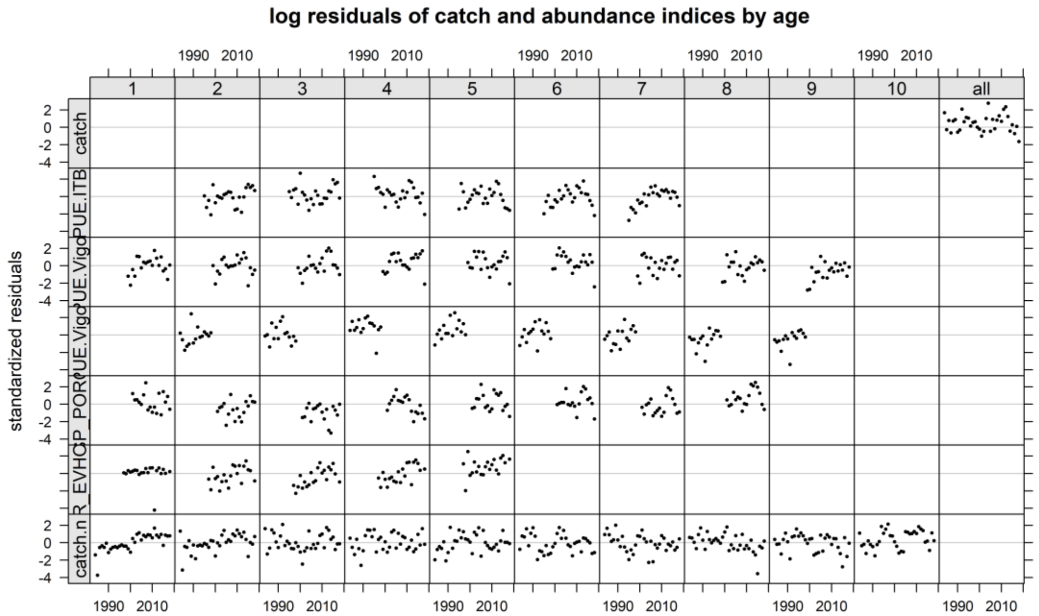


Figure 12. Standarized residuals for abundance indices and for catch in numbers.

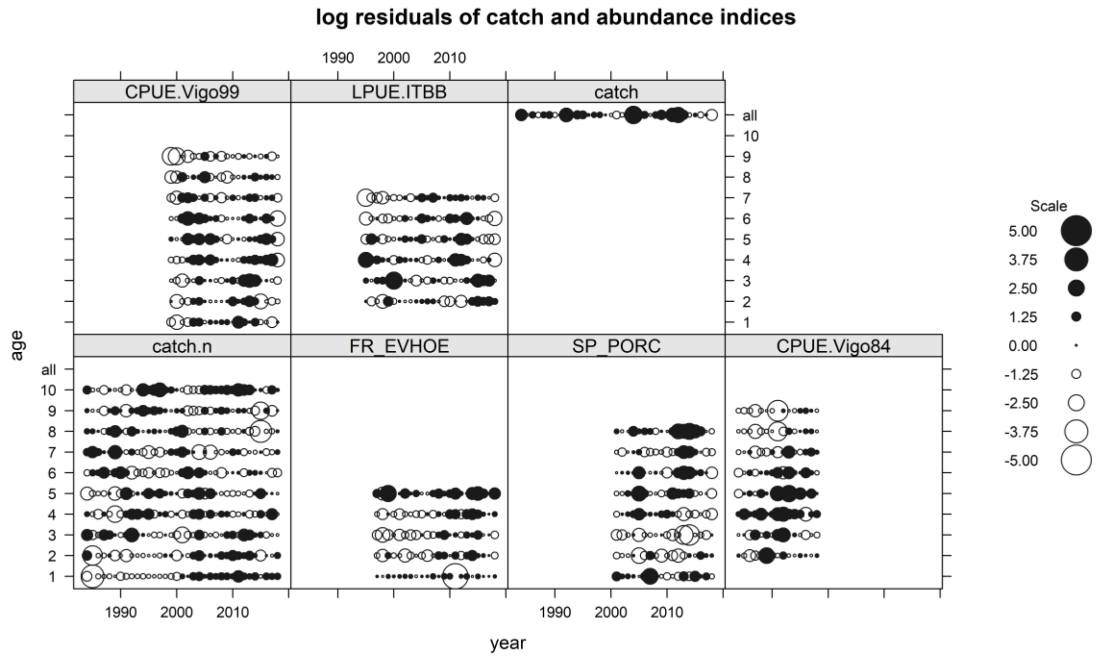


Figure 13. Bubbles plot of standardized residuals for abundance indices and for catch in numbers.

When comparing the stock status estimates using a4a and the results obtained in the WGBIE 2019, the two models give similar absolute estimates.

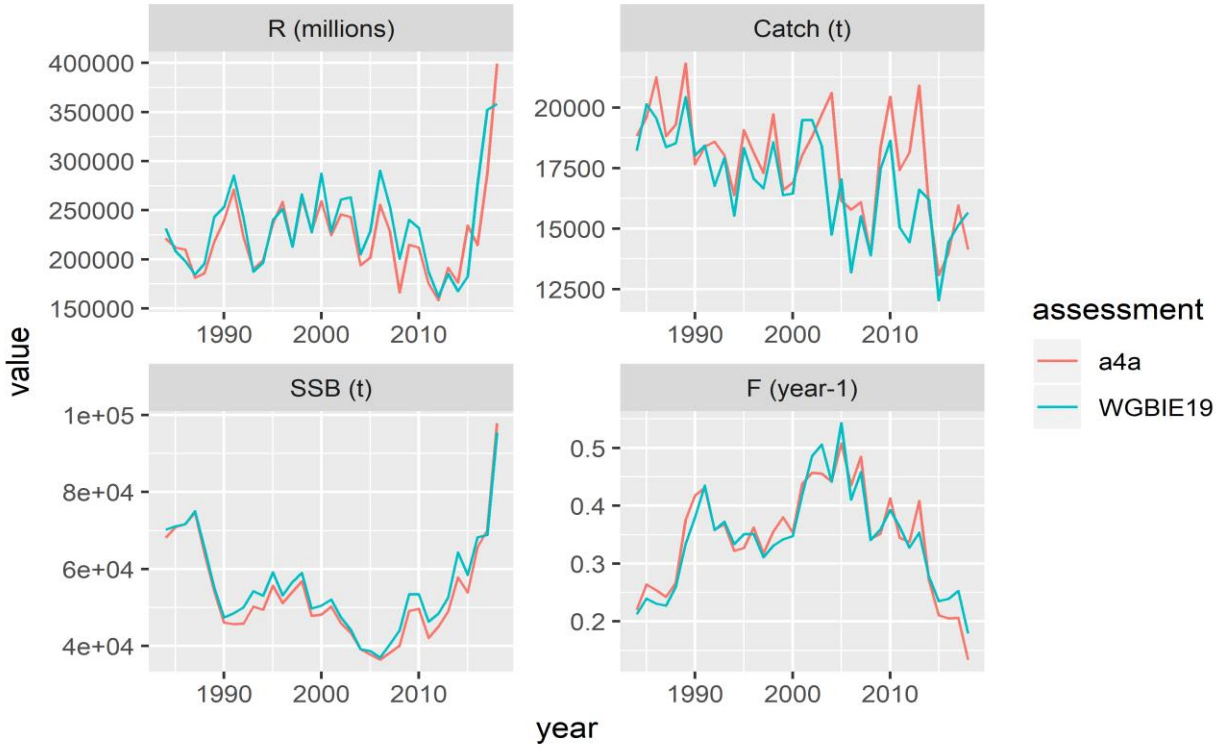


Figure 14. Comparison between a4a and WGBIE19 model results with the same data and default settings.

3.1.2 Retrospective pattern: Base Case

Retrospective analysis was conducted for 6 years, the retrospective time-series of most relevant indicators.

Table 3. Mohn's rho index values for retrospective Base Case and WGBIE19

	RETRO A4A:	RETRO (WGBIE 19)
> mohn(Retro_F,plot=T)	-0.2630001	0.2190796
> mohn(Retro_SSB,plot=T)	0.2210502	0.3080274
> mohn(Retro_R,plot=T) =	0.157887	0.7654102

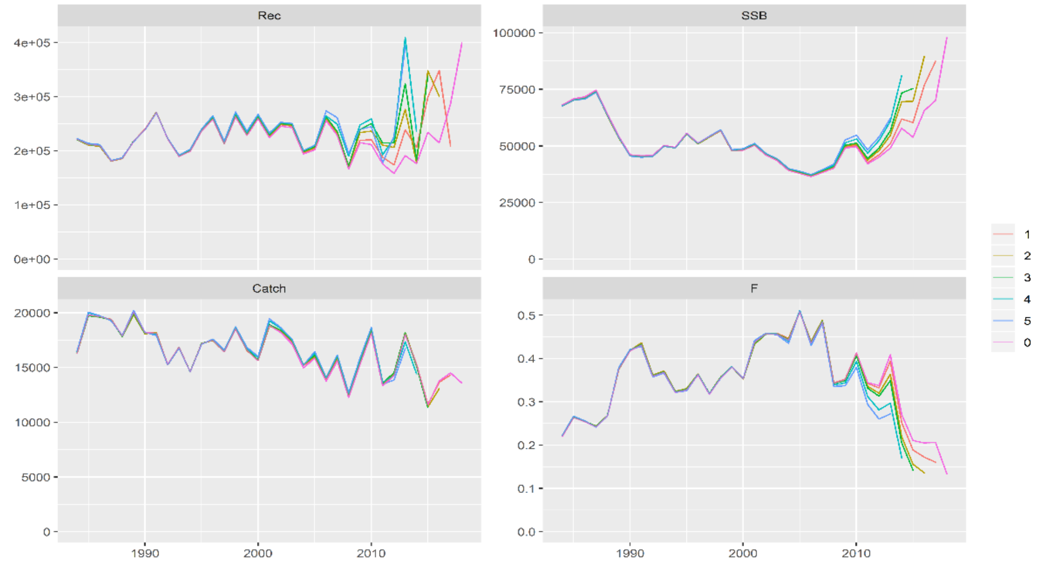


Figure 15. Retrospective pattern of the model resuls using a4a model.

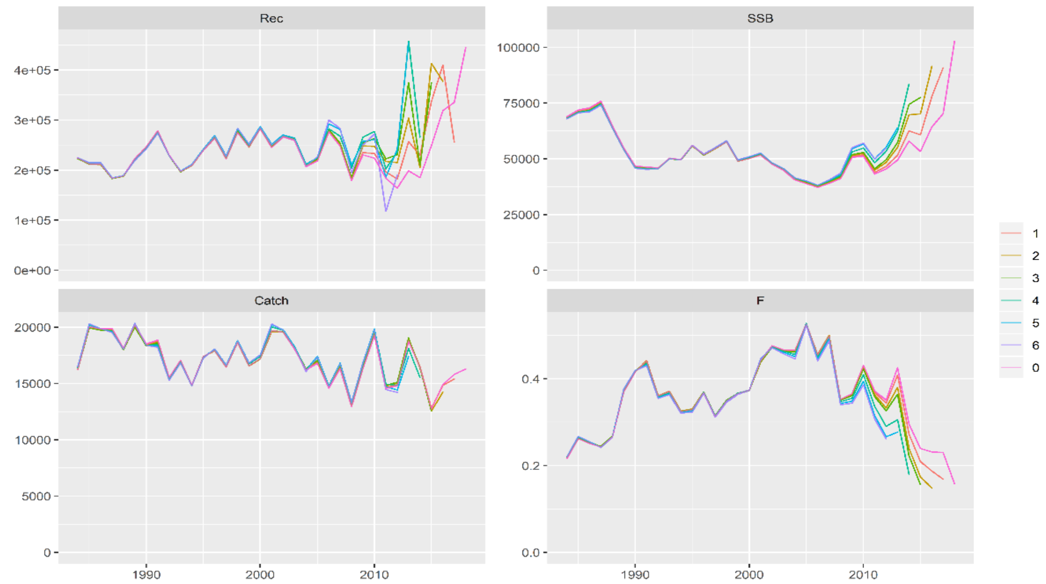


Figure 16. Retrospective pattern of the model resuls using WGBIE19 Bayesian model.

3.1.3 Sensibility analysis

Based on the base case settings, run 1, different alternative runs were executed to analyse the effect of tuning fleets used in the assessment:

- Leave one index out

  - no "FR_EVHOE"
  - no "SP_PORC"
  - no "CPUE.Vigo84"
  - no "CPUE.Vigo99"
  - no "LPUE.ITBB"
- One index at a time

  - only "FR_EVHOE"
  - only "SP_PORC"
  - only "CPUE.Vigo84"
  - only "CPUE.Vigo99"
  - only "LPUE.ITBB"

- No scientific surveys (i.e. only CPUEs and LPUEs)
- Only surveys

<u>Leave one index out:</u>

When living one index out, the trends were very similar for the most important indicators.

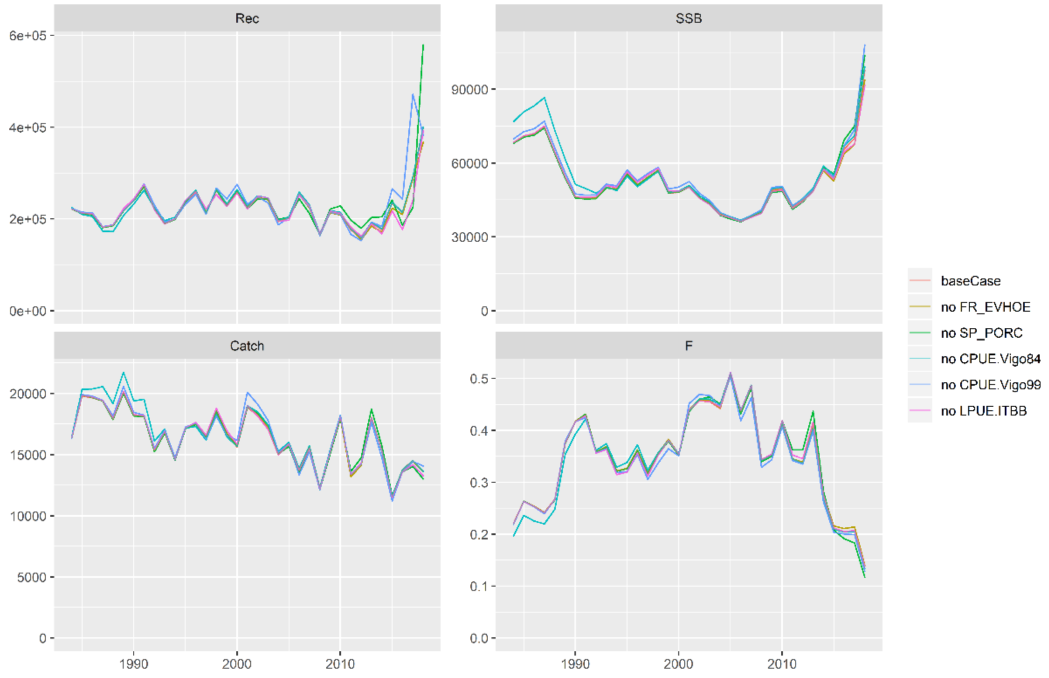


Figure 17. Exploratory run comparison of the Base Case run and leaving one tuning fleet out.

Only one index

When using one index, in the case of using CPUE.Vigo84, results differ significantly as this time series goes from 1984 to 1998.

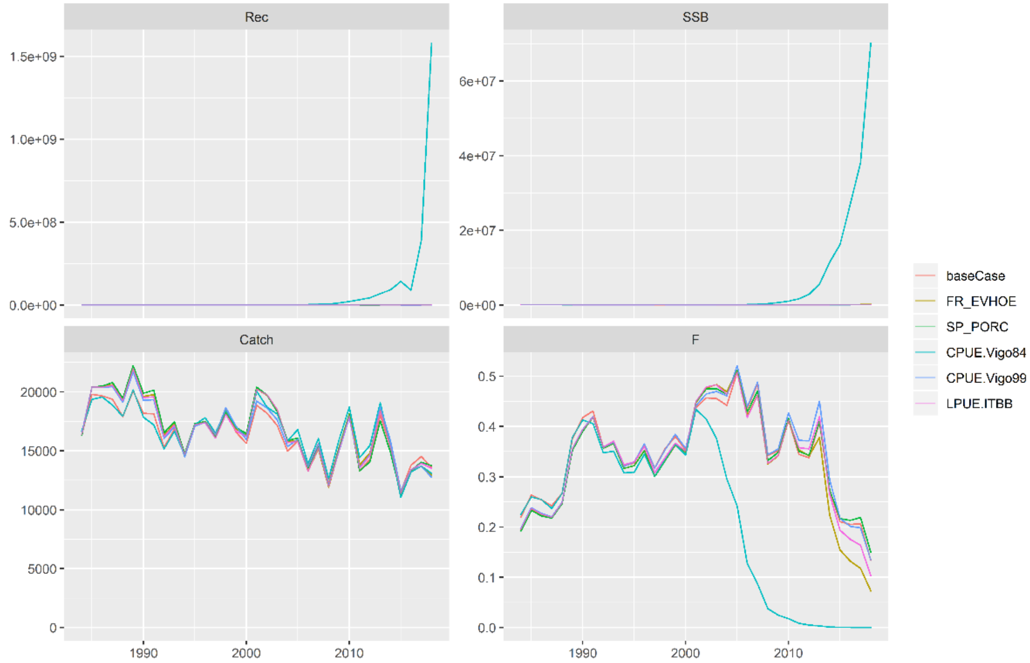


Figure 18. Exploratory run comparison of the Base Case run and using only one index.

No scientific surveys or only scientific surveys

When comparing the base case, where all the available indices are used, to the use of exclusively the non scientific surveys (commercial fleets) or using only scientific surveys, trends are very similar and results show small differences in the most recent years.

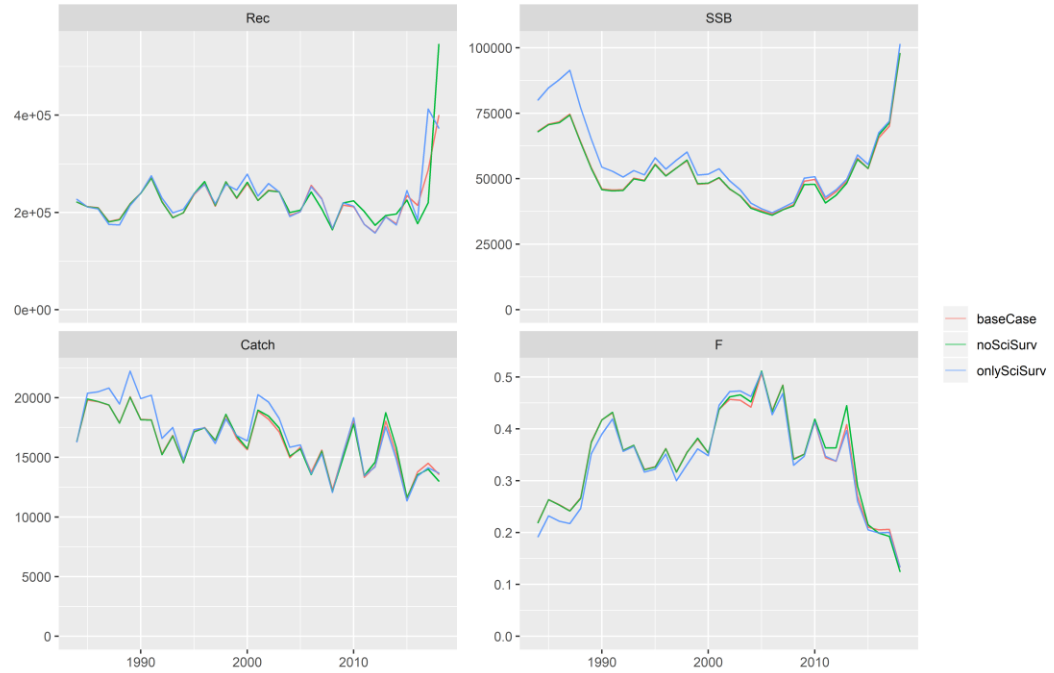


Figure 19. Exploratory run comparison of the Base Case run with using only scientific surveys and using only commercial fleets.

3.2 Run 2: FLAT Q FOR EVHOE

When analising data in the data exploratlion, the log ratios showed that for LPUE.ITBB, SP-PORC, CPUE.Vigo84. CPUE.Vigo99 a logistic curve may be appropriate for catchability. However for FR-EVHOE survey a 'flat' catchability model may be also appropriate (i.e. same q for all years) and it will be analized in this Run 2.

Table 4. Catchability models for the different runs for each of the tuning indices.

DATA	YEARS	AGES	RUN 1 q mod	RUN 2 q mod
Survey EVHOE	1997-2018	1-5	I(1/(1 + exp(-age)))	**-1 (flat q: the same for all ages)**
Survey PORCUPINE	2001-2018	1-8	I(1/(1 + exp(-age)))	**I(1/(1 + exp(-age)))**
Commercial VIGO 84	1984-1998	2-9	I(1/(1 + exp(-age)))	**I(1/(1 + exp(-age)))**
Commercial VIGO 99	1999-2018	1-9	I(1/(1 + exp(-age)))	**I(1/(1 + exp(-age)))**
Commercial IRTBB	1995-2018	2-7	I(1/(1 + exp(-age)))	**I(1/(1 + exp(-age)))**

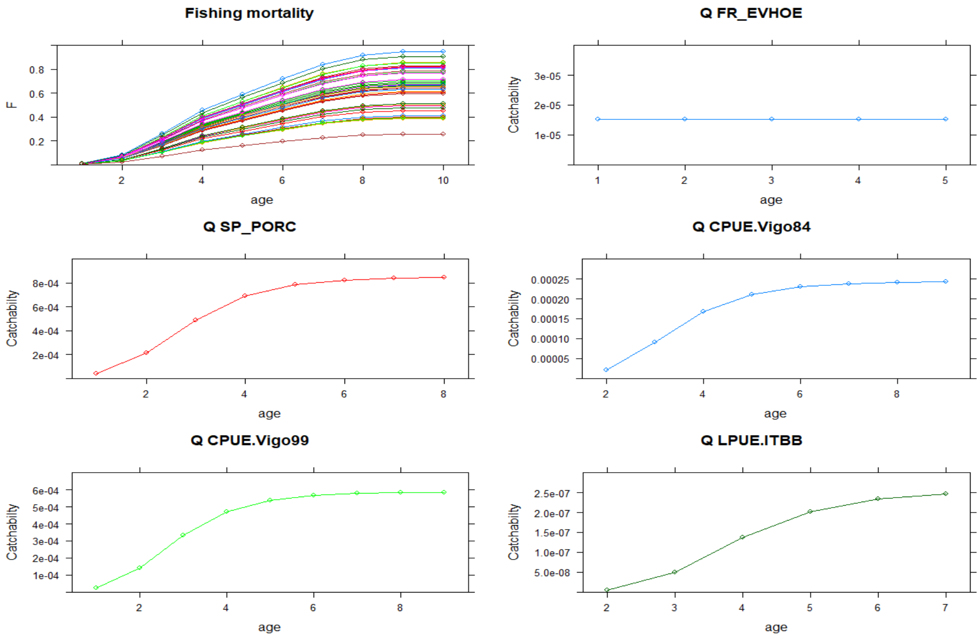


Figure 20. Catchability models used in the Run 2.

3.2.1 Results: flat q for Evhoe

Figure 21. Stock summary results for recruis, SSB, catch and fishing mortality in the Run 2.

The comparison of Base Case (Run 1) with the run using q flat for EVHOE survey (Run 2).

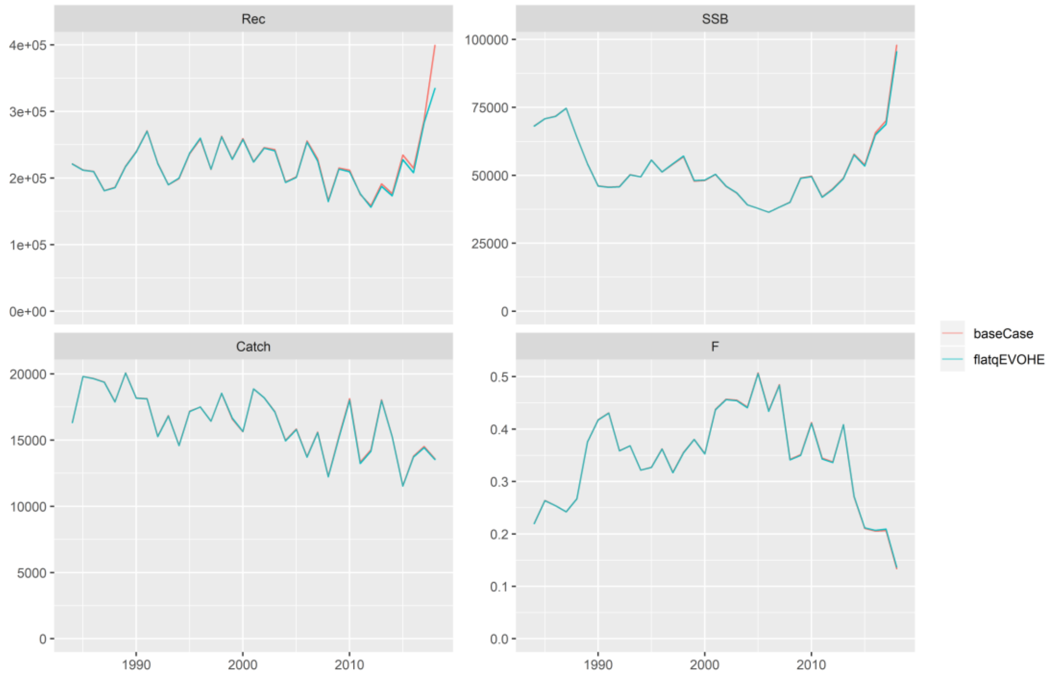


Figure 22. Comparison Base Case (Run 1) with the run using q flat for EVHOE survey (Run 2).

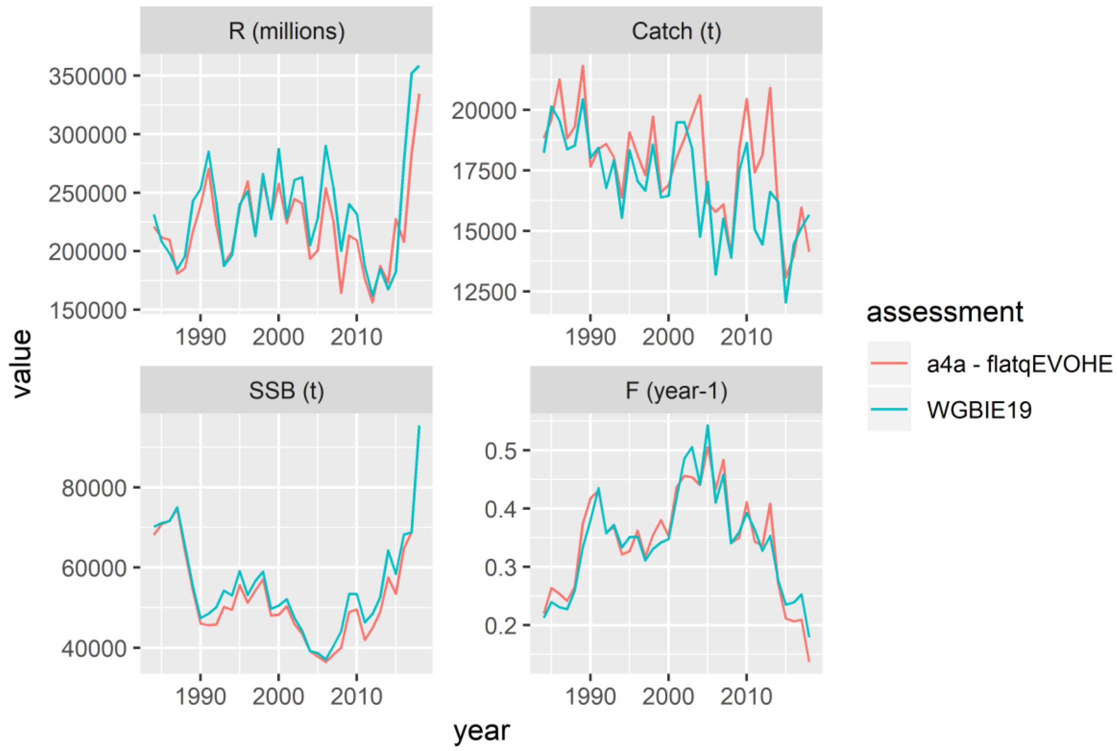


Figure 23. Comparison Run 2 (a4a flatqEVHOE) and WGBIE19 model results.

Run 2: Using q flat for EVHOE survey.

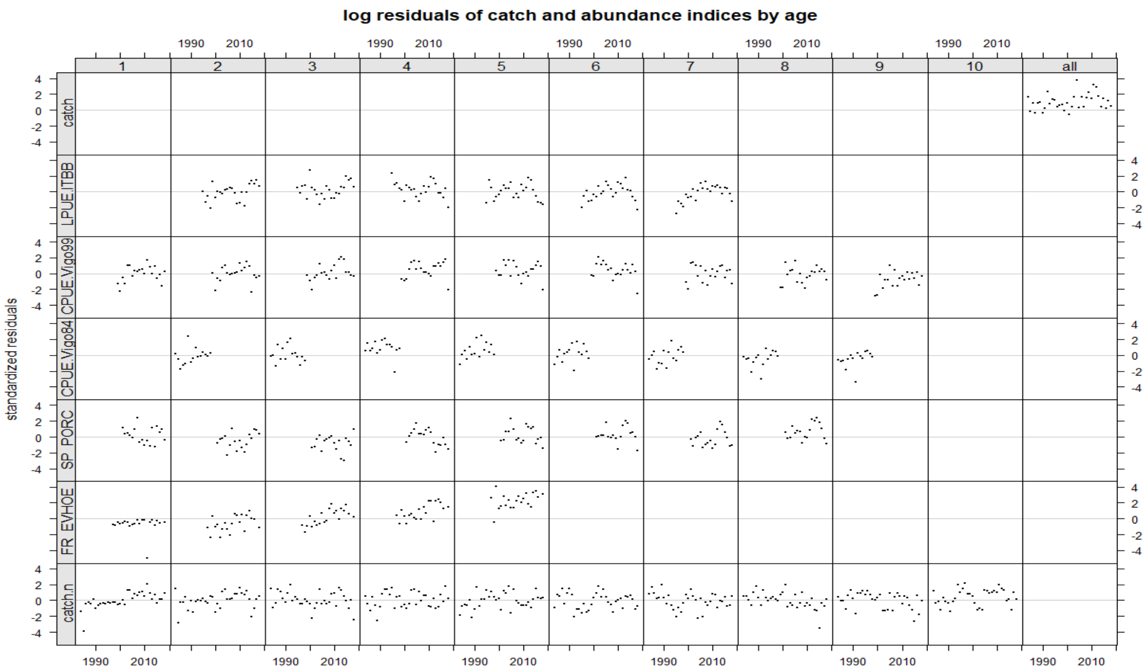


Figure 24. . Standarized residuals for abundance indices and for catch in numbers.

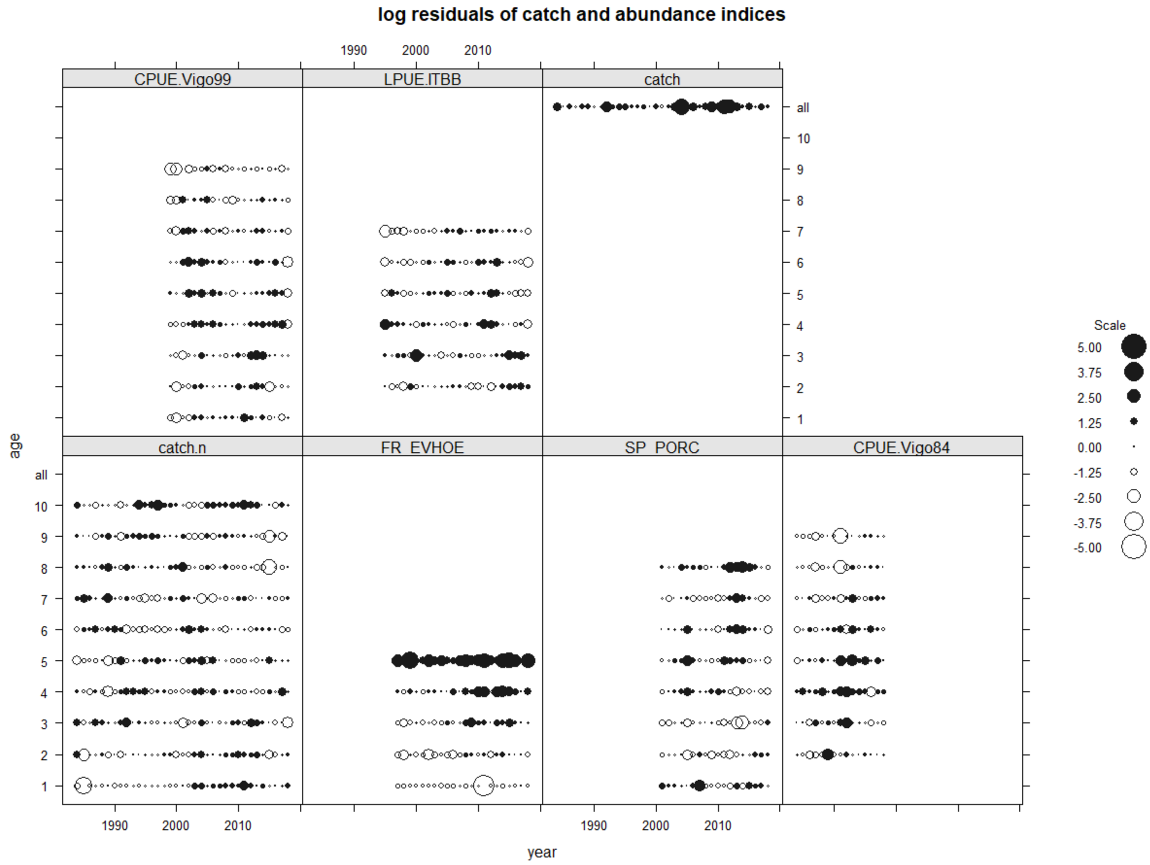


Figure 25. Bubbles plot of standardized residuals for abundance indices and for catch in numbers.

3.2.2 Retrospective pattern: flat q for Evhoe

Retrospective analysis was conducted for 5 years using q flat for EVHOE survey, the retrospective time-series of most relevant indicators are shown in figure below.

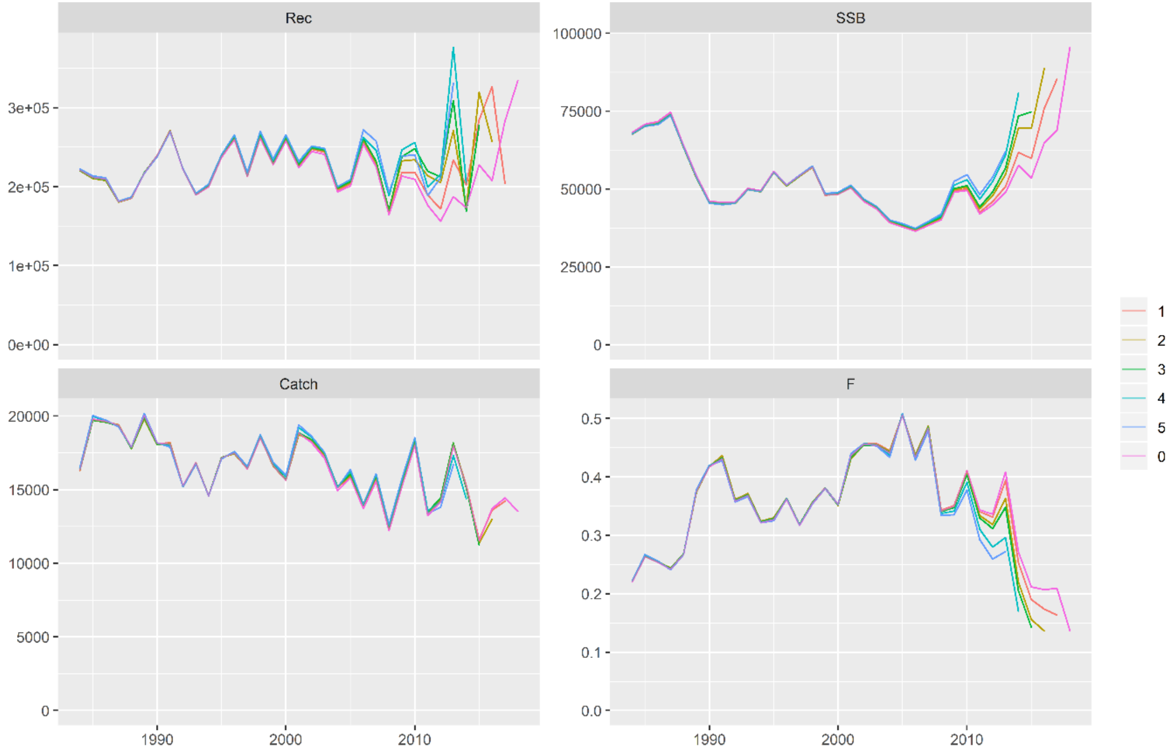


Figure 26. Retrospective pattern of the model resuls of the Run 2 (a4a flatqEVHOE).

When comparing the retro values obtained in the 3 runs for the time-series of most relevant indicators, the lowest values for the Mohn indicator were the ones form the A4A Base Case.

Table 5. Mohn's rho index values for retrospective WGBIE19 , Base Case (Run 1) and A4aQFlat (Run 2).

	RETRO (WGBIE 19)	RETRO RUN 1:BASE CASE	RETRO RUN 2 :Q FLAT_EVHOE
> mohn(Retro_F,plot=T)	0.2190796	-0.2630001	-0.3185868
> mohn(Retro_SSB,plot=T)	0.3080274	0.2210502	0.3348946
> mohn(Retro_R,plot=T) =	0.7654102	0.157887	0.2259444

4 Conclusion

- The results obtained from the comparison of a4a model and Bayesian model using default setting on the same data, results in a very similar trends and absolute values. Similar results were also obtained when considering q flat for Evhoe survey.

- When comparing the results of retrospective analysis using Mohn's rho index, better values are obtained for the a4a model Base Case using the same input data as in WGBIE 2019.

- Results of a4a model seems to be promising, therefore more work will be done for the calculation of reference points and sensitivity analysis.

- To analize more in deep this a4a model inter sessional work is needed.

- As results are very similars in trends and absolute values, a change to this more standardized model a4a is proposed for the northern megrim to ease the implementation and shorten the iteration times from the previous Bayesian model.

Working Document no. 7 of the Working Group for the Bay of Biscay and Iberian Waters Ecoregion (WGBIE)
6-13 May 2020, by WebEx

Nephrops Sentinel Fishery in Functional Unit 25 (North Galicia) 2017-2019

González Herraiz, I.[1], Gómez Suárez, F.J.[1], Fariña, C.[1], Rodríguez, J.[2] and Salinas, I.[3]

[1]Instituto Español de Oceanografía. Centro Oceanográfico de A Coruña. Paseo Marítimo Alcalde Francisco Vázquez, 10. A Coruña, 15001. Spain
[2]Instituto Español de Oceanografía. C.O. Santander. Promontorio San Martín s/n, Santander, 39004. Spain
[3]Instituto Español de Oceanografía. C.O. Vigo. Subida Radio Faro, 50-52. 36390 Vigo, 11006. Spain

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 stock (ICES, 2012) and it is assessed mainly by the analysis of the LPUE series trend. Until 2019 there were no *Nephrops* discards in this FU, therefore catches were equivalent to landings (ICES, 2018a). In the FU 25 trawl fleet trips that catch *Nephrops* there are hauls directed and not directed to *Nephrops*. 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 recommended for 2017, 2018 and 2019. Following this recommendation, a *Nephrops* TAC zero was established in the 8c division, where the FU 25 is located, for that triennium (EU, 2017). The 2019 assessment obtained the same conclusions and the zero TAC was extended for 2020, 2021 and 2022 (EU, 2020).

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). 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".

In order to continue this time series, the fishing industry asked the Spanish General Secretariat of Fisheries (SGP) the possibility of carrying out a survey in 2017. This survey would be restricted to the two vessels used for the calculation of abundance indices submitted to WGBIE 2017 (Fernández et al., 2017) with the aim of obtaining comparable results. 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 this 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). A Sentinel fishery with a special quota of 2 t per year was carried out in August and September of 2018 and 2019. The results of this Sentinel fishery of 2019 and their comparison with the results of the previous years are presented in this working document.

SURVEY OBJECTIVES

The main objective of the Sentinel fishery is to obtain an abundance index for *Nephrops* FU 25 in the period with *Nephrops* TAC zero. Other objectives are to obtain the *Nephrops* size composition and proportion of males.

METHODS

The survey was conducted between 1st August to 26st September 2019 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 2019 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 in this FU (ICES statistical rectangles 15E0-E1 and 16E1, in red).

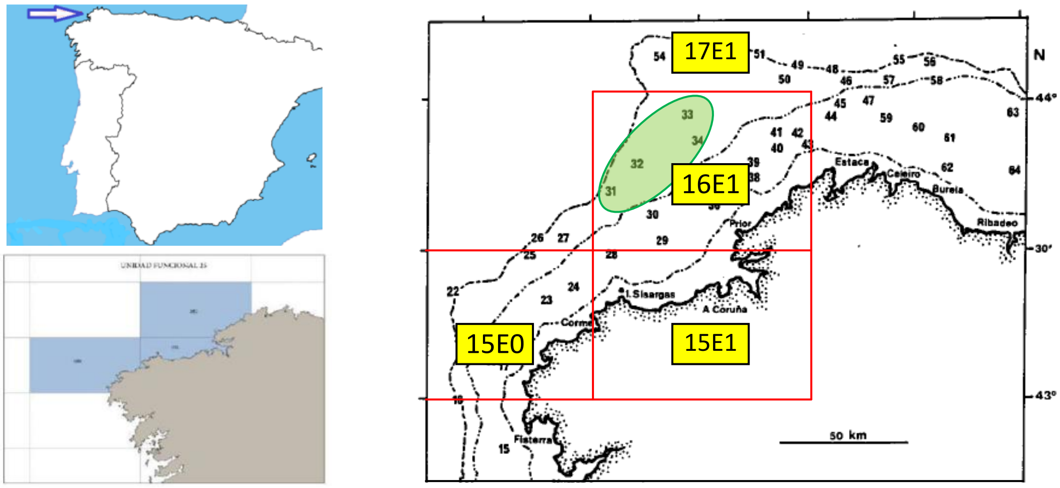


Figure 1. Statistical rectangles of *Nephrops* Functional Unit 25 (North of Galicia) in red, rectangles names in yellow. Study area in the observers survey in green.

Observation and data collection methodology

A total of 16 fishing days targeting to *Nephrops* were made in the 2019 survey, 33% less than in the 2017 survey and half of the 2018. 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. 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	2, 7, 13, 21 and 29	11, 18 y 26	8
Burelés	1, 8, 12, 22 and 28	12, 19 and 25	8

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*. 22 hauls were directed to *Nephrops* and 25 hauls were not (66% and 32% less 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. 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* landings and size distribution are included in the FU 25 data uploaded in Intercatch.

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

16 trips (8 for each vessel) were undertaken during this survey, 11% less than in the previous year. All the trips had one fishing day. 49 hauls were carried out, 53% less than in the previous year. Information by haul (date, hour, duration, depths, total catch and *Nephrops* catch) in Annex II.

Total and Nephrops *catches*

A total catch of 12 469 kg of different species (fishes, crustaceans and molluscs) were caught, a 45% less than in the previous year. The percentage of catch discarded in the 2019 was 20%, the same than in 2018.

The total *Nephrops* catch obtained by the two vessels was 2 270 kg, 15% more than in 2018. *Nephrops* discard was 250 kg, in 2018 there was no discard.

Nephrops CPUE

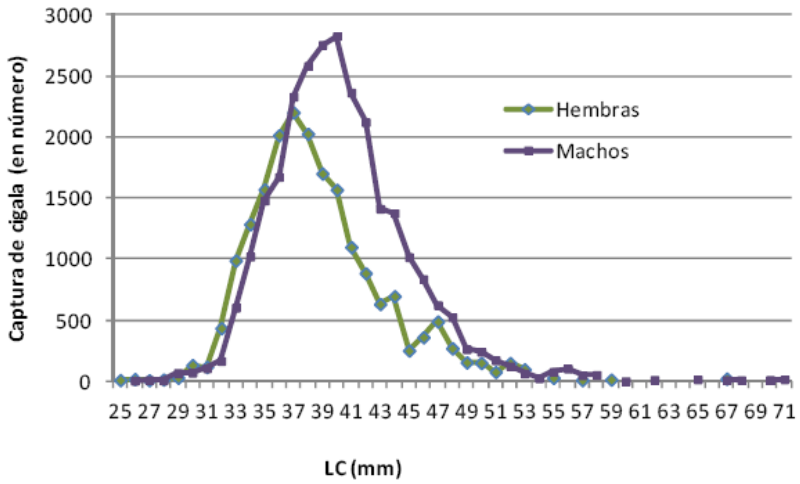
The average yield was 142 kg/trip, 142 kg/fishing day, 46 kg/haul and 7.3 kg/hour, 135% more than in 2018. The mean CPUE during the survey was 7.3 kg/hour. The *Nephrops* CPUE of the whole survey in the hauls directed to *Nephrops* was 16.2 kg/hour, 125% more than in 2017 (7.2 in 2017 and 5.2 in 2018) (Table 3).

Table 3. FU 25 Sentinel survey. *Nephrops* CPUE in kg/hour (2017-2019). CPUE calculated as an average of the hauls CPUE.

Sentinel	Total hauls		Hauls directed to Nephrops			Hauls non directed to Nephrops		
	n	CPUE (kg/hour)	n	CPUE (kg/hour)	s.d.	n	CPUE (kg/hour)	s.d.
2017	79	5.1	54	7.2	3.0	25	0.5	0.8
2018	103	3.6	66	5.1	3.0	37	0.8	1.7
2019	49	7.3	22	16.2	11.1	27	0.0	0
Average		5.3		9.5			0.4	

Size composition and sex-ratio of the Nephrops *catch*

A total of 4 633 individuals were measured, 36% less than in the previous year, 2 934 males and 1 699 females. The percentage of males was 63%, the same than in 2018, in 2017 was 43%. Carapace length fluctuated from 26 mm to 71 mm CL in males and from 25 mm to 67 mm CL in females (Figure 4). Mean sizes decreased from 2018 to 2019 from 42.1 to 40.3 in males and from 40.3 to 38.7 in females (Table 4).



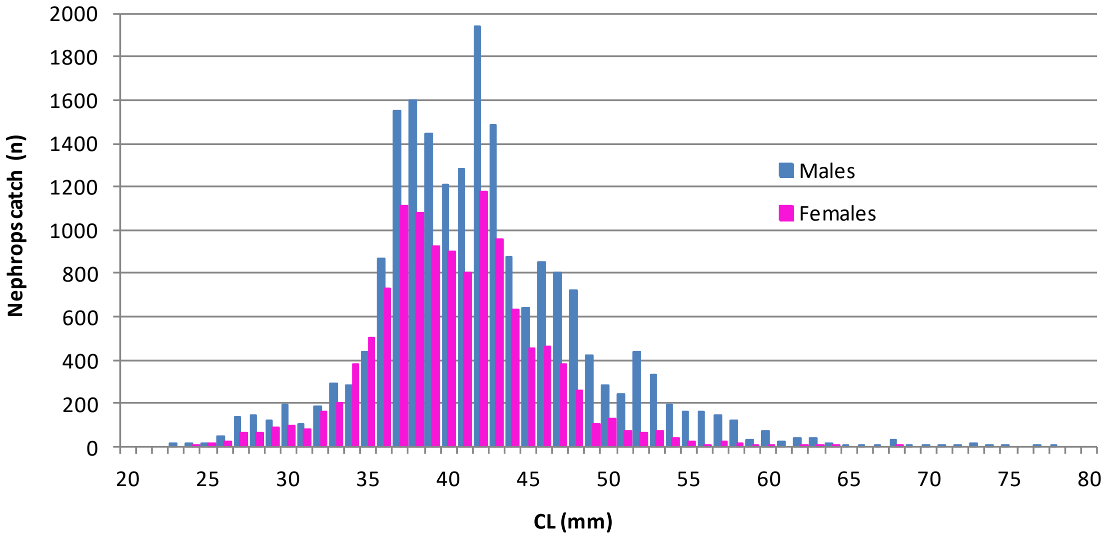


Figure 4. Length frequency distribution for *Nephrops* catch for males and females . Up: 2019, males in blue, females in gree. Down: 2017.

Table 4. *Nephrops* mean sizes for males and females in surveys 2017 and 2018.

	Mean size		
	2017	2018	2019
Males	41.7	42.1	40.3
Females	39.8	40.3	38.7

Nephrops *weight in catch*

The percentage of *Nephrops* in the catch in weight is shown in Table 5. In 2019, *Nephrops* catch represents 32% in the directed hauls and 0% in the non directed hauls.

Table 5. Percentage of *Nephrops* weight in total catch.

Sentinel	Total hauls		Directed to Nep		Non directed	
	N	% Nep	N	%Nep	N	%Nep
2017	79	15	54	15	25	1
2018	103	8	66	12	37	6
2019	49	14	22	32	27	0

CPUE associated species

Data concerning associated species were collected. Retained catch per effort unit (LPUE) and discard per effort unit (DPUE) were roughly estimated (Table 6) for the whole survey (hauls directed and not directed to *Nephrops*). The *Nephrops* LPUE and DPUE in Table 6 allow identify the *Nephrops* LPUE and DPUE positions among the other species data, but the suitable *Nephrops* CPUE data are those presented in Table 3.

Table 6. Landed and discarded main species catch per effort unit (LPUE and DPUE) in kg/hour (all hauls). *Nephrops* appears shaded. LPUE = ∑landings (kg)/∑effort (hours). DPUE = ∑discard (kg)/∑effort (hours).

Species	LPUE
Merluccius merluccius	17.4
Nephrops norvegicus	8.2
Lepidorhombus spp	6.1
Micromesistius poutassou	2.3
Lophius spp	1.6
Trachurus trachurus	1.5
Scyliorhinus canicula	1.2
Illex coindetii	0.6
Eledone cirrhosa	0.4
Triglidae	0.4
Phycis blennoides	0.4
Helicolenus dactylopterus	0.3
Trisopterus luscus	0.2
Holothuria spp	0.1

Species	DPUE
Munida spp	3.4
Galeus spp	3.3
Nephrops norvegicus	1.0
Merluccius merluccius	0.5
Micromesistius poutassou	0.5
Polybius henslowi	0.4
Holothuria spp	0.4
Trachurus trachurus	0.2
Lepidorhombus spp	0.2
Crustacea	0.1

DISCUSSION

Nephrops CPUE average obtained in the *Nephrops* directed hauls of the Sentinel fishery (Table 3, 9.5 kg/hour) is higher than the maximum of the FU 25 commercial fleet time series 1975-2016 (4.1 kg/hour) (Figure 5). In this commercial fleet there are hauls directed and not directed to *Nephrops* in the same trip and LPUE data are calculated on trip bases. If we take into account Sentinel *Nephrops* directed and no directed hauls the average is 5.3 kg/hour (Table 3), still being higher than the commercial series maximum (Figure 5). FU 25 CPUE estimations from “Demersales” scientific survey, and adjacent functional units (FUs 31 and 26) CPUE data (Figure 6, Table 7) corroborate commercial fleet CPUE data (Figure 5).

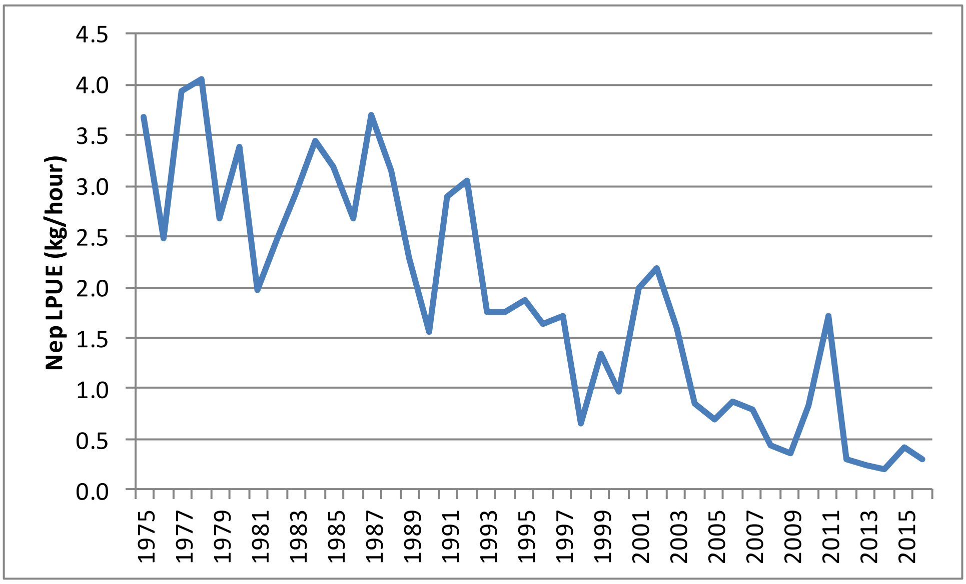


Figure 5. FU 25 *Nephrops* LPUE in kg/hour 1975-2016 from commercial fishery.

Table 7. *Nephrops* LPUE (kg/hour) from different sources and functional units.

	NEP LPUE (kg/hour)
FU 25 Sentinel (2017-2019 average)	**5.3**
FU 25 commercial fleet 2016	0.3
FU 25 “Demersales” trawl survey 2019	0.1
FU 31 commercial fleet 2016	0.2
FU 31 “Demersales” trawl survey 2019	0.1
FU 26 “Demersales” trawl survey 2017	0.02

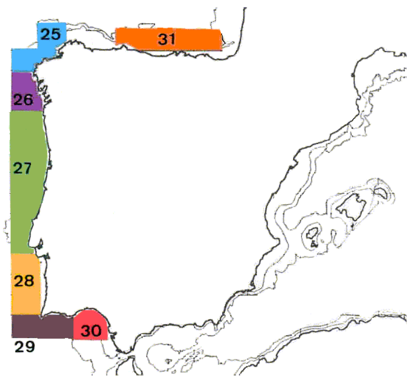


Figure 6. Location of different Functional Units of *Nephrops*.

CPUE values can remain high even when stocks are rapidly depleted (hyperstability) (ICES, 2019). This can happen if catches rates are derived from fishing activities that remain concentrated in areas or periods of relatively higher abundance, as it happened in the FU 25 Sentinel fishery (Figures 7 and 8). In both cases, the CPUE is not representative of the abundance of the the stock.

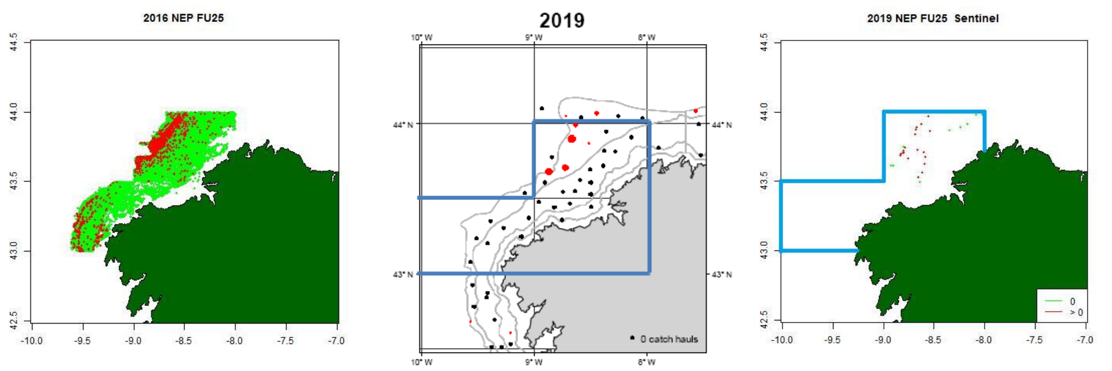


Fig. 7. *Nephrops* presence (red) in FU 25. Left: commercial fleet. Center: survey. Right: 2019 Sentinel. In blue FU limits.

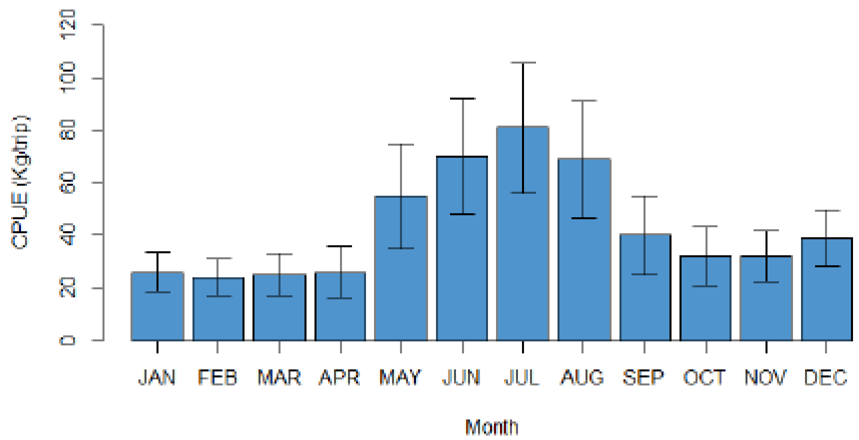


Figure 8. *Nephrops* CPUE in FU 25 (1980-2008) from commercial fleet (ICES, 2019).

CONCLUSIONS

- FU 25 CPUE rates obtained in the Sentinel fishery are higher than the maximum of the 1975-2016 FU 25 CPUE time series.

- The Sentinel fishery in the area and period of high abundance has lead to a hyperstability of the catch rates.

- Therefore, *Nephrops* CPUE data from FU 25 Sentinel fishery (2017-2020) are not representative of the stock.

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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 E INSPECCION

DE:	SUBDIRECCION GENERAL DE CONTROL E INSPECCION		
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:	TMS/JAF
FECHA:	26 de julio de 2019		
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".

C/VELAZQUEZ, 147
28071 MADRID
TEL: [illegible]
FAX: [illegible]

Annex I *cont*

- 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.

La Subdirectora General de Control e Inspeccion

Teresa Molina Schmid

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C/VELAZQUEZ 147
28071 MADRID
TEL: 913471949
FAX: 913470027

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:mm)	Mean depth (m)	Total catch (kg)	Nephrops catch (kg)
1	01-ago-19	4:30	7:00	198	439	196
2	01-ago-19	13:00	5:45	270	308	88
3	02-ago-19	5:26	6:34	395	305	150
4	02-ago-19	13:00	2:10	217	42	0
5	07-ago-19	5:40	6:52	367	253	220
6	07-ago-19	13:36	5:24	229	128	0
7	07-ago-19	19:30	2:36	224	127	0
8	08-ago-19	5:18	6:42	366	281	149
9	08-ago-19	14:35	2:59	234	103	0
10	08-ago-19	18:10	4:20	177	105	0
11	12-ago-19	1:15	4:25	362	143	0
12	12-ago-19	6:07	7:30	177	394	143
13	12-ago-19	14:45	4:11	192	370	0
14	12-ago-19	19:34	3:31	249	127	0
15	13-ago-19	6:57	7:31	382	448	270
16	13-ago-19	15:28	4:48	223	267	0
17	21-ago-19	1:02	5:28	394	145	0
18	21-ago-19	7:15	6:42	185	352	150
19	21-ago-19	14:40	3:57	282	117	0
20	21-ago-19	19:10	3:08	205	243	0
21	22-ago-19	6:30	7:00	360	352	117
22	22-ago-19	14:45	3:15	368	246	39
23	22-ago-19	19:53	4:08	162	265	0
24	28-ago-19	6:52	7:00	383	270	120
25	28-ago-19	14:50	3:30	372	131	31
26	29-ago-19	2:44	3:34	419	637	0
27	29-ago-19	7:25	6:20	463	510	270
28	29-ago-19	14:50	4:10	160	218	0
29	29-ago-19	19:30	4:25	148	194	0
30	11-sep-19	0:20	4:00	434	221	0
31	11-sep-19	5:00	3:58	221	211	0
32	11-sep-19	9:41	4:59	167	372	90
33	11-sep-19	16:25	5:49	185	171	0
34	12-sep-19	5:36	6:09	403	268	78
35	12-sep-19	13:00	4:34	194	187	0
36	12-sep-19	18:10	5:50	148	396	0
37	18-sep-19	0:50	5:25	442	190	0
38	18-sep-19	7:05	4:35	436	210	35
39	18-sep-19	12:25	4:30	160	178	45
40	18-sep-19	18:05	5:10	165	264	0
41	19-sep-19	5:42	6:03	392	286	37
42	19-sep-19	13:20	5:40	341	322	21
43	19-sep-19	20:10	4:00	161	219	0
44	25-sep-19	6:08	5:30	323	253	36
45	25-sep-19	12:35	5:25	417	235	21
46	25-sep-19	19:10	4:00	159	179	0
47	26-sep-19	6:33	5:57	452	357	45
48	26-sep-19	13:17	4:23	412	193	6
49	26-sep-19	18:50	4:08	160	239	0

Working Document no. 8 of the Working Group for the Bay of Biscay and Iberian Waters Ecoregion (WGBIE)
6-13 May 2020, by WebEx

Nephrops **Sentinel Fishery in Functional Unit 31 (Cantabrian Sea) 2019**

González Herraiz, I.[1], Gómez Suárez, F.J.[1], Fariña, C.[1], Rodríguez, J.[2] and Salinas, I.[3]

[1]Instituto Español de Oceanografía. Centro Oceanográfico de ACoruña. Paseo Marítimo Alcalde Francisco Vázquez, 10. A Coruña, 15001. Spain
[2]Instituto Español de Oceanografía. C.O. Santander. Promontorio San Martín s/n, Santander, 39004. Spain
[3]Instituto Español de Oceanografía. C.O. Vigo. Subida Radio Faro, 50-52. 36390 Vigo, 11006. Spain

INTRODUCTION

Nephrops landings in FU 31 (ICES Division 8c, Cantabrian Sea) have decreased a 98% from 1989 to 2016. ICES advice for this stock is on the basis of a data-limited approach since 2002, meaning that no analytical stock assessment is conducted in this FU. According to this approach, FU 31 is considered as category 3.1.4 stock (ICES, 2012) and it is assessed mainly by the analysis of the LPUE series trend. Until 2018 there were no *Nephrops* discards in this FU, therefore catches were equivalent to landings (ICES, 2018). In the FU 31 trawl fleet trips that catch *Nephrops* there are hauls directed and not directed to *Nephrops*. 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. Following this recommendation, a *Nephrops* TAC zero was established in the 8c division, where the FU 31 is located, for that triennium (EU, 2017). The 2019 assessment obtained the same conclusions and the zero TAC was extended for 2020, 2021 and 2022 (EU, 2020).

FU 25 fishing industry got the EU permission to do a *Nephrops* sentinel fishery in that FU since 2017 in order to continue a time series of *Nephrops* data from two commercial vessels presented by them to the WGBIE 2017 (Fernández et al., 2017). Later, FU 31 fishing industry asked for a similar sentinel in their area. ICES advised on the necessary level of catch and characteristics for it (ICES, 2019) and a sentinel fishery in FU 31 with a special quota of 0.7 t per year was carried out in July of 2019. The main results about *Nephrops* of that Sentinel are presented in this working document.

SURVEY OBJECTIVES

The main objective of the Sentinel fishery was to obtain a *Nephrops* abundance index representative of the FU 31 in the period with *Nephrops* TAC zero. Other objectives were to obtain *Nephrops* size composition and proportion of males.

METHODS

The survey was conducted between 10th July to 2nd August 2019 by two commercial vessels on the FU 31. It was chosen the month of July because it is the one with the highest CPUE in the FU (Figure 1) and in other months the low appearance of *Nephrops* in the catch could prevent the realization of the survey. The survey was designed and coordinated by IEO (C.O. A Coruña). Conditions of the authorization of the 2019 observers survey in Annex I.

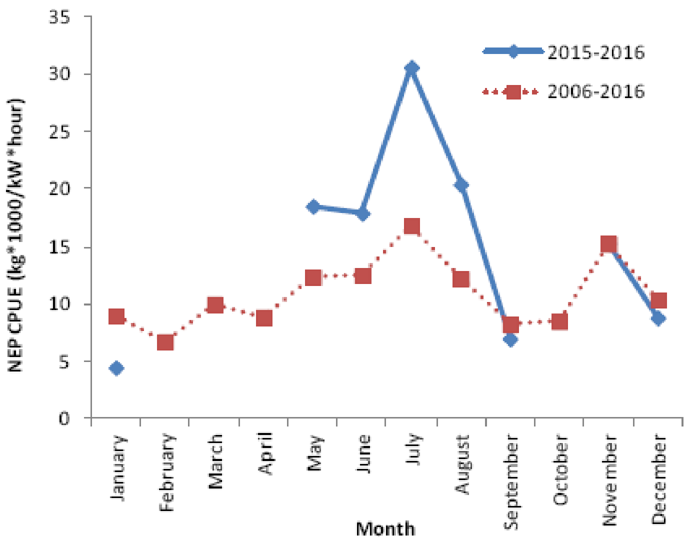


Figure 1. *Nephrops* CPUE in the commercial fleet in FU 31 (ICES, 2019).

With the aim of obtaining results representative of the whole Functional Unit 31, the FU assessment area (mud patches) was identified analysing the *Nephrops* location in the 2009-2016 VMS and logbooks data and excluding the rock and gravel sediment. This showed the existence of seven *Nephrops* patches with a total area of 5300 km^2 in the FU 31. The level of sampling was determined by a previous Special Request advice (ICES, 2019). In that Special Request Advice the level of sampling indicated was 7 fishing days directed to *Nephrops*. In FU 31 a vessel makes 4 hauls per day directed to *Nephrops*, therefore the level of sampling for the Sentinel was 28 hauls. The level of sampling was based in hauls instead of days with the objective of provide facilities and flexibility to the commercial vessel cooperating in the survey. These hauls were distributed in the mud patches proportionally to the area of each patch and, within each patch, randomly in 5 nm grid cells. The hauls were randomly distributed between the two commercial vessels of the survey. The vessel had to pass by a determined grid cell between the starting and the turning of the haul. The objective of this was to try to avoid that the vessels fished only in the zones with the higher *Nephrops* abundances during the sentinel fishery. The vessels could distribute these 28 hauls in the days they considered and combined them with other hauls. An observer on board from the IEO would supervise the hauls.

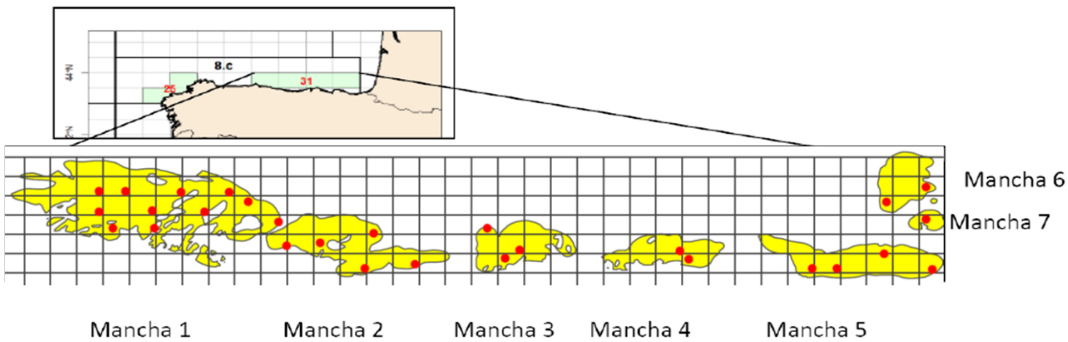


Figure 2. FU 31 *Nephrops* assessment area identification (yellow) and 28 planned hauls grid cells location (red points). Mancha = patch.

Observation and data collection methodology

The sentinel fishery was carried out in four trips, two by vessel. Each vessel did 3 days by trip (Vilaboa uno: 10-12 and 24-26 of July, O Cantiño: 16-18 and 31 of July and 1-2 of August). The vessels were two bottom trawlers "Vilaboa Uno", with a total length of 31.5 m and 441.3 kW, based in the Santander port, and "O Cantiño", with 28.5 m and 474.4 kW, based in the Burela port. The gear used was the usual (baca) with the regulatory 70 mm mesh size.

The duration of each haul was calculated as the elapsed time in hours between the moment in which the gear makes firm in the bottom to the beginning of the turned, therefore the effort unit was trawling hour. The observer 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.

All the information obtained by the observers was recorded in the IEO fishing database (SIRENO). *Nephrops* landings and size distribution were included in the 2019 FU 31 data uploaded in Intercatch.

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

The vessels did 45 hauls during the Sentinel survey and caught a total of 1158 kg of *Nephrops*, but only 953 kg of *Nephrops* were declared. The *Nephrops* special quota for this survey was 700 kg. The discrepancy between the *Nephrops* catch and what was declared was identified applying the length-weight relation to the length distributions obtained by the observer on board.

The two vessels distributed the 28 hauls planned between them by areas and they did not respect the random distribution planned.

14 of the hauls could not be identified in the VMS data, therefore there were not used in the CPUE estimates. In those 14 hauls, 344 kg of *Nephrops* were caught.

From the 31 remaining hauls, 2 of them were nocturnal and 29 diurnal. The nocturnal were not taken into account because *Nephrops* remains in burrows at night (Chapman, 1980). The *Nephrops* catch in the nocturnal hauls was zero.

In the 29 diurnal hauls, 813.72 kg of *Nephrops* were caught. 4 hauls were out of the *Nephrops* patches (27.54 kg of *Nephrops*).

From the 25 remaining hauls (768.18 kg of *Nephrops*), only 16 hauls were in the grid cells indicated (compare Figures 2 and 3), which represent 427.38 kg of *Nephrops*, when should have been 28 hauls. None of the 9 remaining hauls (358.8 kg of *Nephrops*) were in the grid cells randomly selected and some of them were declared in one patch but the VMS data indicated that they were in other patch. Information by haul (date, hour, duration, depths and *Nephrops* catch) in Annex II.

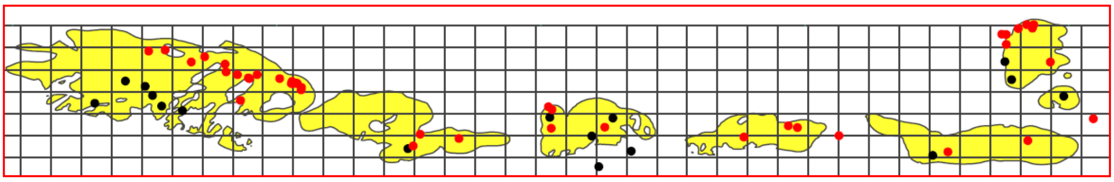


Figure 3. VMS points of FU 31 Sentinel fishery 29 diurnal hauls. Red: points of the hauls with *Nephrops* catch. Black: Points of the hauls without *Nephrops* catch.

In the 31 hauls identified in the VMS, a total catch of 7528 kg of different species (fishes, crustaceans, molluscs, etc) were caught, and the percentage of discard was 19%. In these hauls the *Nephrops* catch obtained was 813.72 kg and the percentage of *Nephrops* discard was 10%.

Nephrops CPUE

The CPUE in the *Nephrops* assessment area (patches) in the total diurnal hauls was 7.7 kg/hour. If we take into account only the 16 hauls that were made in the planned grid cells, the CPUE was 7.1 kg/hour. Final CPUEs were obtained with the average of the patches CPUE weighted to the patches areas.

Table 1. *Nephrops* CPUE (kg/hour) in the FU 31 Sentinel fishery 2019.

	Planned Hauls		Total diurnal hauls	
Nep catch	427.38 kg		813.72 kg	
	No.	CPUE (kg/hour)	No.	CPUE (kg/hour)
Patch 1	6	6.9	11	7.3
Patch2	3	4.6	3	4.6
Patch 3	2	3.7	3	2.5
Patch 4	0	-	1	4.4
Patch 5	2	4.7	3	9.5
Patch 6	2	24.0	3	22.5
Patch 7	1	0	1	0.0
Total patches	16	**7.1**	25	**7.7**
Out of patches	-	-	4	3.1
Total	16	-	29	-

Size composition and sex-ratio of the Nephrops *catch*

A total of 12033 individuals were measured, 6054 males and 5999 females. The percentage of males was 50%. Carapace length fluctuated from 28 mm to 86 mm in males and from 27 mm to 66 mm CL in females (Figure 4). Mean sizes were 45.4 in males and 41.4 in females.

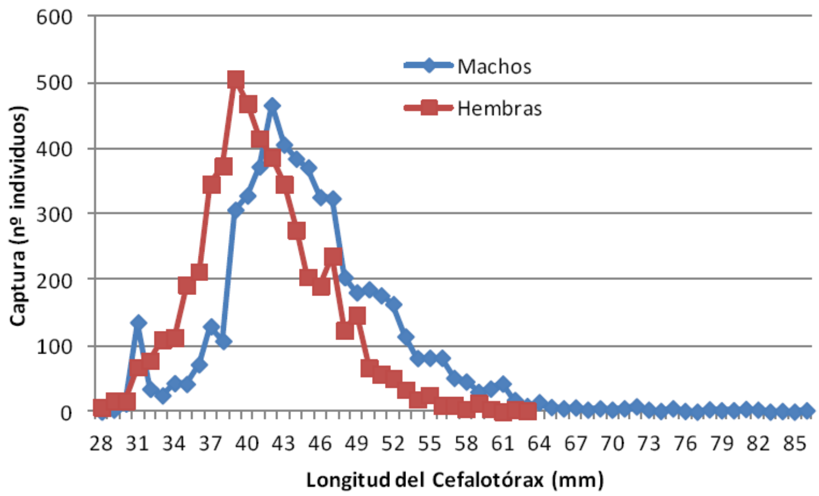


Figure 4. Length frequency distribution for *Nephrops* catch for males (blue) and females (red).

DISCUSSION

Nephrops CPUE values obtained in the Sentinel fishery (Table 1, 7.1 and 7.7 kg/hour) are higher than the maximum of the FU 31 commercial fleet time series 2009-2016 (0.6 kg/hour) (Figure 5). Other *Nephrops* LPUE data from adjacent Functional Unit (Figure 6) are similar to the commercial fleet information (Table 2).

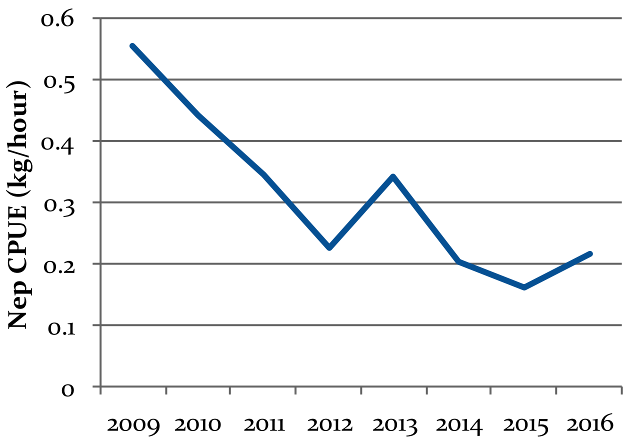


Figure 5. FU 31 *Nephrops* LPUE in kg/hour 2009-2016 from the commercial fleet.

Table 2. *Nephrops* LPUE (kg/hour) from other data sources and adjacent functional unit.

	NEP LPUE (kg/hour)
FU 31 Sentinel 2019	**7.1**
FU 31 commercial fleet 2016	0.2
FU 31 "Demersales" trawl survey 2019	0.1
FU 25 commercial fleet 2016	0.3
FU 25 "Demersales" trawl survey 2019	0.1

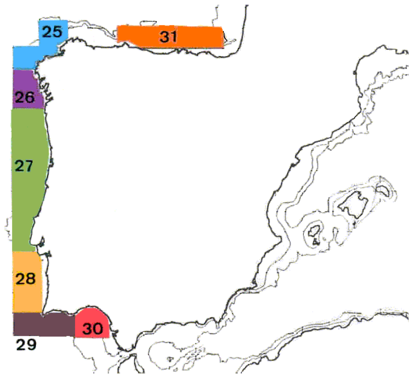


Figure 6. Location of different Functional Units of *Nephrops*.

CPUE values can remain high even when stocks are rapidly depleted (hyperstability) (ICES, 2019). This can happen if catches rates are derived from fishing activities that remain concentrated in areas or periods of relatively higher abundance (Figures 7 and 1, respectively), as it happened in the FU 31 Sentinel fishery (Figure 3). In both cases, the CPUE is not representative of the abundance of the stock.

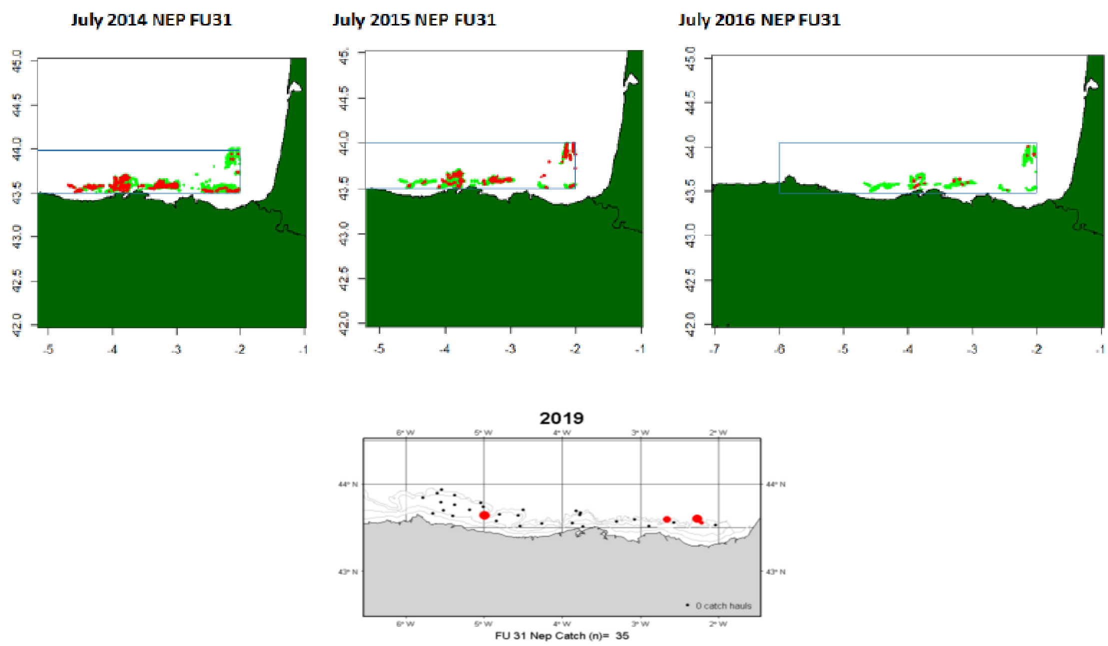
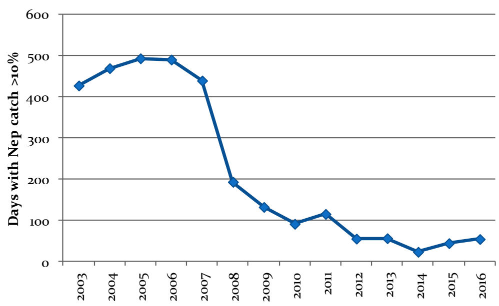


Fig. 7. *Nephrops* presence in FU 31. Up: commercial fleet (red: Nep ≥10% of daily catch). Down: survey (red: Nep kg/haul > 0). In blue FU 31 limits.



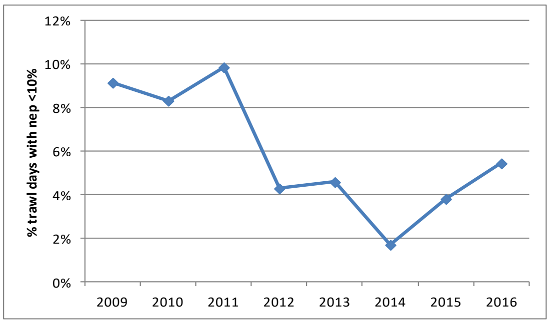


Figure 8. FU 31 trawl days with Nep catches ≥ 10% (left: absolute figures, right: percentage from the total trawl fishing days) (logboks)

The number of FU 31 bottom trawl fishing days with a catch of *Nephrops* equal or higher than a 10% has decreased since 2006 (Figure 8, left). In 2016, only the 5% of the trawl days in FU 31 had a *Nephrops* catch equal or higher than 10% (Figure 8, right). Probably, the fleet has been finding less and less *Nephrops* yield in the last years and in less fishing grounds and FU 31 Sentinel the activity has been concentrated in those grounds.

CONCLUSIONS

- FU 31 CPUE rates obtained in the Sentinel fishery are higher than the maximum of the 1989-2016 FU 31 CPUE time series.

- The Sentinel fishery in the area and period of high abundance has lead to a hyperstability of the catch rates.

- Therefore, *Nephrops* CPUE data from FU 31 Sentinel fishery 2019 are not representative of the stock state.

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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

- C O M U N I C A I C Ó N -

DE:	SUBDIRECCION GENERAL DE CONTROL E INSPECCIÓN
A:	OPP LUGO (info@opplugo.com) DIRECCIÓN ÁREA FUNCIONAL DE AGRICULTURA Y PESCA DE ASTURIAS SUB. GRAL. DE PROTECCIÓN DE LOS RECURSOS PESQUEROS SUB. GRAL. DE CALADERO NACIONAL Y AGUAS COMUNITARIA
ASUNTO:	CAMPAÑA IEO – CENTINELA – CIGALA UF-31
S/REF:	N/REF: TMS/JAF
FECHA:	15 de julio de 2019
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 (UF) 31, se autoriza al buque pesquero **"O CANTIÑO", "3ªFE-2-9-97", Código U.E.: ESP000023639** 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**: 7 días durante el mes de julio de 2019 de lunes a viernes.
- **Zona de actividad**: Unidad funcional 31, correspondiente al Caladero Nacional del CNW (CIEM VIIIc).
- **Especies objetivo:** Cigala (*Nephrops norvegicus*). Con posibilidad de estudio de otras especies secundarias (gallo, rape, merluza, etc). El **tope** de capturas de **cigala** será de **350 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".
- Las cantidades de capturas serán contabilizadas a parte de la cuota general asignada a España hasta el máximo del 2% sobre dicha cuota.

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C/VELAZQUEZ, 147
28002 MADRID
TEL: 913471949

Annex I *cont*

- Las capturas se deberán desembarcar en el puerto de Avilés, puerto habitual de descarga de este pesquero, permitiendo su comercialización, excepto ejemplares de tamaño inferior al reglamentario.

- La campaña tiene un tope de capturas máximo de cigala de 350kg, por lo tanto una vez alcanzado dicho tope, se tendrá que dar por finalizada la campaña. Así mismo, indicar que los ejemplares por debajo de la talla mínima de referencia para la conservación, no se podrán llevar a puerto ya que están sujetas a la exención de "alta supervivencia", por tanto se tendrán que descartar, así como posibles capturas por encima del tope establecido.

- 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.

La Subdirectora General de Control e Inspección

SECRETARÍA GENERAL DE PESCA

Teresa Molina Schmid

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C/VELAZAQUEZ, 147
28002 MADRID
TEL: 913471949

Annex II

Characteristics of hauls carried out during observers survey and *Nephrops* catch by haul.

SURVEY HAUL	TRIP	TRIP HAUL	HAUL STARTING DATE	HAUL STARTING HOUR	HAUL DURATION (HOURS)	HAUL STARTING DEPTH (M)	NEP CATCH (KG)
1	1	1	10 July 2019	10:40	1.8	538	84
2	1	2	10 July 2019	13:40	4.2	274	120
3	1	3	10 July 2019	18:54	4	585	0
4	1	4	11 July 2019	0:01	4	622	0
5	1	5	11 July 2019	6:10	2	256	0
6	1	6	11 July 2019	9:55	3.3	399	12
7	1	7	11 July 2019	14:56	1.9	147	37
8	1	8	11 July 2019	17:55	1.3	433	43
9	1	9	11 July 2019	20:32	2		0
10	1	10	11 July 2019	23:45	5		0
11	1	11	12 July 2019	6:15	3		0
12	1	12	12 July 2019	6:24	2.4	293	22
13	1	13	12 July 2019	9:51	1.8	155	16
14	1	14	12 July 2019	16:20	2		0
15	2	1	16 July 2019	7:30	6.0	512	96
16	2	2	16 July 2019	14:30	4.0	402	66
17	2	3	16 July 2019	19:30	2.0	161	0
18	2	4	17 July 2019	7:15	4.0	421	32
19	2	5	17 July 2019	12:15	4.8	594	108
20	2	6	17 July 2019	18:15	3.3	201	0
21	2	7	17 July 2019	22:30	3.0	159	0
22	2	8	18 July 2019	2:15	3.7	192	0
23	2	9	18 July 2019	6:30	4.1	768	20
24	2	10	18 July 2019	11:48	4.5	549	86
25	2	11	18 July 2019	17:20	3.3	154	0
26	3	1	24 July 2019	6:30	1.8	168	0
27	3	2	24 July 2019	9:46	5.2	384	38
28	3	3	24 July 2019	16:25	2.2	375	14
29	3	4	24 July 2019	23:30	5.2		0
30	3	5	25 July 2019	7:02	2.2	144	0
31	3	6	25 July 2019	10:57	6.9	463	51
32	3	7	25 July 2019	18:19	1.5	130	0
33	3	8	25 July 2019	23:50	6.0	165	0
34	3	9	26 July 2019	7:17	1.5	144	0
35	3	10	26 July 2019	10:04	6.2	236	27
36	3	11	26 July 2019	18:30	0.8	128	0
37	4	1	31 July 2019	6:55	3.9	393	22
38	4	2	31 July 2019	11:45	3.9	457	56
39	4	3	31 July 2019	16:45	4.9	530	68
40	4	4	01 August 2019	7:00	6.5	157	68
41	4	5	01 August 2019	14:15	6.4	393	72
42	4	6	02 August 2019	3:20	1.7	119	0
43	4	7	02 August 2019	6:00	3.4	141	0
44	4	8	02 August 2019	10:00	2.3	155	0
45	4	9	02 August 2019	13:00	2.7	137	0

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ISUNEPCA2019 UWTV Survey on the Gulf of Cadiz *Nephrops* Grounds (FU30 and some stations in FU29) and catch options for 2020 in FU30

Vila, Y., Burgos, C. and Farias, C.

Instituto Español de Oceanografía. C.O. Cádiz. Muelle Pesquero, Muelle de Levante s/n. Cádiz, 11006. Spain

ABSTRACT

This working document details the results of the sixth underwater television survey on the Gulf of Cadiz *Nephrops* grounds (FU 30). The survey is considered multi-disciplinary in nature, collecting UWTV, CTD, beam trawl and dredges information. A total 69 UWTV stations were planned in a randomized 4 nm isometric grid but only 65 UWTV stations were used in the geo-statistical. The mean burrow density observed in 2019, adjusted for cumulative correction factor, was 0.04 burrows/m². The final krigged abundance estimate was 113 million burrows with a CV of 9.7%. The 2019 abundance estimate was 65% lower than in 2018. Additionally, 6 UWTV stations were conducted in FU29 (South Portugal) close to the Spanish border with FU30 in order to explore if both FUs could correspond to the same population. Mean burrow density was 0.05 burrows/m^2, which is comparable to mean burrow density in Spanish stations close to the border. Other information related to the ecosystem is also presented. Catch advised for 2020 in FU30 when the ICES precautionary approach is applied and according to category 3.1.4, was no more than 77 tonnes. The UWTV survey index in 2019 decreased more than 20%, so an uncertainty cap was applied. Beside, the stock status relative to candidate reference points is unknown and therefore, the precautionary buffer was also applied. MSY reference point based on SCA and SCLA could be not deriving during last WKNephrops in November 2019. Those models resulted a very different stock estimates in relation to the UWTV survey abundance. Investigations about other methods to derivate specific F_{MSY} reference points for FU 30 must be conducted in order to meet the requirements for ICES Category 1 *Nephrops* stocks.

1. INTRODUCTION

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 in recent years), this species gives valuable revenues for the trawl fleet. In the Gulf of Cadiz, *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, exploitation status and catch advised 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 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 that 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 followed the category 4 approach for *Nephrops* up to 2018 and the category 3 in 2019 since a 5 years' UWTV survey time series was available.

The Spanish Oceanographic Institute (IEO) conducted the sixth *Nephrops* UWTV survey on the Gulf of Cadiz fishing grounds in 2019, although UWTV survey in 2014 was considered only exploratory. This survey was multi-disciplinary 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
3. To explore the *Nephrops* distribution continuity between FU30 and FU29
4. To obtain estimates of macrobenthic species and the occurrence of trawl marks and litter on the seabed
5. To collect oceanographic data using a sledge mounted CTD
6. To collect sediment samples
7. Sea bed morphological and backscatter analysis

This working document details the FU 30 UWTV survey results in 2019, including the information obtained in Portuguese waters close to the border in order to respond to the advances in ToR WGBIE about the review and evaluation of the potential for assessing FU29 (South Portugal) and FU30 (Gulf of Cadiz) as one stock. The provision of the catch advised in FU30 for 2020 based on the abundance estimate from 2019 UWTV survey is also documented.

2. METHODOLOGY

The ISUNEPCA UWTV survey took place on board RV Angeles Alvariño between 3rd and 15th June in the Gulf of Cadiz waters (FU 30). The UWTV designs followed a randomized isometric grid of stations at 4 nm spacing. A total of 69 stations were planned covering the *Nephrops* area distribution established in last benchmark (ICES, 2016) (Figure 1). The ground perimeter was established using a combination of VMS and logbook data (2011-2012), *Nephrops* abundance data from bottom trawl surveys series (SP-GCGFS-Q1_IBTS) (1994-2014) and bathymetric and morphologic information (INDEMARES project; Vila et al., 2016). The *Nephrops* area corresponds to 3000 Km^2. Stations ranged from 100 to 620 m depth. A total of 6 stations were planned in FU 29 (South Portugal) close to the Spanish border with FU30 in order to explore if both FUs could correspond to the same population and be assessed as only one stock (Figure 1).

A number of hauls from beam trawl (BT) were planned in order to know the presence of *Nephrops* and other burrowing fauna which co-occurring together and that could be source of confusion in the identification of *Nephrops* burrows. A total 14 beam trawl was carried out (9 in FU30 and 5 in FU29) (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 line lasers. Protocols used were those reviewed by WKNEPHTV (ICES, 2007) and annually by Expert Group on *Nephrops* surveys (SGNEPS/WGNEPS), which was finally published in ICES Cooperative Research Report No. 340 (Leocadio et al., 2018). At each station, the sledge was deployed and once stable on the seabed a 10 minute tow was recorded. The sledge was towed between 0.6-0.7 knots in order to obtain the best possible conditions for counting *Nephrops* burrows. Video footage corresponds to 200 m swept, approximately. Vessel position (dGPS) and position of sledge, using a HiPAP transponder, 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 footage prior to recounting at sea. FU30 reference footage was created in WKNEPHS 2018 (ICES, 2018). 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. The numbers of *Nephrops* burrows systems was counted in the whole 10 minutes recorded.

The density estimate at each station was calculated from standardized *Nephrops* burrows recounts divided by the area observed. This area was calculated multiplying the DOG by the FOV. The spatial co-variance and other spatial structuring geo-statistical analysis were conducted using ARCGIS software. Geo-statistic 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 same density range and raising this density to the surface of the each polygon. The summary of the method used in the geo-statistic 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 UWTV surveys. This bias is related to the counting of burrow complexes which lie mainly outside the viewed track. Other biases identified 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).

Footages were also used for quantification of other mega-fauna species by a different team of scientists than the "burrow identification" team. Trawl marks and litter were recorded as presence/absence. Currently, results are only available for exploratory stations in Portuguese waters (FU29) and Spanish station near to the border.

At each station, CTD profile was logged for the duration of the tow using an AML Oceanographic Minos-X mounted on the sledge (Figura 2a). A total of 7 Box-corer and 8 Shipek dredge were carried out in order to know the sediment composition on the seabed (Figura 2b).

3. RESULTS

3.1. ISUNEPCA UWTV survey

Many technical problems occurred in 2019 UWTV survey, which were related to the communication between the sledge and the desk unit by the coaxial cable of the vessel. The new equipment used since 2018 is probably more sensible to electronic noises of the vessel than the previous one. This resulted in a reduction of the effective time of the survey. So, the planned stations had to be prioritized. In the shallowest edge, the visibility is very poor and the *Nephrops* density is low according to the VMS data available and the bottom trawl survey series (SP-GCGFS-Q1_IBTS) generating a high uncertainty in the *Nephrops* burrows identification. Additional information obtained from the beam trawl hauls carried out in 2017-2019 period indicated absence of *Nephrops* in the hauls at lower than 200 m depth (Figure 3b). Therefore, it was decided sacrificed the 12 stations allocated at less depth, which were considered stations with zero *Nephrops* density, as previous years. On the other hand, 2 stations were abandoned because visibility was null due the recent fishing activity and it was not possible to revisit them again and other 2 stations were considered null after their visualization for bad clarity of the water. A total of 65 stations were finally used in the geo-statistical analysis to estimate the *Nephrops* abundance.

Figure 4 shows the *Nephrops* density (adjusted to cumulative bias factors=1.28) for 2019 in this FU. The density ranged between 0.002 and 0.216 burrows/m^2 and the average burrow density was 0.04 burrows/m^2. Mean density decreased in 2019, being the lowest value recorded in the time series. Nevertheless, the highest densities were also observed in the western part of the area as previous years (Figure 3). The final modeled density surfaces in the UWTV surveys time series (2015-2019) are shown as a heat maps and bubble plots in Figure 5. Table 1 shows the summary statistics from the geo-statistical analysis using ArcGis (Ordinary Krigging and positive anisotropy). The abundance estimate derived from the krigged burrow surface (and adjusted for the cumulative bias) was 113 million burrows with a CV of 9.7% in 2019 (Table 3). *Nephrops* abundance estimate decreased 65% in relation to 2018.

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.

The near the bottom temperature and salinity data collected during the survey are shown in Figure 6. Mean temperature by station ranged between 12.5 °C and 13.97 °C while salinity ranged between 35.8 psu and 36.9 psu. Table 4 shows the sediment composition in samples from dredges (Box-corer and Shipek). Sediment samples collected within the survey area shown a high percentage of sand ranging between 75% and 89% and mud fraction is composed by a higher proportion of silt than clay (15%-8%). Sediment samples taken outside the survey area had a great sand composition with a very low proportion of gravel (<2%).

3.2. Exploratory stations in FU29 (South Portugal) results

A total of six stations were planned in Portuguese water close to the border to Spain (Figure 1). Final activities carried out by stations are shown below:

STATION	E1	E2	E3	E4	E5	E6
Dept (m)	**557**	**545**	**496**	**554**	**561**	**679**
TV	X	X	X	Null*	X	X
Beam Trawl	Null*	X	X	X	X	Null*
CTD	X	X	X	X	X	X
Dredges**	na	na	na	na	na	X

* Null Stations and not enough time to revisited them

** Dredges could not carried out for bad weather and not enough time to revisited them

The *Nephrops* density in these Portuguese stations ranged from 0.0007 burrows/m^2 to 0.16 burrows/m^2. The highest value was recorded in station E5 at 561 m depth while in Station E6 was observed the lowest value at 679 m (see Figure 4).

Data from Beam trawl confirm a higher *Nephrops* abundance in station E5 and only in station E2 the abundance was zero. The unique dredge carried out in Portuguese waters (station E6) indicated sediment with 89% sand and only 11% mud which it is not very suitable to *Nephrops* built their burrows (Table 4). This data is agreed with results obtained from footage.

Regarding to oceanographic variables, temperature ranged between 12.9 °C and 13.4 °C while salinity range between 36.4 psu and 36.7 psu (Figure 6).

Figure 7 shows the specific composition from footage in Portuguese and Spanish stations on the border between FU30 and FU29. The main species identifies were *Tenea muricata*, *Kohobelemnun stilliferus* or *Funiculina quadrangularis*.

3.3. Catch Options in 2019 for 2020

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 2019. Discards are considered negligible so all catches are assumed to be landed (ICES, 2017b). Table 5 shows the assessment summary for *Nephrops* FU 30 in 2019.

The ICES framework for Category 3 Norway lobster stocks (ICES, 2012a) was applied for *Nephrops* FU 30 because the survey time-series (ISUNEPCA UWTV survey), is long enough to be used as the index of stock development. The advice was based on the ratio of the mean of the two index value (index A) and the mean of the preceding values (index B) multiplied by the recent advised catch. Table 5 shows the basis for the catch options for this stock for 2020 (Table 6). The mean weight of the three last years was used in order to convert the abundance in biomass (23.3 g).

The abundance index from ISUNEPCA UWTV survey was estimate to have decreased by more than 20% and thus the uncertainty cap was applied. The stock status relative to candidate reference points is unknown; therefore, the precautionary buffer was also applied. The catch advised for 2020 decreased compared to previous advice, due to the large decrease in stock abundance and the application of the precautionary buffer (Table 6).

Misreporting has been quantified since 2016 and included in the assessment. Misreporting decreased 37% in 2018 regarding to the previous year and represents 55% of the official landings. This is probably related to the allocation of the *Nephrops* quota by vessel established since 2014.

ICES advices that when the precautionary approach is applied, catches in 2020 should be no more than 77 tonnes. To ensure that the stock in FU30 is exploited sustainably, management should be implemented at the functional unit level.

4. DISCUSSION

4.1. ISUNEPCA UWTV survey 2019 and Catch Options for 2020

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 since 2018.

The surveyed area and the number of UWTV stations have increased since the first UWTV survey in the Gulf of Cadiz (FU 30) that started in 2014 (exploratory survey). The *Nephrops* ground in FU30 was established in the Benchmark Workshop on *Nephrops* (WKNEPS) base on the VMS and logbook data analysis (2011-2012), *Nephrops* abundance data from SP-GCGFS-Q1_IBTS surveys series (1994-2014) and bathymetric and morphologic information (Vila et al., 2016; ICES, 2016a). The area established range between ~100 to ~700 m depth. VMS and logbook analysis show significant fishing activity targeting *Nephrops* from 200 m depth. However, the bottom trawl survey series carried out in the Gulf of Cadiz (1994-2014) indicates small quantities of *Nephrops* in some points at depths below 200 m. 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. Beam trawl hauls were carried out during ISUNEPCA UWTV surveys in the 2017-2019 period to validate the information obtained in the footage and to confirm the shallowest *Nephrops* boundary. Results of these last three years showed presence of burrowing crustaceans as *Goneplax rhomboids* but individuals of *Nephrops* were not caught in them.

Data compiled during ISUNEPCA UWTV survey series suggest that the survey area is probably smaller than the current area and therefore, it should be reviewed in the near future benchmark. New and more accurate information is available for this issue. The Andalucian Regional Government has installed its own vessel monitoring system on fleets using GPRS/GSM (Global System for Mobile Comunications), a cellular network technology that send data on vessel positions and speed every three minutes instead two hours in the traditional VMS. Additionally, information obtained from beam trawl and sediment samples obtained in the ISUNEPCA UWTV survey during 2017-2019 periods, as well as, the sea bed morphology and backscatter analysis could be also very useful in order to redefine of the survey area in FU 30. A reduction of the *Nephrops* area in the shallowest limit should be evaluated in a future benchmark.

The burrow abundance estimate has greatly decreased regarding the previous year (from 329 million burrows in 2018 to 113 million burrows in 2019). The highest value was observed in 2017 (370 million burrows) and from this year the *Nephrops* abundance estimate shows a declining trend. Regarding to the harvest rate (HR), its trend decreased from 2016 (the maximum value recorded in the time series) to 2018 (the minimum value recorded).

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 using methodologies ad-hoc normally used for calculating F_{MSY} for Category 1 *Nephrops* stocks. 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 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 absence of MSY reference points, the ICES framework for Category 4 Norway lobster stocks (ICES, 2012a) was applied for *Nephrops* FU 30 in the advice 2017 and 2018. In 2019, the ICES framework for category 3 (ICES, 2012) was applied because the ISUNEPCA UWTV survey time series was considered long enough to be used as the index of the stock development. *Nephrops* abundance index from UWTV survey declined more than 20% and an uncertainty cup was applied. Nevertheless, the stock status relative to specific reference points for this FU follows being unknown. For this reason, a precautionary buffer was additionally applied on the catch option for 2020. Therefore, the catch advised for 2020 greatly decreased compared to previous advice, due to the large decrease in the stock abundance and the application of the precautionary buffer.

A workshop on *Nephrops* reference points has been recommended since 2016 in order to evaluate reference point estimation methods for stocks with recent TV surveys. WKNephrops (ICES Workshop on Methodologies for *Nephrops* Reference Points) was finally carried out in November 2019 (Report not available yet). Different models were applied during WKNephrops. Some of them are methods developed for data limited stocks as Length Based Indicators (LBI) or Mean Length-Z while others are used for calculating MSY Reference Points for Category 1 *Nephrops* stocks, such Separable Cohort Analysis (SCA-Ewen's model) and SLCA (Helen's model).

SCA model gave FU 30 stock estimates far below those of the UWTV survey. Factors as the uncertainty of the natural mortality and growth parameters can affect the shape of the catch-at-length distribution and can produce different magnitudes of stock abundance. On the other hand, the abundance from UWTV input value in the model for FU 30 seems be very sensitive since when the UWTV survey input was lower, the model was better fitted. Some explorations runs were carried out using SLCA (Helen's model) but the HRs resulting were also very high.

In conclusion, MSY reference point could not be derived properly for FU30 in this WKNephrops. It is necessary to explore other methods in order to obtain specific FU 30 MSY reference points and upgrade this stock to *Nephrops* category 1.

4.2. Evaluate the potential for assessing FU29 and FU30 as one stock

The potential for assessing FU29 (South Portugal) and FU30 (Gulf of Cadiz) as one stock was evaluated by the WGBIE in 2019. *Nephrops* biological parameters, fishery dependent data, landings, VMS for each FU were presented but results were inconclusive because they should be standardized to facilitate comparisons.

The WGBIE recommended that further investigation is needed. In this sense, some TV stations were carried out in FU29 near to the Spanish border during ISUNEPCA UWTV survey 2019. Results show that stations carried out in Portuguese waters were positive in presence of *Nephrops* with density values similar to the closest Spanish stations, suggesting the *Nephrops* distribution between FU30 and FU29 is a continue.

Recomendations:

1. A benchmark workshop must be carried out in order to redefine the ISUNEPCA UWTV survey area using the new information available in the near future (Andalucian Regional Government GPRS/GSM Global System for Mobile Communications, beam trawl, sediment, sea bed morphological and backscatter data).

2. Investigations about other methods to derivate specific F_{MSY} reference points for FU 30 must be conducted in order to meet the requirements for category 1 *Nephrops* stocks.

3. Continue the work to evaluate the potential for assessing FU29 (South Portugal) and FU30 (Gulf of Cadiz) as one stock.

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Table 1. Geo-statistic method summary

Method	Kriging
Type	Ordinary
Variogram	Semivariogram
Number of lags	9
Lag size	0.066666
Nugget	0.0010425
Anisotropy	Yes
Range (Major)	0.599994
Range (Minor)	0.305059861
Partial sill	0.001941262
Direction (angle)	143.789

Table 2. The bias associated with the *Nephrops* abundance estimates 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 geo-statistical 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
2019	65	0.0377	3000	3000	113	9.7

Table 4. Sediment composition in samples collected from dredges (Box-corer, BC and Shipek, SK).

	SURVEY AREA IN						
	FU30						FU29
	BC_01	BC_02	BC_03	BC_04	BC_05	BC_06	BC_07_E6
Clay	3.13	4.31	2.44	2.15	2.84	9.61	3.23
Silt	11.23	12.10	9.79	9.45	8.12	15.56	7.34
Mud	14.36	16.40	12.23	11.60	10.96	25.17	10.57
Sand	85.41	83.30	87.77	88.39	88.98	74.69	89.43
Gravel	0.23	0.30	0.00	0.01	0.06	0.13	0.00

	SURVEY AERA OUT							
	FU30							
	SK_01	SK_02	SK_03	SK_04	SK_05	SK_06	SK_07	SK_08
Clay	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Silt	1.74	0.00	0.00	0.00	0.72	0.00	0.00	0.77
Mud	3.00	0.00	0.00	0.00	0.72	0.00	0.00	0.82
Sand	96.80	98.35	99.30	97.65	98.08	100.00	100.00	99.18
Gravel	0.19	1.65	0.70	2.35	1.20	0.00	0.00	0.00

Table 5. Assessment summary for *Nephrops* FU 30.

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
2019		0		113	21					

* 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

Table 6. Basis for catch options for 2020 according to ICES category 3 for *Nephrops* FU 30.

Index A (2018–2019)		220900 individuals
Index B (2015–2017)		300333 individuals
Index ratio (A/B)		0.74
Uncertainty cap	Applied	0.80
Advised landings for 2019		120 tonnes
Discard rate		Negligible
Precautionary buffer	Applied	0.80
Catch advice		77 tonnes
% advice change^		−36%

^ Advice value for 2020 relative to advice value for 2019

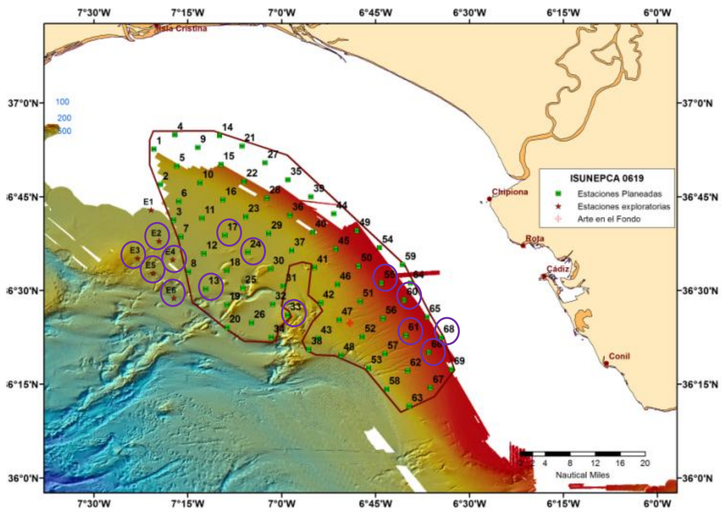


Figure 1. Planned UWTV stations grid and hauls using beam trawl carried out in 2019 ISUNEPCA UWTV survey. Stations labeled with letter "E" and red star symbols correspond to exploratory stations carried out in Portuguese waters.

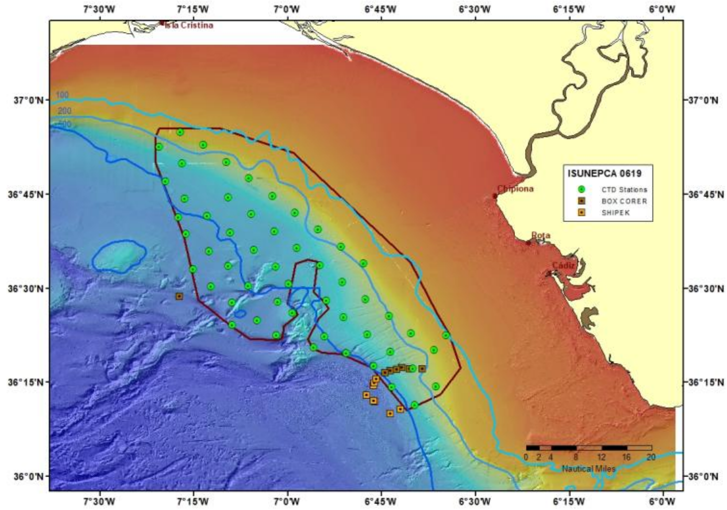


Figure 2. CTD and dredges (Box-corer & Shipek) stations carried out in 2019 ISUNEPCA UWTV survey.

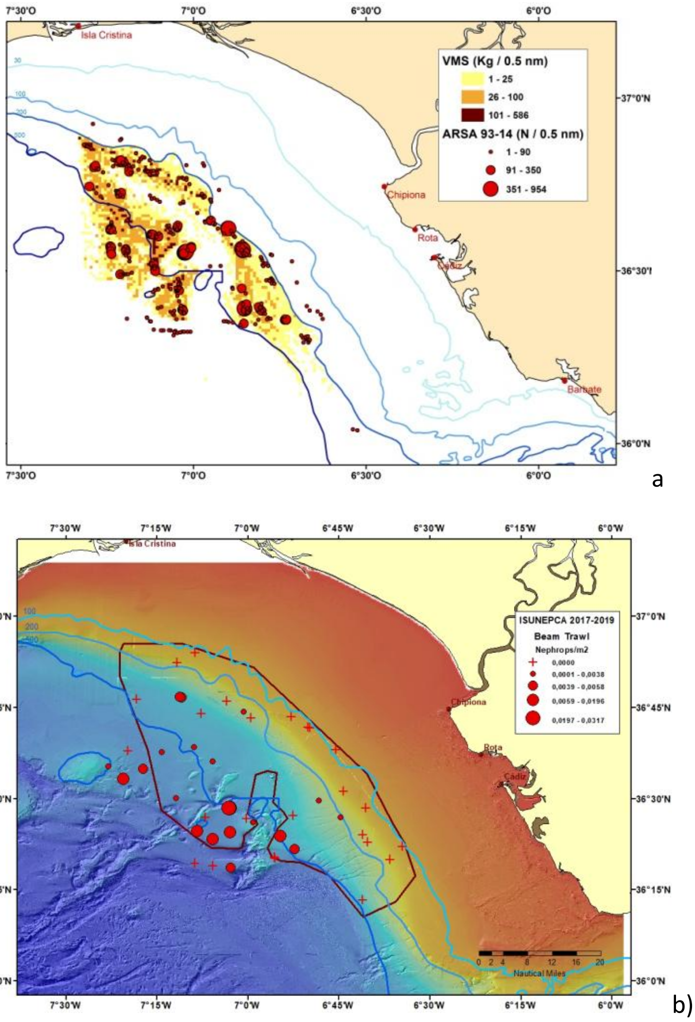


Figure 3. VMS and logbooks analysis (2011-2012) and bottom trawl *Nephrops* abundance (1994-2014) (a); *Nephrops* density from beam trawl hauls (2017-2019).

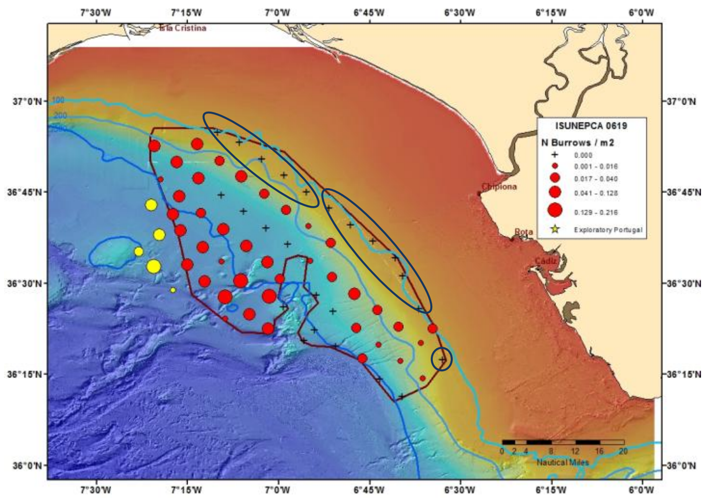
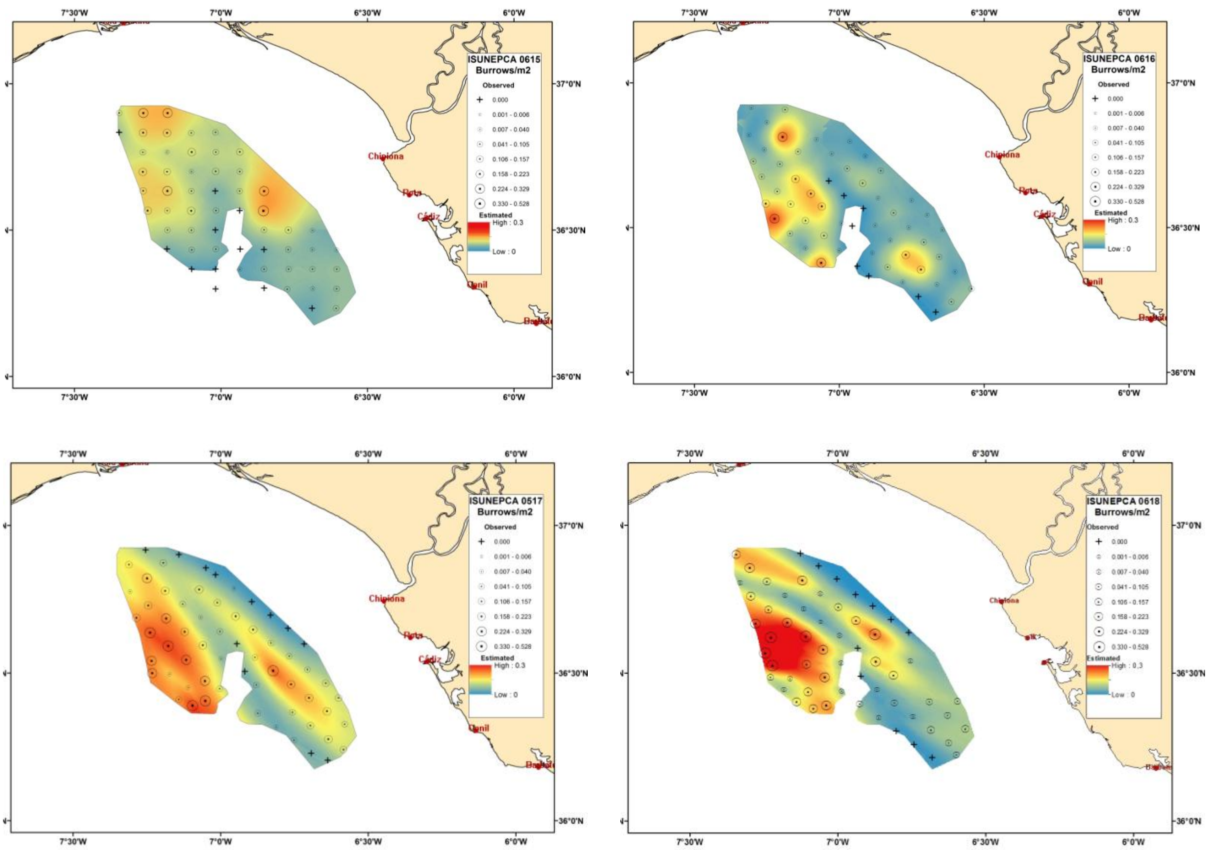


Figure 4.*Nephrops* density adjusted to account for bias factors for 2019 UWTV survey. Blue ellipse shows stations where zero *Nephrops* density is assumed. Red bubbles correspond to *Nephrops* density in FU30 and yellow bubbles in FU29.



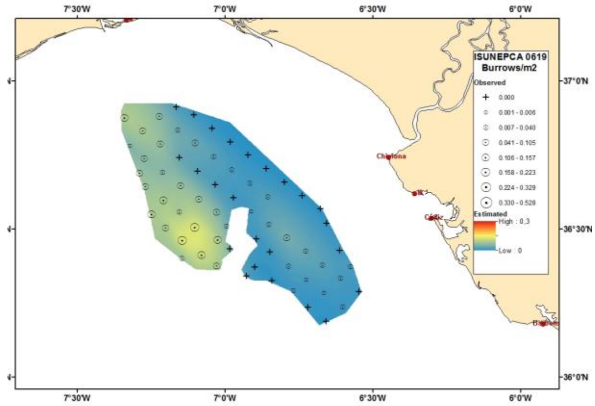


Figure 5. Bubble plot of the burrow density observations overlaid on a head map of the krigged burrow density surface for UWTV survey series (2015-2019). Station positions with zero density are indicated using a +.

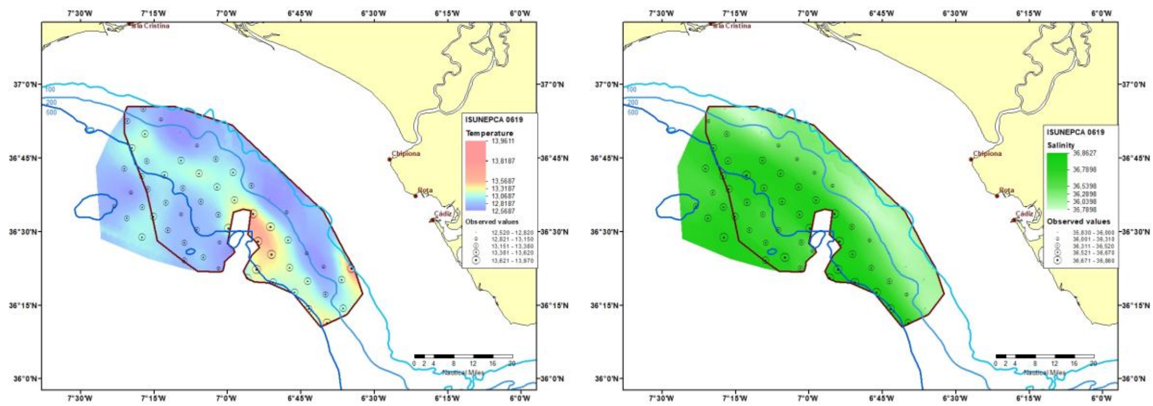


Figure 6. Temperature and salinity on the seabed collected during the survey in FU30 and FU29.

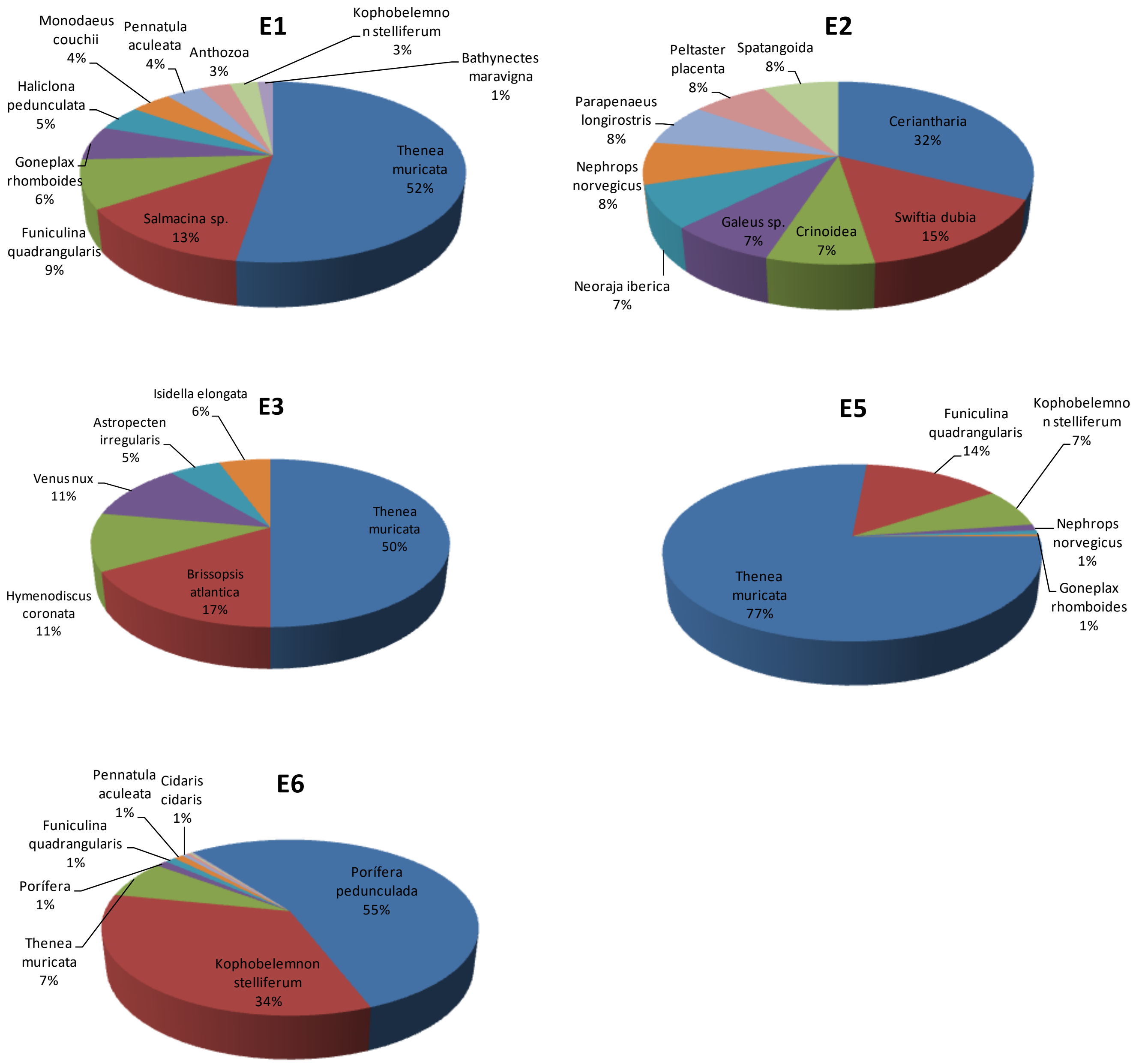


Figure 7. Specific composition of the macro-benthic fauna obtained from footages in Portuguese stations close to the border with FU30.

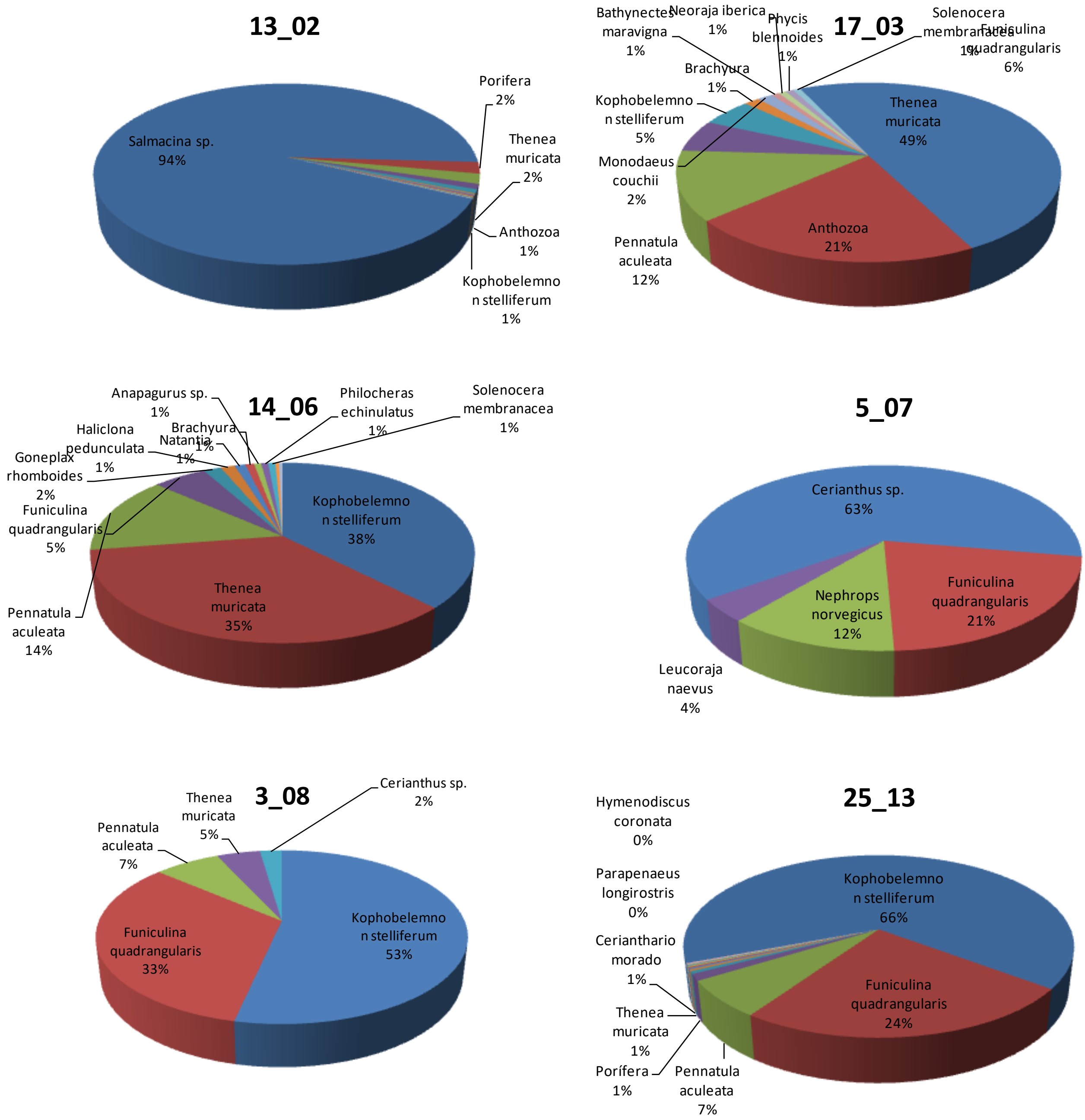


Figure 8. Specific composition of the macro-benthic fauna obtained from footages in Spanish stations close to the border with FU29.

Update of pollack abundance indices from professional fishing data (2016-2018)

Nathalie Caill-Milly[1], Muriel Lissardy[1], Noëlle Bru[2]

[1] Ifremer, Unité LITTORAL, 1, allée du Parc Montaury, F-64600 Anglet, France

[2] Université de Pau et des Pays de l'Adour, E2S UPPA, CNRS, LMAP, Anglet, France

Context

The ROMELIGO project (2015-2018) aimed to contribute to the improvement of the knowledge on three stocks (mur-west, whg-89a and pol-89a – see Table 1) on the basis of the available data (landings data, sampling data for the French fleet, data from scientific campaigns…) or specific data collected during the project.

Table 1: Stocks considered by the ROMELIGO project for red mullet, whiting and pollack.

Species	Stock name	Stock code
Striped red mullet	Striped red mullet areas VI, VIII et sub-areas VIIa-c, e-k et IXa (West area)	mur-west
Whiting	Whiting area VIII et sub-area IXa	whg-89a
Pollack	Pollack area zone VIII et sub-area IXa	pol-89a

The project was organized in the same way in three parts and applied for each of the three stocks:

- Part 1 - Analyzes of catches and activity of the French professional fishery (composition and evolution of catches, seasonality, spatial distribution, gear used and discards);
- Part 2 - Analyzes of the size composition of the catches on professional and scientific vessels, analyzes of the discards, proposition of abundance indicators using professional fishing data and analyzes of CPUE from available scientific surveys;
- Part 3 - Collection of basic biological data relying on various samplings and calculation of biological parameters (length / weight relationships, growth curves, length at first maturity (L50) or maturity ogive…).

The contract report is available online (Léauté et al., 2018a[1]). A paper on the methodology used to select the reference fleets for the calculation of red mullet LPUE was also published (Caill-Milly et al., 2019).

In relation to this work and regarding **pollack**, two WDs were already sent and presented to the WGBIE respectively in 2017 and 2018:

- One dedicated to part 1 integrating as a preamble a bibliographic review on the biology of the species (Léauté et al., 2017);
- One dedicated to parts 2 and 3 (Léauté et al., 2018b).

This WD provides the update of pollack abundance indices from professional fishing data (2016-2018).

[1] https://archimer.ifremer.fr/doc/00440/55126/

A reminder of the previous results (Léauté et al., 2018b)

For this species and for the Bay of Biscay, Table 2 describes the characteristics of the fleets selected to build abundance indices from professional fishing data. The selection was based on gear, technical characteristics of the vessels (defined by clusters), characteristics of the gear (mesh class), time and space specifications. For pollack, the retained gear and cluster are « Set gillnets (anchored) » (GNS) and cluster 3. This third cluster corresponds to medium vessels (10.5 to 18.2 m) with medium tonnage (6.7 to 91.2 grt) and a power comprised between 87 to 331 kW. Second half-year was selected to avoid period of concentrations during breeding season in particular. Only the northern Bay of Biscay was selected (the southern part, under latitude 46, displayed too wide confidence intervals regarding LPUE).

Table 2: Characteristics of the selected fleets regarding pollack.

Retained gear	Cluster	Mesh class of gear	Period	Specific spatial delimitation
Set gillnets (anchored) « GNS »	Cluster 3	Higher than 90 mm	2nd half-year	Northern Bay of Biscay

For the selected mesh class (higher than 90 mm), evolutions of the LPUE mean level and of its use were considered for the second half-year for the north of the Bay of Biscay.
The evolution of the LPUE was marked by a significant increase (Pearson test) in the level of the indices over the period 2005-2015 (Figure 1). A warning on the use of this indicator based on the practice of gillnets was however given in particular due to possible various uses of the gear related to the length of the nets, the exposure time, the influence of the swell…).

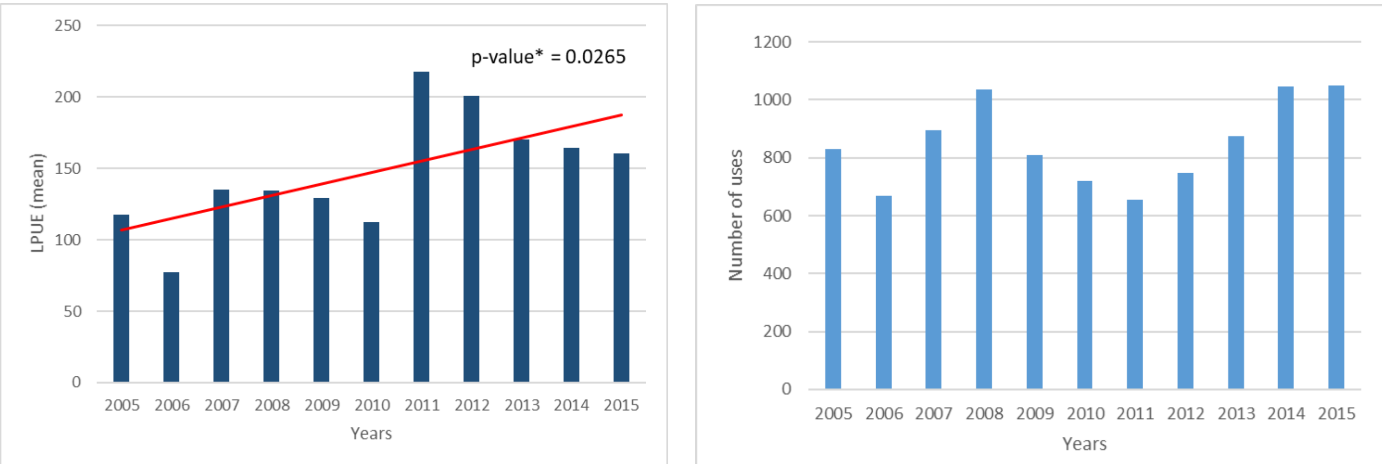


Figure 1: Levels of LPUE and number of uses – Set gillnets (anchored) - Cluster 3 - Mesh class higher than 90 mm – 2nd half-year – Northern Bay of Biscay

Method used to update the abundance indices from professional fishing data

The proposed method allows an update of the LPUEs of the selected fleet after 2015. It requires the assignment of new vessels in one of the clusters defined in the project beforehand. This is to be done at the level of the selected gear for the species (*i.e.* GNS for pollack).

Clusters are the result of a hierarchical classification of vessels based on their technical characteristics (length, tonnage and power). The vessels were grouped according to their degree of similarity for these three variables using Hierarchical Aggregation Clustering (HAC) with Ward aggregation criterion and Euclidean distance.

When grouping with a clustering method such as the above one, it is difficult to identify clearly the bounds allowing to affect one vessel in a specified cluster (because of possible overlaps of some of the characteristics from one cluster to another). A method of assigning vessels was therefore developed for the selected gear.

To do this, a conditional decision tree was built. The targeted variable was the variable “cluster”. Based on the existing classification, the decision tree provides the rules fixing the values that must take the different technical variables for a vessel to belong to a given cluster. The leaves (of the tree) not selected are either because they do not concern the targeted cluster or because the risk of classification error is considered too high.

Once this step has been completed, updating of the data (number of uses of the gear and average levels of LPUE) was carried out. It concerned the years 2016, 2017 and 2018. This update was sent to the professional structures involved in the former "CPUE Working Group" of the Romeligo project. The objective was to identify regulatory or other elements that could potentially disturb the LPUE index constructed for 2016, 2017 and 2018.

Results

Decision criteria for the assignment of new vessels appearing in 2016, 2017 or 2018

Regarding pollack and for GNS, the retained tree (Fig. 2) is the one which setting minimizes the prediction error for cluster 3 and for all the data (cluster prediction error 3: 1.0%; total prediction error 1.0%).

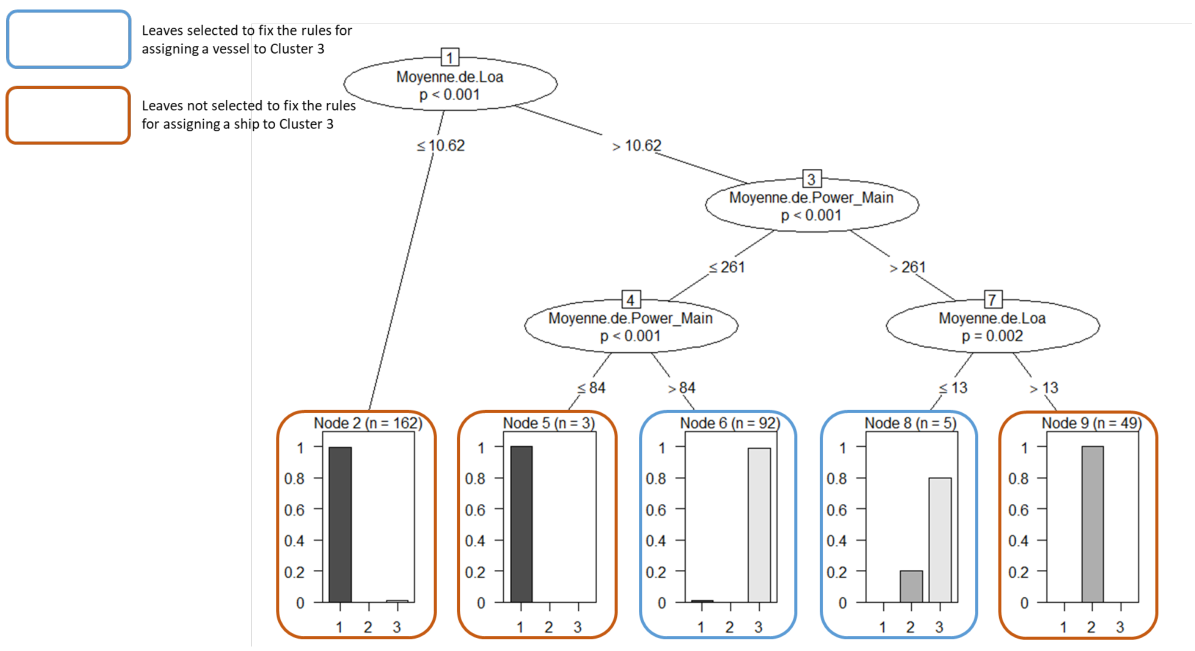


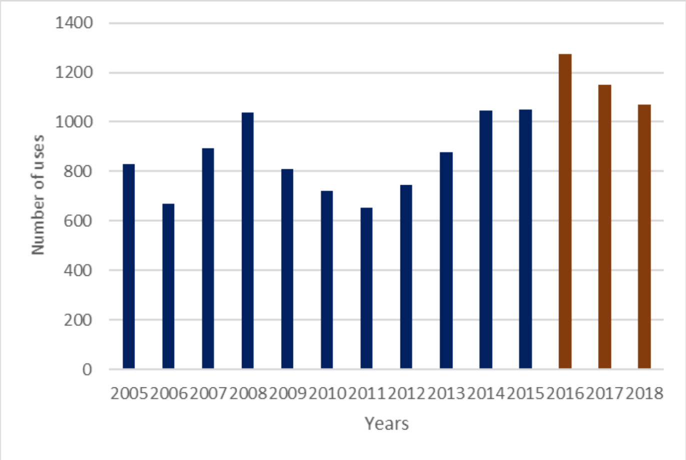
Figure 2: Conditional regression tree on cluster 3 variable (for pollack / GNS) with technical characteristics [Loa : Length (m); Power_Main : power(kW)].

Consequently, a vessel falls into the cluster 3 if its length is greater than 10.62 m and:

- If its power is higher than 84 kW and less than or equal to 261 kW;
- Or if its power is higher than 261 kW and its length less than or equal to 13 m.

Update of data and evolution of the indices

The evolution of the number of uses and of the average level of LPUE are shown for the 2nd half-year and for the north of the Bay of Biscay (Figure 3).



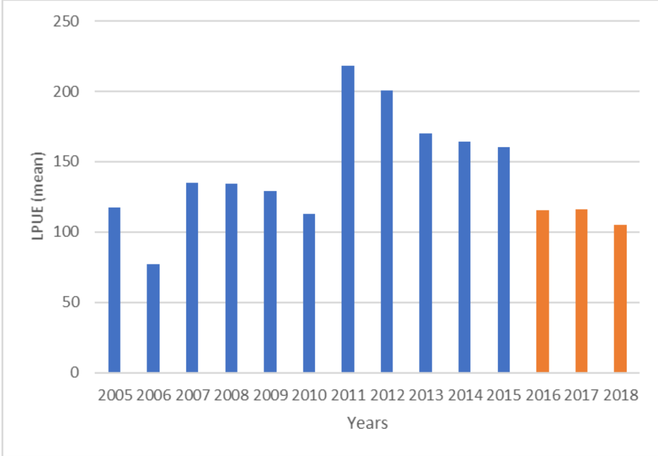


Figure 3: Numbers of uses and levels of LPUE - Set gillnets (anchored) - Cluster 3 - Mesh class higher than 90 mm – 2nd half-year – Northern Bay of Biscay

Over the entire period, the number of fishing sequences ranges from 650 to 1 275; the second part of the series being characterized by higher sequence numbers than at the start of the period.

For the past three years, the LPUEs display low levels compared to the whole series. The highest levels were observed between 2011 and 2015.

Information from the consultation of professional structures

The consultation did not identify regulatory element that could potentially have disturbed the LPUE / GNS indices built for 2016, 2017 and 2018.

Conclusion

Currently one fleet is selected for the Bay of Biscay: GNS - Cluster 3 - Mesh size class greater than 90 mm - 2nd semester - North of the Bay of Biscay. At this time no new element leads to discuss the relevance of this fleet but we must remain cautious about the use of this indicator alone (linked to the possible various uses of the gear).

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Sacrois versions used for the update: V.3.3.7 for the 2016 to 2017 data and V.3.3.8 for the 2018 data (extraction November 2019)

Exploration of length-based data-limited assessments for pollack in Bay of Biscay and Atlantic Iberian Waters

Paz Sampedro

paz.sampedro@ieo.es , Centro Oceanográfico de A Coruña, Paseo Marítimo Alcalde Francisco Vázquez, 10, 15001 A Coruña, Spain

Abstract

Pollack in ICES subarea 8 and division 9a is considered a Data-Limited Stock and classified by ICES in category 5.2. The insufficient data for this stock prevented to perform an analytical assessment with a traditional model. Three length-based approaches were tested for assessing the status of pollack stock: *Length-Based Indicators*, *Length Based Spawning Potential Ratio*, and *Length-based Integrated Mixed Effects*. The three model results indicated that pollack stock was slightly overexploited in 2019 (F > Ftarget) and the SPR is below the SPR target. There is a high uncertainty in the estimation of stock status using these models and, due to their sensitive to input parameters, more sensitivity analysis should be conducted.

1 Introduction

The pollack, *Pollachius pollachius* Linneo, 1758 is a gadid species, that is restricted to the Northeast Atlantic with a main distribution from the Portuguese continental coast northwards around the British Isles, into the Skagerrak and along the Norwegian coast where it is fairly common up to the Lofoten Islands. Juvenile of pollack inhabits in shallow waters and adults migrate to deeper areas 40-100 meters). During the spawning season, adults create groups of high density. The pollack in ICES subarea 8 and division 9a, pol.27.8.9a, is mainly exploited by France, responsible for more than 70% of commercial landings, following by Spain and Portugal. The management advice for this stock is provided on a precautionary approach basis, and considering the trend on commercial landings. Latest ICES advice for pol.27.8.9a recommended that commercial catches in each of the years 2020 and 2021 should be no more than 1131 tones.

In data-limited stocks, length-frequency data from commercial catches are often the primary data type that are collected because to its ease and low cost of being collected. As a result, numerous length-based methods have been recently developed. The overall objective of this study is to analyse the suitability of length-based methods to assess the stock status of pol.27.8.9a.

2. Material and Methods

A set of length compositions of commercial landings, annual and gear-combined, for the period 2010-2019 was considered for three length based approaches (Figure 1). The life history parameters used as input data in the models and their source are presented in Table 1.

The length-based approaches used for this analysis are described below:

Length Based Indicators (LBI)

A set of length-based indicators representing the conservation of large and immature individuals, optimal yield and maximum sustainable yield were defined at WKLIFE2015 (ICES, 2015), and are presented in Table 2. Length-frequency data are often available for exploited stocks, and it was proposed to use them for estimating indicators that reflect size-selective fishing pressure. Indicators of status are compared to reference points that are derived from life-history parameters and ecological theory. The suite of indicators with corresponding reference points, indicator ratio and expected value are shown in Table 2.

The data requirements to estimate LBI are indicated in Table 1. The main assumptions of the LBI theory are that the fishing gear selectivity is asymptotic and the population is in equilibrium: constant selection, fishing mortality and recruitment over time. Analyses were conducted using the R script *utilities.R* available at ICES github repository: https://github.com/ices-tools-dev/LBIndicator_shiny.

Length based spawning potential ratio (LB-SPR)

LB-SPR model uses the characteristics of two life history ratios: M/K and $L50/L_{\infty}$, to analyse the shape of adult length-frequency distributions and to estimate the selectivity ogive, relative fishing pressure (F/M) applied to stocks, and the resulting spawning potential ratio (SPR). SPR is defined as the proportion of the unfished reproductive potential left at any given level of fishing pressure (Hordyk et al., 2015). SPR is 100% in an unexploited stock, and 0% in a stock with no spawning. LB-SPR model relies on many assumptions listed in the referenced papers, being some of them: the assumption of equilibrium conditions, that the length composition data is representative of the exploited population, and a logistic-type selectivity. The input data to LB-SPR are indicated in Table 1. The length-structured version of the LB-SPR model, using growth-type-groups (GTG) to account for size-based selectivity, was applied for pollack stock. The analyses were conducted using the R package LBSPR *v*0.1.5 (Hordyk, 2019).

Length-based integrated mixed effects (LIME)

LIME model relaxes the equilibrium assumptions of LBSPR method, accounting for time-varying recruitment and fishing mortality while assuming constant selectivity for the whole time series (Rudd and Thorson, 2018). Length data and biological information are used to estimate F and SPR. LIME uses automatic differentiation and Laplace approximations to calculate the marginal likelihood for the mixed-effects. LIME has the same data-requirements as LB-SPR plus assumed uncertainty for recruitment and fishing mortality (Table 1). The LIME analysis was performed using the R package LIME *v*2.1.3. (Rudd and Thorson, 2018).

3. Results

The results presented here are not the final versions and they are showed with the purpose of serving as initial point to consider new assessment methods for pol.27.8.9a.

The LBI results are compared to suggested reference points in the traffic light table (Table 3). The conservation parameters for immature were only green ($L_{25\%}/L_{mat}$, Lc/L_{mat}) during 2011-2013. Large fish constitute a small part of landings (Pmega < 0.13). The optimizing yield indicator (Lmean/Lopt) has been below the desirable values of 0.9, showing that the fish caught may be too small. The MSY indicator ($Lc/L_{(F=M)}$) was > 1 in 2017 and 2018, but in 2019 it decreased to 0.97. There is not strong evidence of important overexploitation. The time-series of indicators and indicators ratios (Figure 2) show that the levels of conservation and maximum sustainable yield indicators have been relatively stable throughout the last ten years.

Figure 3 shows annual selectivity curves fitted by the LB-SPR model and the maturity ogive, no particular trend of length in the catch has been detected in recent years. The LB-SPRT smooth results indicated that SPR values were below the SPR 30-40% range in all years (Figure 4) and therefore can be considered to be below proxies that would be consistent with high long-term yields. Except in 2015 and 2017, the F/M ratios were above F/M = 1, what implies an exploitation above F_{MSY} (Table 4). In 2019 the raw F/M was 1.03, slightly above the proxy for F_{MSY}.

LIME model fits an unique selectivity ogive for the whole time series, and for pollack L50 and L95 were estimated at 39 and 50 cm, respectively (Table 5). LIME estimated SPR in 2019 to have been 0.32, but with high uncertainty (95% CI: 0.03-0.61). Fishing mortality estimates were above $F_{40\%}$ reference point (0.25) for the whole time series, indicating that the pollack stock has been overfished (Figure 5).

Figure 6 compares the SPR estimates obtained from LIME and LB-SPR methods for 2019. Both estimates were below the SPR target 0.4, although the LIME SPR_{2019} estimate is more optimistic than the LB-SPR 0.24 (95% CI: 0.21-0.27).

4. Conclusions

The performance of the length-based models indicates that these methods may be a good approach to assess the stock status of pollack. Sensitivity analysis should be conducted to evaluate the impact of input parameter in the results.

5. References

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Léauté, J-P, Caill-Milly,N., Lissardy, M. 2018. ROMELIGO: Improvement of the fishery knowledge of striped red mullet, whiting and pollack of the Bay of Biscay. Working Document presented at WGBIE2018.

Rudd, M. B., and Thorson, J. T. 2018. Accounting for variable recruitment and fishing mortality in length-based stock assessments for data-limited fisheries. Canadian Journal of Fisheries and Aquatic Sciences, 75: 1019–1035.

Table 1. Input data for pollack in 8 and 9a (pol.27.89a) for the three length-based models tested.

Parameter	symbol	value	source	LBI	LBSPR	LIME
Length-frequency data	LD		Annual, gear-combined			
Length were 50% of the fish are mature	L_{50} (cm)	42.3	Alonso *et al.*, 2013			
Length were 95% of the fish are mature	L_{95} (cm)	58	Alonso *et al.*, 2013			
von Bertalanffy growth parameter	K	0.182	Alemany, 2017			
Von Bertalanffy asymptotic Length	L_{∞}	92.8	Alemany, 2017			
Theoretical age at length=0	t_0 (years)	-0.935	Alemany, 2017			
Length-weight relationship parameter a	a	$1.09e^{-5}$	Leauté *et al.*, 2018			
Length-weight relationship parameter b	b	3.0044	Leauté *et al.*, 2018			
Natural Mortality (fixed)	M ($year^{-1}$)	0.32	M-metanalysis			
M/K invariant	M/K	1.8	M/K			
Coefficient of variation of von Bertalanffy asymptotic le	CV L_{inf}	0.1	Assumed			
Steepness	h	0.7	Assumed			
Recruitment deviation	σ_R	0.4	Assumed			
Fishing mortality deviation	σ_F	0.1	Assumed			

Table 2. Length-based indicators to assess the stock status. Reference, IndicatorRatio and expected values are indicated.

Property	Indicator	Calculation	Reference	IndicatorRatio	ExpectedValue
Conservation Large individuals	Lmax5%	Mean length of largest 5%	Linf	Lmax5% / Linf	> 0.8
	L95%	95th percentile	Linf	L95% / Linf	> 0.8
	Pmega	Proportion of individuals above Lopt + 10%	0.3-0.4	Pmega	> 0.3
Conservation Immatures	L25%	25th percentile of length distribution	Lmat	L25% / Lmat	> 1
	Lc	Length at first catch (length at 50% of mode)	Lmat	Lc / Lmat	> 1
Optimal yield	Lmean	Mean length of individuals > Lc	Lopt = 2/3 Linf	Lmean/Lopt	-1
	Lmaxy	Length class with maximum biomass in catch	Lopt = 2/3 Linf *	Lmaxy / Lopt	-1
MSY	Lmean	Mean length of individuals > Lc	LF=M = (0.75Lc+0.25Linf)*	Lmean / LF=M	>=1

* If M/K != 1.5: Lopt=3?Linf/(3+(M/k)) ; L(F=M) = (1 ? a) *Lc + a *Linf; a=1/2*(M/k)+1

Table 3. LBI results. Output table with indications of status compared to reference points for pol.27.8.9a. Green cell: indicator suggests that the stock is in a desirable state relative to the reference; red cell: negative state.

	Conservation				Optimizing yield	MSY
Year	Lc/Lmat	L25/Lmat	Lmax5/Linf	Pmega	Lmean/Lopt	Lmean/LFeM
2010	0.80	0.80	0.72	0.03	0.69	0.89
2011	1.18	1.18	0.80	0.07	0.94	0.95
2012	1.18	1.18	0.80	0.11	0.98	0.99
2013	1.09	1.09	0.79	0.12	0.92	0.98
2014	0.80	0.99	0.77	0.10	0.86	1.10
2015	0.71	0.80	0.74	0.04	0.72	0.99
2016	0.80	0.90	0.71	0.03	0.74	0.94
2017	0.80	0.90	0.80	0.09	0.82	1.04
2018	0.80	0.99	0.82	0.11	0.89	1.14
2019	0.80	0.80	0.76	0.04	0.76	0.97

Table 4. LBSPR annual raw estimates of selectivity (SL50, SL95), fishing pressure (F/M) and spawning potential ratio (SPR).

Year	SL50	SL95	FM	SPR
2010	31.5	33.4	2.00	0.12
2011	50.3	61.7	2.42	0.26
2012	52.0	64.9	1.87	0.32
2013	44.6	52.9	1.34	0.31
2014	62.7	88.9	4.25	0.27
2015	26.9	31.9	0.96	0.24
2016	35.0	40.1	1.93	0.14
2017	34.9	49.8	0.90	0.31
2018	54.5	78.9	1.93	0.32
2019	30.5	35.3	1.03	0.24

Table 5. LIME estimates of selectivity (SL50, SL95), fishing pressure (F/F40%) and spawning potential ratio (SPR).

Year	SL50 (cm)	SL95 (cm)	F/F40%	SPR
2010	39.1	49.9	1.24	0.34
2011	39.1	49.9	1.33	0.32
2012	39.1	49.9	1.55	0.29
2013	39.1	49.9	1.70	0.27
2014	39.1	49.9	1.71	0.26
2015	39.1	49.9	1.46	0.30
2016	39.1	49.9	1.34	0.32
2017	39.1	49.9	1.29	0.33
2018	39.1	49.9	1.35	0.32
2019	39.1	49.9	1.35	0.32

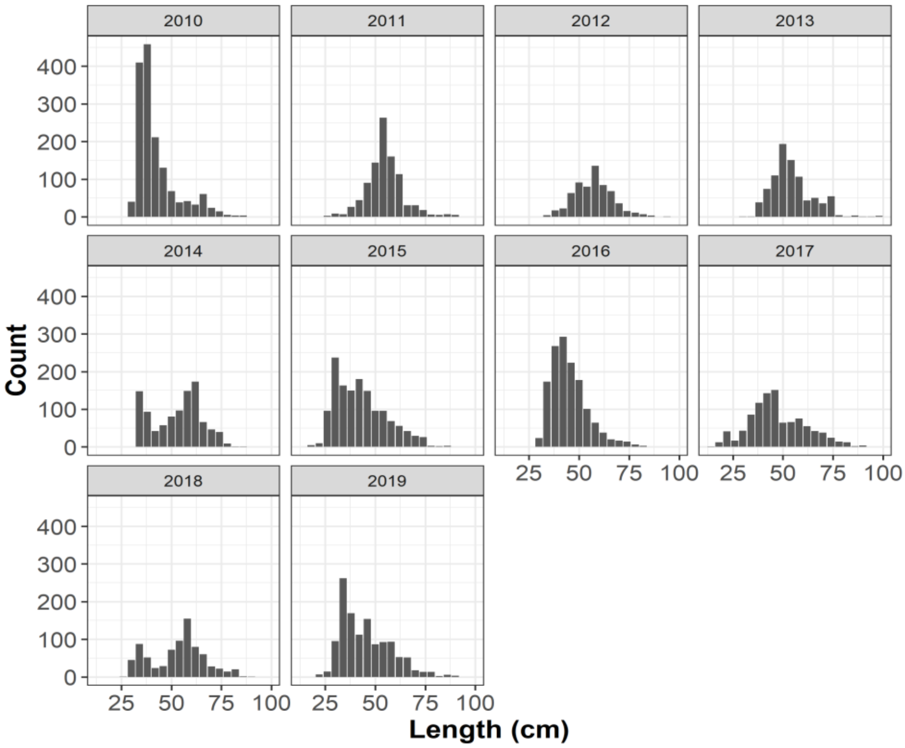


Figure 1. Length frequency distribution of Pollack landings from 2010 to 2019.

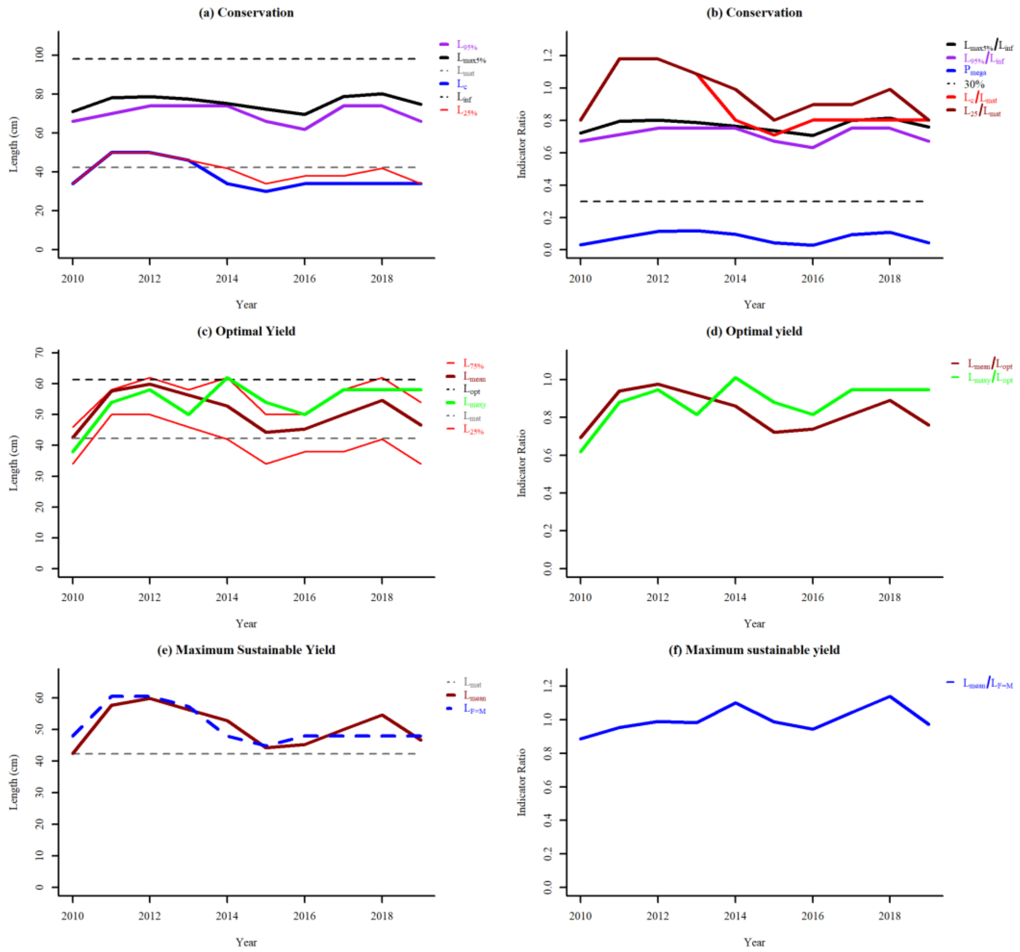


Figure 2. LBI results. Time-series indicators (left side) and indicators ratios (right side).

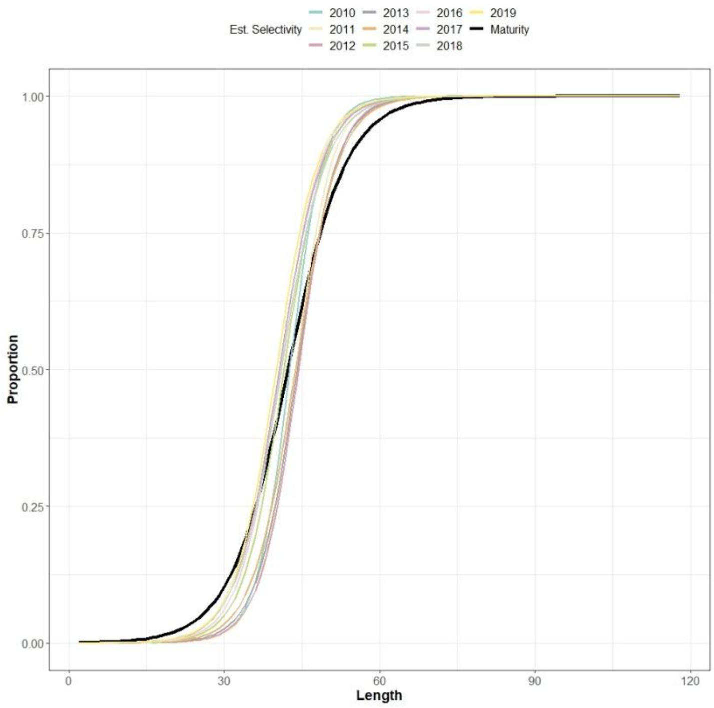


Figure 3. LBSPR results. Maturity at length and selectivity curves for pol.27.8.9a.

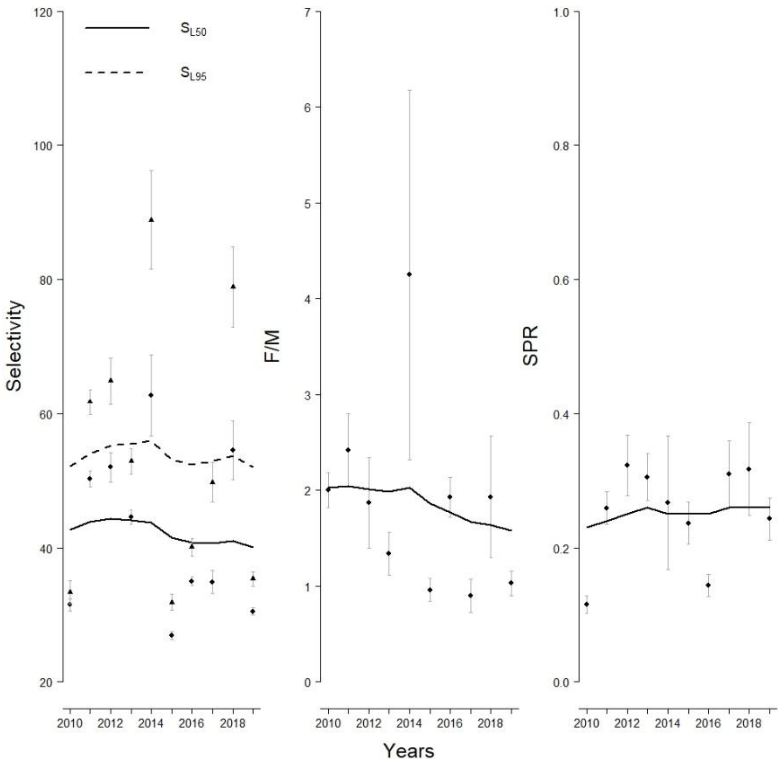


Figure 4 LBSPR results. Proxy of stock status for pol.27.89a stock.

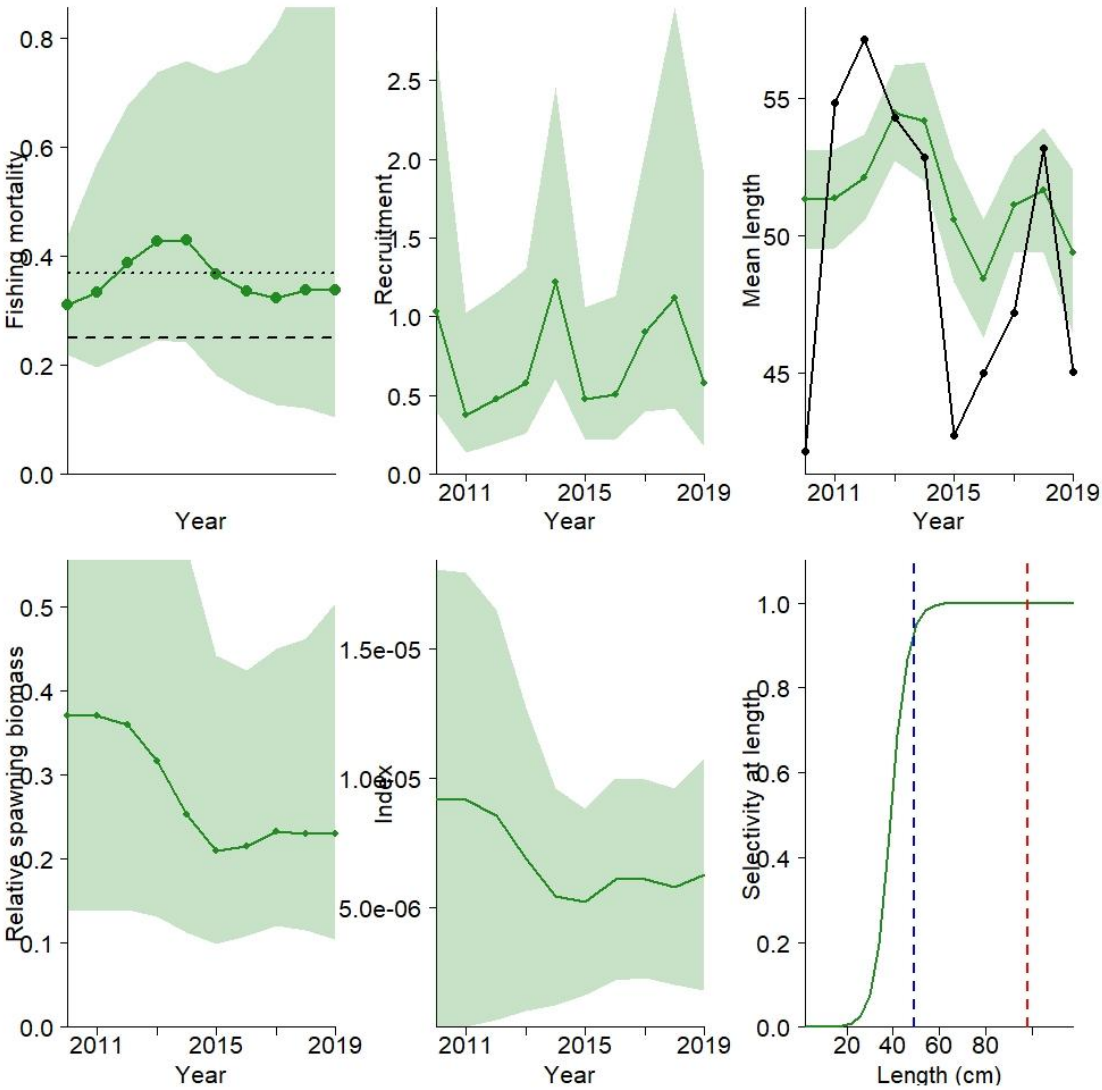


Figure 5. LIME estimates for pollack fishing mortality, recruitment, mean length, relative spawning biomass, and selectivity (blue line: mean-length of catches, red line=Linf) using the annual length composition data.

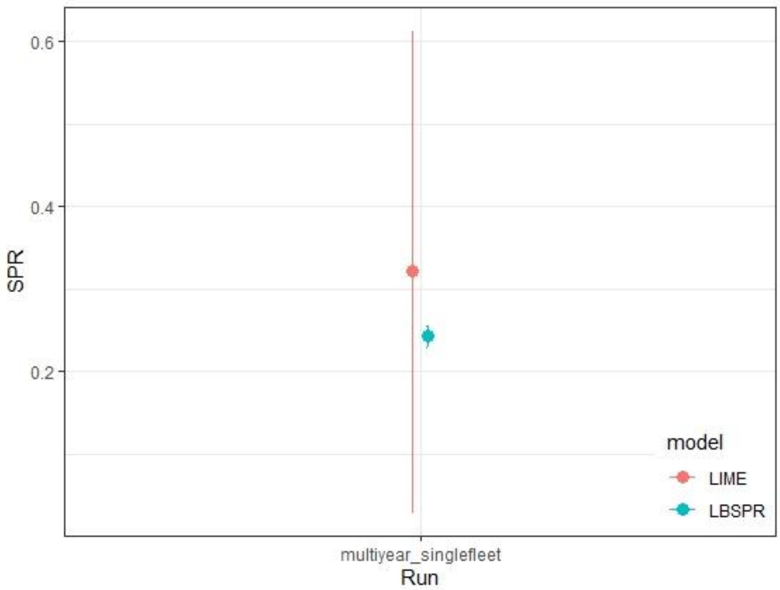


Figure 6. Comparison of SPR estimates obtained by LIME and LB-SPR.

A first approach to stock assessment of pollack in ICES subarea 8 and division 9a using SPiCT

Paz Sampedro
paz.sampedro@ieo.es , Centro Oceanográfico de A Coruña, Paseo Marítimo
Alcalde Francisco Vázquez, 10, 15001 A Coruña, Spain

Abstract

A SPiCT model has been fitted for Pollack stock in ICES subarea 8 and division 9a (pol.27.8.9a). Different scenarios were tested based on abundance indices series selected, time period considered, and the model's options of fixing model parameters and the definition of priors. The implementation showed that the best model was for scenario using the landing series 1986-2018 and the abundance index FR-GNS>902s 2005-2018. Although the uncertainty around the parameters and reference points is high, the estimates of K, r, F and B are realistic indicating that SPiCT could be a good option for assessing this stock.

Introduction

Pollack is a bentho-pelagic species distributed in the Northeast Atlantic with a main distribution from the Portuguese continental coast northwards around the British Isles, into the Skagerrak and along the Norwegian coast where it is fairly common up to the Lofoten Islands. ICES has provided a precautionary advice on pollack in subarea 8 and division 9a based on stock assessment conducted in 2019. In this work, a surplus production model in continuous time (SPiCT) was applied to pollack stock.

Material and Methods

Data

Catch data come from different sources (International data-bases, ICES database and ROMELIGO project) and have been collected for the stock assessment of pol.27.8.9a (Table 1). Three time series of commercial index were compiled. The series "FR-GNS>90-2s" (French Gillnets with mesh size > 90 mm, operating in North Bay of Biscay during the second semester) was provided by ROMELIGO Project for the years 2005-2018 to the WGBIE2019, and the series "GAL-GN-60-79_8c" (Galician Gillnets with mesh size 60-79 operating in 8c) and "GAL-GN-60-79_9ª" (Galician Gillnets with mesh size 60-79 operating in 9a) are available for the period 2000-2016 in published information (Alonso-Fernández et al., 2019).

Model Description

The SPiCT model (Surplus Production model in Continuous Time) is based on the generalized surplus production model, known as the Pella-Tomlinson model, where the shape of the production curve may deviate from the symmetric form. A detailed description of the SPiCT model and all the options available can be found in Pedersen and Berg (2017). The model has a general state-space form that can contain process and observation-error as well as state-space models that assume error-free catches. SPiCT assumes that catches and CPUE indices contain observation error, and the process error in the surplus production function is also estimated. SPiCT has the option of using some weak priors on the production curve shape parameter and the ratios of observation to process error or to perform a frequentist analysis without any priors. The analysis were performed using the R package spict *v.1.2.8* available at https://github.com/DTUAqua/spict

Table 1. Input data available for pollack to perform SPiCT. *Landings in 1999 are estimated

Year	Landings (tonnes)	FR-GNS>90-2s (kg/fishing sequence)	% Stock Landings	GAL-GN-60-79_8c (ind/haul)	GAL-GN60-79_9a (ind/haul)
1986	2806				
1987	2918				
1988	2582				
1989	1973				
1990	1900				
1991	2168				
1992	1958				
1993	1513				
1994	1955				
1995	1679				
1996	1354				
1997	1378				
1998	1165				
1999	1322				
2000	1479			1.98	0.89
2001	1746			0.95	0.55
2002	1972			0.95	0.41
2003	1663			2.18	1.09
2004	1726			1.36	0.55
2005	1986	115	5.3	2.32	1.02
2006	2126	66	2.5	1.36	1.36
2007	1847	129	6.7	0.55	0.48
2008	2313	129	6.2	0.89	0.55
2009	1812	124	6.2	0.89	0.27
2010	1682	108	5.5	1.23	1.09
2011	2032	197	7.7	0.55	0.00
2012	1520	174	10.7	0.55	0.00
2013	1811	157	8.9	1.43	0.82
2014	1959	150	9.1	1.09	0.55
2015	1610	144	10.4	0.82	0.14
2016	1661	121	9.0	0.61	1.64
2017	1481	122	9.2		
2018	1512	112	7.4		

Scenarios

Three different scenarios were fit:

Scenario 1. Including the 3 CPUE indices available (Figure 1).
Scenario 2. Only with the time series of FR.GN.90.2s index.
Scenario 3. Data restricted to the 2005-2018 period.

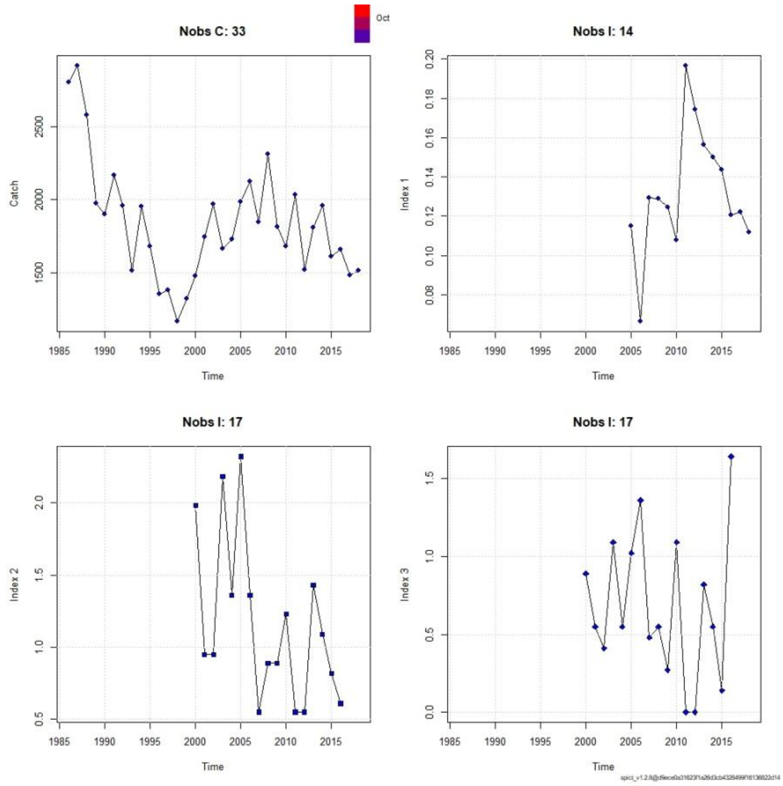


Figure 1. Data used for the SPiCT model.

Results

Scenario 1. The model didn't converge under this scenario. Different priors and options were tried, but it was no possible to get the convergence. This scenario was performed as a trial, as we knew that the two "GAL-GN_60_79" were abundance indices (ind/haul) and SPICT requires biomass indices. The two time series were discarded to be used as indices:

```
Convergence: 1  MSG: false convergence (8)
WARNING: Model did not obtain proper convergence! Estimates and uncertainties are most likely invalid and cannot be trusted.
Gradient at current parameter vector
       logm        logK        logq        logq
   340200916 -15405231125 -7877841761  -6975665140
       logq      logsdb      logsdf      logsdi
  -352240442   455548313 -1356673996  1868871383
     logsdi      logsdi      logsdc
 -2750079384  -494792173   273986241

Objective function: 45.393069
Euler time step (years):  1/16 or 0.0625
Nobs C: 33,  Nobs I1: 14,  Nobs I2: 17,  Nobs I3: 17
Priors
 logbkfrac  ~  dnorm[log(0.4), 0.5^2]
     logn  ~  dnorm[log(2), 2^2]
  logalpha  ~  dnorm[log(1), 2^2]
  logbeta  ~  dnorm[log(1), 2^2]
Fixed parameters
   fixed.value
 n         2
Model parameter estimates w 95% CI
           estimate       cilow       ciupp     log.est
 alpha1 4.547214e+00         NaN         NaN   1.5145147
 alpha2 8.576793e+00   6.8309445  10.7688448   2.1490601
 alpha3 3.816789e+01         NaN         NaN   3.6419946
 beta   9.384499e-01         NaN         NaN  -0.0635258
 r      4.428774e-01         NaN         NaN  -0.8144623
```

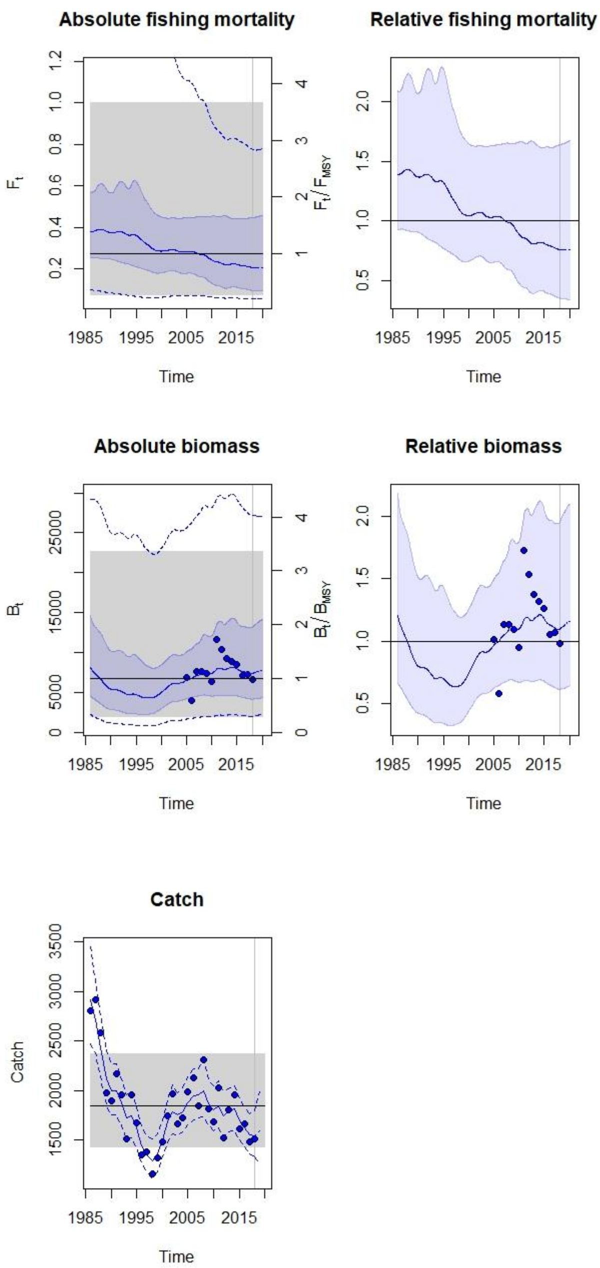
```
rc    4.428774e-01        NaN        NaN  -0.8144623
rold  4.428774e-01        NaN        NaN  -0.8144623
m     2.022001e+03 2000.2657301 2043.9723119   7.6118429
K     1.826240e+04        NaN        NaN   9.8125995
q1    1.130000e-05        NaN        NaN -11.3880312
q2    9.190000e-05        NaN        NaN  -9.2953452
q3    2.400000e-05        NaN        NaN -10.6364315
sdb   5.480930e-02        NaN        NaN  -2.9038957
sdf   9.842900e-02        NaN        NaN  -2.3184194
sdi1  2.492296e-01        NaN        NaN  -1.3893809
sdi2  4.700879e-01    0.4022154    0.5494137  -0.7548356
sdi3  2.091955e+00    2.0532006    2.1314403   0.7380989
sdc   9.237070e-02        NaN        NaN  -2.3819453
Deterministic reference points (Drp)
        estimate    cilow    ciupp   log.est
Bmsyd  9131.1990234      NaN      NaN  9.119452
Fmsyd    0.2214387      NaN      NaN -1.507609
MSYd  2022.0009319 2000.266 2043.972  7.611843
Stochastic reference points (Srp)
        estimate    cilow    ciupp   log.est
Bmsys 9092.0388256      NaN      NaN  9.115154
Fmsys    0.2206993      NaN      NaN -1.510954
MSYs  2006.5779889 1985.395 2027.987  7.604186
      rel.diff.Drp
Bmsys -0.004307087
Fmsys -0.003350305
MSYs  -0.007686192
States w 95% CI (inp$msytype: s)
               estimate      cilow       ciupp
B_2018.00      1.159331e+04 930.7486705 1.444052e+05
F_2018.00      1.321026e-01   0.0087066 2.004345e+00
B_2018.00/Bmsy 1.275106e+00   0.1018978 1.595613e+01
F_2018.00/Fmsy 5.985635e-01   0.0392758 9.122122e+00

               log.est
B_2018.00      9.3581838
F_2018.00     -2.0241767
B_2018.00/Bmsy  0.2430293
F_2018.00/Fmsy -0.5132227

Predictions w 95% CI (inp$msytype: s)
               prediction      cilow       ciupp
B_2019.00      1.186452e+04 1276.6749328 1.102605e+05
F_2019.00      1.309006e-01    0.0097542 1.756671e+00
B_2019.00/Bmsy 1.304935e+00    0.1397139 1.218816e+01
F_2019.00/Fmsy 5.931175e-01    0.0439974 7.995669e+00
Catch_2019.00  1.568420e+03  914.3729741 2.690303e+03
E(B_inf)       1.272223e+04          NA          NA
               log.est
B_2019.00      9.3813077
F_2019.00     -2.0333168
B_2019.00/Bmsy  0.2661532
F_2019.00/Fmsy -0.5223628
Catch_2019.00   7.3578238
E(B_inf)        9.4511060
```

Scenario 2. The model converged and the main estimates were considered realistic values:

```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: -3.2835623
Euler time step (years):  1/16 or 0.0625
Nobs C: 33,  Nobs I1: 14

Priors
 logbkfrac  ~  dnorm[log(0.4), 0.5^2]
     logn  ~  dnorm[log(2), 2^2]
  logalpha  ~  dnorm[log(1), 2^2]
   logbeta  ~  dnorm[log(1), 2^2]

Fixed parameters
   fixed.value
 n         2

Model parameter estimates w 95% CI
          estimate       cilow       ciupp     log.est
 alpha  2.558159e+00    0.8276700 7.906748e+00   0.9392879
 beta   1.360615e+00    0.3235980 5.720907e+00   0.3079371
 r      5.504379e-01    0.1509260 2.007486e+00  -0.5970412
 rc     5.504379e-01    0.1509260 2.007486e+00  -0.5970412
 rold   5.504379e-01    0.1509260 2.007486e+00  -0.5970412
 m      1.873679e+03 1470.1086459 2.388036e+03   7.5356590
 K      1.361591e+04 4044.9930110 4.583274e+04   9.5189946
 q      1.690000e-05    0.0000045 6.320000e-05 -10.9881842
 sdb    8.791260e-02    0.0343829 2.247813e-01  -2.4314117
 sdf    7.004160e-02    0.0201327 2.436743e-01  -2.6586656
 sdi    2.248945e-01    0.1386090 3.648936e-01  -1.4921238
 sdc    9.529970e-02    0.0623478 1.456672e-01  -2.3507285

Deterministic reference points (Drp)
         estimate      cilow       ciupp   log.est
 Bmsyd 6807.9571473 2022.496506 22916.371125  8.825847
 Fmsyd    0.2752189    0.075463     1.003743 -1.290188
 MSYd  1873.6787699 1470.108646  2388.035839  7.535659
Stochastic reference points (Srp)
        estimate       cilow       ciupp   log.est
 Bmsys 6743.692351 2006.6757075 22663.047328  8.816363
 Fmsys    0.273336    0.0745747     1.001848 -1.297054
 MSYs  1843.172759 1435.1973177  2367.121075  7.519244
      rel.diff.Drp
 Bmsys -0.009529616
 Fmsys -0.006888749
 MSYs  -0.016550815

States w 95% CI (inp$msytype: s)
                   estimate       cilow       ciupp
 B_2018.00       7389.4328014 2010.5302360 2.715886e+04
 F_2018.00          0.2076003    0.0554810 7.768044e-01
 B_2018.00/Bmsy     1.0957547    0.6172542 1.945193e+00
 F_2018.00/Fmsy     0.7595059    0.3524866 1.636514e+00
                 log.est
 B_2018.00       8.9078063
 F_2018.00      -1.5721407
 B_2018.00/Bmsy  0.0914434
 F_2018.00/Fmsy -0.2750871

Predictions w 95% CI (inp$msytype: s)
              prediction       cilow       ciupp
 B_2019.00       7603.7905849 2133.2491224 2.710308e+04
 F_2019.00          0.2064361    0.0551233 7.731012e-01
 B_2019.00/Bmsy     1.1275411    0.6255371 2.032412e+00
 F_2019.00/Fmsy     0.7552468    0.3454987 1.650940e+00
 Catch_2019.00  1591.9568594 1274.8107811 1.988002e+03
 E(B_inf)        8281.7260674           NA           NA
                 log.est
 B_2019.00       8.9364022
 F_2019.00      -1.5777642
 B_2019.00/Bmsy  0.1200393
```

```
F_2019.00/Fmsy -0.2807107
Catch_2019.00   7.3727193
E(B_inf)        9.0218067
```

The uncertainty around the reference points is high (Figure 4, grey boxes). The relative values of F and B have narrower confidence intervals. Sensitivity analysis of input values a few trials didn't converge. The overall trend of F/F_{MSY} was decrease since 1986, and the estimate below 1 since 2008. Also, the B/BMSY is above 1 since 2007.



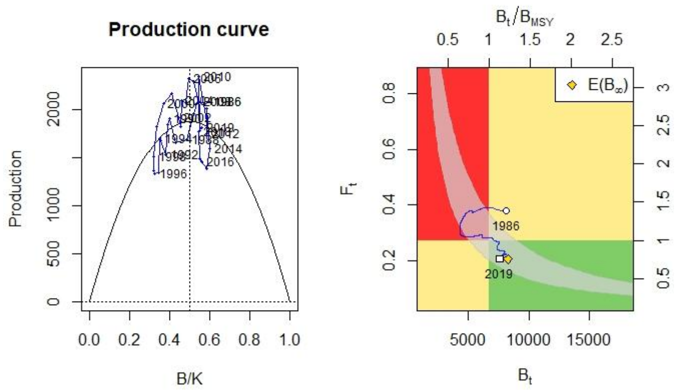


Figure 2. Scenario 2. Plots of results.

Scenario 3. The trial to fit the model to a shorten series, for the period of years (2005-2018) with data for landings and the abundance index. The convergence was not possible. Probably, the absence of contrast in the landing data prevented the model to get a solution.

```
Convergence: 1  MSG: false convergence (8)
WARNING: Model did not obtain proper convergence! Estimates and uncertainties are most likely invalid and cannot be trusted.

Gradient at current parameter vector
      logm      logK      logq    logsdb    logsdf
 469505.63 -546136.87 -539987.19    8135.98 -177966.33
    logsdi    logsdc
 192687.77  -22673.93

Objective function: -1.4832589
Euler time step (years):  1/16 or 0.0625
Nobs C: 14,  Nobs I1: 14

Priors
 logbkfrac  ~  dnorm[log(0.4), 0.5^2]
     logn  ~  dnorm[log(1.478), 0.6^2]
  logalpha  ~  dnorm[log(1), 2^2]
   logbeta  ~  dnorm[log(1), 2^2]

Fixed parameters
   fixed.value
 n         2

Model parameter estimates w 95% CI
           estimate       cilow       ciupp    log.est
 alpha    1.2489836   0.7481107   2.0851995  0.2223301
 beta     0.6474307   0.4527695   0.9257833 -0.4347436
 r       39.1820659         NaN         NaN  3.6682191
 rc      39.1820659         NaN         NaN  3.6682191
 rold    39.1820659         NaN         NaN  3.6682191
 m     2170.6793407 2067.5970780 2278.9008797  7.6827955
 K      221.5992743         NaN         NaN  5.4008707
 q        0.0009032         NaN         NaN -7.0095640
 sdb      0.1737624   0.1703520   0.1772411 -1.7500665
 sdf      0.1460958   0.1005347   0.2123045 -1.9234928
 sdi      0.2170264   0.1310074   0.3595250 -1.5277364
 sdc      0.0945869   0.0930420   0.0961575 -2.3582364

Deterministic reference points (Drp)
        estimate    cilow    ciupp  log.est
```

```
 Bmsyd  110.79964      NaN      NaN 4.707724
 Fmsyd   19.59103      NaN      NaN 2.975072
 MSYd  2170.67934 2067.597 2278.901 7.682796
Stochastic reference points (Srp)
       estimate    cilow    ciupp  log.est  rel.diff.Drp
 Bmsys  110.79909      NaN      NaN 4.707719 -4.980652e-06
 Fmsys   19.59285      NaN      NaN 2.975164  9.258300e-05
 MSYs  2170.86952 2067.755 2279.126 7.682883  8.760418e-05

States w 95% CI (inp$msytype: s)
              estimate     cilow      ciupp    log.est
 B_2018.00      161.2147428       NaN        NaN  5.0827373
 F_2018.00        9.1048022 7.7495066 10.6971226  2.2088020
 B_2018.00/Bmsy   1.4550187 1.4146532  1.4965360  0.3750188
 F_2018.00/Fmsy   0.4647003 0.3751508  0.5756255 -0.7663626

Predictions w 95% CI (inp$msytype: s)
             prediction       cilow       ciupp
 B_2019.00      169.5732401         NaN         NaN
 F_2019.00        8.9882152    7.1793196    11.2528788
 B_2019.00/Bmsy    1.5304570    1.2689356    1.8458768
 F_2019.00/Fmsy    0.4587498    0.3433665    0.6129061
 Catch_2019.00  1533.8244179 1217.1789676 1932.8442304
 E(B_inf)        170.5992137          NA          NA
              log.est
 B_2019.00       5.1332849
 F_2019.00       2.1959143
 B_2019.00/Bmsy  0.4255664
 F_2019.00/Fmsy -0.7792502
 Catch_2019.00   7.3355195
 E(B_inf)        5.1393170
```

Conclusion

Although the scenario 2 provided acceptable results, the model relies on the information from only one index and very short period of the years. Besides, the decision to adopt the SPiCT as model for pollack 89a assessment needed the compromise of France to send every year the value of FR-GN-902s. As the available time series for FR-GN-902s stopped with the end of the ROMELIGO Project.

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Improving abundance index for Sol8c9a stock assessment model calibration.

Working document to the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion WGBIE – 6-13 May 2020.

Maria Grazia Pennino[1], Francisco Izquierdo[1], Marta Cousido[1], Santiago Cerviño[1], Iosu Paradinas[2], Francisco Velasco[3], Jaime Otero[1], Rafael Bañón[4], and Alex Alonso-Fernández[4]

[1]Instituto Español de Oceanografía (IEO), Centro Oceanográfico de Vigo, Subida a Radio Faro 50-52, 36390, Vigo, Pontevedra, Spain.
[2]Ipar Perspective Asociación, Karabiondo Kalea. 48600 Sopela, Spain
[3]Instituto Español de Oceanografía, Promontorio San Martín s/n, 39004, Santander, Spain.
[4]Instituto de Investigaciones Marinas, Rúa de Eduardo Cabello, 6, 36208 Vigo, Pontevedra, Spain.

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Contents

Abstract

Time series of abundance indices are the main source of information to calibrate stock assessment models. Precise abundance indices are essential for successful conservation and management of fish stocks. Commonly, scientific standardized surveys are used for this aim and to ensure that estimates are unbiased. However, the accuracy of these estimated indices may be low under certain circumstances. In particular the common sole (*Solea solea*) is a species with a biological bathymetric range between 0 and 200 meters in the Iberian Atlantic waters. The annual scientific survey that collects data for demersal species in this area only cover partially this bathymetric range and the resultant abundance indexes are consequently underestimated. In addition, habitat variables, (i.e., bathymetry), can influence these estimates as well as the species spatio-temporal variability. Alternatively, standardized CPUEs (catch per unit effort) derived fishery-dependent data can be used as a proxy of the species abundance. In this study two different spatio-temporal abundances indices were computed and the impacts on the common sole evaluation using as stock assessment model the SPiCT (stochastic surplus production model in continuous time) were analyzed. Both abundance indices were produced using Bayesian hierarchical spatio-temporal models, considering bathymetry as an environmental variable and testing three different spatio-temporal structures (i.e. opportunistic, progressive and persistent) to categorize the spatio-temporal behaviour of the sole. We argue that using explicitly spatio-temporal abundance indexes can improve the assessment of stocks and in particular for the ones that are in a data-limited situation.

Introduction

Fishery independent surveys provide important information for species stock assessment and consequently for fisheries management (Cao et al., 2017). Abundance indices are one of the primary information derived from scientific surveys, and are essential to calibrate species stock assessment models. Therefore the accuracy of the abundance indices is essential for the stocks evaluation and the subsequent management decisions (e.g., total allowable catches).

Commonly scientific surveys are designed with randomized sampling locations and to ensure that estimates, as abundance indices, are unbiased. However, under certain circumstances, surveys may produce imprecise estimates of abundance, particularly for species with preferential habitats that are in strata only partially included in the survey sampling design. Therefore, in these cases, the spatial species variation is not adequately captured.

The common sole (*Solea solea*) is a species with a biological bathymetric range between 0 and 200 meters in the Iberian Atlantic waters. The annual scientific survey that collects data for demersal species in this area only cover partially the sole bathymetric range and the resultant abundance index is probably underestimated.

Recently, spatio-temporal models have been implemented to produce more precise abundance indices than the ones provided by conventional surveys (Cao et al., 2017; Thorson, 2015). Indeed, spatio-temporal models can overcome this problem as they link information on the abundance or presence/absence of a species to the space to predict where (and how much of) a species is likely to be present in unsampled locations elsewhere in a area or period of time (Pennino et al., 2019). Additionally, spatio-temporal models can include as covariates environmental variables, (e.g. bathymetry, temperature, salinity, etc.) and potentially generate more precise estimates of abundance, especially when the underlying species distribution is dependent on habitat features.

Different studies have applied spatio-temporal models to improve abundance indices (Cao et al., 2017; Shelton et al., 2014; Thorson, 2015). For example, Thorson (2015) implemented spatio-temporal models to compare the abundance indices of 28 groundfish species off the U.S. West Coast with conventional surveys indices. Overall, abundance indices showed similar trends but the uncertainty associated with the spatio-temporal indices was widely lower than the one of conventional indices.

Alternatively, fishery-dependent data collected from fishery observers on-board commercial vessels or logbooks can be used to construct standardized indices of relative abundance for stock assessment models (Alonso-Fernández et al., 2019). Several standardization techniques have been used for fishery-dependent data of many species (Campbell, 2015; Maunder and Punt, 2004), including also environmental variables and spatio-temporal effects (Alonso-Fernández et al., 2019; Teo and Block, 2010). Overall these methods have been proved to be a useful tool to address ecological and assessment issues, especially in data limited situations (Alonso-Fernández et al., 2019).

However, few studies showed the impact of using a spatio-temporal index in stock assessment models and the derived performance. Recently, Cao et al. (2017) did this exercise for the northern shrimp (*Pandalus borealis*) in the Gulf of Maine. Results of this study showed that using the spatio-temporal index in the assessment model alters the estimates of recruitment and spawning stock biomass, as well as the determination of the stock status. Also, the inclusion of the spatio-temporal index in the assessment improved the predictive performance of the model reducing the retrospective bias.

Given that the abundance index provides primary information for stock assessment, such studies are essential to better understand the practical improvement of spatio-temporal index standardization.

Within this context, in this study two different spatio-temporal abundance indices were produced using (1) a fishery-independent data-set from 2001-2019 collected trough scientific trawl surveys; and (2) a fishery-dependent data-set collected by observers on-board artisanal fisheries vessels from 2000-2018. Both data-sets were analyzed using a Bayesian hierarchical spatio-temporal models, considering bathymetry as an environmental variable.

Produced indices were included in the common sole SPiCT (stochastic surplus production model in continuous time) stock assessment model and performance were explored.

We argue that using explicitly spatio-temporal abundance indices can improve the assessment of stocks and in particular for the ones that are in a data-limited situation.

Material and Methods

Abundance data

Fishery-independent data

Fishery-independent data were collected during the scientific survey series "SP-NSGFS Q4" by the "Instituto Español de Oceanografía" (IEO) carried out in autumn (September to October) from 2001 to 2019. The "SP-NSGFS Q4" 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 (Figure 1). Approximately 115 hauls divided between the three bathymetric strata were performed every year in this zone, using the baka 44/60 gear and following the protocol of the International Bottom Trawl Survey Working Group (IBTSWG) of ICES (ICES, 2017). Due to the high number of zeros only the first two bathymetric strata (i.e., 70–120 m, 121–200 m) were considered in this study, that correspond with the common sole bathymetric biological range.

Two different variables were analyzed in order to characterize the spatio-temporal behavior of common sole individuals. First, we considered a presence/absence variable to measure the occurrence probability of the species. Secondly, we used the weight by haul (kg) as an indicator of the conditional-to-presence abundance of the species.

Fishery-dependent data

Fishery-dependent data were collected by the Galician government Technical Unit of Artisanal Fisheries (Unidade Técnica de Pesca de Baixura, UTPB, in Galician). Usually an on-board observer is assigned to fishing vessels randomly selected from this sector and covers the full set of multiple gears used in Galician waters and all along the geographical range (Figure 2). In a single trip each vessel usually performs several hauls. At each haul, observers record all basic operational data (i.e., date, geographical position, gear, etc.) and the number and weight of all retained and discarded taxa. The analysed database in this study counts 4350 hauls for which common sole was caught from January 2000 until December 2018.

Before fitting any model, we selected the data for the trammel net which is the most representative gear for the common sole in order to reduce sources of variation. This selection was based on three criteria: i) proportion of hauls with zero catch, ii) total number of individuals sampled and iii) the spatio-temporal coverage. The first and second criterion were used as proxies of gear catchability and thus constant catchability was assumed along the time series (Alonso-Fernández et al., 2019).

Modelling abundance data

Fishery-independent data

The annual scientific survey that collects data for demersal species in the studied area only cover partially the common sole bathymetric range and the resultant abundance index presents a large proportions of zeros observed, i.e., zero inflated data. This data is commonly analysed using two-part models, also known as delta models. Generally, both occurrence and abundance are modelled through independent models. However, the abundance and occurrence processes are often related, thus violating the independence assumption of common delta models. In this study we applied hurdle Bayesian spatio-temporal models that fitted simultaneously the common sole occurrence and conditional-to-presence abundance processes sharing bathymetry effects. These effects were incorporated as described in Paradinas et al. (2017) in order to incorporate information on both the occurrence and the abundance to better fit informed environmental effects.

Bathymetry values were 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 (20 m).

Models were fitted using the integrated nested Laplace approximation approach (Rue et al., 2009) in the R (R Core Team, 2017) software. For the spatial component the spatial partial differential equations (SPDE) module (Lindgren et al., 2011) of INLA was implemented. With the SPDE, 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).

Additionally, in order to categorize the spatio-temporal behaviour of the common sole, three different spatio-temporal structures were compared (Paradinas et al., 2017) (see Table 1). 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 does not change every year, while the progressive ones indicate that the spatial pattern changes in a correlated way from one year to another. The progressive structure contains an autoregressive ρ_t parameter 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 along time. We also included an extra temporal effect f_t using a second order random walk (RW2) effect to infer any mean intensity changes over time.

For each spatio-temporal model we considered Y_{st} and Z_{st} that denote, respectively, the spatio-temporally distributed occurrence and the conditional-to-presence abundance, where $s = 1, ..., n_t$ is the spatial location and $t = 1, ..., T$ the temporal index, being $i = 1, ..., I$ the bathymetry in location s. Occurrence Y_{st}, was modeled using a Bernoulli distribution with a logit link and conditional-to-presence abundance, Z_{st}, with a gamma distribution with a log link, to capture the overdispersion of the data. Then:

$$\begin{aligned} Y_{st} &\sim \text{Ber}(\pi_{st}) \\ Z_{st} &\sim \text{Gamma}(\mu_{st}, \phi_{st}) \\ \text{logit}(\pi_{st}) &= \alpha^{(Y)} + f_i(d_{ist}) + U_{st}^{(Y)} \\ \log(\mu_{st}) &= \alpha^{(Z)} + \theta_i f_i(d_{ist}) + U_{st}^{(Z)} \end{aligned} \tag{1}$$

where π_{st} represents the probability of occurrence at location s at time t and μ_{st} and ϕ_{st} are the mean and dispersion of the conditional-to-presence abundance. The linear predictors, which contain the effects that link the parameters π_{st} and μ_{st} include: $\alpha^{(Y)}$ and $\alpha^{(Z)}$, that represent the intercepts of each respective variable; $f_i(d_{ist})$ is the bathymetric effect modelled as a RW2 smooth function that allow us to fit any possible non-linear relationship of the bathymetry (Fahrmeir and Lang, 2001) and it is scaled by θ_i to allow for differences in scale across the different linear predictors in shared effects; 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 above.

Fishery-dependent data

Similarly to the precedent abundance data, the fishery-depended data-set was analyzed using Bayesian spatio-temporal models with a gamma distribution and log link. All the spatio-temporal structures were tested and the bathymetry was included as possible predictor and fitted using a RW2 model. In order to capture the intra-annual variability of this abundance index, the month of the fishery haul was also included in the model as fixed effect.

Fishing effort was included as the duration of gear deployment (i.e. soak time). As it is known that gear saturation can exert a significant nonlinear effect on catchability this variable was included as continuous explanatory variable (in minutes, log transformed). The remaining potential source of abundance variability could be due to differences among vessels caused by a skipper effect or unobserved gear characteristics. To remove bias caused by vessel-specific differences in fishing operation, we included a vessel random effect.

The Bayesian approach requires the assignation of prior distributions to every parameter of the model. For both fishery-independent and depended data-sets, 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 (θ) of the shared effects. For the geostatistical terms and the ρ parameters of the of the second order random walks penalised complexity priors (PC priors, weak informative priors) (Fuglstad et al., 2018) were assigned. Specifically, we used PC priors that satisfied the following criteria: 1) the probability that the spatial effect range was smaller than 150 km was 0.15, to avoid very small spatial autocorrelation ranges, 2) the probability that the spatial effect variance was greater than 1 was 0.20, to avoid masking the bathymetric effect through the spatial effect, and 3) the probability that ρ was greater than 0.5 in the occurrence model and greater than the observed abundance standard deviation in the abundance model were 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

In both cases, 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.

SPiCT, stochastic surplus production model in continuous time

The SPiCT explicitly models both abundance and fishing dynamics as stochastic processes in a state-space framework. It is formulated as a continuous time model to allow a representation of seasonal fishing patterns and incorporation of sub-annual catch and index data Pedersen and Berg (2017).

The most important input for fitting SPiCT is catch data (by weight). Pedersen and Berg (2017) define the catch as the product of instantaneous fishing mortality and stock biomass. Fishing mortality is not decomposed into the product of effort and catchability. Therefore, it is not necessary to standardise the catch data based on changes in fishing efficiency: all such changes will be encompassed in the instantaneous fishing mortality.

Here we used as catch data the common sole official landings provided by Portugal and Spain in ICES divisions 8.c and 9.a (Figure 3) (2000-2019). For this time-series the observation noise was not constant in time. Indeed, there is some evidence that the common sole catch could be misclassified in the past, which means that common sole official landings might not then have corresponded only to this species but a mix of *Solea solea*, *Solea senegalensis* and *Pegusa lascaris*. Using port sampling length data it was possible to separate the Solea spp. landings and apply the proportions to provide a raised landings for the common sole. However, as in the SPiCT it is possible to add knowledge that certain data points are more uncertain than others, the first 10 years of the catch were considered uncertain relative to the remaining time series and therefore are scaled by a factor 5. In particular using the $stdevfacC$ vector that contains the factor that is multiplied onto the standard deviation of the data points of the corresponding observation vector.

Catch data must be supplemented in the SPiCT model by at least one independent abundance index. An important advantage of SPiCT over other surplus production models is that it allows the use of multiple abundance indices with different time-series in addition to the catch time series. Here we performed three different runs using: 1) only the spatio-temporal abundance index produced with fishery-independent data; 2) only the spatio-temporal abundance index produced with fishery-dependent data; 3) both produced spatio-temporal abundance indices.

The continuous-time SPiCT formulation, time-stepping is achieved through an Euler scheme with a default time increment dt_{Euler} equal to 1/16 (where time is measured in years). As common sole catch data were collected annually, the discrete-time realisation of SPiCT, obtained by setting the time-step dt_{Euler} equal to one, was considered sufficient.

For the ratios between observation and process error for abundance and fishing dynamics, α and β, we specified priors vaguely informative priors as recommended by Pedersen and Berg (2017). Optimisation of the model fit is achieved using log-likelihood functions so that many variables and parameters are log-transformed as standard. Therefore, log α and log β were assumed to have normal distributions with mean values of log 1 and standard deviations equal to 2.

Production curve shape parameter n was allowed to vary during optimisation and we prescribed a vaguely informative prior normal distribution for log n with a mean of log 2 (corresponding to the logistic curve) and standard deviation 2. These prior specifications are considered a fair reflection of our prior knowledge of the system. The SPiCT model fit is relatively insensitive to increases in the standard deviation of the lognormal distributions; a standard deviation of 10 did not cause any visible changes in the biomass and fishing mortality trends. No other prior information was available regarding the fishing process or biomass production.

Model and post-processing R code R Core Team (2017) supplied by Pedersen and Berg (2017) was used to fit the model and analyze the results.

Results

Fishery-independent data

According to model selection scores (see Table 2), the occurrence and abundance distributions of the common sole were progressive. Persistent model scores were quite close to the progressive structure, suggesting that distributions were relatively persistent between 2001 and 2019. These results were supported by the strong temporal correlation parameters in the progressive spatio-temporal model (0.98 and 0.96 for the occurrence and abundance processes, respectively).

The predicted bathymetric distribution of occurrence and abundance revealed a clear decrease with depth from 60 m (Figure 4). Bathymetry explained 41% of spatio-temporal variation of the abundance process, which suggests that this habitat variable has an important impact on spatial variation in common sole density.

The overall abundance of the common sole shows a slightly increasing trend (Figure 5). Note that the marginal temporal effect of Figure 5 is in the log scale.

Occurrence and abundance maps (Figures 6 and 7 respectively) highlight two main preferential habitats for the common sole, located over the continental shelf in front of La Coruña and Bilbao cities. It worth to be mentioned that the predictions did not include the extra temporal effect f_t RW2.

Fishery-dependent data

Model selection scores (see Table 3) show that the abundance distribution of the common sole was progressive. The ρ parameter was 0.45, suggesting more opportunistic distributions (i.e., uncorrelated distributions between years).

The predicted bathymetric distribution revealed an increasing abundance trend until 100 m and then a decreasing pattern (Figure 8). Bathymetry explained 31% of spatio-temporal variation of the abundance process.

The overall abundance of the common sole shows a slightly decreasing trend (Figure 9). Note that the marginal temporal effect of Figure 9 is in the log scale.

Abundance maps (Figure 10) highlight not persistent hot-spots but overall two main preferential habitats for the common sole can be identified. They are located one in front of La Coruña city and another in the northern part of the area in front of the Ria do Viveiro. Also in this case, it worth to be mentioned that the predictions did not include the extra temporal effect f_t RW2.

Abundance indices

When the produced spatio-temporal abundance indices are compared with the observed data, in both cases it is possible to see that temporal tendencies are maintained but more smoothed indices are obtained (Figures 11 and 12). However both indices showed significant correlation with observer data, 0.65 with fishery-independent data and 0.70 for fishery-dependent.

SPiCT

For the three runs the assessment converged and all the variance parameters of the model were finite as recommended by Pedersen and Berg (2017). However in the three cases some of the model assumptions based on one-step-ahead residuals (i.e. auto-correlation and normality) were violated (Figures 13, 14 and 15). It worth to be mentioned that slight violations of this assumptions do not necessarily invalidate model results (Mildenberger et al., 2020).

Table 4 shows the model parameter estimates with 95% confidence intervals for all the models. Results are very different among models and the 95% confidence intervals are very wide.

Conclusions

Overall the inclusion of the spatio-temporal indices improved the results of the SPiCT model. Indeed before the standardization of the indices (i.e. using observed data) the SPiCT model did not converge at all. However results are very preliminary and they need to be improved. Future steps will be:

1) improving the standardization of the fishery-independent and dependent data. For the fishery-dependet data standardization could be improved adding seasonal trends and more effort information.

2) include in the predictions and consequent abundance indices the extra temporal effect f_t RW2.

3) Pedersen and Berg (2017) outline that the SPiCT formulation describes the dynamics of the exploited part of the fish stock. Therefore, abundance index need to be modified to include only the size-classes exploited by fishery.

4) sensitive analysis for the production curve skewness parameter n need to be performed.

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Tables

Model	Notation	Description
Opportunistic	$U_{st} = \boldsymbol{W}_t$	Different and uncorrelated realizations of the spatial field every year.
Persistent	$U_{st} = \boldsymbol{W} + f(t)$	A common realization of the spatial field for all years and an additive temporal trend $f(t)$
Progressive	$U_{st} = \boldsymbol{W}_t + \rho U_{st-1}$	Spatial realizations change over time through a first order autoregressive model. ρ controls the level of correlation between subsequent time events.

Table 1: Summary of fitted spatio-temporal models U_{st}. $\boldsymbol{W}$ represents a geostatistical spatial field, $f(t)$ is a temporal trend function and ρ is an autoregressive correlation parameter bounded to [0,1].

Model	WAIC	LCPO	Time (sec.)
Persistent structure	1732.17	0.52	128.23
Opportunistic structure	1770.42	0.54	121.57
Progressive structure	**1728.22**	**0.61**	**7882.21**

Table 2: Spatio-temporal structures comparison for the conditional-to-presence abundance distribution of common sole model fishery-independent data 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 (sec.)
Persistent structure	57602.89	6.62	102.05
Opportunistic structure	57685.80	6.63	107.175
Progressive structure	**57290.89**	**6.50**	**834.471**

Table 3: Spatio-temporal structures comparison for abundance distribution of common sole model fishery-dependent data based on WAIC and LCPO scores. Time scores refer only to the estimation process of the model. The best model is highlighted in bold.

Parameter	estimate	cilow	ciupp	log.est
RUN 1				
$Bmsyd$	266.27011	75.49005	939.19361	5.584511
$Fmsyd$	15.77595	14.83957	16.77142	2.758487
$MSYd$	4200.66483	1246.62167	14154.72351	8.342998
K	4200.6648274	1246.6216654	1.415472e+04	8.3429981
m	532.5402196	150.9800969	1.878387e+03	6.2776584
RUN 2				
$Bmsyd$	3.324751e+05	512.828416	2.155490e+08	12.714320
$Fmsyd$	5.654210e-02	0.011523	2.774462e-01	-2.872769
$MSYd$	1.879885e+04	21.075496	1.676813e+07	9.841551
m	1.879885e+04	21.0754961	1.676813e+07	9.841551
K	6.649501e+05	1025.6568328	4.310981e+08	13.407467
RUN 3				
$Bmsyd$	1945.35	442.82	8546.08	7.57
$Fmsyd$	0.3525605	0.08096485	1.53522	-1.042533
$MSYd$	685.6973461	345.63207027	1360.35076	6.530436
m	7.073595e+02	359.48682933	1.391866e+03	6.5615390
K	3.964599e+03	904.04950017	1.738627e+04	8.2851601

Table 4: Parameter estimates (deterministic) and associated confidence intervals for MSY parameter m, carrying capacity k, biomass at MSY $Bmsyd$, fishing at MSY $Fmsyd$ and $MSYd$.

405 # Figures

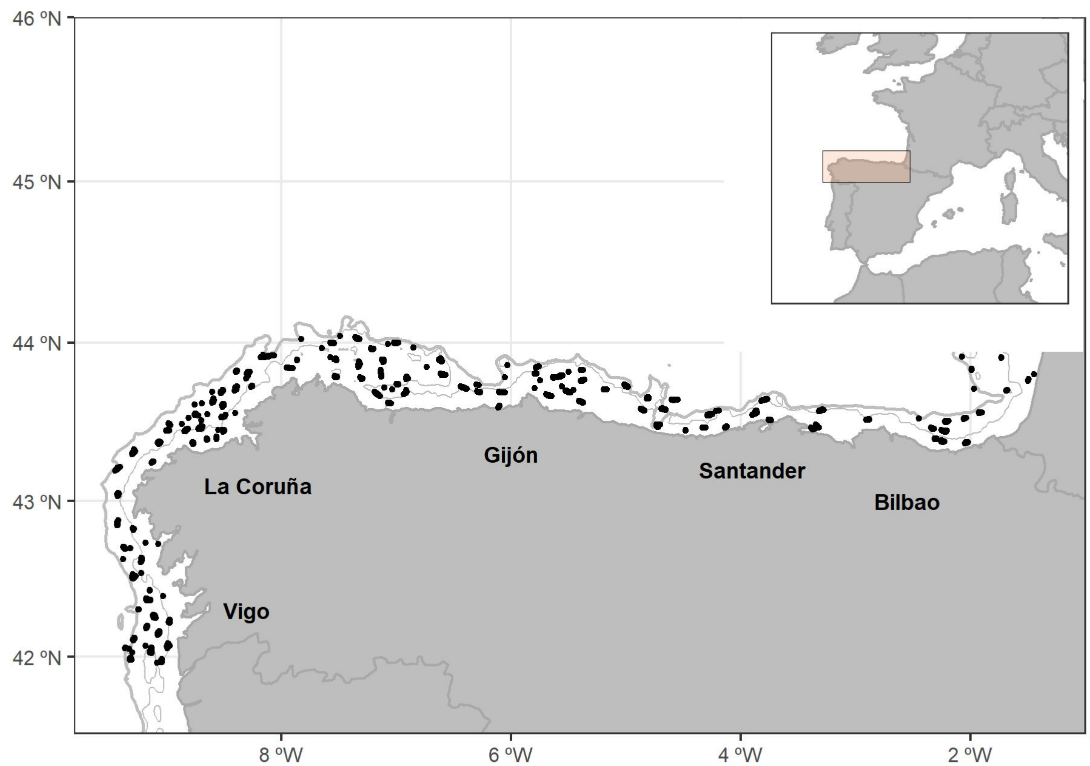

Figure 1: Map of the study area showing the distribution of the annual sampling locations of fishery-independent hauls.

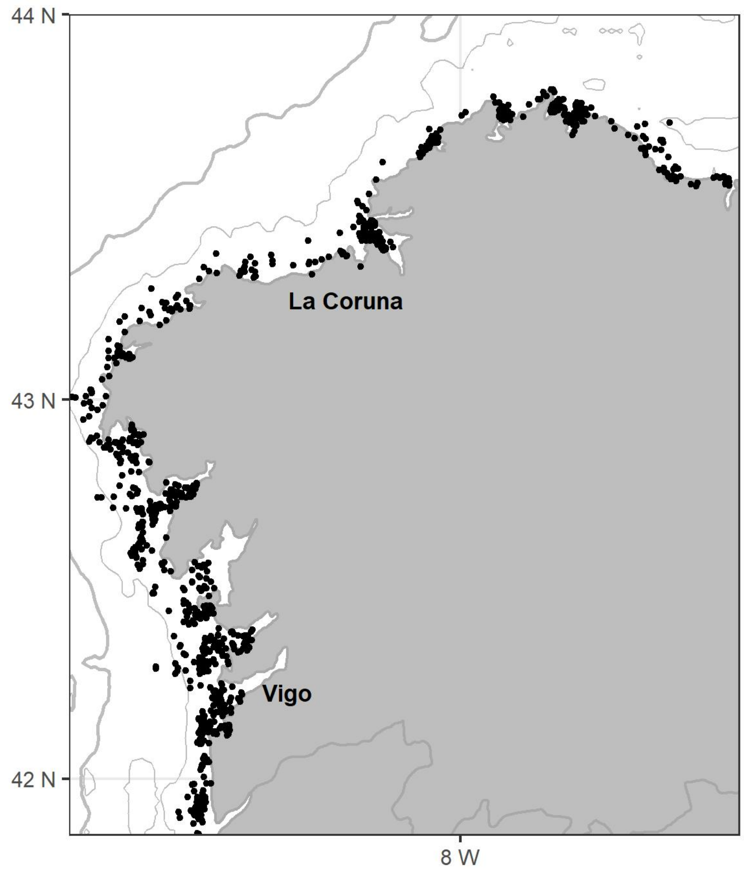

Figure 2: Map of the study area showing the distribution of the fishery-dependent sampling locations.

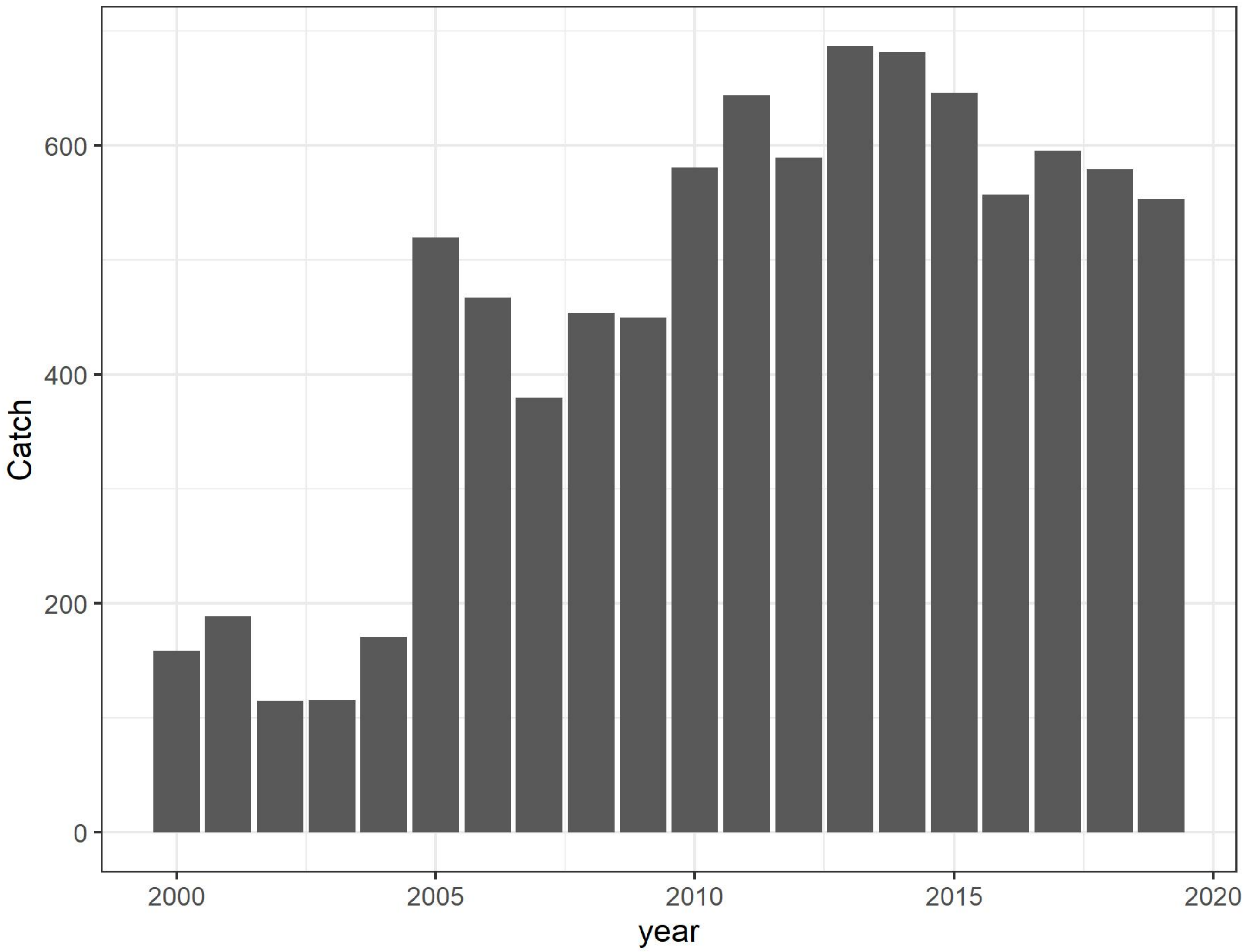

Figure 3: Common sole catch in ICES divisions 8.c and 9.a.

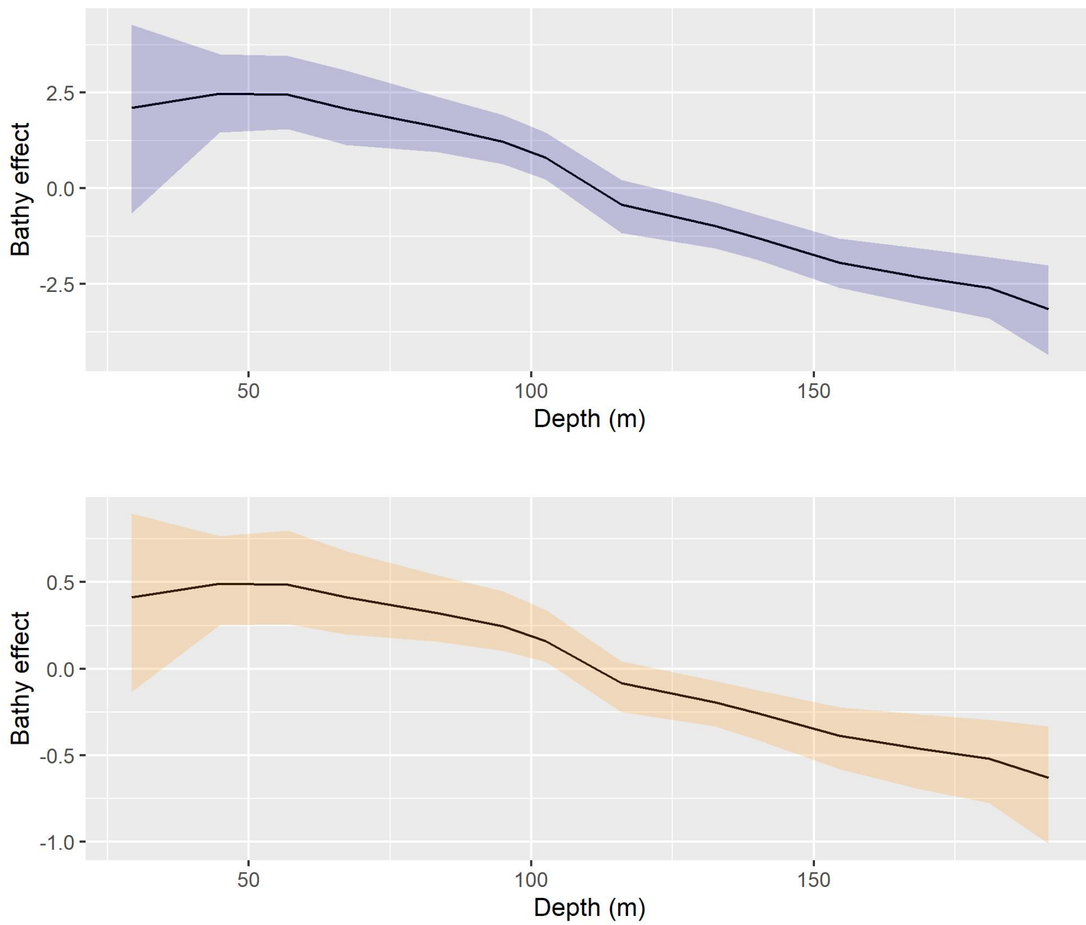

Figure 4: Smooth functions of the predicted occurrence (top) and abundance (bottom) for the bathymetry effect using fishery-independent data-set. The solid line is the smooth function estimate, and shaded regions represent the approximate 95% credibility interval.

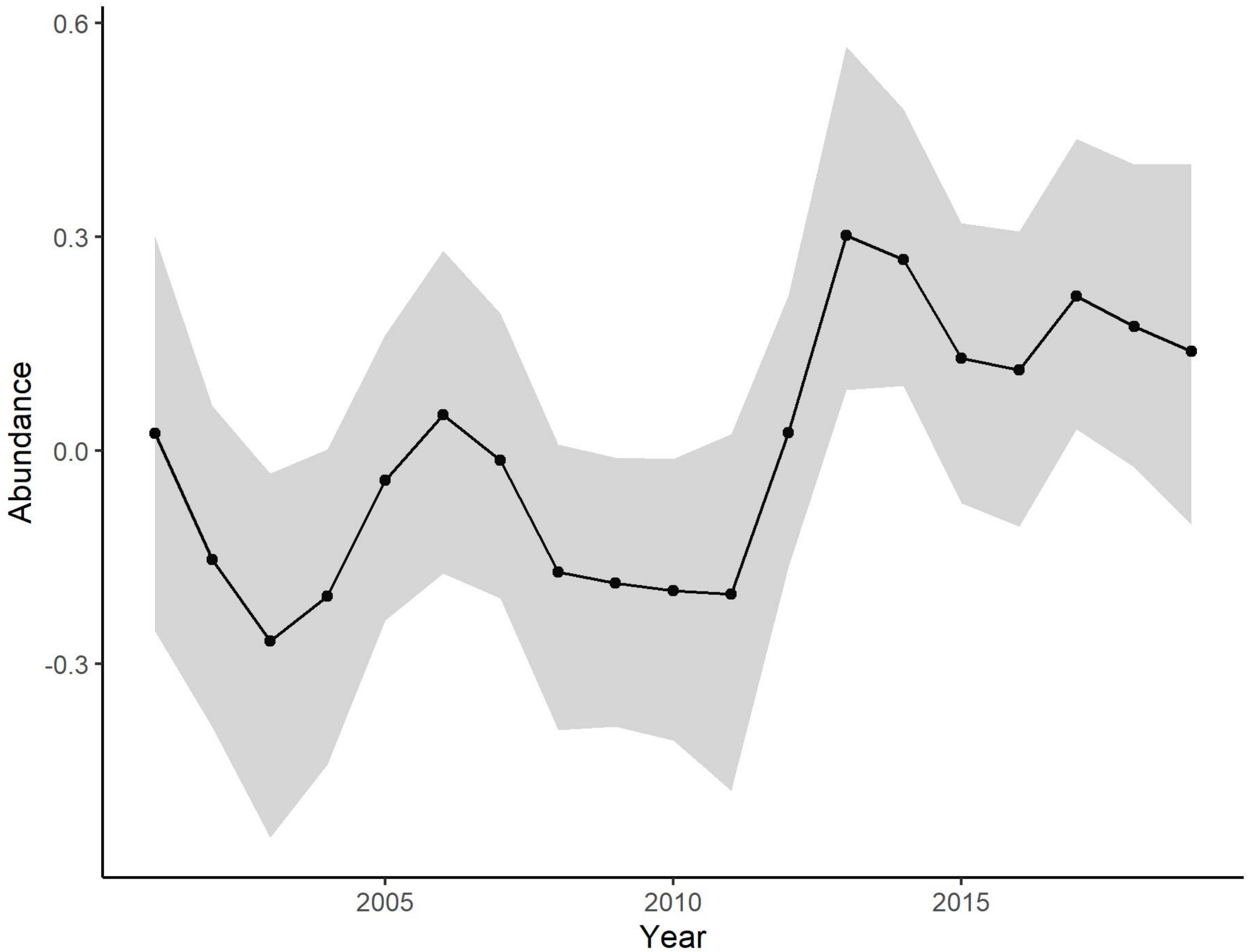

Figure 5: Marginal temporal effects in the linear predictor scale (logarithmic link) of common sole for fishery-independent data. Shaded regions represent the approximate 95% credibility interval.

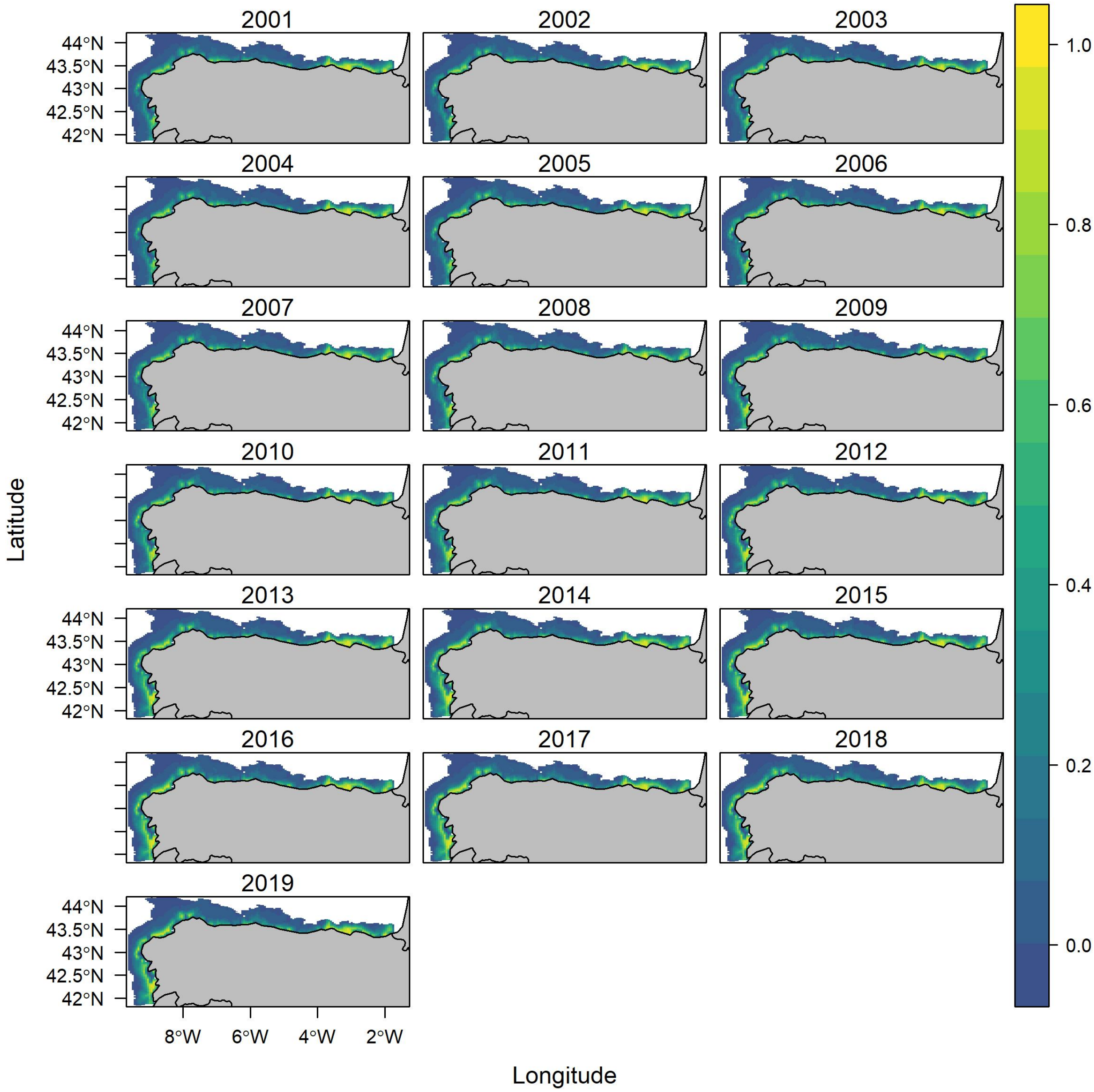

Figure 6: Prediction maps (2001-2019) of the common sole occurrence estimated by the hurdle Bayesian spatio-temporal model for fishery-independent data.

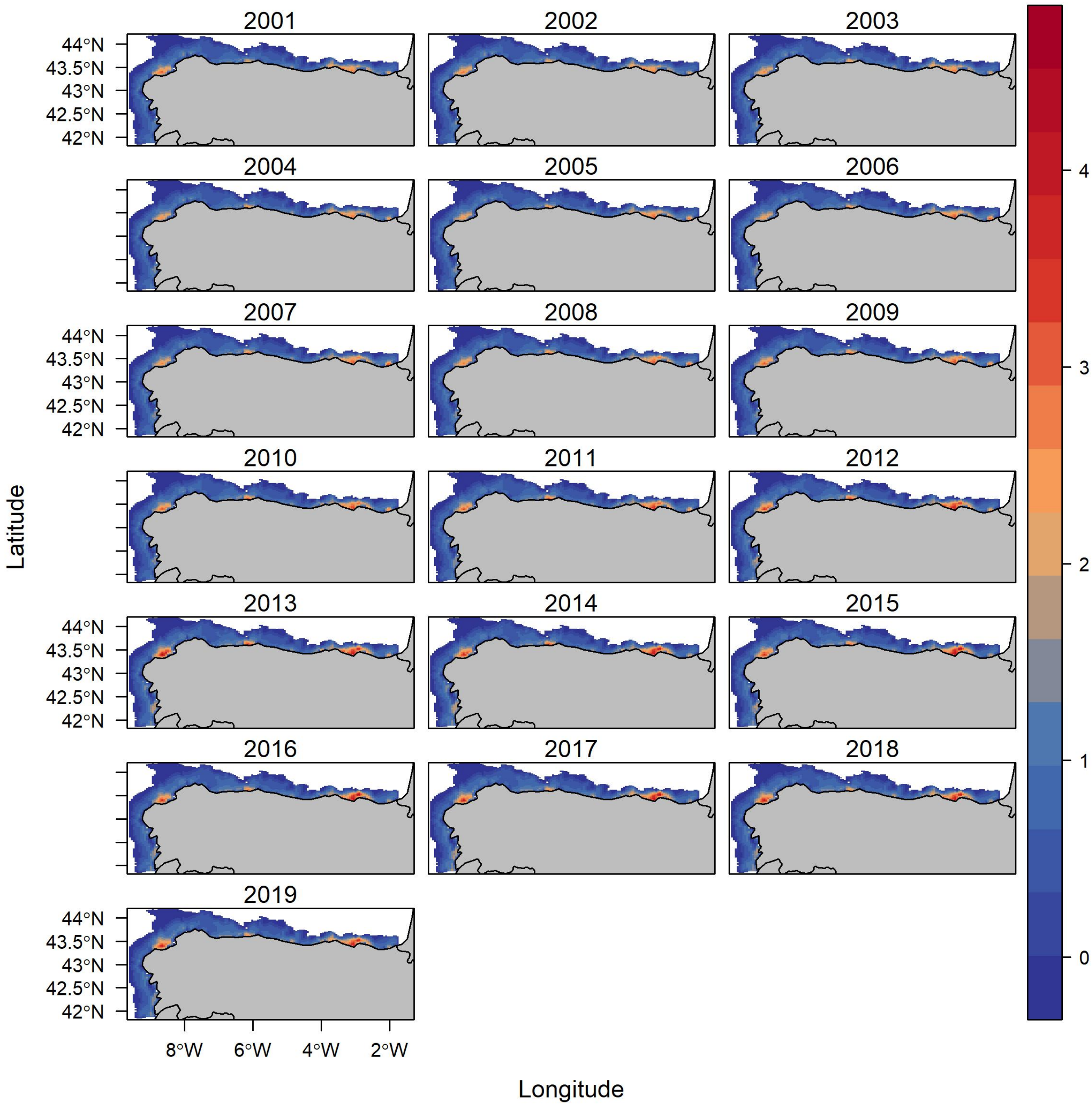

Figure 7: Prediction maps (2001-2019) of the common sole abundance estimated by the hurdle Bayesian spatio-temporal model for fishery-independent data.

Figure 8: Smooth functions of the predicted abundance for the bathymetry effect using fishery-dependent data-set. The solid line is the smooth function estimate, and shaded regions represent the approximate 95% credibility interval.

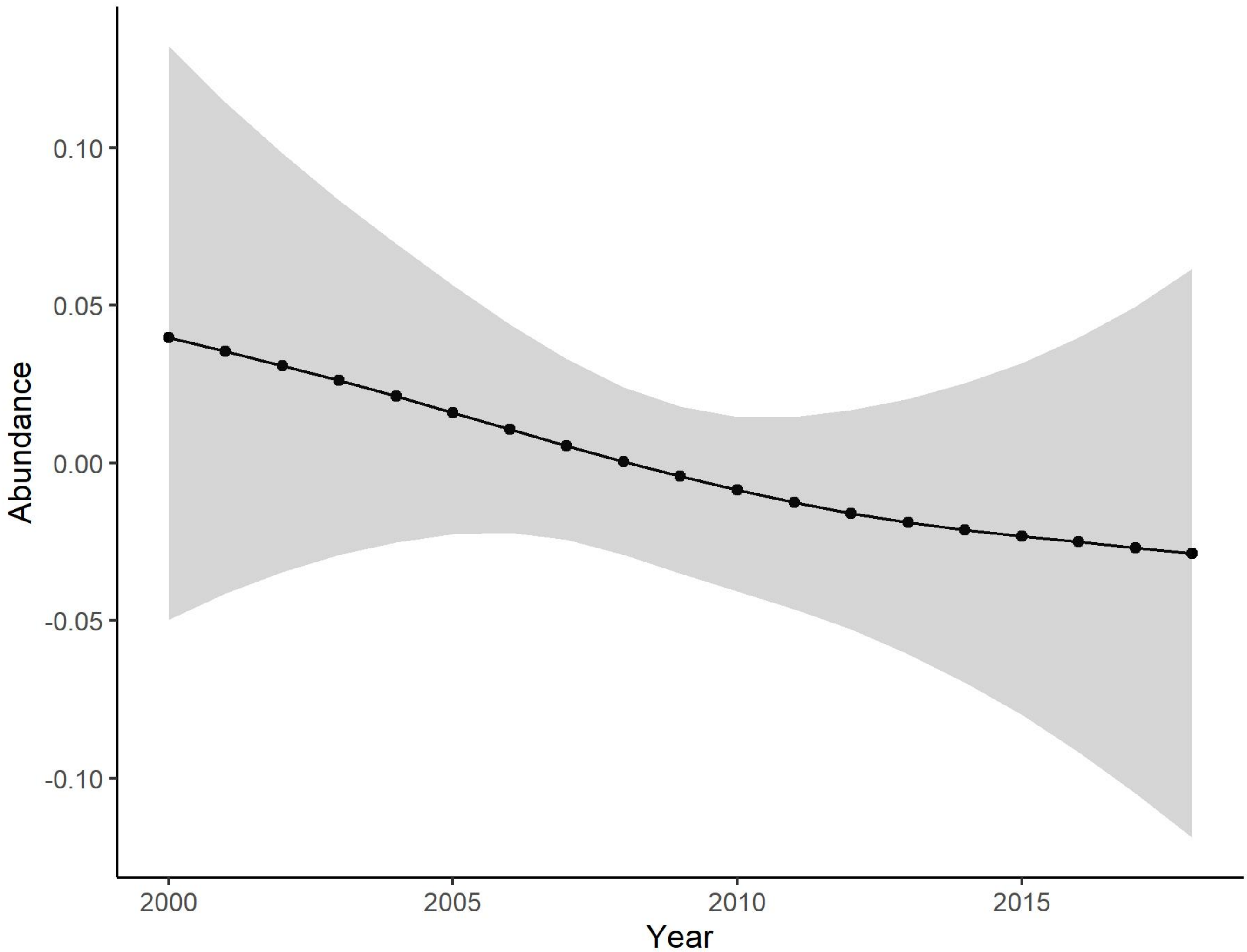

Figure 9: Marginal temporal effects in the linear predictor scale (logarithmic link) of common sole for fishery-dependent data. Shaded regions represent the approximate 95% credibility interval.

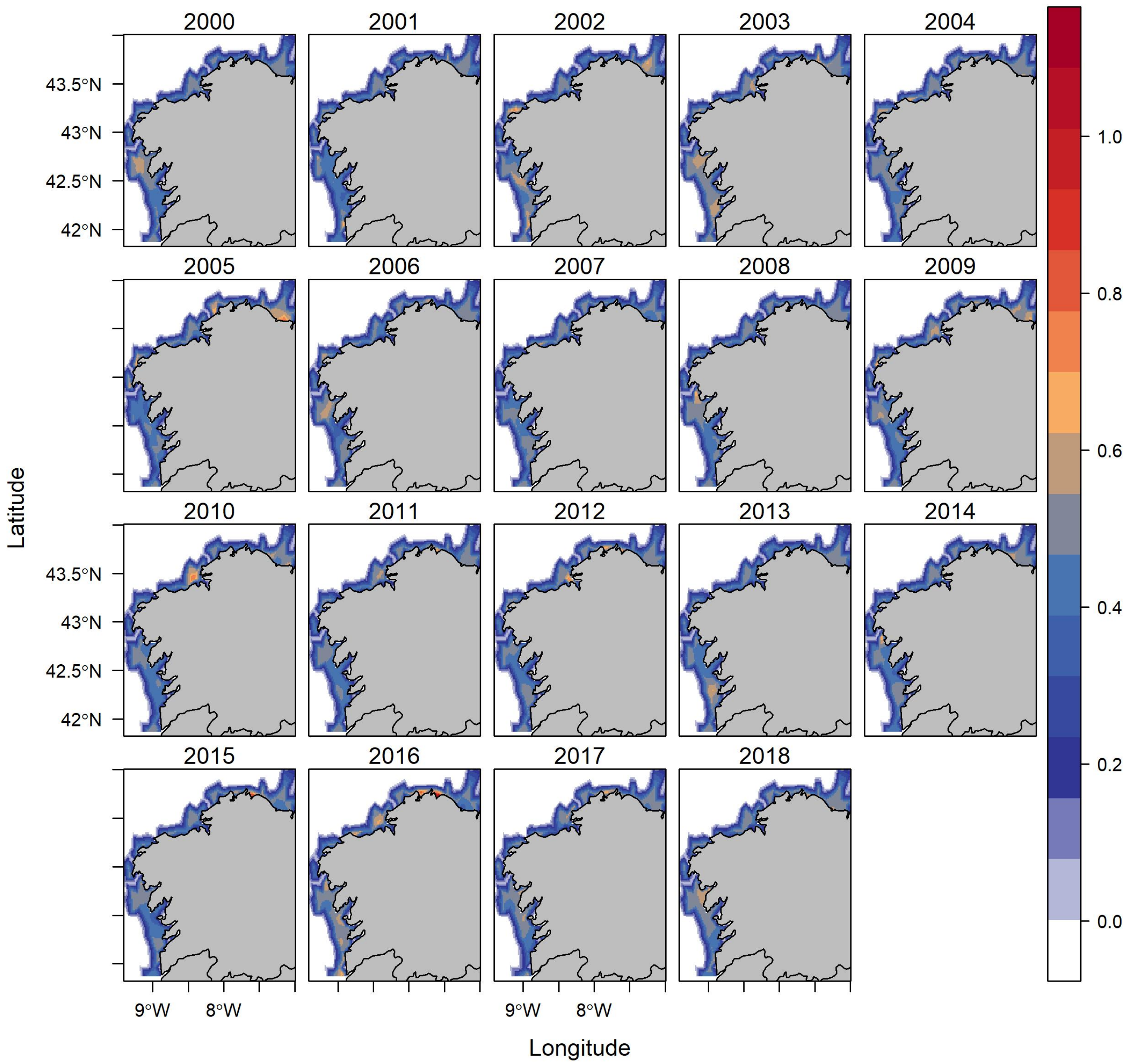

Figure 10: Prediction maps (2000-2018) of the common sole abundance estimated by the Bayesian spatio-temporal model for fishery-dependent data.

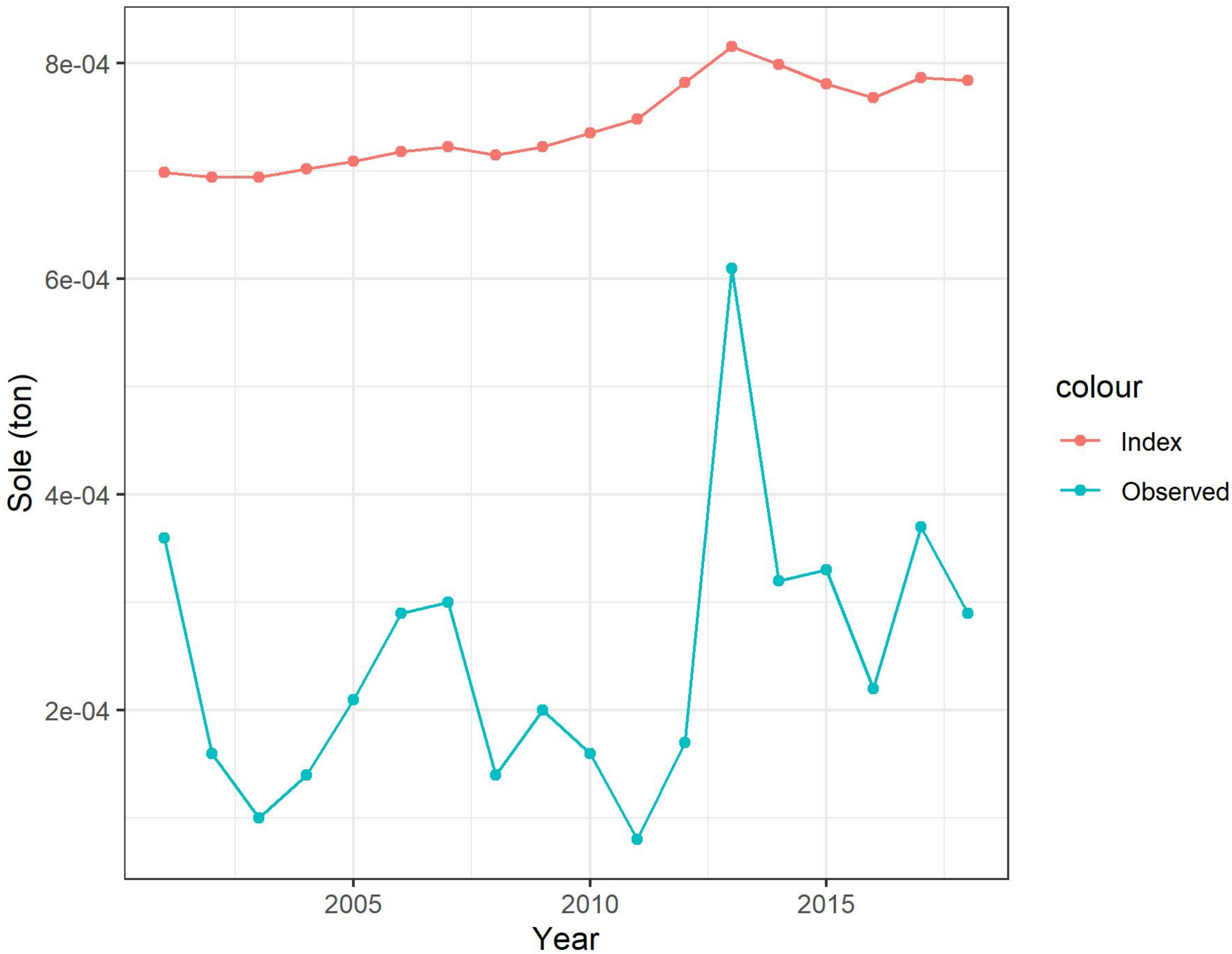

Figure 11: Spatio-temporal abundance index obtained for fishery-independent data (2001-2019) versus the survey abundance index standardized for the three bathymetric strata (i.e. 70–120 m, 121–200 m and 201–500 m).

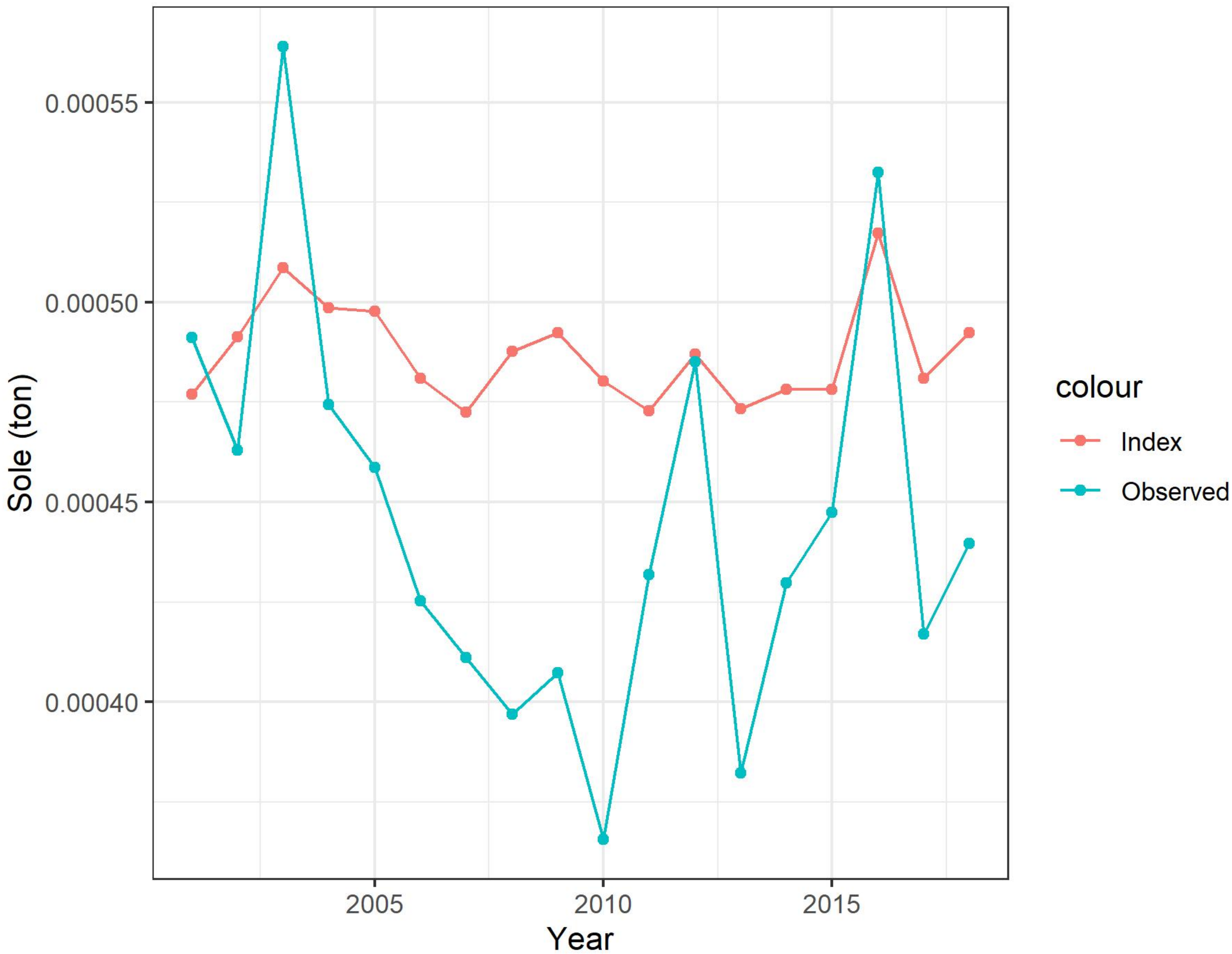

Figure 12: Spatio-temporal abundance index obtained for fishery-dependent data (2000-2018) versus observed fishery-dependent data.

406 # Appendix

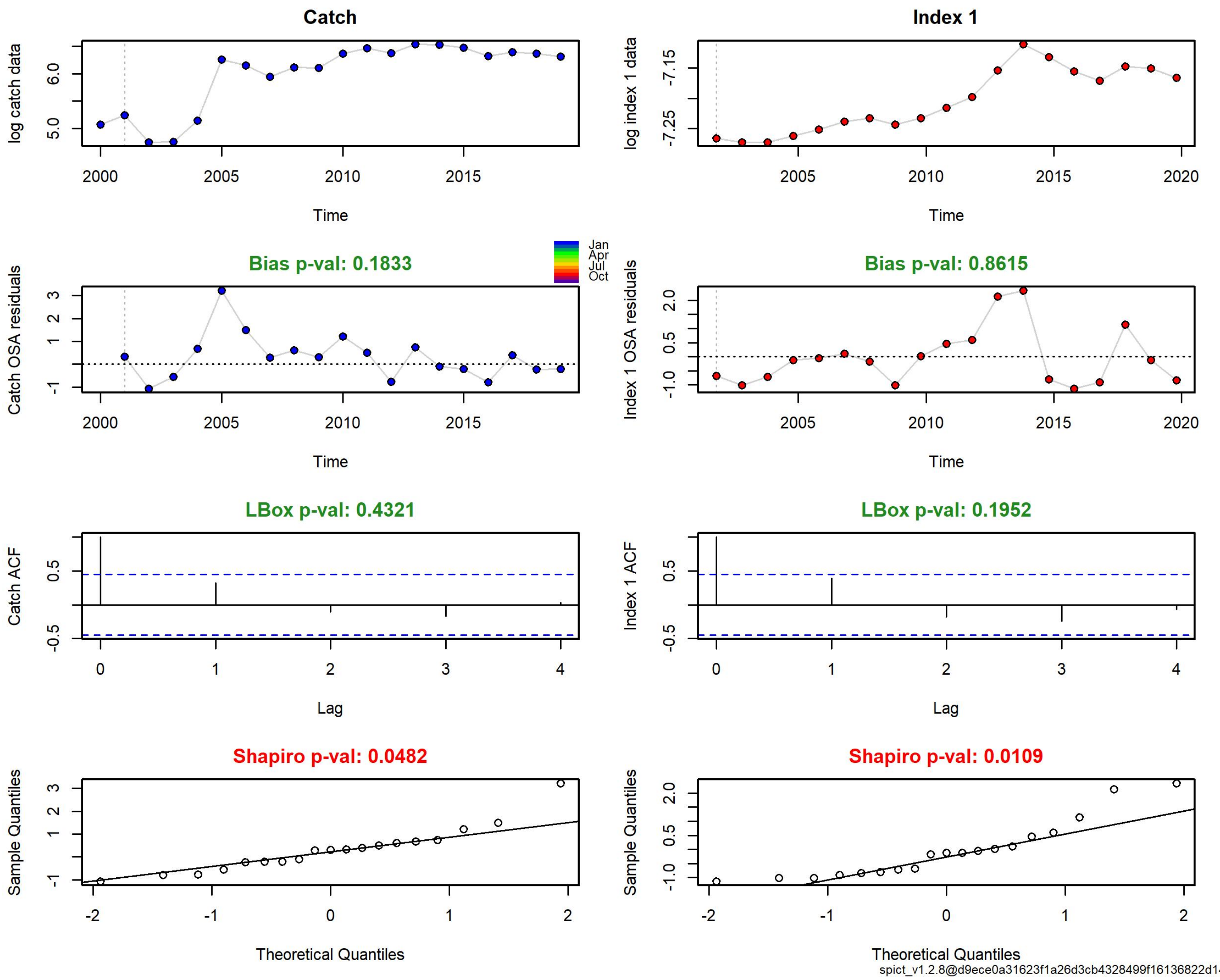

Figure 13: Standard OSA residuals for the run 1 surplus production model obtained using catch data and the spatio-temporal index of fishery-independent data.

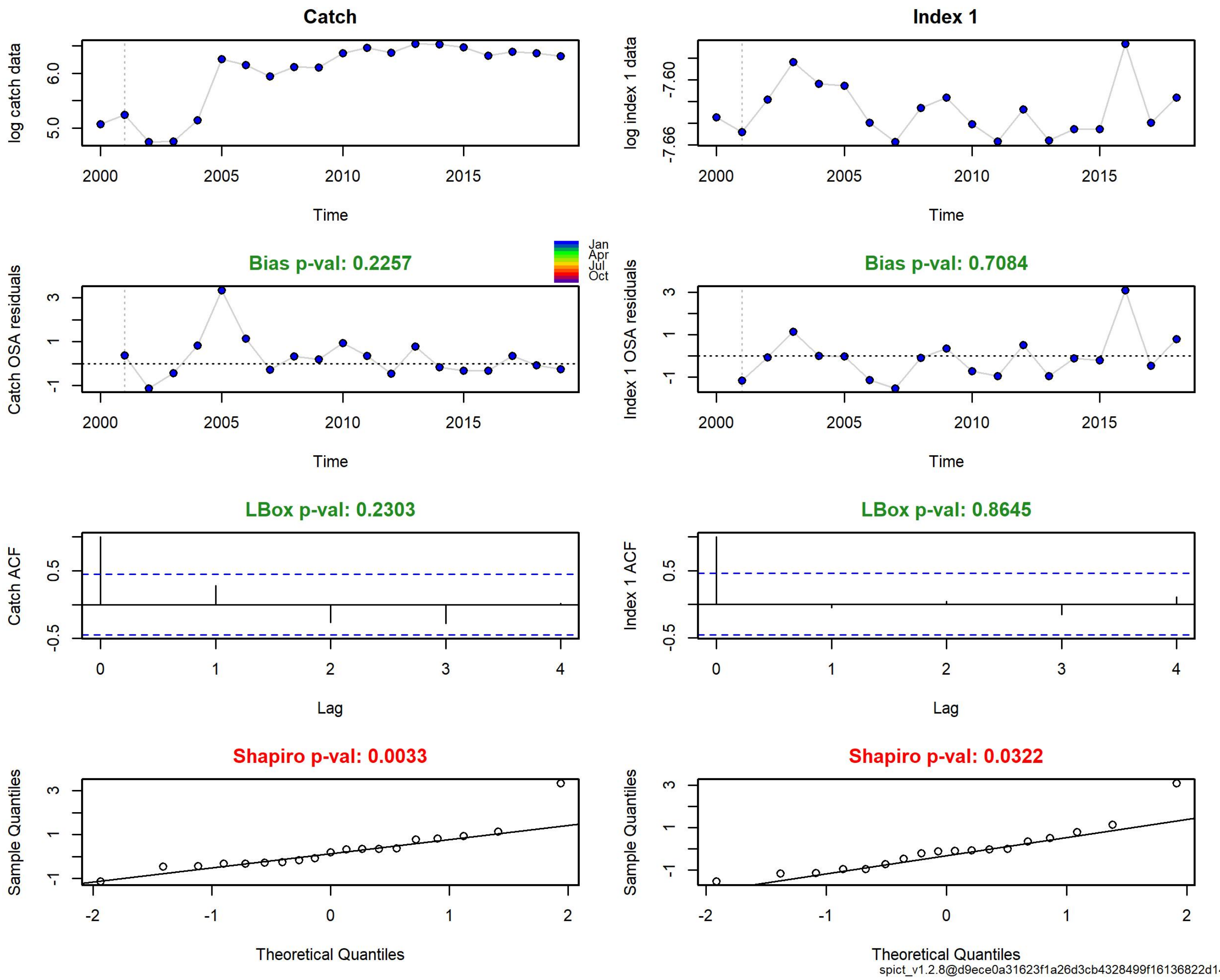

Figure 14: Standard OSA residuals for the run 2 surplus production model obtained using catch data and the spatio-temporal index of fishery-dependent data.

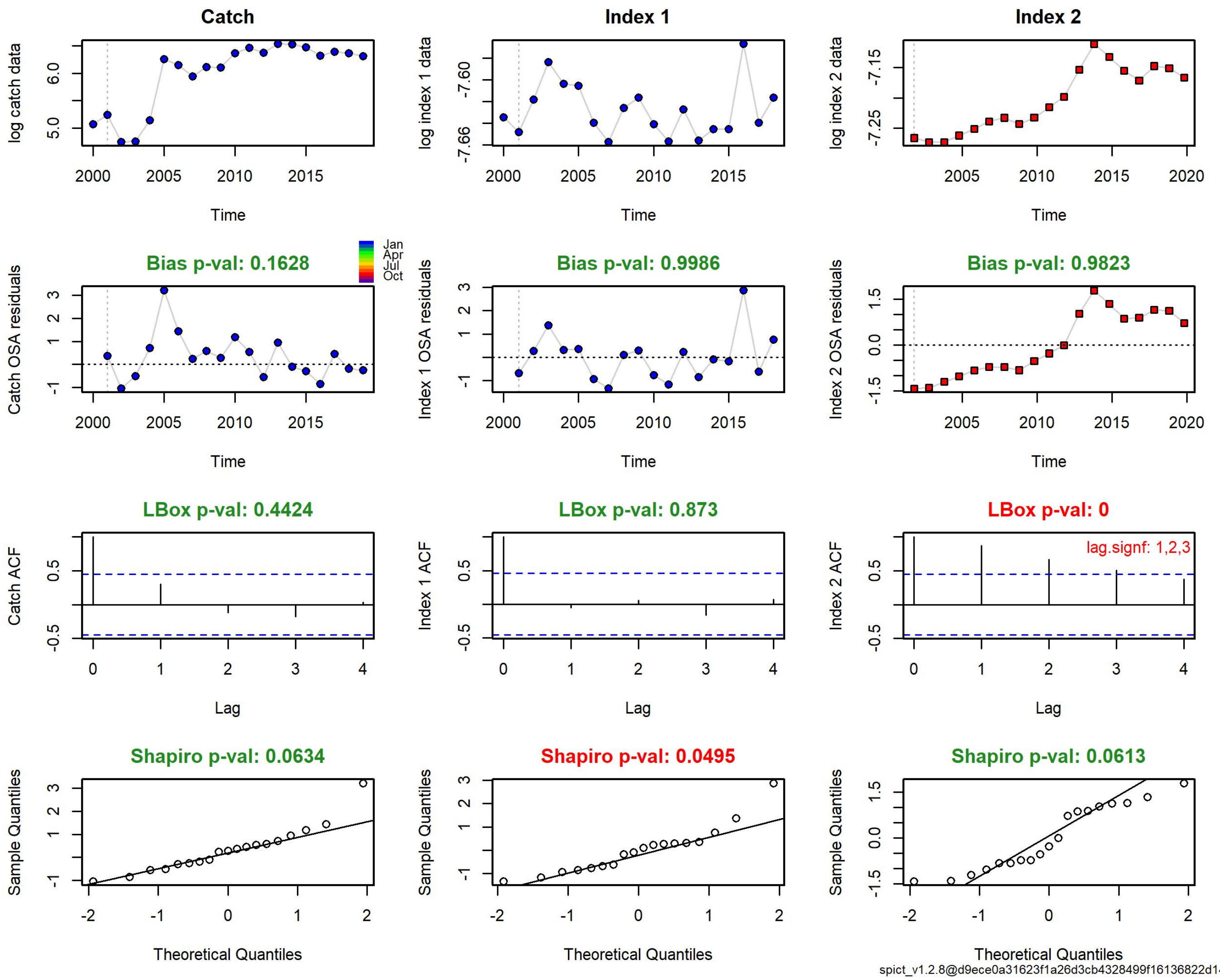

Figure 15: Standard OSA residuals for the run 2 surplus production model obtained using catch data and both spatio-temporal indices.

Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE)
6 – 13 May 2020, Copenhagen (Denmark)

Update of whiting abundance indices from professional fishing data (2016-2018)

Nathalie Caill-Milly[1], Muriel Lissardy[1], Noëlle Bru[2]

[1] Ifremer, LITTORAL, 1, allée du Parc Montaury, F-64600 Anglet, France

[2] Université de Pau et des Pays de l'Adour, E2S UPPA, CNRS, LMAP, Anglet, France

Context

The ROMELIGO project (2015-2018) aimed to contribute to the improvement of the knowledge on three stocks (mur-west, whg-89a and pol-89a – see Table 1) on the basis of the available data (landings data, sampling data for the French fleet, data from scientific campaigns...) or specific data collected during the project.

Table 1: Stocks considered by the ROMELIGO project for red mullet, whiting and pollack.

Species	Stock name	Stock code
Striped red mullet	Striped red mullet areas VI, VIII et sub-areas VIIa-c, e-k et IXa (West area)	mur-west
Whiting	Whiting area VIII et sub-area IXa	whg-89a
Pollack	Pollack area zone VIII et sub-area IXa	pol-89a

The project was organized in the same way in three parts and applied for each of the three stocks:

- Part 1 - Analyzes of catches and activity of the French professional fishery (composition and evolution of catches, seasonality, spatial distribution, gear used and discards);
- Part 2 - Analyzes of the size composition of the catches on professional and scientific vessels, analyzes of the discards, proposition of abundance indicators using professional fishing data and analyzes of CPUE from available scientific surveys;
- Part 3 - Collection of basic biological data relying on various samplings and calculation of biological parameters (length / weight relationships, growth curves, length at first maturity (L50) or maturity ogive...).

The contract report is available online (Léauté et al., 2018a[1]). A paper on the methodology used to select the reference fleets for the calculation of red mullet LPUE was also published (Caill-Milly et al., 2019).

In relation to this work and regarding **whiting**, two WDs were already sent and presented to the WGBIE respectively in 2017 and 2018:

- One dedicated to part 1 integrating as a preamble a bibliographic review on the biology of the species (Léauté et al., 2017) ;
- One dedicated to parts 2 and 3 (Léauté et al., 2018b).

This WD provides the update of whiting abundance indices from professional fishing data (2016-2018).

[1] https://archimer.ifremer.fr/doc/00440/55126/

A reminder of the previous results (Léauté et al., 2018b)

For this species and for the Bay of Biscay, Table 2 describes the characteristics of the fleets selected to build abundance indices from professional fishing data. The selection was based on gear, technical characteristics of the vessels (defined by clusters), characteristics of the gear (mesh class), time and space specifications. For whiting, the retained gear and cluster are « Bottom otter trawls » (OTB) and cluster 1. Cluster 1 corresponds to small vessels (8.1 to 15.8 m) with small tonnage (2.8 to 43.9 grt) and a engine power comprised between 44 and 258 kW. Quarter 3 was selected to avoid period of concentrations during breeding season in particular. A North/South separation within the Bay, latitude 46, was applied due to very different LPUE levels between both areas.

Table 2: Characteristics of the selected fleets regarding whiting.

Retained gear	Cluster	Gear mesh class	Period	Specific spatial delimitation
Bottom otter trawls (1 vessel) « OTB »	Cluster 1	70 to 79 mm	Quarter 3	Northern Bay of Biscay
				Southern Bay of Biscay

For the selected mesh class (70 - 79 mm), evolutions of the LPUE mean level and of its use were considered for quarter 3 and for the north and the south of the Bay of Biscay.
For the north, no significant trend was detected either for LPUE or for the use (Figure 1).

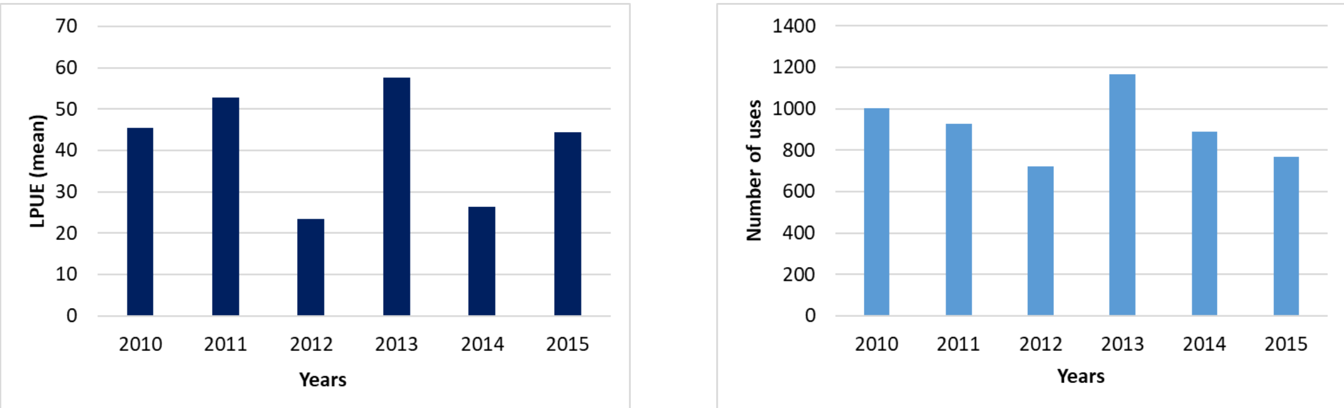

Figure 1: Levels of LPUE and number of uses - Bottom otter trawls - Cluster 1 - Mesh class 70 - 79 mm - Quarter 3 – Northern Bay of Biscay

For the south, a decrease of the LPUE mean is observed in 2013 and 2014. Then in 2015, an increase was observed. Nevertheless its overall evolution showed no significant trend between 2010 and 2015 (Figure 2). In the same time, the number of uses displayed globally an increase and then a decrease.

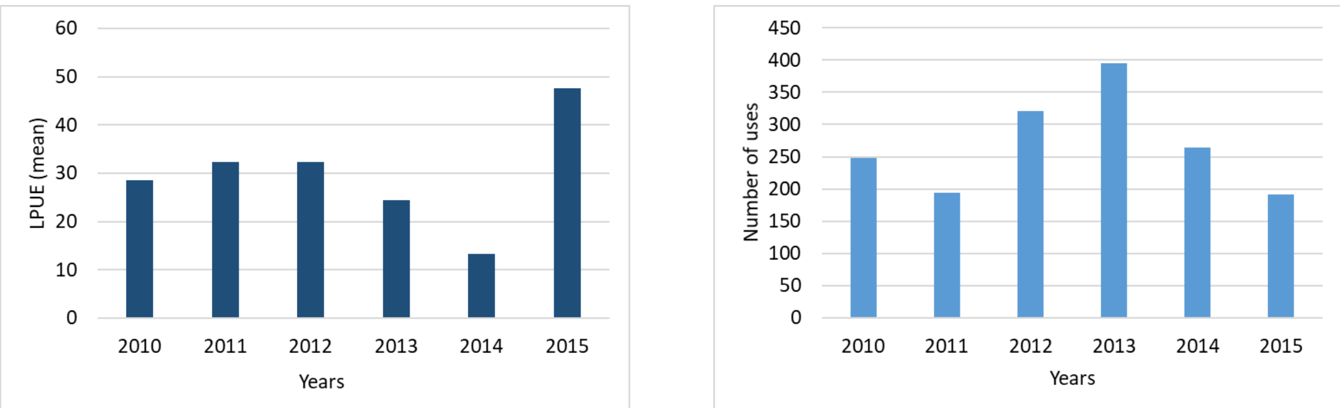

Figure 2: Levels of LPUE and number of uses - Bottom otter trawls - Cluster 1 - Mesh class 70 - 79 mm - Quarter 3 – Southern Bay of Biscay

Method used to update the abundance indices from professional fishing data

The proposed method allows an update of the LPUEs of the selected fleet after 2015. It requires the assignment of new vessels in one of the clusters defined in the project beforehand. This is to be done at the level of the selected gear for the species (*i.e.* OTB for whiting).

Clusters are the result of a hierarchical classification of vessels based on their technical characteristics (length, tonnage and engine power). The vessels were grouped according to their degree of similarity for these three variables using Hierarchical Aggregation Clustering (HAC) with Ward aggregation criterion and Euclidean distance.

When grouping with a clustering method such as the above one, it is difficult to identify clearly the bounds allowing to affect one vessel in a specified cluster (because of possible overlaps of some of the characteristics from one cluster to another). A method of assigning vessels was therefore developed for the selected gear.

To do this, a conditional decision tree was built. The targeted variable was the variable "cluster". Based on the existing classification, the decision tree provides the rules fixing the values that must take the different technical variables for a vessel to belong to a given cluster. The leaves (of the tree) not selected are either because they do not concern the targeted cluster or because the risk of classification error is considered too high.

Once this step has been completed, updating of the data (number of uses of the gear and average levels of LPUE) was carried out. It concerned the years 2016, 2017 and 2018. This update was sent to the professional structures involved in the former "CPUE Working Group" of the Romeligo project. The objective was to identify regulatory or other elements that could potentially disturb the LPUE index constructed for 2016, 2017 and 2018.

Results

Decision criteria for the assignment of new vessels appearing in 2016, 2017 or 2018

Regarding whiting and for OTB, the retained tree (Fig. 3) is the one which setting minimizes the prediction error for cluster 1 and for all the data (cluster prediction error 1: 2.4%; total prediction error 2.2%).

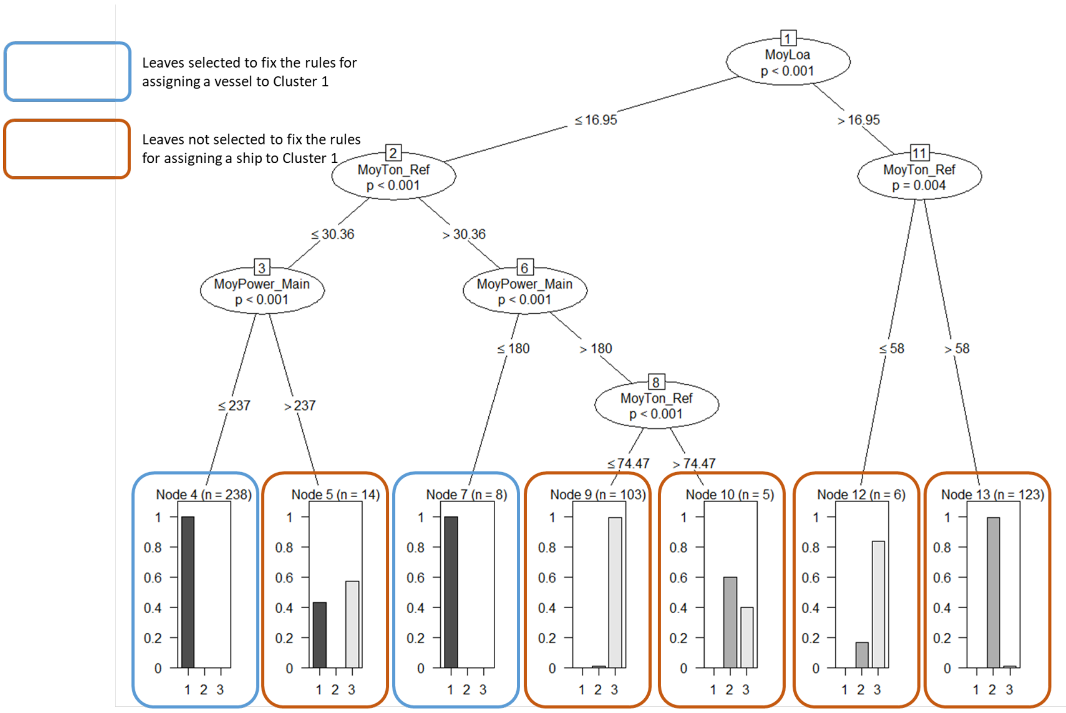

Figure 3: Conditional regression tree on cluster 1 variable (for whiting / OTB) with technical characteristics [Loa : Length (m); Ton_Ref : tonnage (grt); Power_Main : power(kW)].

Consequently, a vessel falls into the cluster 1 if its length is less than 16.95 m and:

- If its power is less than or equal to 237 kW and its gauge less than or equal to 30.36 grt;
- Or if its power is less than or equal to 180 kW and its gauge strictly greater than 30.36 grt.

Update of data and evolution of the indices

The evolution of the number of uses and of the mean level of LPUE are shown for quarter 3 and for the north and the south of the Bay of Biscay (Figures 4 and 5).

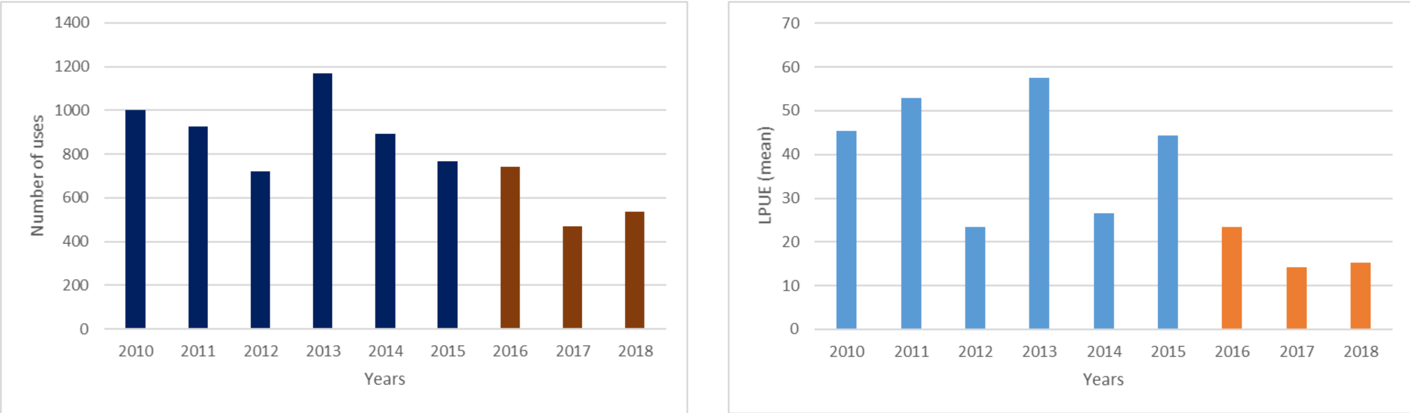

Figure 4: Numbers of uses and levels of LPUE - Bottom otter trawls - Cluster 1- Mesh class 70 - 79 mm – Quarter 3 – Northern Bay of Biscay

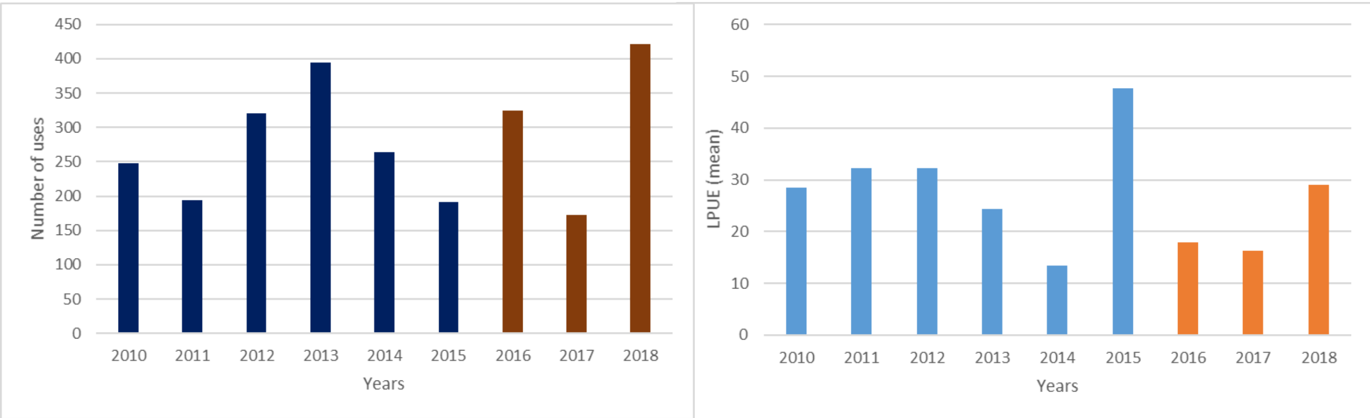

Figure 5: Numbers of uses and levels of LPUE - Bottom otter trawls - Cluster 1- Mesh class 70 - 79 mm – Quarter 3 – Southern Bay of Biscay

In recent years, the LPUEs calculated for the northern Bay of Biscay show low levels, but the decrease is not significant over the whole period (Pearson test).

For the south, no trend emerges.

Information from the consultation of professional structures

The consultation identified two regulatory elements that could potentially have disturbed the LPUE indices built for 2016, 2017 and 2018:

- The whiting management plan implemented by the "OP Vendée" from January 2017 for trawlers;

- The decree concerning trawlers over 12m which have a European Fishing Authorization (EFA) to fish common sole in the Bay of Biscay[2].

[2] Since January 1st, 2016, this decree imposes a mandatory minimum mesh size of 80 mm for the vessels concerned (having this authorization), out of derogation period from June 1st to September 30th each year. This latter period makes it possible to practice specific metiers (for example bottom trawls targeting wedge sole). This decree was modified at the end of 2018, with the possibility of shifting the derogation period of 4 consecutive months.

In the case of the whiting management plan, the organization "OP Vendée" transmitted to Ifremer the registration numbers of the vessels belonging to this organisation and concerned by the measure. The analyzes showed that only the indicator for the northern Bay of Biscay is concerned.

⇨ Considering all the available data and assuming that all things are equal, it is estimated that the levels of LPUE (north of the Bay of Biscay) for 2017 and 2018 could have been impacted by the management measure but without changing the trend of the indicator.

In the case of the measures applied to vessels having a EFA for common sole, the list of these vessels was not recovered. We only looked at the evolution of the number of fishing sequences by vessels over 12 m and their associated LPUE. For the northern part of the Bay, the sequence number began to decline in 2014; it increased from 2015 and the level remained very low in 2018. This came together with a very large decrease in the average LPUE for these vessels. For the southern part of the Bay, the sequence number also recorded a sharp decline concomitantly with the implementation of the measure, but there was a strong change in 2018 since the level observed is the highest in the series (2010-2018). The associated LPUEs for the north increased again in 2018 without however reaching the levels prior to the implementation of the measure.

⇨ Considering all the available data and assuming that all things are equal, it is estimated that the levels of LPUE (north and south of the Bay of Biscay) between 2016 and 2018 could have been impacted by the measurement management, but without changing the trend of the indicator.

Conclusion

Currently two fleets are selected for the Bay of Biscay: OTB - Cluster 1 - Mesh size 70 - 79 mm - Quarter 3 - Northern Bay of Biscay and OTB - Cluster 1 - Class mesh 70 - 79 mm - Quarter 3- Southern Bay of Biscay. For the south, the number of uses varies significantly from year to year. The confidence interval of the LPUE is wider for the south than the north, the levels of LPUE are less stable within the quarter in the south than in the north. It could therefore be proposed to retain only the northern indicator in future years.

References

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Léauté J.-P., Caill-Milly N., Lissardy M., 2017. ROMELIGO : Improvement of the fishery knowledge of striped red mullet, whiting and pollack of the Bay of Biscay. The whiting part. Working Document for the Working Group for the Bay of Biscay and Iberian Waters Ecoregion (WGBIE). 4-11 May 2017, Cadiz (Spain). https://archimer.ifremer.fr/doc/00413/52452/

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Léauté J.-P., Caill-Milly N., Lissardy M., 2018b. ROMELIGO: Improvement of the fishery knowledge of striped red mullet, whiting and pollack of the Bay of Biscay. Whiting part. Working Document for the Working Group for the Bay of Biscay and Iberian Waters Ecoregion (WGBIE). 3-10 May 2018, Copenhagen (Denmark).

Sacrois versions used for the update: V.3.3.7 for the 2016 to 2017 data and V.3.3.8 for the 2018 data (extraction November 2019)

What is the effect of including the North Sea International Bottom Trawl Survey data on the assessment of the Northern European hake stock?

Judith Horrill[a], Liz Clarke[a], Dorleta Garcia[b]

[a] *Marine Scotland Science, Aberdeen, Scotland*
[b] *AZTI Tecnalia, Sukarrieta, Bizkaia, Spain*

The current assessment model for the Northern European hake stock is developed to include data from the two North Sea International Bottom Trawl Surveys (NS-IBTS). The inclusion of these surveys results in a substantial increase in estimates of spawning stock biomass (SSB), which implies that the current assessment method, which does not include surveys covering the full range of the stock, could be under-estimating the current status of the stock. We therefore recommend that WGBIE considers the inclusion of these surveys, and also other IBTS surveys carried out in 27.6.a in the stock assessment model at the next benchmark.

Introduction

Over the last 20 years there appears to have been a considerable expansion in both the estimated spawning stock biomass (SSB) and the range of the northern stock of European hake *Merluccius merluccius*. This species, which was previously only seen in low numbers in the North Sea, is now consistently found here in much larger numbers (Figure 1) and has become a prevalent target species. The assessment of this stock, which covers ICES Subareas 4, 6 and 7 and Divisions 3a, 8a-b and 8d, is based on a combination of fisheries and survey data. However, the surveys currently used in the assessment each only cover part of the southern range of the stock and miss much of the area it has expanded in to. The ICES group responsible for the assessment of this stock, Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE), suggested in Annex 5 of the 2018 Inter-benchmark report that in order for the assessment to more accurately represent the dynamics of the stock a number of changes should be considered. One of these was the inclusion of North Sea International Bottom Trawl Survey (NS-IBTS) data in the assessment. The purpose of this paper is to consider if the inclusion of NS-IBTS survey data would result in the assessment more accurately representing the stock.

The northern European hake stock has been assessed using Stock Synthesis v3.24 (SS3) since 2010 (Vigier, 2017). Although primarily designed as an age structured model (Methot and Wetzel, 2013) the great utility of SS3 comes from the fact that it can work in data poor situations and be used in a length-based approach such as that required for hake. In that case it does this by converting length data into age groups. This is a flexible model in that it can work with gaps in the data but, obviously, the more information that is included the greater the accuracy is likely to be.

The northern hake stock is currently assessed using landings and discards data from fisheries throughout its range, as well as data from 4 surveys, the French EVHOE (FR-EVHOE), Irish Groundfish Survey (IE-IGFS), Spanish Porcupine Groundfish Survey (Sp-PGFS) and historical data from the RESSGASC surveys (ICES, 2018).

The EVHOE and IGFS are both conducted in the 4th quarter of each year and cover depths down to around 600m, on the shelf from the Bay of Biscay to southern Ireland, and off the west coast of Ireland to around 56.5°N, respectively. They use Grand Ouverture Verticale (GOV) trawl gear with a 20mm codend liner. The EVHOE has run annually since 1997 and the IGFS has run since 2003. The SpPGFS started in 2001 and has continued each year in the 4th quarter since. It covers deeper water ranging from 150 to 800m depths on Porcupine Bank (ICES, 2016). Finally, historic data is included from the French RESSGASC groundfish surveys which were conducted in the Bay of Biscay. Although there is data available going back to the beginning of these surveys in 1978, only that from 1985 until 2001 are included. WGBIE considered that data prior to 1985 were unreliable as an older vessel was used and, although the survey finished in 2002, it was felt that the last years data was also unreliable due to poor weather conditions experienced during the 2002 cruise. This survey covered the Bay of Biscay. It was conducted quarterly until 1997 and thereafter was conducted in quarter 2 and quarter 4. Each quarterly survey is treated separately for the stock assessment.

The North Sea International Bottom Trawl Surveys (NS-IBTS) are co-ordinated by several countries in the North Sea (ICES Subarea 27.4). The surveys also use the GOV trawl, but comparable catchability with IGFS or EVHOE cannot be assumed. The NS-IBTS are conducted in quarter 1 (NS-IBTS-Q1) and quarter 3 (NS-IBTS-Q3) each year and are considered as 2 separate surveys, as is the case with those already included. NS-IBTS-Q1 has been carried out since 1965 but for the current study only data from 1978 is included, as 1978 is the starting year for this assessment although none of the currently used survey data goes back before 1985. Data from NS-IBTS-Q3 will be included from its start in 1997.

Addition of data from NS-IBTS

The models tested in this study were based on the most recent hake stock assessment model, fitted to data from 1978-2018 (ICES, 2019b). Model diagnostics were explored using standard graphs created using the R-package R4SS (Taylor, 2019). The results from the most recent hake assessment model were compared with those from 3 models including: NS-IBTS-Q1 series as additional data; NS-IBTS-Q3 as additional data; both NS-IBTS-Q1 and NS-IBTS-Q3 series as additional data.

Indices for the NS-IBTS surveys were obtained from the ICES DATRAS website using the standard ICES calculation (ICES, 2012) Annual variance estimates were also calculated, which involves reproducing the survey indices (see Appendix 1). There are some discrepancies between the ICES index and the recalculated index but these were not considered to greatly affect the variance estimate. Data from NS-IBTS-Q1 was included from 1978 is included, whilst data from NS-IBTS-Q3 was included from its start in 1997.

The data from the indices calculated for all the surveys are then treated in the same way. The data are divided into 'length bins', giving number at length per survey per year. The length classes were dictated by those already used in the assessment. These were 0 to 4 cm in intervals of 1 cm, 40 to 100 cm in intervals of 2 cm and 100 to 130 cm in intervals of 10 cm. This resulted in 73 individual length bins. The tails of this distribution were then compressed so that 0-4 cm became 1 bin and fish ≥100 cm were also classed together.

The parameters set in the input files were left the same as for the existing assessment, with the exception of additional parameters required to incorporate the NS-IBTS surveys. These parameters are listed in Appendix 2. The initial parameter values for selectivity for the NS-IBTS surveys were set to be the same as for the Sp-PGFS survey, as the Sp-PGFS catches larger fish than the IGFS and EVHOE surveys and was therefore considered to be more similar to the North Sea data. It is however, unlikely that this would have a significant impact on the overall output of the model.

Results

In general, the surveys show similar patterns of abundance indices with high variability that fluctuate around a general trend (Figure 2). The RESSGASC survey indicates a relatively constant, slightly decreasing trend from 1985 to 2000, and this is reflected in NS-IBTS-Q1 also. All the recent surveys show an increasing trend from 2000 to 2015, though there are indications of a possible decrease since 2015 in SpPGFS, NS-IBTS-Q1 and NS-IBTS-Q3. NS-IBTS seem to follow similar patterns to the currently used surveys, although the increase in abundance in the last 20 years is more extreme (Figure 2).

Model diagnostics for each of the new models were similar and so only the diagnostics for the model including data from both NS-IBTS series are described here. Residuals of logged survey abundance for the model including both NS-IBTS series are similar to those for the model used in WGBIE 2019, for the currently used surveys, with similar trends and peaks (Figures 3a and 3b). The fit to the NS-IBTS surveys indices is not as good as to the currently used surveys, with consistently negative residuals before 2000 and positive residuals after 2000, with the residuals for NS-IBTS-Q1 in recent years being approximately twice those of the other surveys (Figure 3b). Similarly, the residual patterns for the survey numbers-at-length for the currently used surveys do not change substantially between models (Figures 4a and 4b). The model consistently under-estimates numbers-at-length at around 30 cm and over-estimates numbers-at-length at smaller lengths for NS-IBTS-Q1, whereas it consistently over-estimates numbers-at-length at around 20 cm for NS-IBTS-Q3, and under-estimates numbers-at-length for larger fish (Figure 4b). This over-estimation of small individuals is reflected in higher recruitment estimates that in the 2019 assessment, which produces the higher increase in biomass in the last years.

Comparing fitted selectivity in 2018, again we find little difference in fit between the models (Figures 5a and 5b). However the selectivity for the NS-IBTS series are quite different to the other surveys, and possibly reflect that the model is struggling to fit these surveys and that the fit could be improved (Figure 5b).

All the models with the NS-IBTS data have spawning stock biomass (SSB) estimates that are generally higher than the current estimates throughout the time series, and are substantially larger than the current estimates for later years (Table 1 and Figure 6). The model including both surveys results in an SSB estimate for 2018 of 538562 t, almost twice that of the most recent assessment of 277482 t for 2018 (Table 1).

Fishing mortality is consistently lower across the time series for the new models, whilst recruitment is similar but generally higher for the new models (Table 1 and Figure 7).

Conclusion

The results of this study show that the inclusion of data from one or more of the NS-IBTS could change the perception of the stock, substantially increasing the SSB estimates for recent years, whilst not appearing to negatively affect the fit of the model to data currently included. This in turn implies that not including the NS-IBTS could result in an under-estimation of the SSB for this stock. However it is possible that the fit of the models presented here could be improved (as indicated by the residual plots and fitted selectivity curves). Further IBTS surveys, using the GOV net, and covering 27.6.a to the West of Scotland, are carried out in quarters 1 and 4 (SCW-IBTS, 1985 – 2010, and SCOWCGFS, 2011 – present), and the inclusion of these surveys in the assessment model would ensure that the full range of the stock was covered.

We therefore recommend that the inclusion of surveys covering the full range of the stock is considered at the next benchmark, and propose that further inter-sessional work is carried out to improve the model fits and to consider the inclusion of the SWC-IBTS and SCOWCGFS indices, taking into account the methods of Vigier et al (2017) to further this aim.

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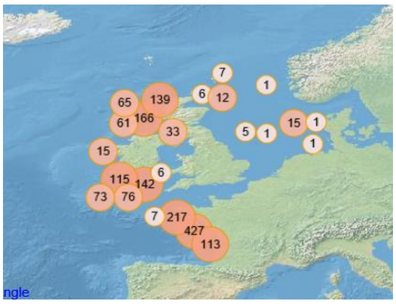
Table 1 *Comparison of key stock assessment parameter estimates for the model used by WGBIE 2019 (current data) and the models fitted to data including the NS-IBTS Q1 (Plus NS Q1), the NS-IBTS Q3 time series (Plus NS Q3) and both NS-IBTS time series (Plus NS Q1 & Q3). Estimated Recruitment numbers (RECRUITMENT), Spawning stock biomass (SSB - tonnes), Fishing Mortality (F), observed landed weight (LANDINGS - tonnes) and observed discard weight (DISCARDS - tonnes).*

	RECRUITMENT				SSB				F				LANDINGS	DISCARDS
YEAR	Current data	Plus NS Q1	Plus NS Q3	Plus NS Q1 & Q3	Current data	Plus NS Q1	Plus NS Q3	Plus NS Q1 & Q3	Current data	Plus NS Q1	Plus NS Q3	Plus NS Q1 & Q3	All	All
1978	316562	248598	312581	260311	71702	76368	79091	81241	0.54	0.51	0.52	0.5	50551	NA
1979	291398	266342	287279	280150	91895	95052	99454	101178	0.58	0.53	0.56	0.53	51096	NA
1980	321687	273680	316859	289119	94241	101944	101723	108712	0.68	0.63	0.66	0.62	57265	NA
1981	608284	531455	600950	558002	80167	88003	87128	94895	0.69	0.64	0.66	0.63	53918	NA
1982	418243	437095	408592	463278	64406	70938	70637	77400	0.72	0.69	0.69	0.67	54994	NA
1983	147050	160015	145003	174637	62898	66132	68496	72811	0.67	0.65	0.64	0.62	57507	NA
1984	293380	189776	289770	206042	76056	76854	81341	84741	0.7	0.66	0.68	0.65	63286	NA
1985	643145	584903	636782	660948	72957	76828	77586	84816	0.85	0.79	0.83	0.77	56099	NA
1986	373157	368652	369604	422086	54100	58901	57958	66399	0.96	0.9	0.92	0.86	57092	NA
1987	449506	389067	447138	442041	39906	41475	42892	49048	1.05	1.02	1	0.98	63369	NA
1988	511711	459304	508786	509548	43169	44280	45684	51046	1.06	1.01	1.01	0.98	64823	2.2
1989	495038	441528	490203	480226	42492	44356	44891	50028	1.14	1.09	1.09	1.05	66473	72.8
1990	503507	458975	494855	515467	39704	40931	42235	46024	1.08	1.04	1.03	0.97	59954	NA
1991	277635	246795	275396	294284	38676	39728	41512	46262	1.03	1	0.97	0.91	58129	NA
1992	303104	275486	288820	303808	37236	38340	40193	46925	1.07	1.02	1	0.97	56617	NA
1993	532745	490717	516629	558627	36649	37794	39611	45463	1.1	1.05	1.04	1.01	52144	NA
1994	300750	285082	300317	325712	28823	29855	31630	35850	1.13	1.09	1.06	1.05	51259	356.2
1995	152607	148012	152514	166905	28062	29063	30036	33753	1.19	1.15	1.13	1.09	57621	NA
1996	372604	339655	362971	372570	33133	33834	34749	38206	1.04	1	0.99	0.98	47210	NA
1997	262295	257109	264782	285820	28370	29058	30159	32754	1.12	1.09	1.07	1.05	42465	NA
1998	432554	404815	442624	455526	22678	23128	24263	26663	1.04	1.02	0.99	0.98	35060	NA
1999	213948	195468	194503	194580	26026	26192	27521	29476	1.03	1	0.97	0.96	39814	348.6
2000	192163	181903	188451	191701	28722	29584	31072	33702	0.97	0.93	0.89	0.87	42026	82.6
2001	354782	330532	341444	322558	34027	35305	37579	40631	0.8	0.77	0.74	0.73	36675	NA
2002	281646	270503	283554	270911	34673	35900	38038	40604	0.86	0.83	0.81	0.8	40107	NA
2003	163911	165862	166422	168452	35009	35928	37645	39390	0.87	0.85	0.83	0.81	43162	2109.804
2004	343418	334295	353808	345319	40085	40313	42041	42632	0.87	0.86	0.84	0.84	46417	2552.443
2005	221999	220471	225848	225931	38523	38511	40388	40352	1.02	1.01	0.97	0.97	46550	4675.8487
2006	296671	298164	314644	318944	30822	31263	33098	33459	0.92	0.9	0.85	0.84	41467	1816.1534
2007	453127	449780	475432	478091	36353	37475	39973	41155	0.82	0.79	0.74	0.71	45028	2191.4212
2008	756719	767920	788799	815291	41909	44053	47838	50457	0.68	0.64	0.59	0.55	47739	3247.73
2009	251180	261584	264351	282363	62188	66402	73138	78886	0.57	0.52	0.47	0.43	58818	10589.773
2010	267234	279991	284950	307392	114775	123017	134671	146875	0.42	0.39	0.36	0.32	72799	9977.6677
2011	274040	312260	302532	356010	190397	205834	223108	246860	0.33	0.3	0.28	0.25	87540	14155.978
2012	527664	585479	598105	688862	215395	237835	257901	293024	0.27	0.24	0.23	0.2	85677	12680.2225
2013	392229	443254	427622	504018	218143	247908	267768	314446	0.26	0.23	0.22	0.19	77753	15886.1017
2014	230026	253680	252090	290834	233524	275296	292309	357056	0.25	0.21	0.21	0.17	89940	9913.4663
2015	239321	293414	263908	337746	277274	337621	351206	444285	0.23	0.19	0.19	0.15	93670	9820.384
2016	411718	519460	474835	623063	312407	391489	399672	521234	0.24	0.2	0.2	0.15	109106	12740.653
2017	310754*	311458*	319175*	340742*	297848	390339	391272	533085	0.26	0.2	0.21	0.15	104671	7385.5581
2018	310754*	311458*	319175*	340742*	277482	386119	374655	538562	0.22	0.16	0.17	0.12	89671	6512.439
2019	310754*	311458*	319175*	340742*	285371	417487	389864	584757						
2020					276565	412152	380807	584095						



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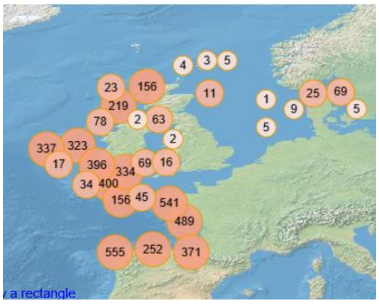

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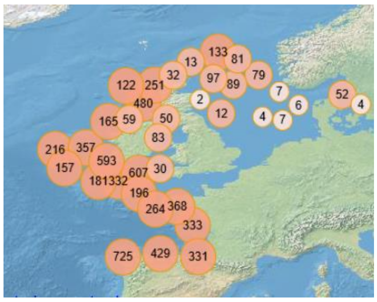

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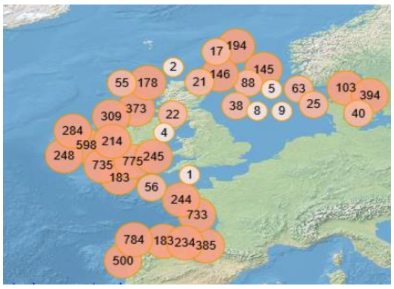

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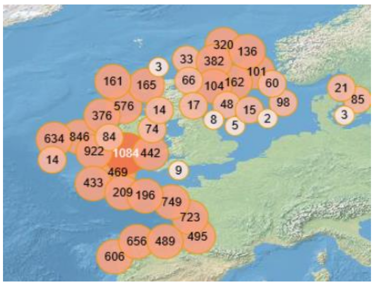

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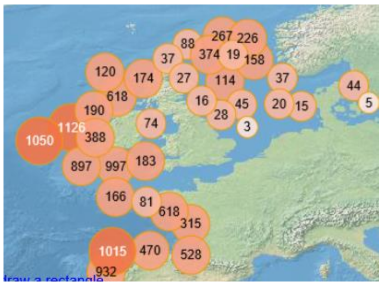

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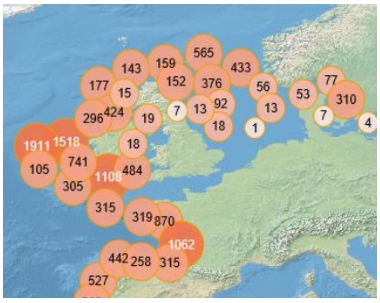

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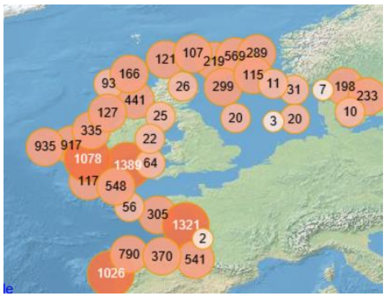

2016

Figure 1 *Abundance and range changes in northern European hake stock 2000-2016. Numbers of hake per survey haul for bottom trawl surveys taking place in 27.3.a, 27.4, 27.6, 27.7 and 27.8. (Extracted from ICES 'Fishmap' website 8th April 2020.)*

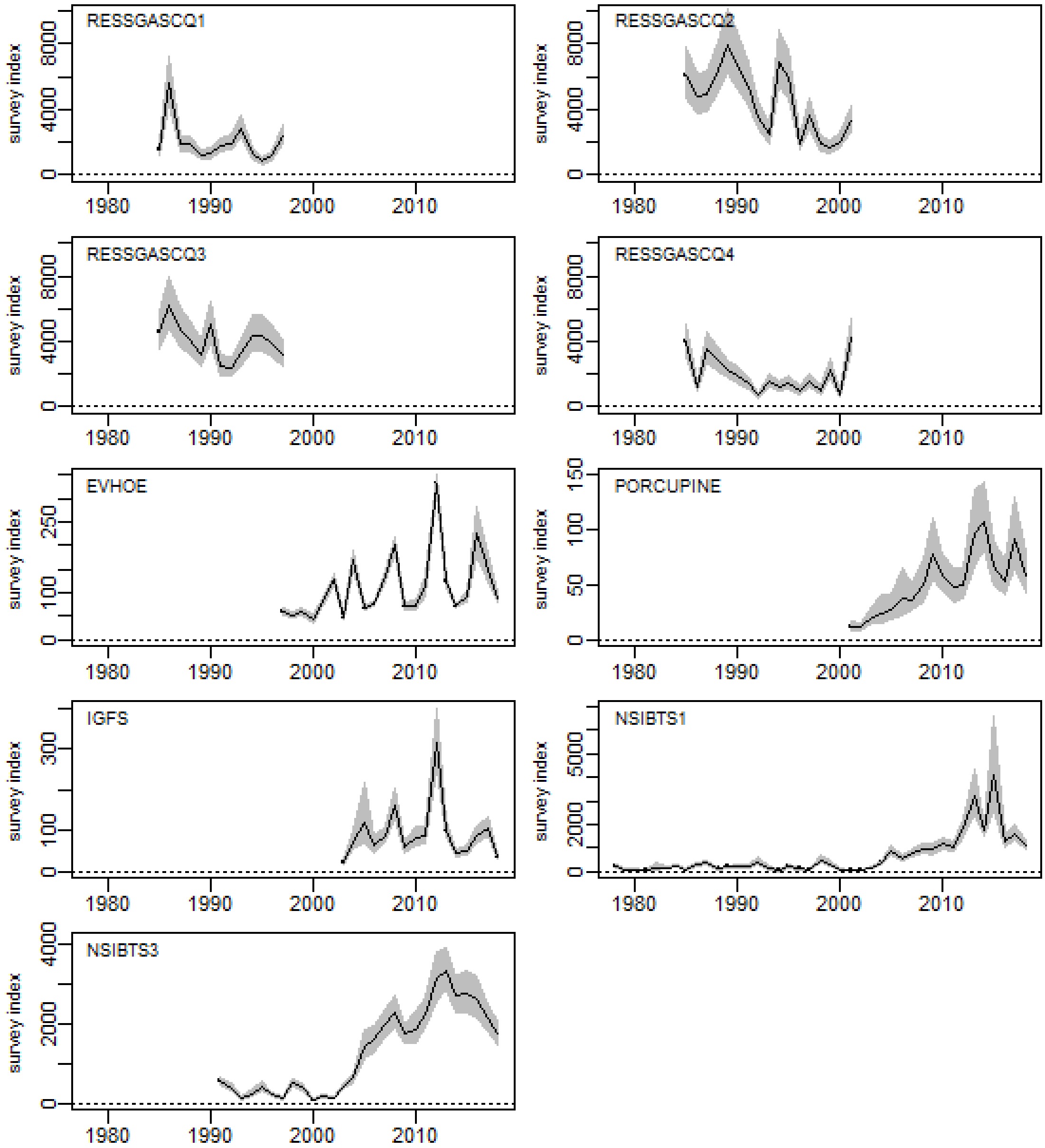

***Figure 2** Survey abundance indices, with 95% confidence intervals, for the surveys being considered in this study: RESSGASC, quarters 1-4; EVHOE; SpPGFS(PORCUPINE); IFGS; NS-IBTS-Q1 and NS-IBTS-Q3.*

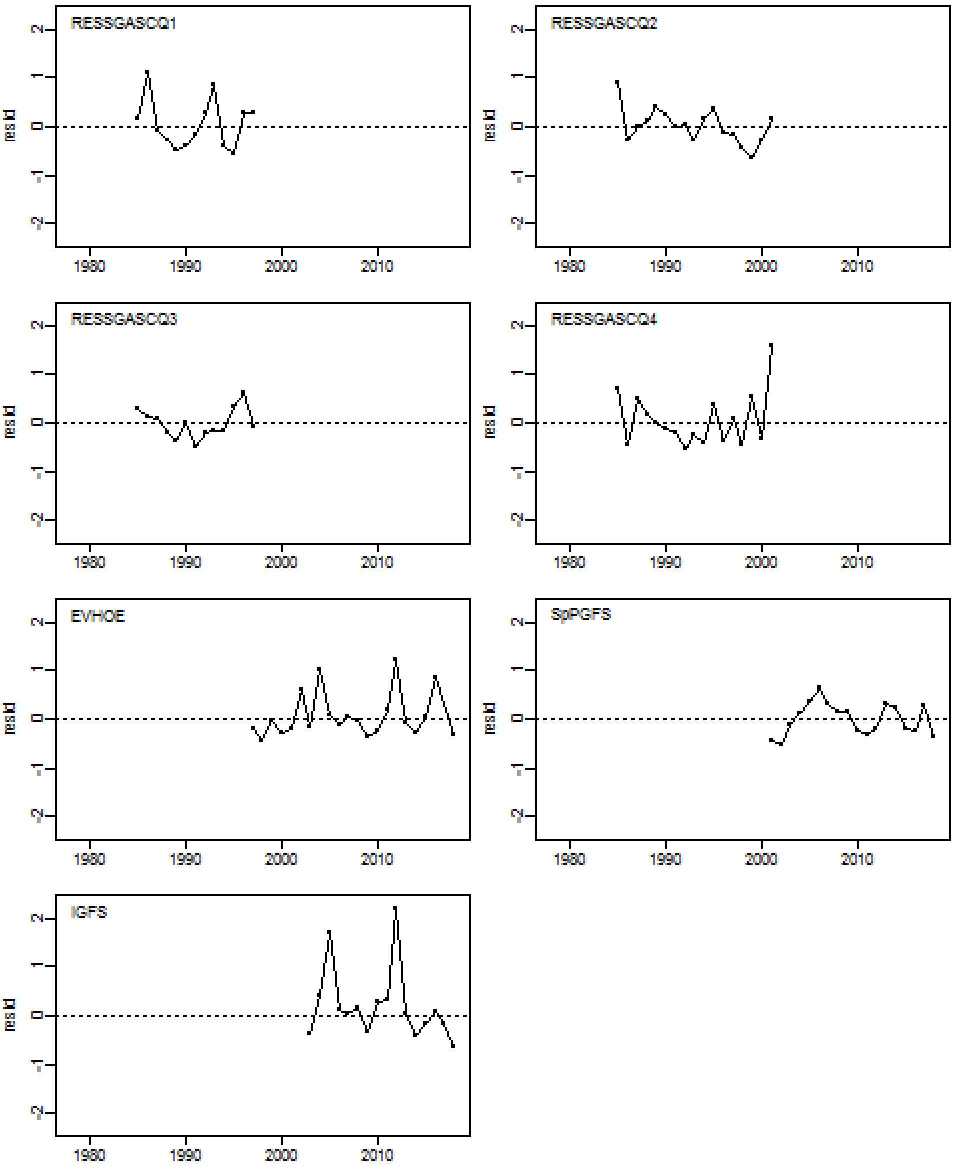

Figure 3a *Residuals of the fits to the surveys log(abundance indices) for the model presented by WGBIE 2019. For RESSGASC, fits are by quarter. Residuals of the fits to the current survey indices.*

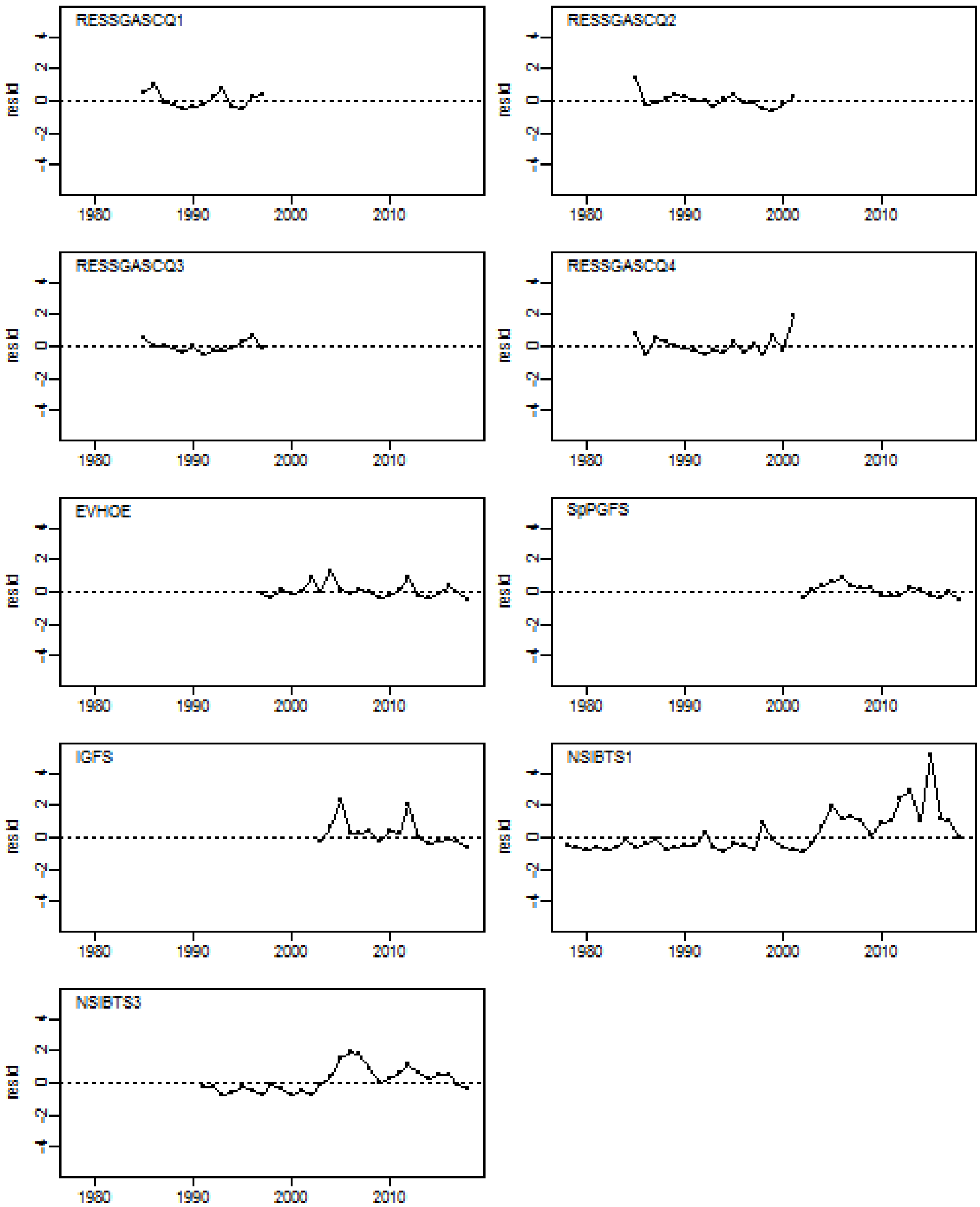

Figure 3b *Residuals of the fits to the surveys log(abundance indices) for the model fitted to a dataset including NS-IBTS-Q1 and NS-IBTS-Q3 data. For RESSGASC, fits are by quarter.*

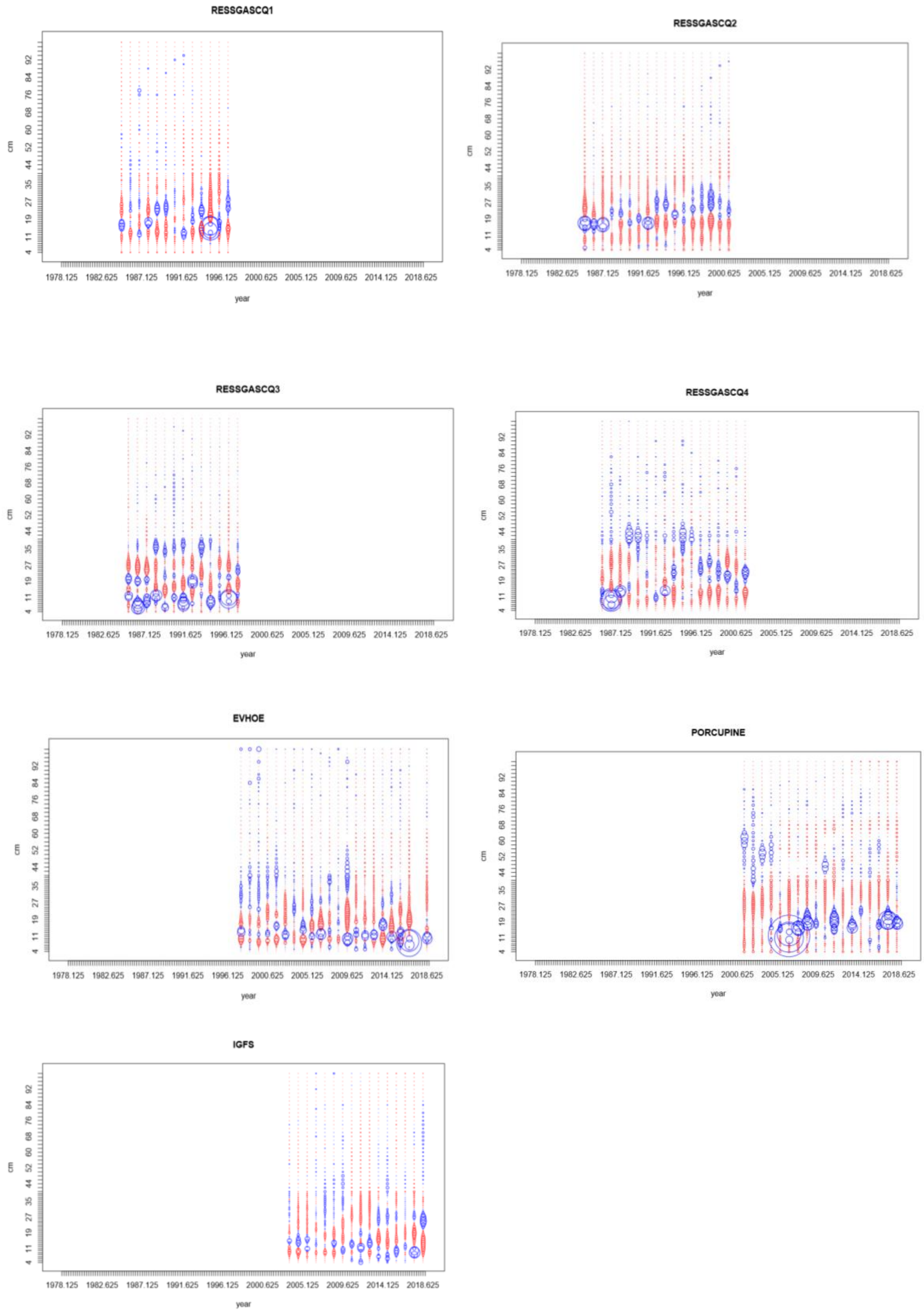

Figure 4a *Pearson residuals of the fit to the length distributions of the surveys abundance indices for the model used by WGBIE 2019. For RESSGASC, fits are by quarter. Blue and red denote positive and negative residuals, respectively.*

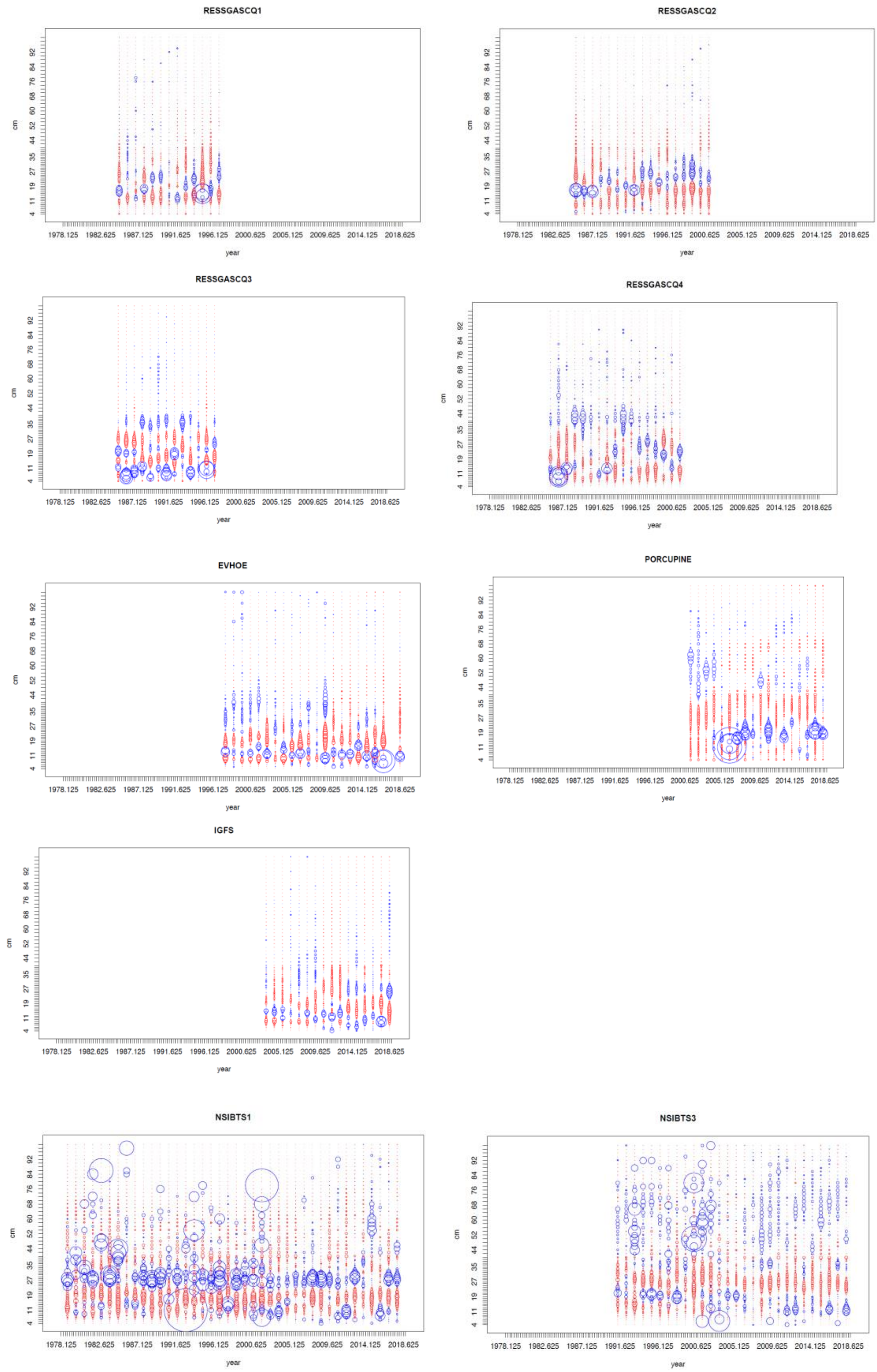

Figure 4b *Pearson residuals of the fit to the length distributions of the surveys abundance indices for the model fitted to a dataset including NS-IBTS-Q1 and NS-IBTS-Q3. For RESSGASC, fits are by quarter. Blue and red denote positive and negative residuals, respectively.*

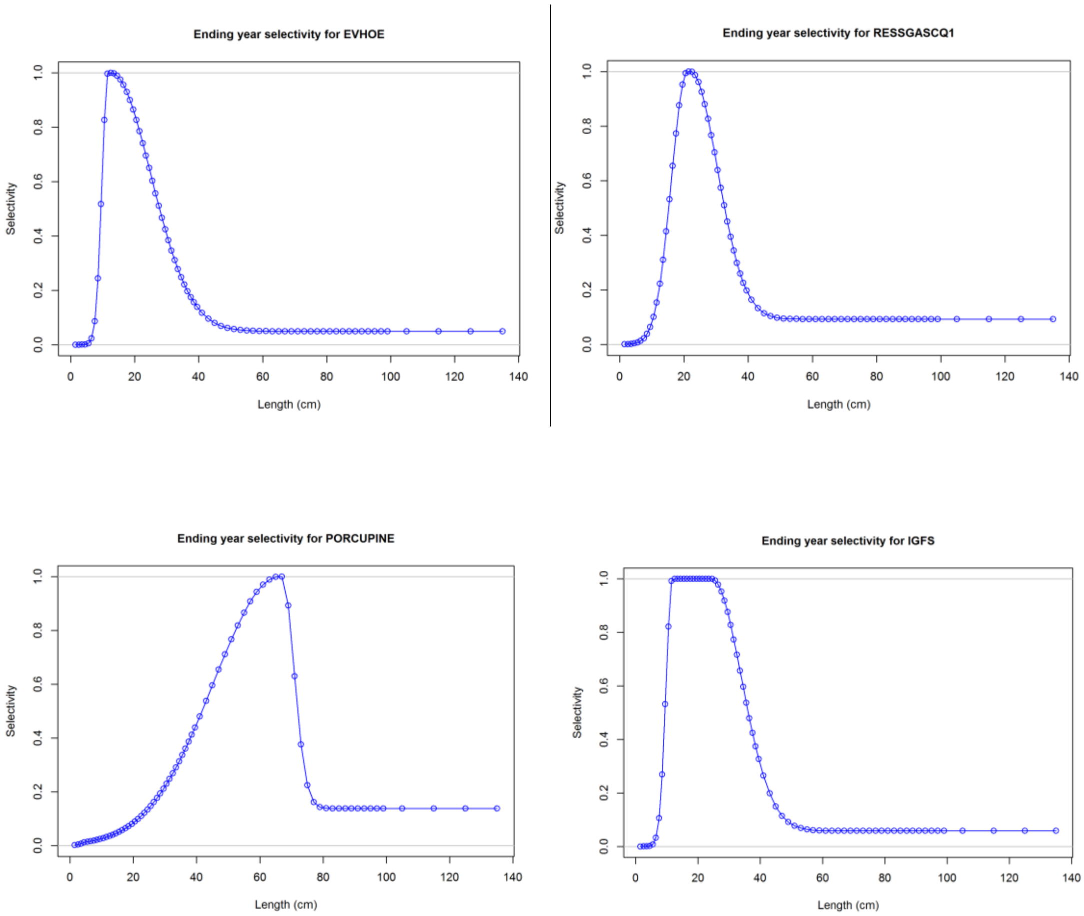

Figure 5a *Selection patterns at length for surveys, estimated by SS3, for the model fitted to the model used by WGBIE 2019.*

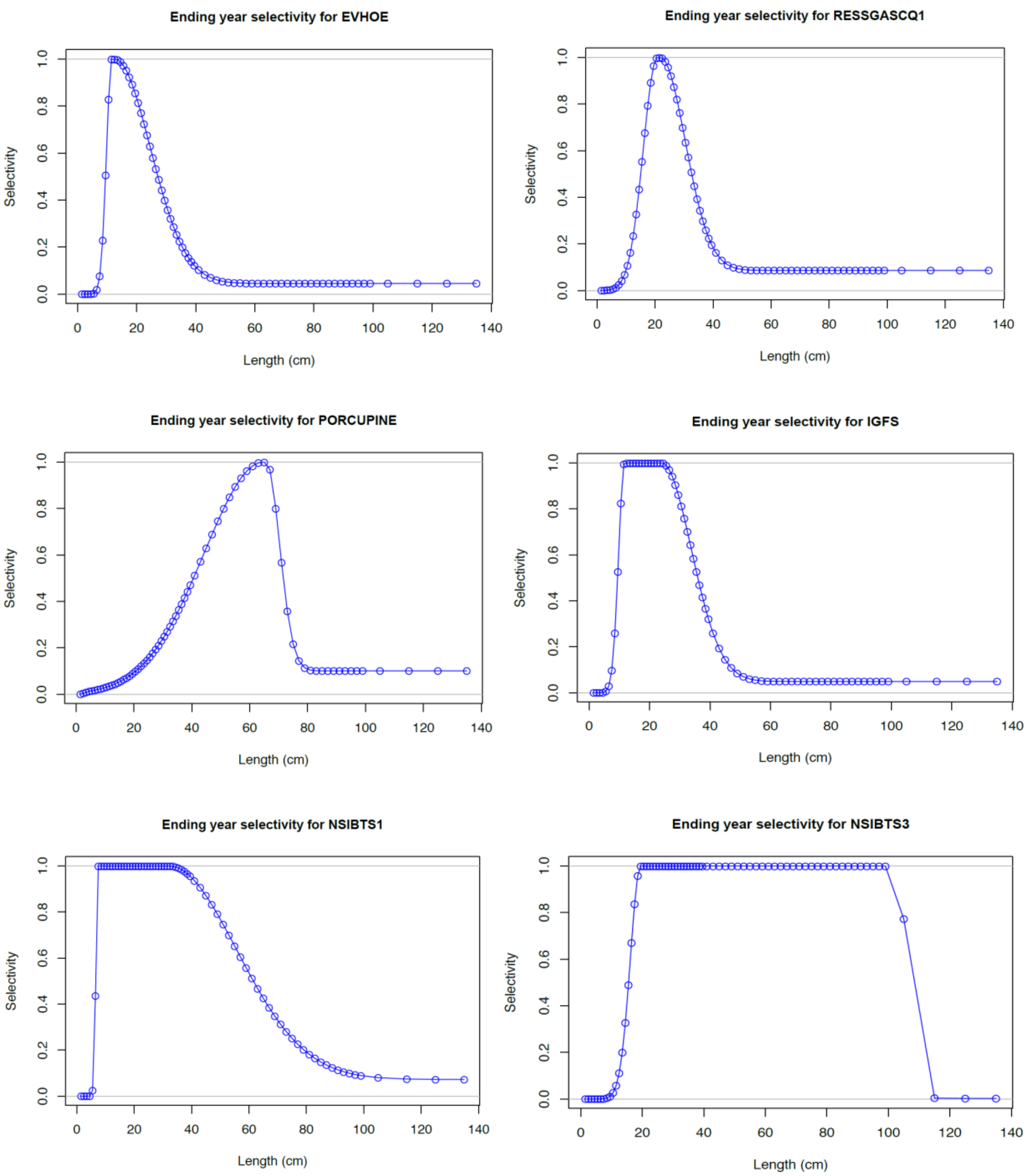

Figure 5b *Selection patterns at length for surveys, estimated by SS3, for the model fitted to the model fitted to a dataset including NS-IBTS-Q1 and NS-IBTS-Q3.*

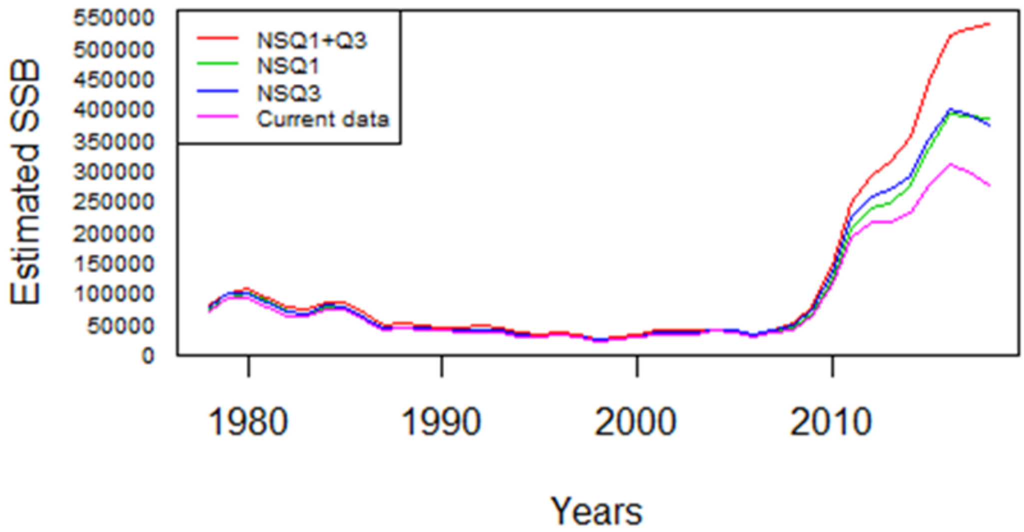

Figure 6 *Estimated spawning stock biomass (SSB) estimates, in tonnes, from 1978 to 2018, for the 4 alternative models: the model currently used in the assessment ("current data" - violet), the model fitted to data including NS-IBTS-Q1 (NSQ1 – green), the model fitted to data including NS-IBTS-Q3 (NSQ3 – blue) and the model fitted to data including both NS-IBTS series (NSQ1+Q3 – red).*

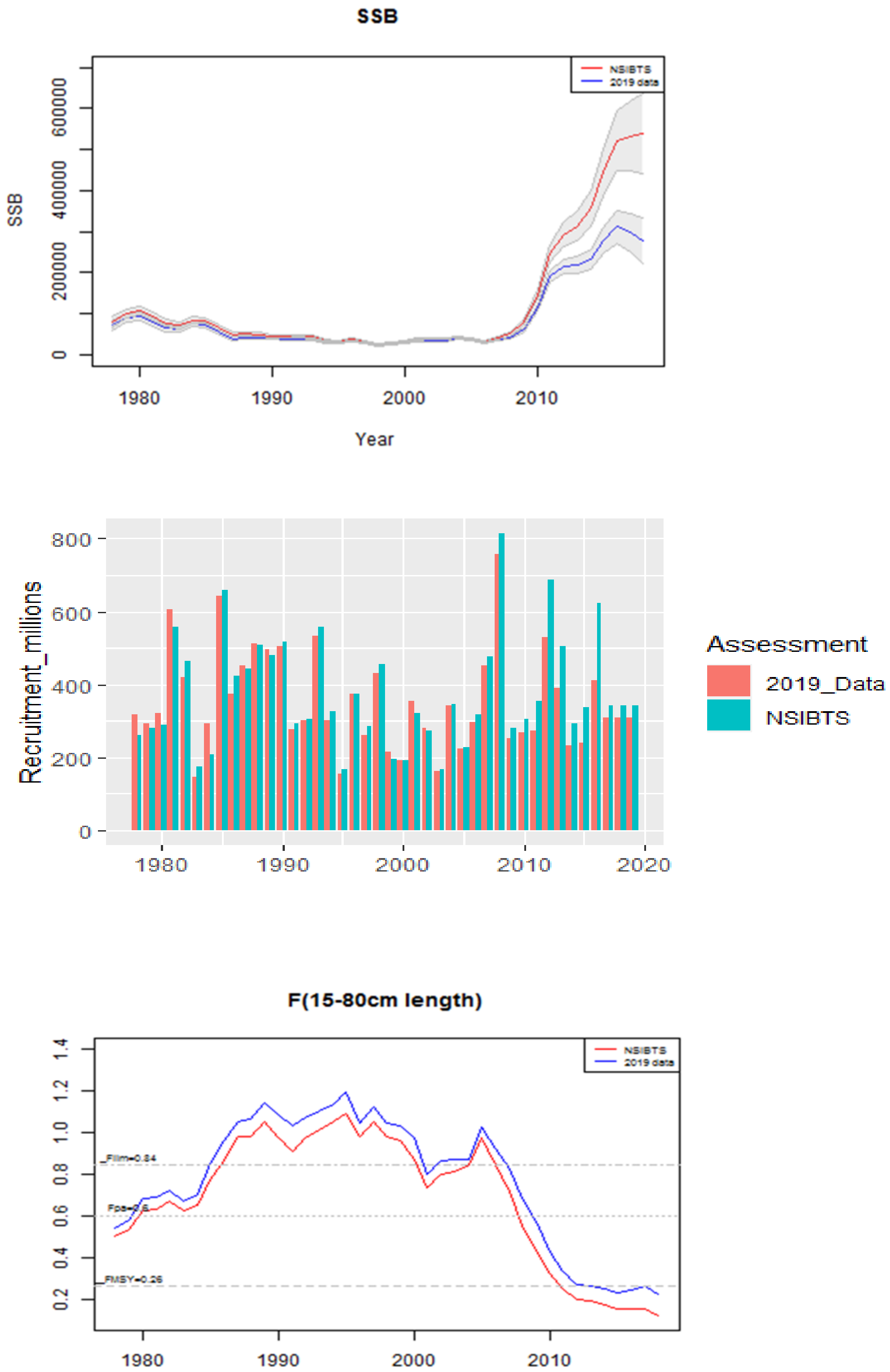

Figure 7 *Stock status indicators from 1978 to 2018 for the WGBIE 2019 model (2019 data – red) and the model fitted to data including the two NS-IBTS series (NSIBTS – blue). Top panel – estimated SSB (tonnes) with 95% confidence intervals; middle panel – recruitment (total numbers); bottom panel – mean fishing mortality (F) averaged over lengths 15-80 cm.*

Appendix 1

The survey abundance CPUE index at length l, $\widehat{N}_l$, is given by:

$$\widehat{N}_l = \sum_{r=1}^{m} \hat{n}_{l,r} = \sum_{r=1}^{m} \frac{1}{m_r}\left(\sum_{h=1}^{m_r}\left(\frac{t_e}{t_h} n_{l,h}\right)\right) \quad (6)$$

where $n_{l,h}$ is the observed number of hake at length l in haul h, t_h is the duration of haul h, t_e is the expected duration of the hauls, m_r is the number of hauls in rectangle r, $\hat{n}_{l,r}$ is the mean CPUE of hake at length l in rectangle r, and m is the number of rectangles in the survey area. Similarly, the total abundance CPUE index, $\widehat{N}$, is given by:

$$\widehat{N} = \sum_{r=1}^{m} \hat{n}_r = \sum_{r=1}^{m}\left(\frac{1}{m_r}\sum_{h=1}^{m_r}\left(\frac{t_e}{t_h} n_h\right)\right) \quad (7)$$

where n_h is the observed number of hake in haul h and $\hat{n}_r$ is the mean CPUE of hake per haul in rectangle r. Then the estimated variance of $\widehat{N}$, $\widehat{\sigma_N^2}$, is given by:

$$\hat{\sigma}_N^2 = \sum_{r=1}^{m} \hat{\sigma}_{\hat{n}_r}^2 = \sum_{r=1}^{m}\left(\frac{1}{m_r}\frac{1}{m_r-1}\sum_{h=1}^{m_r}\left(\frac{t_e}{t_h}(n_h - \bar{n}_r)\right)^2\right) \quad (8)$$

where $\bar{n}_r$ is the mean number of obsverved hake per haul in rectangle r.

Information on Soleidae species landings from mainland Portugal

David Dinis, Catarina Maia, Ivone Figueiredo and Ana Moreno

Portuguese Institute for Sea and Atmosphere, I. P. (IPMA, IP)

Avenida de Brasília, 1449-006 Lisboa

PORTUGAL

Summary

The present working document summarizes the information on Portuguese Soleidae species landings for the period 2017-2019 The document is structured in the following sections: a) landing statistics for different landing ports and; b) evaluation of species misidentification base on DCF/PNAB biological sampling

A) Portuguese landing statistics for Soleidae

From 2017 to 2019, Soleidae species have been landed under four different commercial denominations: 'Linguado legítimo', 'Linguado-branco', 'Linguado da areia' and 'Linguados nep' which are considered to correspond to *Solea solea* (SOL)*, Solea senegalensis* (OAL), *Pegusa lascaris* (SOS) and *Solea spp.* (SOX), respectively.

According to official statistics, 'Linguado legítimo' accounted for 76% in 2017, 81% in 2018 and 73% in 2019, of the total Soleidae species landings. For that period the three major ports in terms of annual landed weight of Soleidae species were Peniche, Aveiro and Viana do Castelo (Figs. 1 and 2) (for detail see table in Annex A).

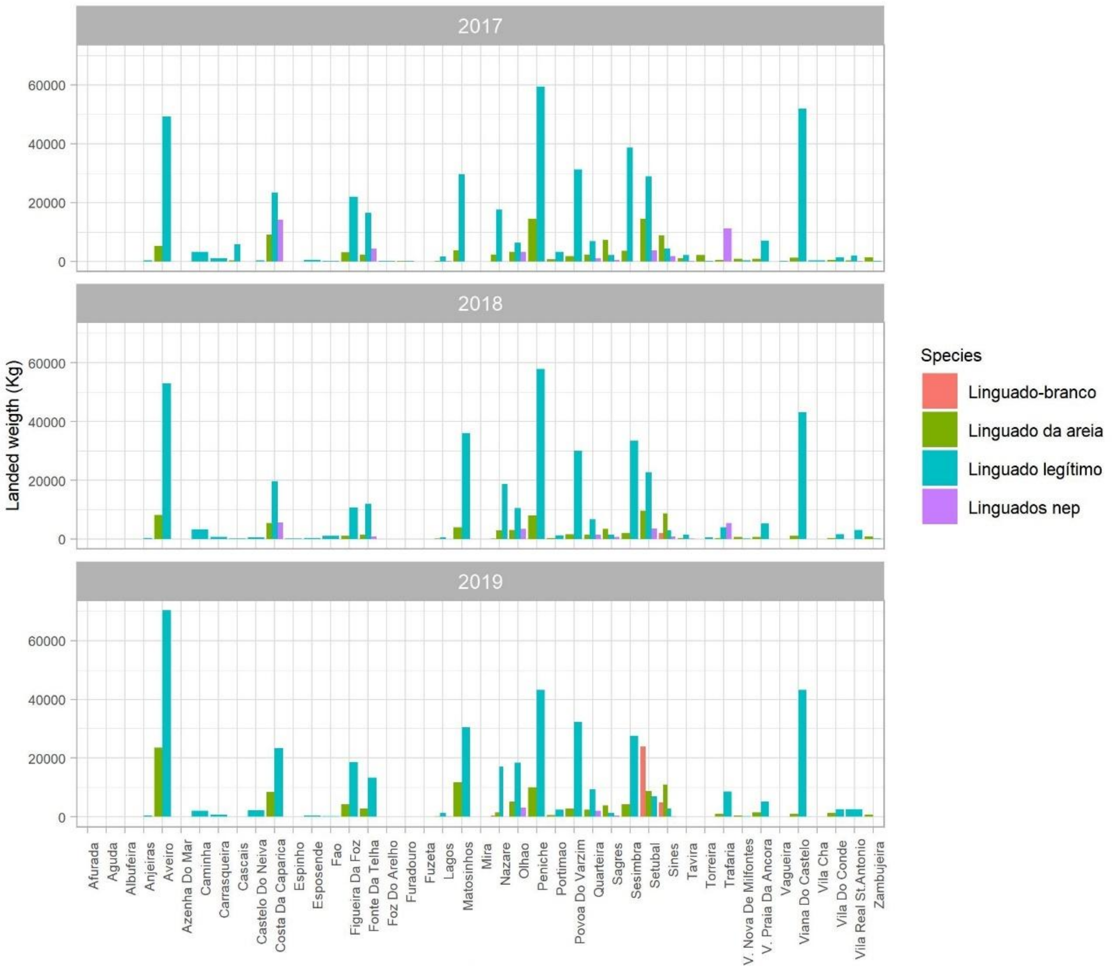

Figure 1: Official landings (kg) of 'Linguado legítimo', 'Linguado-branco', 'Linguado da areia' and 'Linguados nep' per landing port for the period 2017-2019. Source: Portuguese Directorate-General for Natural Resources (DGRM).

B) Evaluation of Soleidae species misidentification in landing ports

Biological sampling conducted in several landing ports along the Portuguese continental coast (Fig. 2) and held under the National Data Collection Programme (DCF/PNAB) for the period 2017-2019 was analysed. For each landing port and year, the biological sampling data were compared with the corresponding official landings. Note that Soleidae species were sampled in 17 landing ports along the Portuguese continental coast, but due to the reduced number of samples for some of them, the present analysis was restricted to: Póvoa de Varzim, Matosinhos, Aveiro, Peniche, Costa da Caparica, Sesimbra and Setúbal (for detail see Annex B). This comparison was used to evaluate Soleidae species misidentification in official landings.

The adopted procedure consisted on the estimation of the proportion of each species identified under the DCF/PNAB program for each commercial denomination (i.e., 'Linguado legítimo', 'Linguado-branco', 'Linguado da areia' and 'Linguados nep'). The results of the analysis are presented by landing port and year.

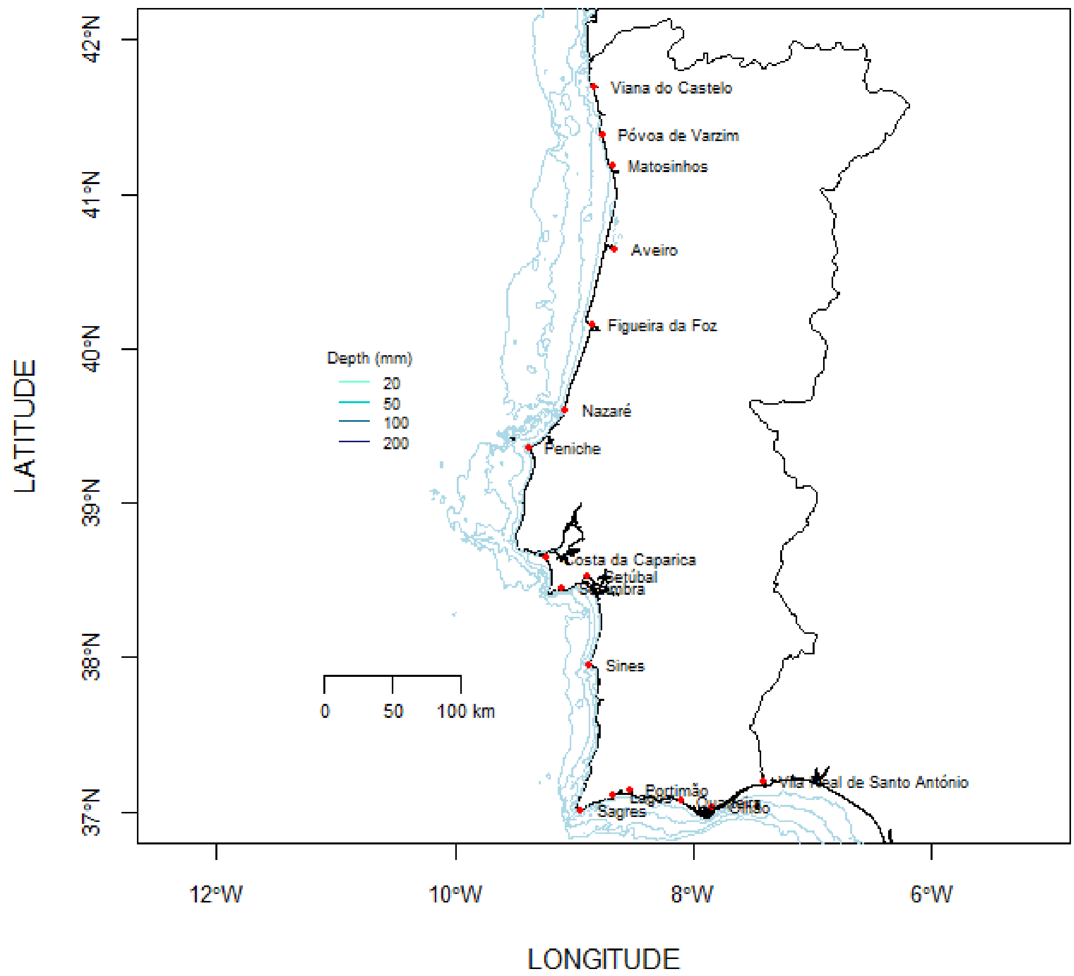

Figure 2: Map of the landing ports covered by DCF/PNAB sampling program from where samples were collected.

The present analysis shows the existence of species misidentification problems in official landings of Soleidae as mentioned previously by Moreira and Moreno (2013).

The results obtained in the DCF/PNAB program indicate that landings under the commercial denomination 'Linguado legítimo' are the ones showing higher problems attaining >70% of misidentification in some of the addressed landing ports (Fig. 3). This is likely to imply that the official landings may be biased towards a higher value of *S. solea* landings. For 2017, 2018 and 2019, 'Linguado legítimo' represented 79%, 82% and 74% of Soleidae species in official landings, respectively, while the present results based on DCF/PNAB sampling data, suggested a lower representativeness of *S. solea* in Portuguese landings (Fig.3).

S. senegalensis is the main misidentified species, being often landed with the commercial denomination of 'Linguado legítimo' (Fig. 3). This species was frequently sampled under the DCF/PNAB program but presents extremely low records in official landings. Historically, the commercial denomination 'Linguado-branco' is not used in Portuguese landing ports (Moreira and Moreno, 2013) and only recently started to appear in landing statistics (in particular in Nazaré, Setúbal and Sines), although still not reflecting the real landed values of the species.

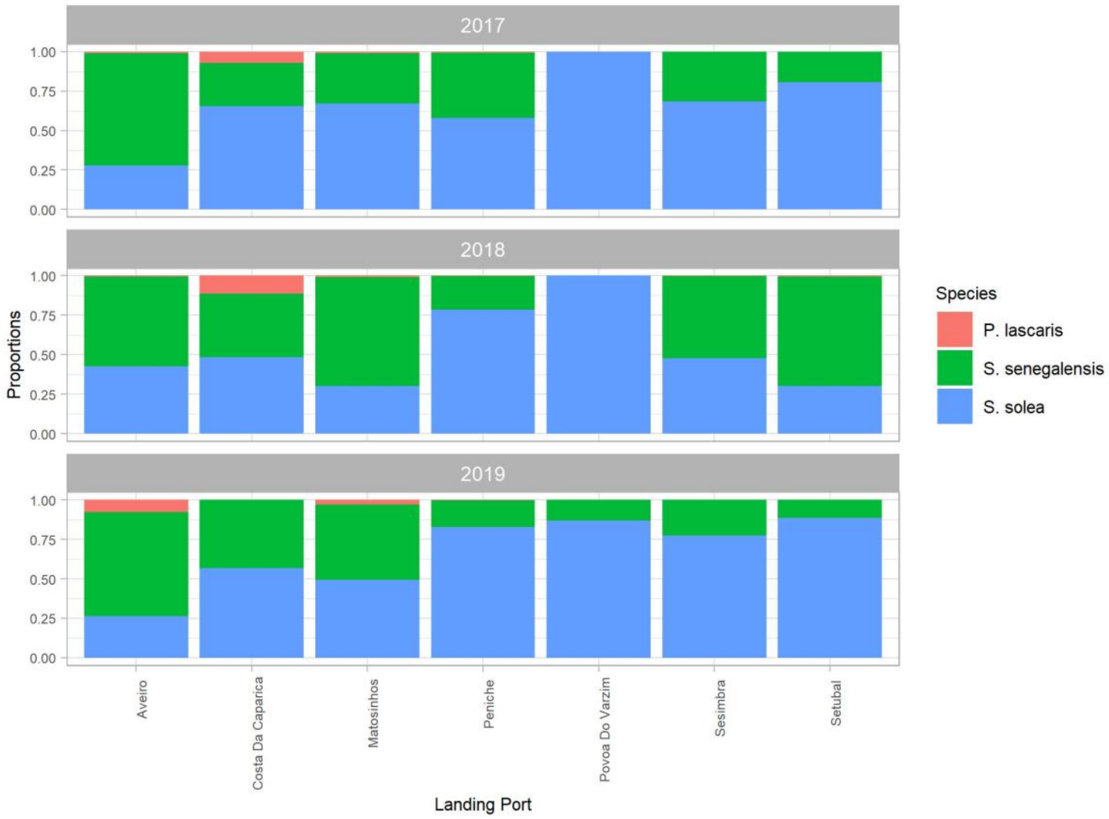

Figure 3: Proportion of each Soleidae species landed under the commercial denomination 'Linguado legítimo'.

On the other hand, regarding the commercial denomination 'Linguado da areia', DCF/PNAB sampling analysis indicates that official landing data may be considered reliable in relation to species correct identification as *P. lascaris* (Fig. 4).

Additionally, DCF/PNAB sampling analysis indicates that official landings under the commercial denomination 'Linguados nep' correspond mainly to *S. solea* with a small proportion of *S. senegalensis*. Nevertheless, the landings under the 'Linguados nep' denomination have a relatively low representativeness in Portuguese official landings of Soleidae species.

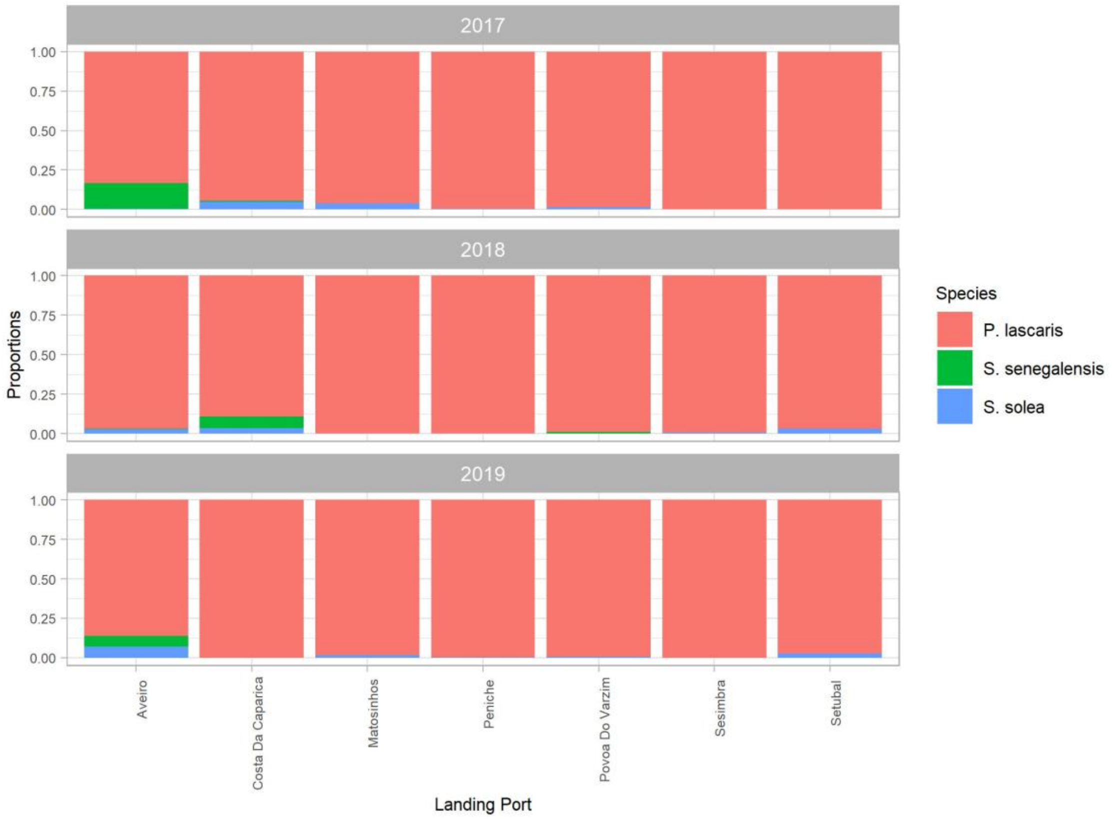

Figure 4: Proportion of each Soleidae species landed under the commercial denomination 'Linguado da areia'.

Conclusion

This work presents a preliminary analysis of Soleidae landings and evaluate its adequacy to provide landings statistics at species level. The misidentification errors detected (up to 71% misidentification of *S. solea* annual landings in some ports) renders the use of official data to follow landing trends and its use on exploratory stock assessment assays. The analysis made so far based on DCF/PNAB data, did not entered consideration the variable fishing gear which may imply differences in Soleidae species composition and thus rending the extrapolation more complex. Furthermore, official data does not include information on fishing gear(s) used by trip and logbooks are not available for all fishing vessels (only vessels with LOA larger than 12 m are obliged to fill logbooks) and they also contain species misidentification errors.

Given the heterogeneity of Portuguese fishing fleets, particularly the polyvalent fleet, a proper estimate of landings by species should take into consideration the different types of gears catching Soleidae species, as well as fishing seasonality and grounds. All these factors had been proved to influence species catches (Moreira and Moreno, 2013).

The analysis of the field sampling data available, showed that the ongoing sampling program does not cover properly Soleidae landings along the Portuguese continental coast - lower or unbalanced number of sampled trips throughout the years and regions. A robust estimation of species-specific landings will imply a specific sampling program for Soleidae.

References

Moreira, A. M. and Moreno A. (2013) Sole, *Solea solea*, in Portuguese waters (ICES div. IXa). Working Document presented at ICES Working Group on Assessment of New MoU Species (WGNEW), Copenhagen, 18-22.

Annex A

Official statistics landed weight (kg) of Soleidae species per landing port and year. Source: Portuguese Directorate-General for Natural Resources (DGRM)

Landing Port	2017			2018				2019			
	Linguado da areia	Linguado legítimo	Linguados nep	Linguado da areia	Linguado-branco	Linguado legítimo	Linguados nep	Linguado da areia	Linguado-branco	Linguado legítimo	Linguados nep
Afurada		10				13				9	
Aguda		11				14		4		30	
Albufeira	10,8	9,6				7					
Anjeiras	13,8	288,7		43,8		278,7		26,4		471,8	
Aveiro	5228,3	49212,1		8102,2		52934,9		23462,9		70297,8	
Azenha Do Mar	6,8	1,6		29		24,5		7			
Caminha		3166,7				3251,8				2081,1	
Carrasqueira		1086,3				658,4				757	
Cascais	260,6	5681,1	3,2			132,4					
Castelo Do Neiva	9	334				452,3				2235,8	
Costa Da Caparica	9088,5	23442,4	14115	5386,8		19611,2	5598,1	8356,6		23360,4	
Espinho						165				70,2	
Esposende		408,5				442,5				378	
Fao		82,5				1002				172	
Figueira Da Foz	3089,2	21951,8		1087,4		10784,4		4243,1		18651,5	
Fonte Da Telha	2349,1	16450,4	4226,9	1372,5		12033,8	987,7	2809		13403,7	
Foz Do Arelho		32									
Furadouro	42	79				3,5				69,5	
Fuzeta				10,9		1		71,8		14,7	
Lagos	154,7	1605,9	50,4	124,8		589,1	60,8	184,1		1343,2	198
Matosinhos	3669,2	29617,1	2,2	3910,4		36012,3		11630,1		30428	
Mira		6,8				3,2					
Nazare	2357,7	17498,7	8	2872,5	149,2	18807,1		1550,3	369,7	17119,3	8,9

Olhao	3206,5	6255,8	3164,8	3078,6		10637,8	3455,4	5222,3		18362,7	3164
Peniche	14433,2	59402,1		7988,8		57915		9999,3		43259,4	
Portimao	724,3	3185,1		422,5		1341,8		632,5		2378,1	
Povoa Do Varzim	1803	31256,2		1570,2		30034,8		2872,9		32291,6	
Quarteira	2336,6	6915,9	1103,8	1538,9		6743,5	1518,6	2459,4		9414	2055,7
Sagres	7189	2141,3	560,1	3457,2		1495	768,4	3951,2		1294,2	400,7
Sesimbra	3517,3	38752,6	4,4	2038,2		33534,3		4212,2		27480,9	
Setubal	14447,5	28781,2	3753	9638,1		22765	3632,9	8809,5	23887,6	7060,5	
Sines	8803,3	4251,1	1696,2	8734,6	2041,8	2965,9	890,9	10962,5	4988,5	2708,9	198,4
Tavira	935,1	2121,2	116,6	438,1		1431,2	146,3				
Torreira	2096,4	95		4,5		486,2		4,5		147,5	
Trafaria	500,8		11212,1	341,3		4052,3	5428,8	896,1		8630,2	
V. Nova De Milfontes	764,4	202,5		666,3		123,9		427,8		175,1	
V. Praia Da Ancora	749,5	6935,4		749,3		5350,5		1442,4		5203,7	
Vagueira	6	58				30				69	
Viana Do Castelo	1191,8	51923,5		1010,2		43187,5		1032,1		43109,6	
Vila Cha		220				23				39,5	
Vila Do Conde	432,9	1430,8		439,2		1655,6		1376,4		2671,5	
Vila Real St.Antonio	210,7	1977,6	21,7	9,1		3130				2531,6	
Zambujeira	1367,1	184,9		996,7		118,5		827,3		127,4	
Total	90995,1	417066,4	40038,4	66062,1	2191	384243,9	22487,9	107473,7	29245,8	387848,4	6025,7

Annex B

Number of DCF/PNAB sampled trips with landings of Soleidae species per landing port and year

Landing port	2017	2018	2019
Aveiro	68	51	37
Matosinhos	39	39	42
Póvoa de Varzim	11	16	20
Costa da Caparica	25	13	9
Peniche	84	90	87
Sesimbra	15	29	25
Setúbal	8	15	20